DESCRIPTION OF THE DATA BASE AND GENERAL OBSERVATIONS

ANALYSIS OF VARIABLES ASSOCIATED WITH THE OCCURRENCE OF ELECTRIC AND MAGNETIC FIELDS WHICH MAY CONTRIBUTE TO LOW PRODUCTIVITY OF DAIRY ANIMALS

Submitted to:

The Low Livestock Productivity Advisory Board

Submitted by:

Dataright, Inc.
Milaca, Minnesota

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LEGISLATIVE REFERENCE
STATE OF MINNESOTA

PROJECT CONTRIBUTORS

The research described in this report benefited from the contributions of a number of organizations and individuals. Major commitments of professional service time were donated by Dr. Dan Hartsell and the Alexandria Veterinary Clinic, Alexandria, Minnesota. Mr. Jerry Martens and Ottertail Power Company, Fergus Falls, Minnesota also contributed professional time and provided access to specialized equipment to aid the monitoring efforts. Of particular importance was the cooperation received from the operators of the study farms which was without compromise in all cases. Farm schedules were routinely interupted to aid project efforts and all requests for farm record maintenance and access were readily met without exception. Dr. Dennis Johnson at the University of Minnesota, Morris, Minnesota was very helpful in gathering information at that location as were personnel responsible for daily operation of the dairy barn. Dataright, Inc. is keenly aware of the contributions that individuals have made allowing a data base of the scope included here to be assembled and their efforts based on interest and in lieu of compensation are very much appreciated.

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1. PROJECT OVERVIEW

This research was initiated in response to a request for proposal issued by the Low Livestock Productivity Board as administered by the Minnesota Department of Agriculture. The objective of this work, as outlined in the request for proposal, was to " ...establish the causes which continue to bring on low livestock productivity and poor animal health which may be related to other than traditional stray voltage."

On January 11, 1988, Dataright, Inc. submitted a proposal which named the scope of a preliminary research effort directed "...toward the identification and selection of key variables which can be shown to be associated with low animal productivities." This proposal identified funding limitations in conflict with a causality based approach to this work and identified its objective as providing "... an assessment of the nature of the problem and to support its refined definition, rather than to attempt it's resolution."

The proposal concluded by offering the following products:

1. A review and summary of the data gained from the analysis of the records from the Joe Kenning farm.
2. Literature citations as reviewed to support this research.
3. A record and statistical interpretation of the data gained from field measurements on study farms.
4. A record of the soils, topography, water resources and local electrical distribution for each of the study farms.
5. A summary of the research experience.

This proposal as submitted by Dataright, Inc. was accepted and approved by the Low Livestock Productivity Board on January 19, 1988, and a contract was issued to begin these studies on March 3, 1988.

This report presents the outcomes of the project tasks in accord with the products detailed in the proposal. It is important to realize that the research proposed by Dataright, Inc. required the development of a measurement system and data acquisition technology in order to collect the quantity and quality of information needed to support this kind of evaluation. Consequently, this work has proceeded in three major phases; system development, on the farm monitoring and analysis. Within this format there were, by resource and personnel necessity, significant priority decisions required. Foremost was the refinement and development of a high quality microcomputer based hardware and software system capable of continuous measurement and recording of analog signals by conversion to a digital format as needed for subsequent statistical evaluation. Second, was the need to collect as much related data as was possible relevant to

the operations of the farms studied. The final priority was the analysis of the data base. This approach was preferred because it allowed subsequent activity and information development whereas neglect of either of the first two would pre-empt further consideration.

As the data record presented in this report now stands, we believe it represents the most comprehensive evaluation of the electrical environment that has been attempted for any purpose at a singular location.*

We encourage further consideration of this information within the aforementioned context. We feel the previous lack of success in resolving this problem on the farms we studied is due largely to the failure to acknowledge the potential complexity of the issue. There is a certain determination of scientific investigators to employ the tools of inquiry in which they are versed and then claim that problems which continue beyond that point are either non-real or in another causal domain. This approach has encouraged the development of an adversarial environment that is without utility. Many of the on farm investigations have only pursued a problem that is limited to contact potentials or "stray voltage", and not considered important unless these potentials exceed 300 to 500 millivolts. This is a very narrow consideration of the electrical environment that ignores immune system effects which have been associated with factors such as current densities and leukemia in humans(30). Meanwhile, the farm operators, often with decades of experience on the same farm, are offended because their anecdotal claims are not heard and they then fail to apply management advice which may have benefited their operation, even though a continuing electrical problem existed.

This adversarial contest has resulted in a spiral of declining profitability for problem farms. The farmer confronts a production problem that will not respond to his previous (and in all cases reviewed here successful) management experiences. The investigators work to mitigate a "stray voltage" condition. The on farm production experience typically improves, then declines. The investigation then points to management practices that should benefit productivity. The farmer does not implement these suggestions, because his previous experience indicated that the herd will not respond to the additional investment and his current and declining economy will not sustain the investment. There are numerous reports of dairy farm failures which follow this scenario.

* Literature authored in Russian was not reviewed, but per review of English abstracts we would expect that comparable non public domain studies have been done bearing on the welfare of individuals exposed to non power frequency fields. The reader is referred to the reference listing (Appendix G) relevant to sources of additional information.

This report is offered as a working or transition document. It is an introduction to the database and the scope of the investigation. It should not be considered a "final report in the traditional sense. Rather, it should be reviewed and considered as a scientific invitation to a further consideration of these data as they relate to the resolution of problems experienced by dairy farmers in Minnesota.

None of the variables examined appear to be directly, that is, singularly, associated with the productivity problems encountered on the study farms. We can not make this claim because we have conducted an exhaustive analysis, (although this is now possible) but rather because of the diversity of experience encountered. Management styles, soil types (but not the remarkably high managed soil fertility), topography, water resources, electrical service, ration quantity and quality, and herd management vary immensely between these farms. Yet, they almost uniformly report non-responsive problems with low production, nervous behavior, high replacement rates, breeding problems, swollen legs and joints, depressed immune systems, mastitis, and twisted stomachs. The anguish of these farmers is that they are experiencing a major decline in the profitability of their operation and that neighboring farms do not have these problems and that at a previous time, their own success equaled or exceeded that of other farms in their area.

Based on our work to date, it is apparent that deeper questions need to be asked. We have very little information in this report related to the distribution and occurrence of earth currents. Yet, the theory, and indeed the judicial experience, with these issues indicates an apparent need for these considerations. The reader is referred to:

Gönen, Turan, "Electric Power Distribution System Engineering," Mcgraw-Hill, Inc., 1986, p.322.

"Figure...shows a single-phase two-wire lateral with multigrounded common neutral. ...the neutral wire is connected in parallel (i.e., multigrounded) with the ground wire at various places through ground electrodes in order to reduce the current in the neutral wire. I_a is the current in the phase conductor, I_n is the return current in the neutral wire, and I_d is the return current in the Carson's equivalent ground conductor. According to Morrison [1], the return current in the neutral wire is

$$I_n = Z_1 I_a \quad \text{where } Z_1 = 0.25 \text{ to } 0.33$$

and it is almost independent of size of the neutral conductor."

"[1] Morrison, C.: "A linear Approach to the Problem of Planning New Feed Points Into a Distribution System," AIEE Trans., ;. III (PAS) December 1963, pp. 819-832."

The theory represented here indicates that 0.66 to 0.75 of the return neutral current flows through the ground back to the substation and it is observed that all of the farms studied are close to a line representing the shortest distance through the earth between what appear to be the most proximate substations (see Appendix B).

None of our data indicated that the problems reported on the farms studied are attached to an acute causality that will yield to a simple solution. However, many farms experiencing the more obvious "stray voltage" condition would.

In this report we make no claim that this information is conveniently packaged or that the analysis is complete. We do claim that the scope, quality and quantity of this information as represented in this report is necessary to further understanding. In that same regard, we acknowledge contributions of individuals and organizations who have provided services and equipment without compensation or at cost to benefit this inquiry.

Dataright, Inc.,
Milaca, Minnesota

June 15, 1989

2. FARM DESCRIPTION - BORGERDING

The Borgerding farm is located about one half mile west of central Freeport, Minnesota and is bounded on the east by residential property. Art Borgerding farmed this land with his father until 1961 when he purchased the property. His son Randy, who now represents the forth generation on this land, works with him on a full time basis. Their dairy operation is the sole of economy for this farm and all crop land is devoted to the production of dairy feed stocks. The principal crops are alfalfa and corn for silage and for high moisture shelled corn. The dairy barn has 52 stalls and is arranged for feeding from the center asile. This barn was expanded in 1978 from forty stalls to its current capacity. A feed room is attached to the south side of the barn and accomodates the discharge points for three sealed crop storage structures representing silage, haylage, and high moisture corn. High moisture corn is rolled as discharged and just prior to feeding. Barn cleaning is accomplished by delivery of manure to a holding pit equiped with a manure pump that discharges to a slurrystore structure adjacent to the barn. Cows are milked twice per day at 6:00 am and 6:00 pm and are typically let out of the barn after morning milking when the barn is cleaned.

Production problems have been experienced on this farm since the early in this decade. All of the principal stray voltage assessment groups in Minnesota have conducted studies on this farm excepting Ottertail Power Company. The electrical service for this farm is provided by Northern States Power Company. The owners have made efforts to bond interior barn conducting structures and tried without success various electrical isolation procedures. During 1987 more than seventy percent of the cows in this barn were open at one time and some of which had been bred more than four times. The principal operator of this farm has been engaged in dairying for more than thirty years and conditions such as this are entirely contrary to his earlier experience. A thorough health evaluation of this herd was conducted by veterinarians from the University of Minnesota during 1987 and it is our understanding their assessment failed to reveal metabolic problems attributable to conception failure. The owner estimates his replacement stocking is at fifty percent capacity and there is a substantial economic hardship imposed at this location as a result of these continuing conditions.

The farmland is of minimal relief compared to other study farms but appears well drained and highly productive based on yields achieved in years previous to 1988. This area and the area immediately to north was the worst observed by project personnel in terms of drought impacts seen in 1988. No corn for grain was developed for harvest on this farm in 1988 and vegetative growth is estimated to have been twenty five to fifty percent of normal. Except for a drainage ditch located about fifty meters north of the barn, proximity to surface waters or wetlands is minimal in contrast to other farms studied.

Electrical service to the farm is the terminal point of an

substation located in the City of Freeport. Several residences in route to the Borgerding farm are included in this service. We have no information related to the balance of the componets of this three phase load.

FARM DECRIPTION - JOHNSON:

The Harold Johnson farm is located 1.5 miles west and 2.5 miles north of Upsala, Minnesota. This farm is operated by Harold and his son Bruce and now represents the forth generation of this family's farming enterprise in the Swanville area. The principal production unit of this farm is its dairy facility housing 52 milk cows. About 50 replacement heifers are produced on this farm each year to support the sixty seven percent replacement rate these operators experienced in 1987. The dairy installation includes; tie stalls, milkline, barn cleaner, liquid manure pit and four stave silos for corn silage, haylage and high moisture rolled ear corn. About two thirds of the stalls have rubber mats which appear to be non-conducting. Cows are milked twice per day at 6:00 am and 6:00 pm and are kept in the barn until dry because they refuse to reenter the barn if turned out.

The 1988 crop consisted of 105 acres of corn, 110 acres of hay and about 20 acres of pasture. The farm is bounded on the west by Long Lake and by county road 15 on the east though adjacent property is both owned and rented as a part of this operation. Single phase electric power is supplied by underground cable and distributed to the farm overhead from a pole that is located centrally on the north property line and about 200 meters north of the barn.

Mr. Johnson has experienced definite dairy production problems since January of 1983 which he attributes to a change in the electrical environment of the barn. Since that time he has made substantial investments to better understand and attempt to correct his production problems. In this endeavor he has worked with representatives of his local electrical cooperative, agents of the University of Minnesota and area electrical contractors. In the spring of 1983 he installed a tingle voltage filter which helped reduce ac shock potentials found on interior barn structures. In December of 1986 he installed a Blackburn Electronic Grounding System to further mitigate these problems. Various concepts are associated with the operation of this device but it presumably operates to dissipate electrical energy found on the barn neutral to a remote earthen location. Coincident with its operation is the common bonding of all conducting interior barn structures and a grounding grid installed at the barn perimeter. A second grounding grid was installed about 200 meters northeast of the barn in the direction of the substation in Elmdale township. The difference in potentials as detected between these two grids is significant to its operation but technical information describing its use is not provided to the owner and the case of the unit is locked at the time of installation. Preliminary information indicates beneficial effects associated with the operation of the Blackburn System influencing cow behavior, milk production and butterfat content

but these changes have been minor. Continuing problems on this farm relate to animal behavior, displaced stomachs, swollen knees, and infections that do not respond well to conventional treatments. Bruce Johnson feels the immune systems of his cows are substantially impaired as they have very little resistance to disease conditions and are very slow to recover from normal stresses such as those associated with calving.

FARM DESCRIPTION - MORRIS:

The West Central Experiment Station is located about 2 miles east of the City of Morris. Various livestock industries are represented at this site. The dairy barn has 60 tie stalls in two widths accomodating the sizes of younger and older animals. Four individuals are directly assigned to the operation of this facility to accomplish herd management and maintenance activities. Dr. Dennis Johnson is responsible for design, conduct and analysis of experimental trials with this herd.

This facility has been in operation for about twelve years and appears to represent some of the best constuction technology available at that time. Ventilation, lighting, temperature control and cleaning needs have been addressed in the design and operation of the barn with certain effort to provide a model for dairy operations. The cows are fed from a center asile and ration quantity and quality are closely monitored in relation to milk production on a per cow per milking basis for every cow every day. All ration, production and herd health data is computer based to allow ready access and analysis. Cows are milked twice per day at 4:00 am and 4:00 pm and are typically let out of the barn after morning milking and observed.

Personnel responsible for the dairy operation do not feel stray voltage or electrical problems are associated with the production of this herd but do acknowledge that production is lower than might be expected for a herd with this quality of breeding and management. Electrical service to the barn is three phase underground cable and power delivered to the barn distribution panel is also three phase. Three broadcasting towers are located near this property and radio frequency energies were associated with some of the measurements made at this site.

The station facilities are elevated from the City of Morris but the topography at the farm and to the south and east is of relatively shallow relief and appears well drained with few surface water features.

FARM DESCRIPTION - KENNING:

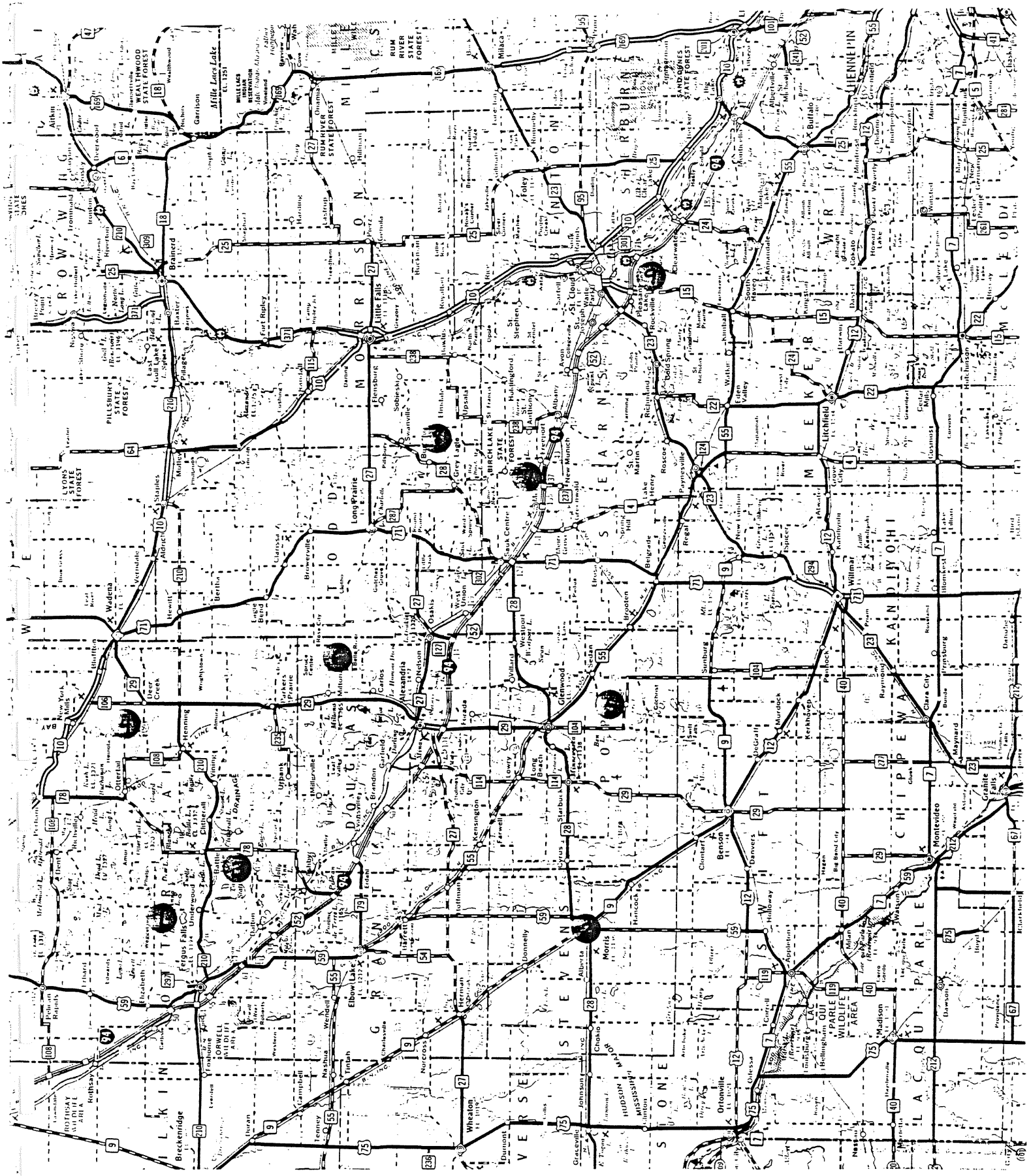
The Kenning farm is located 2.5 miles west and .5 miles south of St. Augusta, Minnesota. The farm site is a local elevation from the north and west. St. Augusta creek passes through the property about 250 meters north of the barn and the property is bounded on the east by county road 136. Joe Kenning farms this land with his father Norbert and in partnership with

property is bounded on the east by county road 136. Joe Kenning farms this land with his father Norbert and in partnership with Francis Ketner. This is a diversified farm producing milk, hogs, and cash grain for market. The soils in this area are sandy and most of the crop production for dairy feedstocks is under center pivot irrigation. The dairy facility is parlor based with nine milking stations and free stall area with slated concrete floor. About 50 cows are milked twice per day at 6:00 am and 6:00 pm with assistance of Kenning family members. Substantial investments and innovations have been made and implemented by operators of this farm to combat what they feel is an electrical environment problem with general adverse effects on their operations. Additionally, they have assembled and computerized a great deal of related information to assess their progress. An isolation transformer was installed in 1980 and in 1984 a 115 KV transmission line was moved off a diagonal crossing of their property to the western and northern property borders. In July of 1985 they installed a 110 volt transformer and non neutral to earth electrical system which to our knowledge is unique to farm and residential electrical services. Their farm is now at the open end of a 7200 volt above ground single phase service.

The milk production on this farm has historically been low and problems with mastitis and high somatic cell counts have been routine. The operators are currently experimenting with elevated and electrically isolated livestock housing conditions which they feel benefit both production and health. A great deal of supporting information is available from this location, some of which is described elsewhere in this report.

Kenning - Corrective Actions:

Sept. 4, 1980	Put in isolation transformer.
May-Aug. 1984	Transmission line moved.
July 22, 1985	Put total steel plates on parlor floor
July, 1985	Installed 110V transformer and non-neutral to earth system.
June, 1986	REA put tie line in to take load off line past farm.
Aug-Sept 1986	REA changed line to St. Augusta.
Mar. (approx) 1987	REA disconnected neutral from tie line
Nov. 1987	Bad vacuum tank



1. D. HAGEN - UNDERWOOD
2. U of M - MORRIS
3. L. NELSON - BATTLE LAKE
4. F. PESOLA - NEW YORK MILLS
5. H. JACOBSON - SEDAN
6. D. LUSTY - MILTONA
7. A. BORGERDING - FREEPORT
8. H. JOHNSON - SWANVILLE
9. J. KENNING - ST. AUGUSTA
10. U of M - ST. PAUL

3. ELECTRICAL ENVIRONMENT ASSESSMENT

Continuous Measurements

Several variables associated with the electrical environment of dairy barns lent themselves well to automatic measurement. These included ac and dc potentials and short circuit currents between points in the barn, one dimension each of the dc electric field and the ac magnetic field at specific locations inside and outside the barn, and the meteorological variables wind speed/direction, temperature, relative humidity and precipitation. A description of each of these measurements and the associated data collection equipment and software follows.

The only measurement requiring no signal conditioning between the point of measurement and the data collection equipment was the dc potential between locations in the barn. Up to eight direct dc millivolt inputs were available; each was a differential input allowing a range of -5000 to +5000 mV with 10 Mö of input impedence. In these respects, each input can be thought of as equivalent to that of a modern digital voltmeter. The manufacturer's stated accuracy for these inputs is 0.01% of reading ± 1 bit (0.01% $\pm$ 2.4 mV as operated). Typically, several dc potential measurements were made simultaneously between objects directly accessible to the cow. Potential differences between two points can be calculated if measurements were made between each and a common third point. For instance, if V_{dc} was directly measured between the stall and milkline, and also between the stall and waterline but not between the milkline and waterline, this last can be calculated from the first two through the common measurement point (stall). In this way it is possible to gain up to 50% more data than is directly measured.

Provision was made for dc potential measurements with near-electrometer-grade inputs to allow measurement of static charge potentials in the barn. Three signal conditioning units (instrument amplifiers or IA) were constructed as illustrated in figs. 1 and 2. At a dc potential input of 1000 mV, IA #1 requires 15 nA (nanoamp or 10^{-9} amp) of source current and IA #2 requires 0.0001 nA compared to the unconditioned inputs' requirement of 100 nA. In actual practice it was discovered that no significant static potentials existed in the barn because of high relative humidity and surface moisture on objects in the barn. The standard dc potential inputs were adequate for the measurements made.

Ac potentials were measured using up to three signal conditioning units built for that purpose and described in fig. 4. Because ac potentials found in barns are most often not purely sinusoidal 60 Hz but contain higher frequencies as well, it was necessary to use devices capable of **true** rms (root mean square) conversion. Agreement between independent ac potential measurements can only be assured using true rms conversion when the ac voltage shows other than a pure 60 Hz waveform. These battery powered converters were placed at the point of

measurement and could be set for FS (full scale) inputs of ± 0.2, 2, 20 or 200 V_{ac}. The inputs were differential (as operated) with an impedence of 10 Mö, identical to the standard dc potential inputs.

Currents were measured between objects in the barn using two methods, short circuit and steady state. The short circuit current was approximated using a 4ö shunt resistor across the inputs allowing a conversion from mV to mA using the ohmic relation i=v/4. Similar measurements were made to represent the steady state current through a cow assuming various substitute shunt resistance values in the range of 1 to 10 kö (kilohms, 10^3 ohm). Note that by "input" it is meant either the standard dc mV input or any of the potential signal translators described above.

The dc electric field was measured in the barn using an electric field mill supplied by Dr. Duane Dalberg sans electronics. A power supply board and an amplifier board were constructed adhering to the design of the original builder of the field mill (Dr. Donald Olson, University of Minnesota, Duluth). The instrument was tested, calibrated and operated in conformation to several years experience using similar instruments in a field environment. Compared to operation out of doors, use of the field mill in a barn to obtain accurate and meaningful absolute values of the dc electric field is considerably more difficult. While the field mill is the single most accurate and reliable method of measuring the dc electric field, the measurement assumes that the field is uniform (does not vary in the immediate space) and its direction can be predicted beforehand (preferably vertical). Neither of these conditions can be assured in a barn, the reason being that the configuration of electric charge producing the field, whether residing as space charge in the air or charge on the surface of objects, is much too complicated to assume that the resultant field is uniform, let alone vertical. The method adopted in this study necessarily falls short of an absolute determination of the field at points in the barn. On the other hand, the method to be described permits reasonable repeatability of the measurement through time and between barns to produce a proportional value which is equally correlatable with other variables, as is the electric field itself.

At each farm the field mill and amplifier package were placed on the floor in the center isle of the barn supported on a plastic milk crate. An instrument calibration (zero and span) was obtained at each measurement location both before and after (often also during) measurement runs. The electric field in V/m (volts per meter) can then be calculated by the product of V_s (signal volts) thus obtained, C (instrument calibration constant, V/m per V_s) and F (form factor, unitless). The constant F was not determined for the mill in this operating configuration but its value is approximately 10 and does not change if the mill configuration remains fixed.

A second method to measure the dc electric field was tried in

one barn. It has been noted above that the electric field inside a barn is quite complicated due to the presence of conductors such as stanchions, water- and milklines, not to mention the cows themselves. The Borgerding barn has one section that has a metal ceiling. A differential dc potential was recorded between the ceiling and an aluminum pad attached to the concrete floor with electrode gel. A "representative" electric field value for this section of the barn can then be calculated by dividing the dc potential thus obtained by the constant ceiling height. Again, the presence of conductive objects precludes an absolutely meaningful value; the values though can be thought of as approximately correct and proportional to the "true values", however that term is defined, because the configuration of conductors in the area of measurement does not change.

The ac electric field, due presumably to ac potentials on objects in the barn, was not measured in this study. It can be argued successfully perhaps that the ac field is really a secondary measurement to determining the source potentials on elements in the barn. (This is not the case for the dc field in that static fields can be caused also by net space charge in the air).

While electric fields are due to electric charge or potentials, the movement of charge (current) gives rise to magnetic fields (ac currents/ac magnetic fields, dc currents/ dc fields). Much work was done to find out how the ac magnetic field varied throughout the barn under different operating conditions (see the section on manual measurements) and to see how at least one component of the ac magnetic field varied with time in a vacant stall. A one dimensional magnetic field meter (42B Milligaussmeter) designed for dosimetry surveys (E. Leeper, Monitor Industries, Boulder, CO) was obtained. This instrument has several ranges enabling measurement of fields up to 250 mG (milligauss, 10^{-3}G). "Linear" and "flat" modes respond differently to non-60 Hz fields, allowing one to test for their presence.

For an automatic time survey of the ac magnetic field in a stall, a stand was constructed with a wood base, a pvc pipe upright and a pvc crossarm which positioned the meter and its sensor coil to measure the vertical component of the ac magnetic field at a height of 1 meter near the center of the stall. A custom addition to the meter was a true rms dc voltage output which allowed connection to the data logging equipment in the instrument trailer. Time series were collected on a separate channel of the data logger during different periods of activity in the barn. Conversion to magnetic field values is accomplished by multiplying the signal voltage V_s by the conversion constant C (mG/V_s) for the range used.

An obvious extension of this measurement is to measure the three components of H_{ac} (ac magnetic field) simultaneously with three orthogonal sensor coils and three instrument channels, then vector add them to obtain the total field. This works for H_{ac}

because each component of the field is relatively independent of the presence of the other two coils. Work was begun to design and construct such an instrument but was not completed in time for the 1988 field season. Instruments such as this are presently available on an experimental or limited production basis but the project schedule and budget constraints precluded purchasing one for this study.

A meteorological package was incorporated into the continuous measurement system as proposed. Sensors for wind speed/direction (revolving slotted drum/rotating vane), temperature (calibrated diode), relative humidity (gold leaf hygrometer) and precipitation (tipping bucket) were connected by signal cable to a translator/indicator unit in the equipment trailer. Data in real units was transmitted to data logging equipment once per minute via RS-232C data link. In general, the wind data is not reliable because nearby farm buildings altered air flow at the point of measurement on the trailer roof. Temperature, relative humidity and precipitation totals were checked daily by on-site independent means (see section on Manual Measurements) and proved to be reliable.

All of the measurements thus far described were logged automatically using a microcomputer-based data logger. The system consists of the following elements: 1) Xerox 6064 IBM compatible computer, 2) Dash-16 data acquisition board, 3) Software. The function of the system is to scan and record high level voltage signals from up to 16 separate instruments (with analog outputs) at a preprogrammed rate, calculate an average of each channel periodically and store the averages on disk for future processing.

The Xerox 6064 computer contains an 8086-2 CPU operating at 8 MHz. It includes one serial port, one parallel port, seven expansion slots, two half-height 360 K 5 1/4" disk drives, 640 K RAM, 640 X 400 pixel CGA monochrome monitor, 8087 math coprocessor and a full function keyboard. For comparison purposes and in most respects, this Xerox configuration is equivalent to that of the IBM Personal System/2 Model 30.

The analog data acquisition function is accomplished by a high performance analog and digital interface board, Metrabyte's Dash-16. This board is capable of converting 16 single-ended or 8 differential analog input channels into 12-bit resolution digital format. Direct Memory Access allows a maximum conversion rate of 100,000 samples per second. A/D gain can be selected to provide an input range of 1 V to 10 V in either unipolar or bipolar modes. Two analog outputs and two 4-bit digital outputs are also available for control functions.

High level dc signals from the points of measurement were transmitted via terminal box and 30 m of multiconductor cable (24 AWG twisted pair x 3, pair-Beldfoil-shielded with drain wire) to the data logging equipment in the trailer. Each channel to the computer system was accessed through an individually protected

and filtered input on an input board (sometimes referred to as a breakout box). A pair of opposing 20 V zener diodes bridge the inputs limiting the input signal voltage to 20 V (ac or ±dc). Protecting the zener diodes from overcurrent are two 10 kö inline resistors, one in each input. Immediately upstream from these resistors is a capacitor across the inputs which acts as a simple low pass filter with the resistors to reduce the effect ac components on top of the desired dc signal. A ribbon cable routes all inputs to the DASH-16 board inside the computer.

Software was written to accomplish the following data acquisition tasks. Eight -5 to +5V differential input channels are scanned once per second in real time. At the end of each minute, the meteorological translator/indicator is queried for met data and the 60 accumulated values for each a/d channel are averaged and stored temporarily in RAM as a one-minute record with a date/time stamp attached. Each ten minutes the accumulated one-minute data are written to disk. A menu allows access to other features such as date/time adjustment, comment inclusion, data file listing and printing, missing data channel designation, etc. Also accessible through the menu is a one second data logging mode in which the one second differential data are written to disk with a time stamp, a feature developed in the field when it was found desirable to look at short term phenomona. Other functions and different operating characteristics can be incorporated as the need arises; the program was written in BASIC which is easily modified while being more than fast enough for one-second scans, given the speed of the hardware. As configured, the system can accomodate a three-day data record, limited only by disk space. Larger single data files would require the addition of a hard disk drive to the system. In practice however, new data files were started more frequently than that to accomplish various changes in the monitoring system.

In all, some 15000 one-minute records were collected at each of the four farms. This data was eventually transferred from floppy disk to a 30 Mb hard disk on a second Xerox 6064 for analysis. The individual files for each farm were linked into one sequential file within a graphics and statistical software package. Daily summary graphs of the minute data for each channel were produced and are included here in figs. FFF-FFF.

Manual Measurements

A number of measurements were made which, by their nature, did not lend themselves well to automatic data logging. These included the mapping of ac and dc magnetic fields in the barn, spot checks of potentials with a multimeter, min/max determinations with the multimeter, waveform surveys with an oscilloscope, spectral analysis of ac potentials in the barn, and independent checks of the meteorological variables temperature, barometric pressure, relative humidity and precipitation.

The ac magnetic field meter was used to map the ac field in each of the barns. First, a two-meter cubic grid was established in the barn by stretching a set of strings 2 m apart down the length of the barn at a height of 2 m. Markers were then attached to each string at 2 m intervals to serve as a guide for measurement points. A scan of the barn was then made by recording the position data and the values for all three orthogonal components of the ac field. A typical scan required approximately 40 minutes per barn. In most cases, data was entered simultaneously into a data base via cordless phone link between the measurer and the recorder to speed the process.

A number of scans were made under different conditions, ie, milking/not milking, flourescent lights on/off, ventilating fans on/off, farm power on/off, line power/generator power to barn, etc. Another contrast was made between H_{ac} in the linear and flat meter operating modes to determine sources of non-60 Hz fields (eg, three-phase motors). At the completion of each mapping, the field components were added vectorily, summary statistics were generated and a magnetic field map was produced as well as maps describing the contrasts mentioned above. In most cases it was possible from such data to identify sources of ac fields in the barn and to say something about them almost immediately after the scan was made.

A record representing typical dc magnetic field values was obtained using a Schonstedt Instrument Co. Digital Magnetometer Model DM 2000 (courtesy of Dr. D. Dalberg, Concordia College, Moorehead). The meter was capable of milligauss precision. In each barn a representative stall was chosen for mapping where a 2m square grid was established at floor level and at a height of 1 m to mark points of measurement. At each point three orthogonal readings were taken to establish the vector quantity and added later within a data base system to determine the field magnitude which was then used to produce a dc field map of the stall. In general, the magnetic fields thus obtained exhibited marked variation between locations in the stall. Although the earth's field is relatively constant over small distances, the presence of ferrous objects (and, presumably the presence of dc currents) strongly influenced the values found in the stall. At each farm, the undisturbed earth's magnetic field was determined out of doors in an open area away from metal objects. Three sets of components were obtained there, averaged and added vectorily to determine magnitude, dip (angle in degrees from horizontal) and deviation (angle in degrees from true north).

Often it was necessary and desirable to measure potentials and currents by hand with a hand-held multimeter. For this purpose a Fluke Model 27 Multimeter was used. Stated accuracy for this 3200 count, 3½ digit meter was $\pm(0.1\%+1)$ in the dc voltage mode and $\pm(0.5\%+3)$ in the ac voltage mode. A minimum/maximum storage feature allowed unattended monitoring of potentials on an exploratory basis. An ac current clip allowed currents up to 150 amp ac to be monitored. A high voltage probe was available to measure potentials above the 1000 v limit of the

meter (to 10 kV).

A BK Precision Model 2125 oscilloscope was used to explore the nature of ac potentials in the barn. This instrument is a two channel instrument capable of single-ended or differential measurement of frequencies from dc to 20 MHz. This instrument was used in an exploratory manner and as a buffer for spectral analysis measurements to be described next.

As a general observation, ac potentials found in dairy barns are seldom purely 60 Hz sinusoids. An effort was made to document the nature of the ac potentials found at the various contact points used for continuous monitoring. A record of these measurements exists for each contact point in the form of 1) a waveform graph, 2) a frequency spectrum from dc to 1 kHz, and 3) a frequency spectrum from dc to 10 kHz. These were produced using the system next to be described.

Spectral analysis equipment included the Xerox 6064 computer and DASH-16 a/d data acquisition board (used also for the continuous monitoring function) equipped with software (PCGEN Transfer Function Analyzer Program, Hanson Instruments, Pleasanton, CA) to emulate a storage oscilloscope/waveform analyzer, the 20 MHz oscilloscope used above, a 5th-order Butterworth filter and coax signal cable. The oscilloscope was provided with a "quiet" signal ground connection, usually through the shielded center conductor of coax cable to a ground stake; the x10 scope probe attached to the contact point. As such, true differential measurements corresponding to the continuous monitoring data were not made; the oscilloscope itself was capable of this measurement but the analog output of the differential trace necessary for signal buffering was not available. The buffered signal was then available through an analog output port of the oscilloscope to the filter through coax line. The purpose of the passive Butterworth filter was to sharply (5th order) attenuate frequencies above 10 kHz to prevent aliasing (phantom frequency images in the fast-Fourier spectrum caused by frequency components higher than that sampled for). The buffered and filtered signal was then routed to the input of the data acquisition equipment through a 30 m coax cable.

Spectral data were obtained as follows. The waveform at each contact point was observed visually and a stable trace on the oscilloscope was obtained. Then the storage scope mode in the acquisition software was invoked to produce a data file representing a digital record of the analog scope's trace. Next, a set of 16 scans were run to provide data for the fast-Fourier transform routine to produce spectra to 1 kHz and then to 10 kHz using 512 spectral lines and a Hanning digital filter supplied with the Scope software. Each spectrum was stored as a digital data record. These data files can, but have not been, converted to paper graphs, pending data reduction (present records are useful for frequency information but signal magnitudes need adjustment to correct for scale changes inherent in use of the oscilloscope probe and analog output).

During the monitoring season, daily weather observations were made manually to augment and check automatic weather data. These included minimum/maximum temperature, wet/dry bulb temperature from which relative humidity was determined, barometric pressure, precipitation accumulation, and general observations such as sky cover, visibility, wind speed/direction estimates and broadcast local barometric pressure. These observations were recorded in the daily monitoring log usually in the early part of the morning. Notes on unusual weather occurances such as thunderstorms were noted as they happened.

The minimum and maximum temperatures for the previous 24 hours were obtained with a Taylor min/max recording thermometer placed in shade with adequate air circulation. Comparison with two other lab grade thermometers indicated an accuracy within $\pm 1^{\circ}F$.

Wet and dry bulb temperatures were obtained according to manufacturer's recommendations using a Taylor Sybron sling psychrometer. These were converted into a relative humidity value using tables of NBS (National Bureau of Standards) origin. The RH was not corrected for barometric pressure.

A National Weather Bureau approved graduated cylinder-type rain guage was placed outdoors at each monitoring site to back up the tipping bucket data. Precipitation total was read after each rain event and compared to the current digital record.

Ancillary Equipment

The base for monitoring was provided by a 30' 5th wheel trailer which served as on-site housing for monitoring personnel as well. The trailer was equipped with air conditioning, heat, water and electrical systems and kitchen and living accomodations to support the 24 hour personnel schedule required for this research.

Two separate electrical services were maintained; one for the trailer itself and another for the monitoring systems and computer. This separation precluded undervoltages to critical monitoring equipment. A 4 Kw gas genset was available to operate the system independent of external power though this option was not used during the 1988 monitoring season because onsite independent power was available as a farm facility at each location.

Data Base Description

The 1988 data base consists of several parts for each of the four farms visited. There is the primary data base consisting of one minute data for eight channels and meteorological readings. Next there is an ac magnetic field data base for each barn and a dc magnetic field data base for a representative stall in each

barn. A spectral analysis data base exists for each contact point in the primary data base. Field notes constitute a written record of field observations and procedures. Last, the Kenning 1987 data on milk production and potentials on overhead wires now exists as a computer record. A more detailed description of each of these data bases follows.

The primary data base has been assembled as a spreadsheet file from original ASCII disk files collected in the field using a personal computer. A spreadsheet file exists for each farm and consists of approximately 15000 records arranged chronologically; each record includes: date, time, V1 through V8 (each an average of sixty 1 second readings of dc millivolts between contact points in the barn or signal volts from various sensors), temperature, barometric pressure, wind direction, wind speed, precipitation, and relative humidity. The spreadsheet file is directly operable upon by a comprehensive statistical and graphics package, Number Cruncher Statistical System, Version 5.01, (NCSS 5.01) by Dr. Herry L. Hintze, Kaysville, UT. This package provides the means to operate on the primary data base to produce virtually every common statistical analysis in modern use as well as an assortment of graphical presentations such as scatter plots, two dimensional multiple plots and three dimensional graphics images. NCSS 5.01 supports importing from- and exporting to- ASCII format files for transfer of data between software packages. To date, the primary data base has been described and is documented as summary statistics for each of the parameters (V1-V8 and met data) and as an annotated two-dimensional time series graphic rendition of the one-minute data (V1-V8 only) in 8-hour-by-4-channel format. Future analysis could include such procedures as; more detailed descriptive statistics, cross tabulation, multiple regression, descriminant analysis, factor analysis, cluster analysis, T-tests, Anova using unweighted means, GLM-Anova, repeated measures Anova, nonparametric tests, and forecasting/time series, to enumerate NCSS 5.01 features.

Spatial surveys of the ac magnetic field in each barn are assembled as NCSS spreadsheet files as described above. Each file consists of a number of records, each describing the ac magnetic field at a 2-meter grid point in the barn in terms of its x and y position, the three components of the magnetic field and a vector addition representing the ac magnetic field strength each for (typically) two (or more) contrasting conditions such as linear/flat, milking/not, barn power on/off, etc. NCSS was used to facilitate transformation of the data and production of summary statistics and three-dimensional graphs enabling a visualization of B_{ac} and contrasts in the barn; a map, as it can be considered. Conceivably, all the statistical procedures of NCSS are available for operating on this data as well.

An analogous procedure was used to assemble a data base to describe the dc magnetic field variations in one stall of each barn. The NCSS spreadsheet record here consists of the position (x,y,z 2-meter grid), three orthogonal components of the dc

field, the summed magnitude, dip angle and deviation angle of the dc magnetic field. Summary statistics and a three dimensional map describe these data.

A data base consisting of spectral data has been obtained at each farm to document the frequency components present in the ac voltage component superimposed upon the dc potential at each contact point monitored in the barn in producing the primary data base. A typical spectral data base for a barn consists of approximately seven groups of three ASCII data files each. The three files are used by the software package, PCGEN Transfer Function Analyzer Program, to produce three graphic images. The first graph presents a snapshot of the ac+dc waveform at the contact point. The second graph is a plot of the ac potential in dBV (decibel volts, $20\log_{10}V$) vs frequency up to 1 kHz. The third graph plots the same as the second but extends the frequency spectrum to 10 kHz. Hard copy of these graphs can be produced when the data files are transformed to account for a linear offset imposed upon the data by the equipment used to make the measurement.

Considerable effort was expended to digitize the data collected on the Kenning farm documenting ac and dc potentials on overhead wire antennae and milk production records for four cows in 1987. The "wire" data exists as a NCSS spreadsheet file, the records of which include: date, hour, ac (high, low and average) voltage, dc (high, low and average) voltage, as well as a comment code describing stripchart record observations to represent a one-hour average record. A time series graphic representation of this data summarizes the ac and dc potentials as a one month record by month. Another NCSS file contains daily milk production records for four cows (morning milk weight, evening milk weight, difference between am and pm weights, and total weight for each cow) and four-cow-herd average and high-minus-low individual milk weights divided by herd average. Milk production data is described in summary statistics, yearly graphic summaries and monthly graphs to compare with the "wire" data. A statistical comparison of the milk and wire data was not made because of dissimilar time bases between the two. Project funding and time limitations precluded the programming necessary to further reduce the wire data to daily averages for comparison with the milk production data.

PRIMARY

DATA

FILE

The following pages (3.11 - 3.288) contain the primary data base as described previously (p. 3.9). The primary data base is presented here in four sections, one for each of the four study farms. Because the form of the presentation is identical for each farm, a generic description referring to the pages in the first section (Borgerding Primary Data File, pp. .13 - 3.87 is included here to aid the reader in an interpretation of the primary data base. It is suggested that the reader refer ahead to pages referenced in the next paragraph to become familiar with the format; thereafter the logic of the presentation should be evident without further notation.

A title page prefaces each section to identify the farm to which the data applies (3.13). The next page (3.14) again identifies the farm/data base and lists the names of the variables contained therein ("Variable"), the number of one-minute averages ("Rows") and a short description of the variable ("Label"). The next few pages (3.15 - 3.21) present descriptive statistics for each of the eight millivolt channel variables plus the meteorological variables. Referring to p. 3.15, the reader notes that it contains a statistical description of the first two millivolt channel variables ("V1" and "V2"). The variable V1 is found to be millivolt channel 1 ("CH#1 (mV)"). It could be noted that the average of 3287 one-minute averages for this variable is -42.1363 millivolts (mV). Further, scanning down the list of statistics, one notes that the standard deviation about this mean is 606.6591 mV which is a standard measure of the variability of the V1 data. The last few lines for V1 give a cumulative frequency distribution for variable V1. Here the largest value of V1 is 175 mV (100-%tile); the lowest value is -5000 mV (0-%tile); the mean or 50-%tile is 7 mV (half of the observations were higher and the other half lower than this value). The absolute range of the data for V1 is 5175 mV and the range from the 75th to 25th %tile (the middle chunk) is 93 mV. Similar statistical reports for V2 through V8 and the weather variables follow.

The charts that follow (3.22 - 3.85)present the actual data for millivolt channels V1 to V8. They can be thought of as a time record similar to an 8-channel strip chart record of one-minute averages. The hope is that the reader will use these charts as a means of verifying at a glance that the data base is real and documented in its entirety, to identify the actual measurements

represented by the variables V1 to V8, and to gain a feeling for how these electrical variables behave from hour to hour and day to day. Refer to pages 3.22 and 3.23. These two opposing pages contain eight "strip charts" of V1 to V8. The title at the top identifies them as mV channels from the Borgerding farm on 7/30/88. The time line at the bottom tells the reader that the data start at midnight (0) and go to 8 am (time is represented in 24-hour format). Each strip chart spans a range of -1000 to +1000 mV vertically. Tic marks delineate 0 mV and the hours of the day. Actual data is evident as a series of dots different from tic marks which most often show up as a dashed line when the variability of the data is low. At the bottom of the two-page presentation is a listing of the variables (or channels) an what each represent. Unless otherwise noted, these are dc millivolt readings between two contact points. For example, V3 represents the dc (milli)voltage between the south (S) waterline and barn ground. V8 represents the dc potential between the barn ground and a remote ditch ground. Where mV channels are used to measure ac potentials, electric fields, magnetic fields, or other quantities, these notations at the bottom of the page describe them appropriately. Also included in the KEY are notes of special occurrence such as can be found on p. 3.63 where it is noted that the barn was operated on "generator power" from 1739 to 1931. (The reader can view the accompanying charts near those times to see for himself if the variables changed at these times.)

This then describes the primary data presentation to follow. A practical approach for the average reader is suggested to be the following: Begin an examination of the data for a farm by scanning through the strip charts of the actual data. Note what quantities are represented and how these quantities vary in time, particularly around times of interest such as milking time and events noted in the "KEY". Explore whether shifts in one variable are accompanied by concurrent shifts in other variables. Get a feel for the levels of these quantities. If necessary, refer back to the descriptive statistics pages for specific information (bearing in mind that in some cases, a mV channel was used to record more than one kind of data).

At the end of each farm section, general observations are presented concerning the primary data. These observations should not be considered to be conclusions based on an analysis of the data; they are instead one author's interpretation of the data arrived at using the procedure suggested to the reader in the previous paragraph. **Only a comprehensive computer analysis, and not these general observations, should be used to form conclusions from this data.**

BORGERDING

PRIMARY

DATA

FILE

7/30/88 to 8/9/88

----------NCSS Editor----------

Data Base Name C:\BORGERDI

No.	Variable	Rows	Vlab	Label
1	DATE	15,052		
2	TIM	15,052		
3	V1	15,052		CH#1 (mV)
4	V2	15,052		CH#2 (mV)
5	V3	15,052		CH#3 (mV)
6	V4	15,052		CH#4 (mV)
7	V5	15,052		CH#5 (mV)
8	V6	15,052		CH#6 (mV)
9	V7	15,052		CH#7 (mV)
10	V8	15,052		CH#8 (mV)
11	T	15,052		TEMPERATURE (deg C)
12	BP	15,052		BAROMETRIC PRESSURE (in.H2O)
13	WD	15,052		WIND DIRECTION (deg)
14	WS	15,052		WIND SPEED (mph)
15	P	15,052		PRECIPATATION TOTAL (in.)
16	RH	15,052		RELATIVE HUMIDITY (%)
17	TIME	15,052		DECIMAL TIME
18	C18	0		
19	C19	0		
20	C20	0		

----------Descriptive Statistics----------

Data Base Name C:BORGERDI

Detail Report

Variable: V1	CH#1 (mV)		
Mean - Average	-42.1363	No. observations	15052
Lower 95% c.i.limit	-62.87554	No. missing values	11765
Upper 95% c.i.limit	-21.39705	Sum of frequencies	3287
Adj sum of squares	1.209364E+09	Sum of observations	-138502
Standard deviation	606.6591	Std.error of mean	10.58144
Variance	368035.3	T-value for mean=0	-3.982094
Coef. of variation	-14.39754	T prob level	0.0001
Skewness	-7.94763	Kurtosis	61.92314
Normality Test Value	0.869	Reject if > 0.996(10%)	0.997(5%)
100-%tile (Maximum)	175	90-%tile	98
75-%tile	83	10-%tile	-72
50-%tile (Median)	7	Range	5175
25-%tile	-10	75th-25th %tile	93
0-%tile (Minimum)	-5000		

Variable: V2	CH#2 (mV)		
Mean - Average	-30.71603	No. observations	15052
Lower 95% c.i.limit	-32.56308	No. missing values	4875
Upper 95% c.i.limit	-28.86897	Sum of frequencies	10177
Adj sum of squares	9.197293E+07	Sum of observations	-312597
Standard deviation	95.06955	Std.error of mean	.9423919
Variance	9038.22	T-value for mean=0	-32.59369
Coef. of variation	-3.095112	T prob level	0.0000
Skewness	17.51436	Kurtosis	668.1431
Normality Test Value	0.592	Reject if > 0.993(10%)	0.995(5%)
100-%tile (Maximum)	4239	90-%tile	79
75-%tile	5	10-%tile	-88
50-%tile (Median)	-61	Range	4415
25-%tile	-77	75th-25th %tile	82
0-%tile (Minimum)	-176		

----------Descriptive Statistics----------

Data Base Name C:BORGERDI

Detail Report

Variable: V3	CH#3 (mV)		
Mean - Average	403.319	No. observations	15052
Lower 95% c.i.limit	402.1375	No. missing values	862
Upper 95% c.i.limit	404.5006	Sum of frequencies	14190
Adj sum of squares	7.317154E+07	Sum of observations	5723097
Standard deviation	71.8117	Std.error of mean	.6028407
Variance	5156.919	T-value for mean=0	669.0287
Coef. of variation	.1780518	T prob level	0.0000
Skewness	-3.504889	Kurtosis	78.85822
Normality Test Value	0.792	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	2267	90-%tile	476
75-%tile	427	10-%tile	389
50-%tile (Median)	412	Range	2342
25-%tile	399	75th-25th %tile	28
0-%tile (Minimum)	-75		

Variable: V4	CH#4 (mV)		
Mean - Average	91.19457	No. observations	15052
Lower 95% c.i.limit	89.8766	No. missing values	862
Upper 95% c.i.limit	92.51254	Sum of frequencies	14190
Adj sum of squares	9.104343E+07	Sum of observations	1294051
Standard deviation	80.10294	Std.error of mean	.6724457
Variance	6416.48	T-value for mean=0	135.6163
Coef. of variation	.8783739	T prob level	0.0000
Skewness	1.229291	Kurtosis	17.51586
Normality Test Value	0.920	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	1611	90-%tile	202
75-%tile	162	10-%tile	-1
50-%tile (Median)	74	Range	1745
25-%tile	33	75th-25th %tile	129
0-%tile (Minimum)	-134		

---------- -------Descriptive Statistics ----------

Data Base Name C:BORGERDI

Detail Report

Variable: V5	CH#5 (mV)		
Mean - Average	351.0088	No. observations	13[illegible]92
Lower 95% c.i.limit	348.9348	No. missing values	777
Upper 95% c.i.limit	353.0827	Sum of frequencies	14275
Adj sum of squares	2.281444E+08	Sum of observations	5010650
Standard deviation	126.4247	Std.error of mean	1.058141
Variance	15983.21	T-value for mean=0	331.7218
Coef. of variation	.3601754	T prob level	0.0000
Skewness	19.87103	Kurtosis	545.4975
Normality Test Value	0.796	Reject if < 0.993(10%)	0.991(5%)
100-%tile (Maximum)	4179	90-%tile	372
75-%tile	366	10-%tile	334
50-%tile (Median)	356	Range	4362
25-%tile	345	75th-25th %tile	21
0-%tile (Minimum)	-183		

Detail Report

Variable: V6	CH#6 (mV)		
Mean - Average	-88.01441	No. observations	15052
Lower 95% c.i.limit	-90.26369	No. missing values	342
Upper 95% c.i.limit	-85.76514	Sum of frequencies	14710
Adj sum of squares	2.849597E+08	Sum of observations	-1294691
Standard deviation	139.1875	Std.error of mean	1.147609
Variance	19373.15	T-value for mean=0	-76.69375
Coef. of variation	-1.581417	T prob level	0.0000
Skewness	-1.306e09	Kurtosis	.5230348
Normality Test Value	0.838	Reject if < 0.993(10%)	0.991(5%)
100-%tile (Maximum)	952	90-%tile	16
75-%tile	-8	10-%tile	-354
50-%tile (Median)	-27	Range	1672
25-%tile	-81	75th-25th %tile	73
0-%tile (Minimum)	-720		

----------Descriptive Statistics----------

Data Base Name C:BORGERDI

Detail Report

Variable: V7	CH#7 (mV)		
Mean - Average	173.0052	No. observations	15052
Lower 95% c.i.limit	171.2536	No. missing values	336
Upper 95% c.i.limit	174.7568	Sum of frequencies	14716
Adj sum of squares	1.729541E+08	Sum of observations	2545944
Standard deviation	108.414	Std.error of mean	.8936977
Variance	11753.59	T-value for mean=0	193.5836
Coef. of variation	.6266518	T prob level	0.0000
Skewness	15.74707	Kurtosis	678.5132
Normality Test Value	0.902	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	4769	90-%tile	249
75-%tile	238	10-%tile	63
50-%tile (Median)	187	Range	6841
25-%tile	144	75th-25th %tile	94
0-%tile (Minimum)	-2072		

Variable: V8	CH#8 (mV)		
Mean - Average	-110.1852	No. observations	15052
Lower 95% c.i.limit	-111.3518	No. missing values	329
Upper 95% c.i.limit	-109.0185	Sum of frequencies	14723
Adj sum of squares	7.680158E+07	Sum of observations	-1622256
Standard deviation	72.22735	Std.error of mean	.5952556
Variance	5216.79	T-value for mean=0	-185.1056
Coef. of variation	-.6555089	T prob level	0.0000
Skewness	-.3296857	Kurtosis	-.3812844
Normality Test Value	0.950	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	84	90-%tile	-16
75-%tile	-40	10-%tile	-221
50-%tile (Median)	-105	Range	463
25-%tile	-170	75th-25th %tile	130
0-%tile (Minimum)	-379		

----------Descriptive Statistics----------

Data Base Name C:BORGERDJ

Detail Report

Variable: T TEMPERATURE (deg C)

Mean - Average	73.17587	No. observations	15052
Lower 95% c.i.limit	73.02479	No. missing values	1
Upper 95% c.i.limit	73.32695	Sum of frequencies	15051
Adj sum of squares	1345996	Sum of observations	1101370
Standard deviation	9.457004	Std.error of mean	7.706518E-02
Variance	89.43491	T-value for mean=0	949.2859
Coef. of variation	.1292366	T prob level	0.0000
Skewness	.3846205	Kurtosis	-.3290135
Normality Test Value	0.993	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	98	90-%tile	87
75-%tile	79	10-%tile	61
50-%tile (Median)	72	Range	46
25-%tile	66	75th-25th %tile	13
0-%tile (Minimum)	52		

Variable: BP BAROMETRIC PRESSURE (in.H2O)

Mean - Average	29.86912	No. observations	15052
Lower 95% c.i.limit	29.86666	No. missing values	1
Upper 95% c.i.limit	29.87159	Sum of frequencies	15051
Adj sum of squares	357.4273	Sum of observations	449560.3
Standard deviation	.1541081	Std.error of mean	1.256154E-03
Variance	2.374932E-02	T-value for mean=0	23778.23
Coef. of variation	5.159447E-03	T prob level	0.0000
Skewness	-1.422438	Kurtosis	7.554717
Normality Test Value	0.797	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	30.15	90-%tile	30
75-%tile	29.95	10-%tile	29.71
50-%tile (Median)	29.9	Range	1.02
25-%tile	29.84	75th-25th %tile	.1100006
0-%tile (Minimum)	29.13		

----------Descriptive Statistics----------

Data Base Name C:SORGERD1

Detail Report

Variable: WD WIND DIRECTION (deg)

Mean - Average	129.6465	No. observations	15052
Lower 95% c.i.limit	128.2063	No. missing values	1
Upper 95% c.i.limit	131.0908	Sum of frequencies	15051
Adj sum of squares	1.226512E+08	Sum of observations	1951240
Standard deviation	90.27505	Std.error of mean	.7358428
Variance	8149.584	T-value for mean=0	176.1905
Coef. of variation	.696306	T prob level	0.0000
Skewness	.3090125	Kurtosis	-1.366971
Normality Test Value	0.929	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	360	90-%tile	240
75-%tile	220	10-%tile	20
50-%tile (Median)	90	Range	350
25-%tile	50	75th-25th %tile	170
0-%tile (Minimum)	10		

Variable: WS WIND SPEED (mph)

Mean - Average	3.247425	No. observations	15052
Lower 95% c.i.limit	3.185538	No. missing values	1
Upper 95% c.i.limit	3.309471	Sum of frequencies	15051
Adj sum of squares	227002.6	Sum of observations	48877
Standard deviation	3.883713	Std.error of mean	3.165662E-02
Variance	15.08323	T-value for mean=0	102.5823
Coef. of variation	1.195936	T prob level	0.0000
Skewness	1.442168	Kurtosis	1.872834
Normality Test Value	1.337	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	26	90-%tile	8
75-%tile	5	10-%tile	0
50-%tile (Median)	2	Range	26
25-%tile	0	75th-25th %tile	5
0-%tile (Minimum)	0		

----------Descriptive Statistics----------

Data Base Name C:BORGERDI

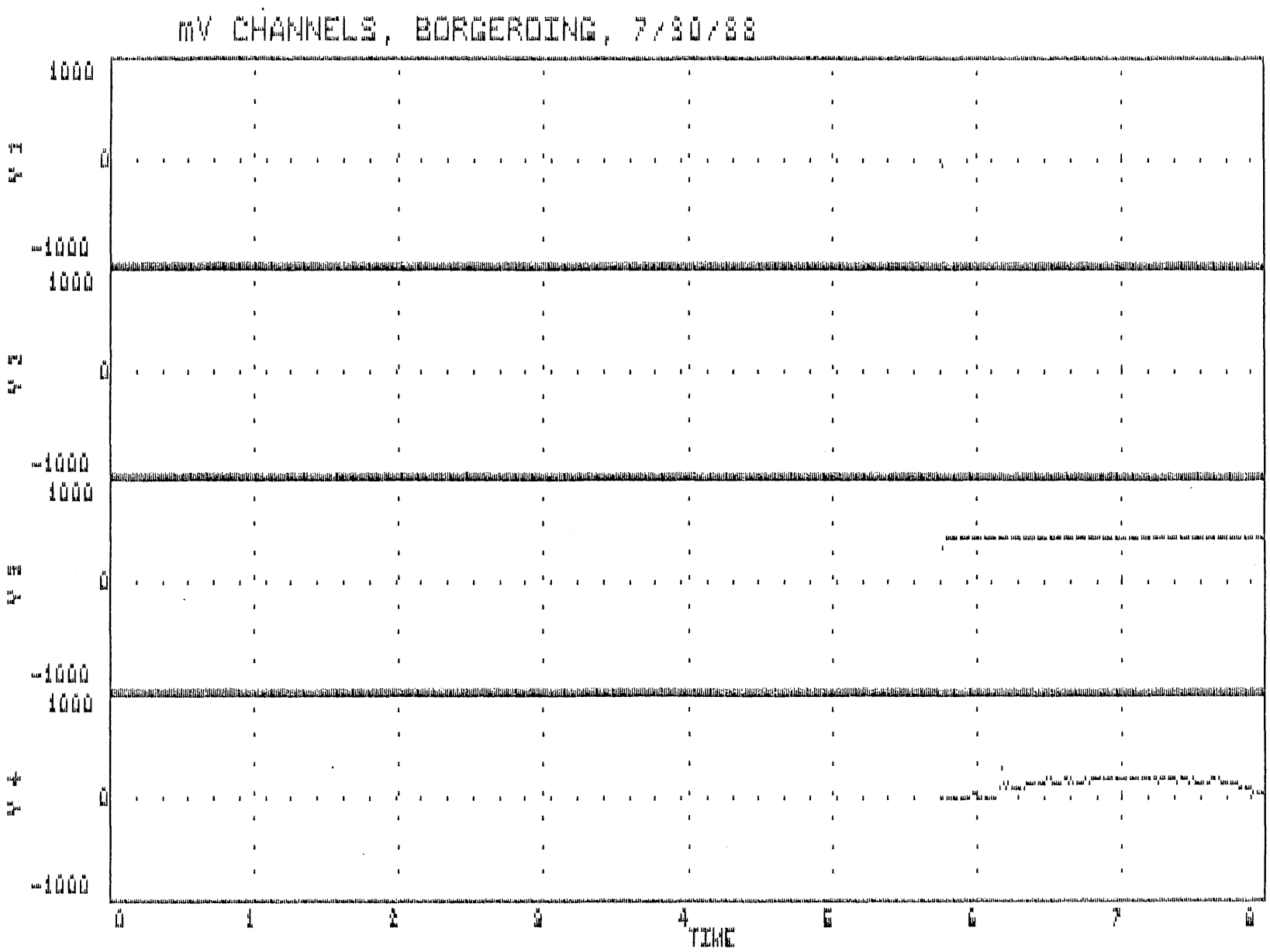
Detail Report

Variable: P PRECIPATATION TOTAL (in.)

Mean - Average	6.100581E-02	No. observations	15052
Lower 95% c.i.limit	5.757017E-02	No. missing values	1
Upper 95% c.i.limit	6.444845E-02	Sum of frequencies	15051
Adj sum of squares	707.0018	Sum of observations	918.65
Standard deviation	.2167415	Std.error of mean	1.766686E-03
Variance	4.697686E-02	T-value for mean=0	34.5482
Coef. of variation	3.551054	T prob level	0.0000
Skewness	3.658434	Kurtosis	11.57878
100-%tile (Maximum)	.93	90-%tile	.05
75-%tile	.01	10-%tile	0
50-%tile (Median)	0	Range	.93
25-%tile	0	75th-25th %tile	.01
0-%tile (Minimum)	0		

Variable: RH RELATIVE HUMIDITY (%)

Mean - Average	65.12192	No. observations	15052
Lower 95% c.i.limit	64.84242	No. missing values	1
Upper 95% c.i.limit	65.40142	Sum of frequencies	15051
Adj sum of squares	4606562	Sum of observations	980150
Standard deviation	17.49525	Std.error of mean	.1426059
Variance	306.0838	T-value for mean=0	456.6566
Coef. of variation	.2686578	T prob level	0.0000
Skewness	-.1445702	Kurtosis	-1.010731
Normality Test Value	0.932	Reject if < 0.997(10%)	0.991(5%)
100-%tile (Maximum)	97	90-%tile	88
75-%tile	80	10-%tile	42
50-%tile (Median)	66	Range	72
25-%tile	50	75th-25th %tile	30
0-%tile (Minimum)	25		


mV CHANNELS, BORGEROING, 7/30/88
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
0
1
2
3
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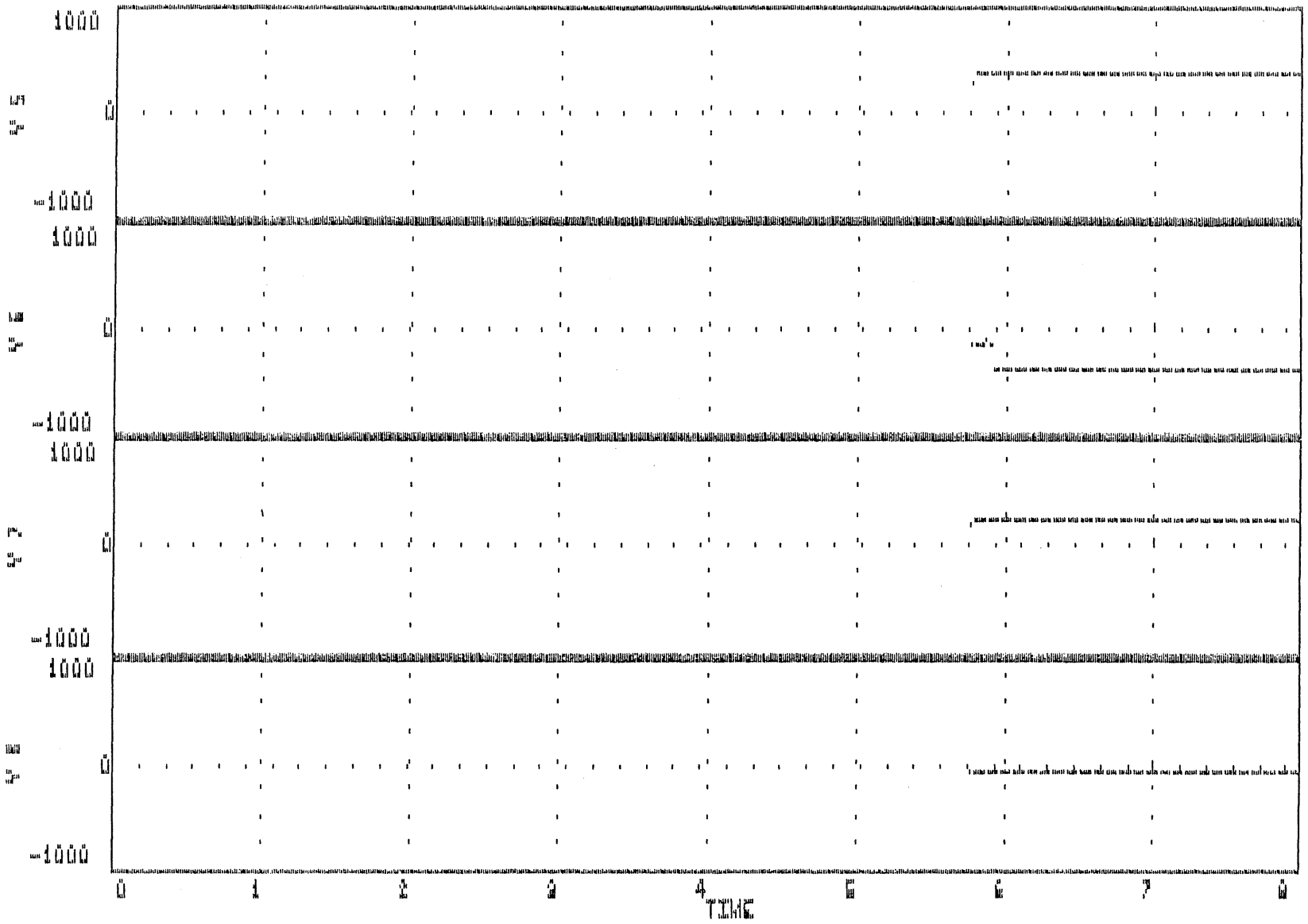
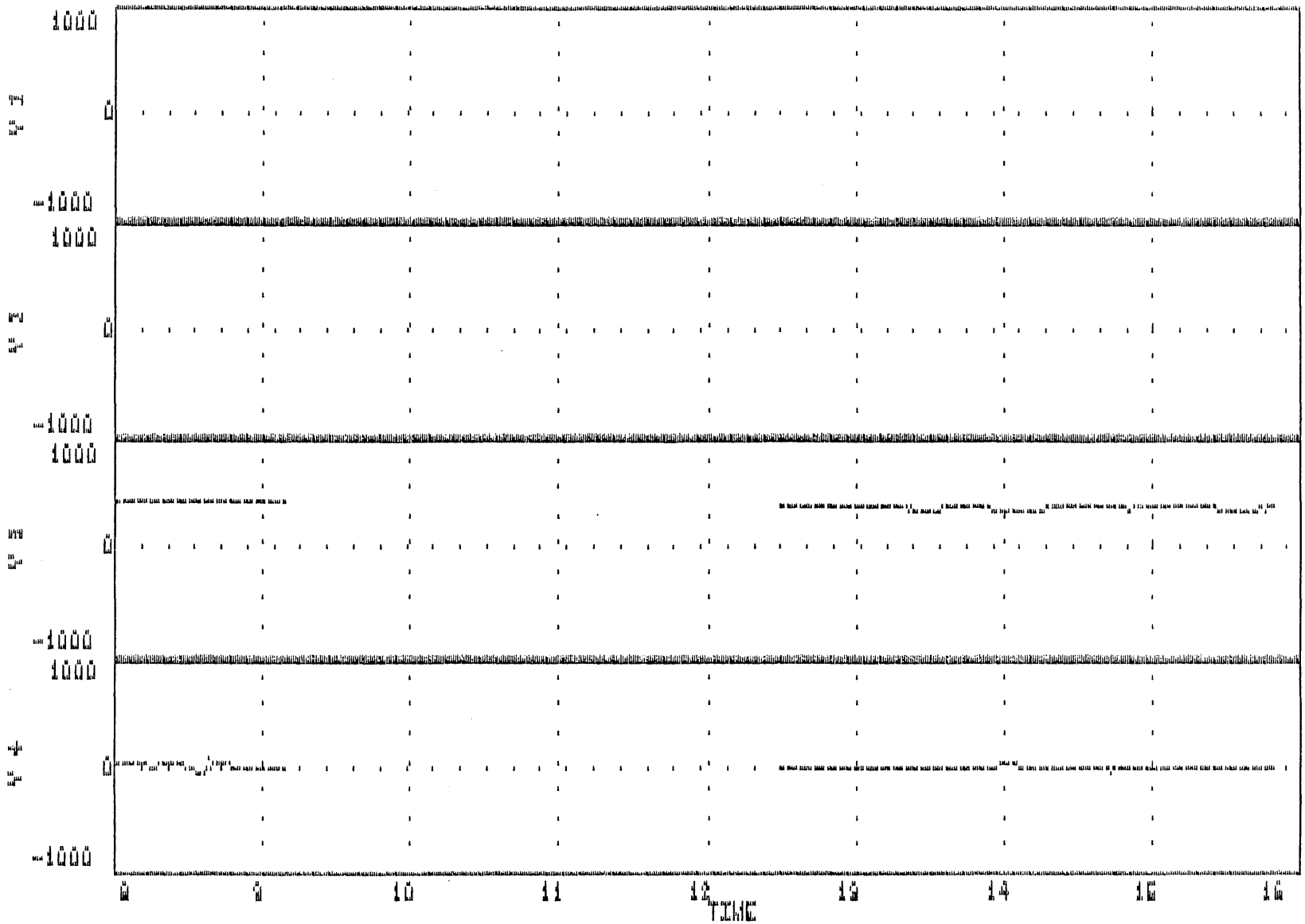
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 7/30/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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11
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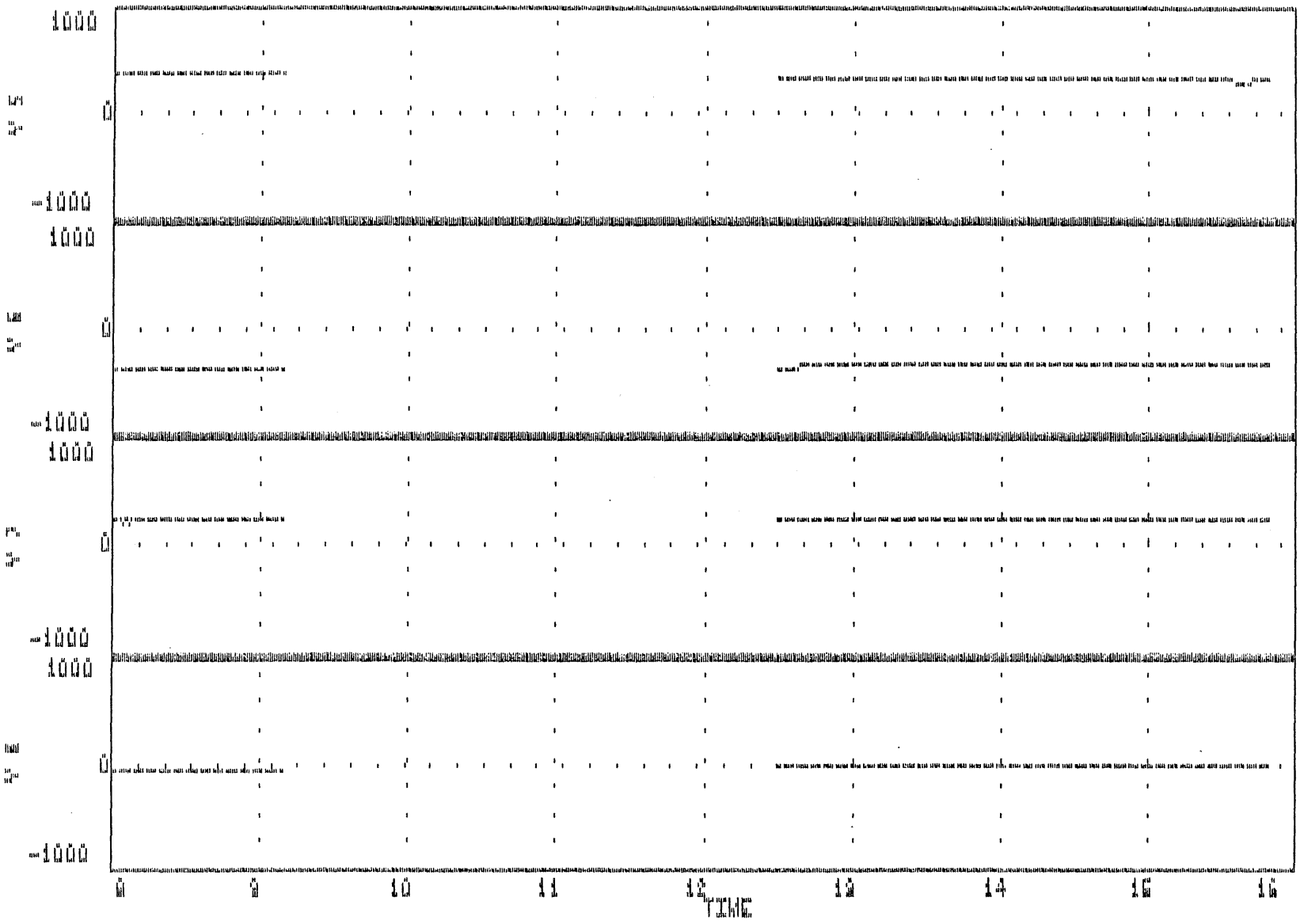
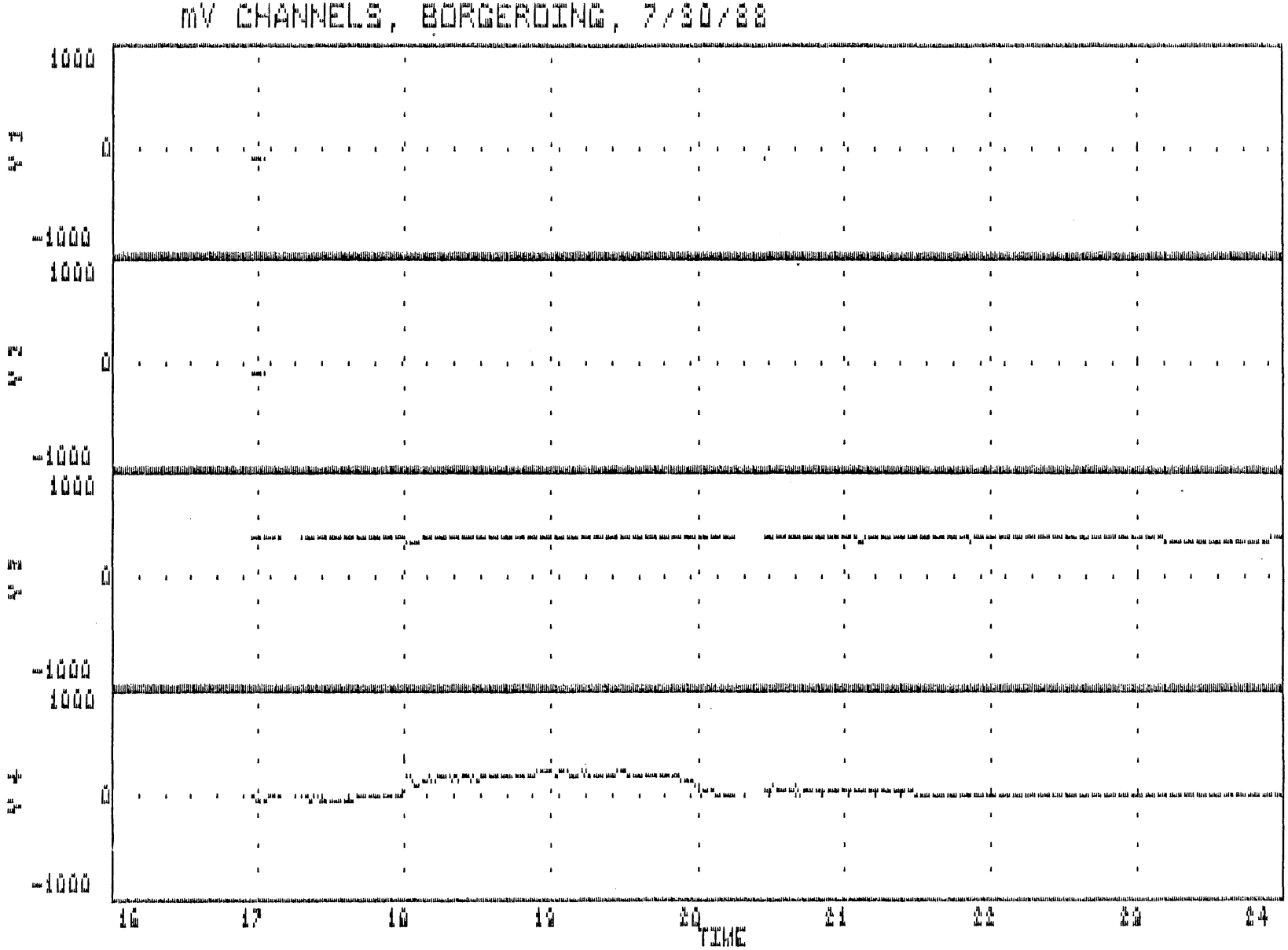
13
14
15
16
TIME

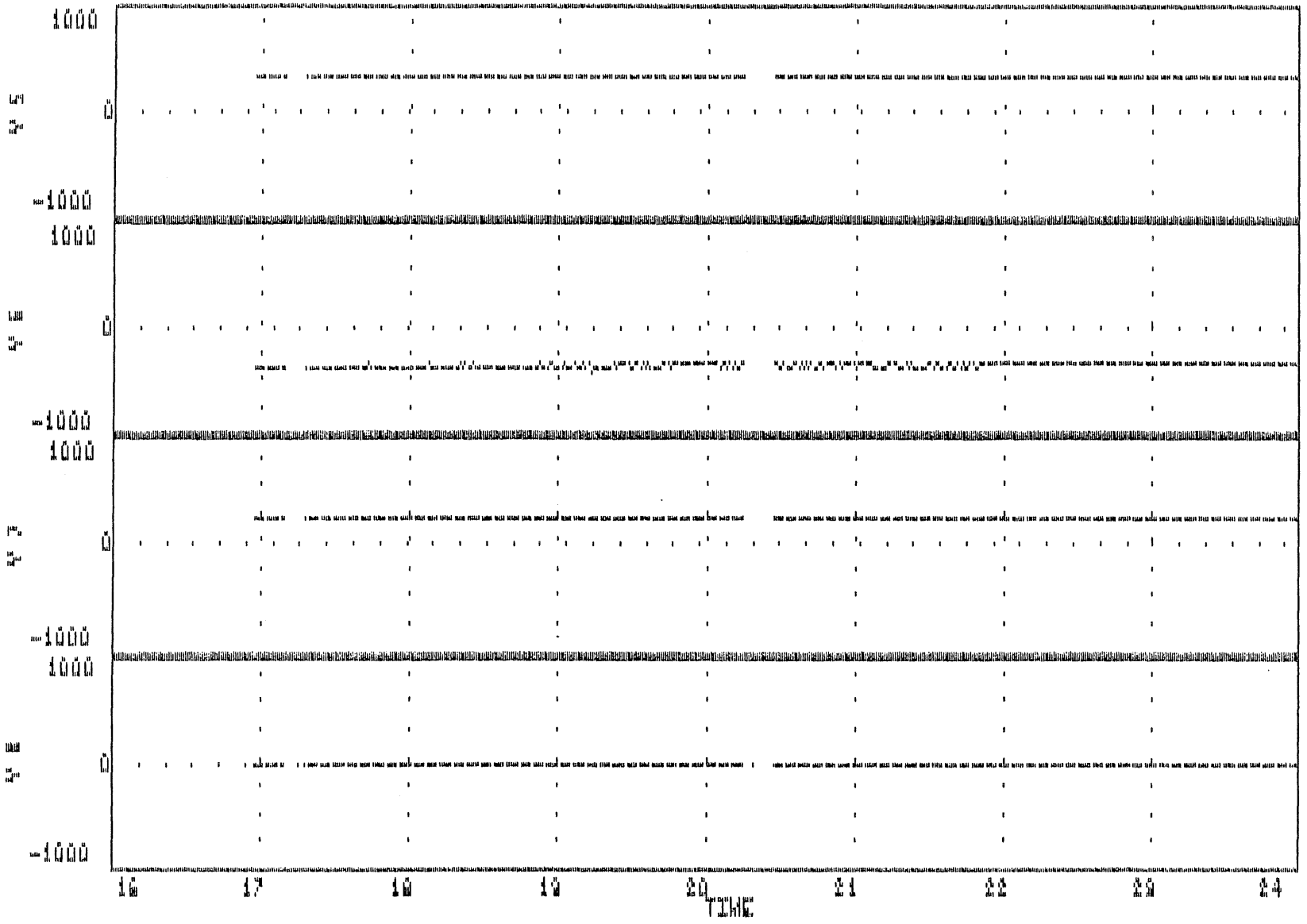


KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

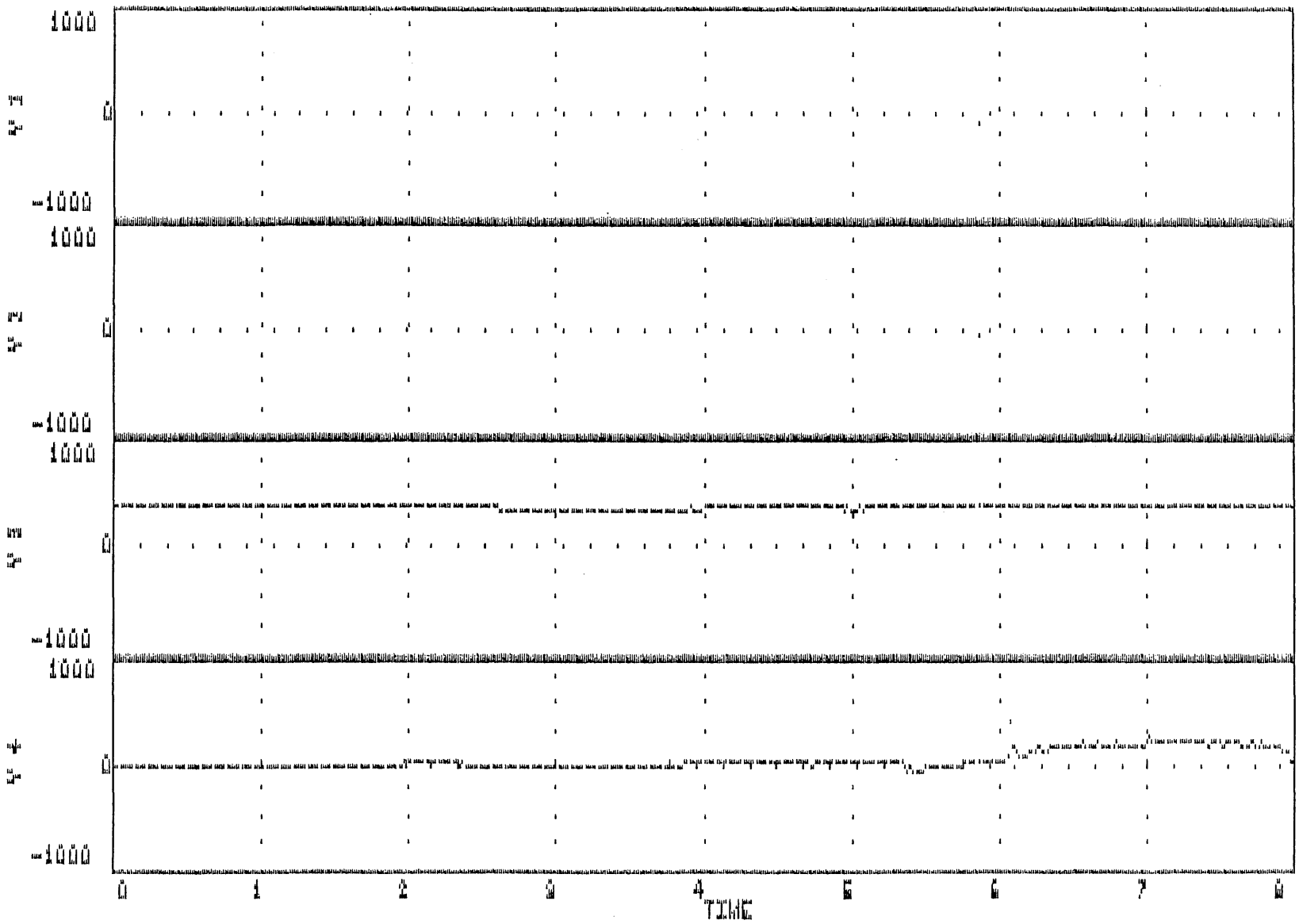

mV CHANNELS, BORGEROING, 7/30/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
16
17
18
19
20
21
22
23
24
TIME

mV CHANNELS, BORDERING, 7/30/88



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 7/31/88
1000
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-1000
CH 1
CH 2
CH 3
CH 4
0
1
2
3
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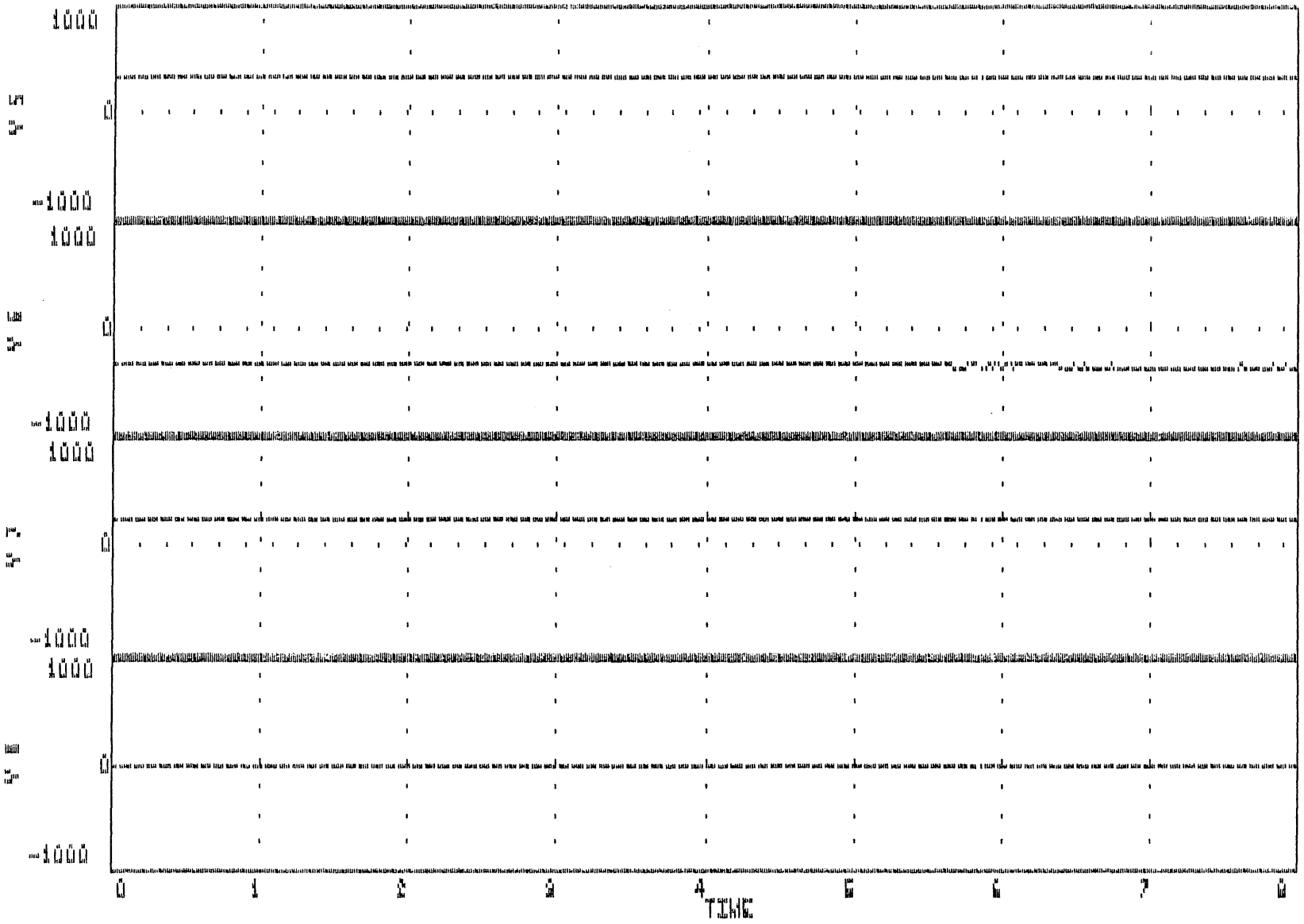
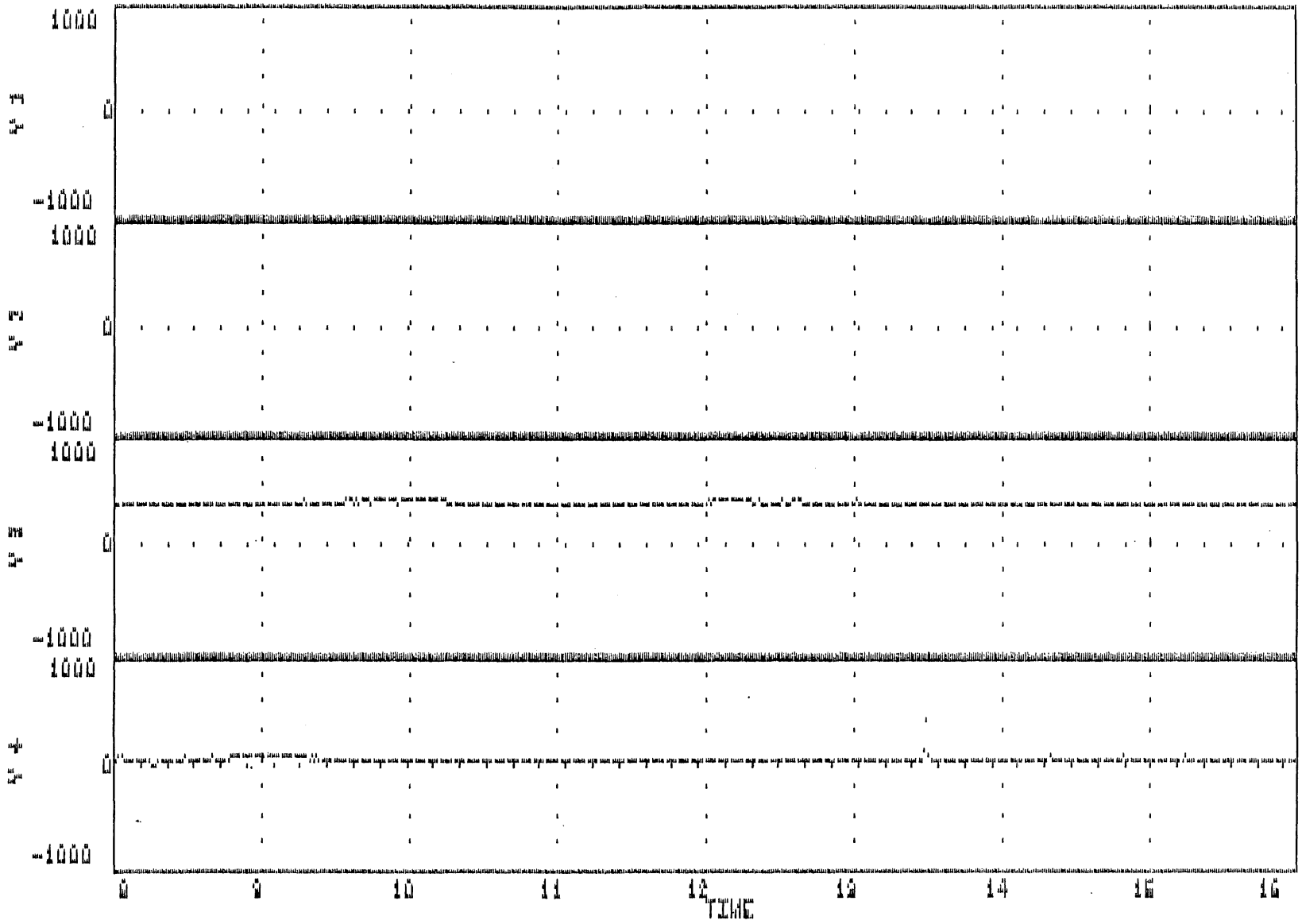
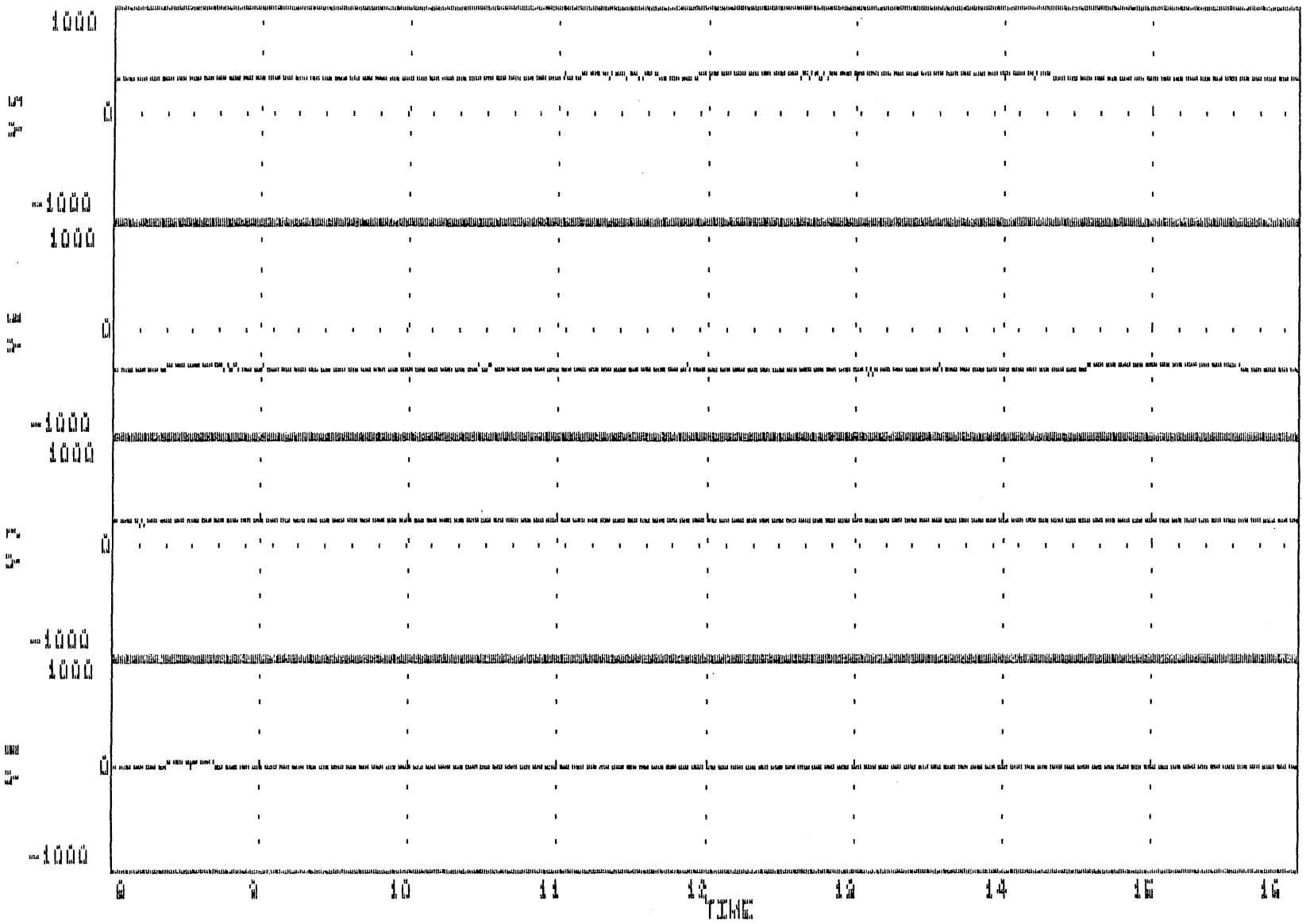
5
6
7
8
TIME



KEY

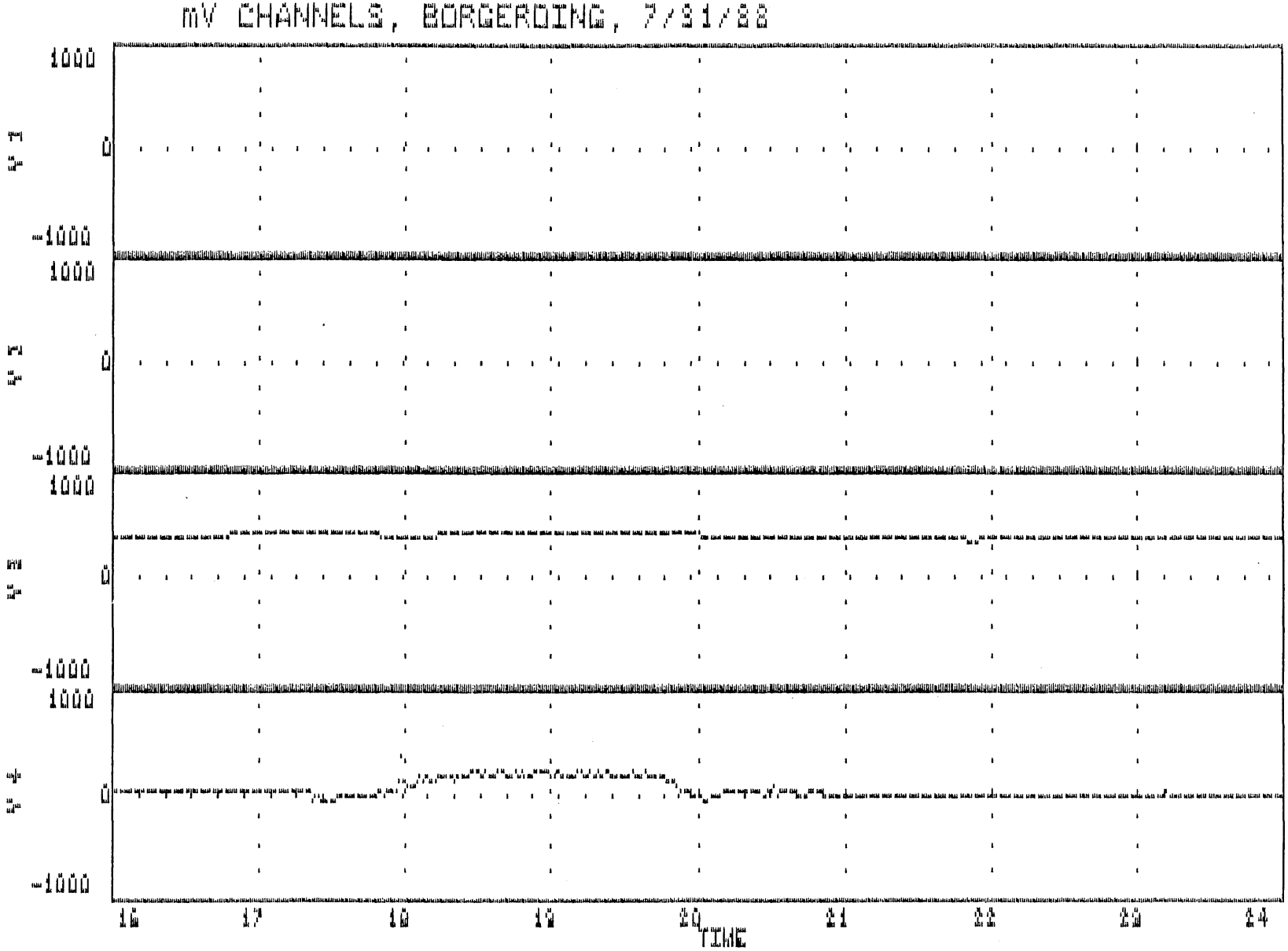
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORDERDING, 7/31/85
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
8
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGEROING, 7/31/88
1000
0
-1000
E1
E2
E3
E4
16
17
18
19
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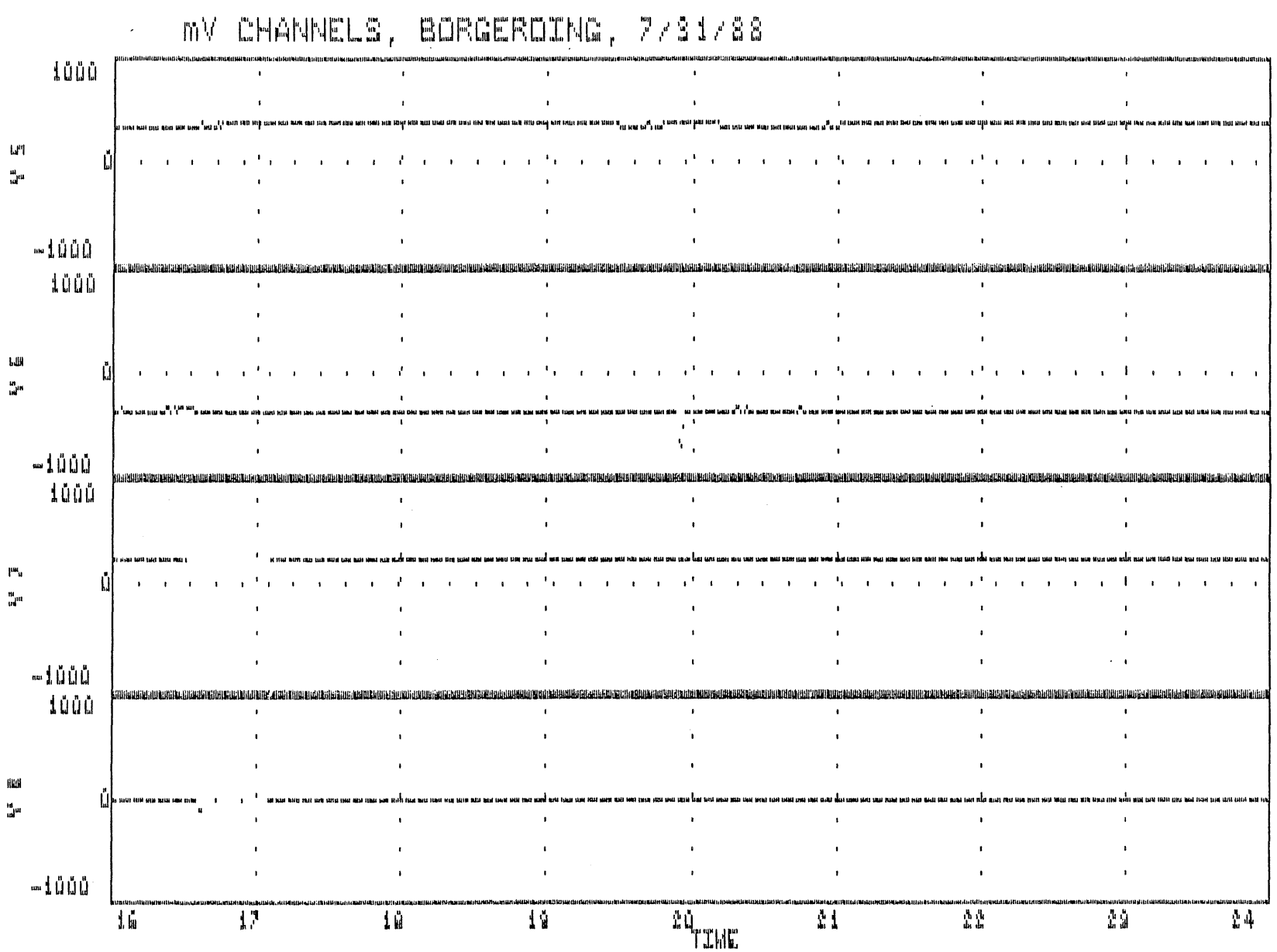
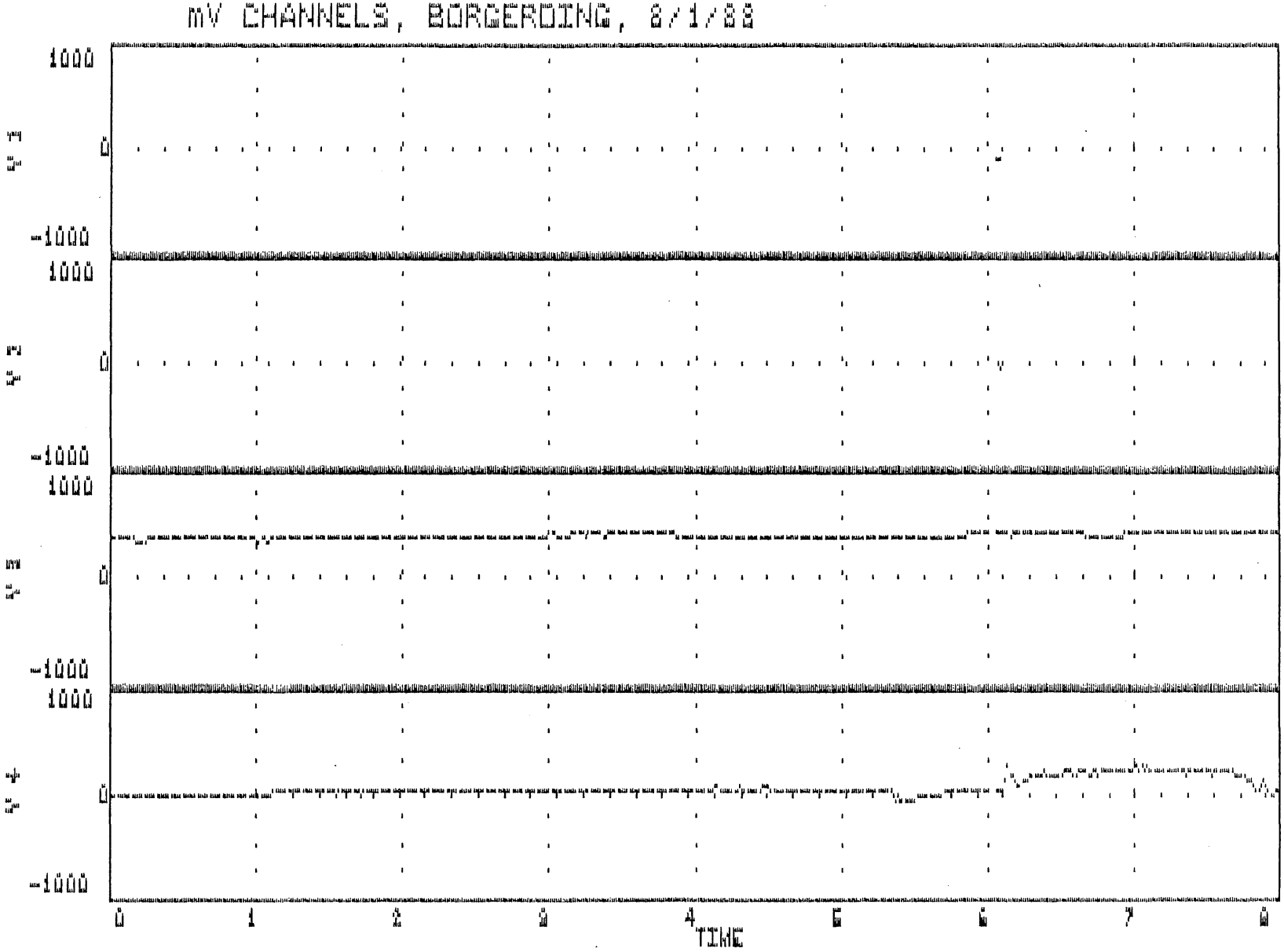
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/1/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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2
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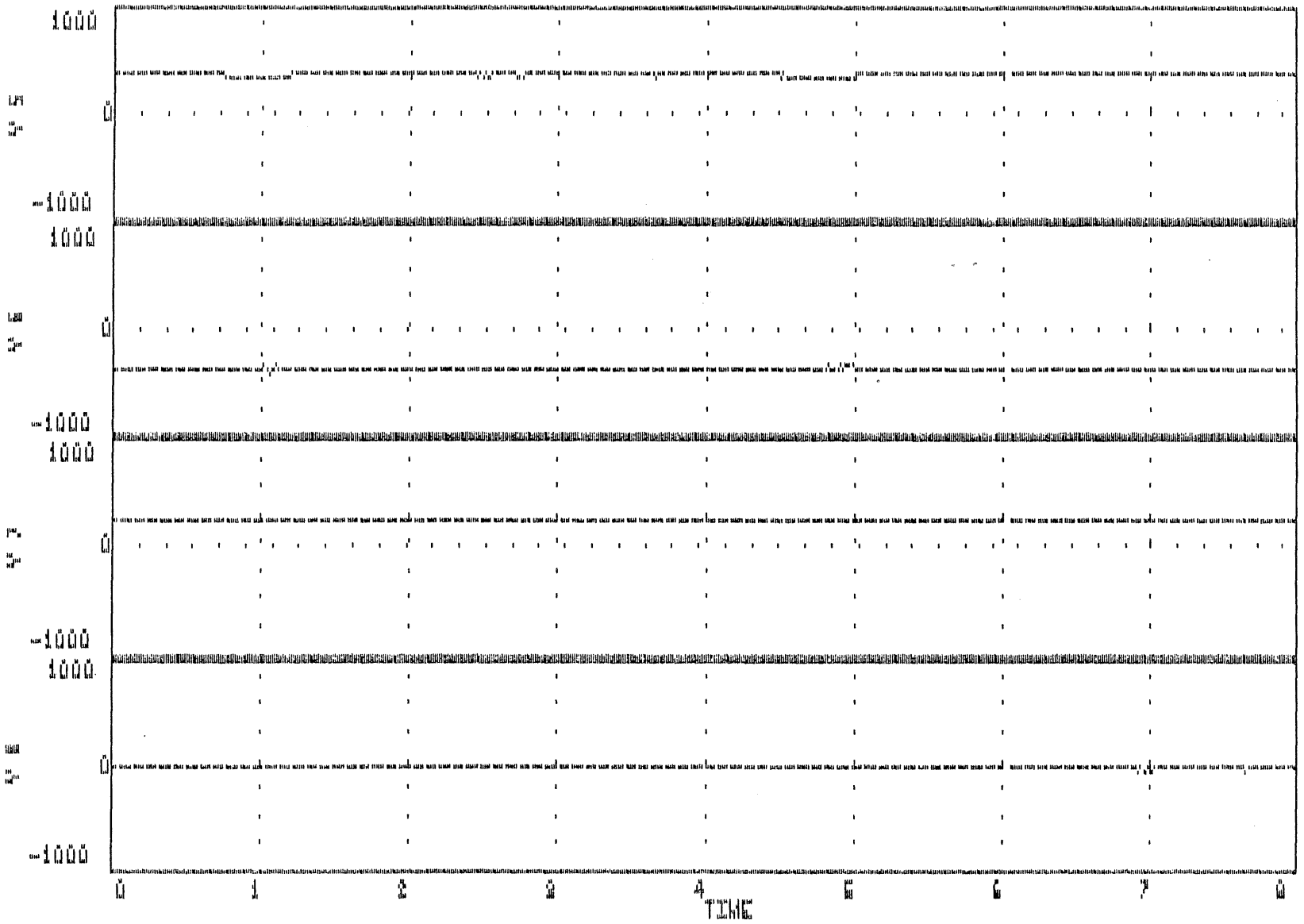
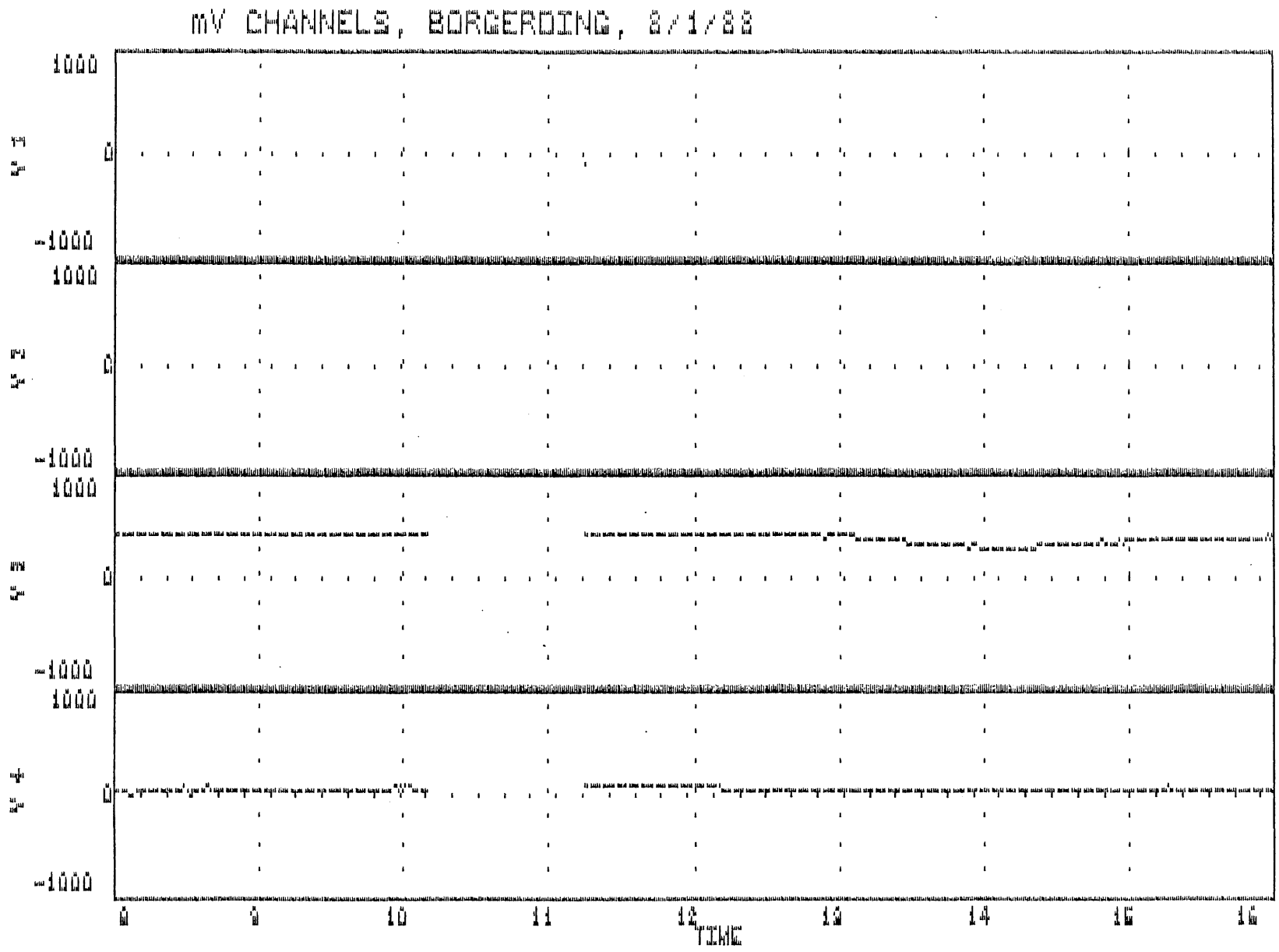
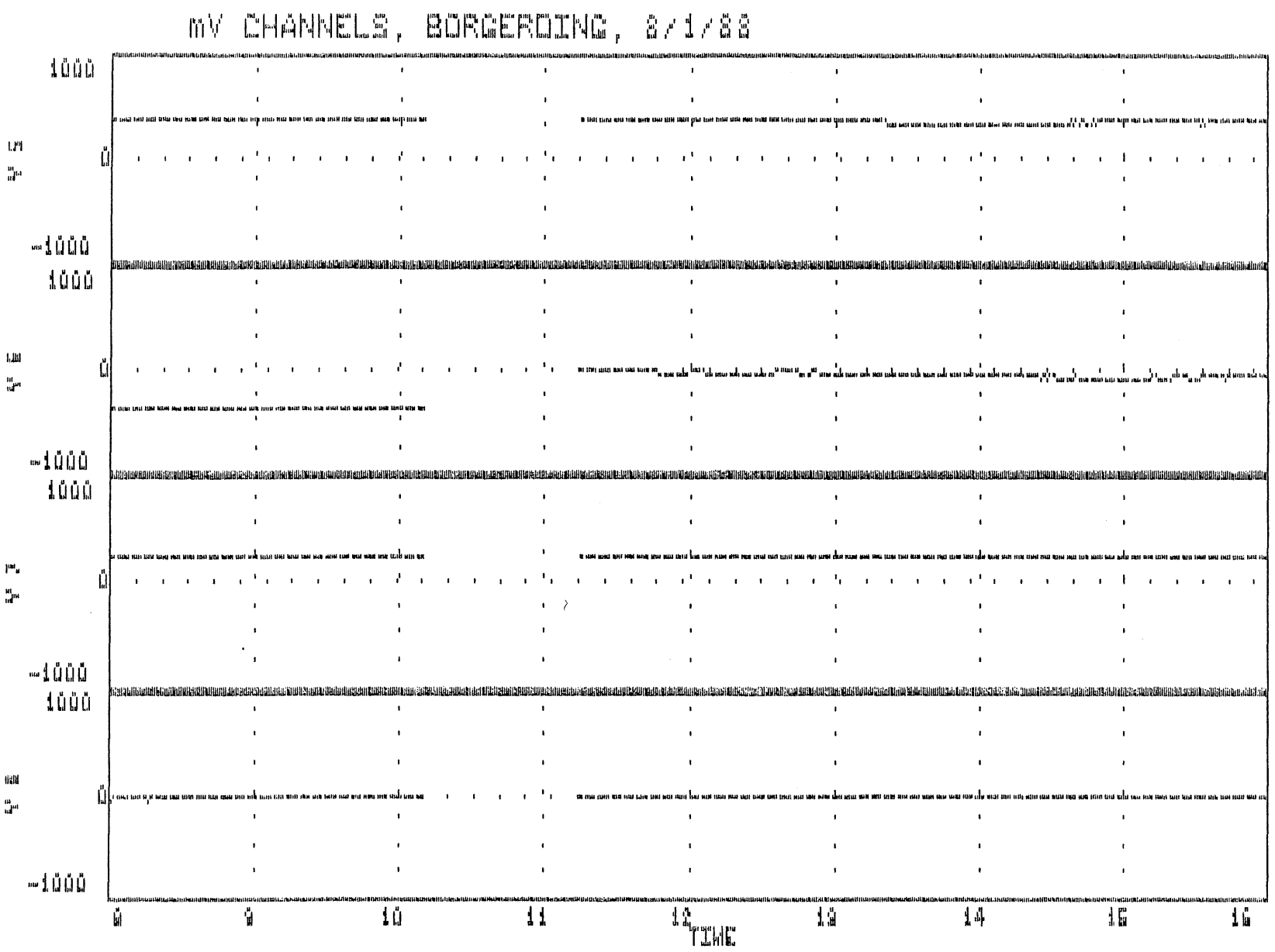
5
6
7
8
TIME



KEY

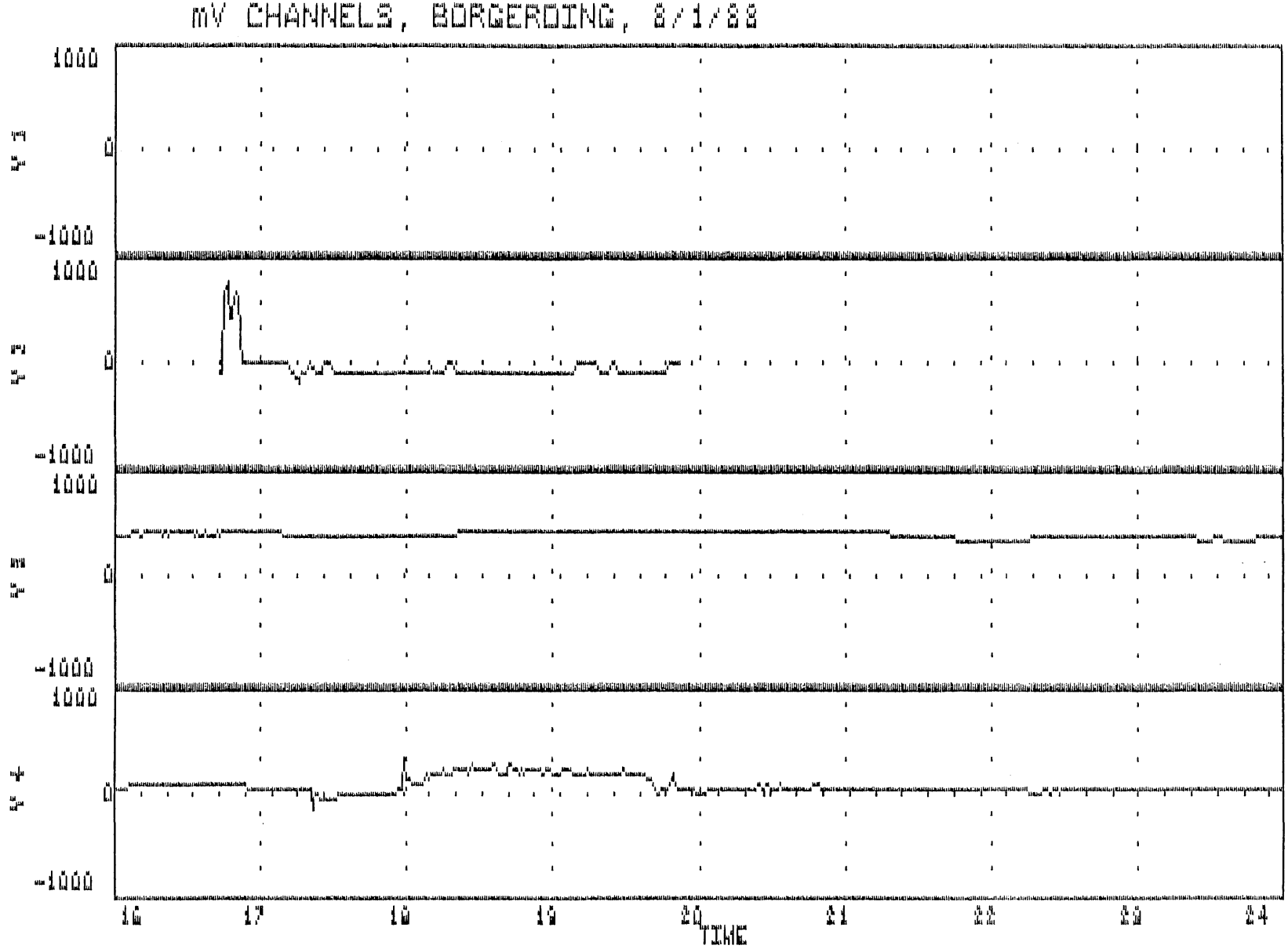
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/1/88
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/1/88
1000
0
-1000
E1
E2
E3
E4
16
17
18
19
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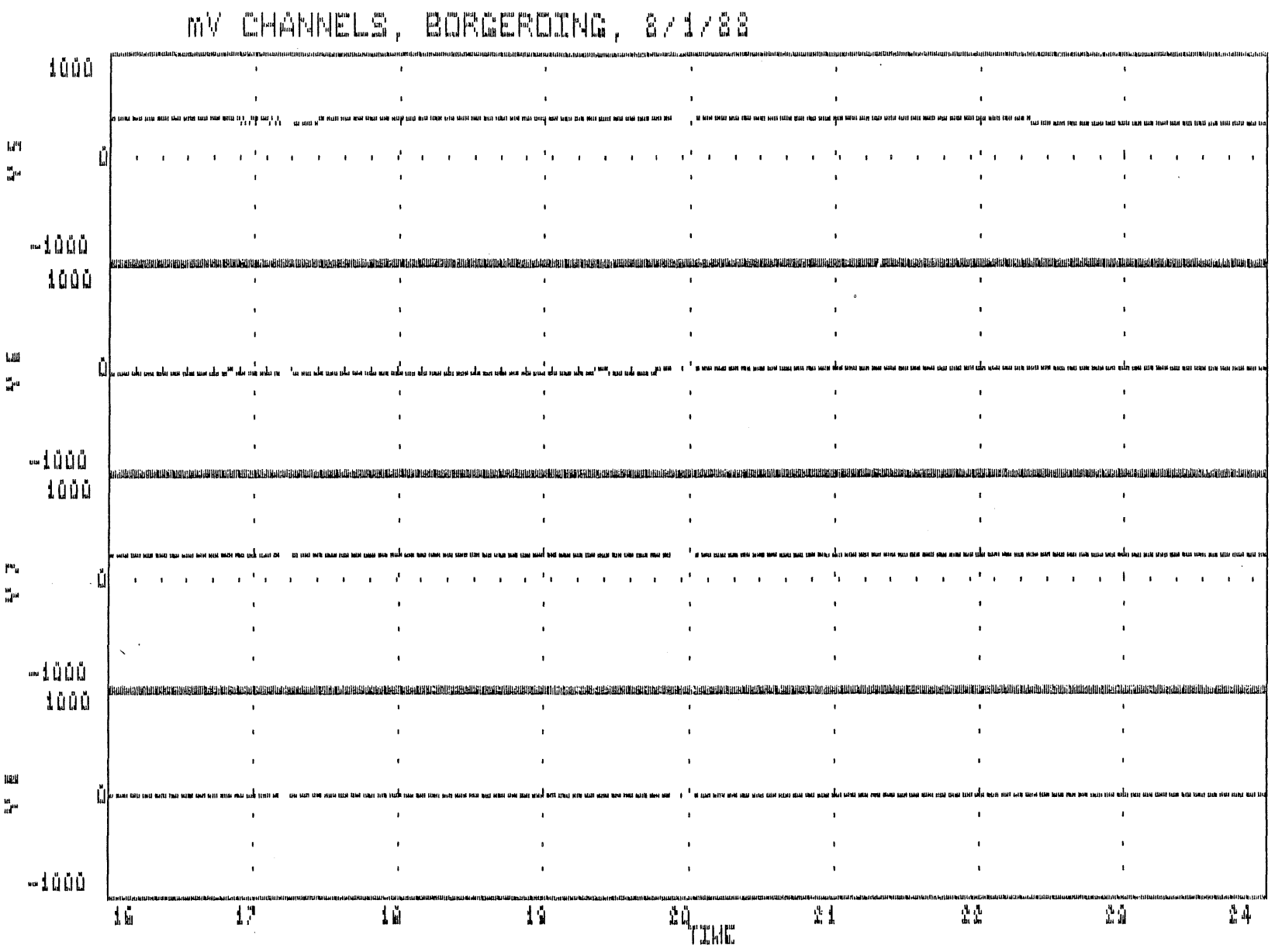
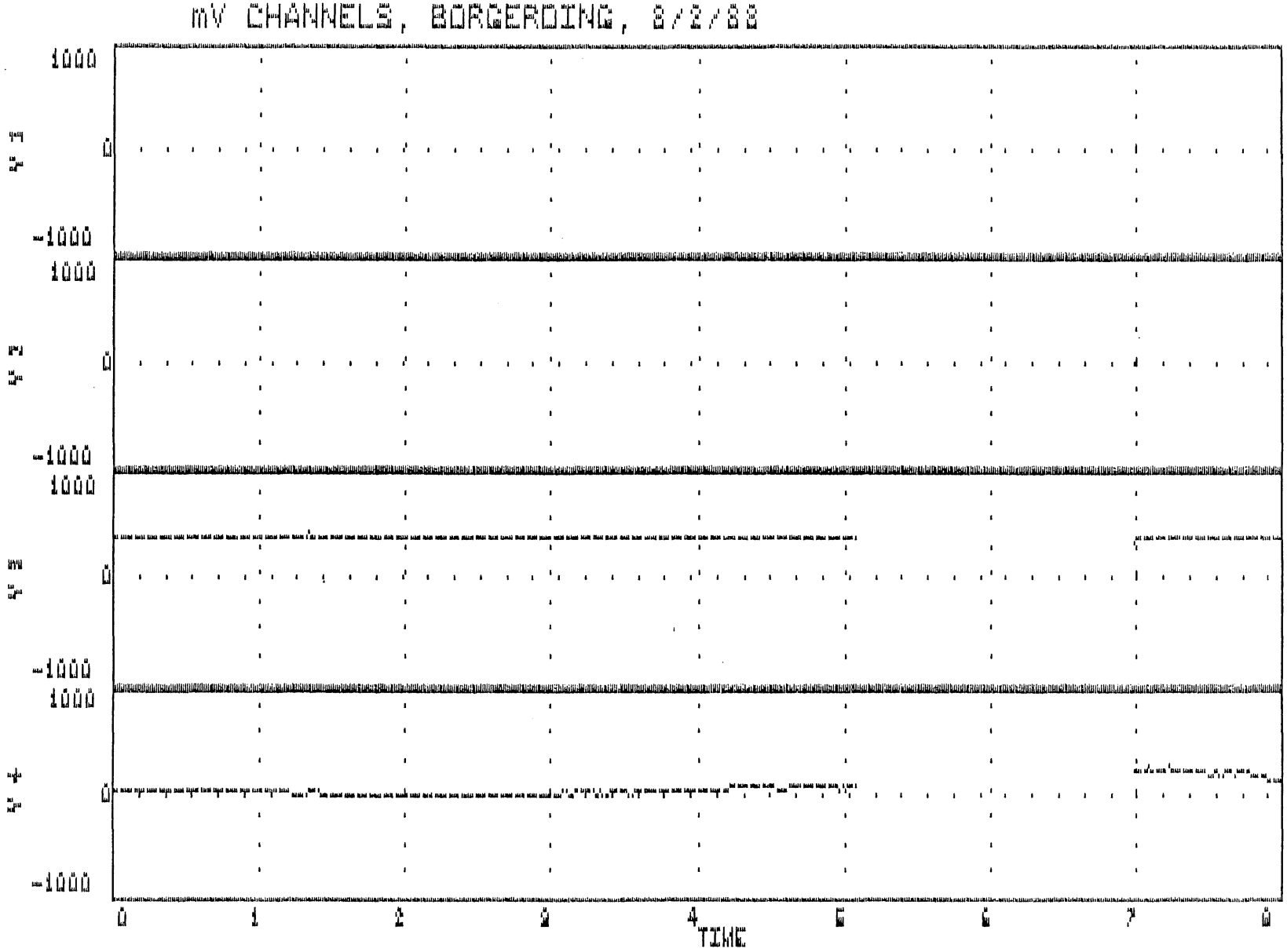
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	experimental		V6	barn ceiling	S waterline
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/2/83
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
0
1
2
3
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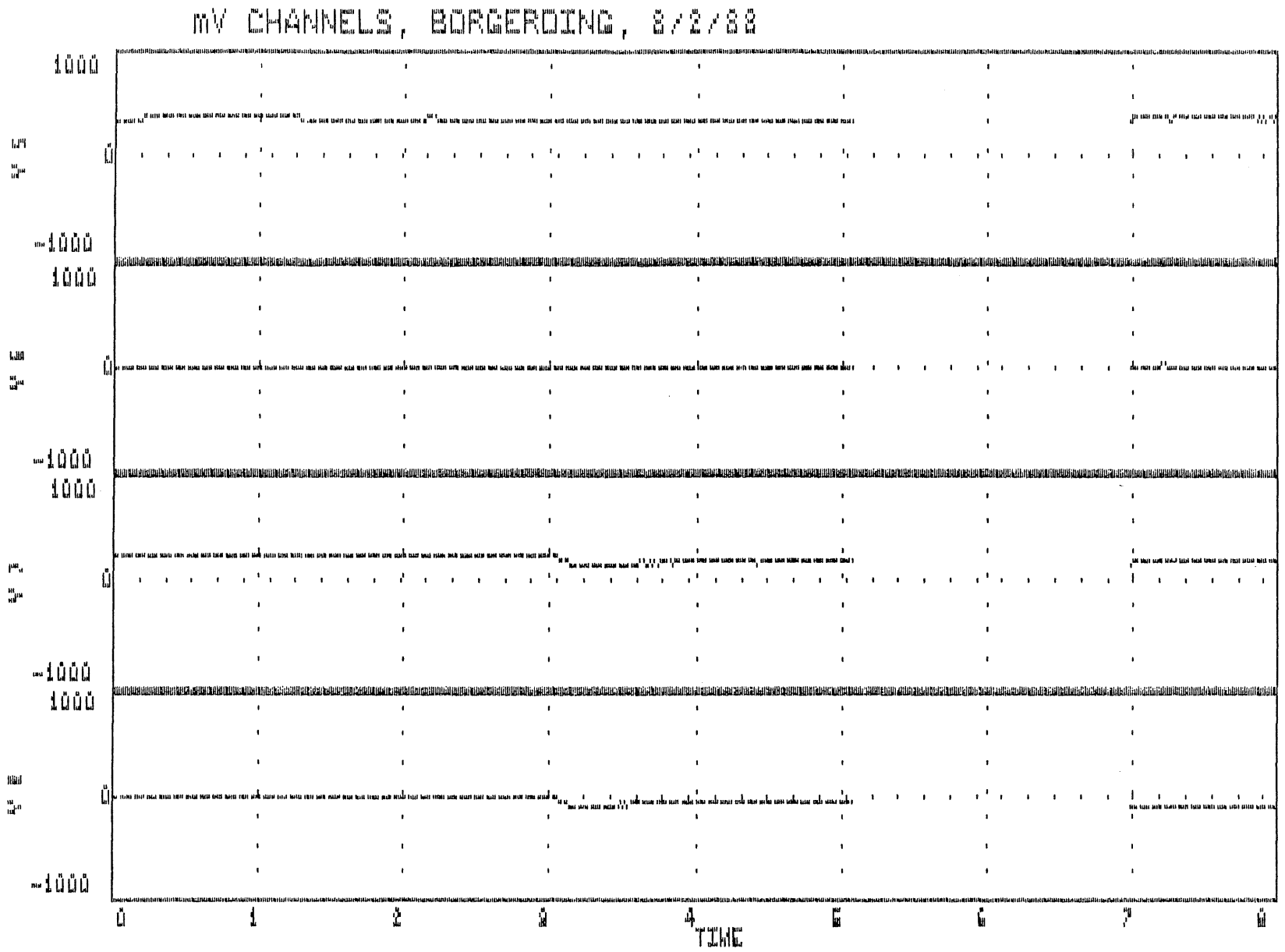
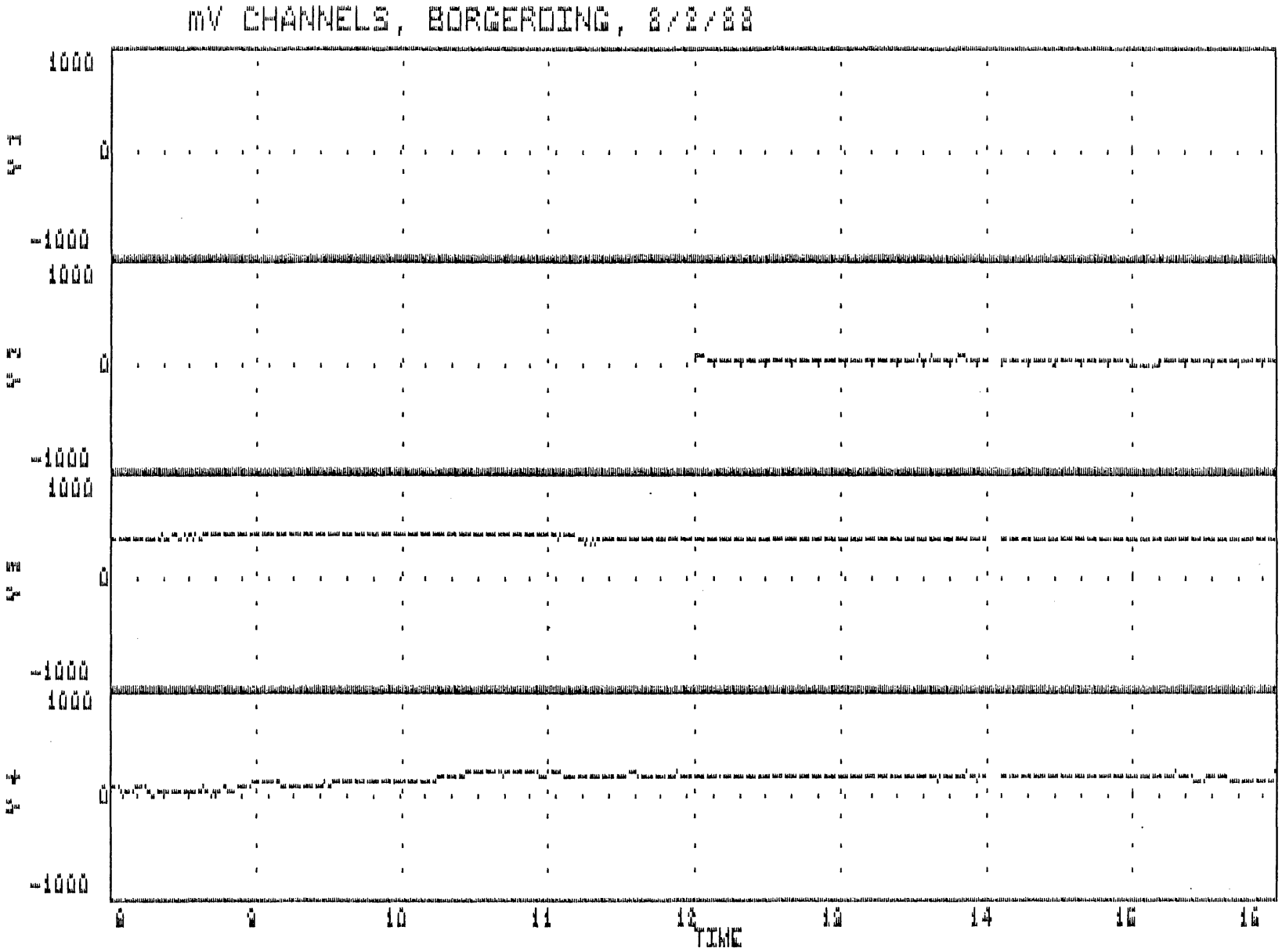
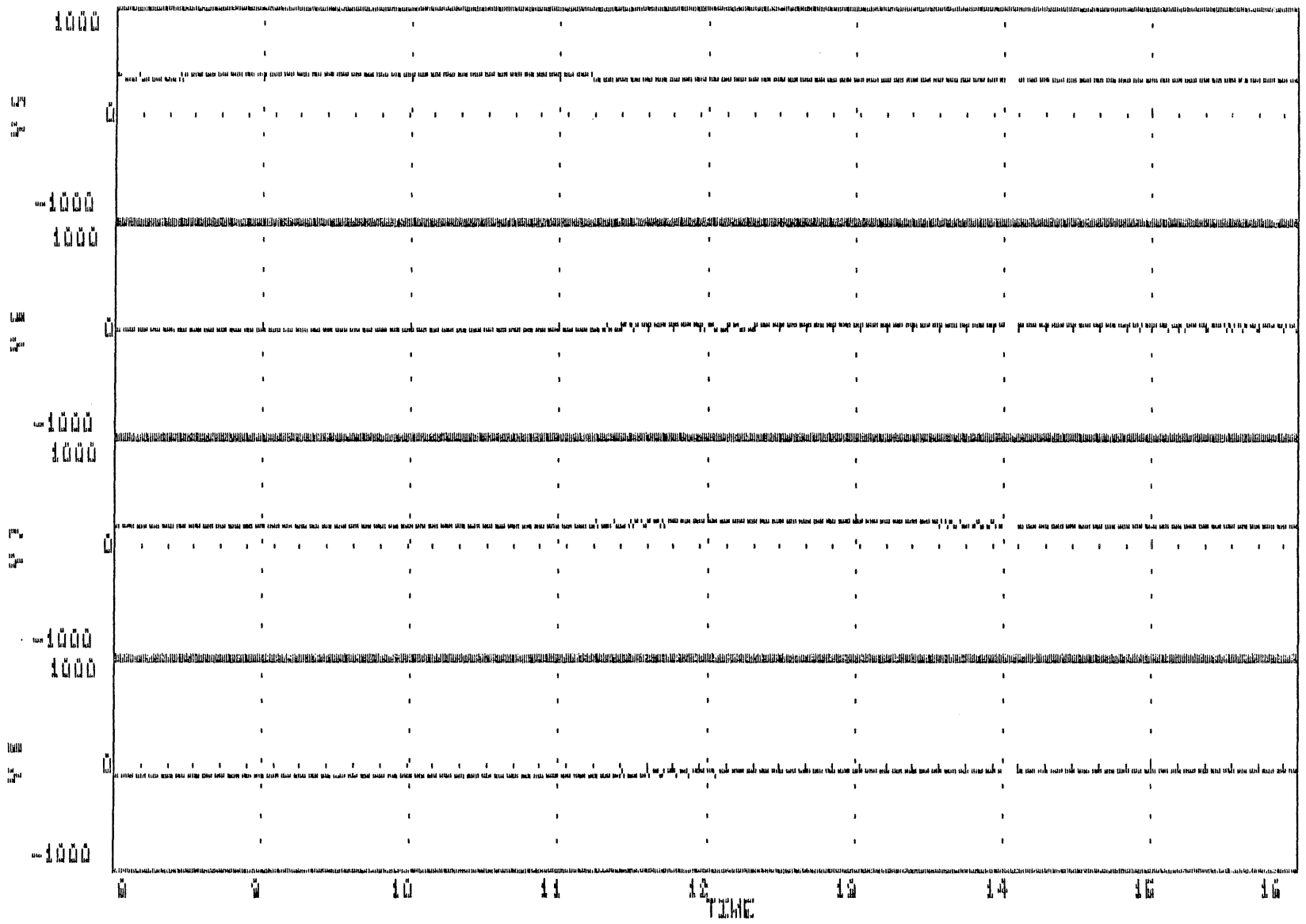
5
6
7
8
TIME



KEY

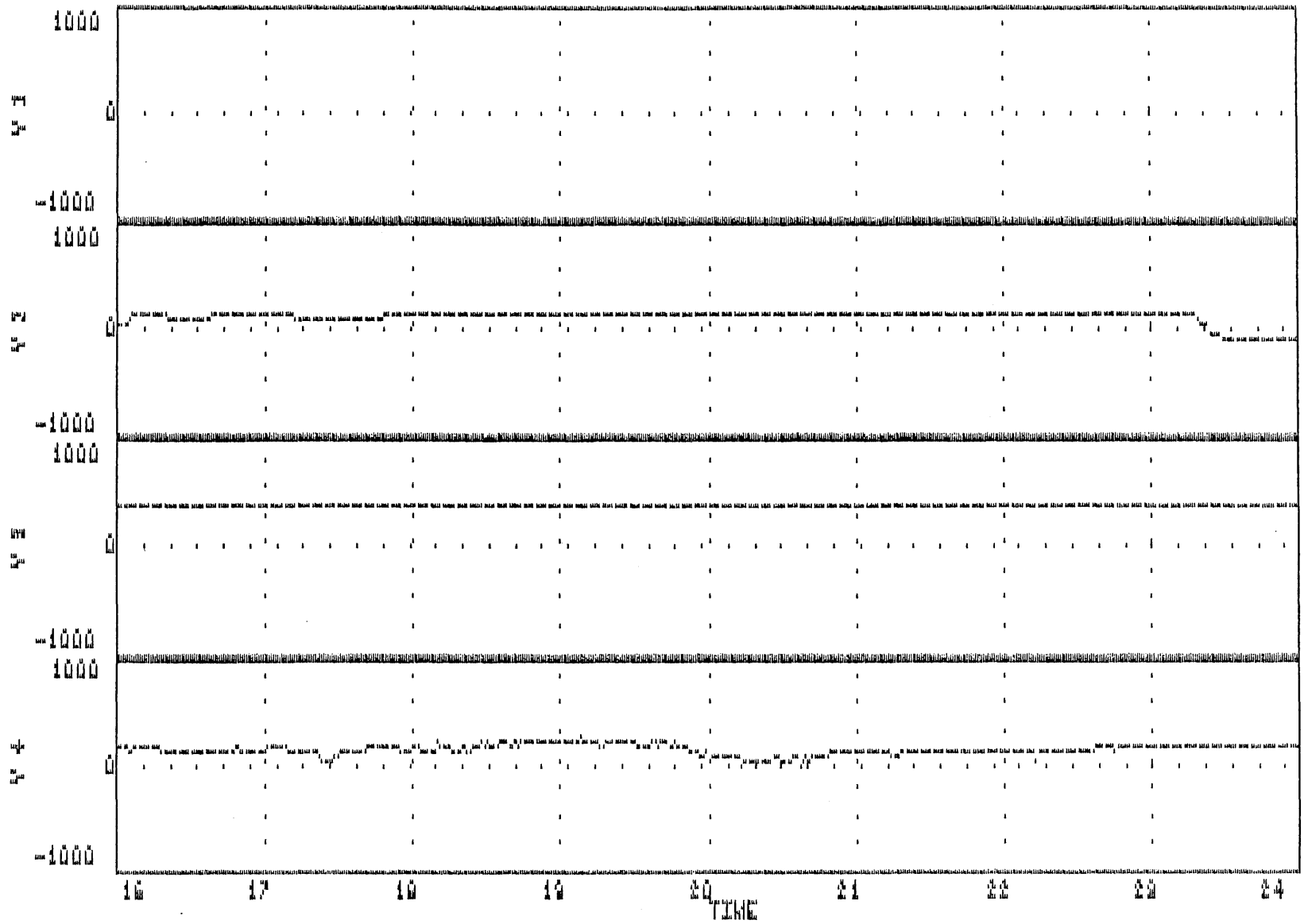
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2			V6*	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/2/88
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2*	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/2/88
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
16
17
18
19
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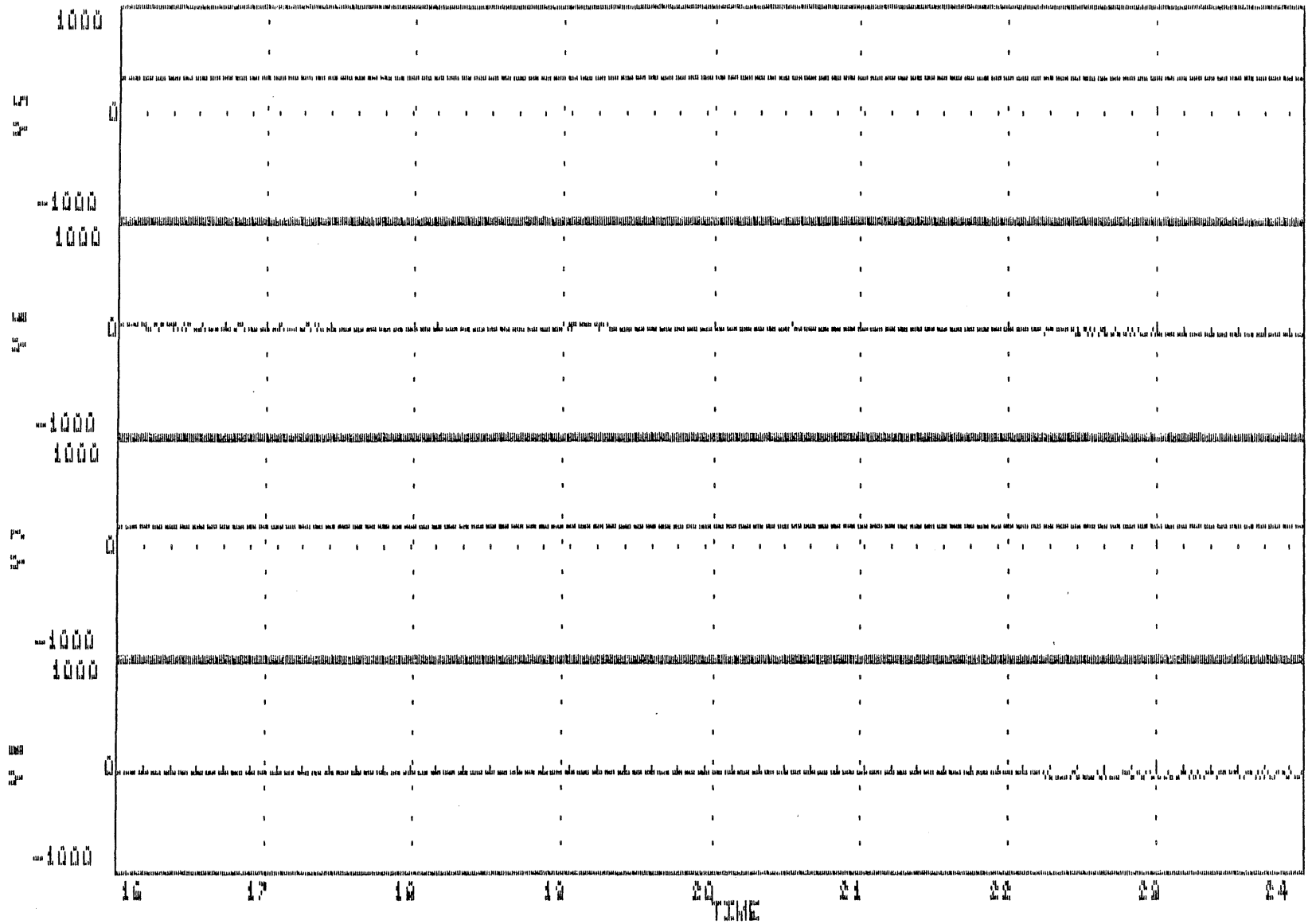
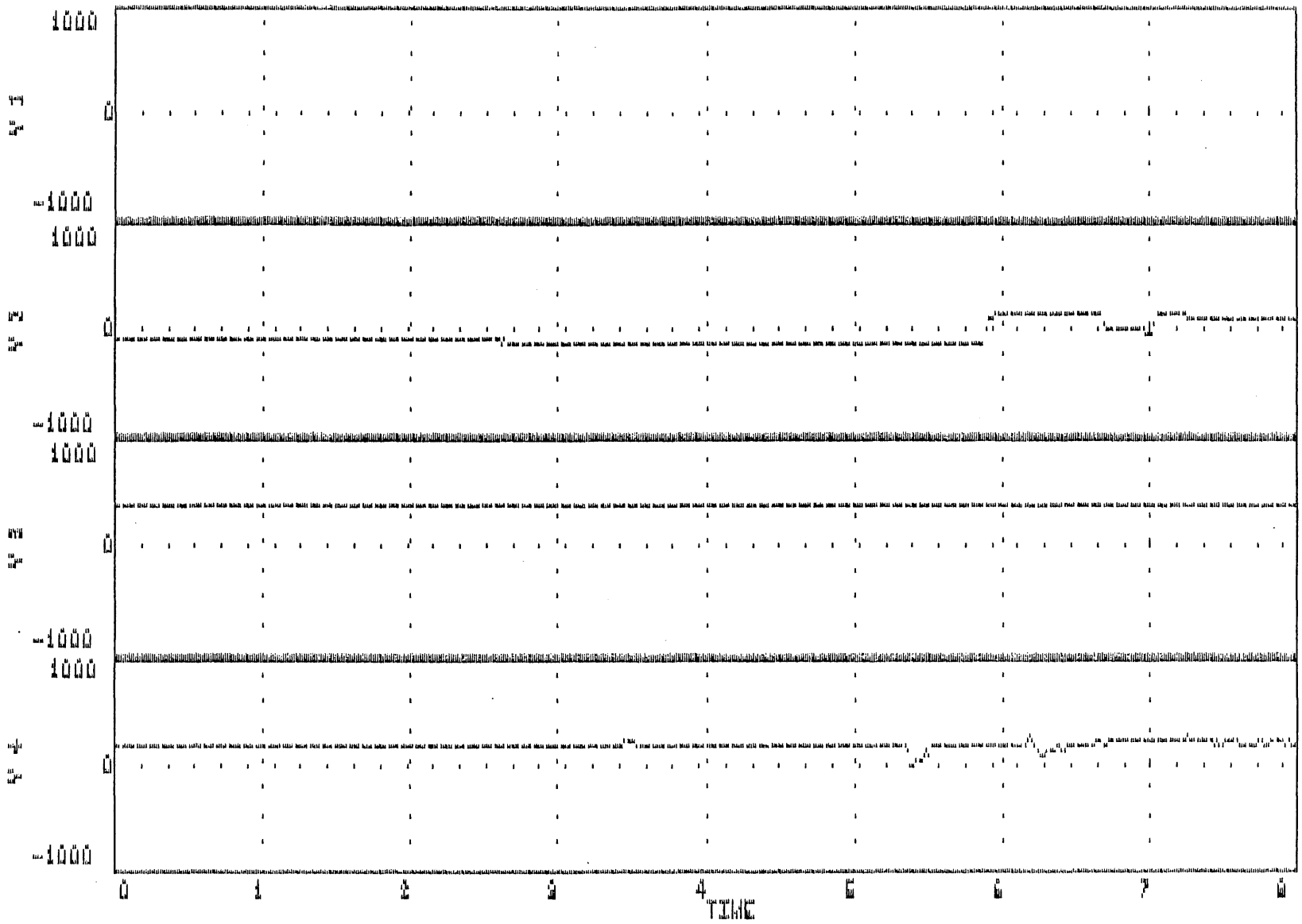
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/3/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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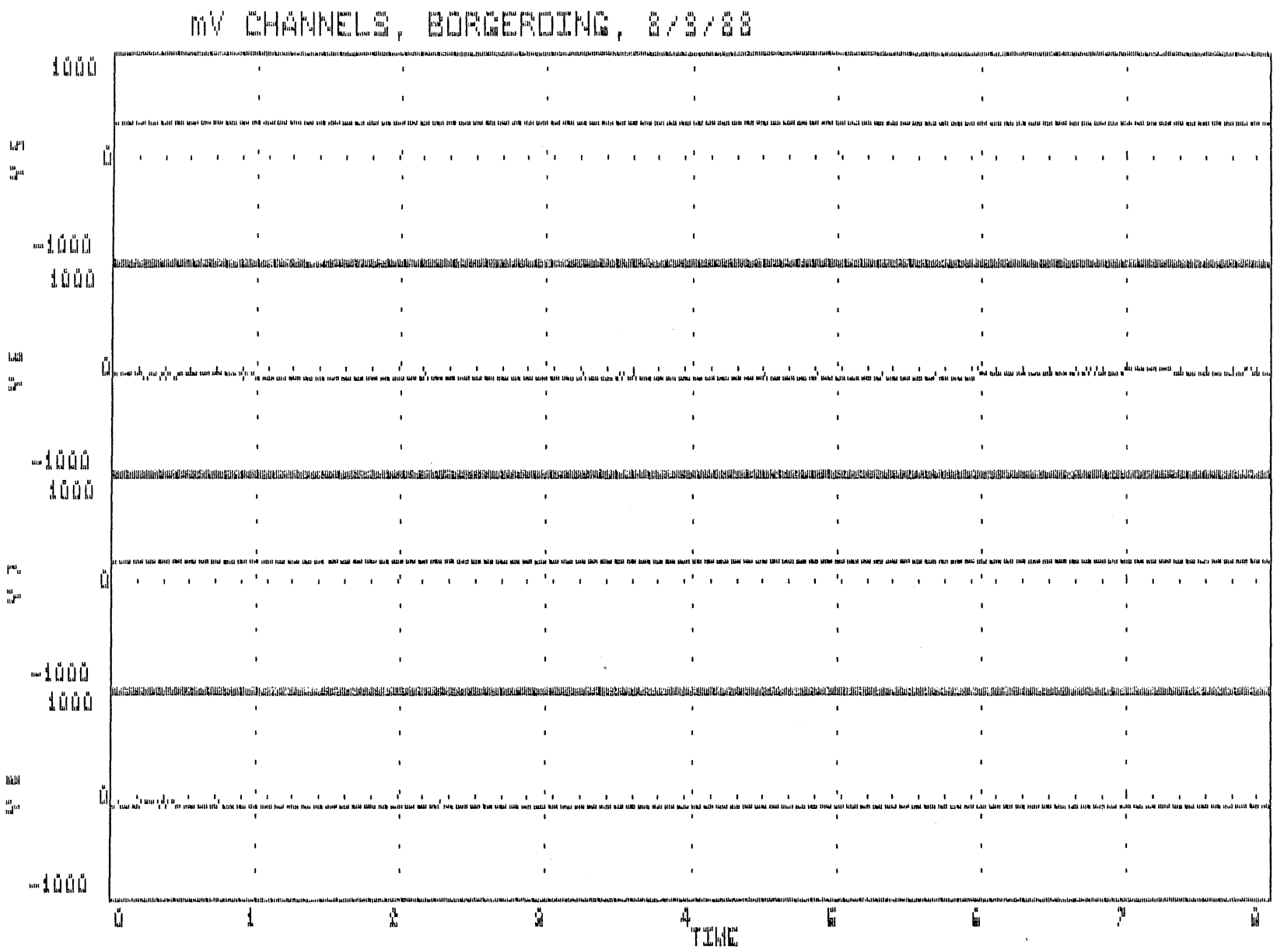
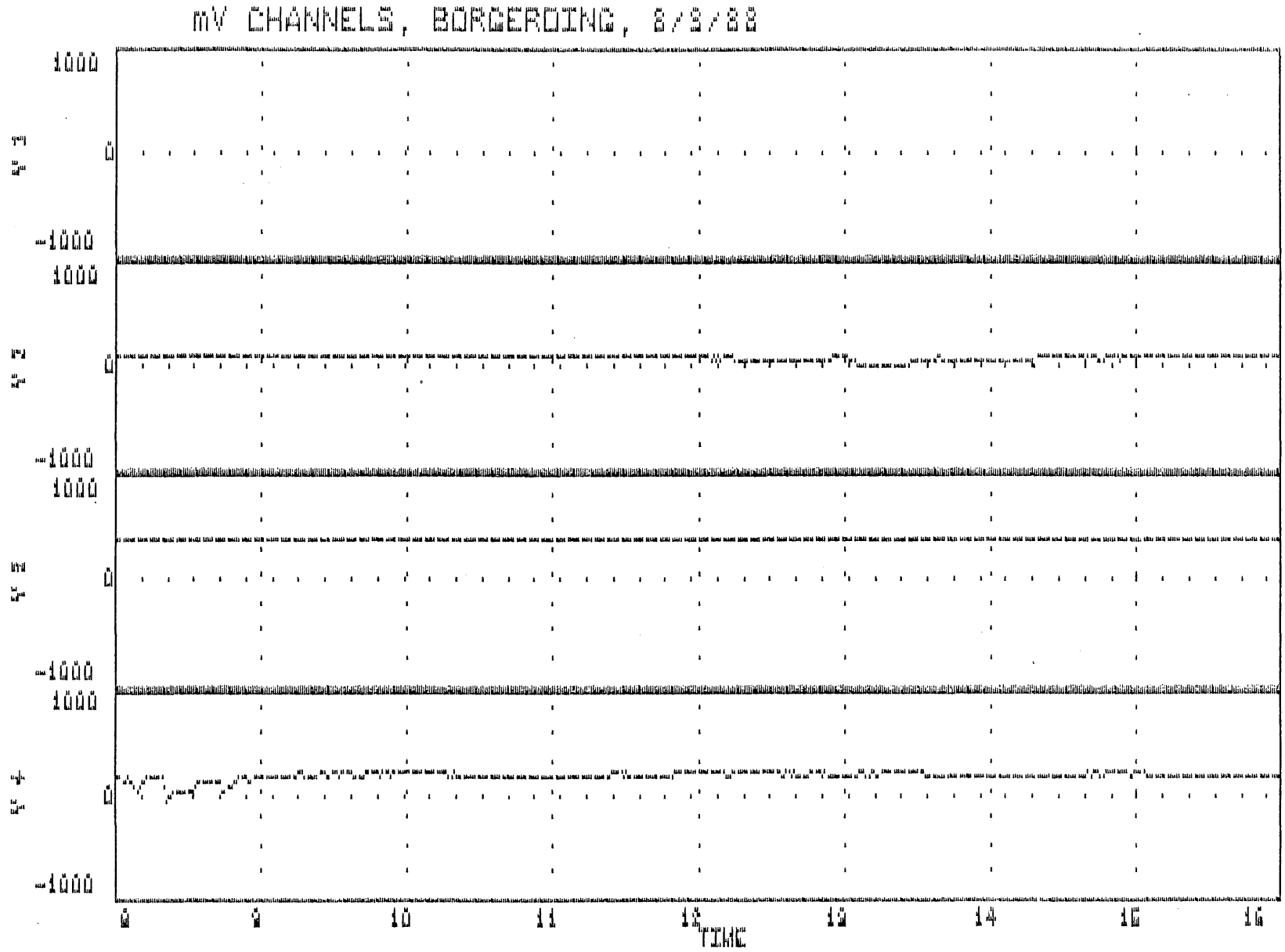
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/3/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
9
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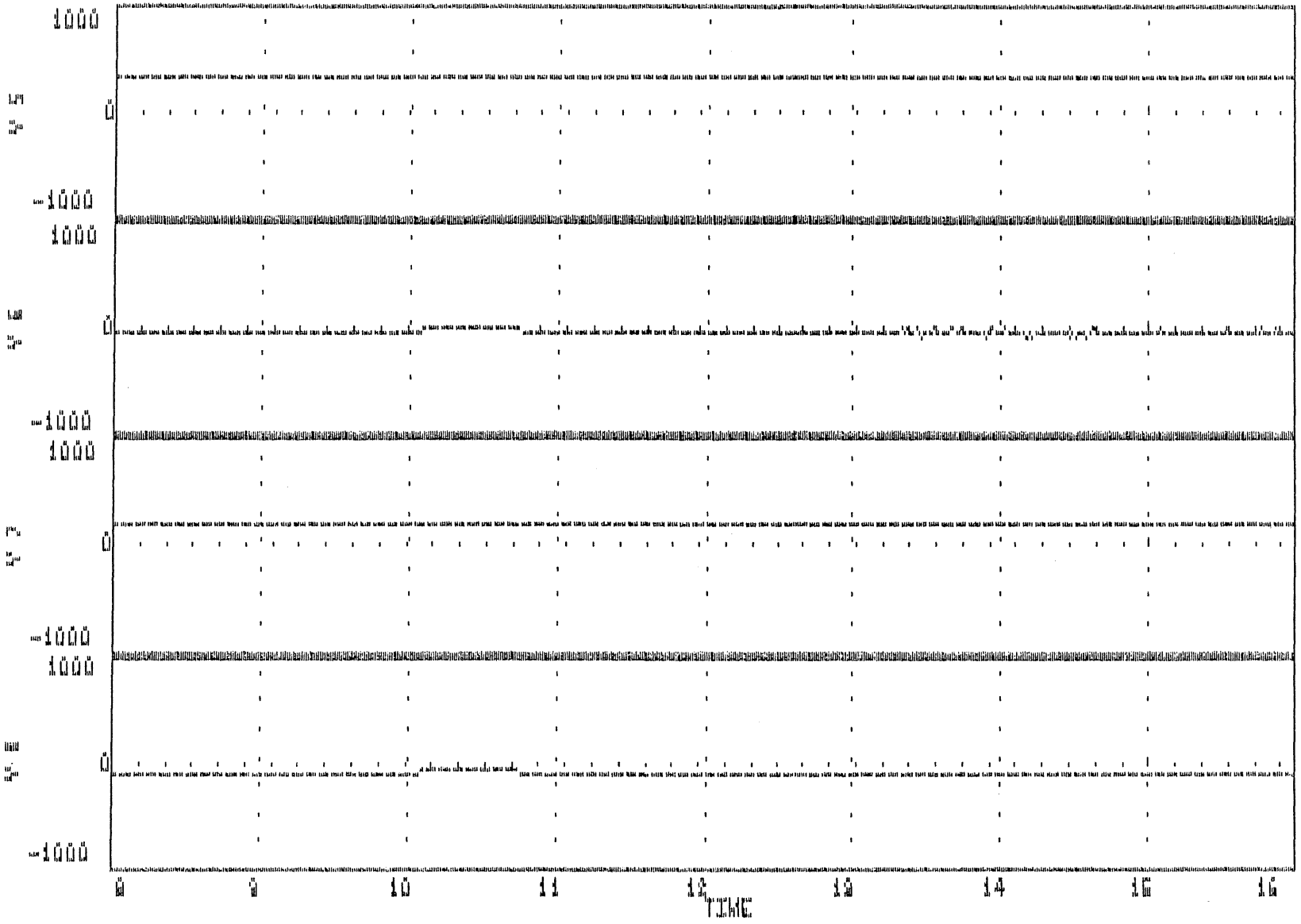
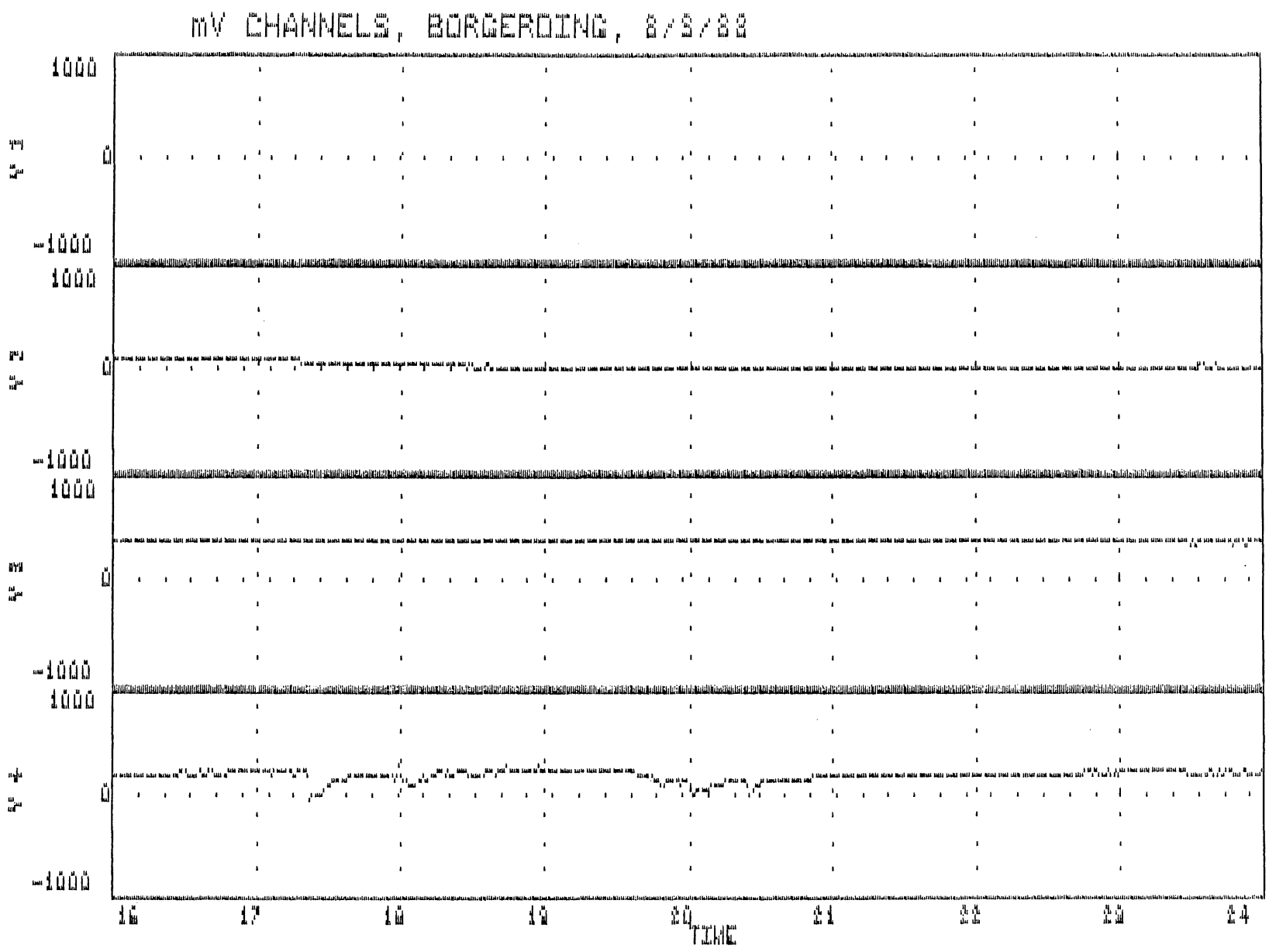
16
TIME

mV CHANNELS, BORGEROING, 8/9/88



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BOREHOLE, 8/5/82
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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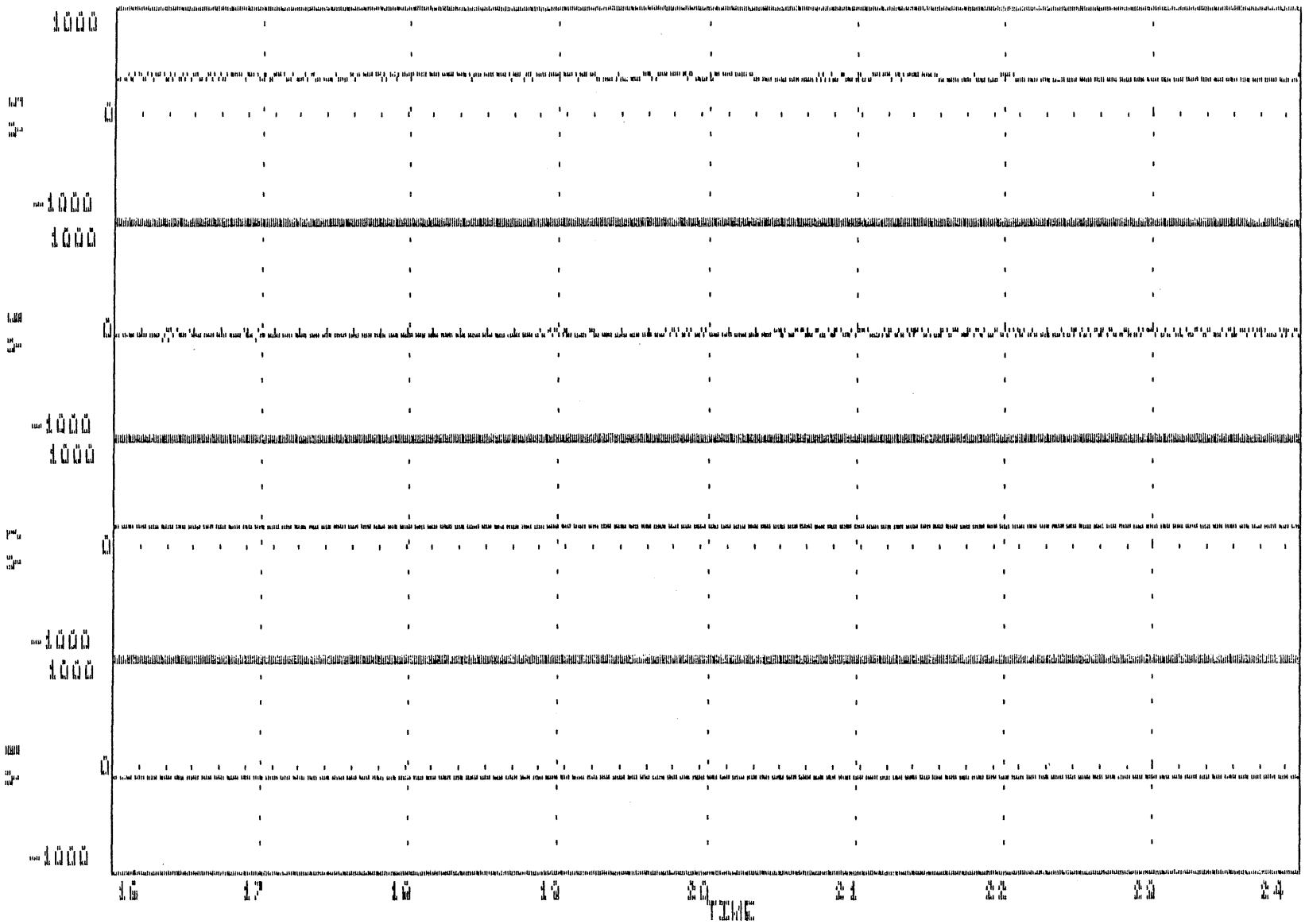
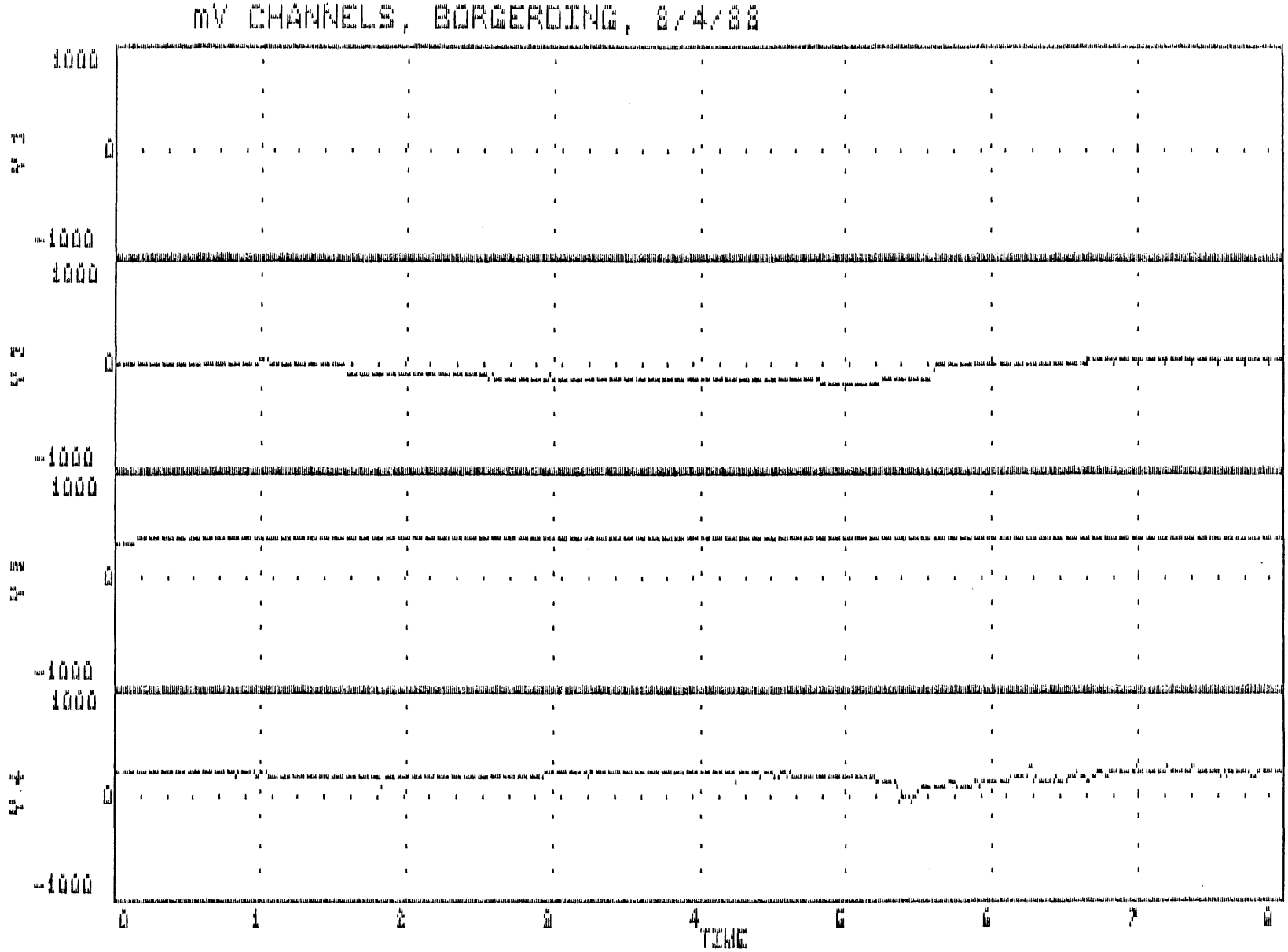
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGEROING, 8/4/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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2
3
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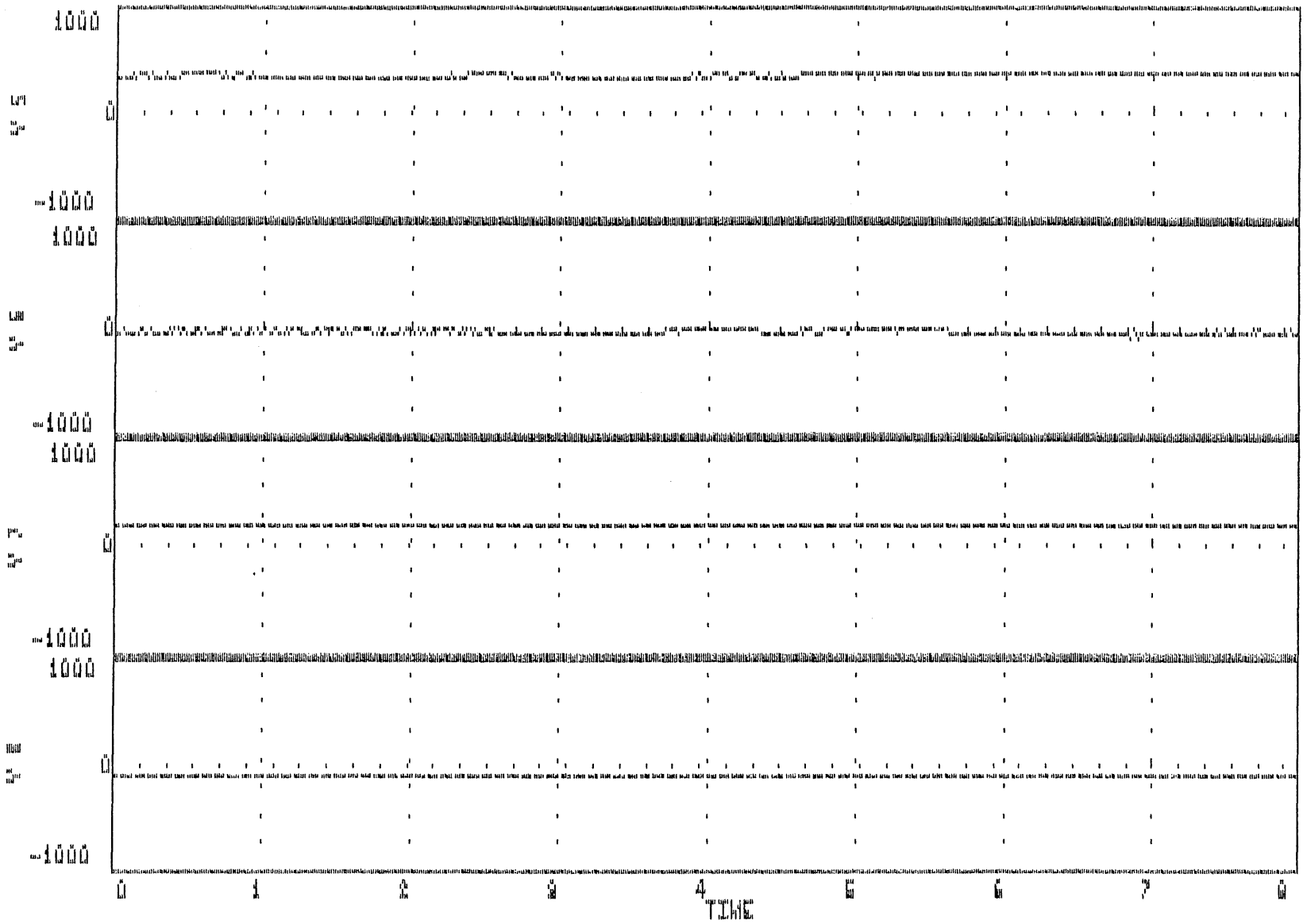
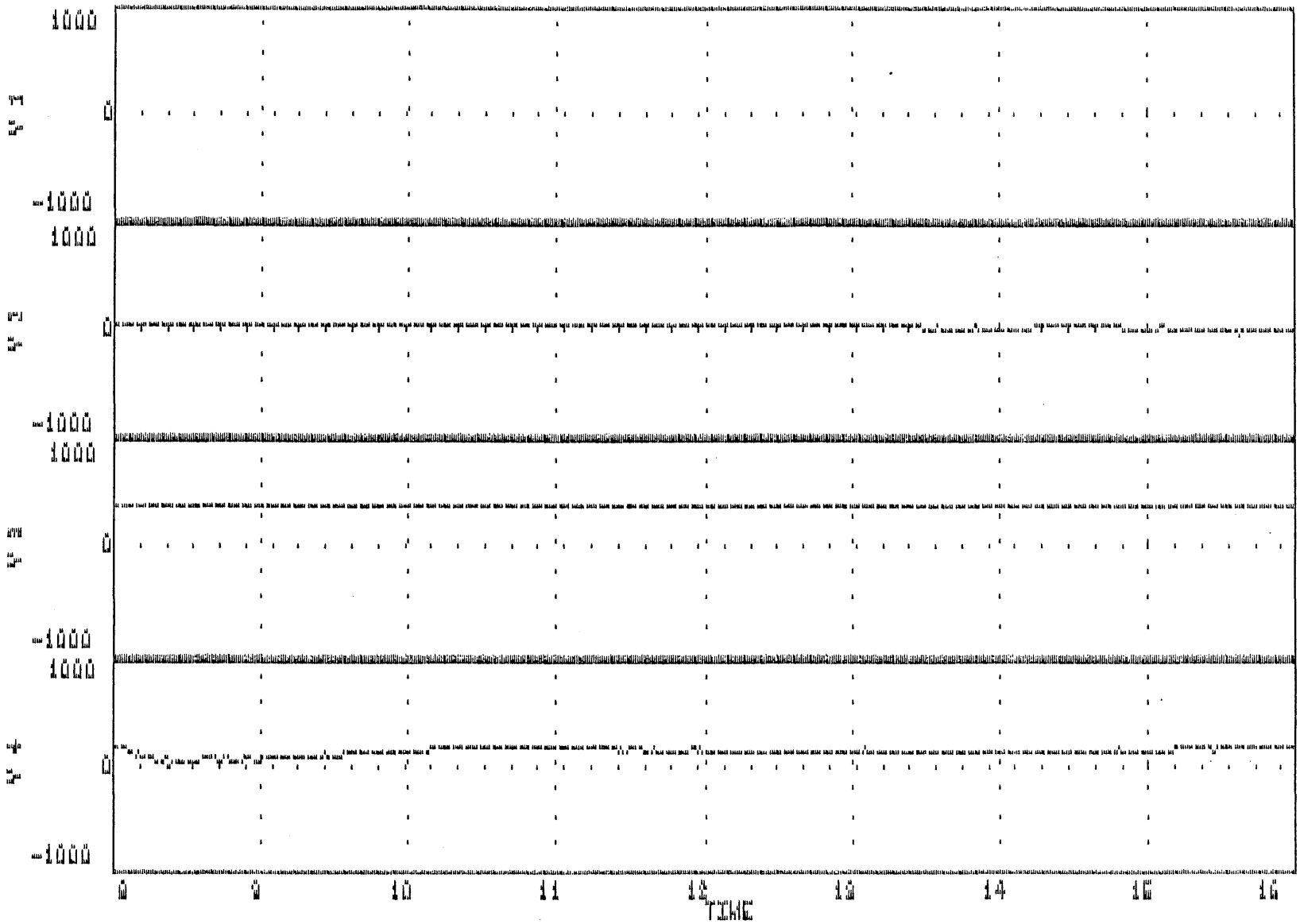
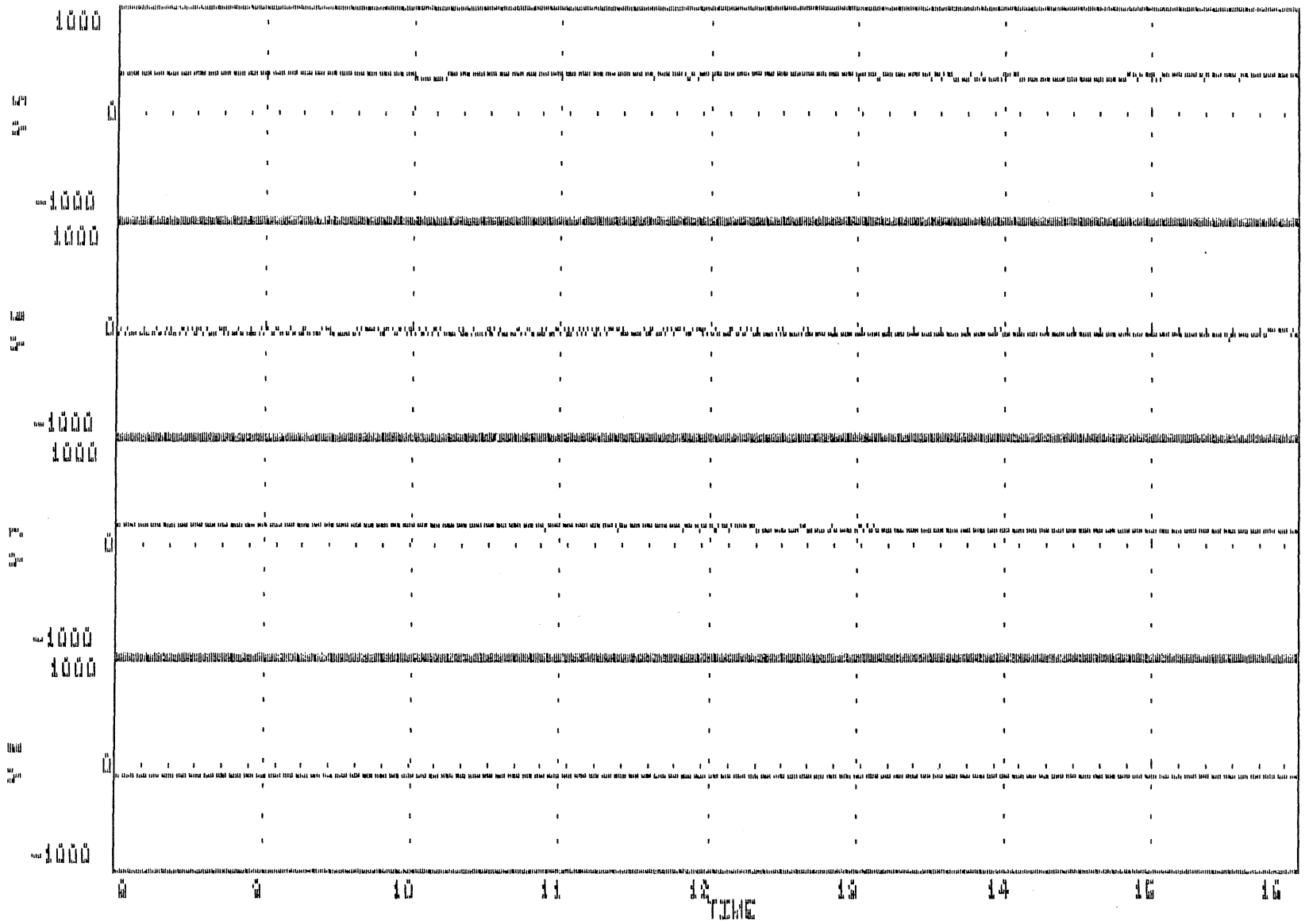
5
6
7
8
TIME



KEY

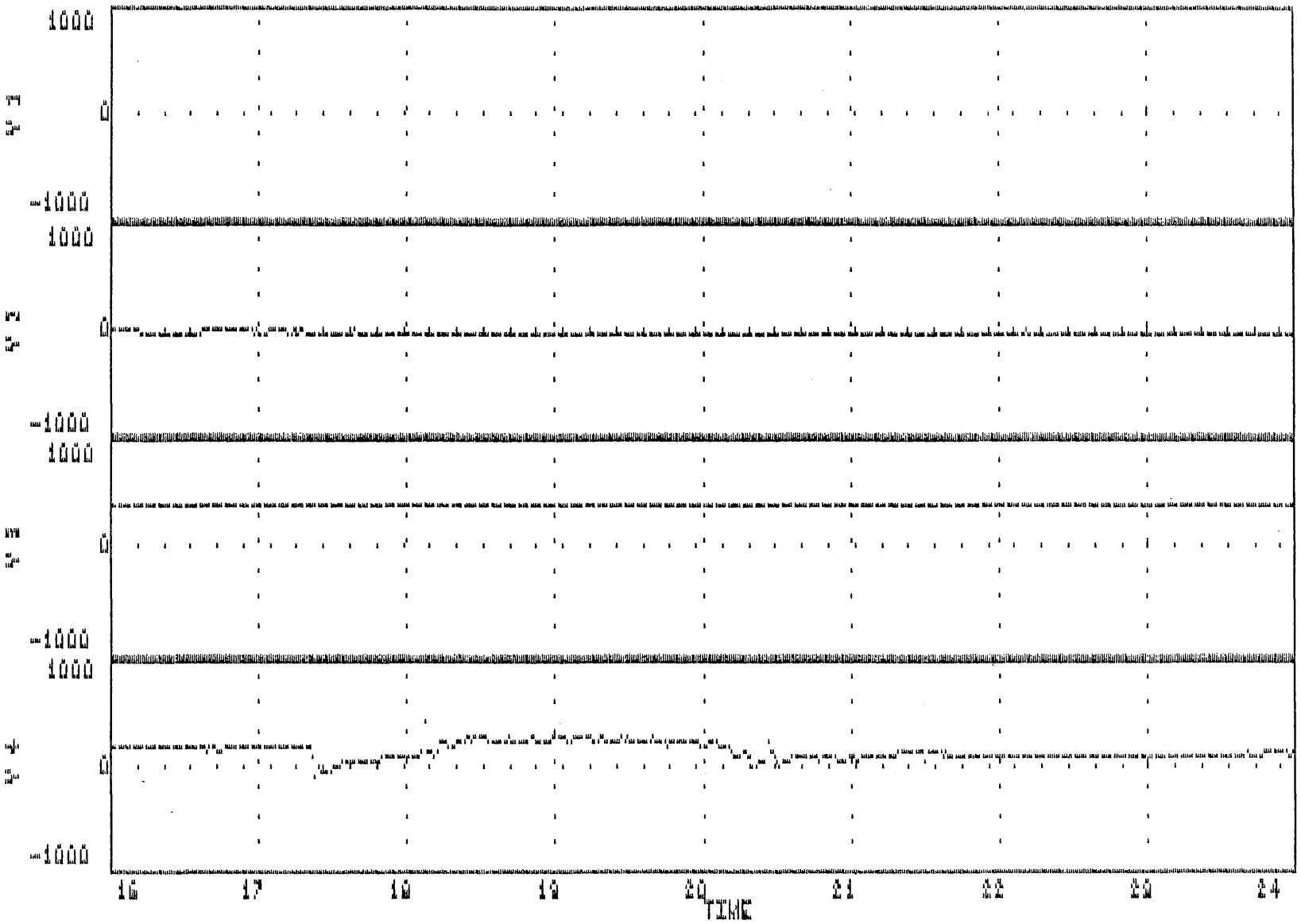
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

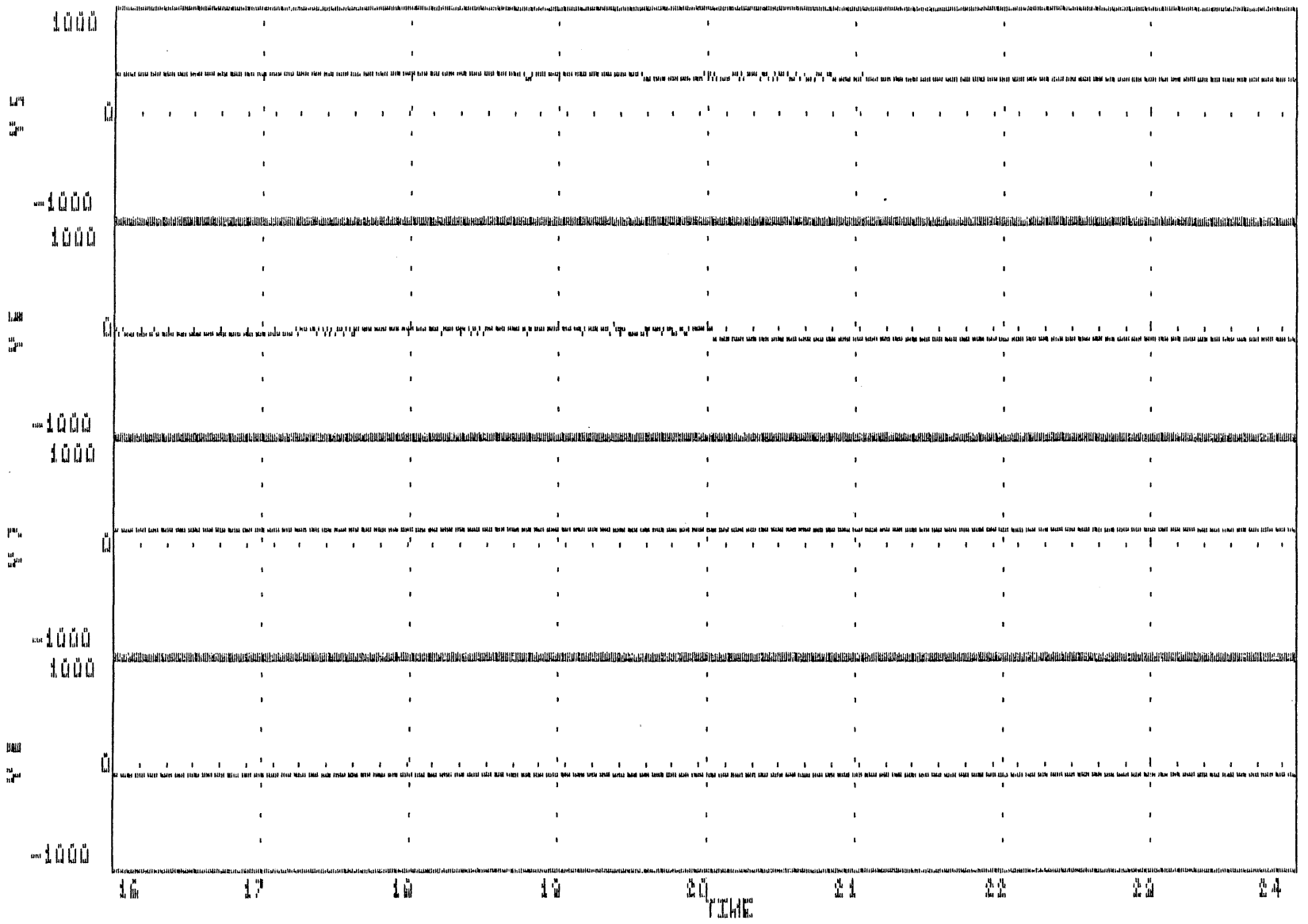

mV CHANNELS, BOREHOLING, 8/4/82
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
10
11
12
13
14
15
16
TIME



KEY

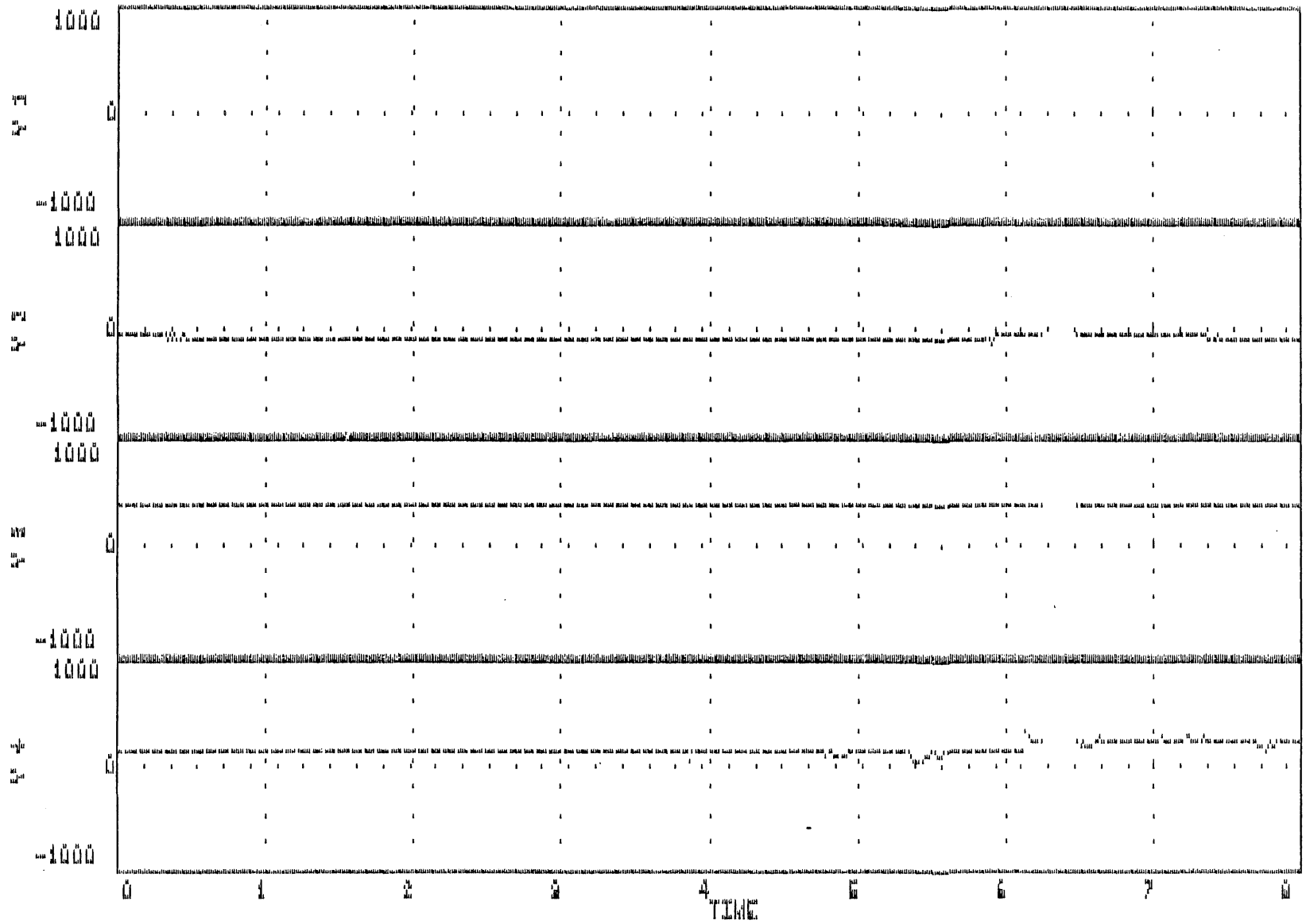
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

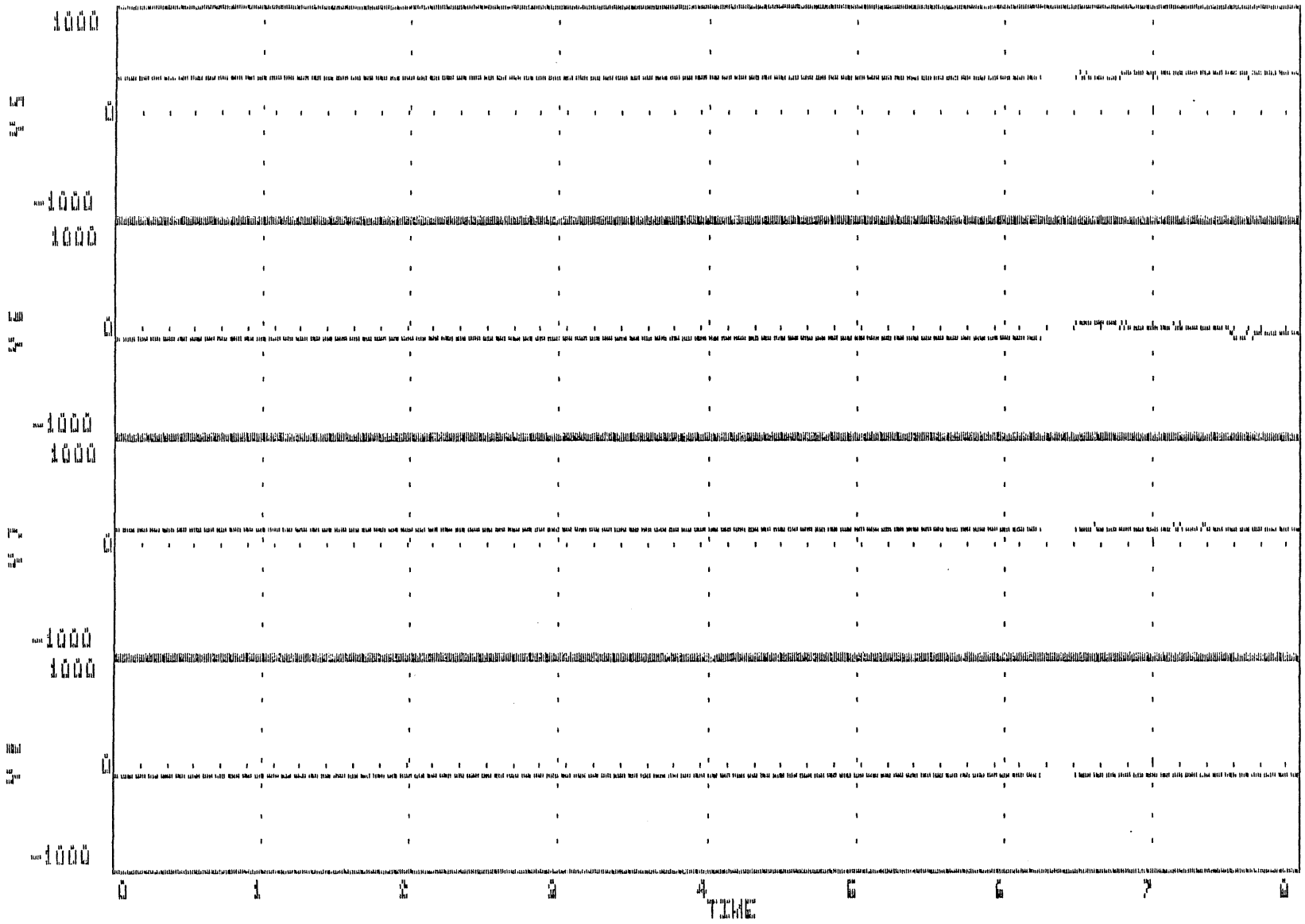

mV CHANNELS, BORGERDING, 8/4/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
16
17
18
19
20
21
22
23
24
TIME



KEY

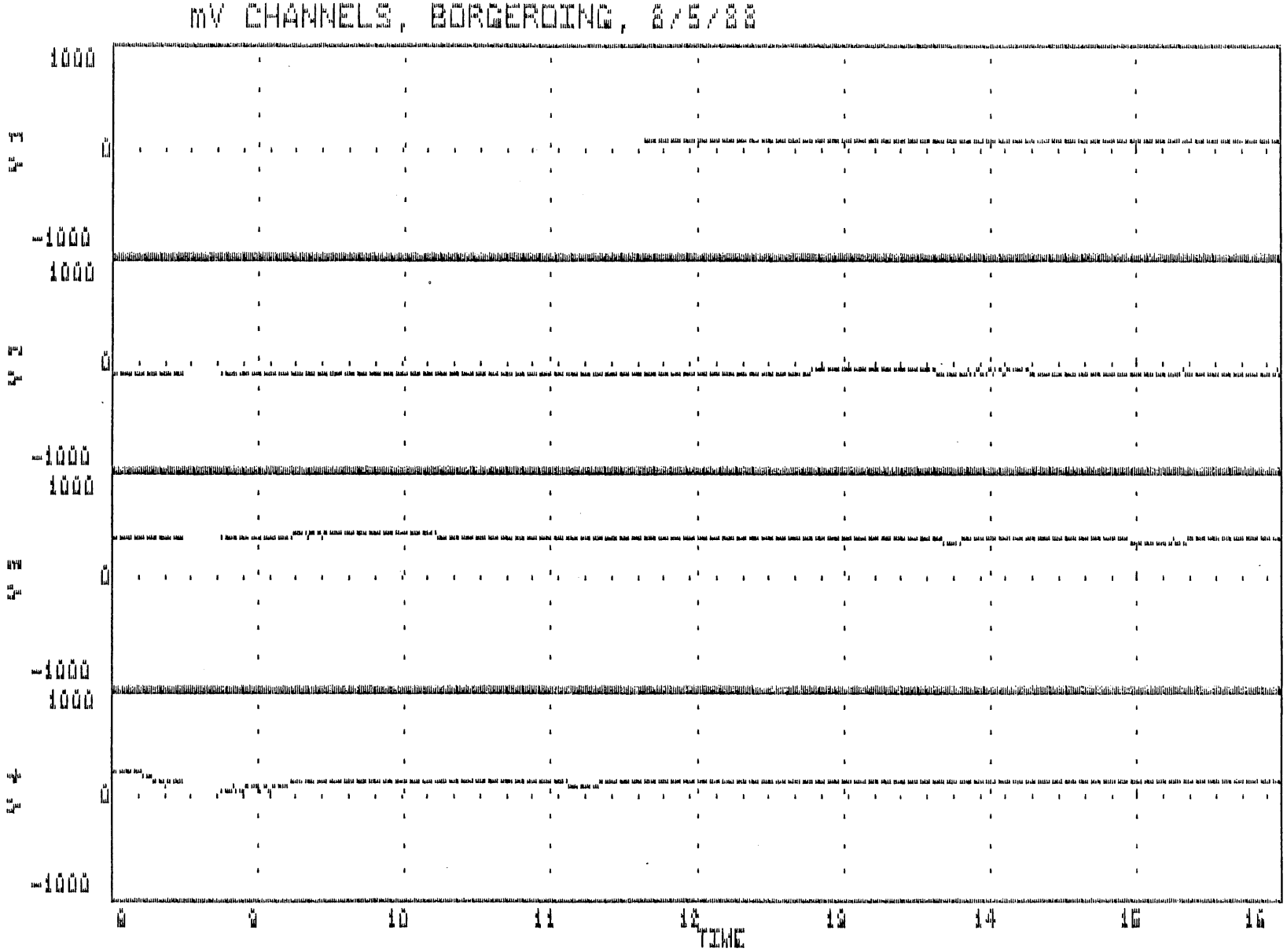
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

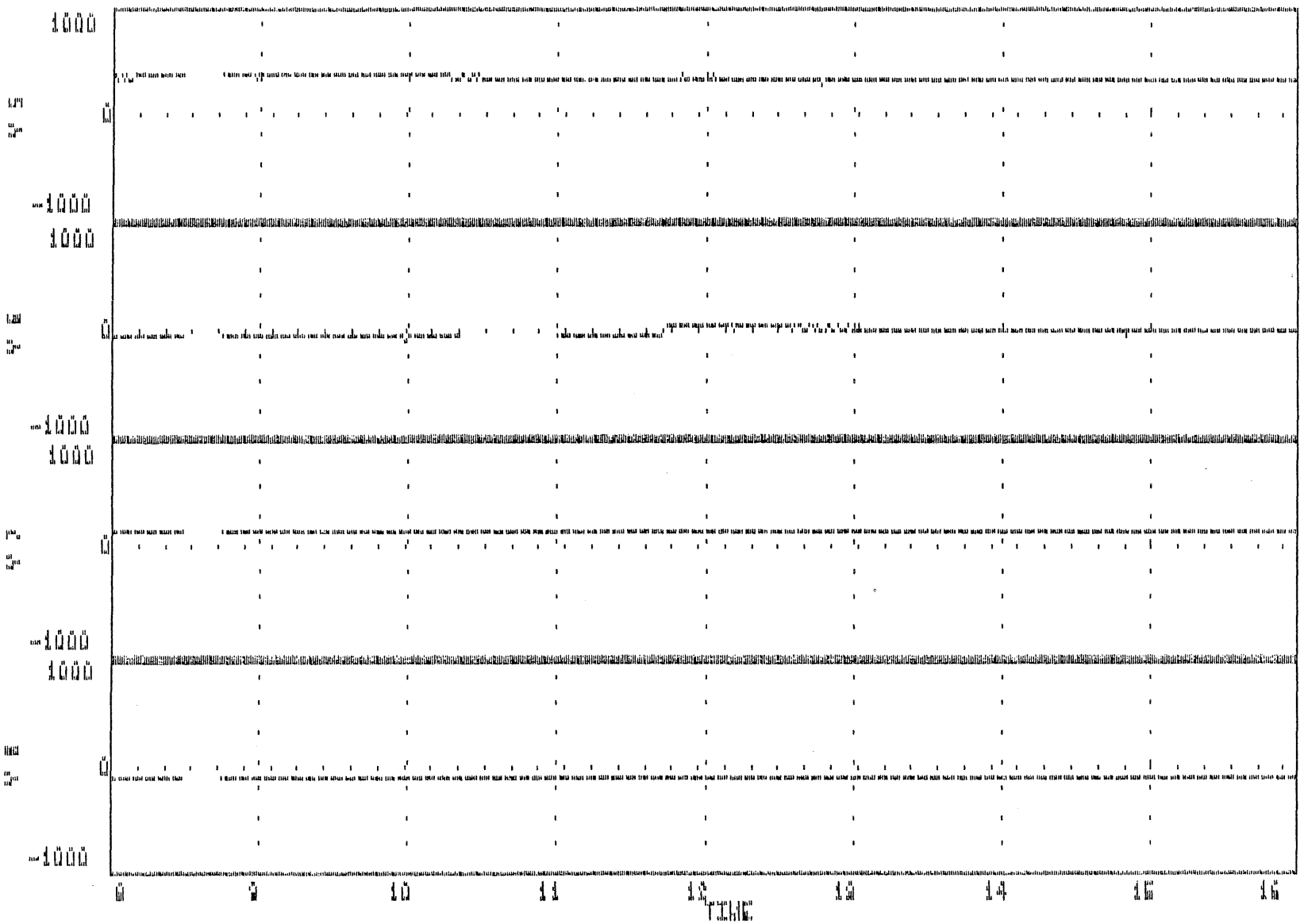

mV CHANNELS, BORDEROING, 8/5/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
1
2
3
4
5
6
7
8
TIME



KEY

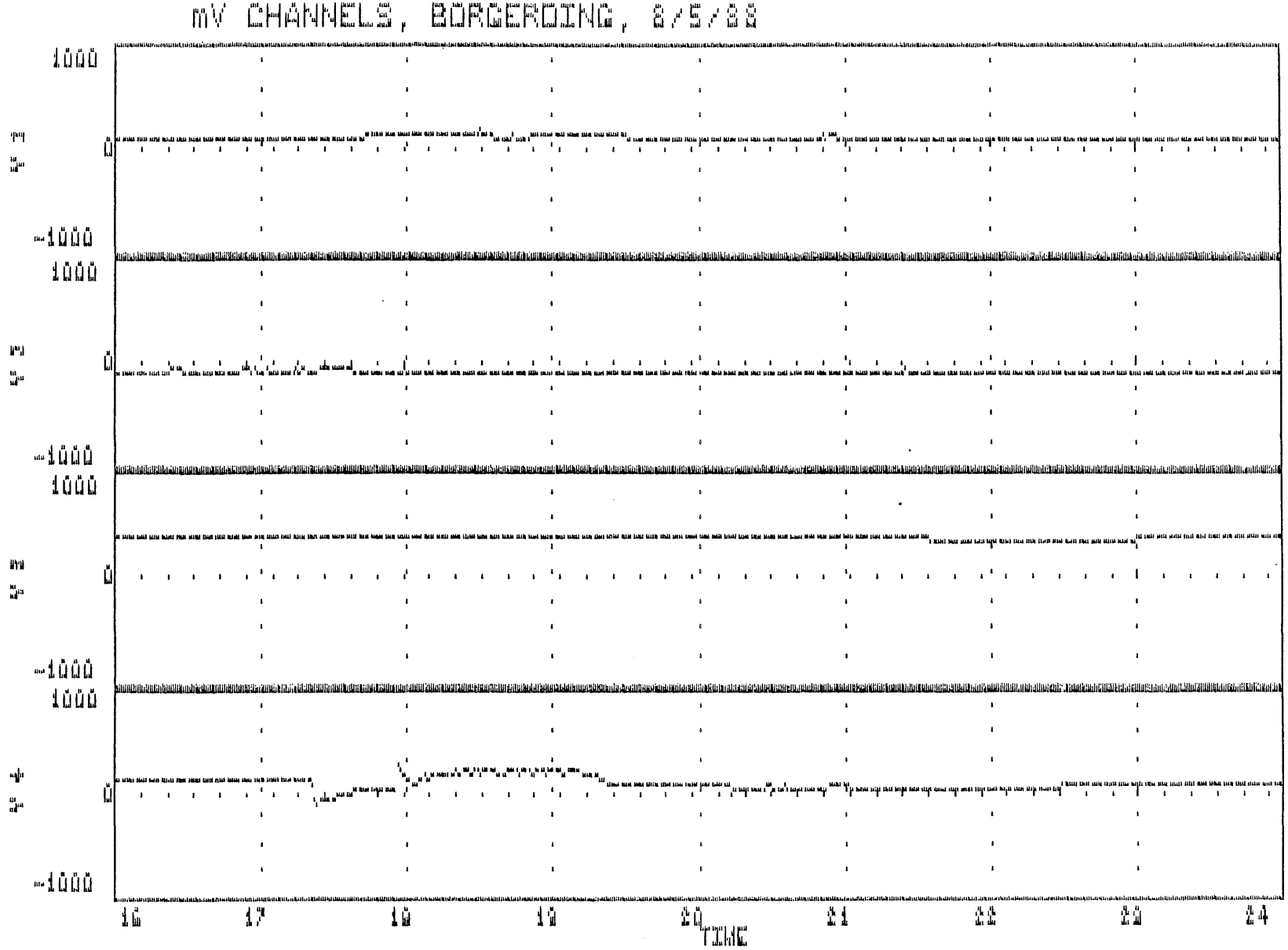
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

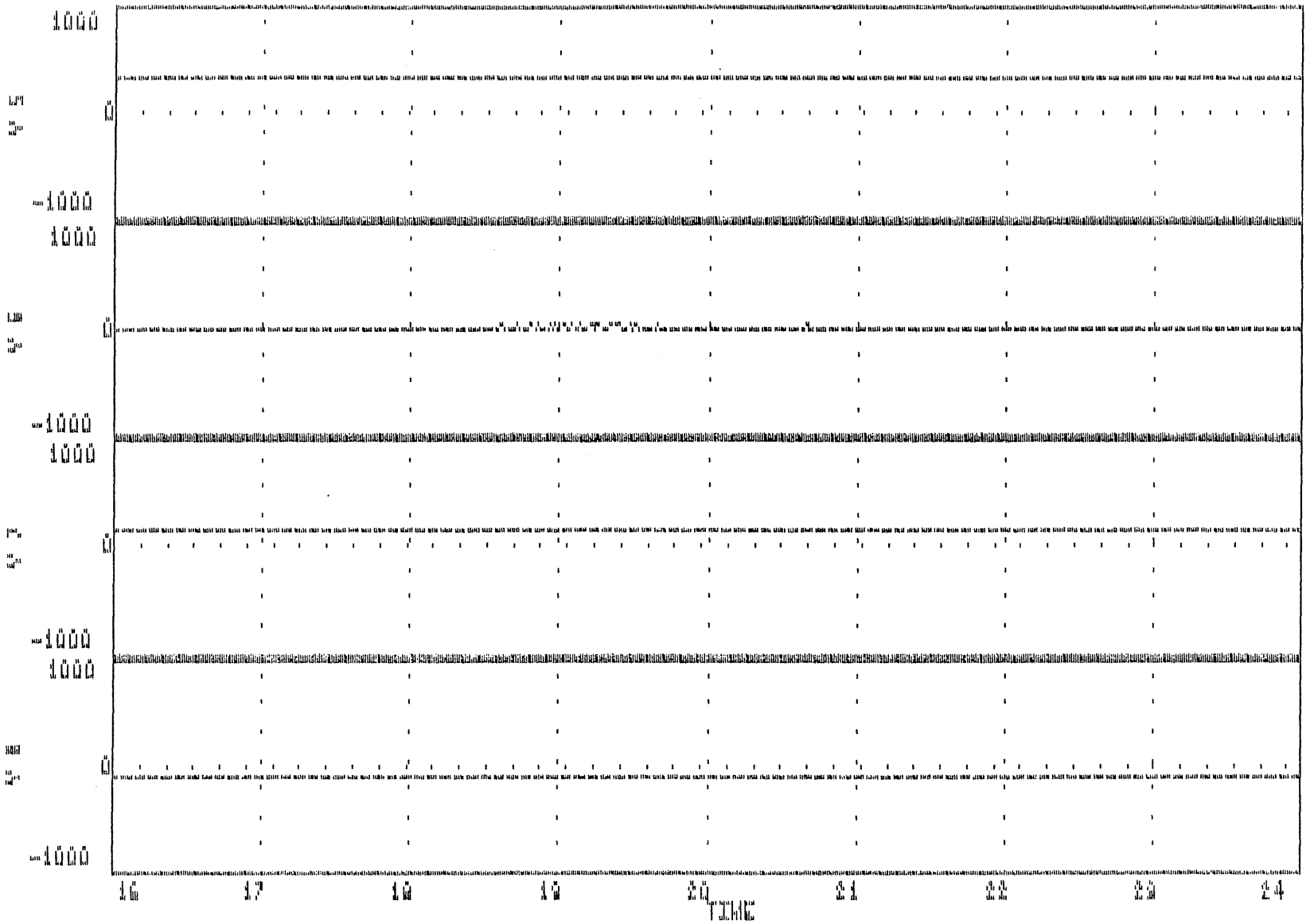

mV CHANNELS, BORGEROING, 8/5/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
9
10
11
12
13
14
15
TIME



KEY

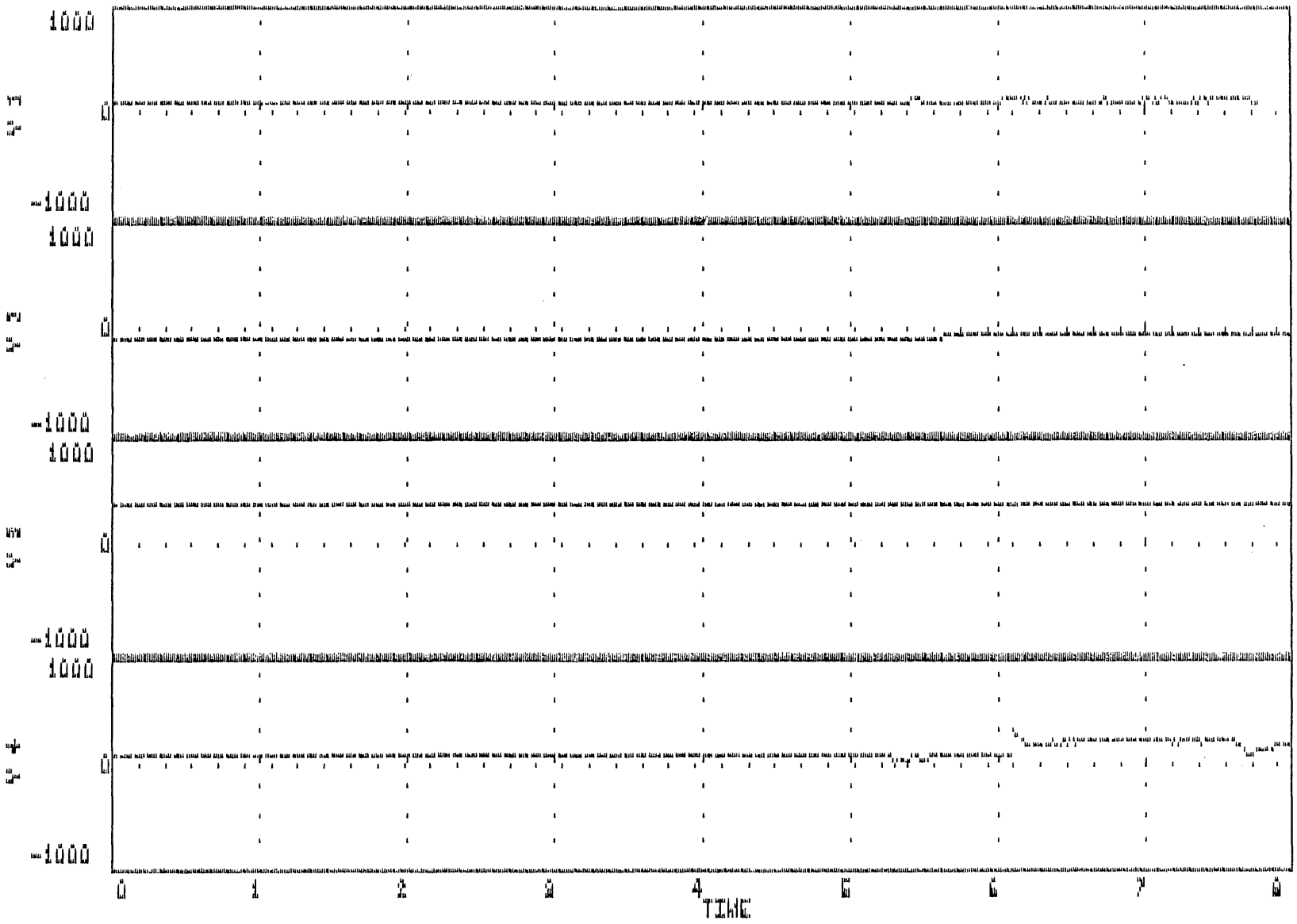
CHAN	HI	LO	CHAN	HI	LO
V1*	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

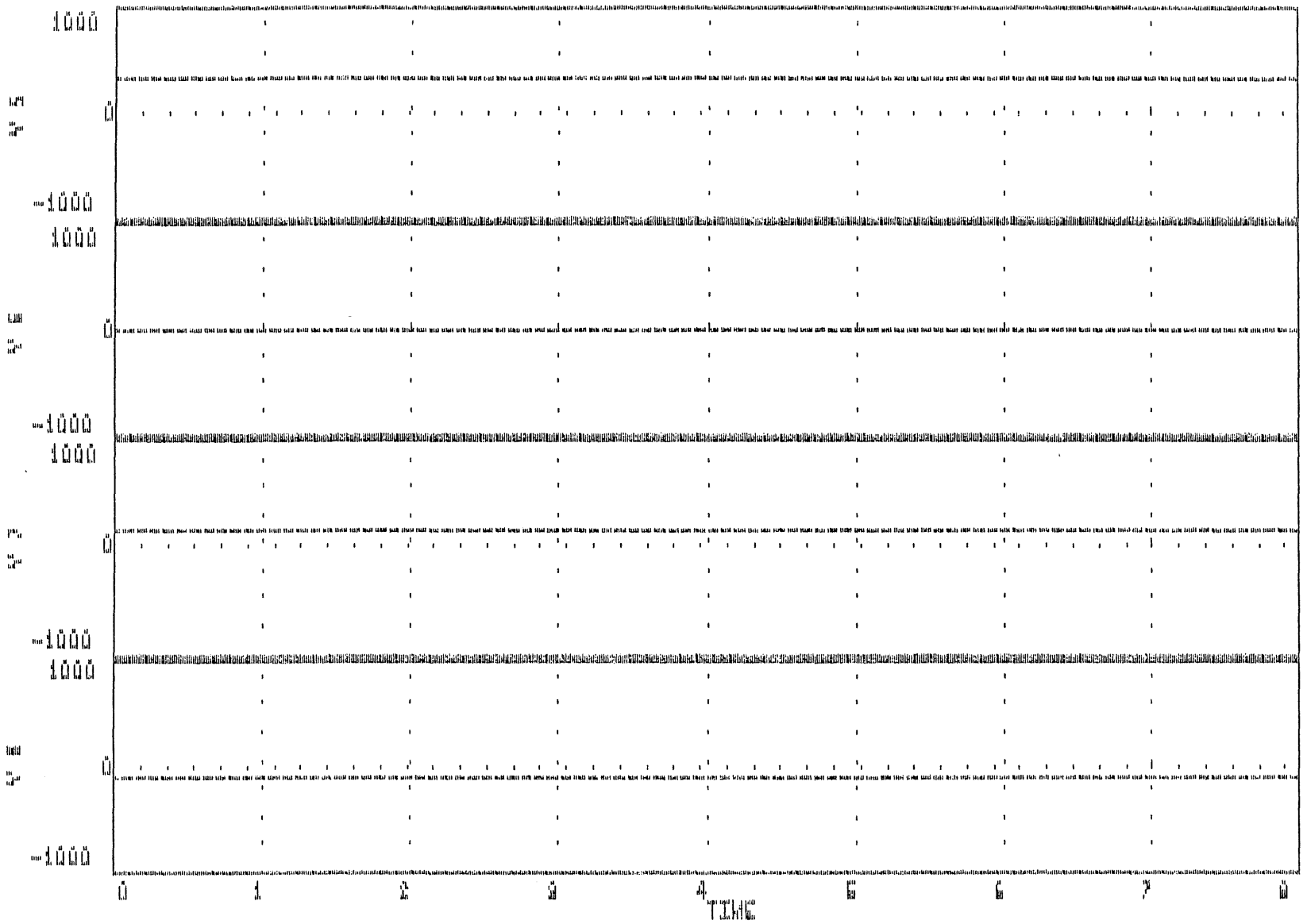

mV CHANNELS, BORGEROING, 8/5/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
mV
16
17
18
19
20
TIME
21
22
23
24



KEY: generator power 1739-1931

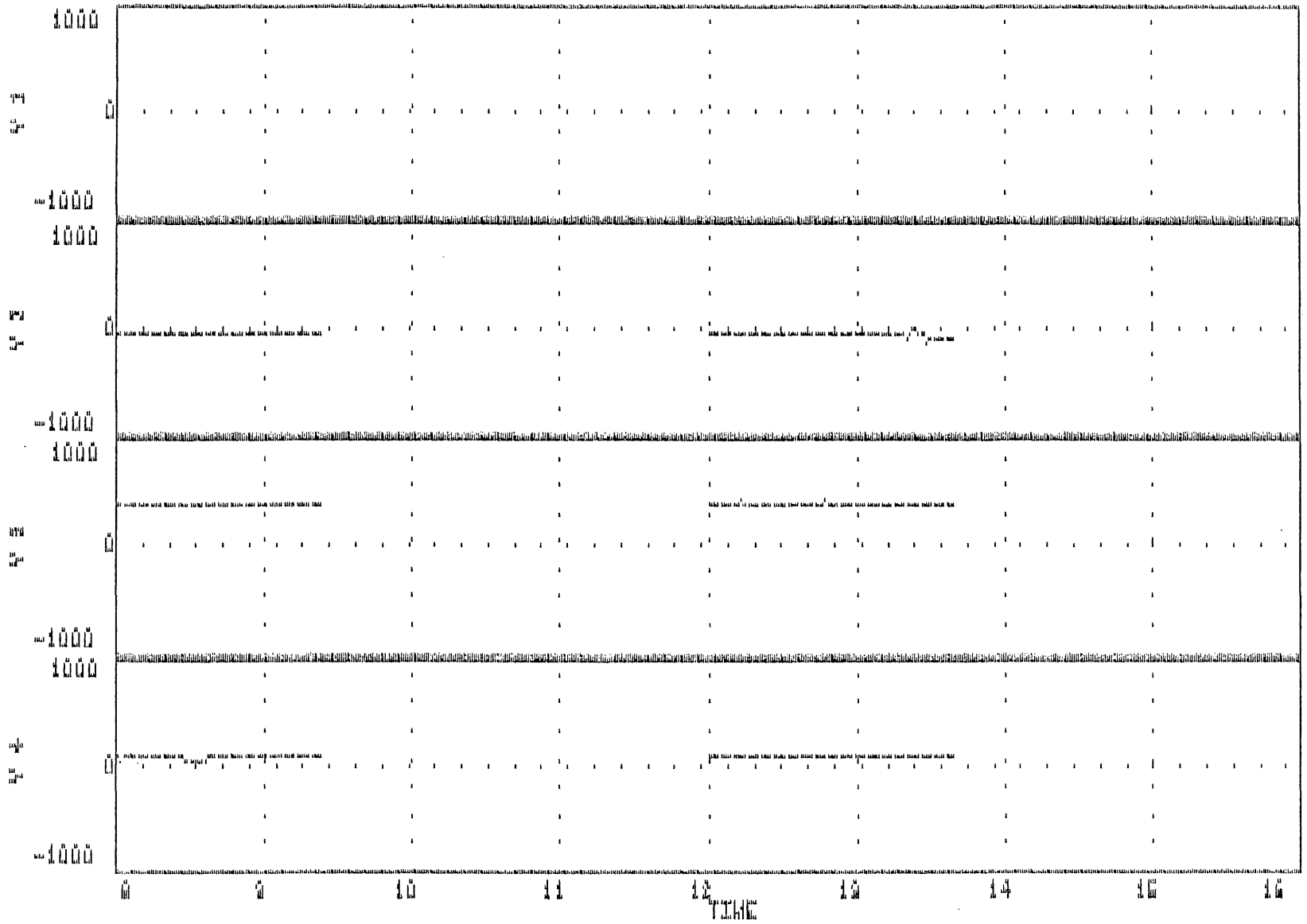
CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	--	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

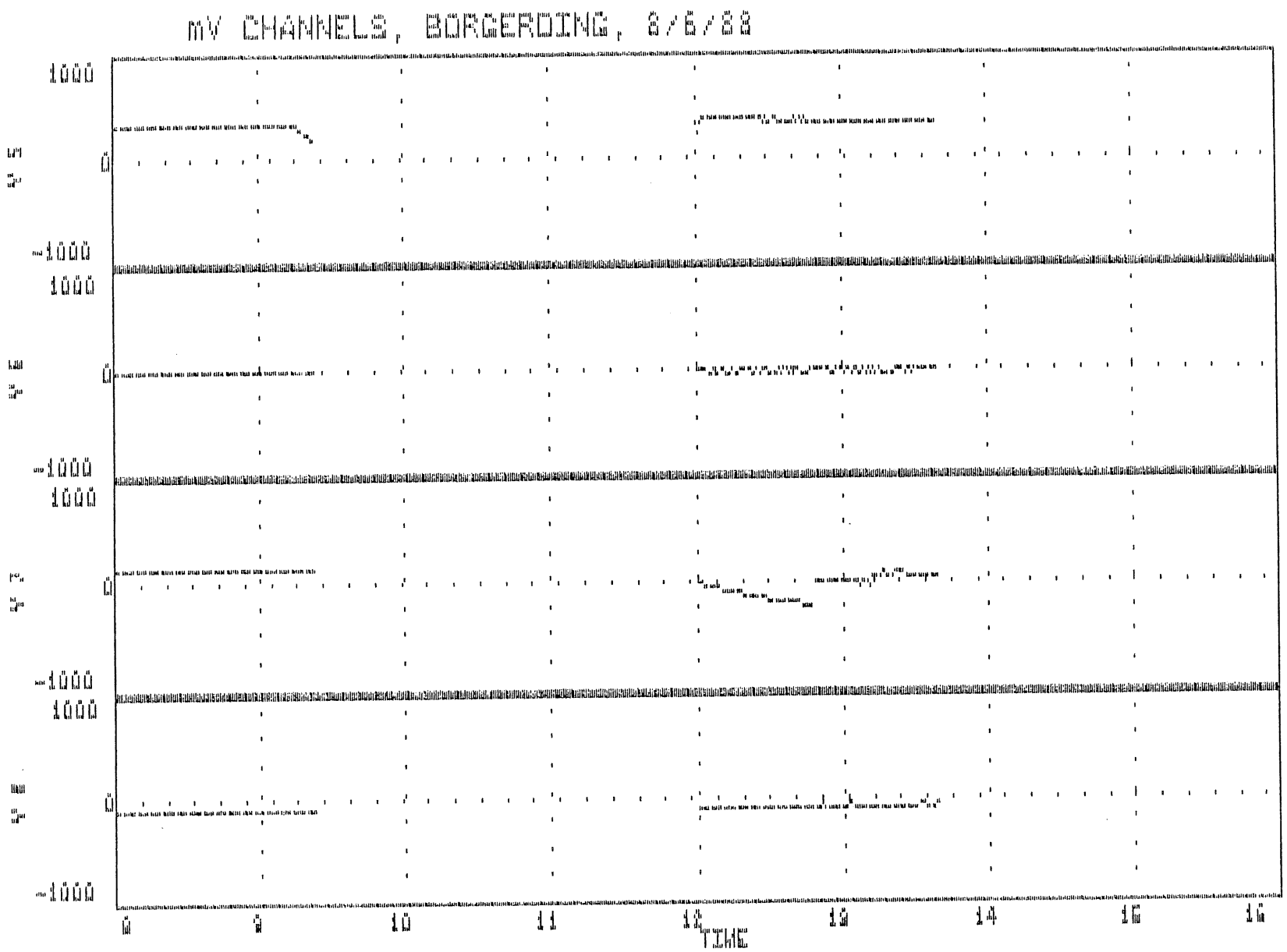

mV CHANNELS, BORDERDING, 2/6/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
1
2
3
4
5
6
7
8
Time



KEY: generator power 0602-0745

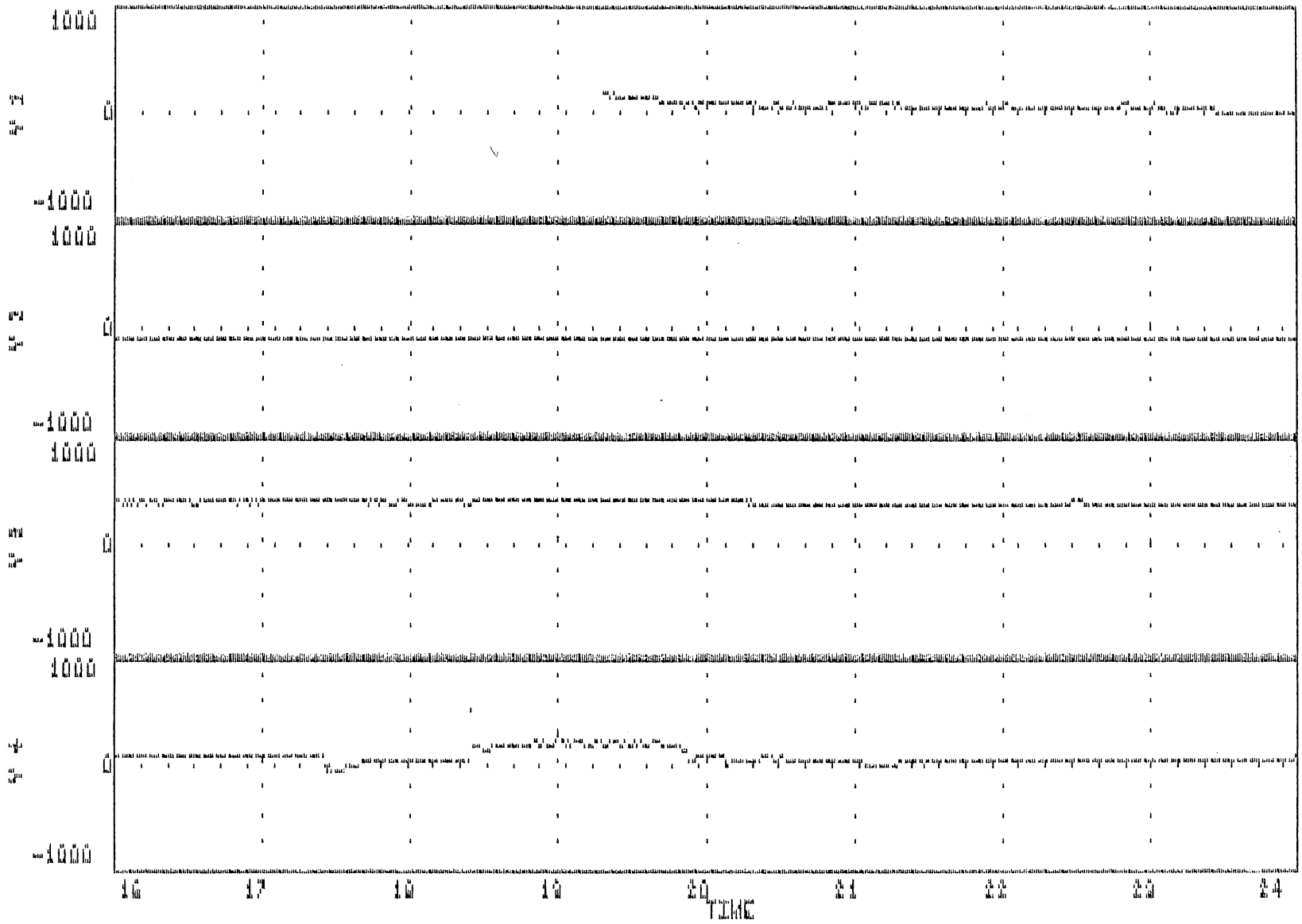
CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

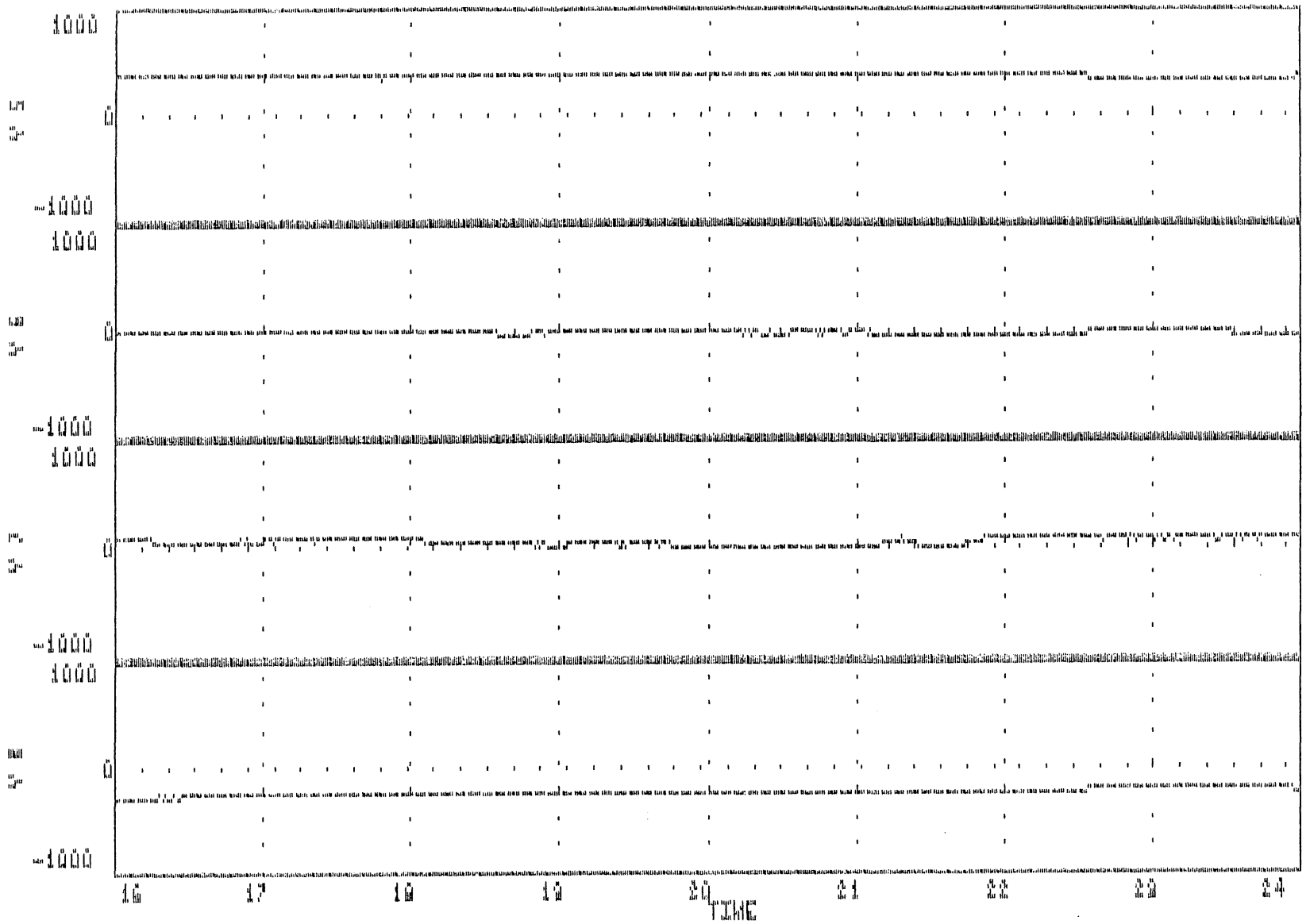

mV CHANNELS, BORGERDING, 8/6/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
9
10
11
12
13
14
15
16
TIME



KEY

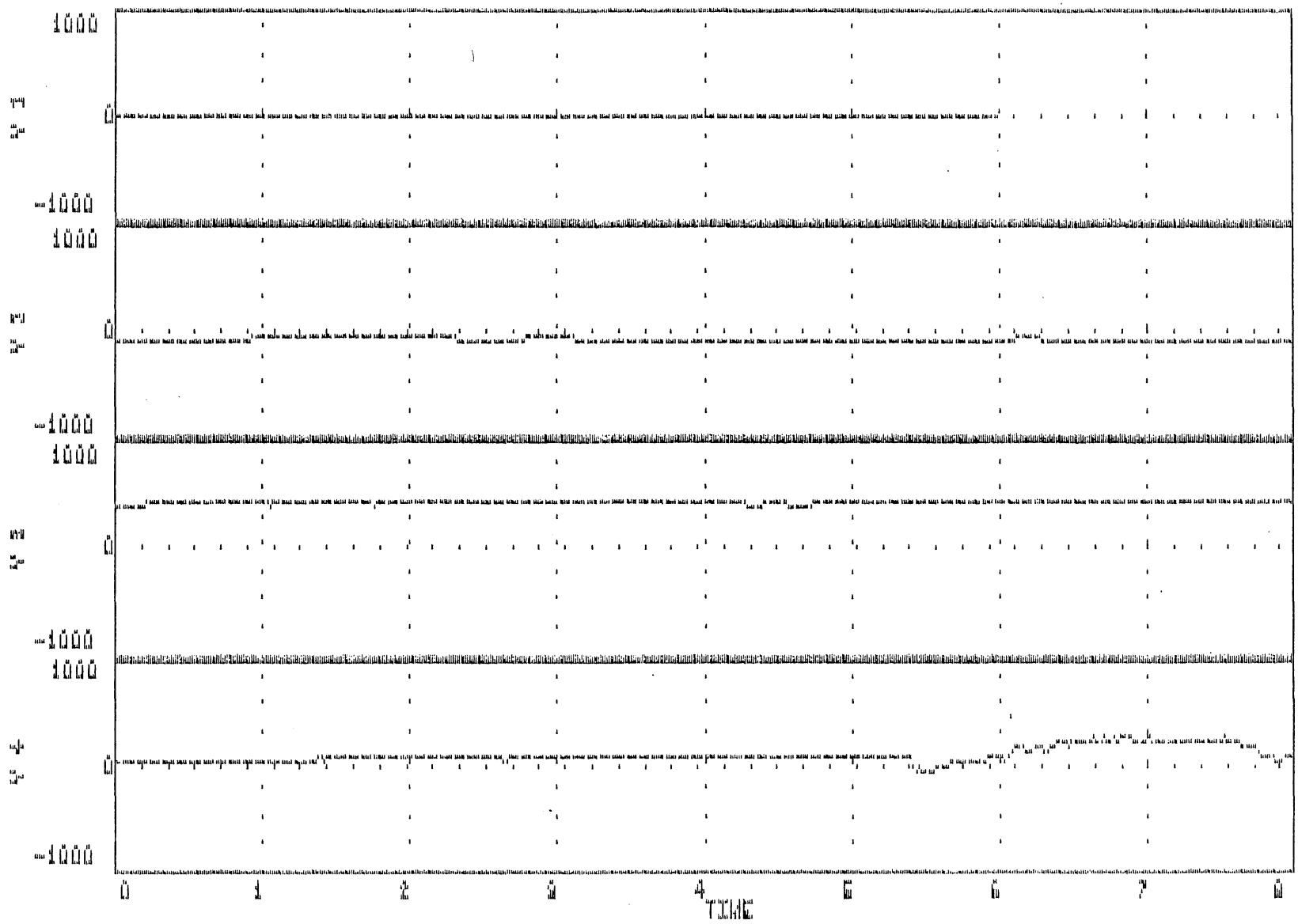
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

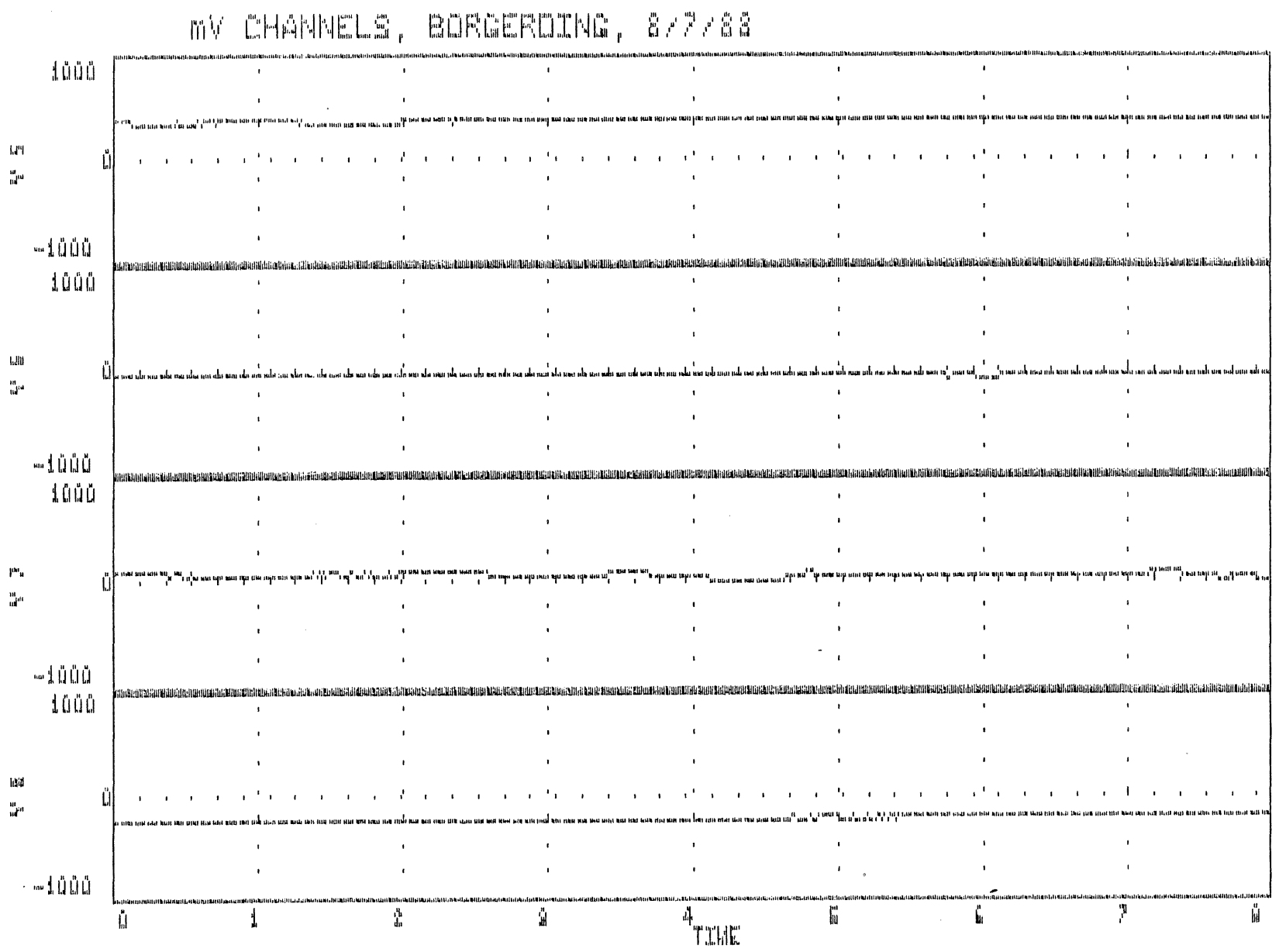

mV CHANNELS, BOREHOLING, 8/6/82
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
16
17
18
19
20
21
22
23
24
TIME



KEY

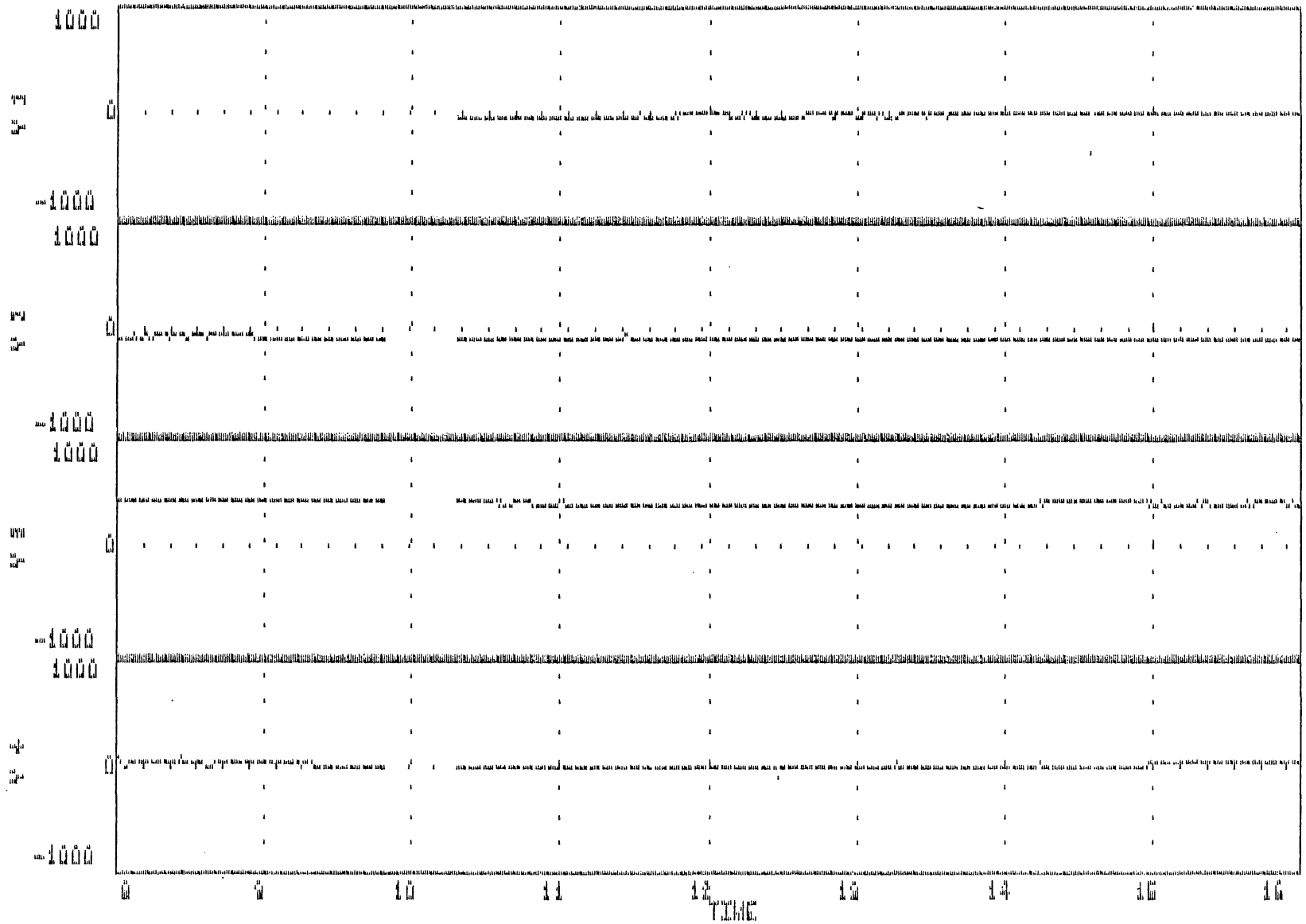
CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

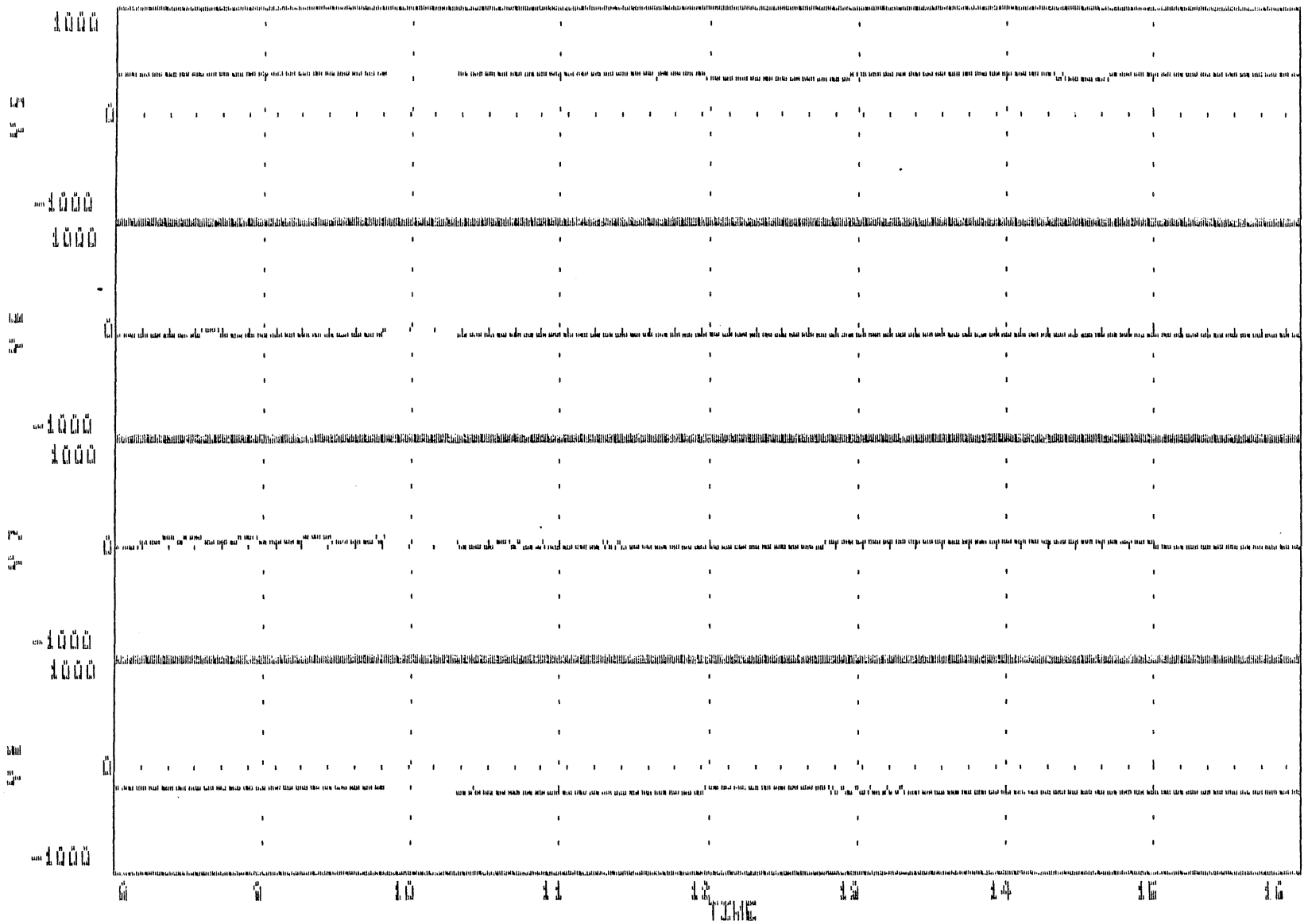

mV CHANNELS, BORGERDING, 8/7/82
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
1
2
3
4
5
6
7
8
TIME



KEY

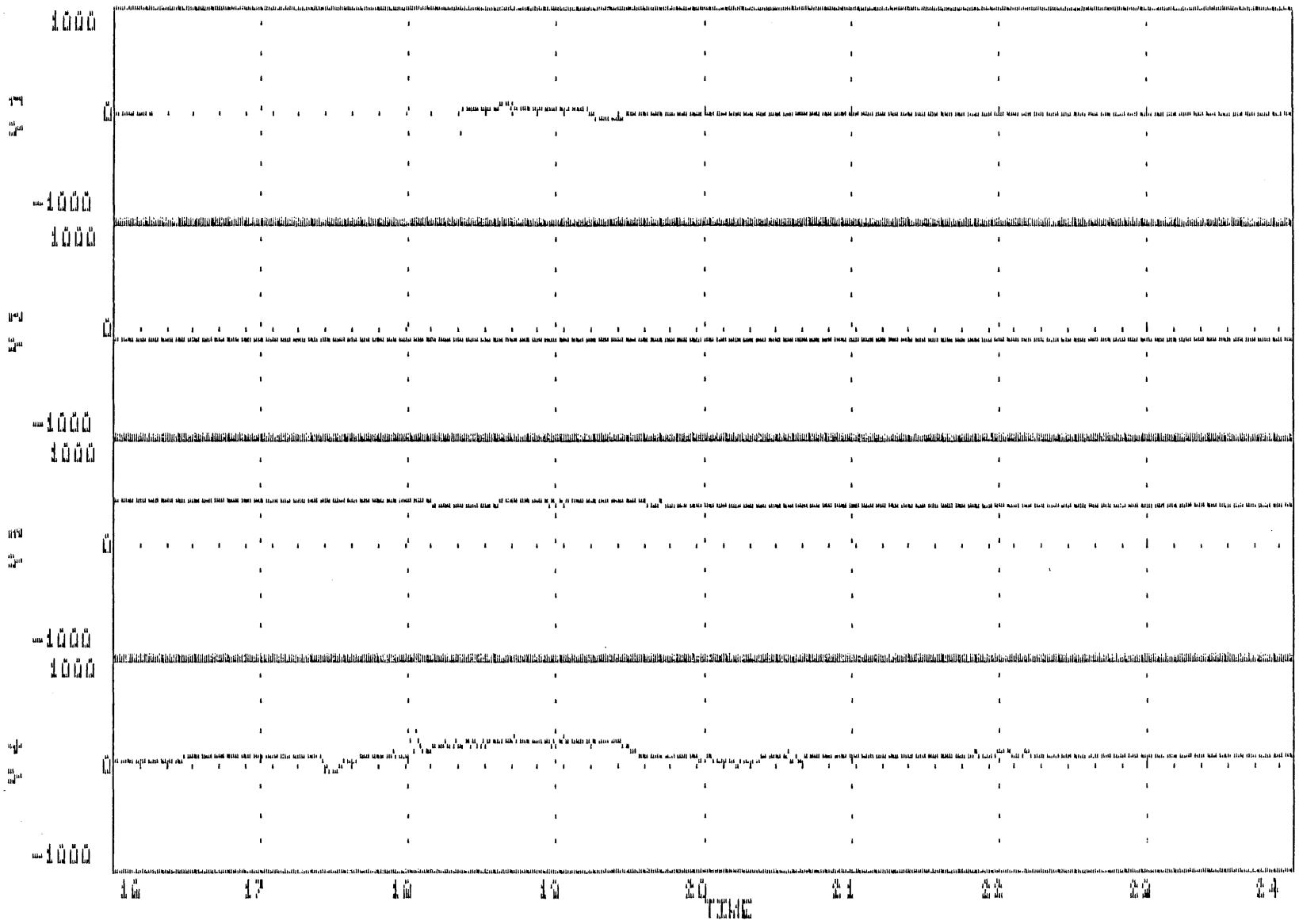
CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORGERDING, 8/7/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
9
10
11
12
13
14
15
16
TIME

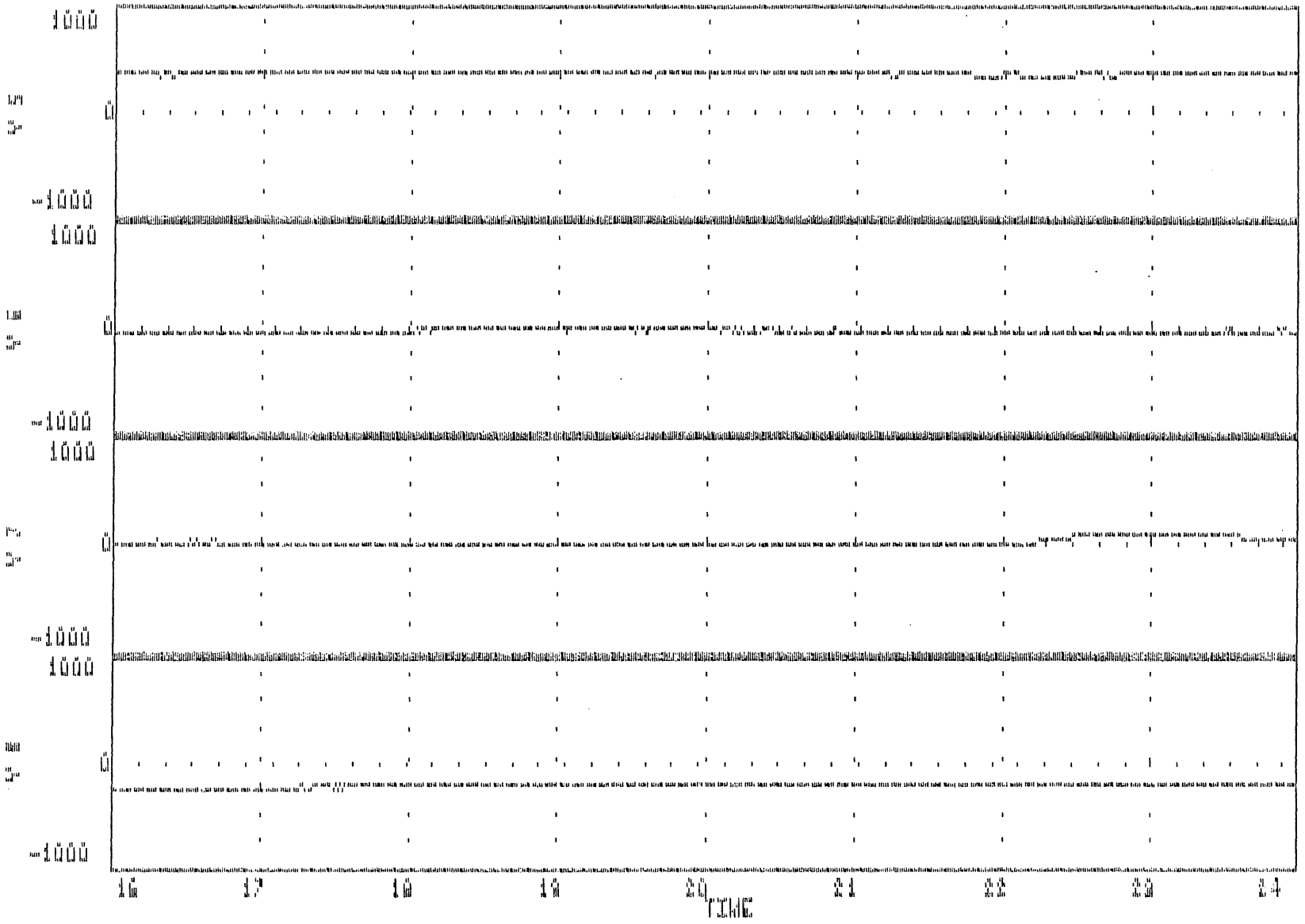


KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

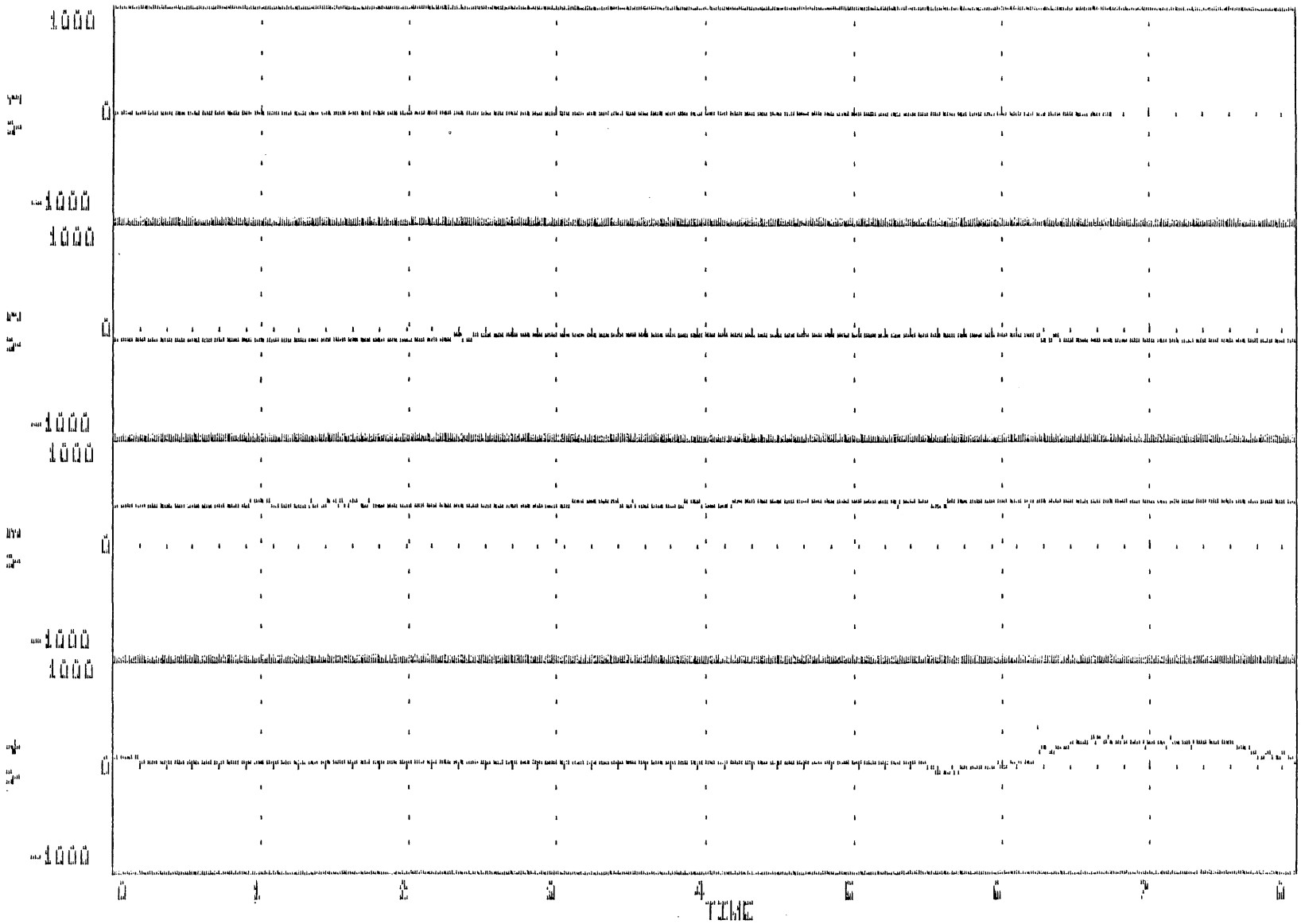

mV CHANNELS, BORGERDING, 8/7/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
16
17
18
19
20
21
22
23
24
TIME

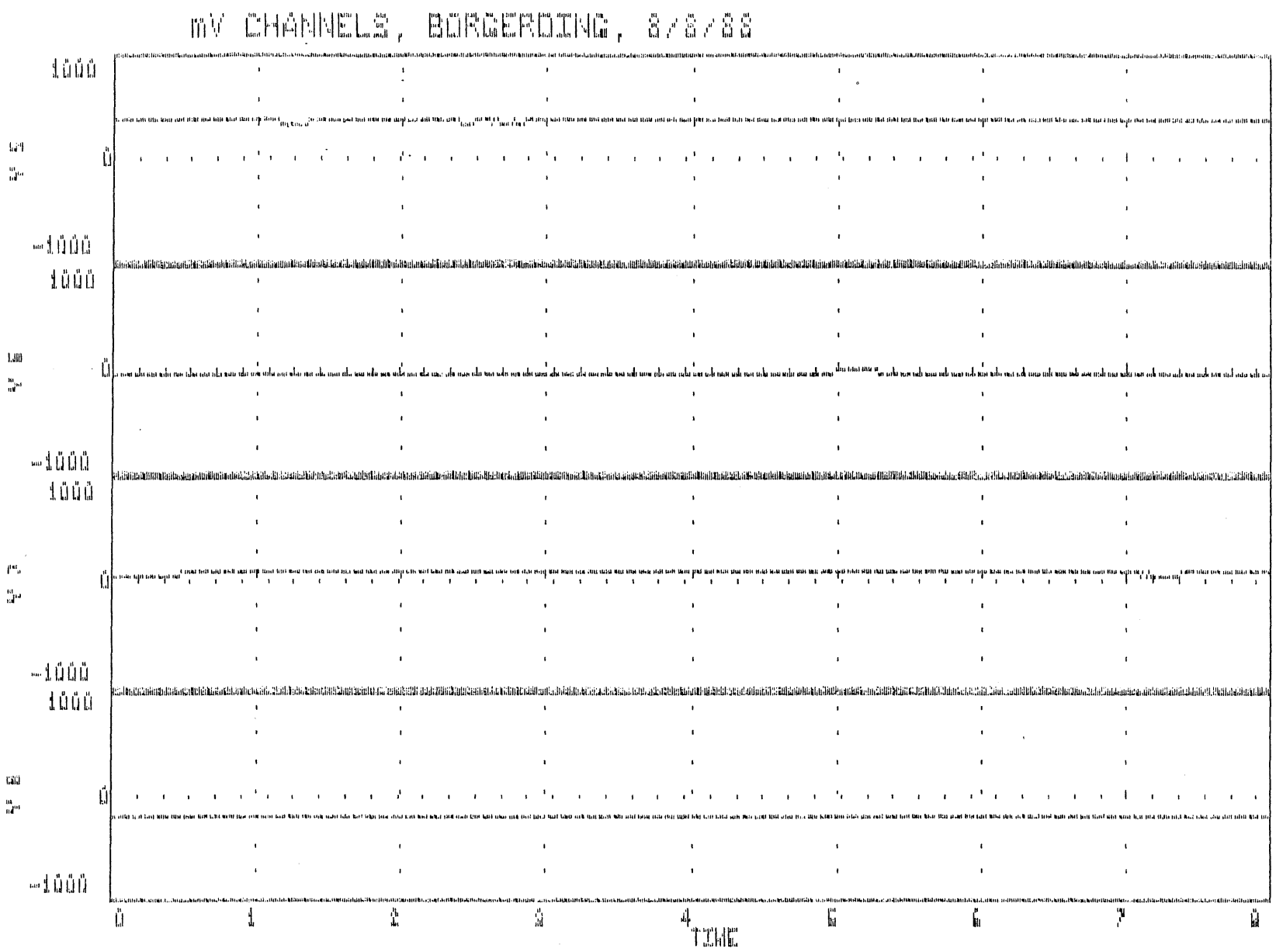
mV CHANNELS, BORGERDING, 8/7/88



KEY: generator power 1700 ^1830

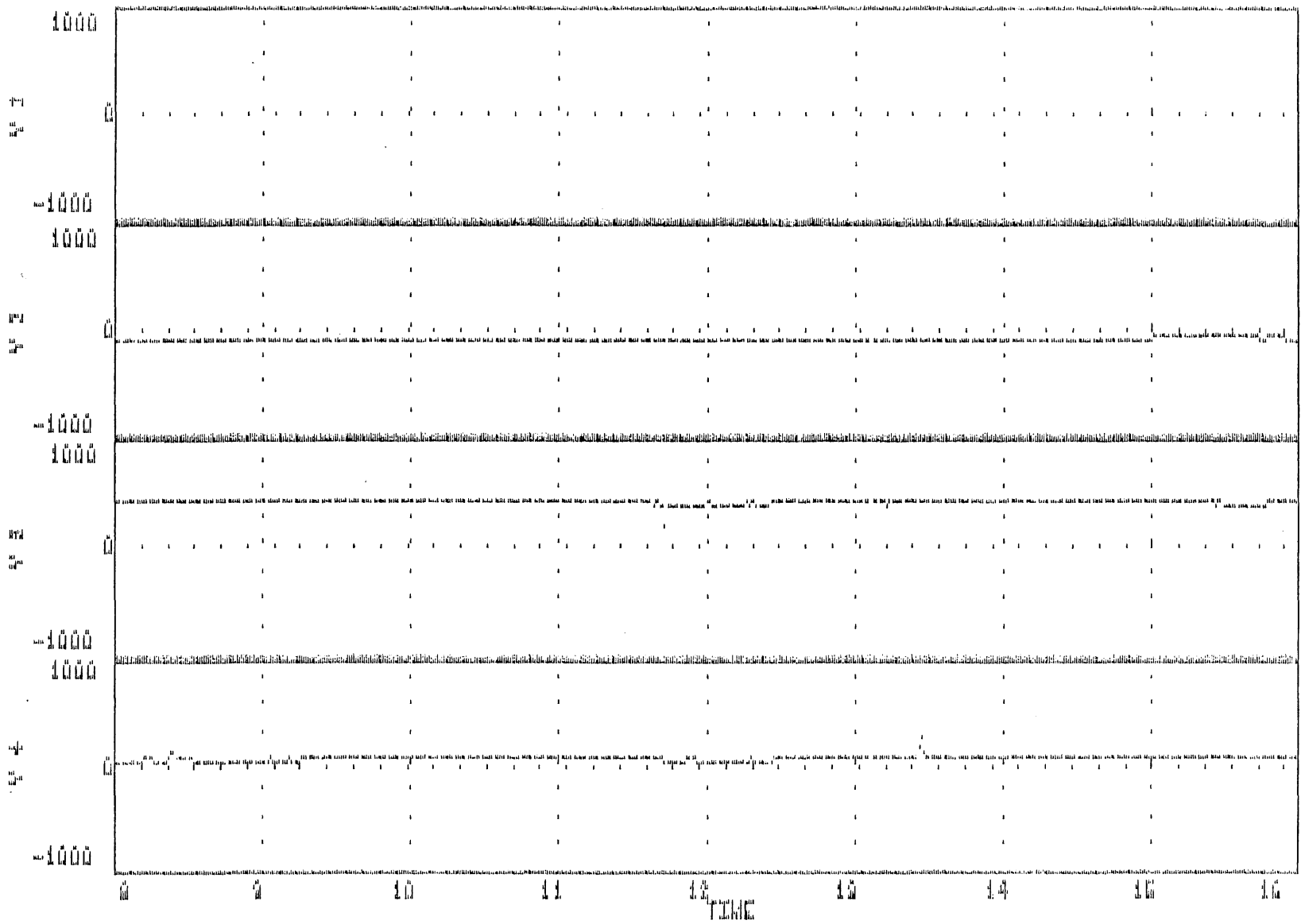
CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

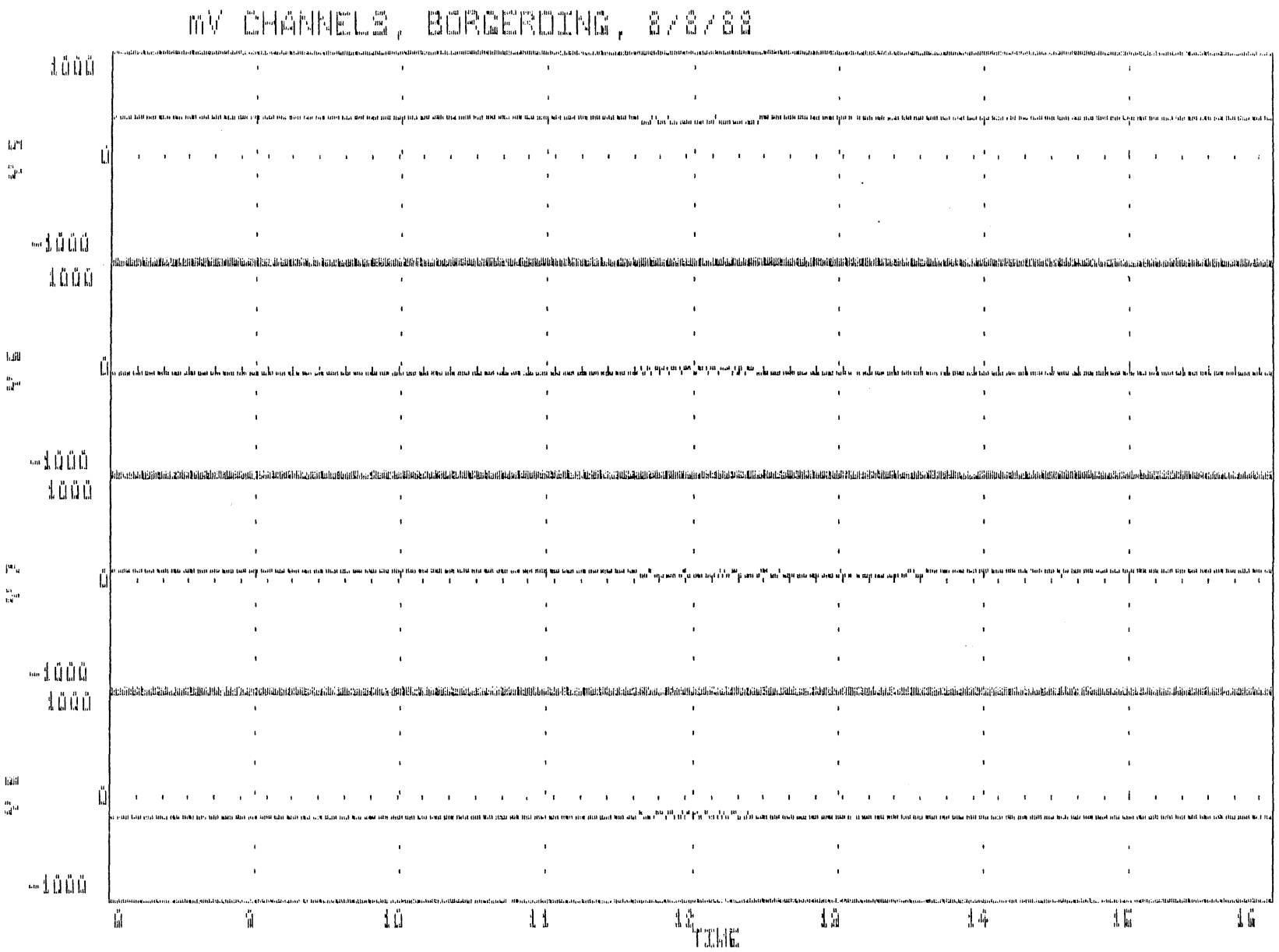

mV CHANNELS, BORGEROING, 8/3/83
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
1
2
3
4
5
6
7
8
TIME



KEY: generator power 0610-0752

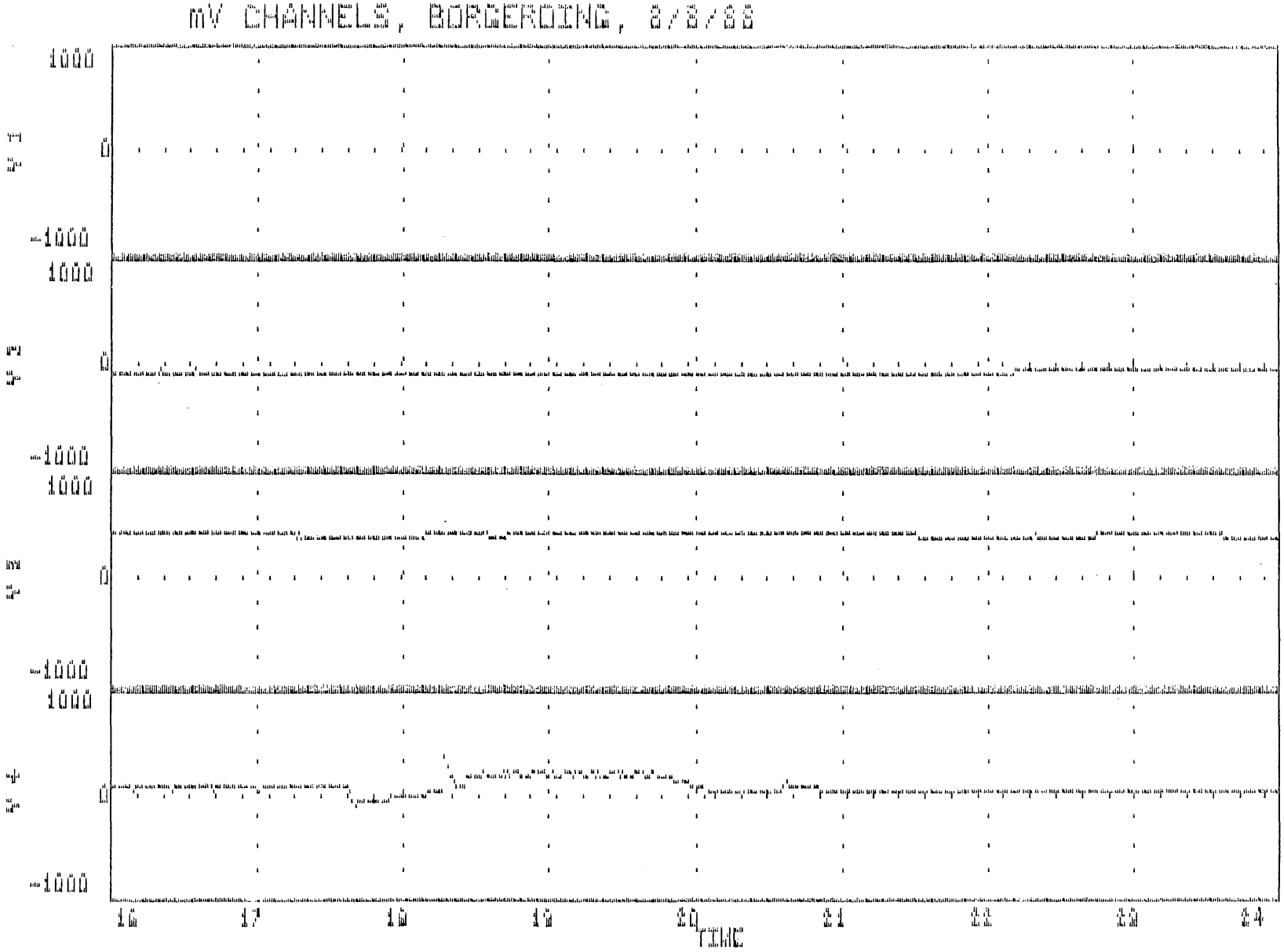
CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

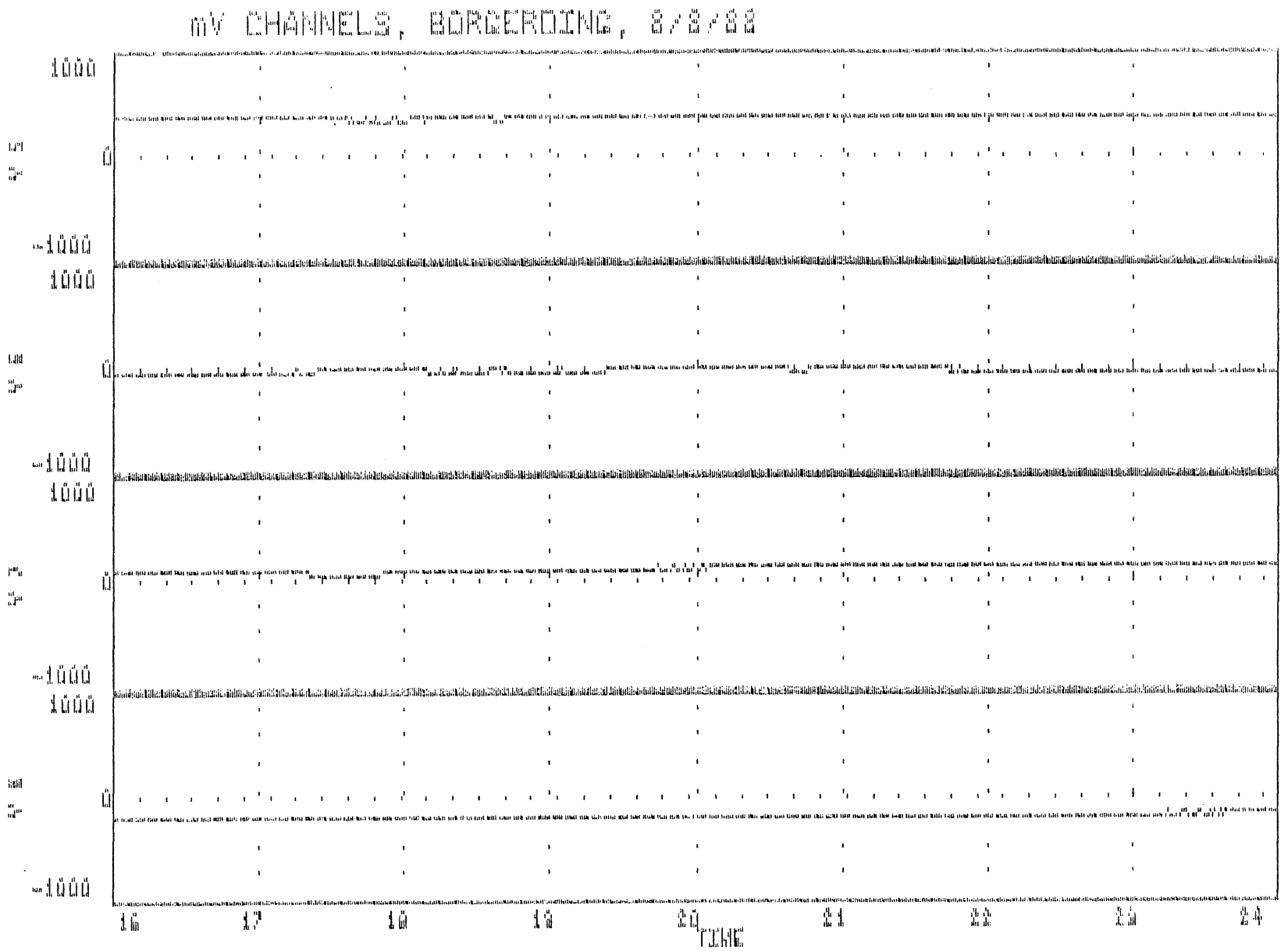

mV CHANNELS, BORDERLINE, 2/28/83
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
10
11
12
13
14
15
16
TIME



KEY

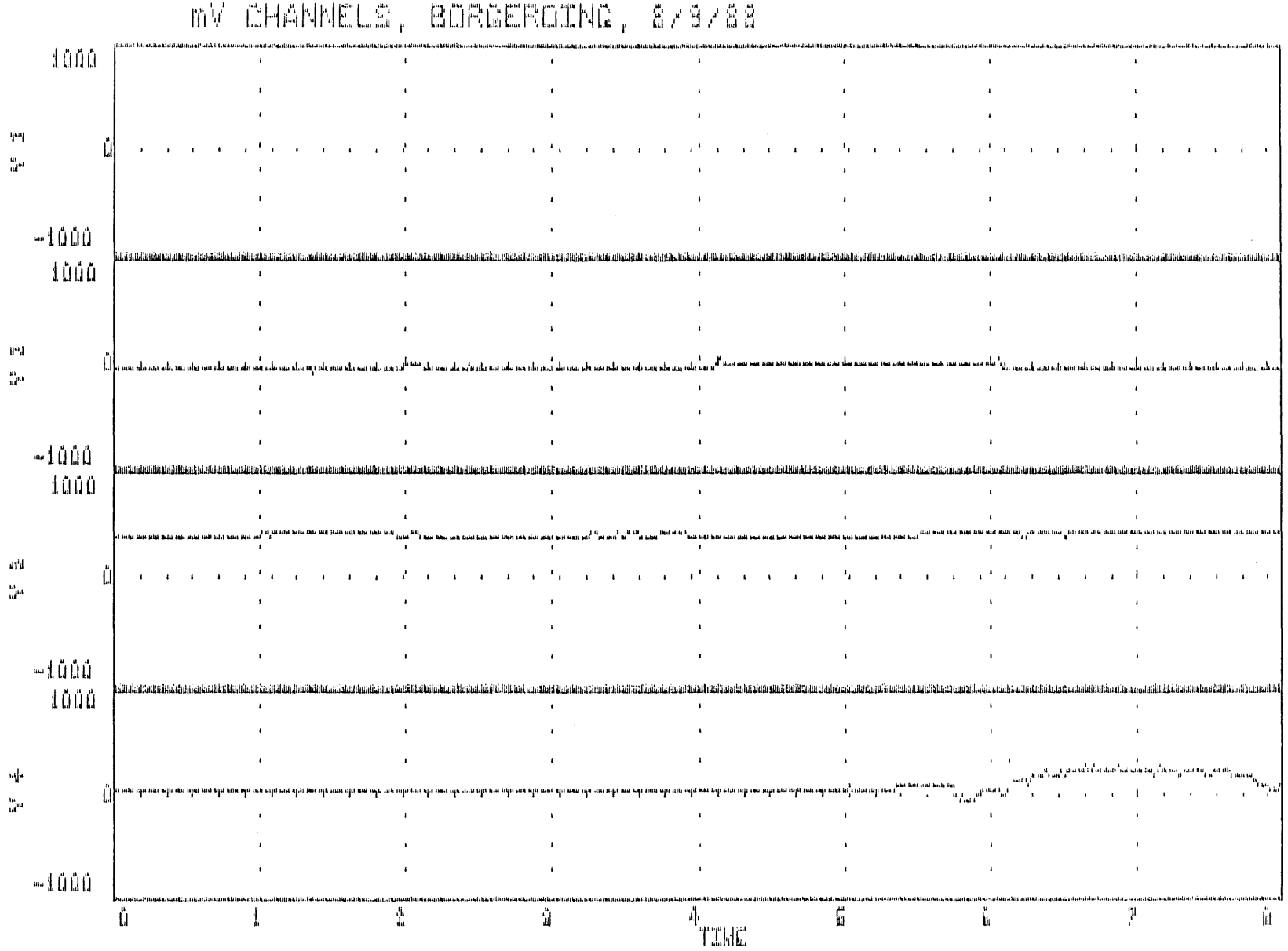
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

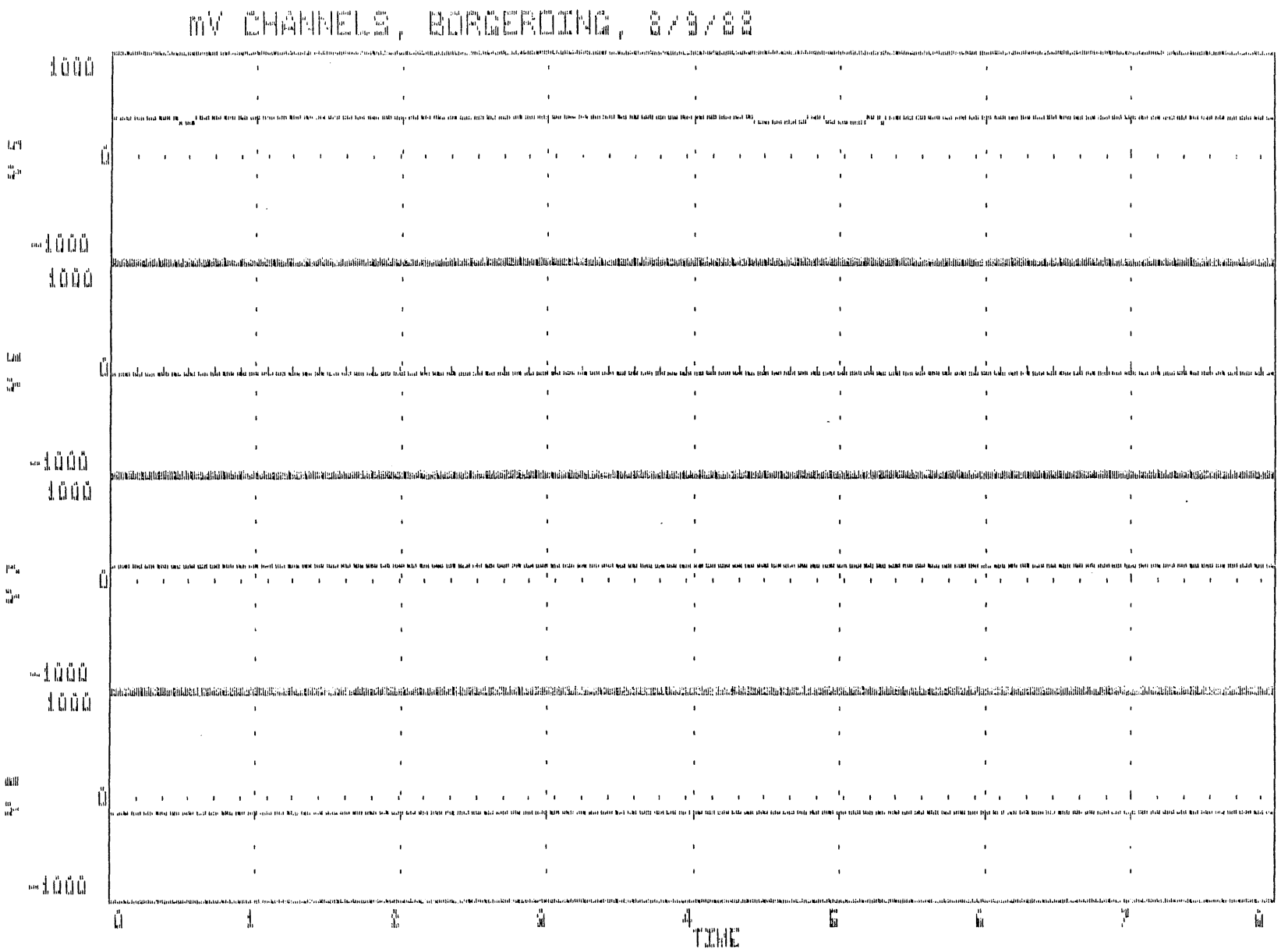

mV CHANNELS, BORGERDING, 8/8/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
mV
mV
mV
mV
16
17
18
19
20
21
22
23
24
TIME



KEY

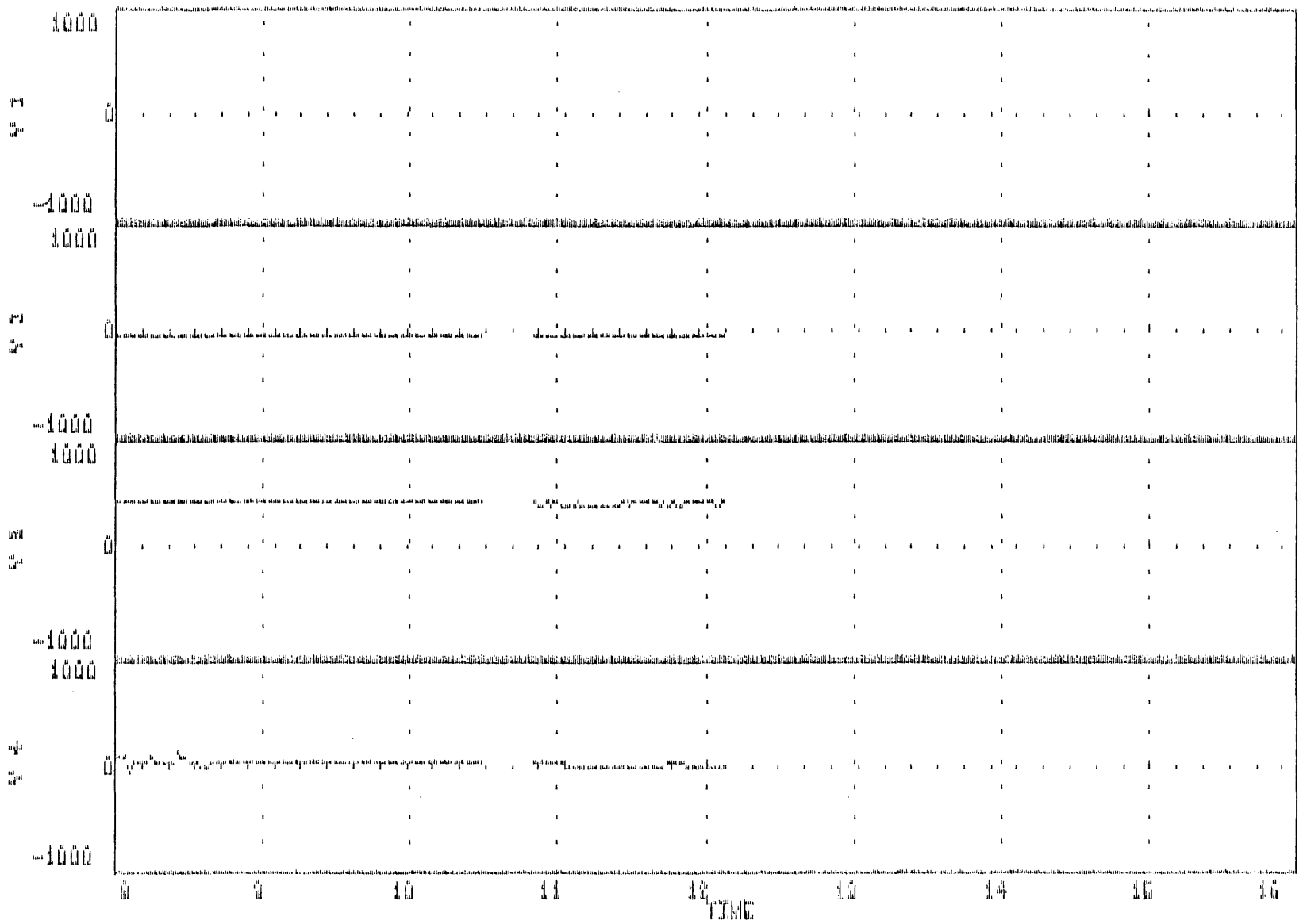
CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

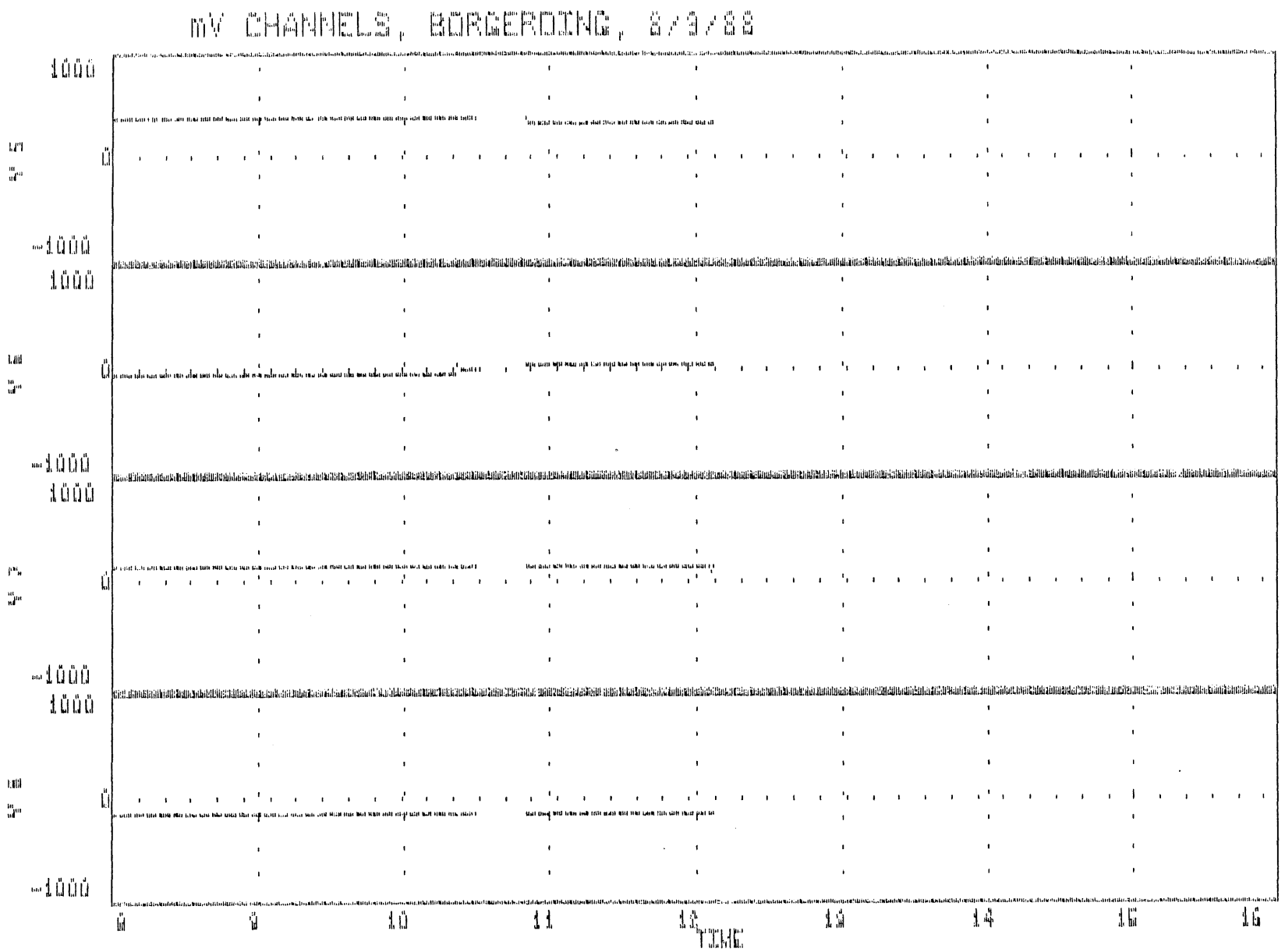

mV CHANNELS, BORDERDING, 8/3/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
1
2
3
4
5
6
7
8
Time



KEY: generator power 0605-0757

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground


mV CHANNELS, BORDERDING, 6/3/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	N waterline	barn ground
V2	step S	step N	V6	barn ceiling	floor plate
V3	S waterline	barn ground	V7	remote ground	ditch ground
V4	S milkline	barn ground	V8	barn ground	ditch ground

Borgerding Primary Data - General Observations

DC Millivolt Variables:

1. Step potential between two contact plates positioned to measure a possible dc potential between front and rear hooves of a cow ranged between -88 and 79 mV (10 and 90 %tile). Readings were generally steady.

2. South waterline to barn ground: Readings were remarkably steady, ranging between 389 and 436 mV.

3. South milkline to barn ground: The dc potential between these two points was the only reading that noticeably changed from its "normal" value when milking operations commenced. At times its "normal" value was near 0 mV with a "milking anomaly" of about 200 mV. At other times the "normal" value was near 100 mV with a "milking anomaly" dipping to 0, then rising to about 200 mV during milking. Overall, the range was -1 to 202 mV.

4. North waterline to barn ground: This dc potential was very steady and predictable throughout. Its range was 334 to 372 mV.

5. Barn ceiling to south waterline: This potential was steady and uninteresting, ranging between -300 and -400 mV. It was abandoned after three days to allow another measurement.

6. Barn ceiling to contact plate on floor: This measurement was meant to provide an independent measurement of the dc electric field in one portion of the barn. Its range was approximately 0 to -100 mV corresponding to a dc field of 0 to -33 mV/meter (mV/height). This is a very small electric field compared to a fair-weather electric field outdoors on the order of 100 V/meter. This reading agrees with spot checks of E with a field mill.

7. Remote ground to ditch ground: The dc potential between these two distant grounds ranged between 63 and 249 mV and was generally steady.

8. Barn ground to ditch ground: Range, -221 to -16 mV, generally steady.

Time series of the ac magnetic field in the center isle at a 2 m height showed very small, negligible readings, indicating that no large source affected the magnetic field throughout the barn for long periods of time.

The only anomaly noticeably correlative with milking activities was the dc potential on the south milkline (detailed in 3 above). The only anomaly possibly correlative with operating the barn on generator power was the dc potential on the south milkline (same

as above). This observation remains in doubt owing to the fact that operating on generator power coincided with milking in every case and this potential varied during milking consistently regardless of the barn power source.

Weather variables: The following table presents the distribution of weather variables over the Borgerding monitoring period.

Variable	90%tile	50%tile	10%tile
Temp(degF)	87	72	61
Bar Pres	30.0	29.9	29.7
Wind(mph)	8	2	0
Rel Hum	88	66	42

JOHNSON

PRIMARY

DATA

FILE

8/12/88 to 8/23/88

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------------------------NCSS Editor------------------------
Date/Time       11-15-1988  13:23:01
Data Base Name C:\EMD\JOH
Description     Data base created at 11:13:14 on 11-15-1988

No. Variable   Rows Vlab     Label
  1 DATE     14,606
  2 TIM      14,606
  3 V1       14,606          CH#1 (mV)
  4 V2       14,606          CH#2 (mV)
  5 V3       14,606          CH#3 (mV)
  6 V4       14,606          CH#4 (mV)
  7 V5       14,606          CH#5 (mV)
  8 V6       14,606          CH#6 (mV)
  9 V7       14,606          CH#7 (mV)
 10 V8       14,606          CH#8 (mV)
 11 T        14,606          TEMPERATURE (deg C)
 12 BP       14,606          BAROMETRIC PRESSURE (in.H20)
 13 WD       14,606          WIND DIRECTION (deg)
 14 WS       14,606          WIND SPEED (mph)
 15 P        14,606          PRECIPITATION TOTAL (in.)
 16 RH       14,606          RELATIVE HUMIDITY (%)
 17 TIME          0          DECIMAL TIME
 18 C18           0
 19 C19           0
 20 C20           0
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----------Descriptive Statistics----------

Data Base Name C:\EMD\JOH

Detail Report

Variable: V1	CH#1 (mV)		
Mean - Average	-137.0061	No. observations	14606
Lower 95% c.i.limit	-147.7353	No. missing values	61
Upper 95% c.i.limit	-126.2768	Sum of frequencies	14545
Adj sum of squares	6.339263E+09	Sum of observations	-1992753
Standard deviation	660.2029	Std.error of mean	5.474199
Variance	435867.9	T-value for mean=0	-25.0276
Coef. of variation	-4.818787	T prob level	0.0000
Skewness	-7.225099	Kurtosis	50.25428
Normality Test Value	0.790	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	-6	90-%tile	-23
75-%tile	-32	10-%tile	-75
50-%tile (Median)	-47	Range	4994
25-%tile	-63	75th-25th %tile	31
0-%tile (Minimum)	-5000		

Variable: V2	CH#2 (mV)		
Mean - Average	60.58558	No. observations	14606
Lower 95% c.i.limit	59.5011	No. missing values	0
Upper 95% c.i.limit	61.67006	Sum of frequencies	14606
Adj sum of squares	6.530985E+07	Sum of observations	884913
Standard deviation	66.87112	Std.error of mean	.5533156
Variance	4471.746	T-value for mean=0	109.4955
Coef. of variation	1.103746	T prob level	0.0000
Skewness	.7270502	Kurtosis	-.9352198
Normality Test Value	0.928	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	269	90-%tile	154
75-%tile	121	10-%tile	7
50-%tile (Median)	9	Range	278
25-%tile	7	75th-25th %tile	114
0-%tile (Minimum)	-9		

----------Descriptive Statistics----------

Data Base Name C:\EMD\JOH

Detail Report

Variable: V3	CH#3 (mV)		
Mean - Average	133.4296	No. observations	14606
Lower 95% c.i.limit	132.4961	No. missing values	0
Upper 95% c.i.limit	134.3631	Sum of frequencies	14606
Adj sum of squares	4.83887E+07	Sum of observations	1948873
Standard deviation	57.56005	Std.error of mean	.4762725
Variance	3313.16	T-value for mean=0	280.1539
Coef. of variation	.4313889	T prob level	0.0000
Skewness	1.962479	Kurtosis	2.867775
Normality Test Value	0.767	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	321	90-%tile	260
75-%tile	140	10-%tile	90
50-%tile (Median)	112	Range	254
25-%tile	102	75th-25th %tile	38
0-%tile (Minimum)	67		

Variable: V4	CH#4 (mV)		
Mean - Average	-387.2817	No. observations	14606
Lower 95% c.i.limit	-389.3663	No. missing values	0
Upper 95% c.i.limit	-385.1971	Sum of frequencies	14606
Adj sum of squares	2.413167E+08	Sum of observations	-5656636
Standard deviation	128.5414	Std.error of mean	1.063597
Variance	16522.88	T-value for mean=0	-364.1243
Coef. of variation	-.3319067	T prob level	0.0000
Skewness	.8002523	Kurtosis	-.6893926
Normality Test Value	1.090	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	0	90-%tile	-170
75-%tile	-294	10-%tile	-511
50-%tile (Median)	-443	Range	541
25-%tile	-493	75th-25th %tile	199
0-%tile (Minimum)	-541		

----------Descriptive Statistics----------

Data Base Name C:\EMD\JDH

Detail Report

Variable: V5	CH#5 (mV)		
Mean - Average	74.27176	No. observations	14606
Lower 95% c.i.limit	73.33551	No. missing values	1
Upper 95% c.i.limit	75.208	Sum of frequencies	14605
Adj sum of squares	4.866914E+07	Sum of observations	1084739
Standard deviation	57.72859	Std.error of mean	.4776834
Variance	3332.59	T-value for mean=0	155.4832
Coef. of variation	.7772616	T prob level	0.0000
Skewness	.7062827	Kurtosis	-.6662249
Normality Test Value	0.993	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	304	90-%tile	155
75-%tile	122	10-%tile	20
50-%tile (Median)	42	Range	289
25-%tile	22	75th-25th %tile	100
0-%tile (Minimum)	15		

Variable: V6	CH#6 (mV)		
Mean - Average	283.1897	No. observations	14606
Lower 95% c.i.limit	275.051	No. missing values	9787
Upper 95% c.i.limit	291.3283	Sum of frequencies	4819
Adj sum of squares	4.003419E+08	Sum of observations	1364691
Standard deviation	288.2585	Std.error of mean	4.152447
Variance	83092.96	T-value for mean=0	68.19833
Coef. of variation	1.017899	T prob level	0.0000
Skewness	.927661	Kurtosis	.2879214
Normality Test Value	1.024	Reject if > 0.995(10%)	0.995(5%)
100-%tile (Maximum)	1599	90-%tile	677
75-%tile	475	10-%tile	5
50-%tile (Median)	259	Range	1769
25-%tile	33	75th-25th %tile	442
0-%tile (Minimum)	-170		

----------Descriptive Statistics----------

Data Base Name C:\EMD\JOH

Detail Report

Variable: V7	CH#7 (mV)		
Mean - Average	31.73794	No. observations	14606
Lower 95% c.i.limit	31.19591	No. missing values	365
Upper 95% c.i.limit	32.27997	Sum of frequencies	14241
Adj sum of squares	1.550954E+07	Sum of observations	451980
Standard deviation	33.00232	Std.error of mean	.2765504
Variance	1089.153	T-value for mean=0	114.7637
Coef. of variation	1.039838	T prob level	0.0000
Skewness	.1477353	Kurtosis	.5887066
Normality Test Value	0.944	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	353	90-%tile	75
75-%tile	61	10-%tile	-17
50-%tile (Median)	36	Range	387
25-%tile	2	75th-25th %tile	59
0-%tile (Minimum)	-34		

Variable: V8	CH#8 (mV)		
Mean - Average	-209.8485	No. observations	14606
Lower 95% c.i.limit	-210.4093	No. missing values	366
Upper 95% c.i.limit	-209.2878	Sum of frequencies	14240
Adj sum of squares	1.659665E+07	Sum of observations	-2988243
Standard deviation	34.14055	Std.error of mean	.2860985
Variance	1165.577	T-value for mean=0	-733.4836
Coef. of variation	-.1626914	T prob level	0.0000
Skewness	1.783901	Kurtosis	6.655053
Normality Test Value	1.499	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	223	90-%tile	-160
75-%tile	-198	10-%tile	-243
50-%tile (Median)	-220	Range	496
25-%tile	-231	75th-25th %tile	33
0-%tile (Minimum)	-273		

----------Descriptive Statistics----------

Data Base Name C:\EMD\JOH

Detail Report

Variable: T TEMPERATURE (deg C)

Mean - Average	70.30254	No. observations	14606
Lower 95% c.i.limit	70.15099	No. missing values	0
Upper 95% c.i.limit	70.4541	Sum of frequencies	14606
Adj sum of squares	1275462	Sum of observations	1026839
Standard deviation	9.345079	Std.error of mean	7.732454E-02
Variance	87.33051	T-value for mean=0	909.1881
Coef. of variation	.1329266	T prob level	0.0000
Skewness	.5959721	Kurtosis	-.3370161
Normality Test Value	0.989	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	94	90-%tile	83
75-%tile	77	10-%tile	60
50-%tile (Median)	69	Range	40
25-%tile	63	75th-25th %tile	14
0-%tile (Minimum)	54		

Variable: BP BAROMETRIC PRESSURE (in.H2O)

Mean - Average	29.79745	No. observations	14606
Lower 95% c.i.limit	29.79347	No. missing values	0
Upper 95% c.i.limit	29.80144	Sum of frequencies	14606
Adj sum of squares	881.9432	Sum of observations	435221.6
Standard deviation	.2457364	Std.error of mean	2.033311E-03
Variance	6.038639E-02	T-value for mean=0	14654.64
Coef. of variation	8.246894E-03	T prob level	0.0000
Skewness	-99.12866	Kurtosis	11212.54
Normality Test Value	0.749	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	30.02	90-%tile	29.91
75-%tile	29.87	10-%tile	29.68
50-%tile (Median)	29.79	Range	28.02
25-%tile	29.75	75th-25th %tile	.1200008
0-%tile (Minimum)	2		

----------Descriptive Statistics----------

Data Base Name C:\EMD\JOH

Detail Report

Variable: WD	WIND DIRECTION (deg)		
Mean - Average	111.455	No. observations	14606
Lower 95% c.i.limit	110.0627	No. missing values	1
Upper 95% c.i.limit	112.8472	Sum of frequencies	14605
Adj sum of squares	1.076238E+08	Sum of observations	1627800
Standard deviation	85.84563	Std.error of mean	.7103419
Variance	7369.473	T-value for mean=0	156.9033
Coef. of variation	.770227	T prob level	0.0000
Skewness	1.05541	Kurtosis	.5055843
Normality Test Value	1.048	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	360	90-%tile	270
75-%tile	150	10-%tile	20
50-%tile (Median)	110	Range	350
25-%tile	50	75th-25th %tile	100
0-%tile (Minimum)	10		

Detail Report

Variable: WS	WIND SPEED (mph)		
Mean - Average	3.41164	No. observations	14606
Lower 95% c.i.limit	3.361267	No. missing values	1
Upper 95% c.i.limit	3.462013	Sum of frequencies	14605
Adj sum of squares	140887.2	Sum of observations	49827
Standard deviation	3.105989	Std.error of mean	2.570095E-02
Variance	9.647166	T-value for mean=0	132.7437
Coef. of variation	.9104093	T prob level	0.0000
Skewness	1.083766	Kurtosis	1.384846
Normality Test Value	1.099	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	23	90-%tile	7
75-%tile	6	10-%tile	0
50-%tile (Median)	3	Range	23
25-%tile	1	75th-25th %tile	5
0-%tile (Minimum)	0		

----------Descriptive Statistics----------

Data Base Name C:\EMD\JOH

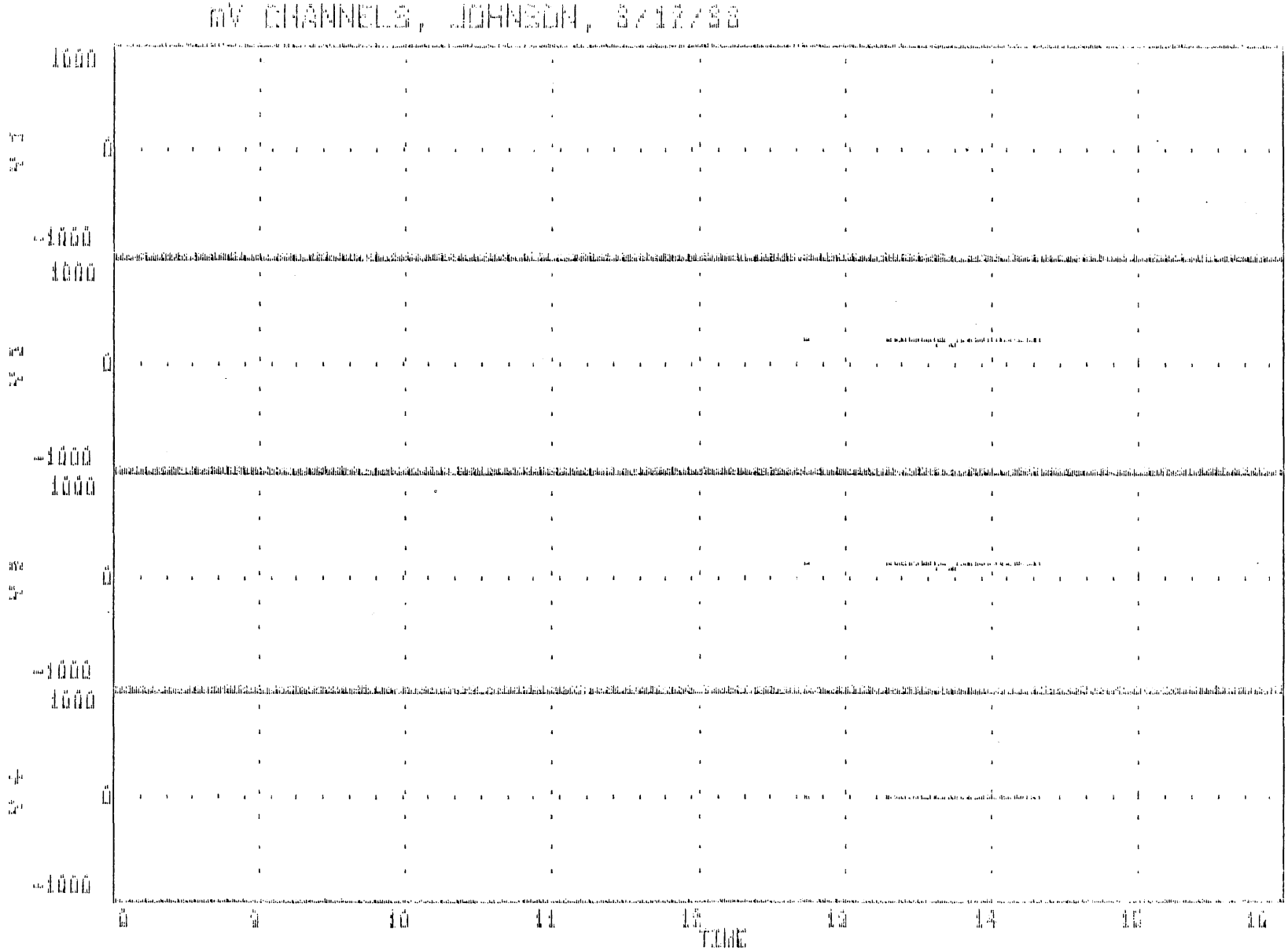
Detail Report

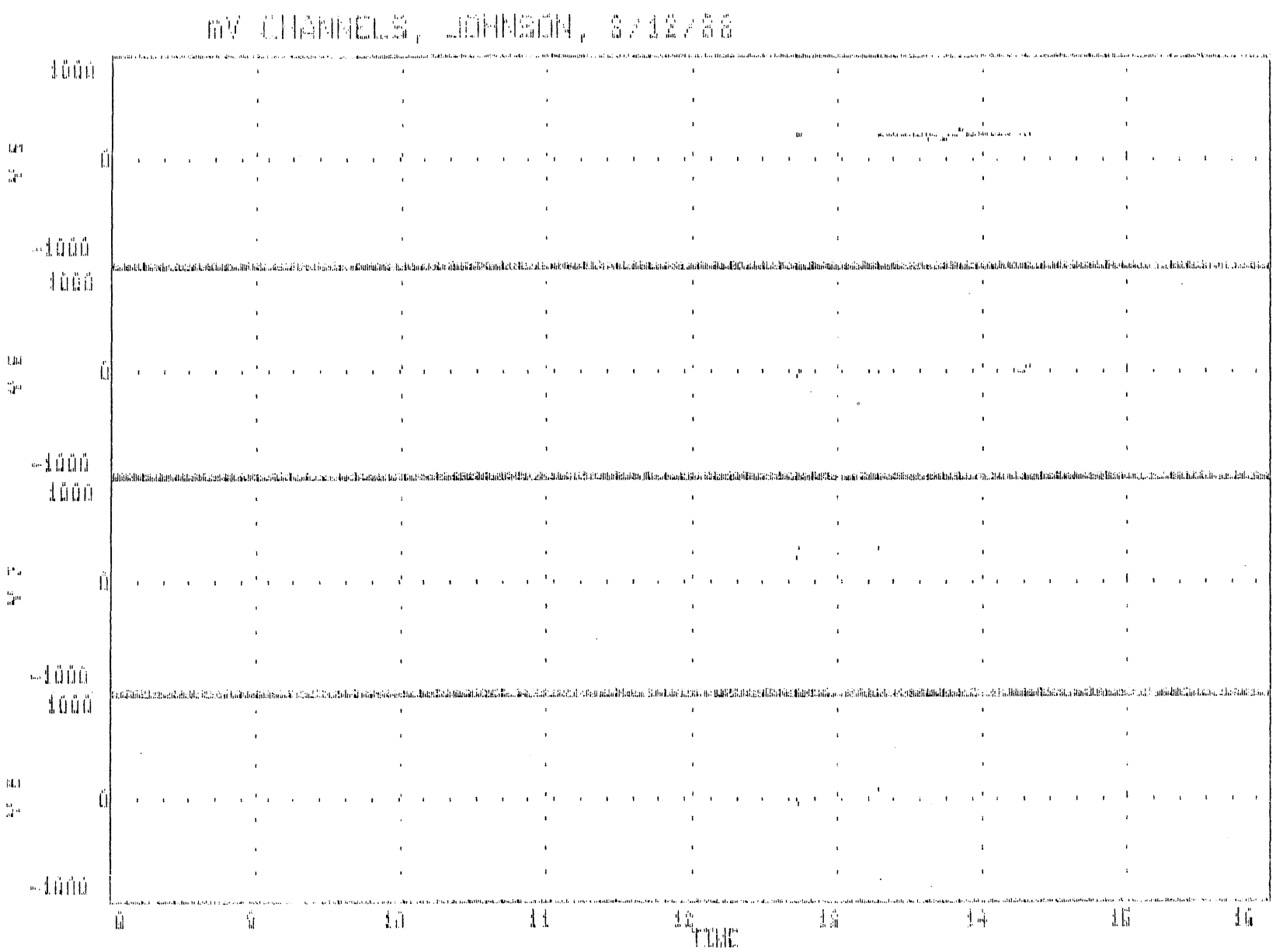
Variable: P PRECIPITATION TOTAL (in.)

Mean - Average	.130771	No. observations	14606
Lower 95% c.i.limit	.1260165	No. missing values	1
Upper 95% c.i.limit	.1355255	Sum of frequencies	14605
Adj sum of squares	1255.124	Sum of observations	1909.91
Standard deviation	.2931618	Std.error of mean	2.425809E-03
Variance	8.594386E-02	T-value for mean=0	53.90818
Coef. of variation	2.241796	T prob level	0.0000
Skewness	2.20724	Kurtosis	3.177562
100-%tile (Maximum)	1.13	90-%tile	.91
75-%tile	.02	10-%tile	0
50-%tile (Median)	0	Range	1.13
25-%tile	0	75th-25th %tile	.02
0-%tile (Minimum)	0		

Variable: RH RELATIVE HUMIDITY (%)

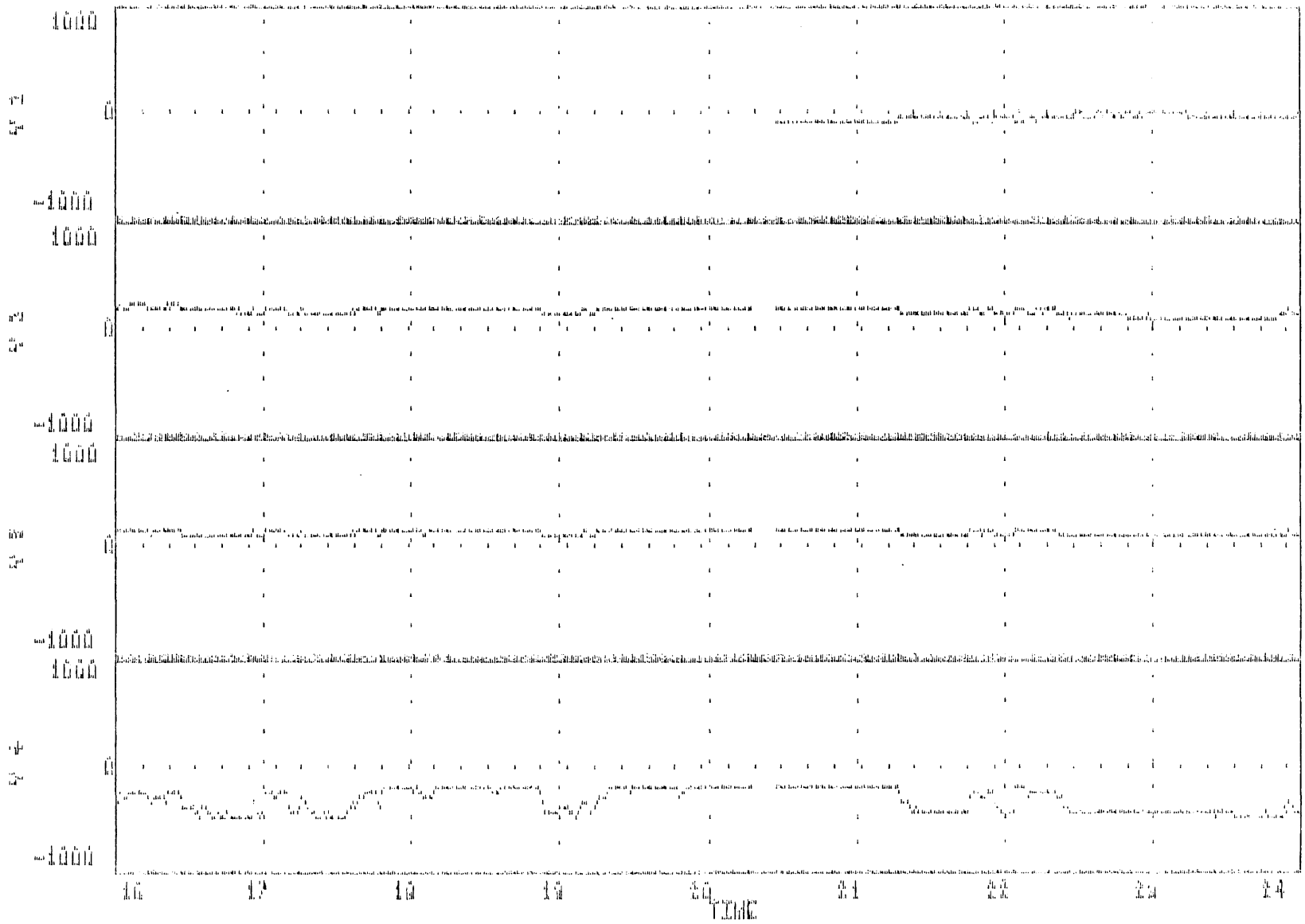
Mean - Average	74.45293	No. observations	14606
Lower 95% c.i.limit	74.26328	No. missing values	1
Upper 95% c.i.limit	74.64259	Sum of frequencies	14605
Adj sum of squares	1997127	Sum of observations	1087385
Standard deviation	11.6941	Std.error of mean	9.676452E-02
Variance	136.752	T-value for mean=0	769.4238
Coef. of variation	.1570671	T prob level	0.0000
Skewness	-.19374	Kurtosis	-.8888163
Normality Test Value	0.935	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	96	90-%tile	90
75-%tile	84	10-%tile	59
50-%tile (Median)	74	Range	50
25-%tile	65	75th-25th %tile	19
0-%tile (Minimum)	46		


mV CHANNELS, JOHNSON, 8/17/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
10
11
15
13
14
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


MY CHANNELS, JOHNSON, 3/12/88
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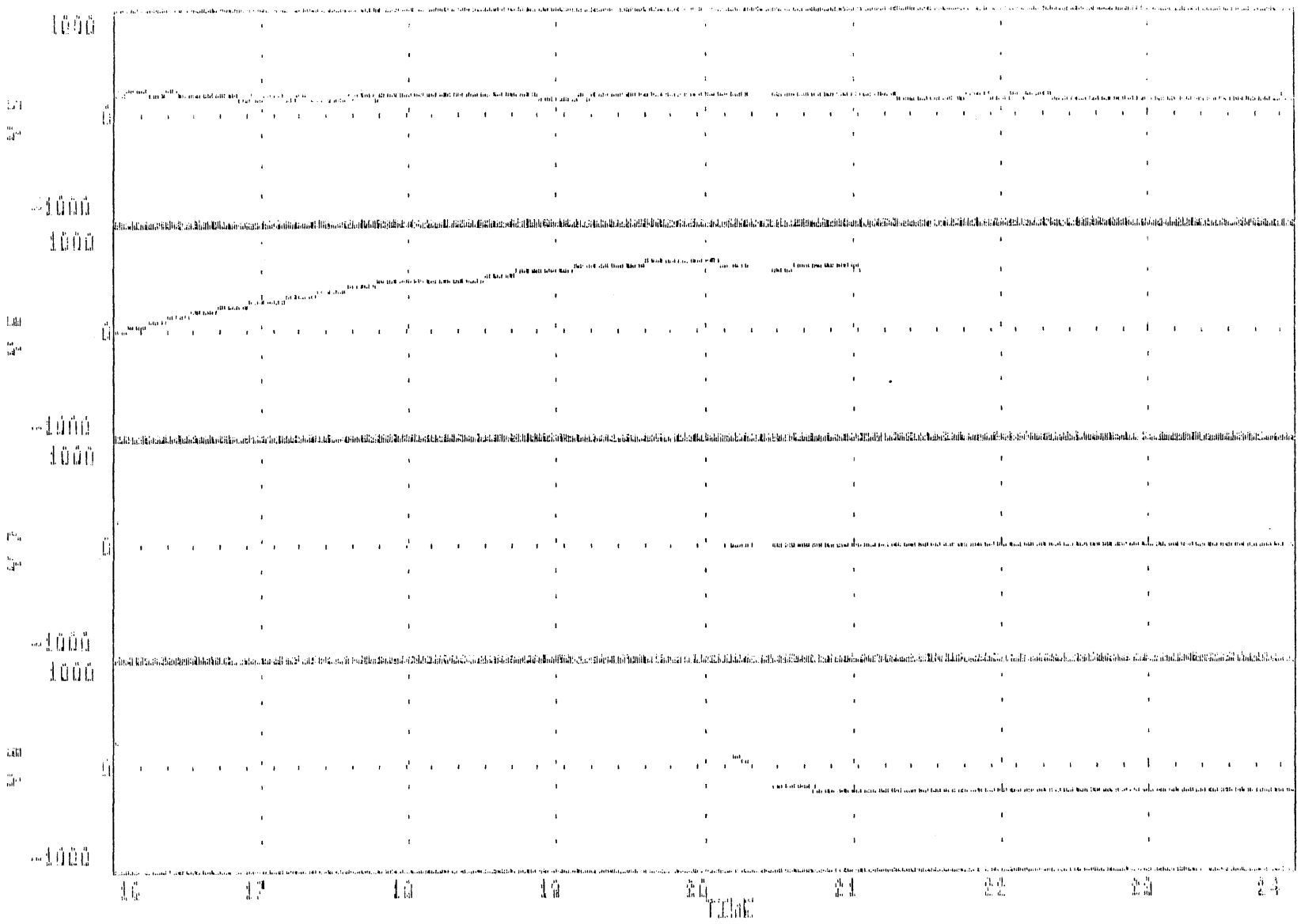
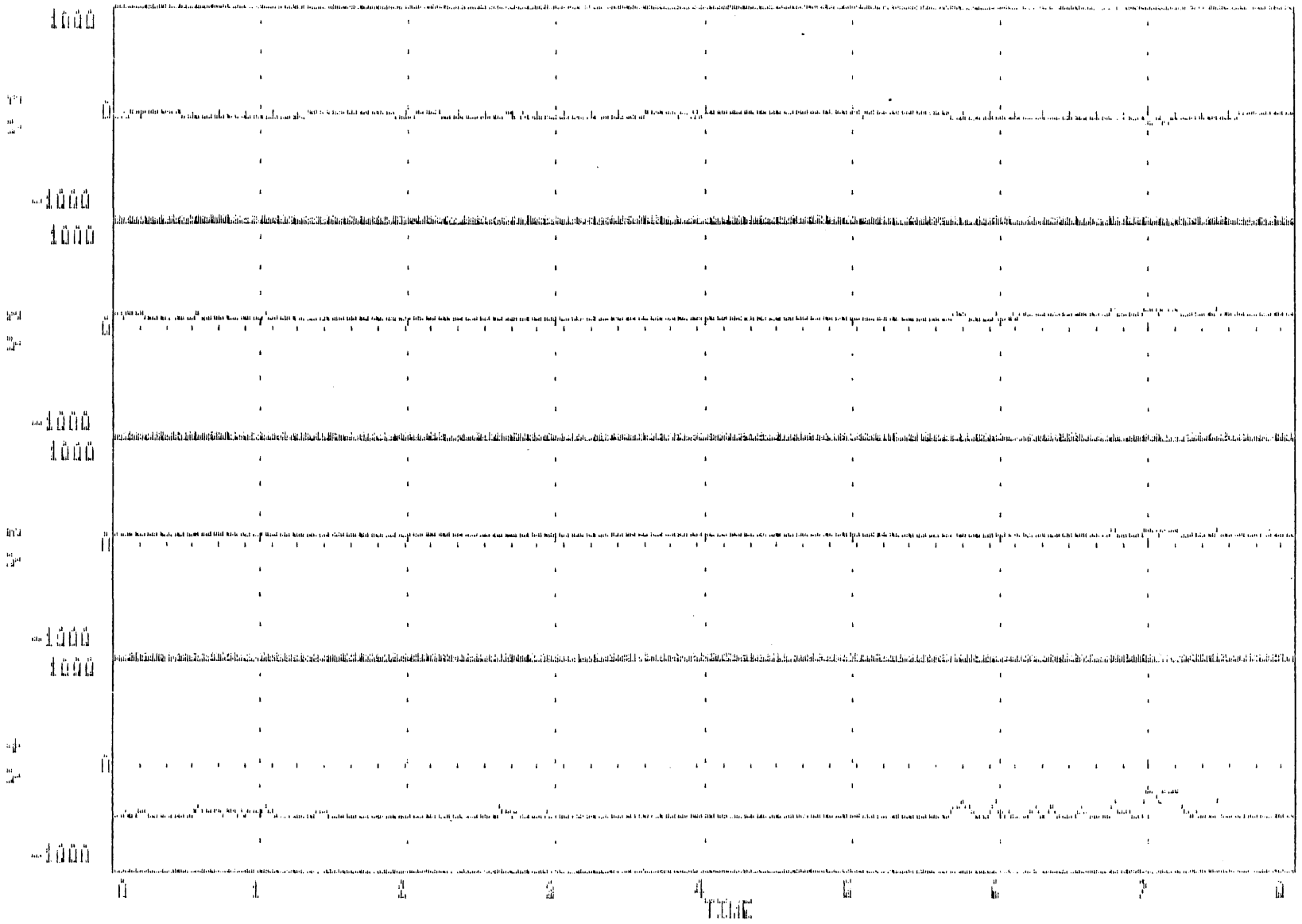
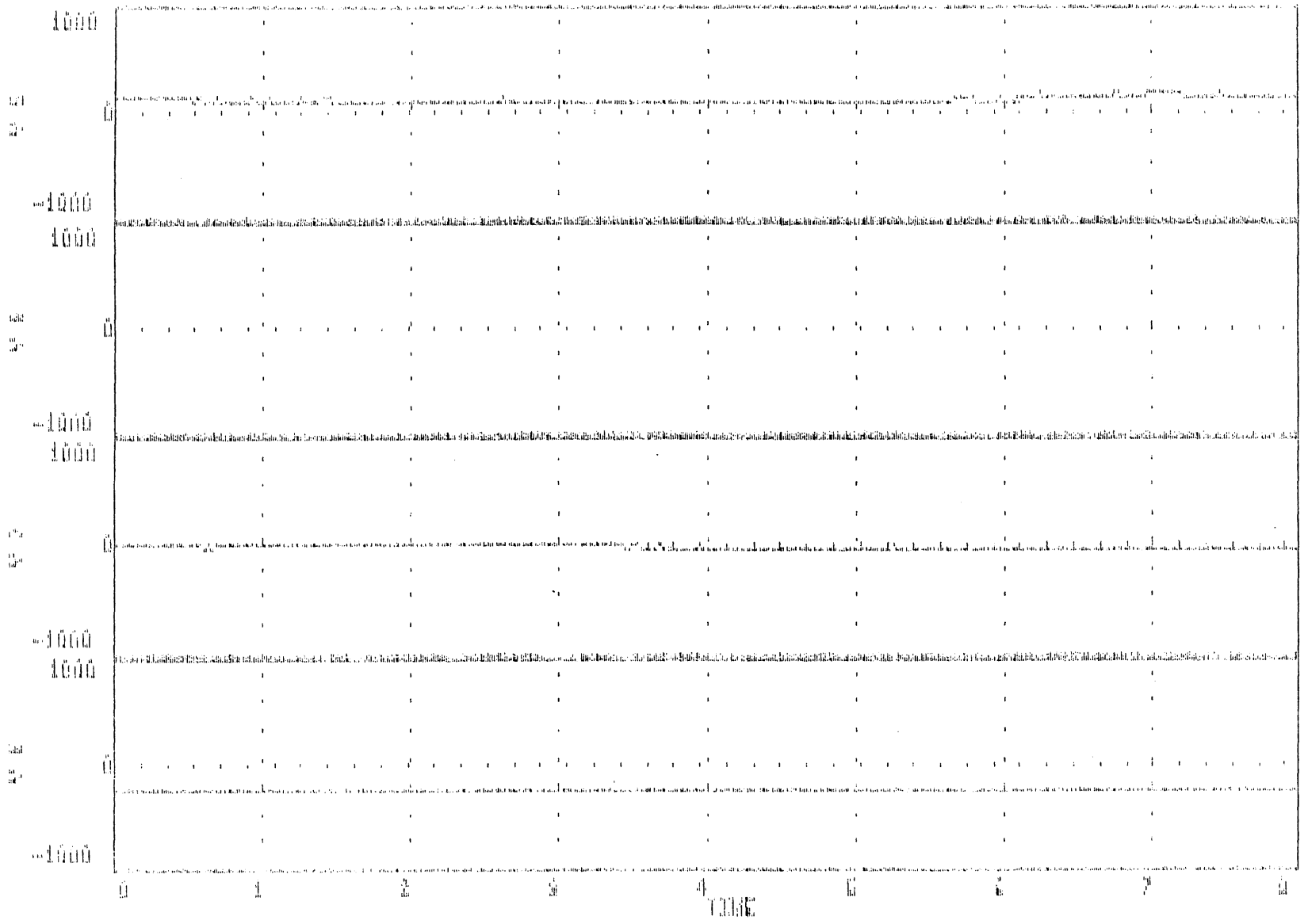
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
TIME



KEY

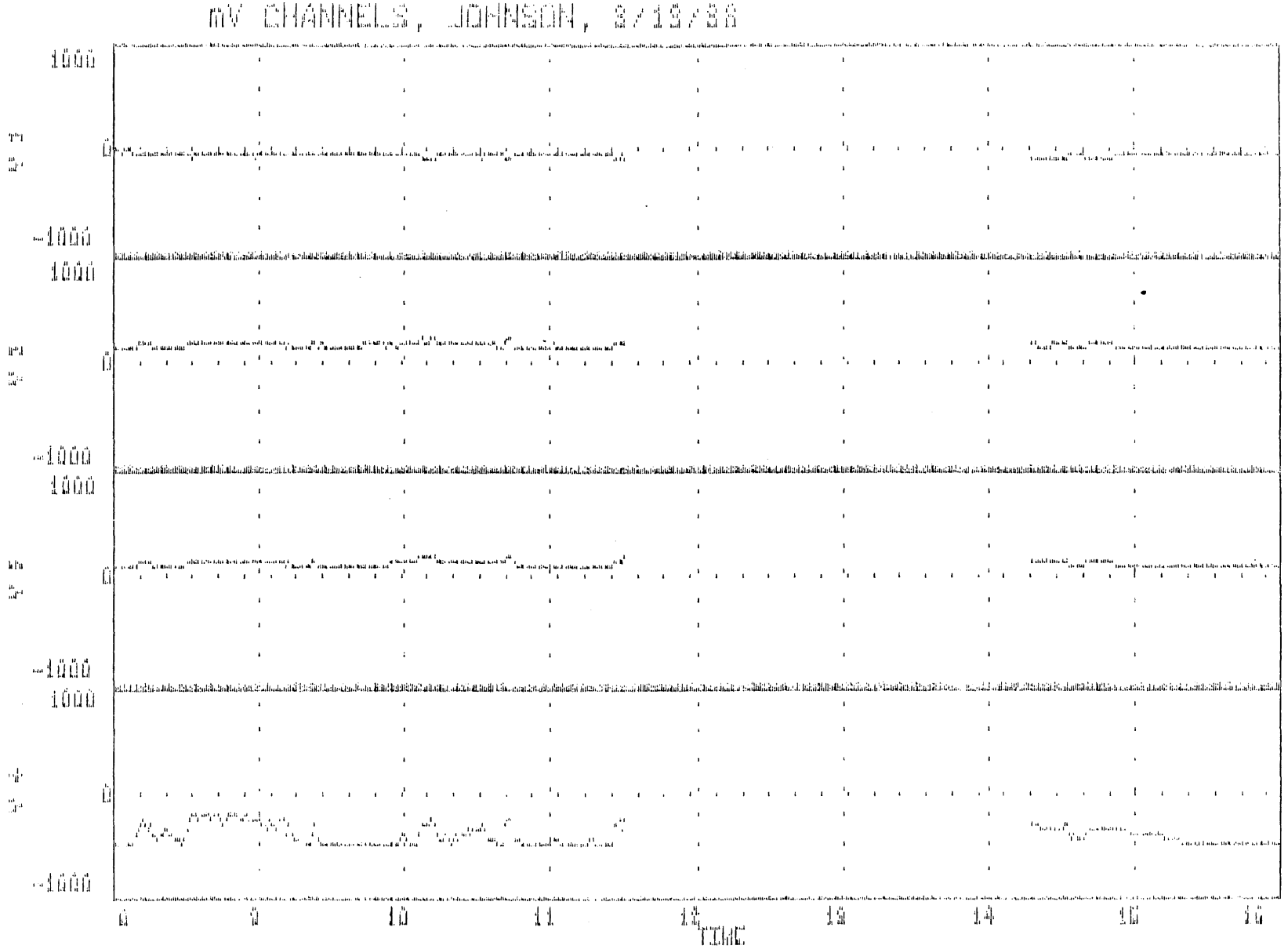
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

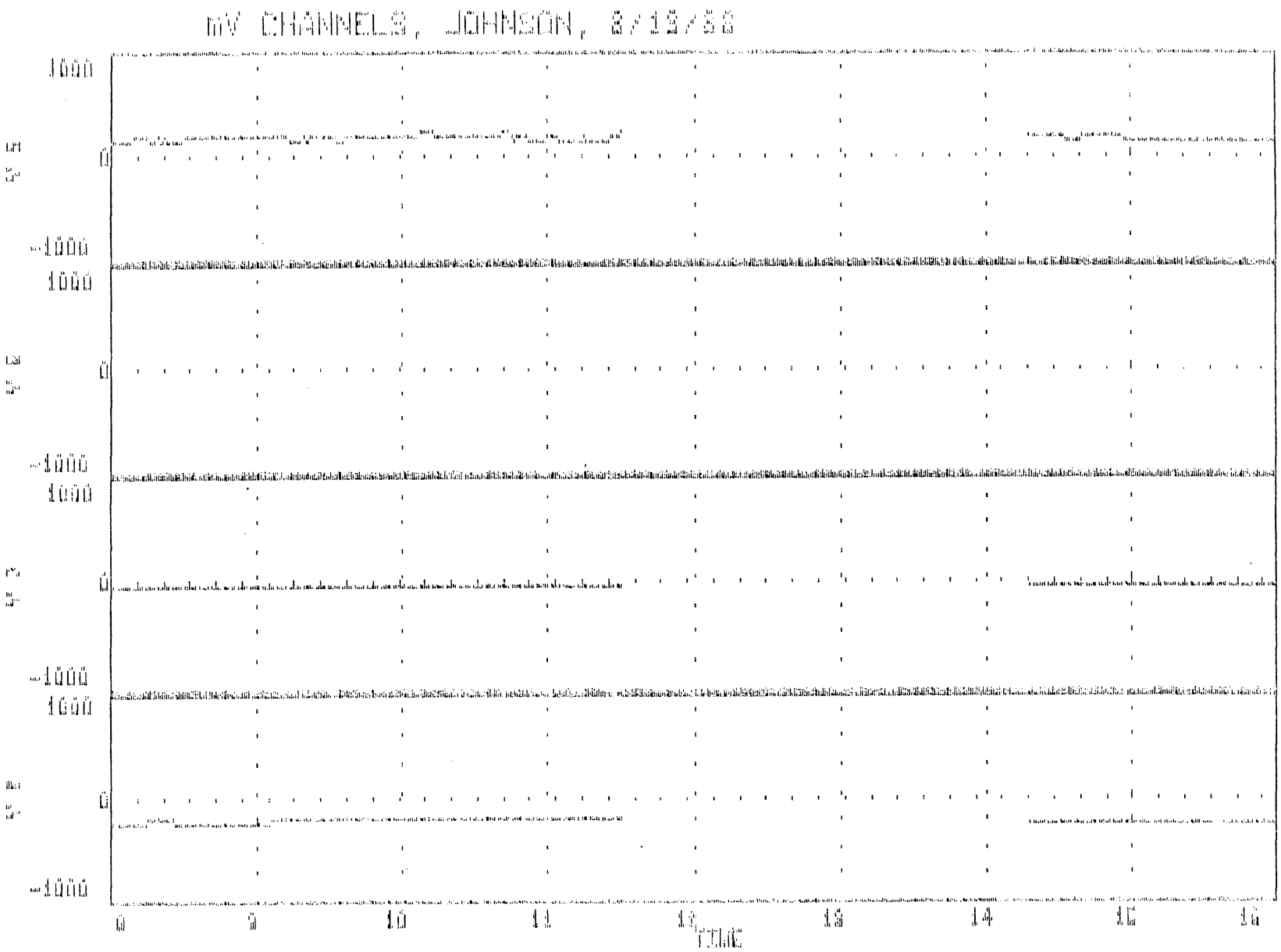

mV CHANNELS, JOHNSON, 2/18/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
1
2
3
4
5
6
7
8
Time



KEY

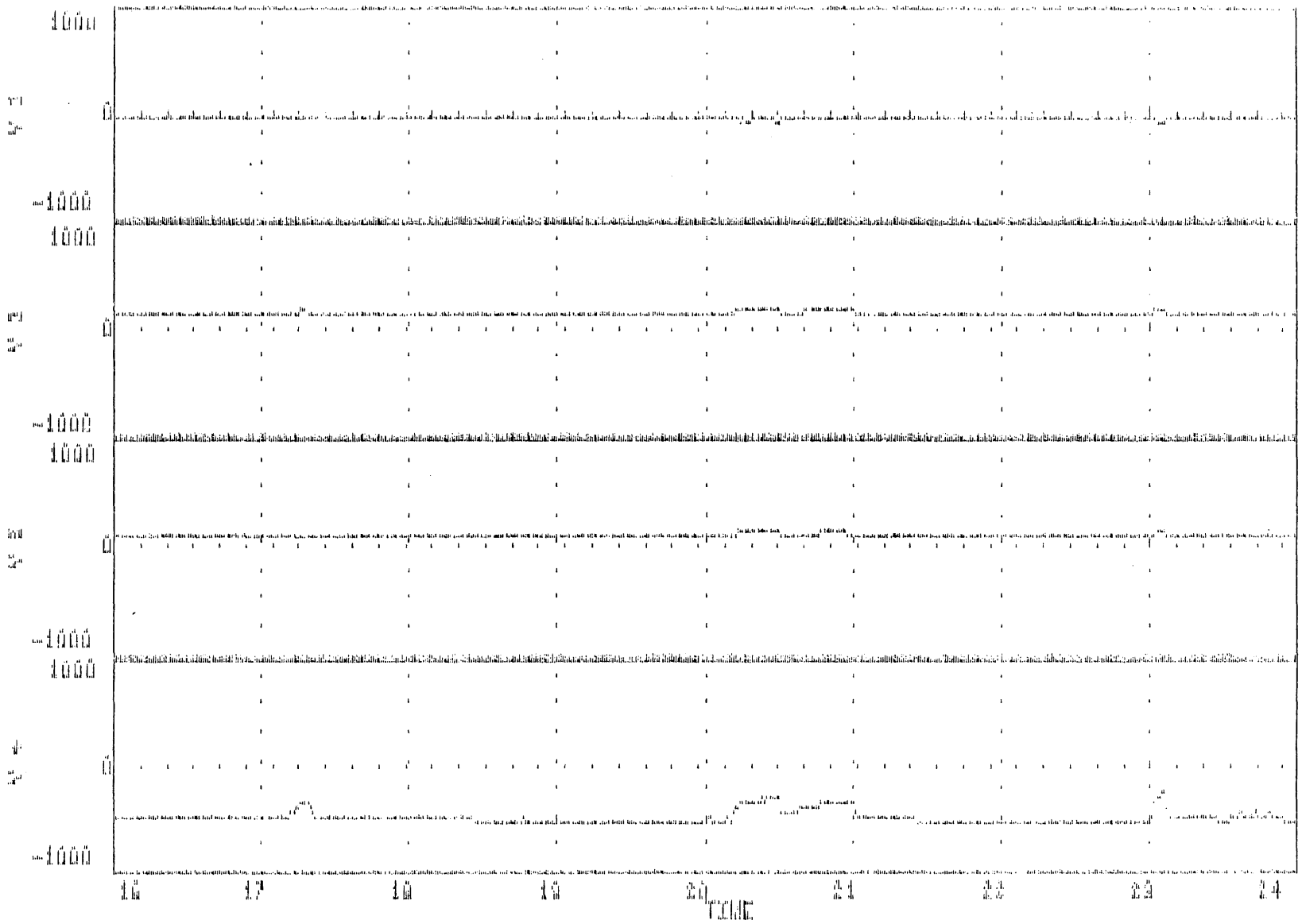
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6	•	
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


mV CHANNELS, JOHNSON, 8/19/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
5
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


mV CHANNELS, JOHNSON, 9/13/88
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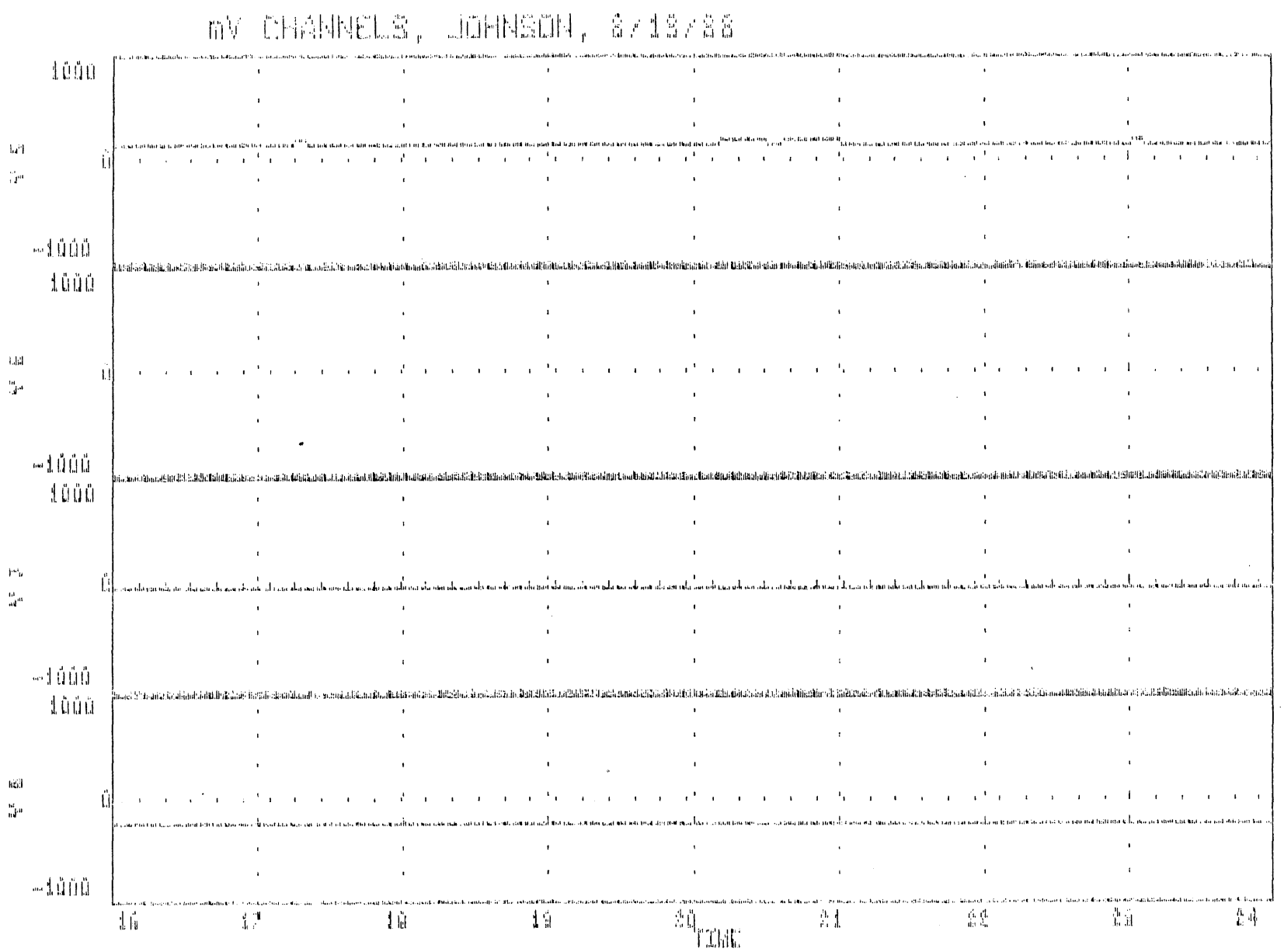
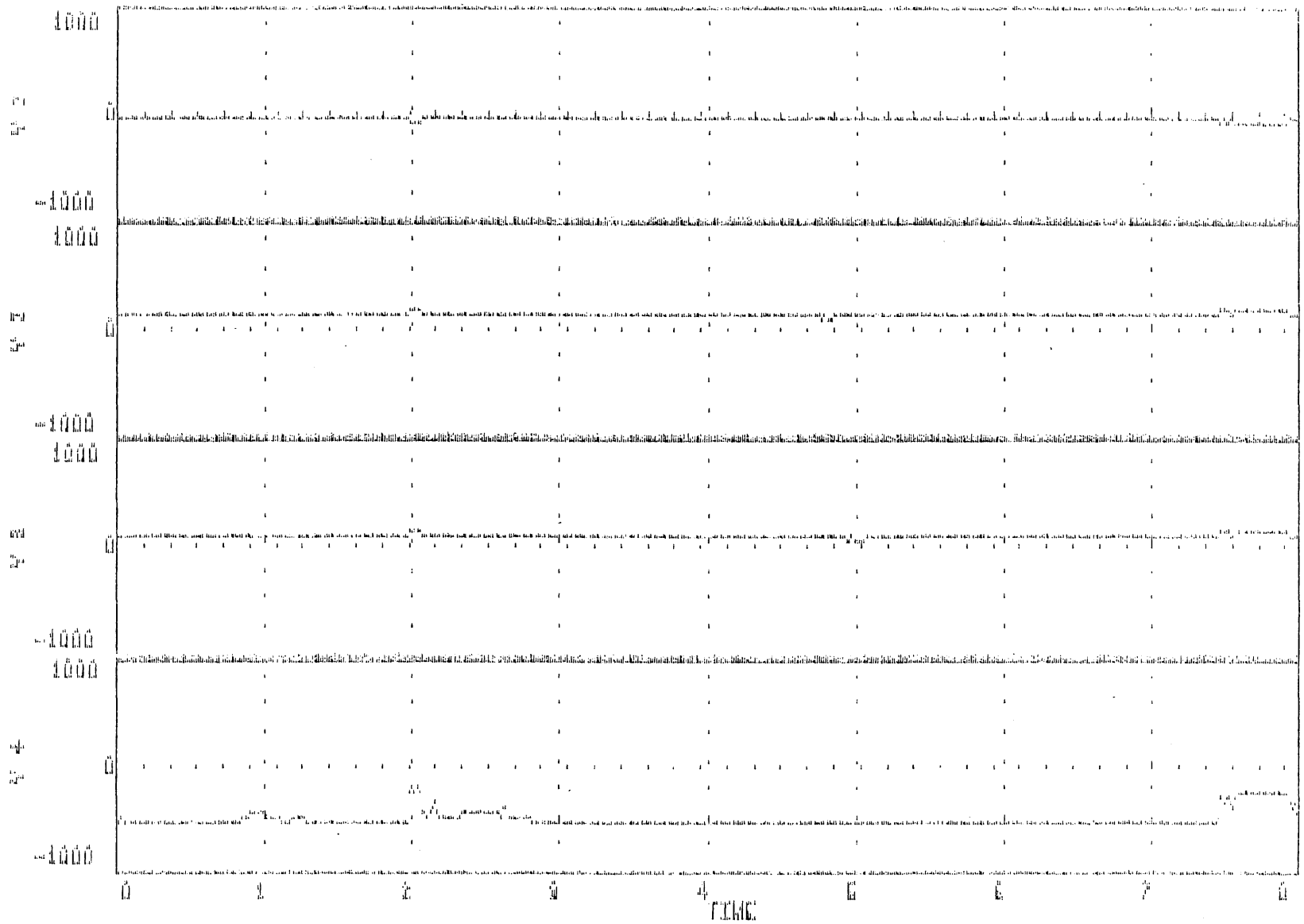
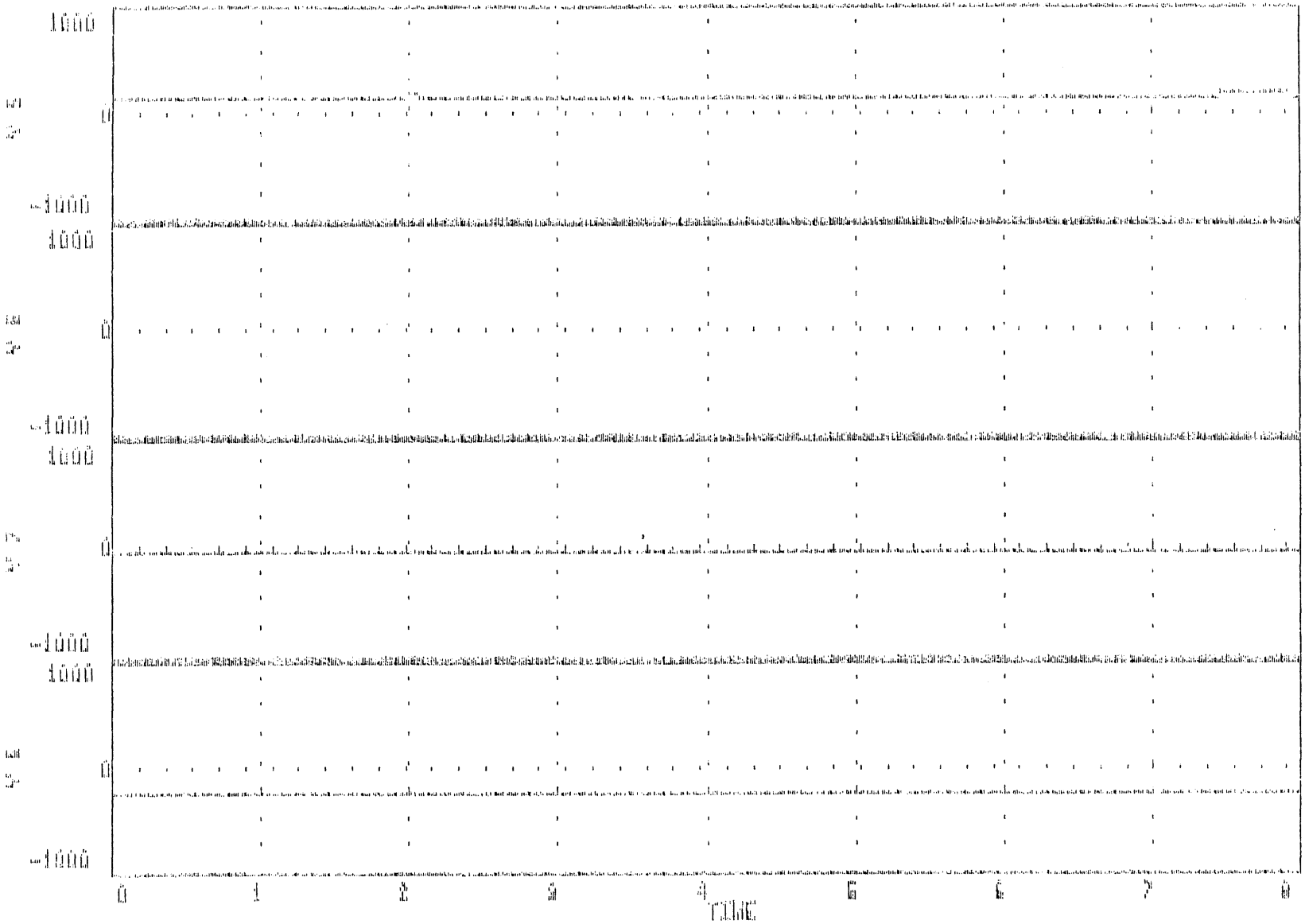
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
16
17
18
19
20
21
22
23
24
TIME



KEY

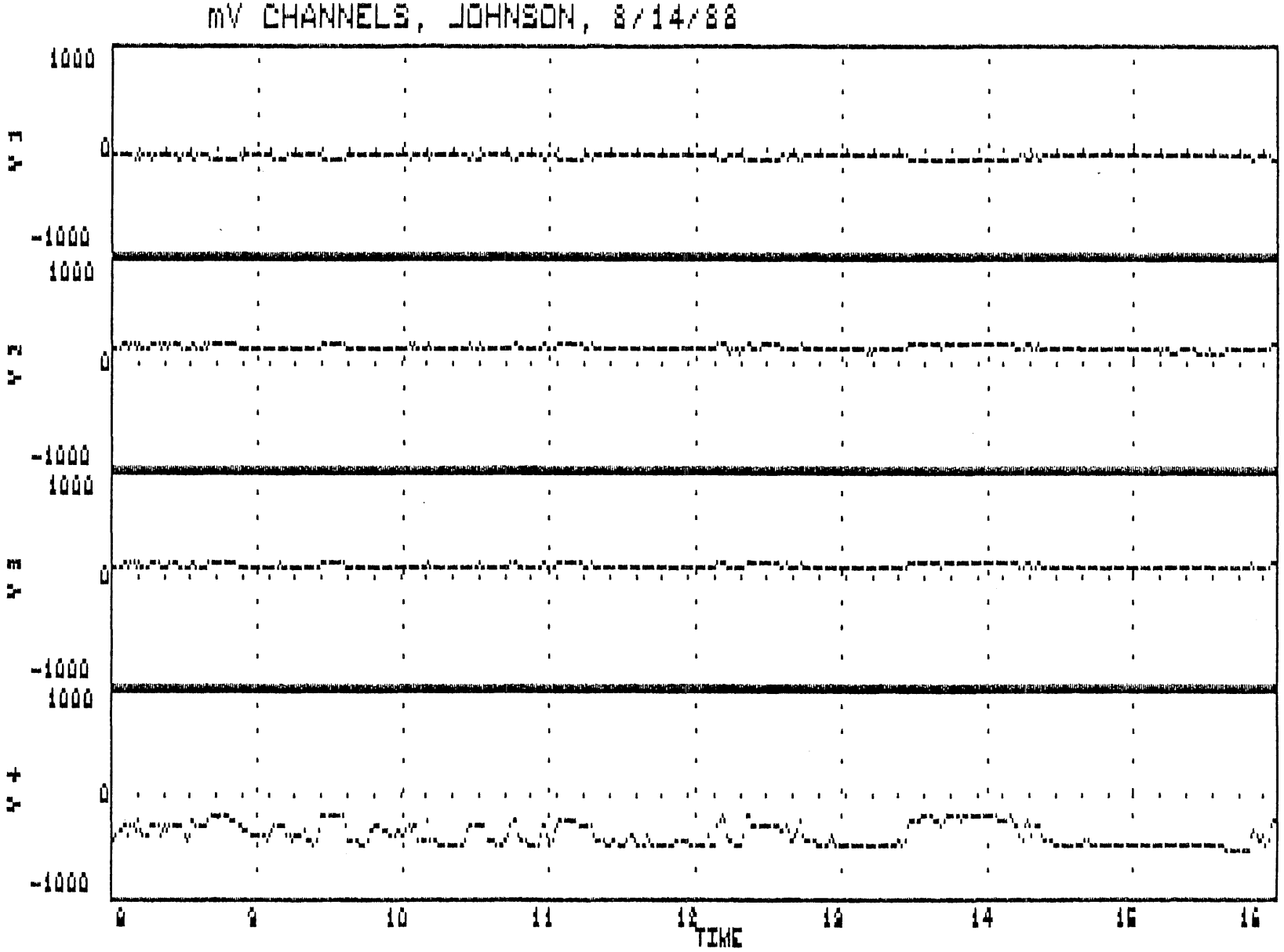
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

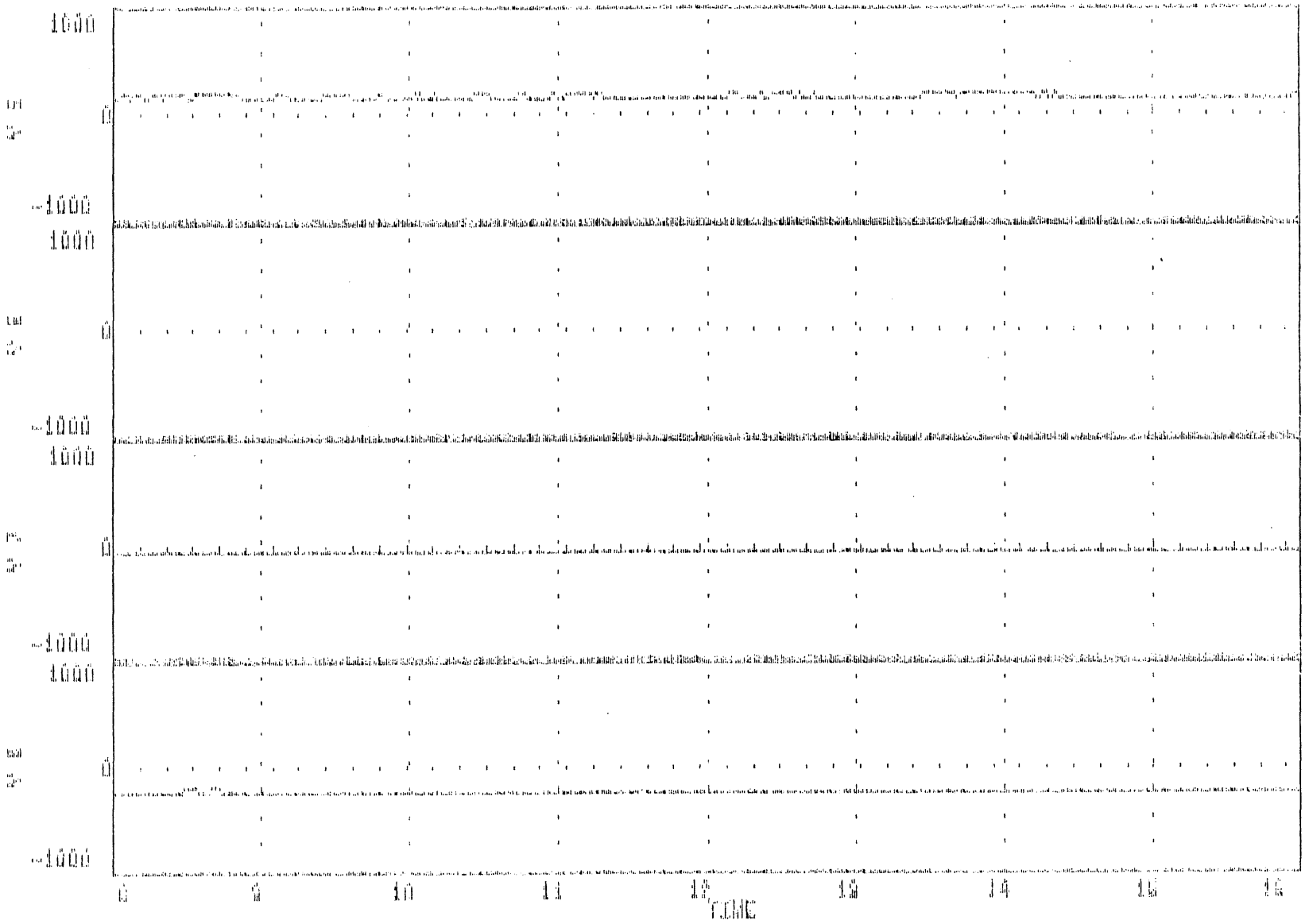

mV CHANNELS, JOHNSON, 8/14/88
1000
-1000
1000
-1000
1000
-1000
TIME



KEY

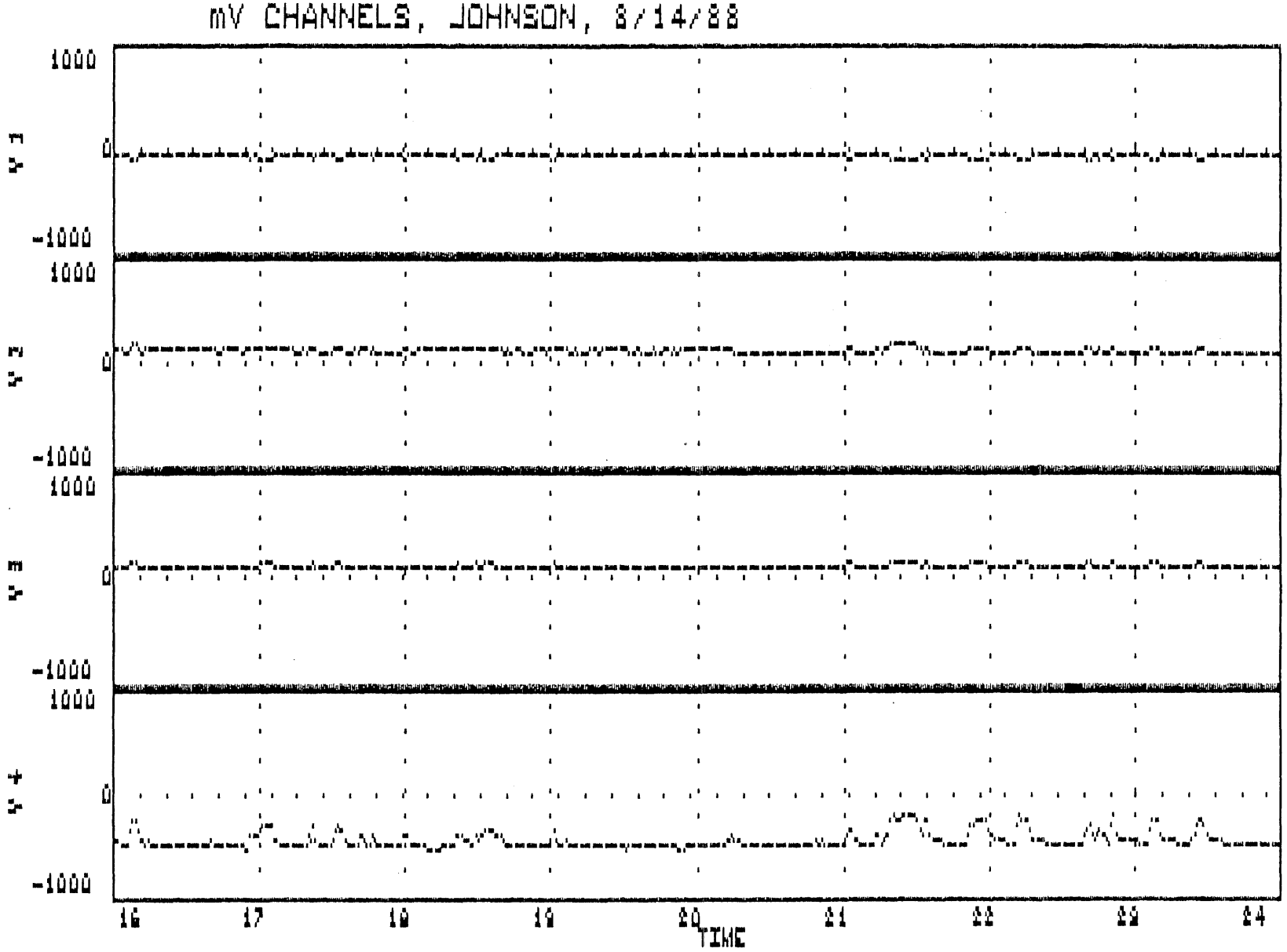
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


mV CHANNELS, JOHNSON, 8/14/88
1000
0
-1000
V 1
V 2
V 3
V 4
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


mV CHANNELS, JOHNSON, 8/14/88
1000
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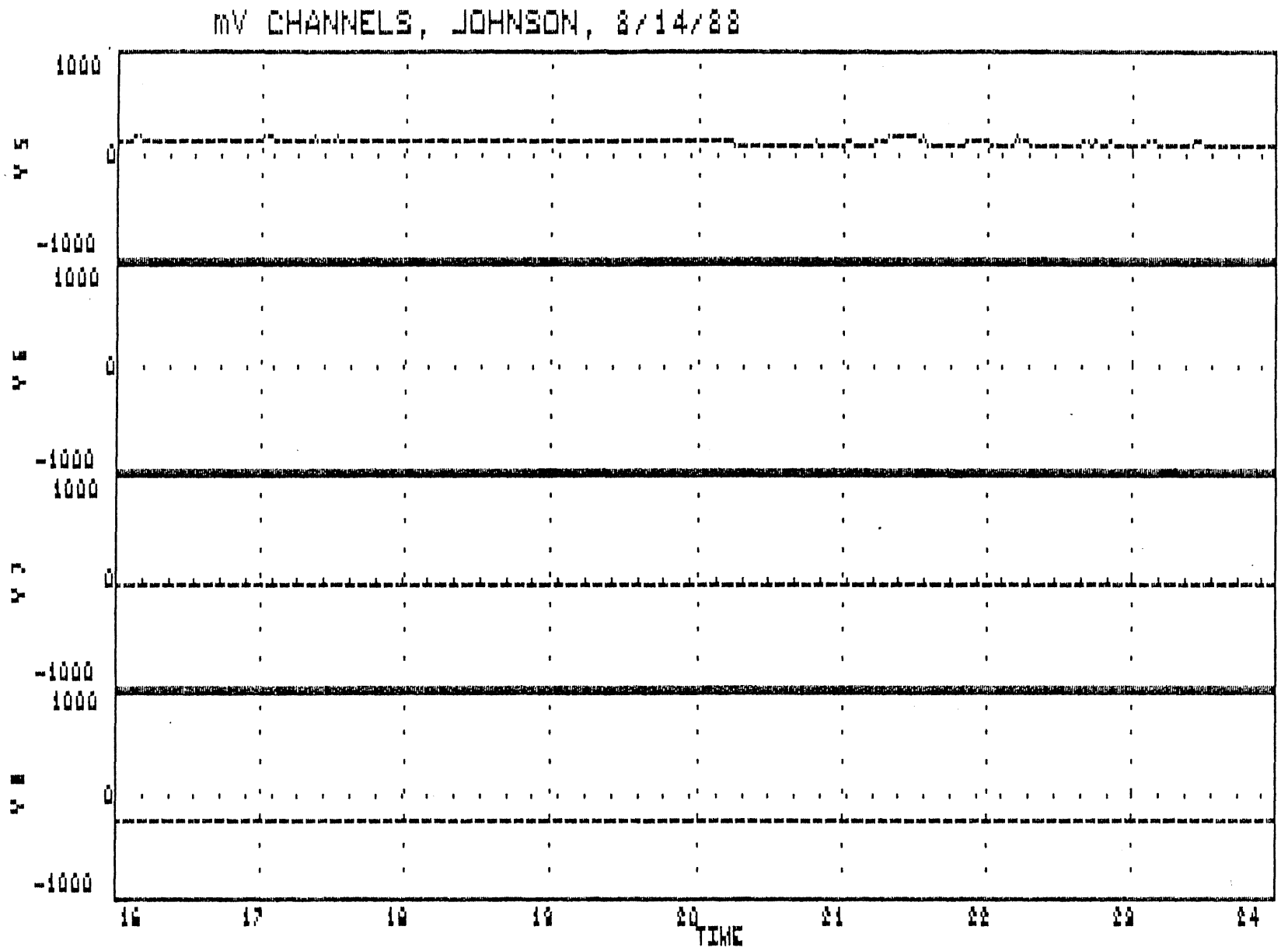
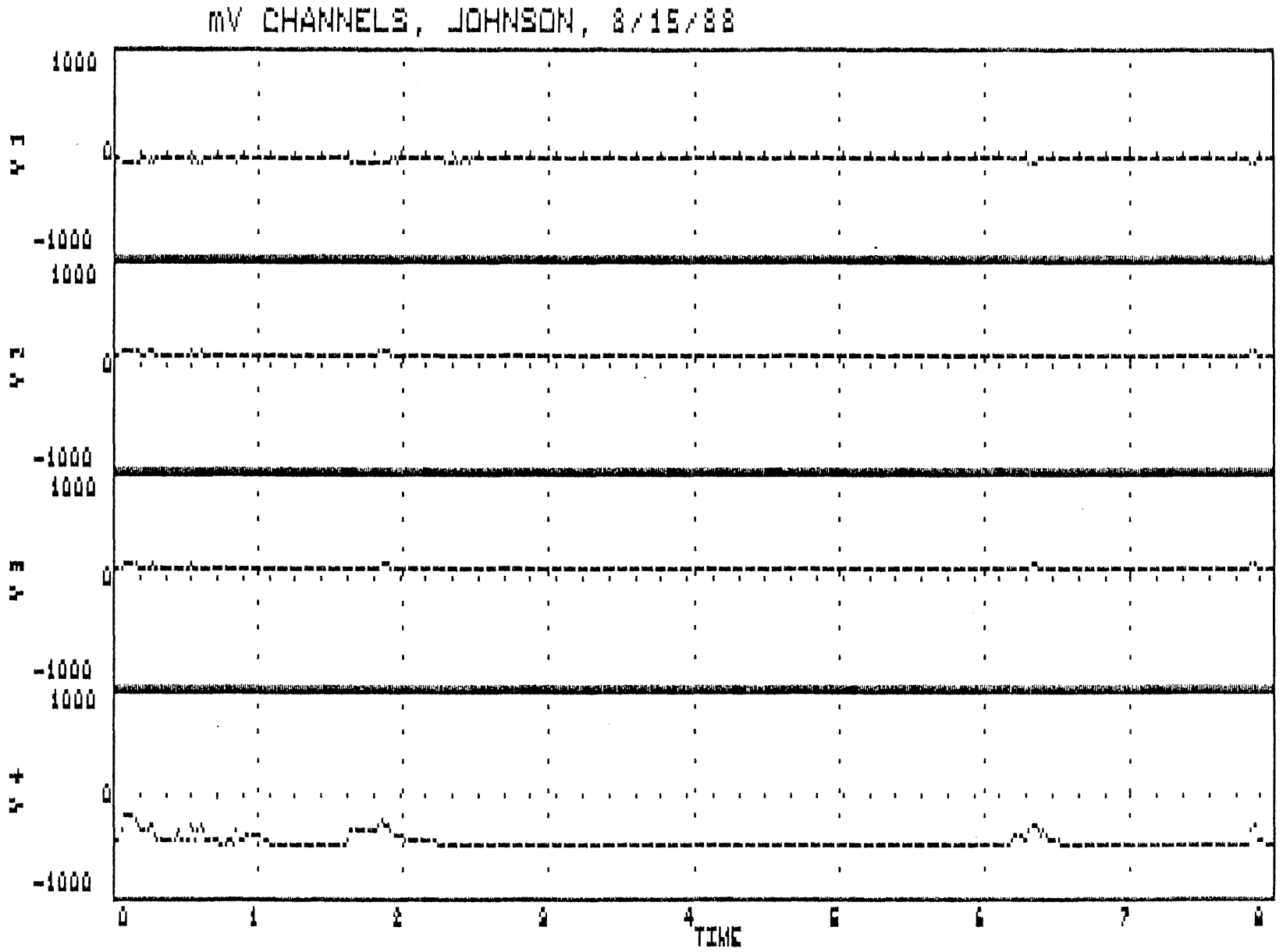
-1000
mV 1
mV 2
mV 3
mV 4
16
17
18
19
20
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


mV CHANNELS, JOHNSON, 8/15/88
1000
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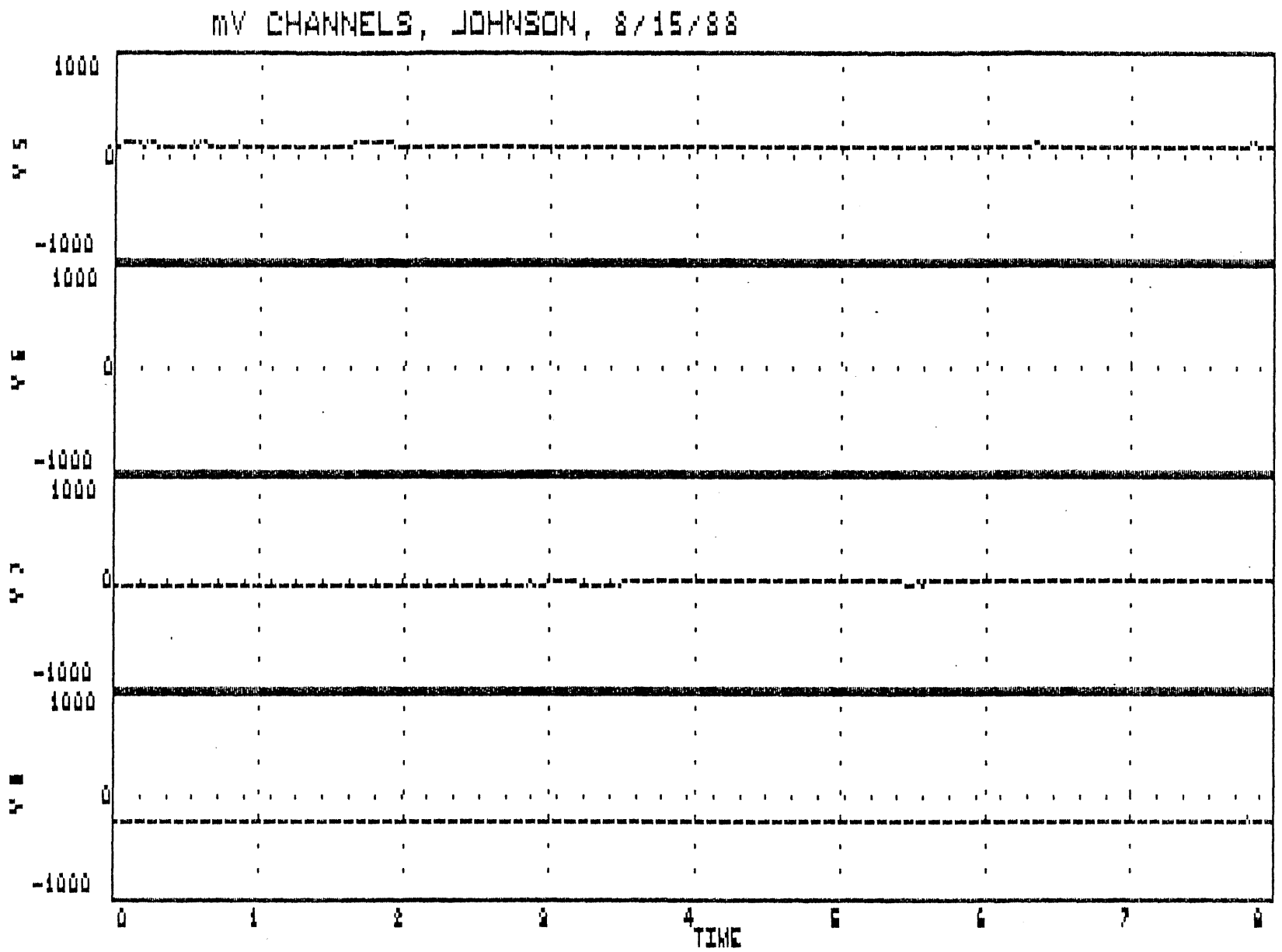
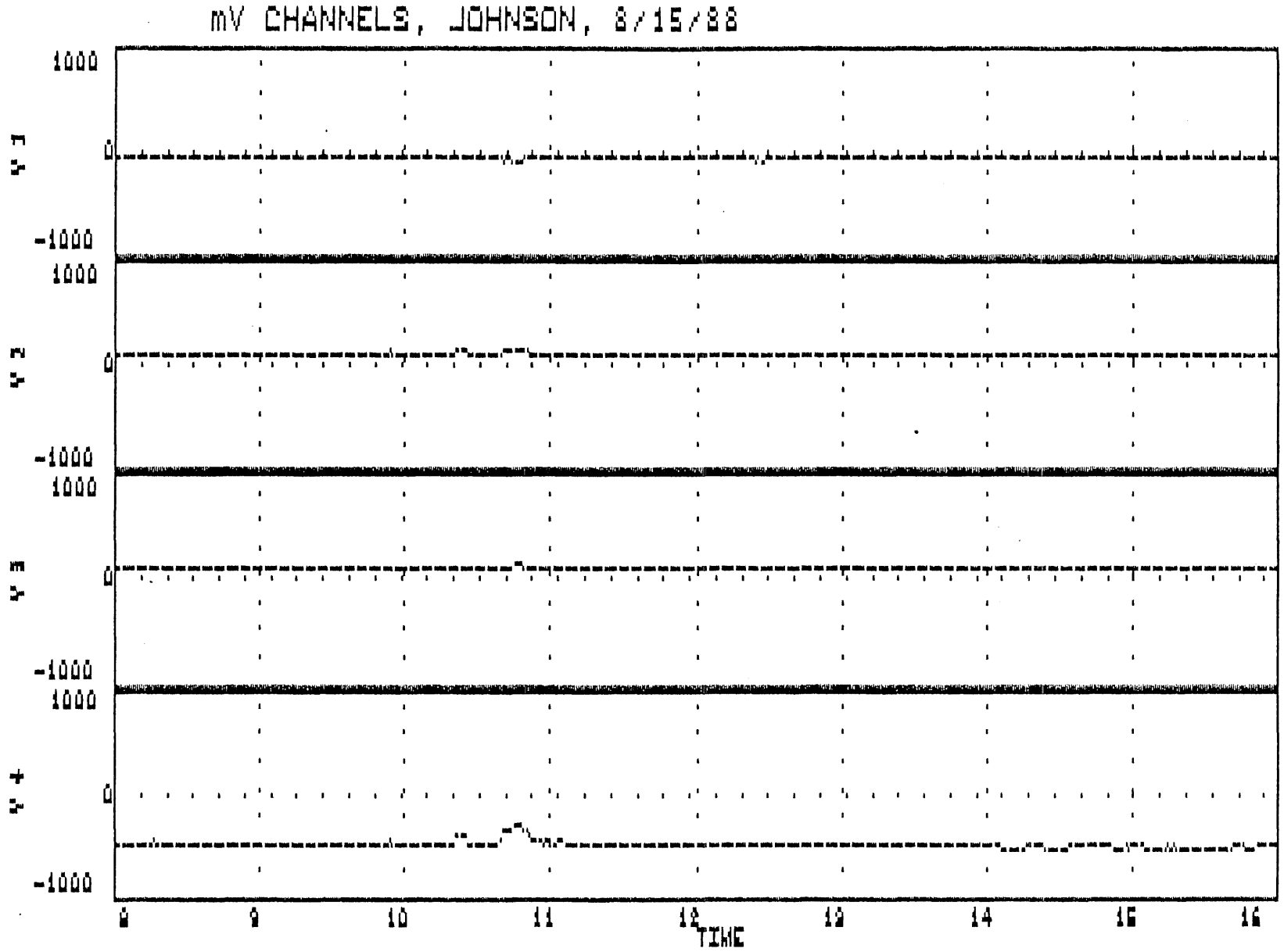
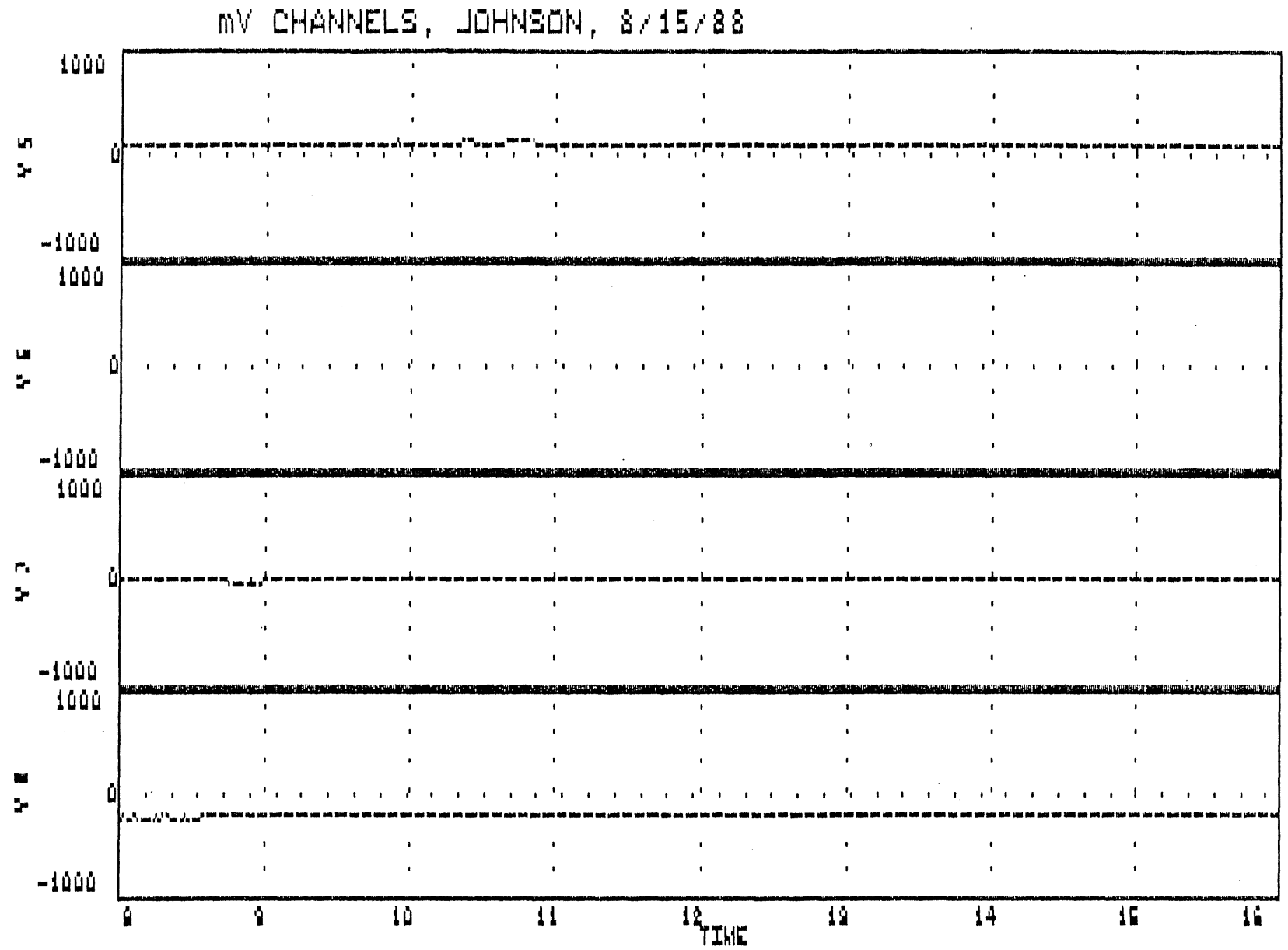
-1000
E x
E y
E z
H y
0
1
2
3
4
5
6
7
8
TIME



KEY

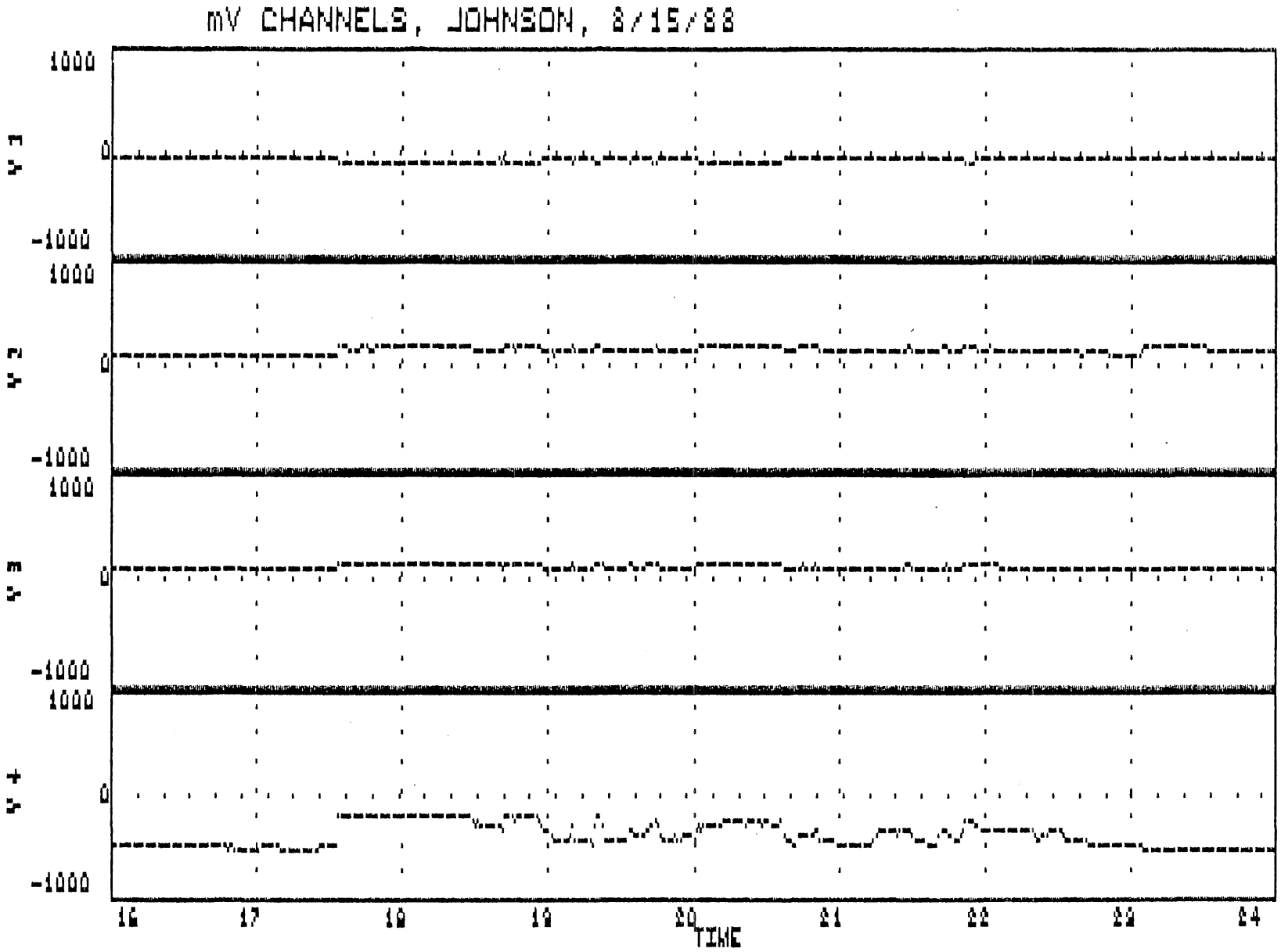
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

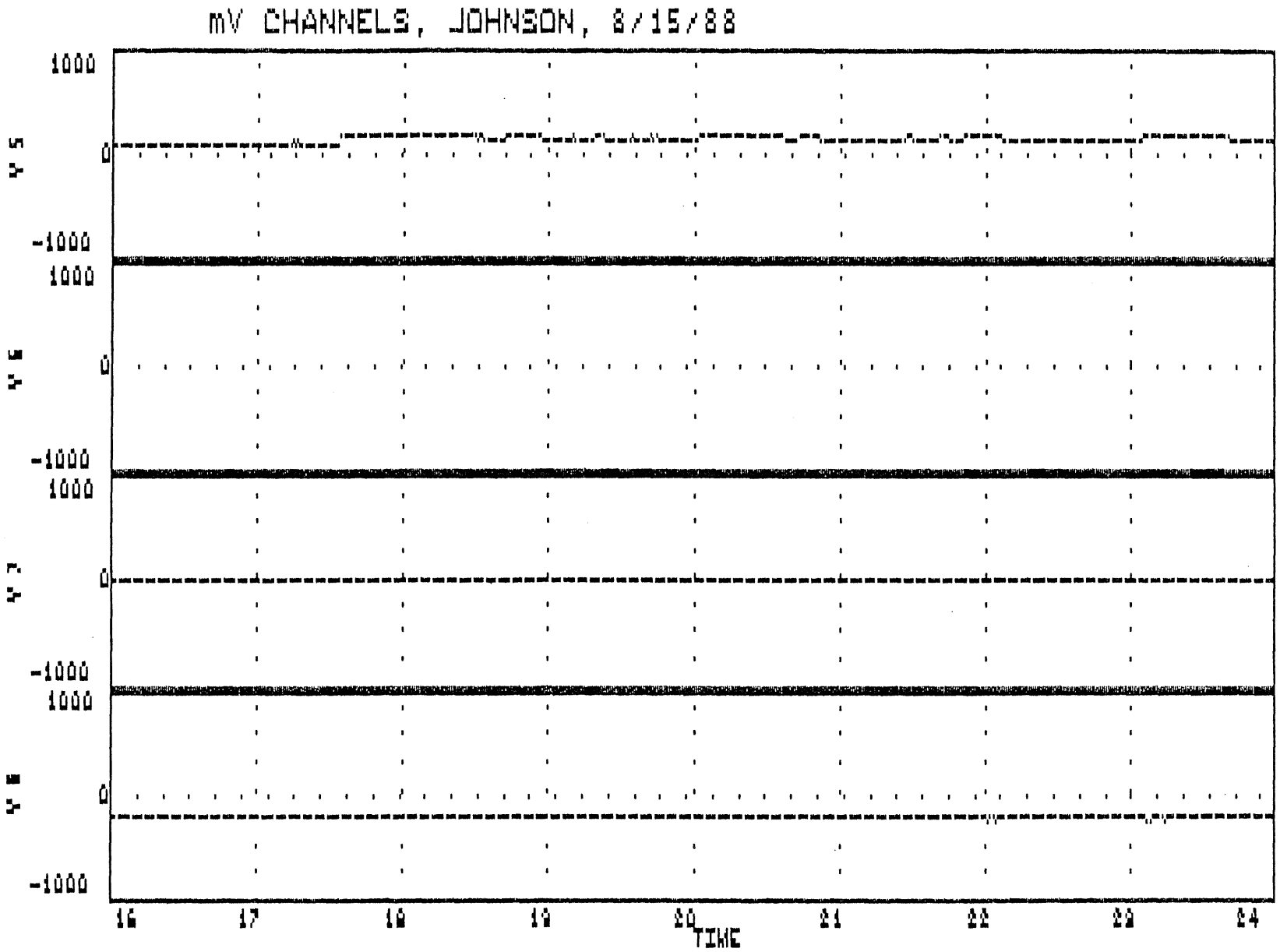

mV CHANNELS, JOHNSON, 8/15/88
1000
0
-1000
E-W
1000
0
-1000
N-S
1000
0
-1000
+V
1000
0
-1000
8
9
10
11
12
13
14
15
16
TIME



KEY

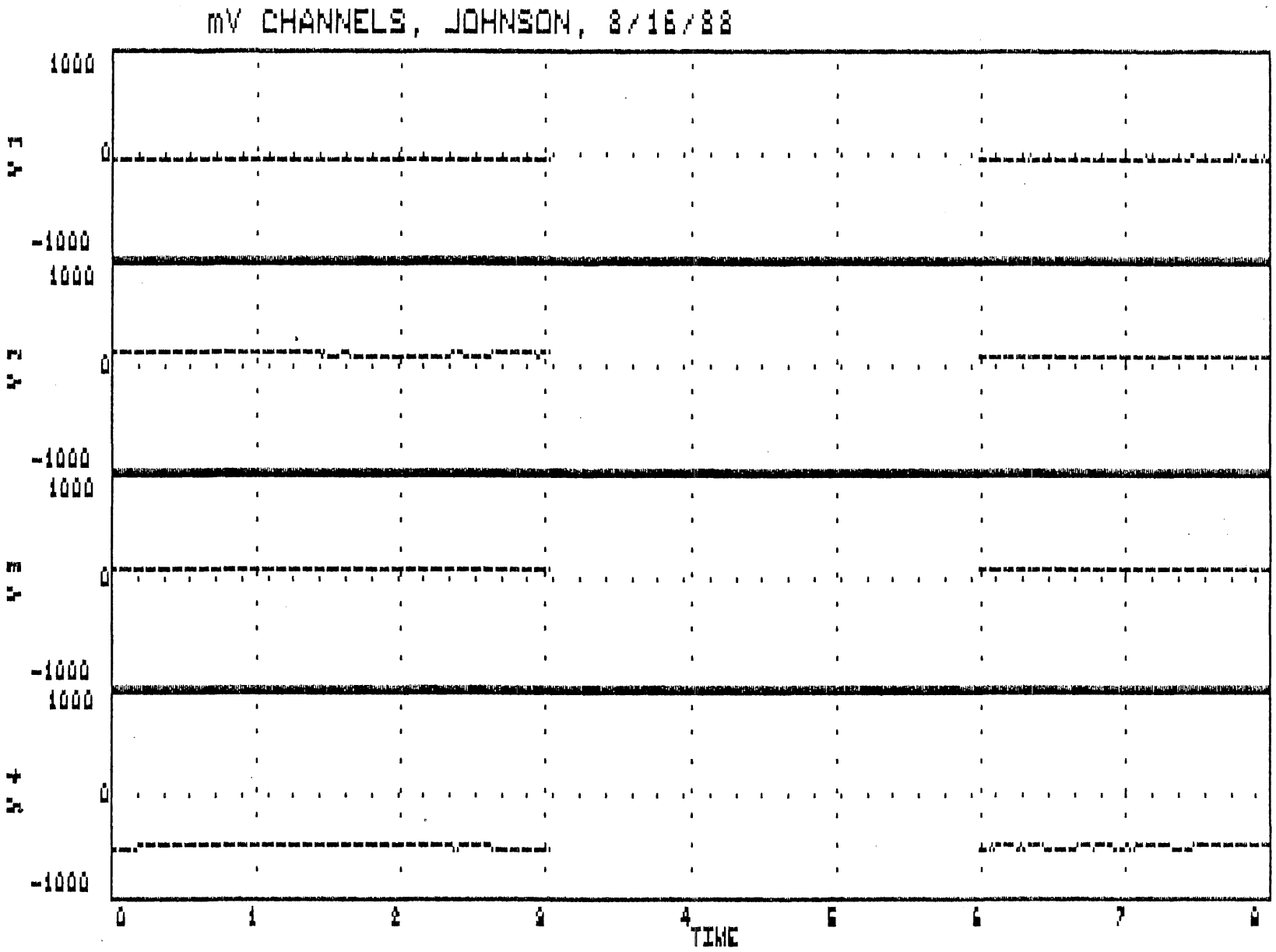
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

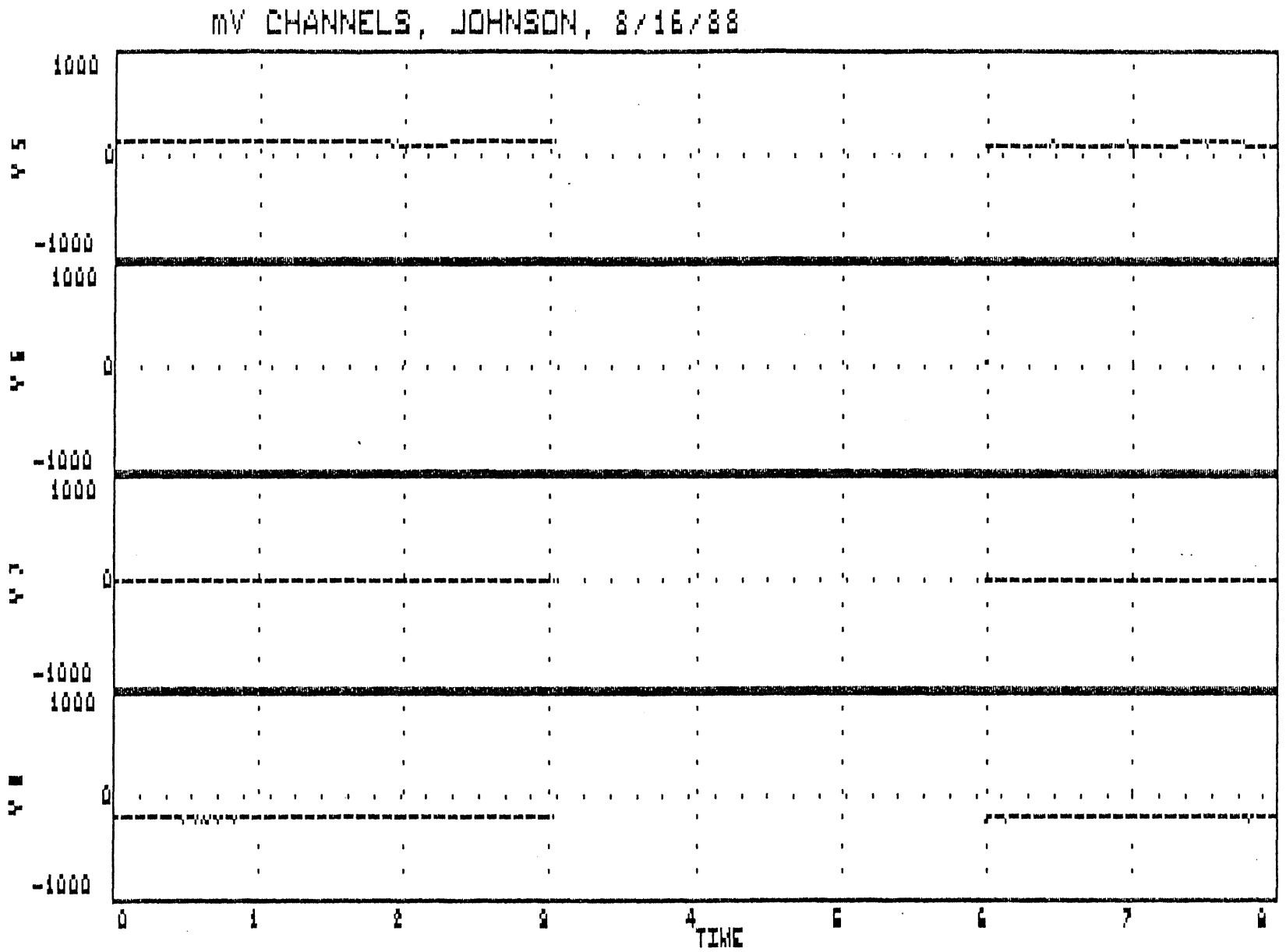

mV CHANNELS, JOHNSON, 8/15/88
1000
0
-1000
V1
V2
V3
V4
16
17
18
19
20
21
22
23
24
TIME



KEY

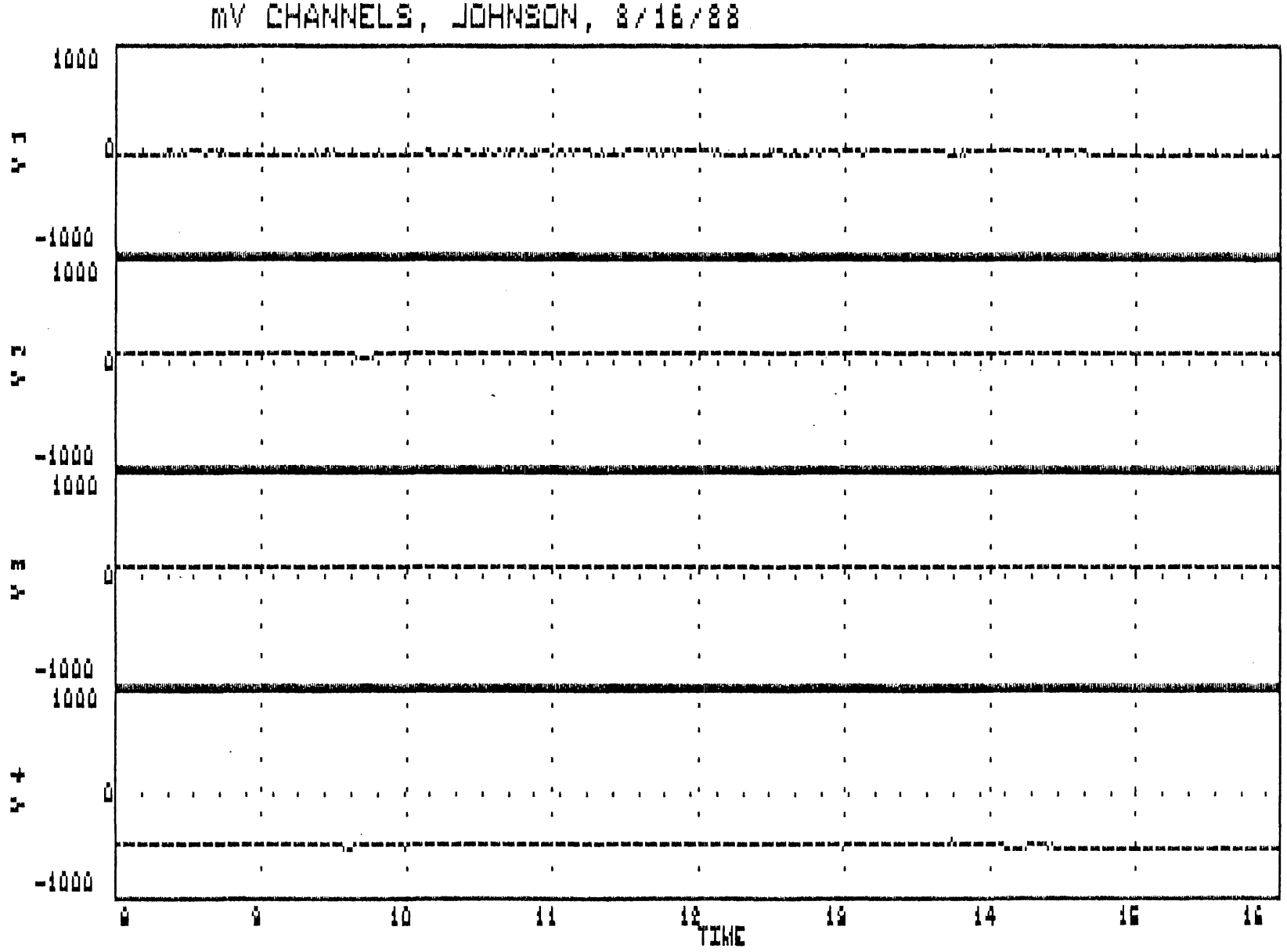
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

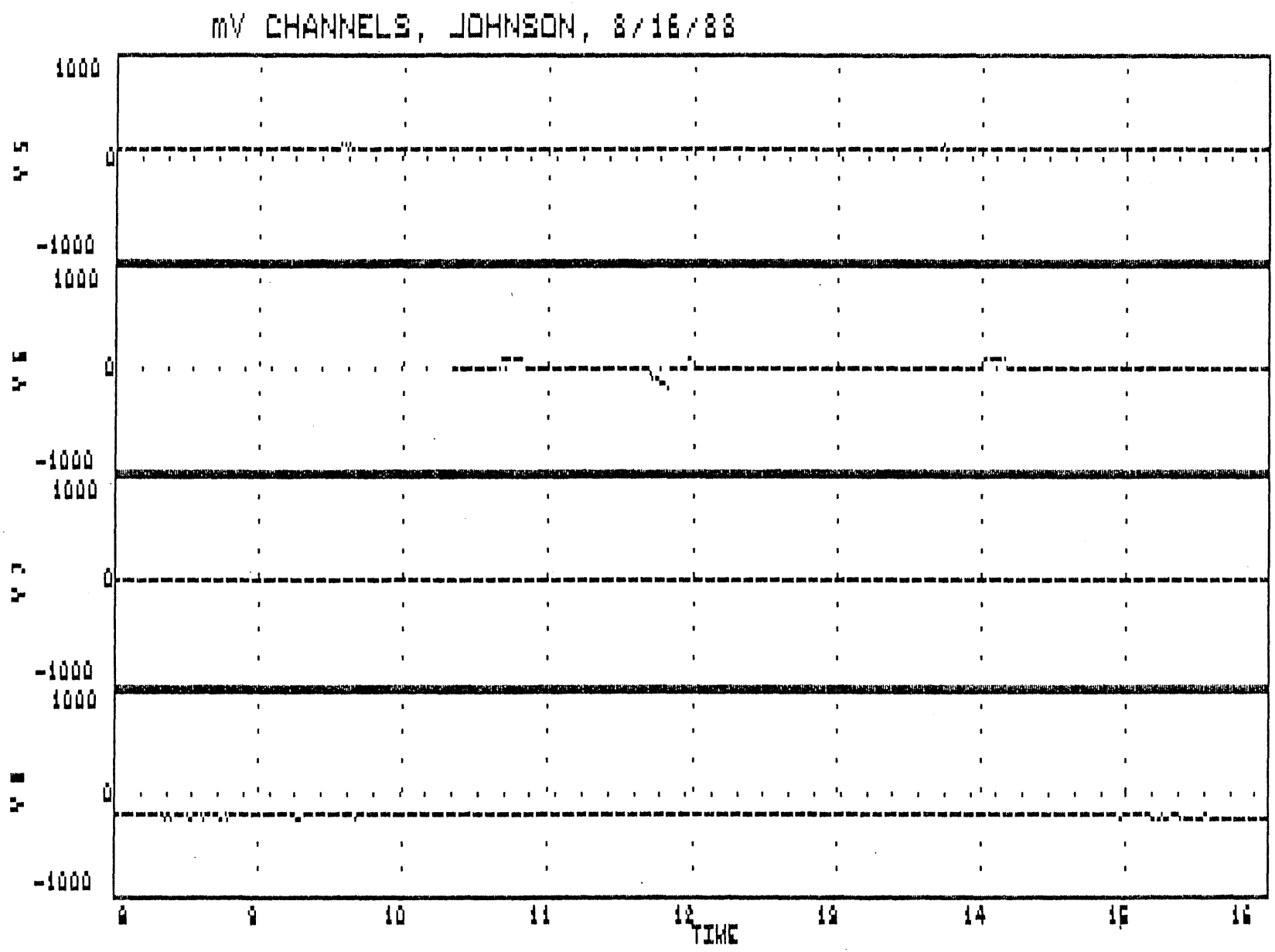

mV CHANNELS, JOHNSON, 8/16/88
1000
0
-1000
mV 1
1000
0
-1000
mV 2
1000
0
-1000
mV 3
1000
0
-1000
mV 4
0
1
2
3
4
5
6
7
8
TIME



KEY

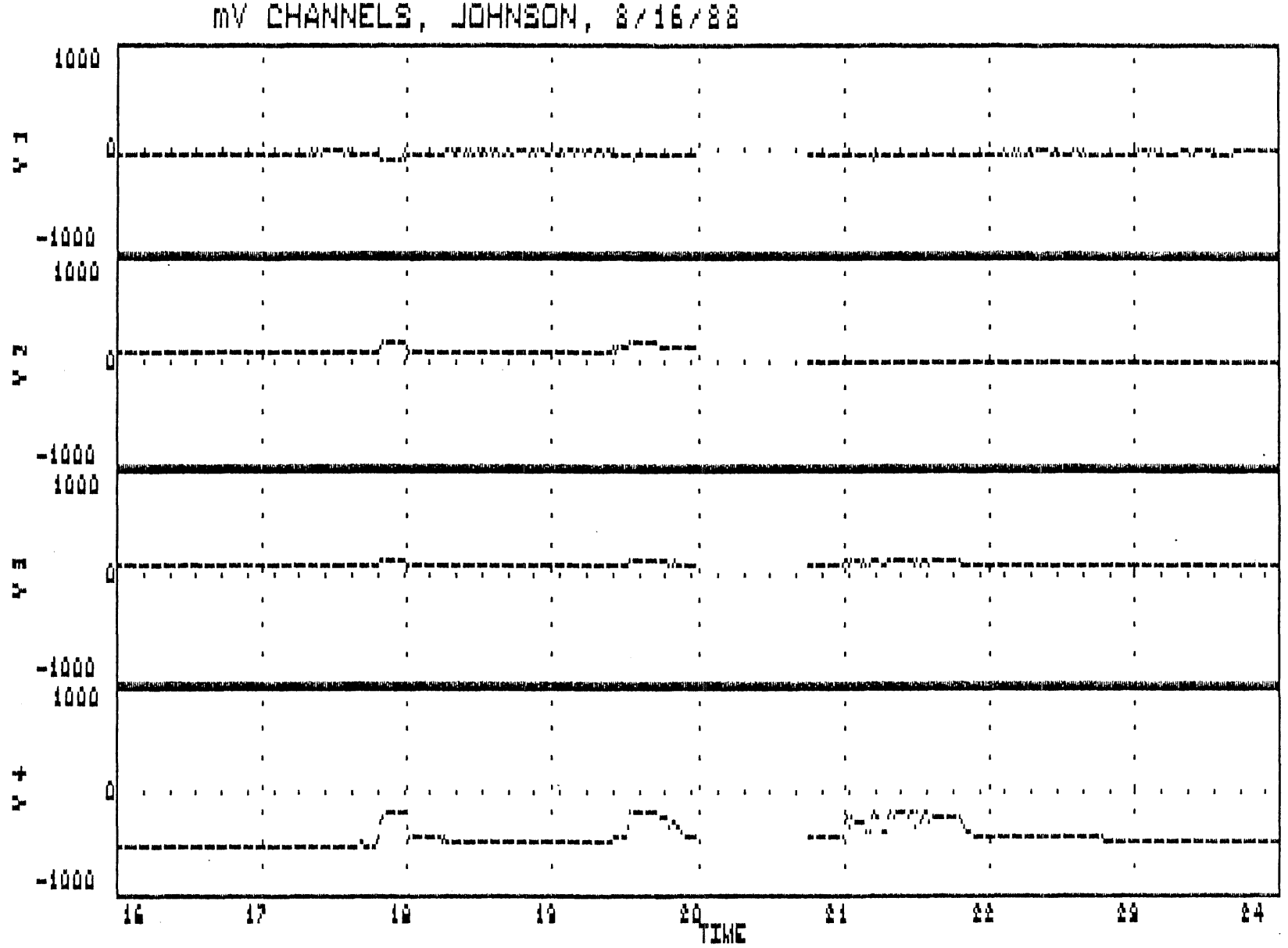
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6		
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

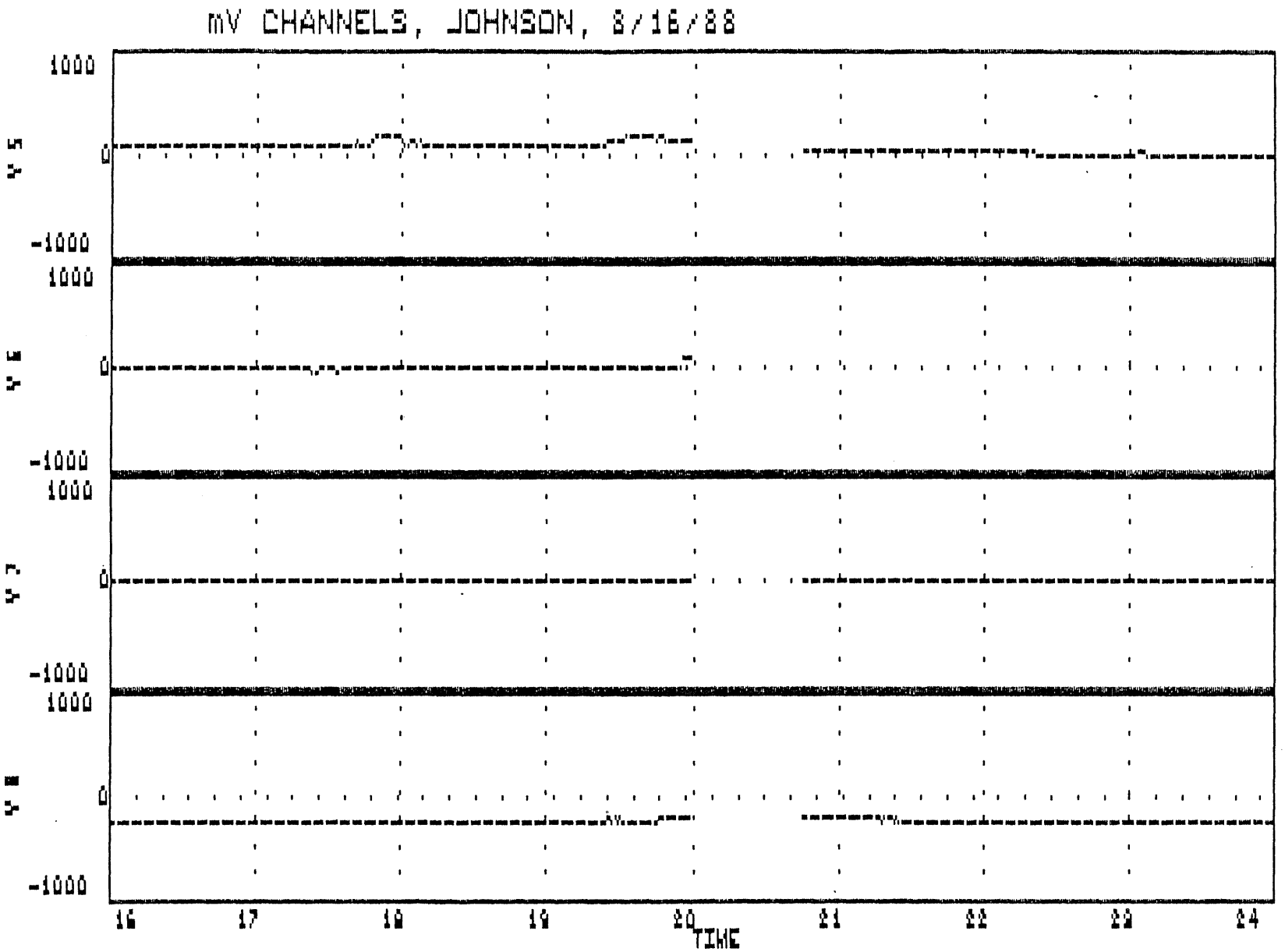

mV CHANNELS, JOHNSON, 8/16/88
1000
0
-1000
E-W
1000
0
-1000
E-W
1000
0
-1000
E-W
1000
0
-1000
+-W
8
9
10
11
12
13
14
15
16
TIME



KEY

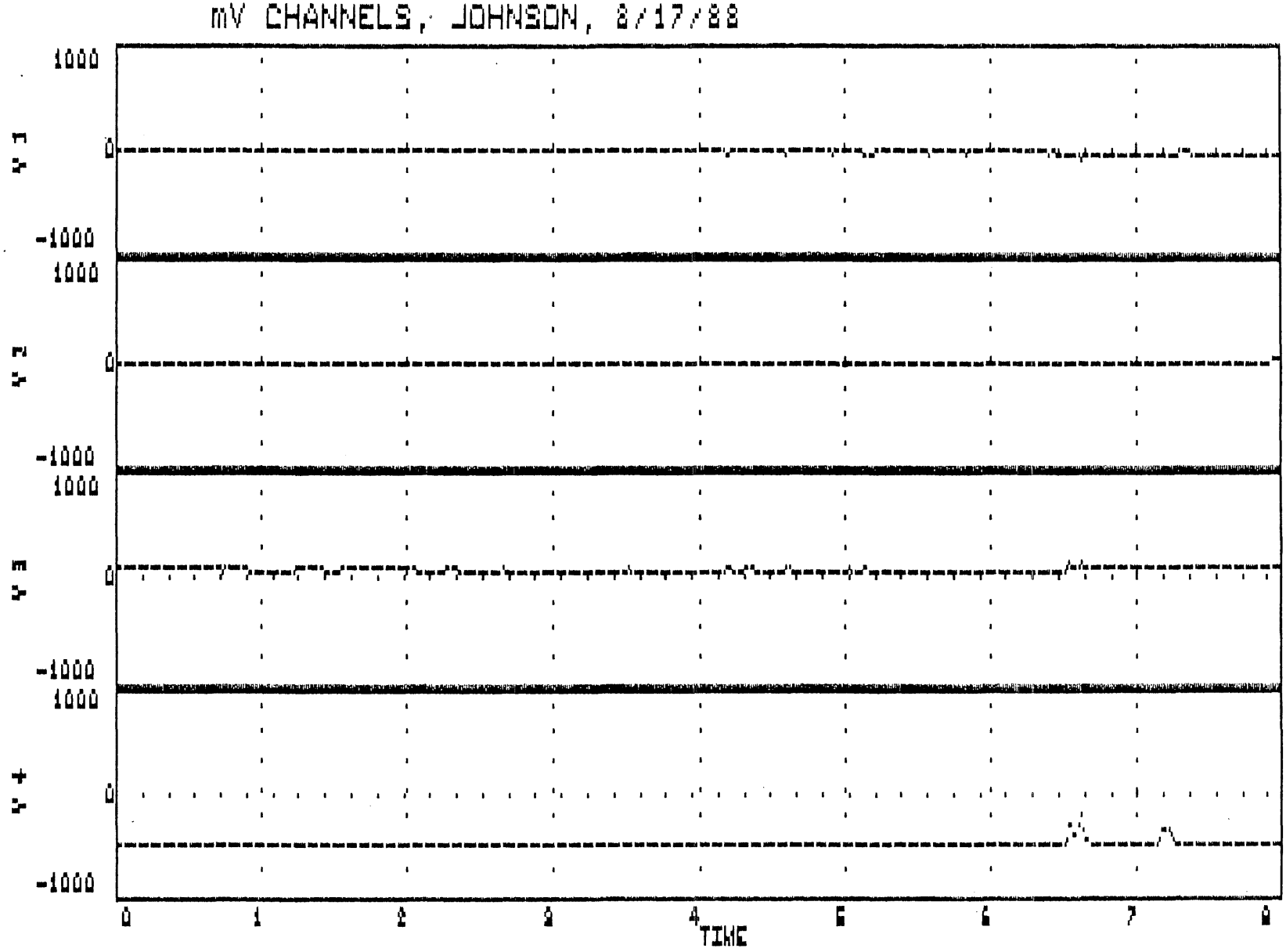
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline	front block on mat
V2	waterline	front block on mat	V6*	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

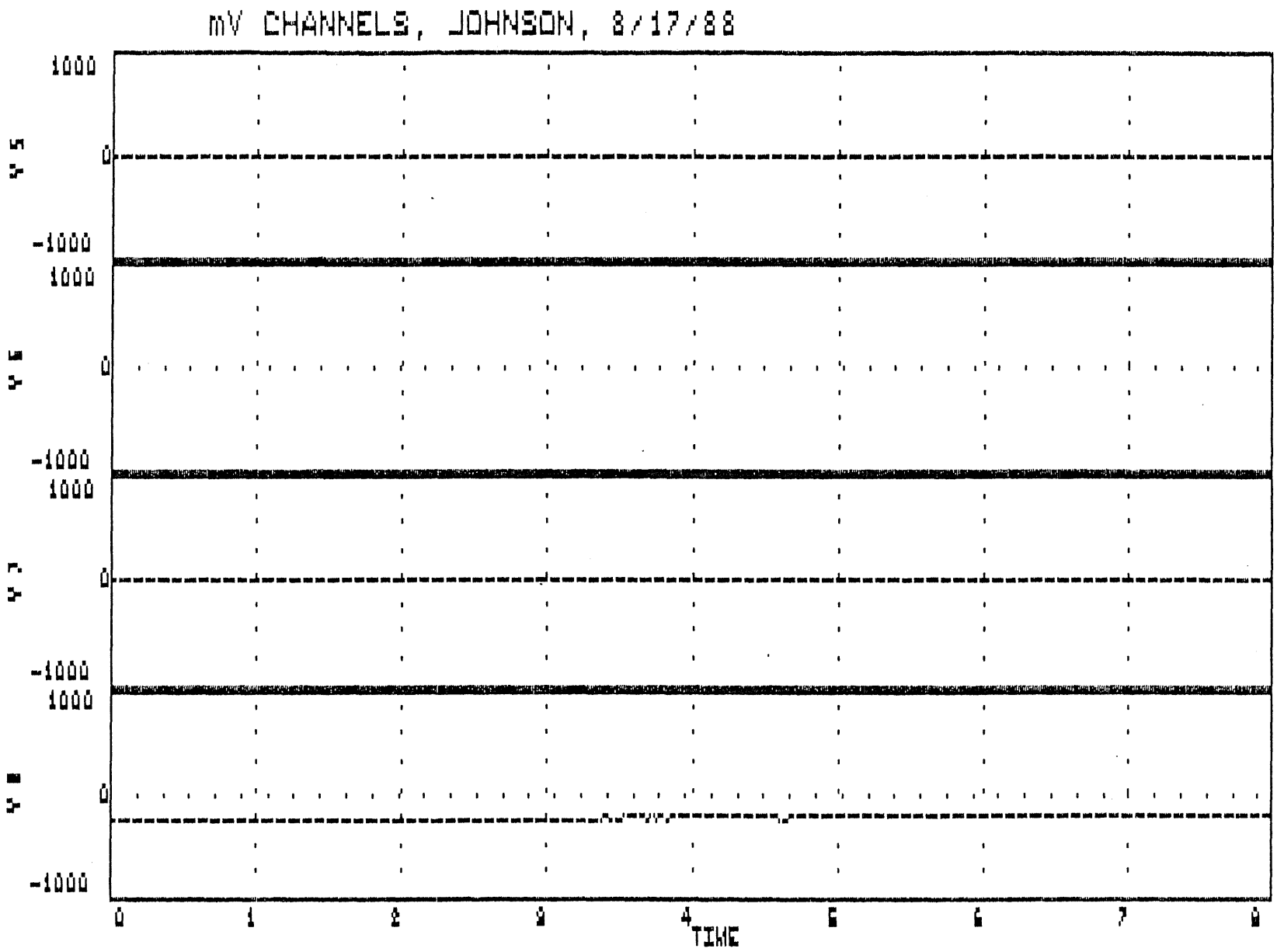

mV CHANNELS, JOHNSON, 8/16/88
1000
0
-1000
E-W
N-S
E-W
+ W
TIME



KEY

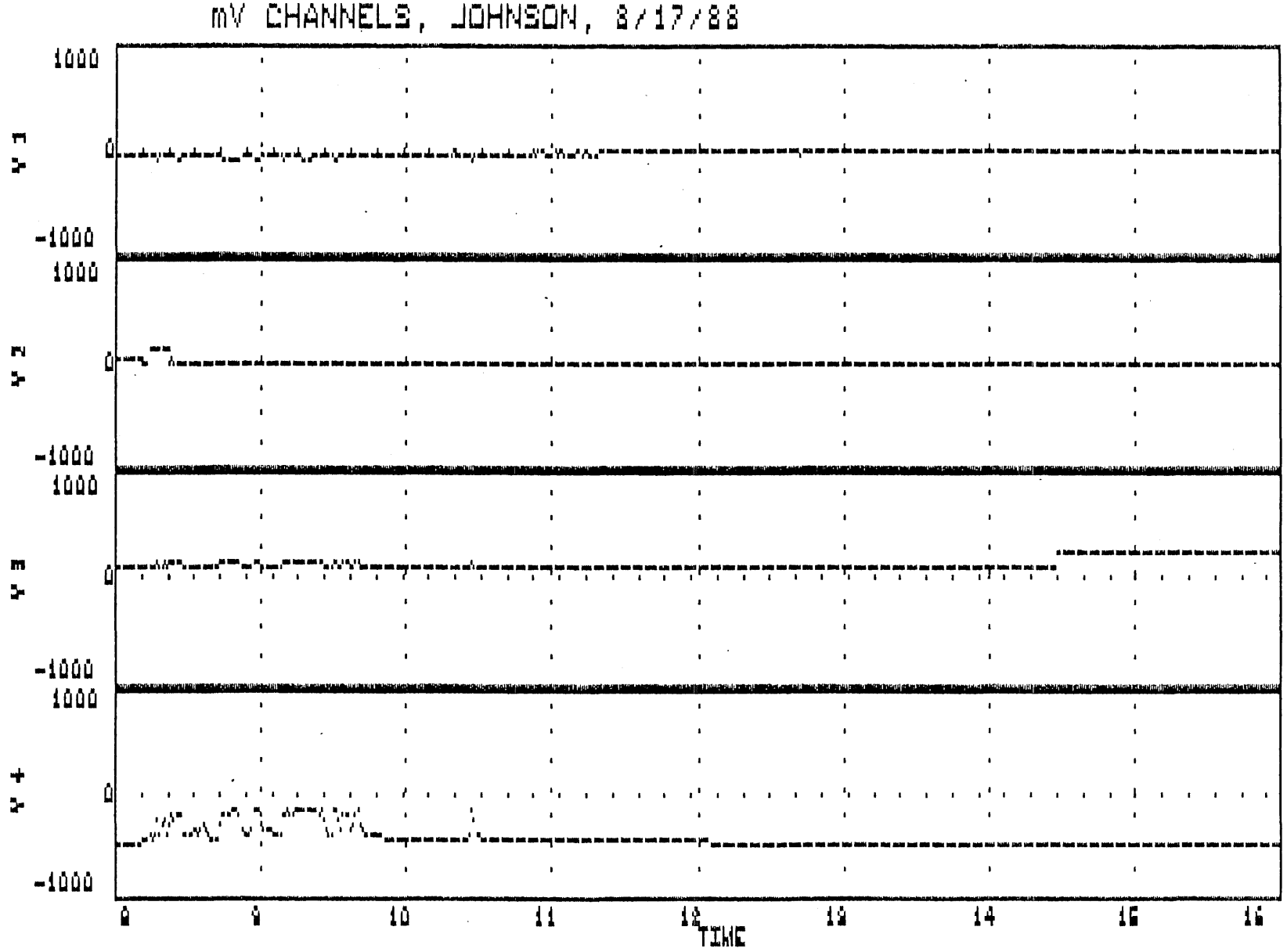
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5*	milkline ac/rms	front block on mat
V2*	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

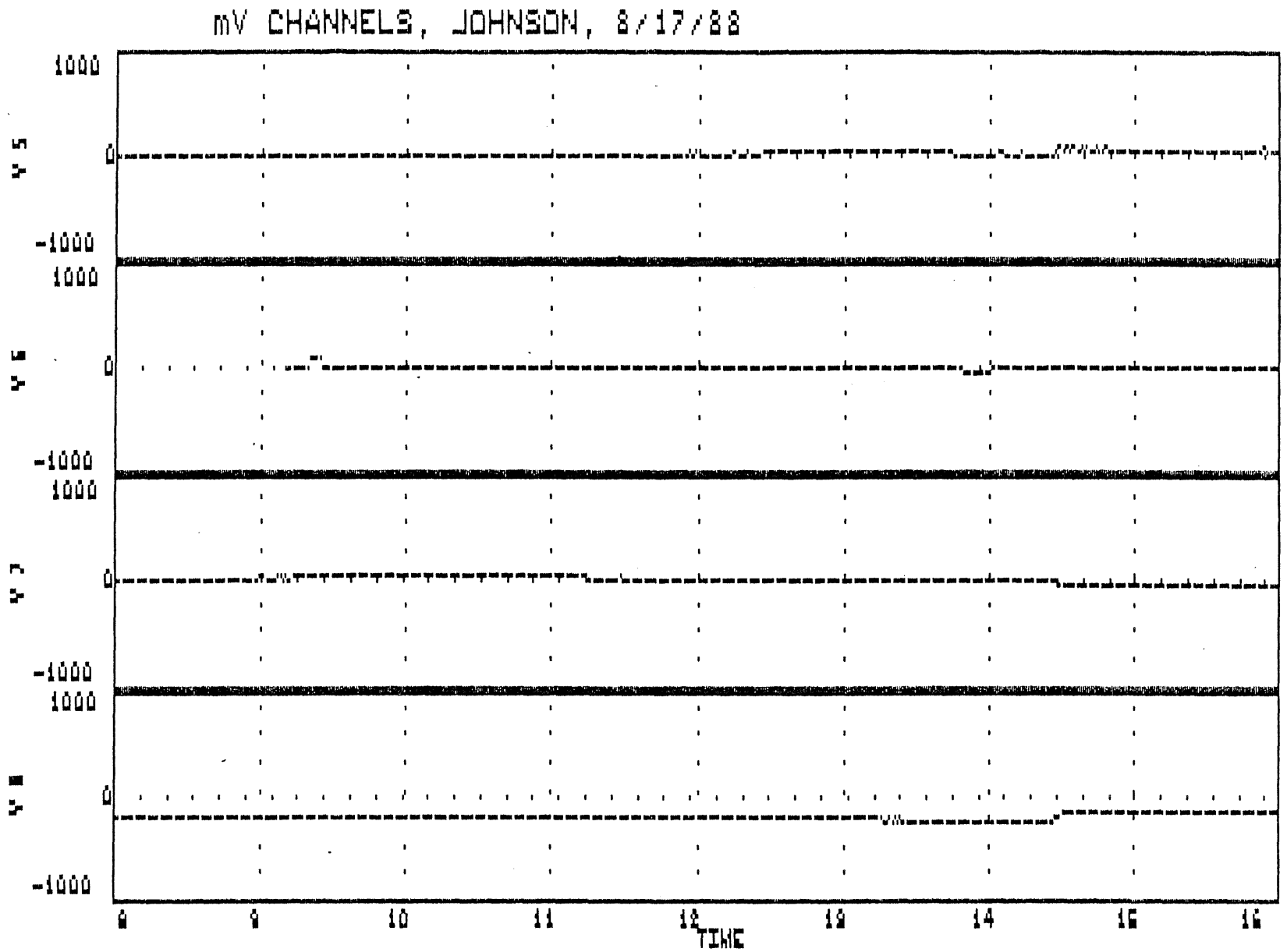

mV CHANNELS, JOHNSON, 8/17/88
1000
0
-1000
E1
E2
E3
E4
0
1
2
3
4
5
6
7
8
TIME



KEY

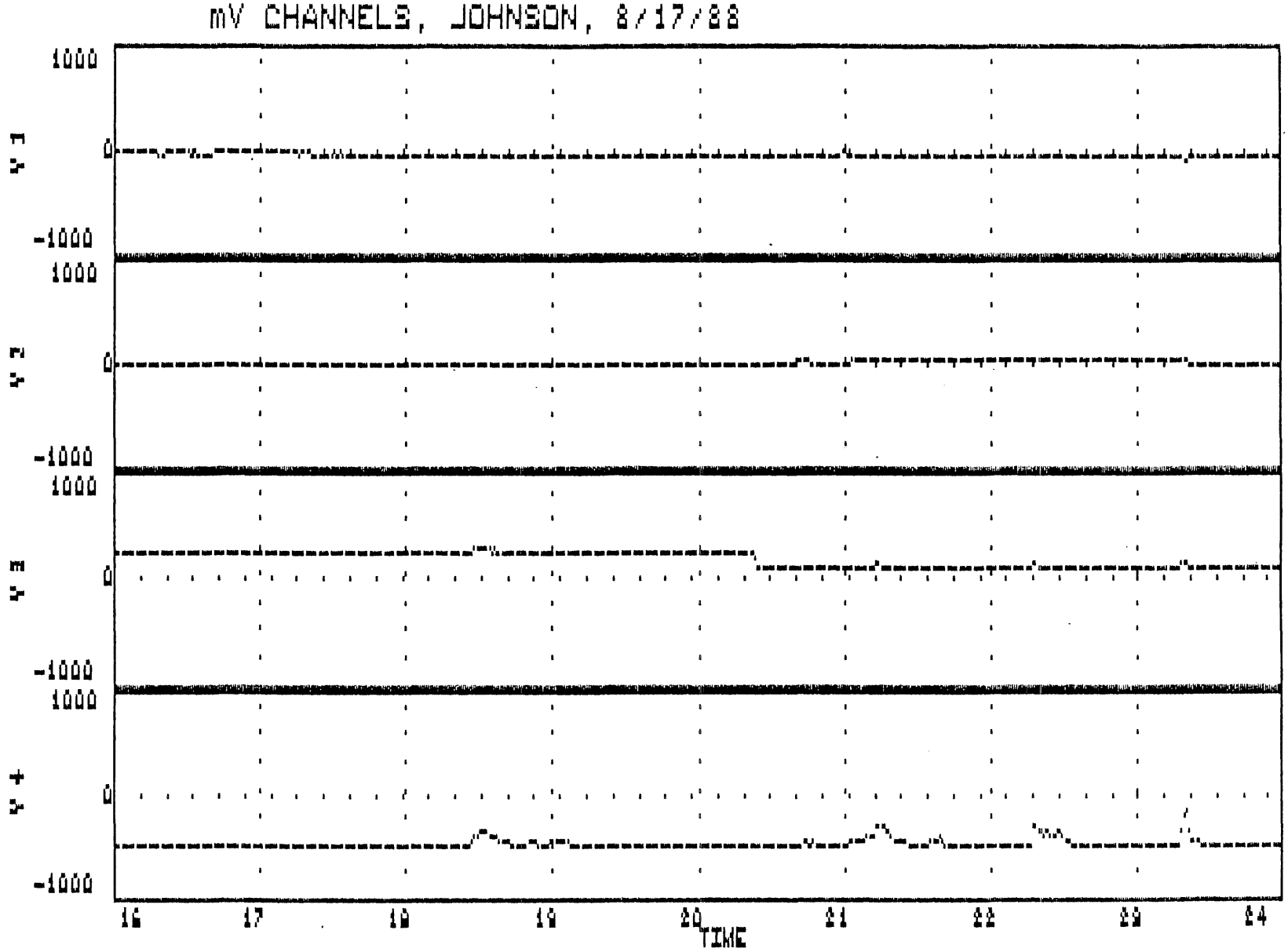
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	–
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

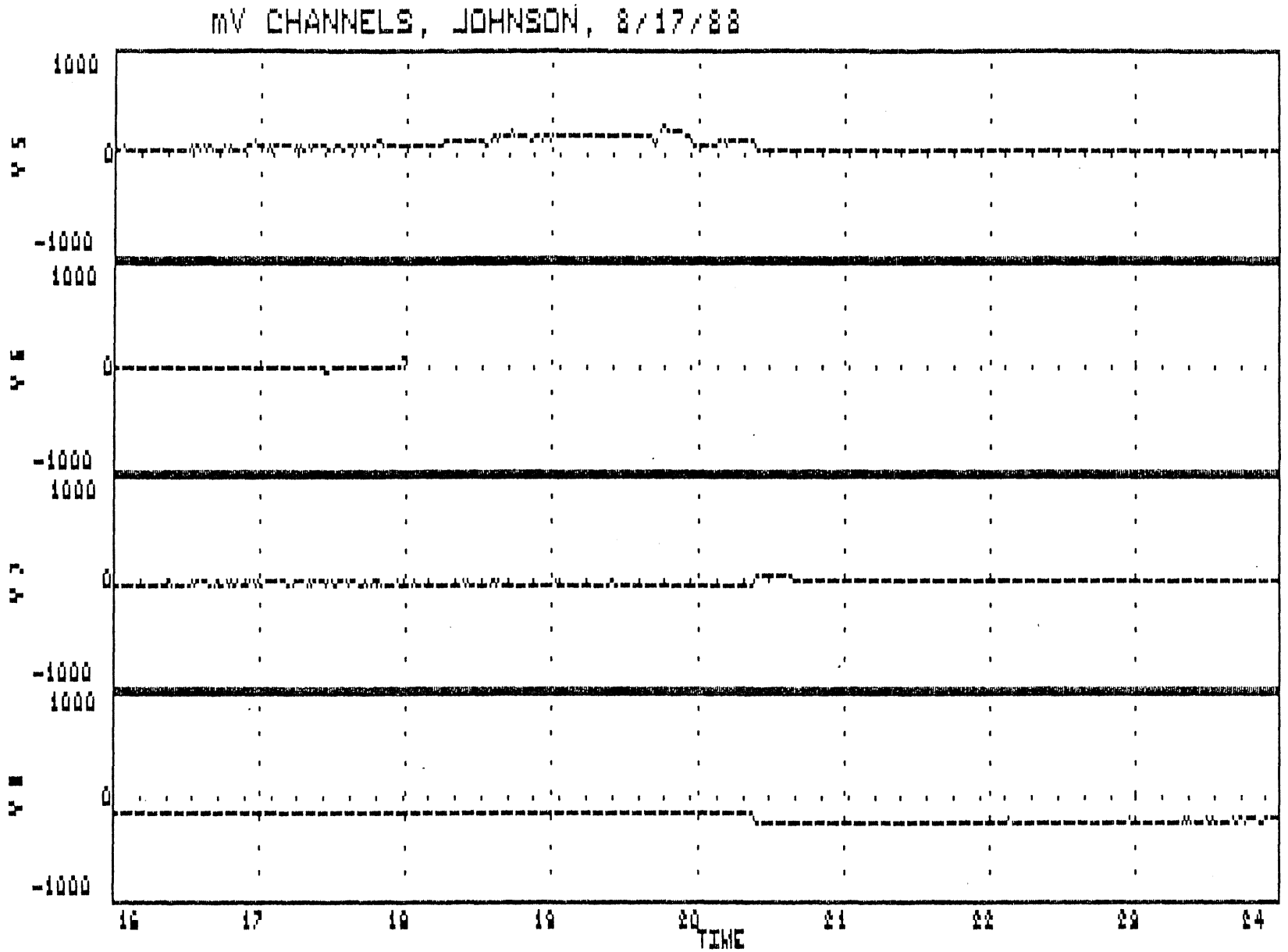

mV CHANNELS, JOHNSON, 8/17/88
1000
0
-1000
E-W
N-S
TIME
8
9
10
11
12
13
14
15
16



KEY: Blackburn off 1400-2023

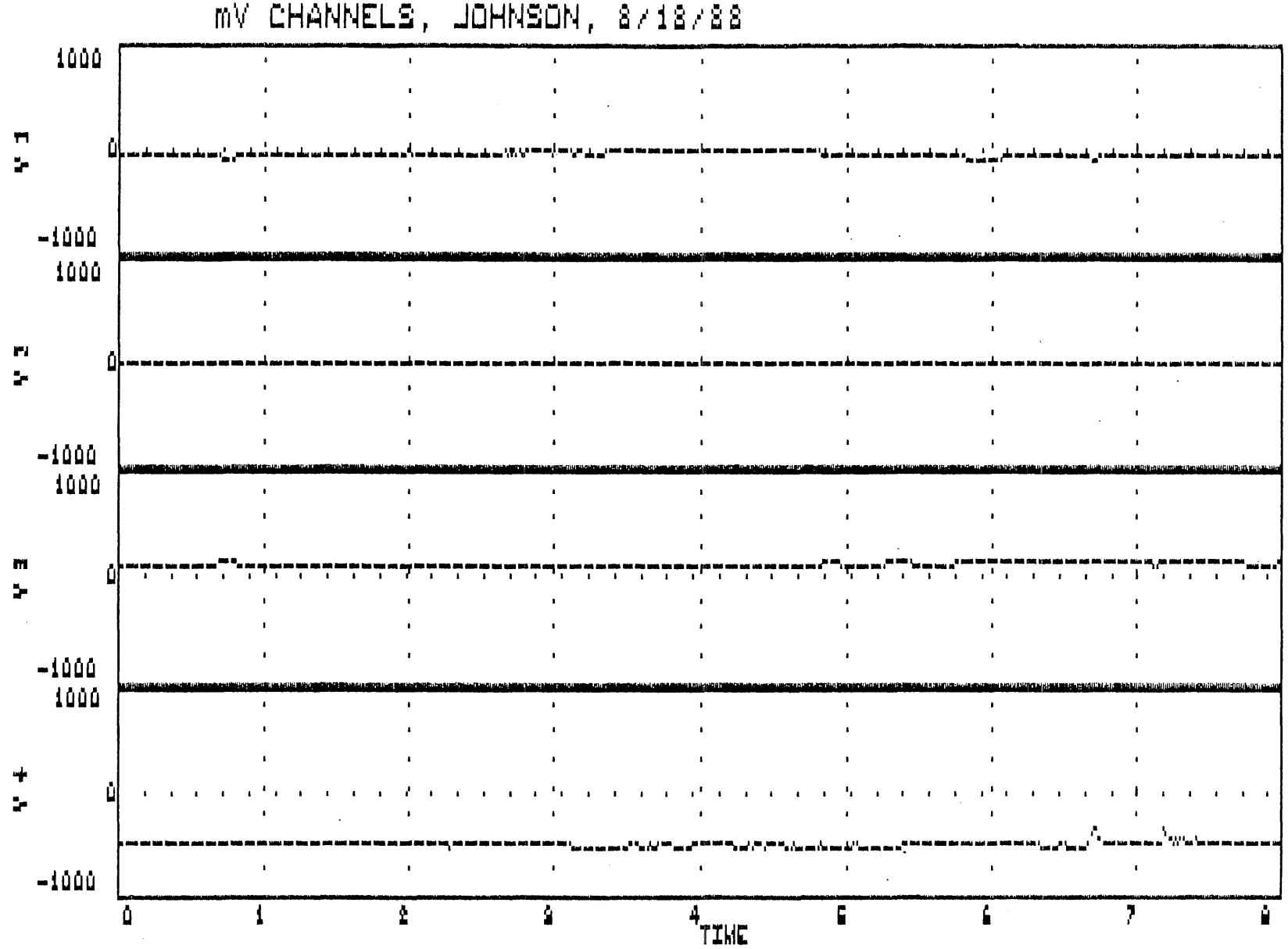
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

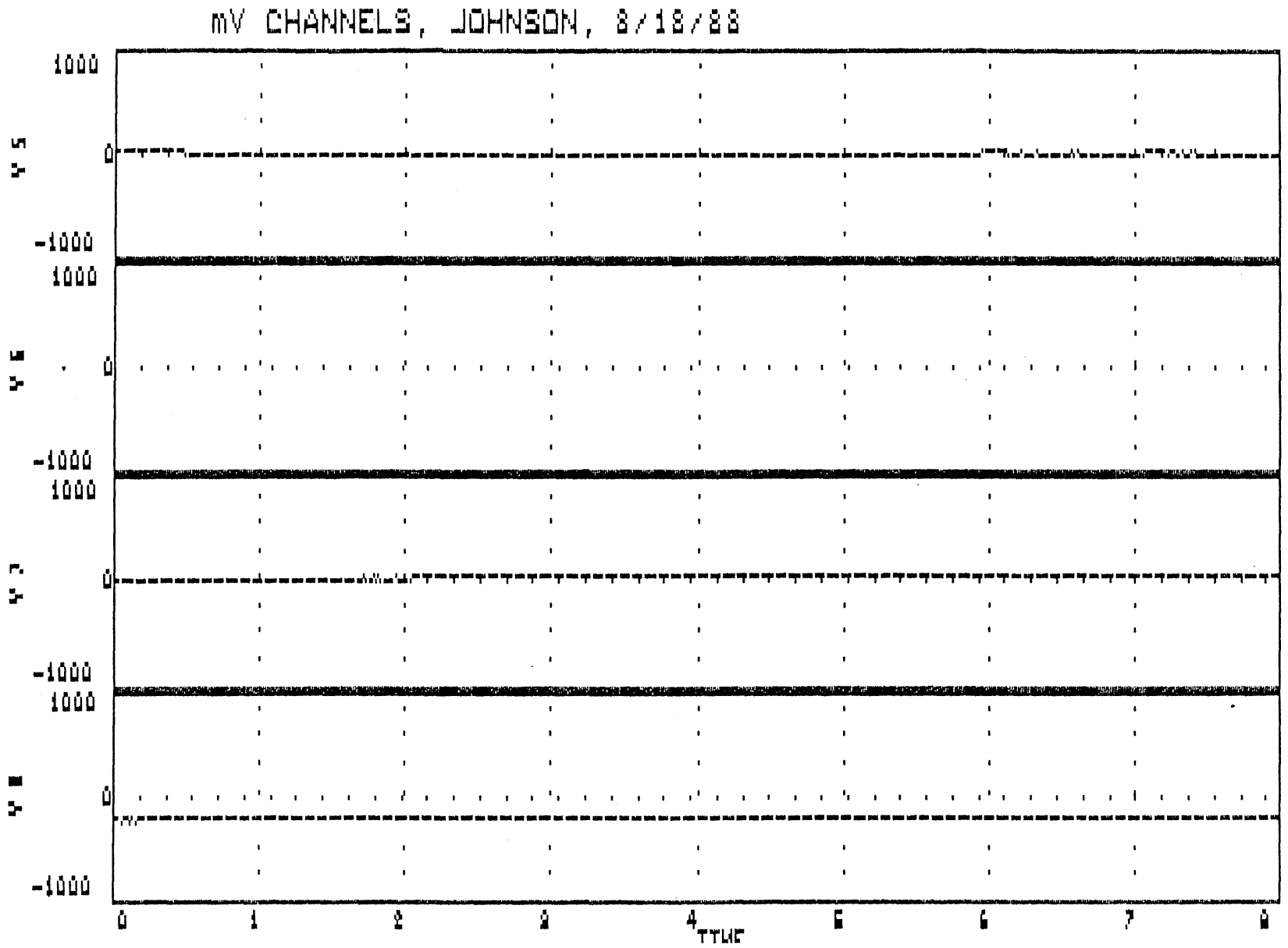

mV CHANNELS, JOHNSON, 8/17/88
1000
0
-1000
V 1
V 2
V E
V 4
16
17
18
19
20
21
22
23
24
TIME



KEY: Blackburn off 1400-2023

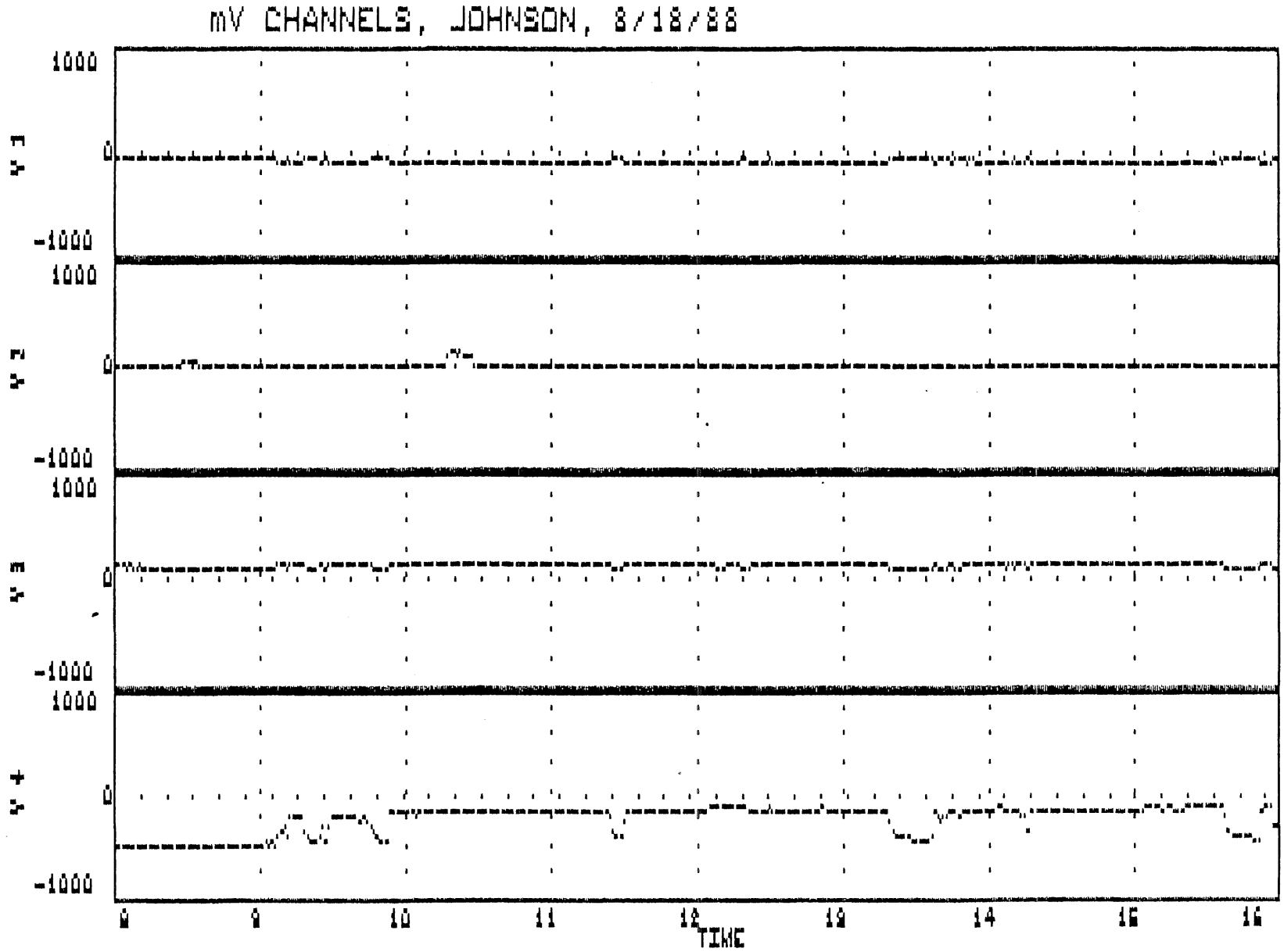
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

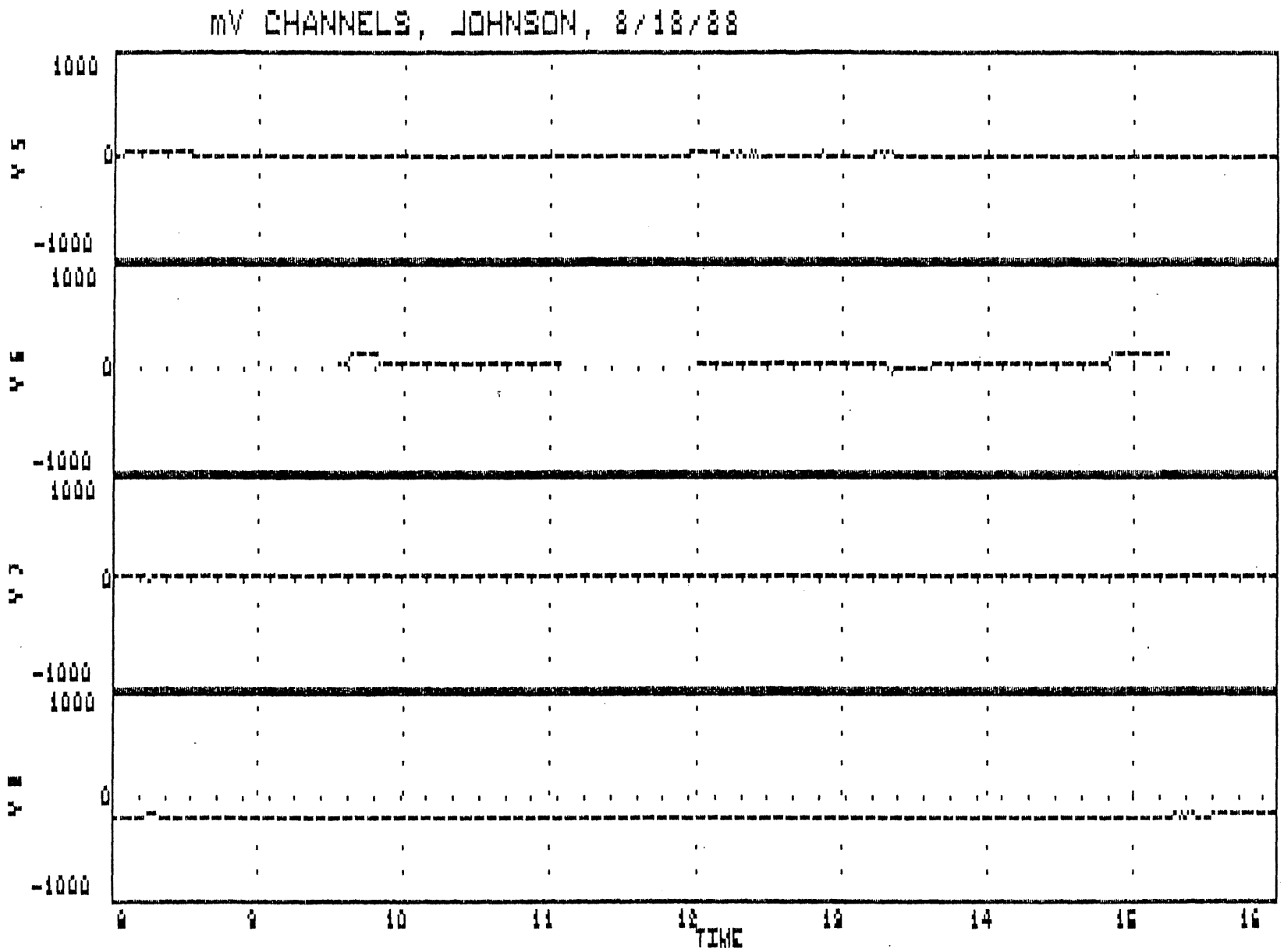

mV CHANNELS, JOHNSON, 8/18/88
1000
0
-1000
mV
TIME
0
1
2
3
4
5
6
7
8



KEY

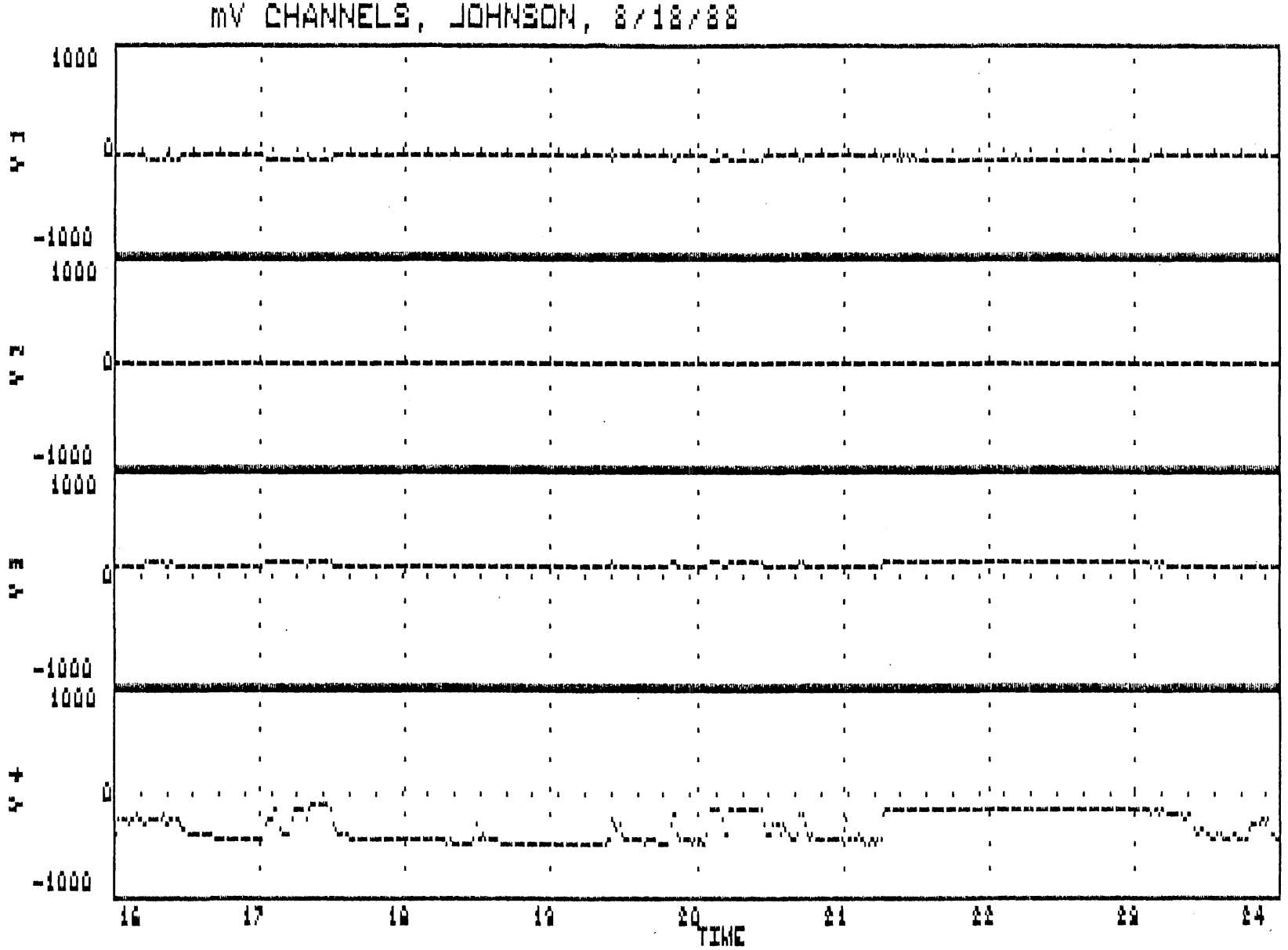
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

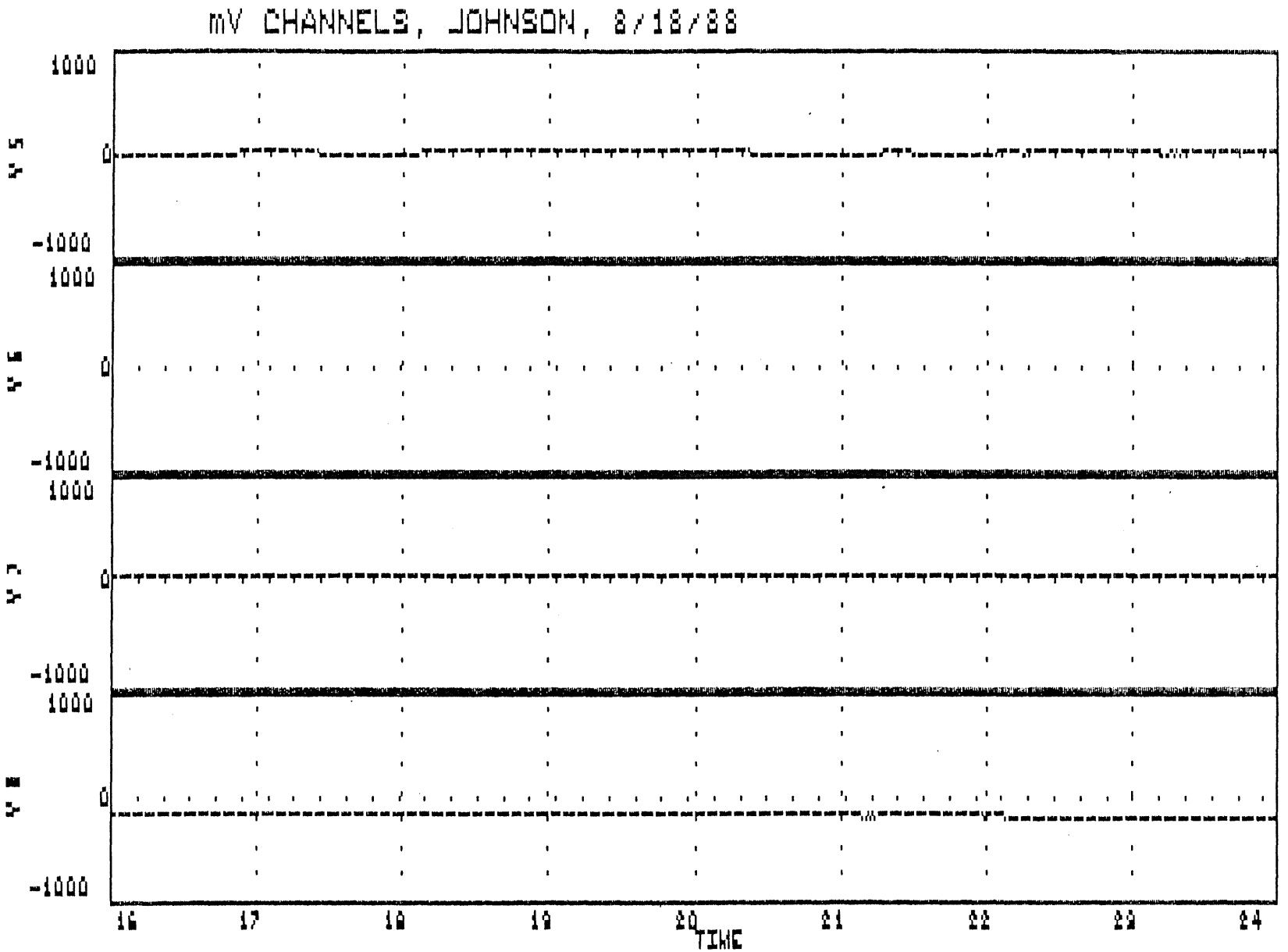

mV CHANNELS, JOHNSON, 8/18/88
1000
0
-1000
V 1
V 2
V 3
V 4
8
9
10
11
12
13
14
15
16
TIME



KEY

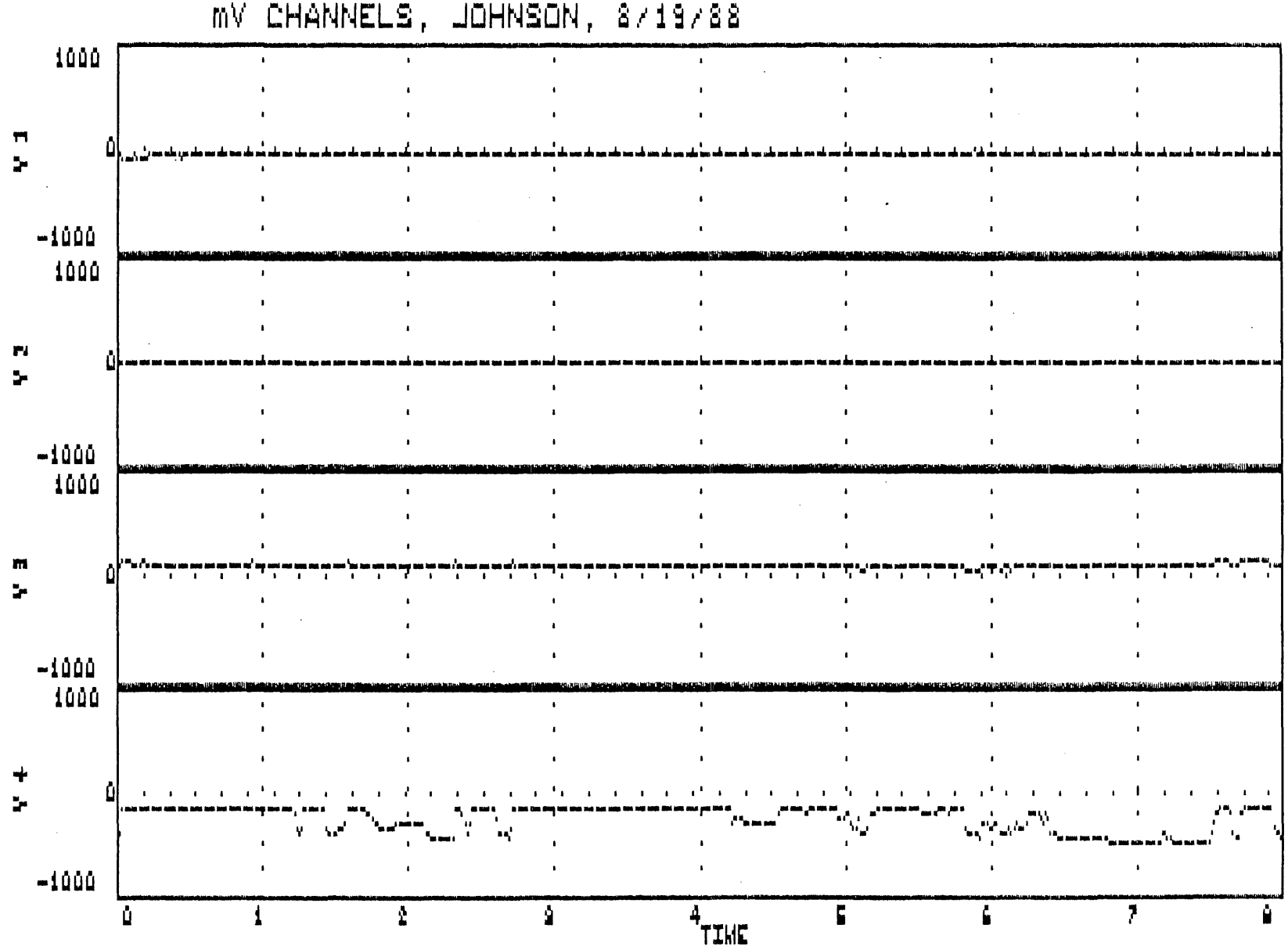
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

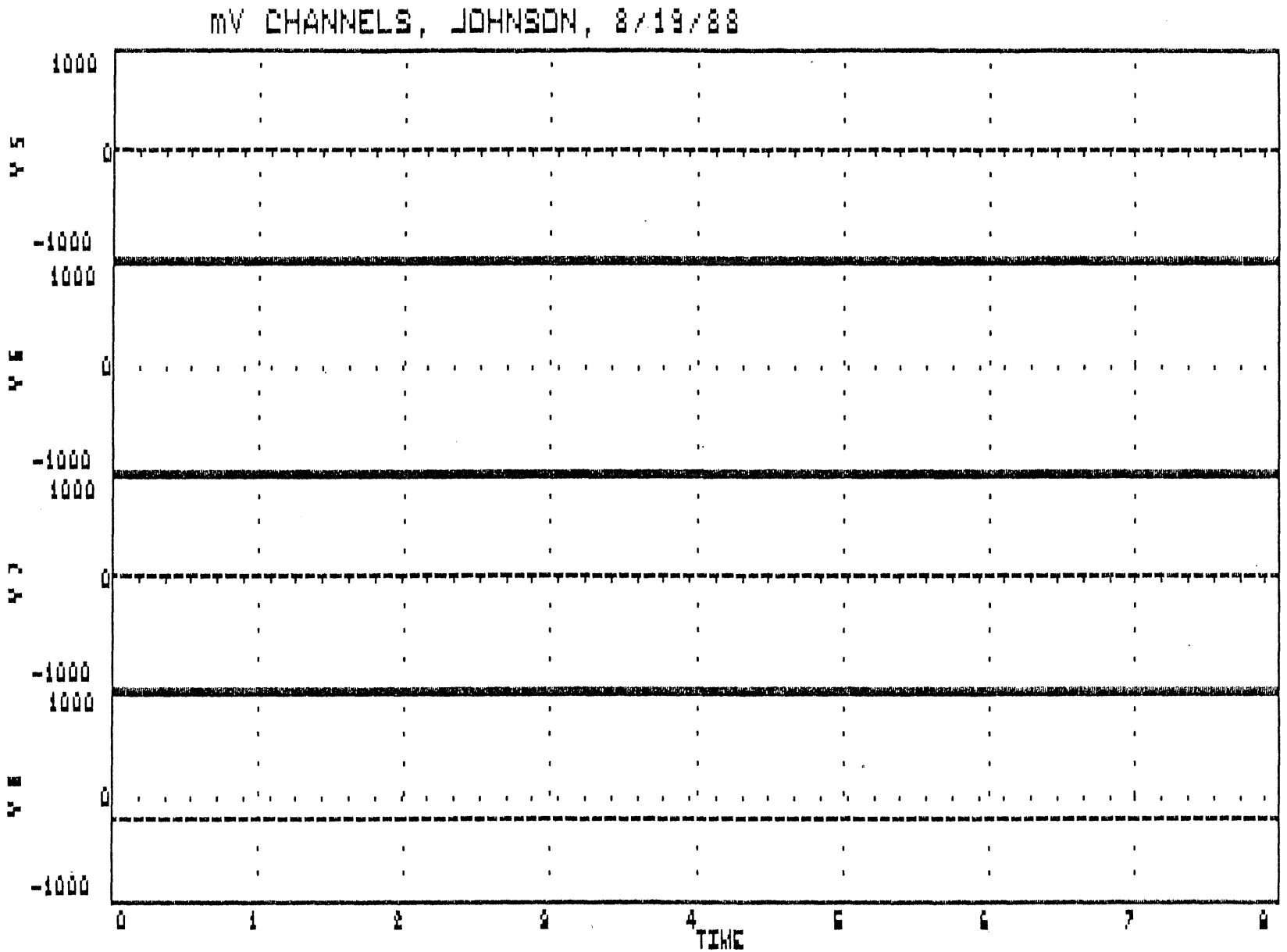

mV CHANNELS, JOHNSON, 8/18/88
1000
0
-1000
E W
N S
TIME



KEY

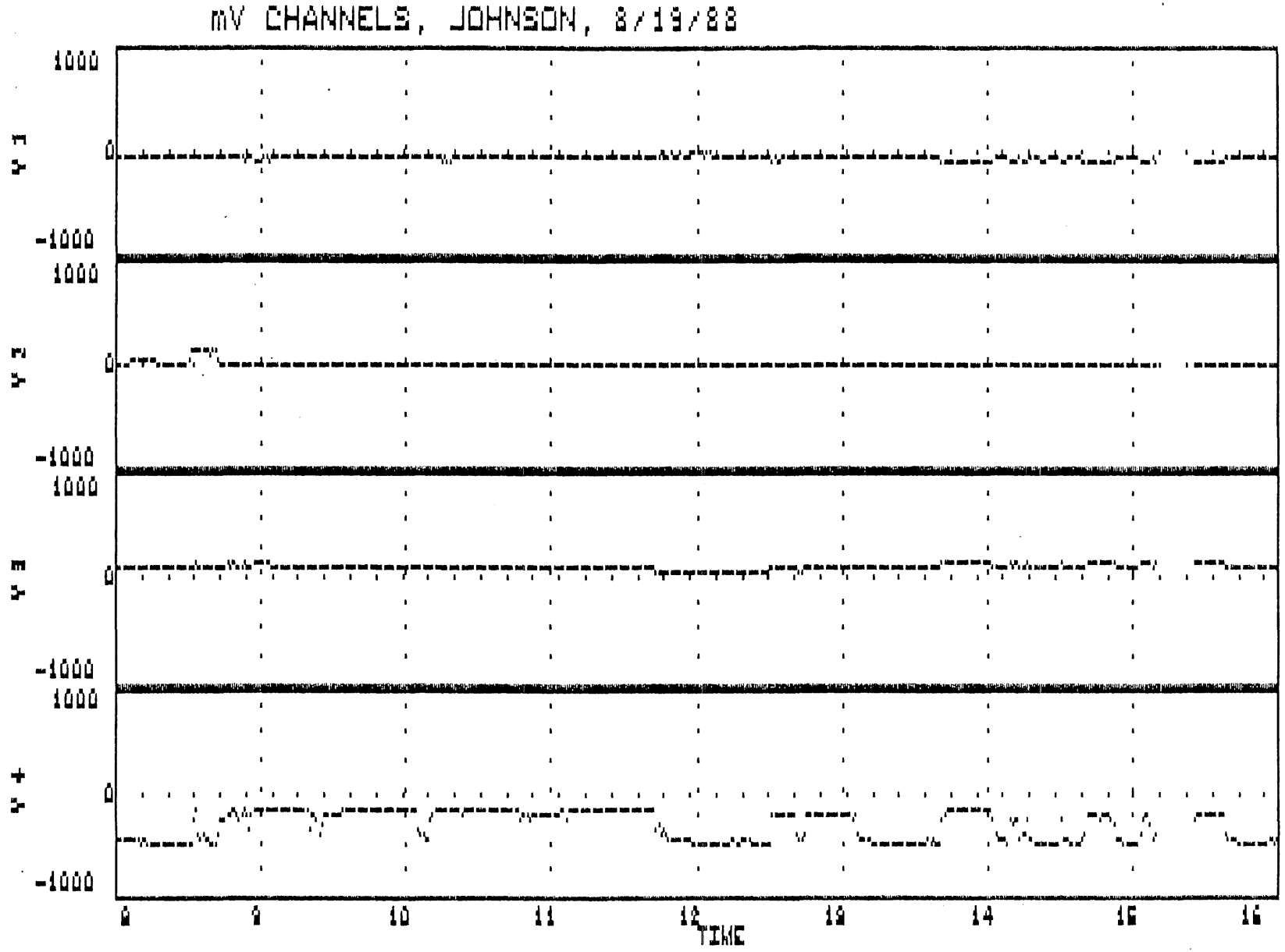
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

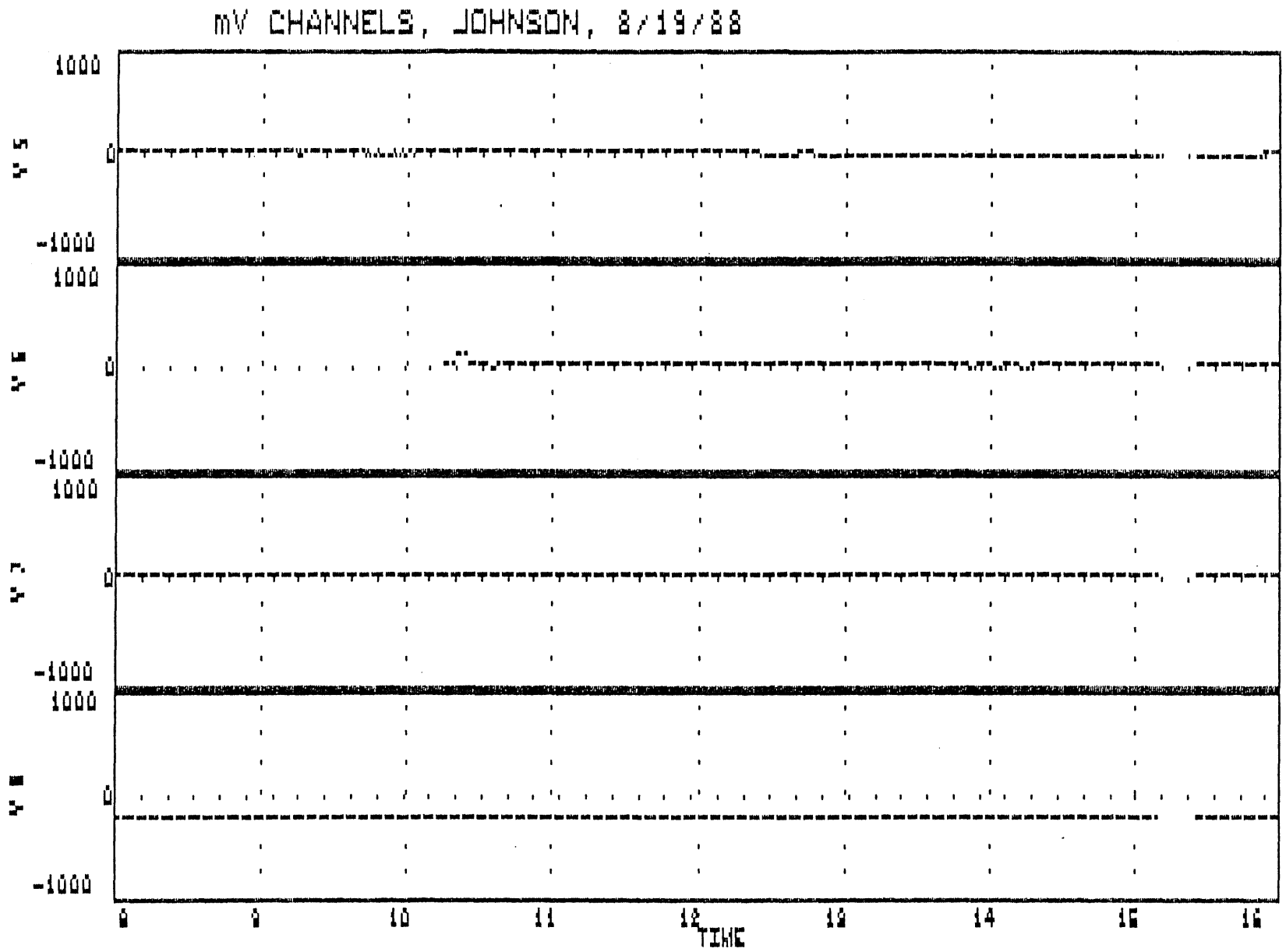

mV CHANNELS, JOHNSON, 8/19/88
1000
0
-1000
E1
E2
E3
E4
0
1
2
3
4
5
6
7
8
TIME



KEY

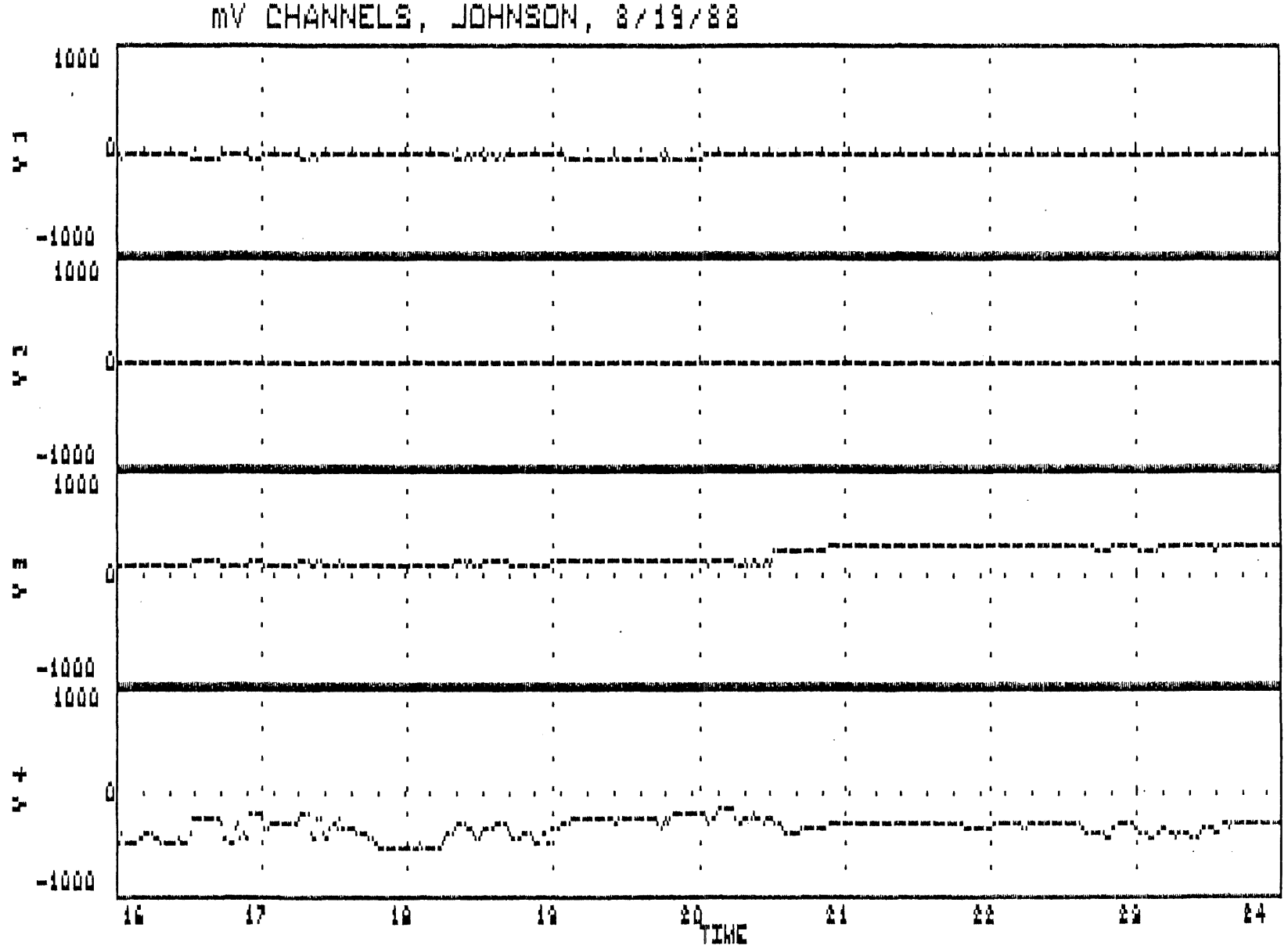
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

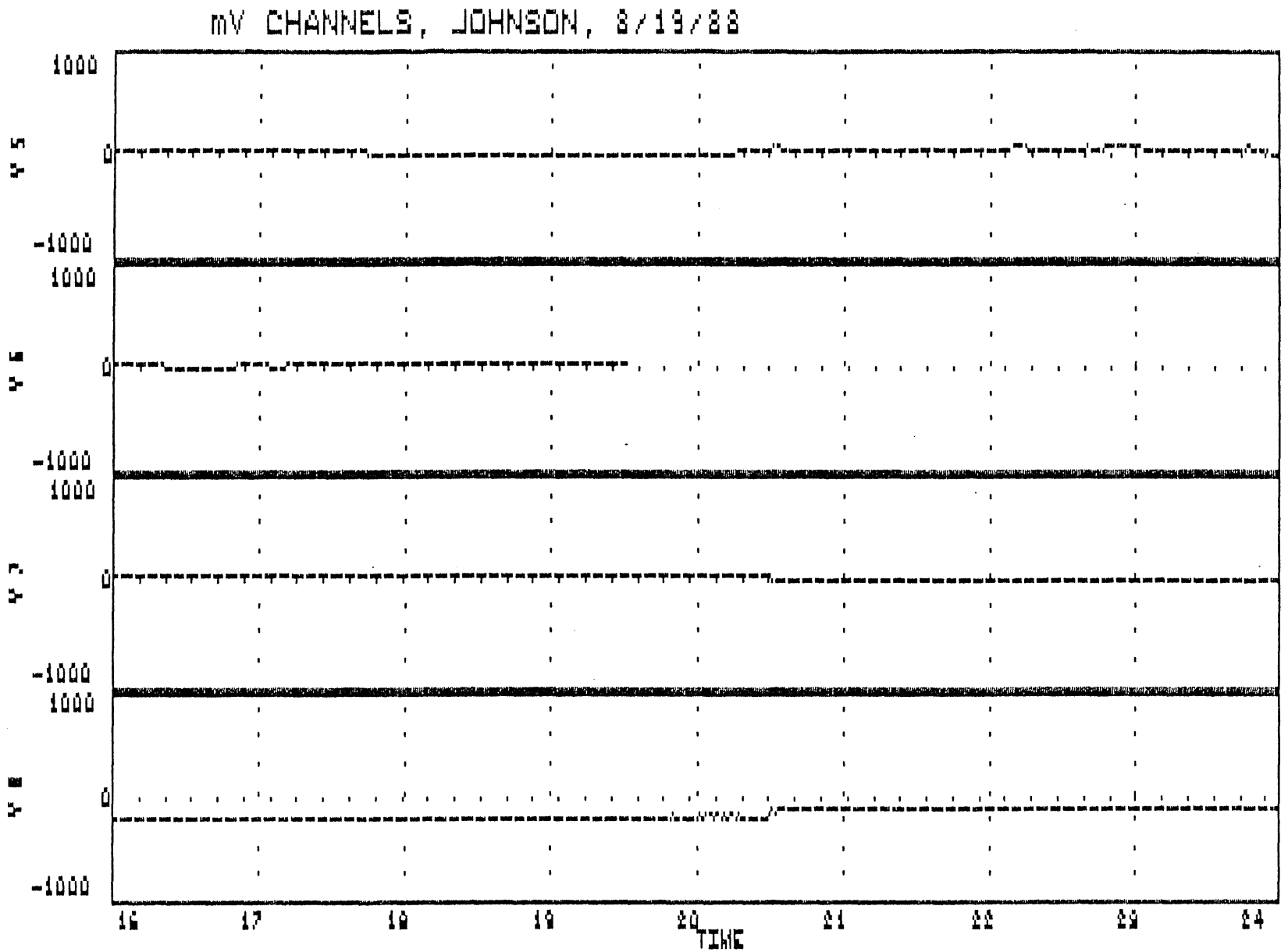

mV CHANNELS, JOHNSON, 8/19/88
1000
0
-1000
E W
N S
+ W
9
10
11
12
13
14
15
16
TIME



KEY

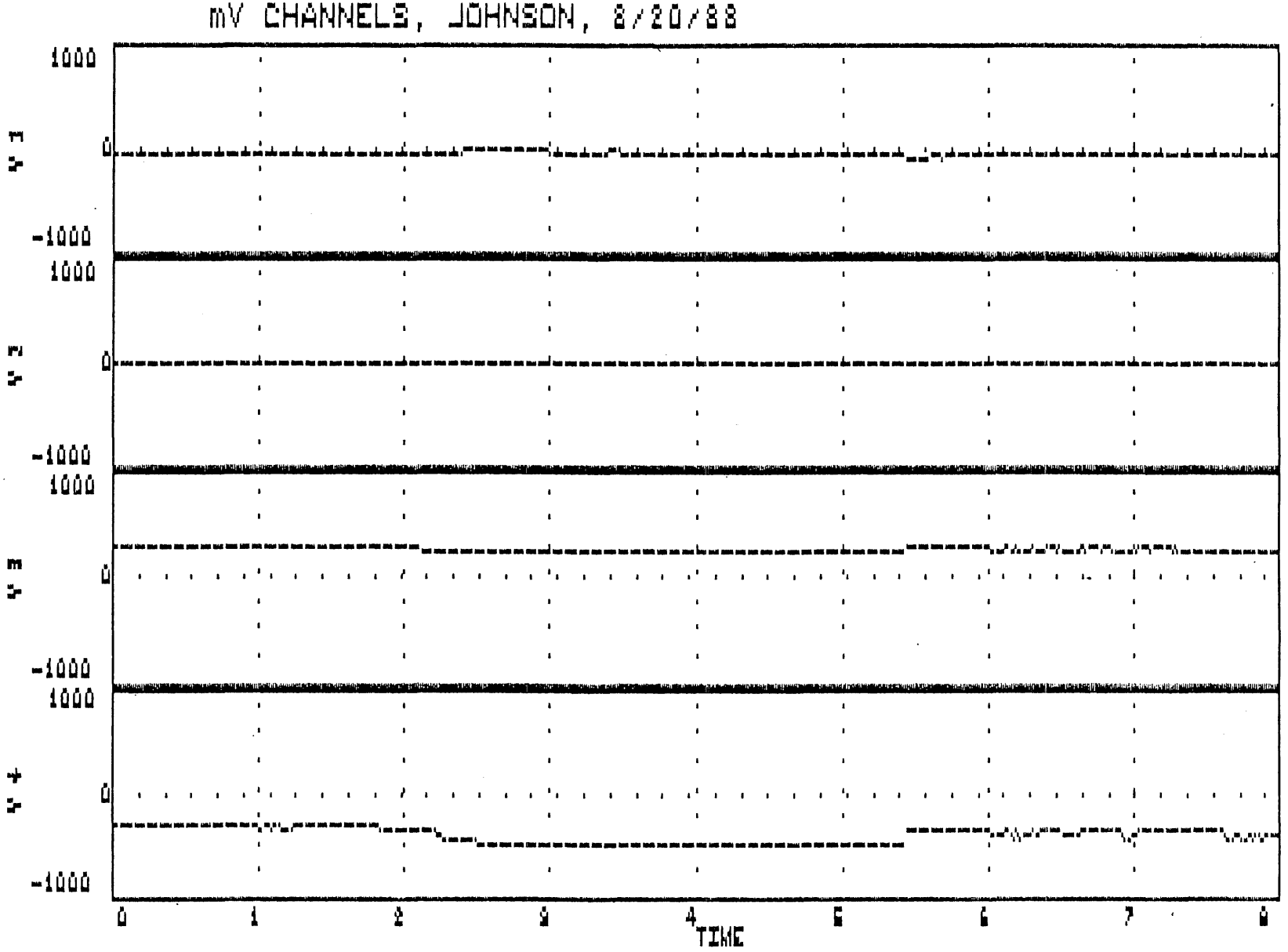
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

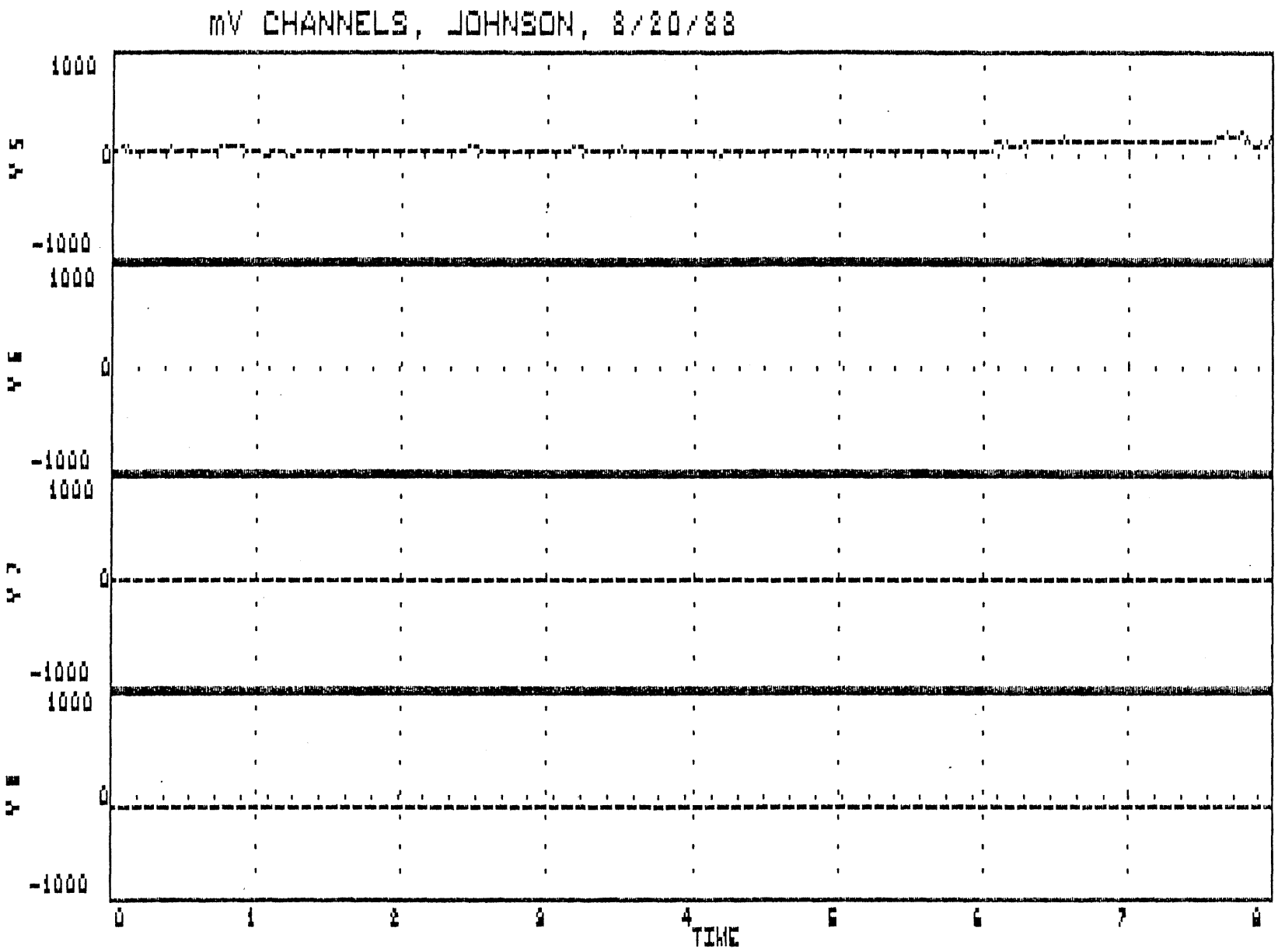

mV CHANNELS, JOHNSON, 8/19/88
1000
0
-1000
E W
N S
TIME



KEY: Blackburn off 2031-(2002,8/20)

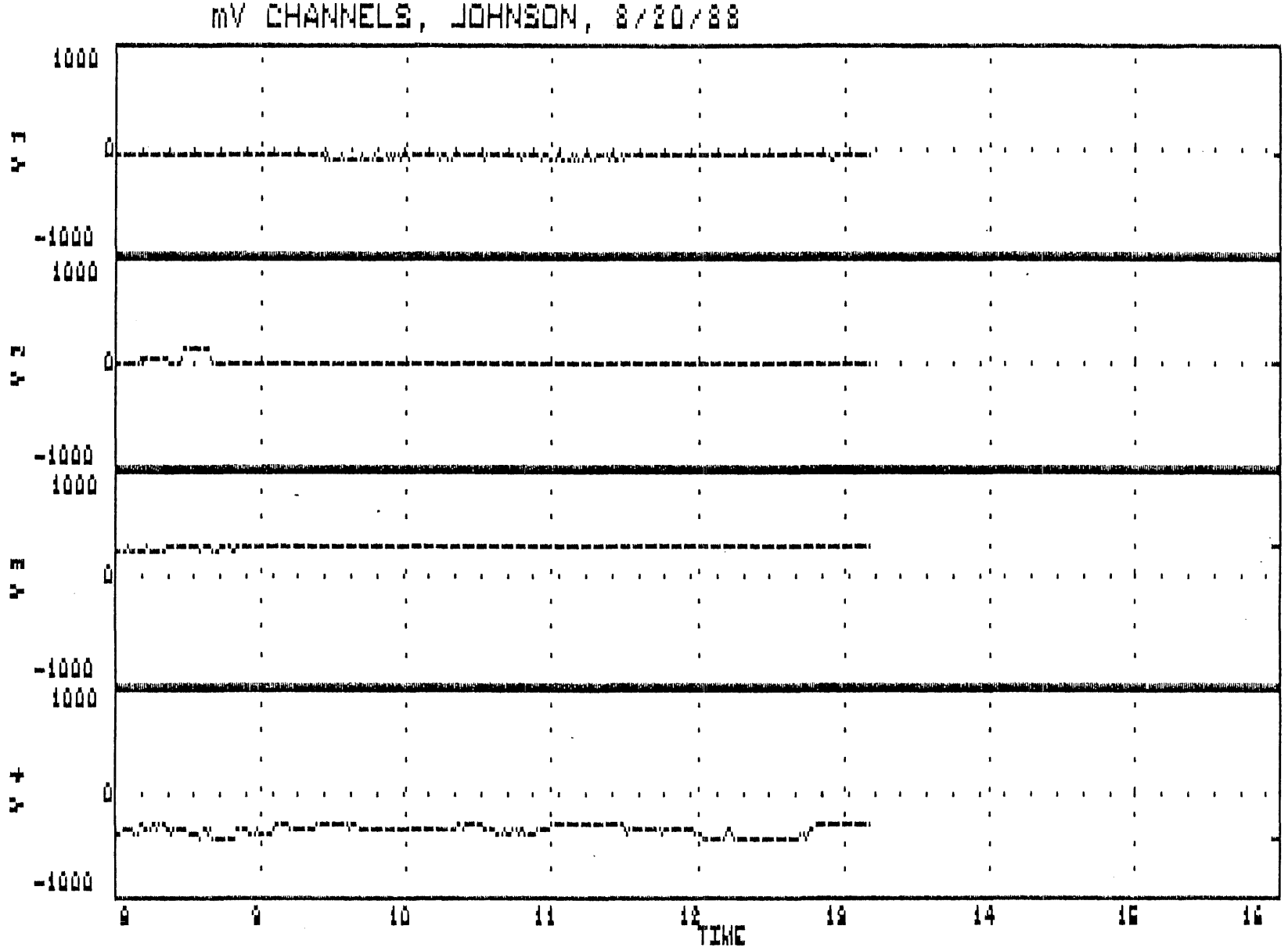
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

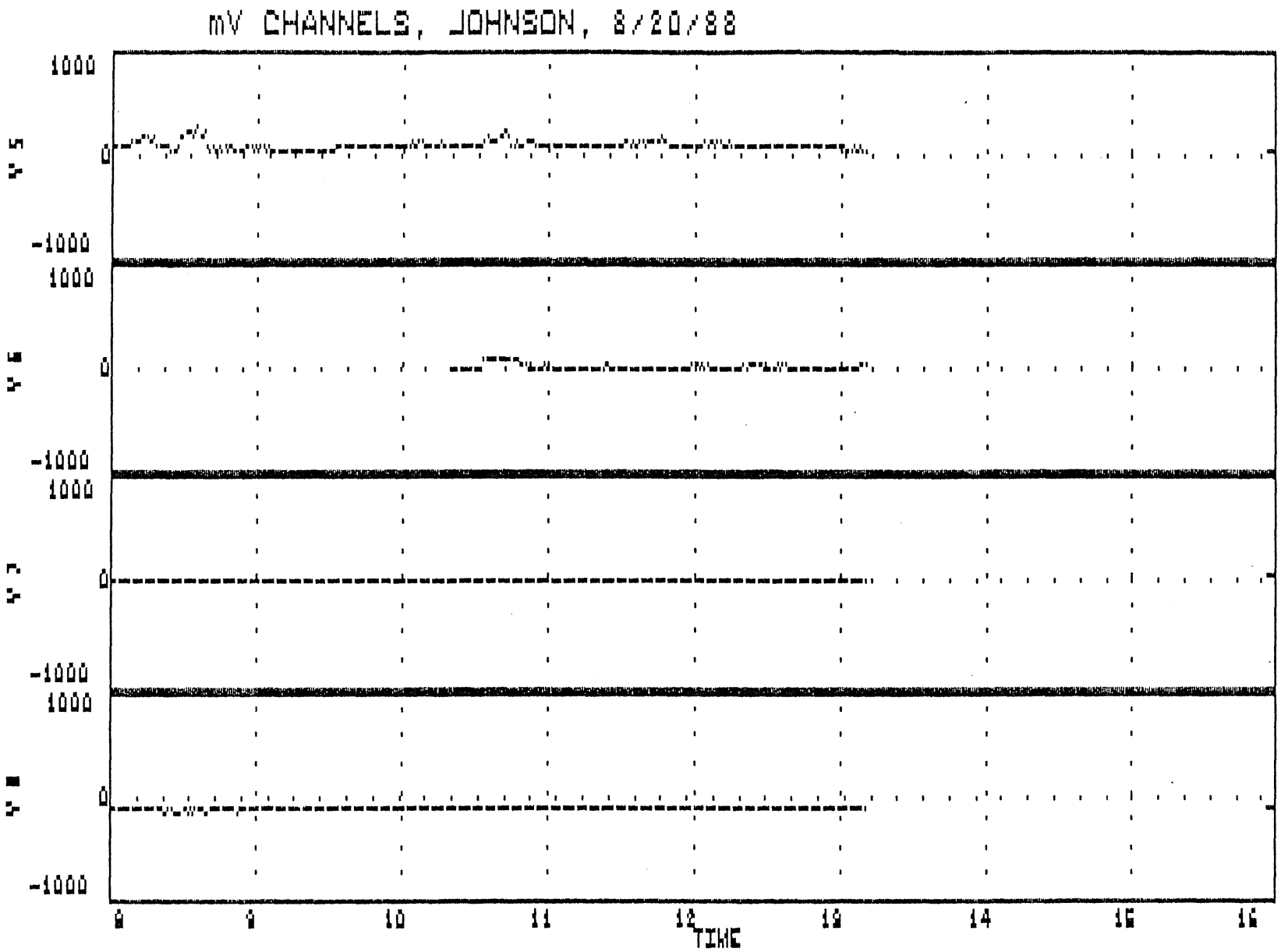

mV CHANNELS, JOHNSON, 8/20/88
1000
0
-1000
E1
E2
E3
E4
0
1
2
3
4
5
6
7
8
TIME



KEY: Blackburn off (2031,8/20)-2002

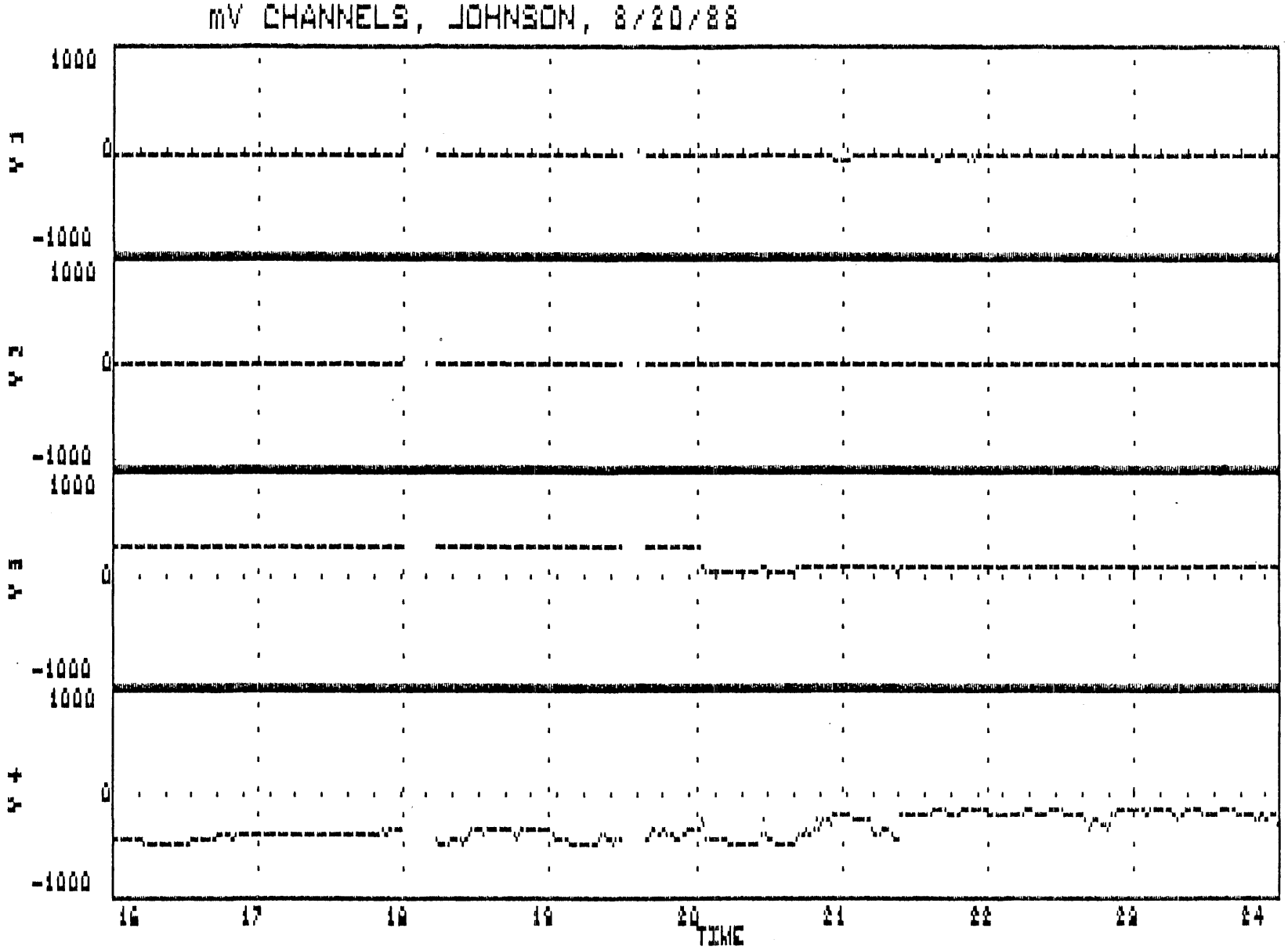
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

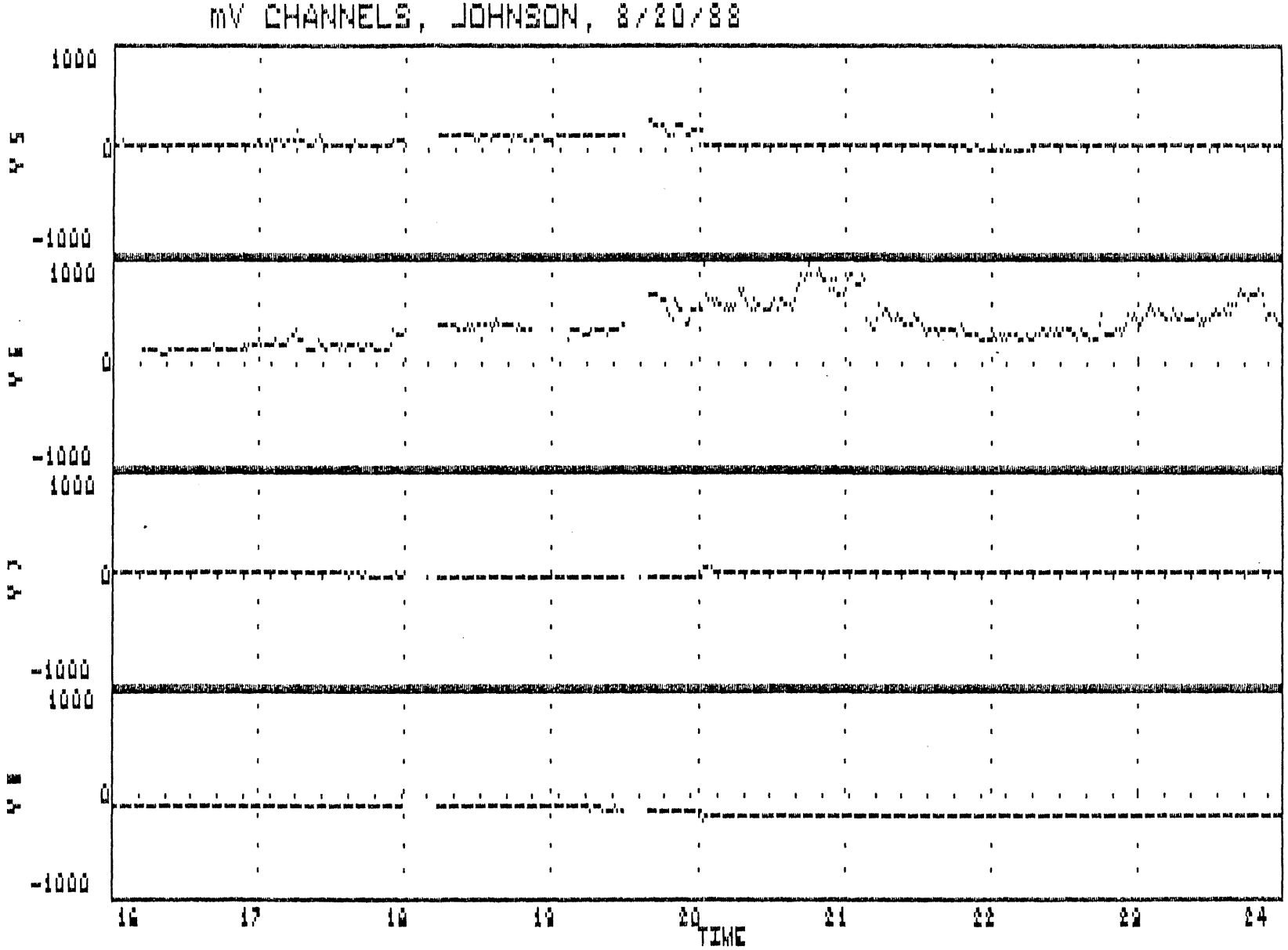

mV CHANNELS, JOHNSON, 8/20/88
1000
0
-1000
E-W
N-S
TIME
8
9
10
11
12
13
14
15
16



KEY: Blackburn off (2031,8/20)-2002

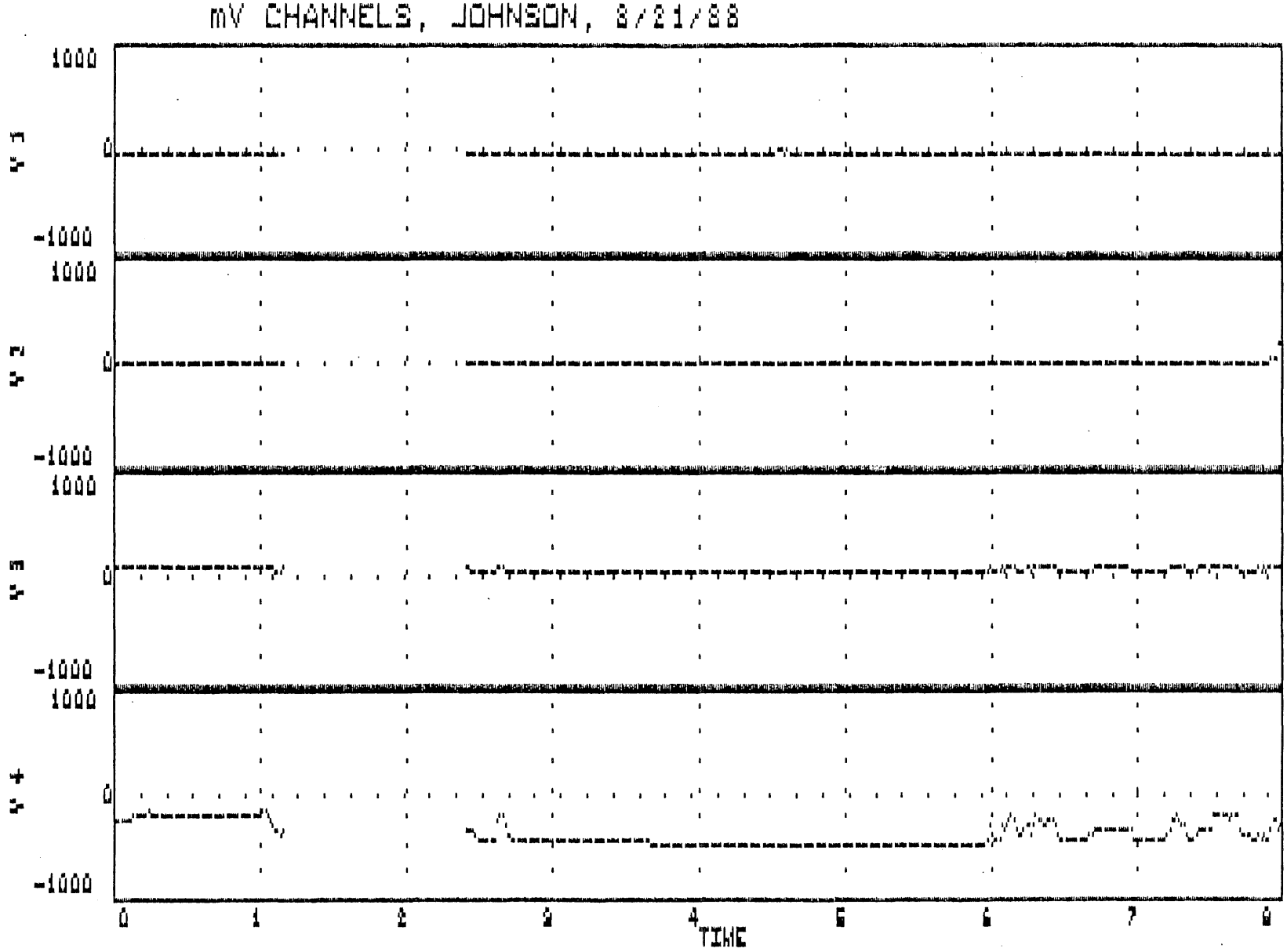
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	E field (dc)	–
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

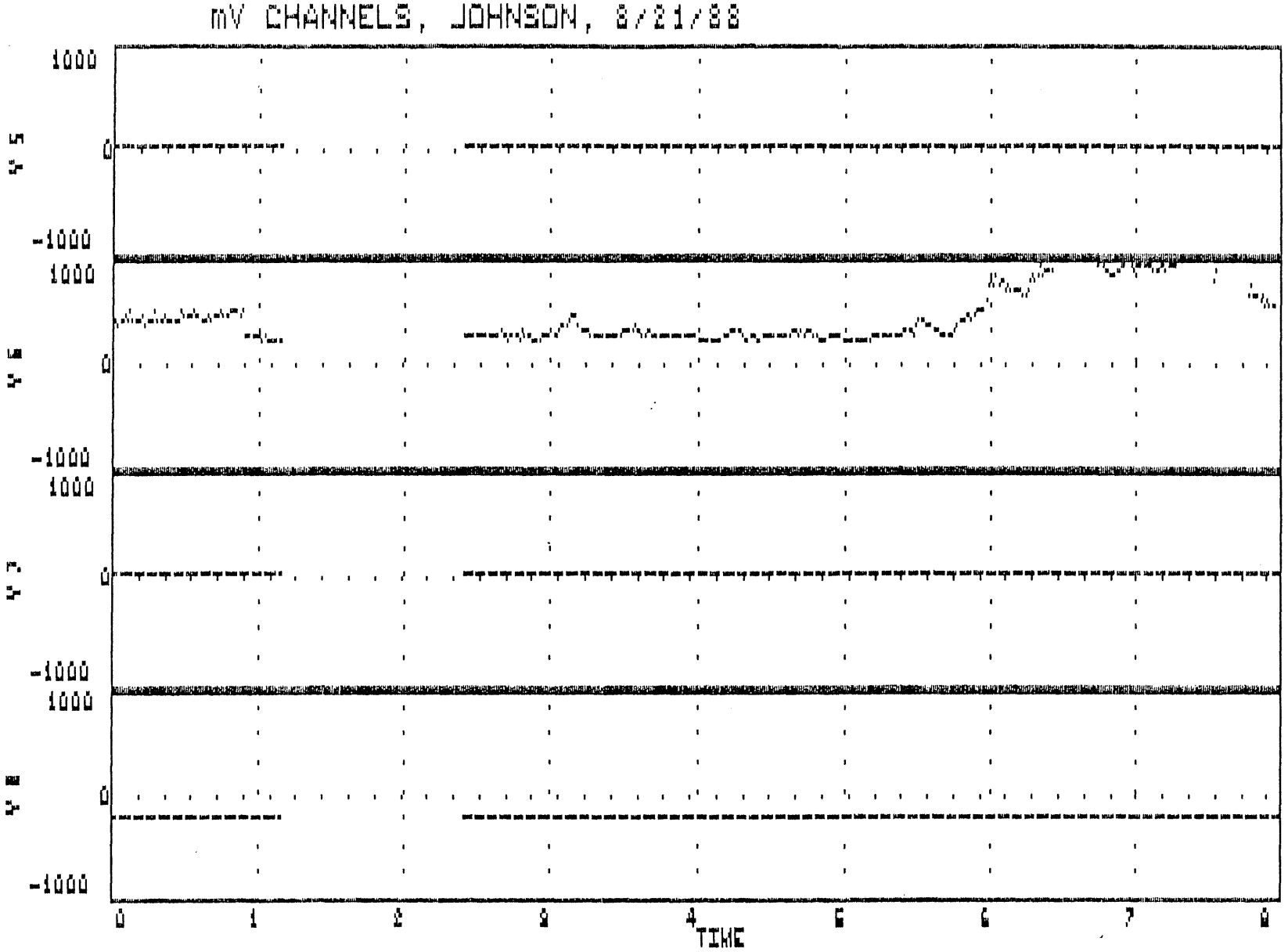

mV CHANNELS, JOHNSON, 8/20/88
1000
0
-1000
E W
N S
+ N
16
17
18
19
20
21
22
23
24
TIME



KEY: Blackburn off (2031,8/20)-2002, generator power 1811-1937

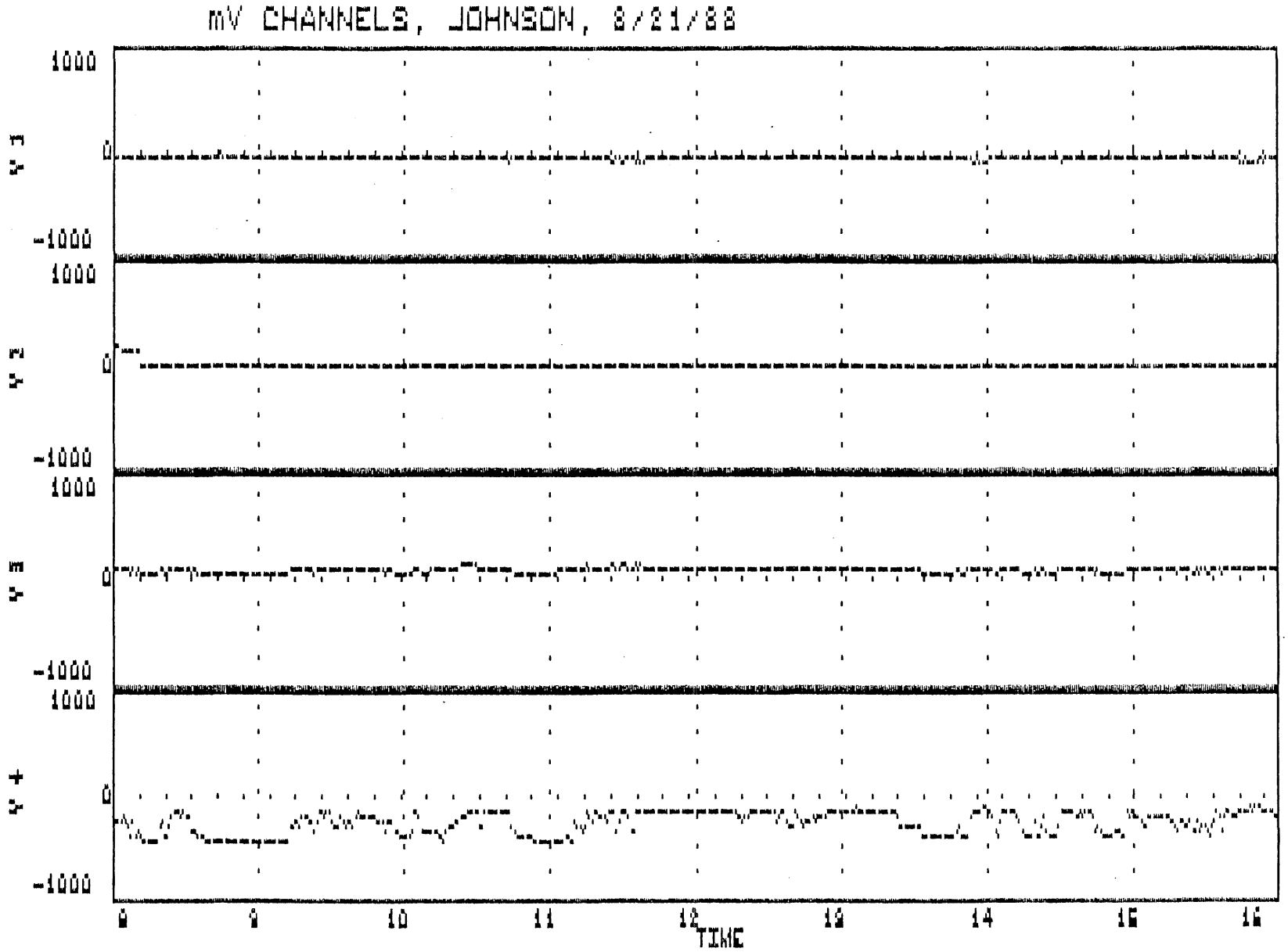
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6*	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

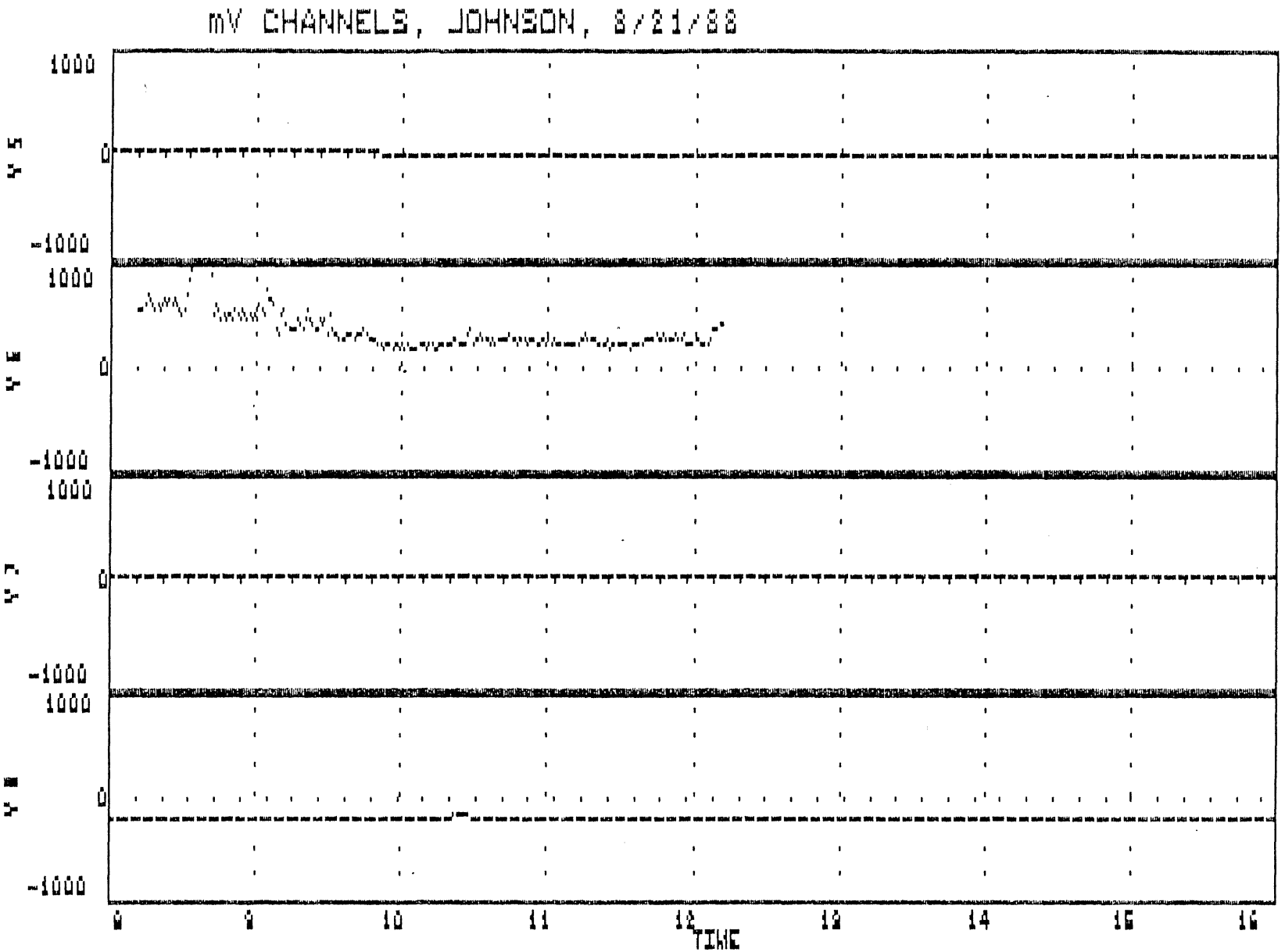

mV CHANNELS, JOHNSON, 8/21/88
1000
0
-1000
V 1
V 2
V 3
V 4
0
1
2
3
4
5
6
7
8
TIME



KEY

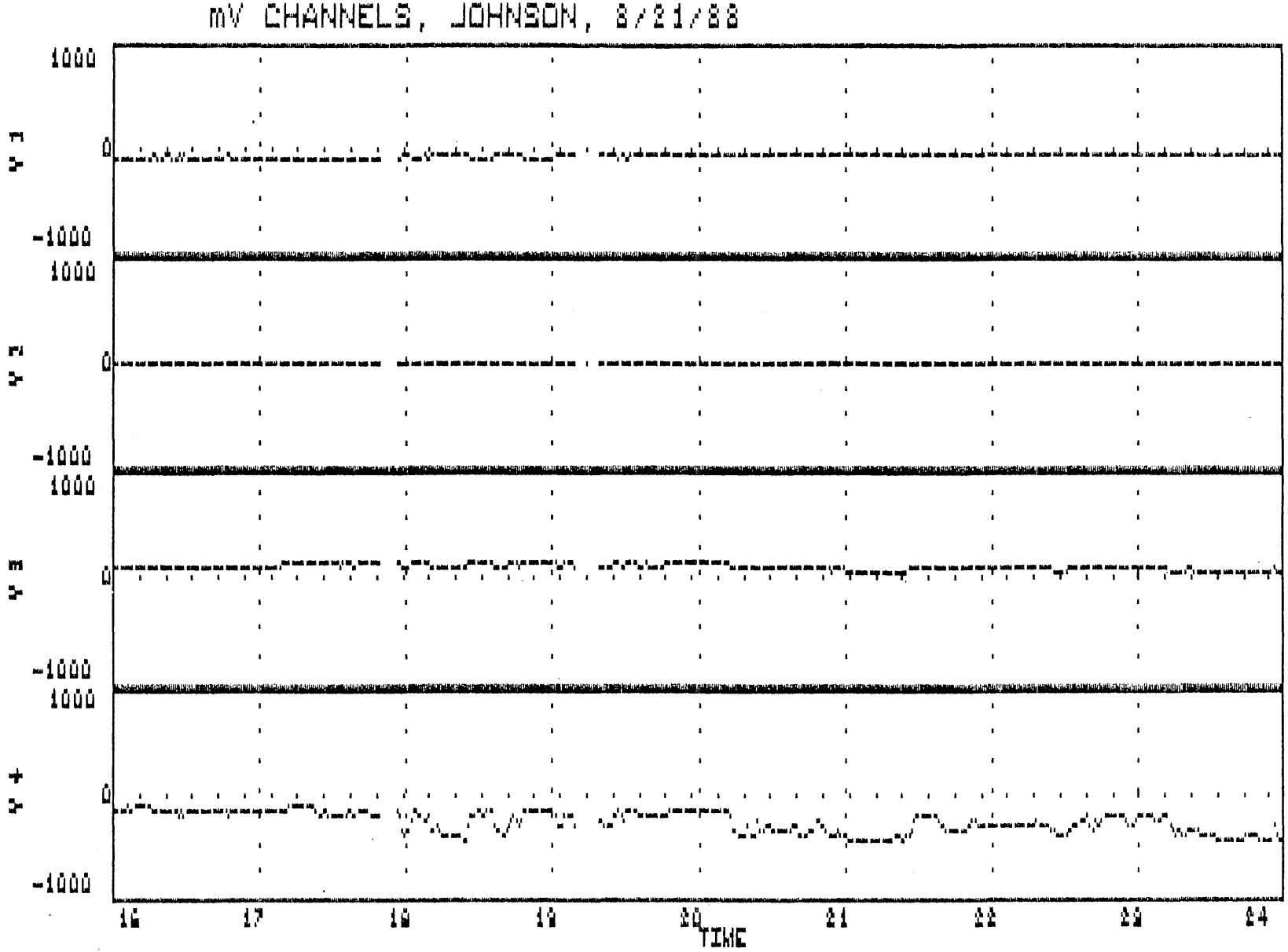
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

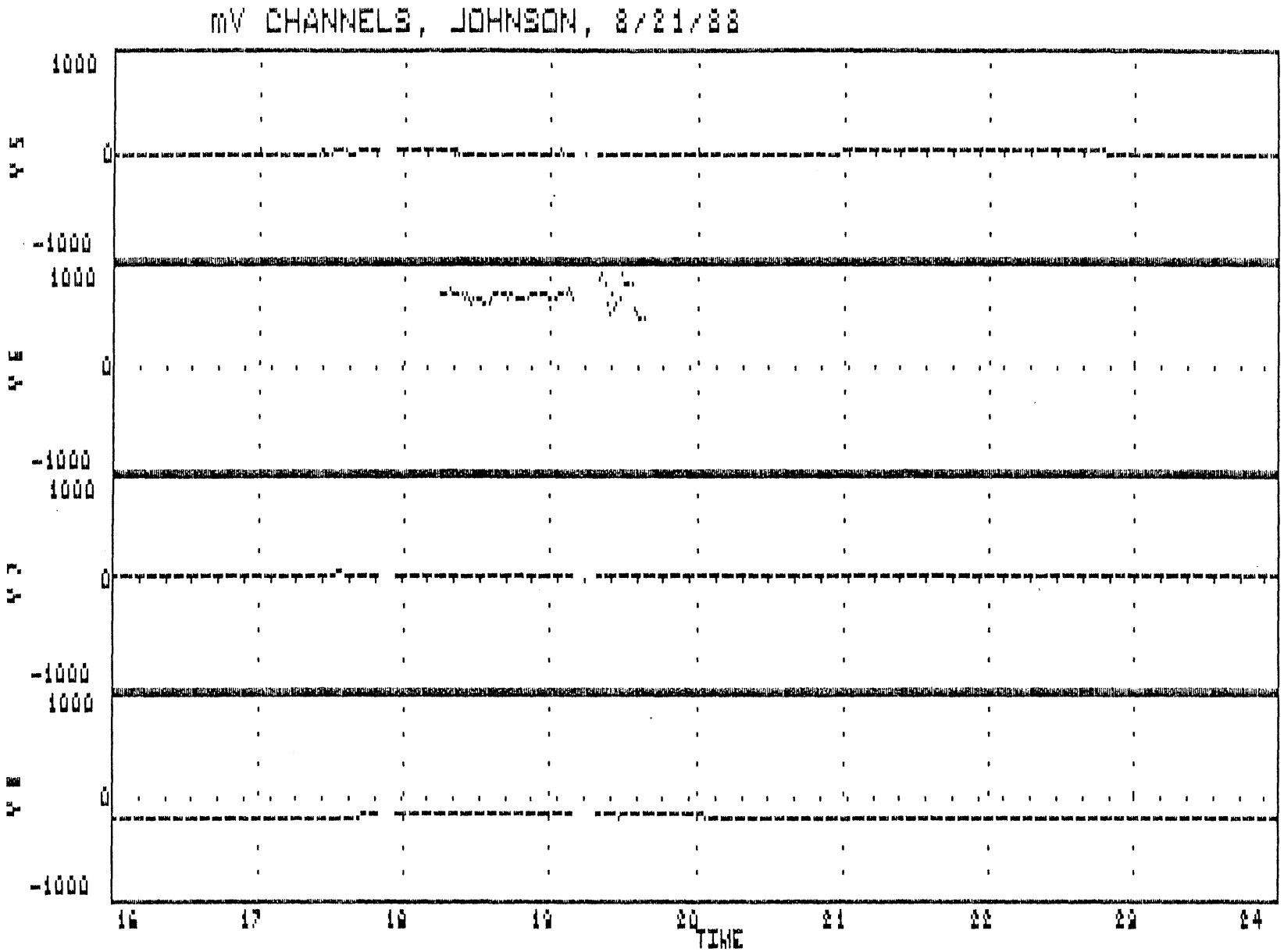

mV CHANNELS, JOHNSON, 8/21/88
1000
0
-1000
V 1
V 2
V 3
V 4
9
10
11
12
13
14
15
16
TIME



KEY

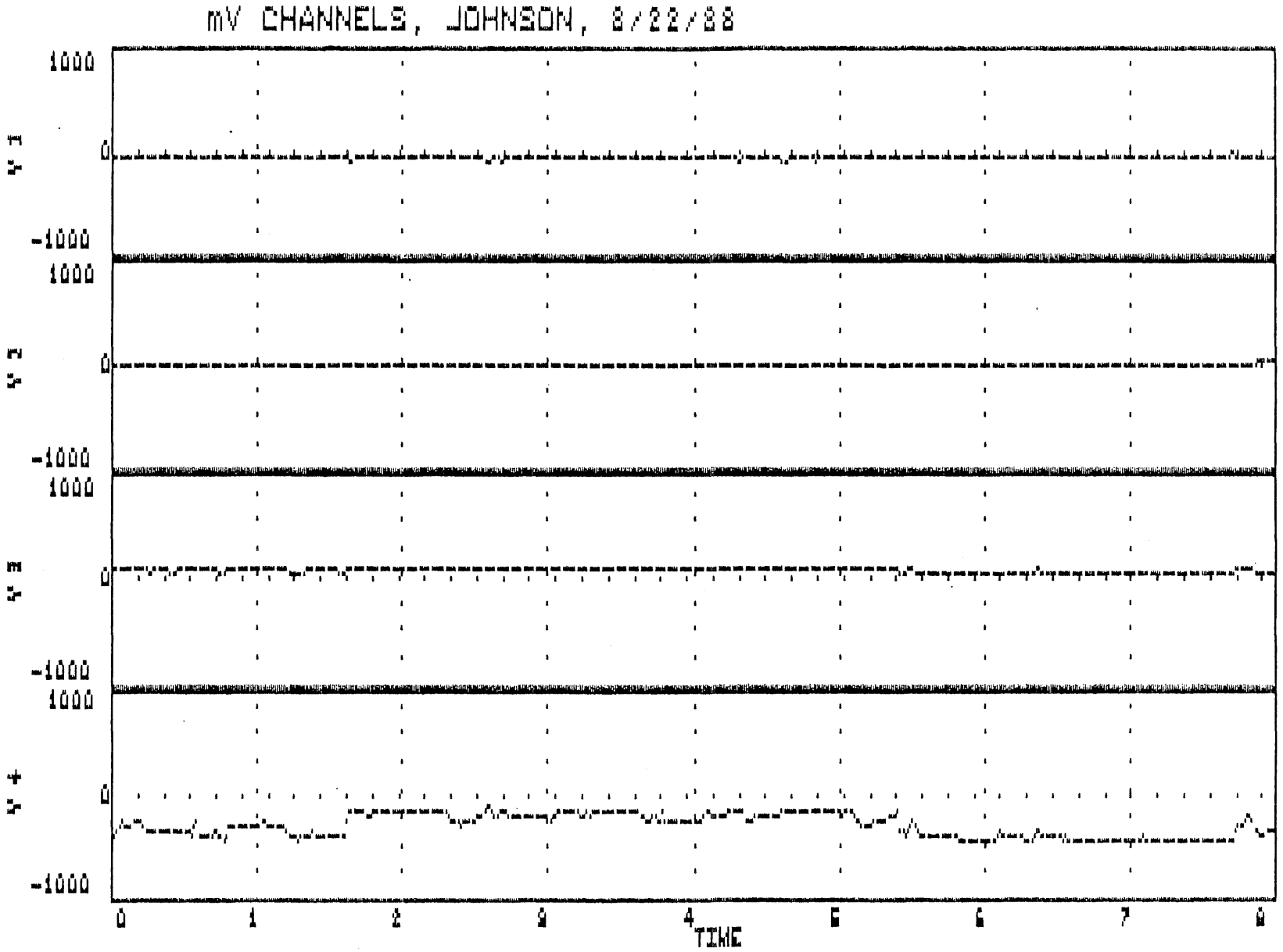
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

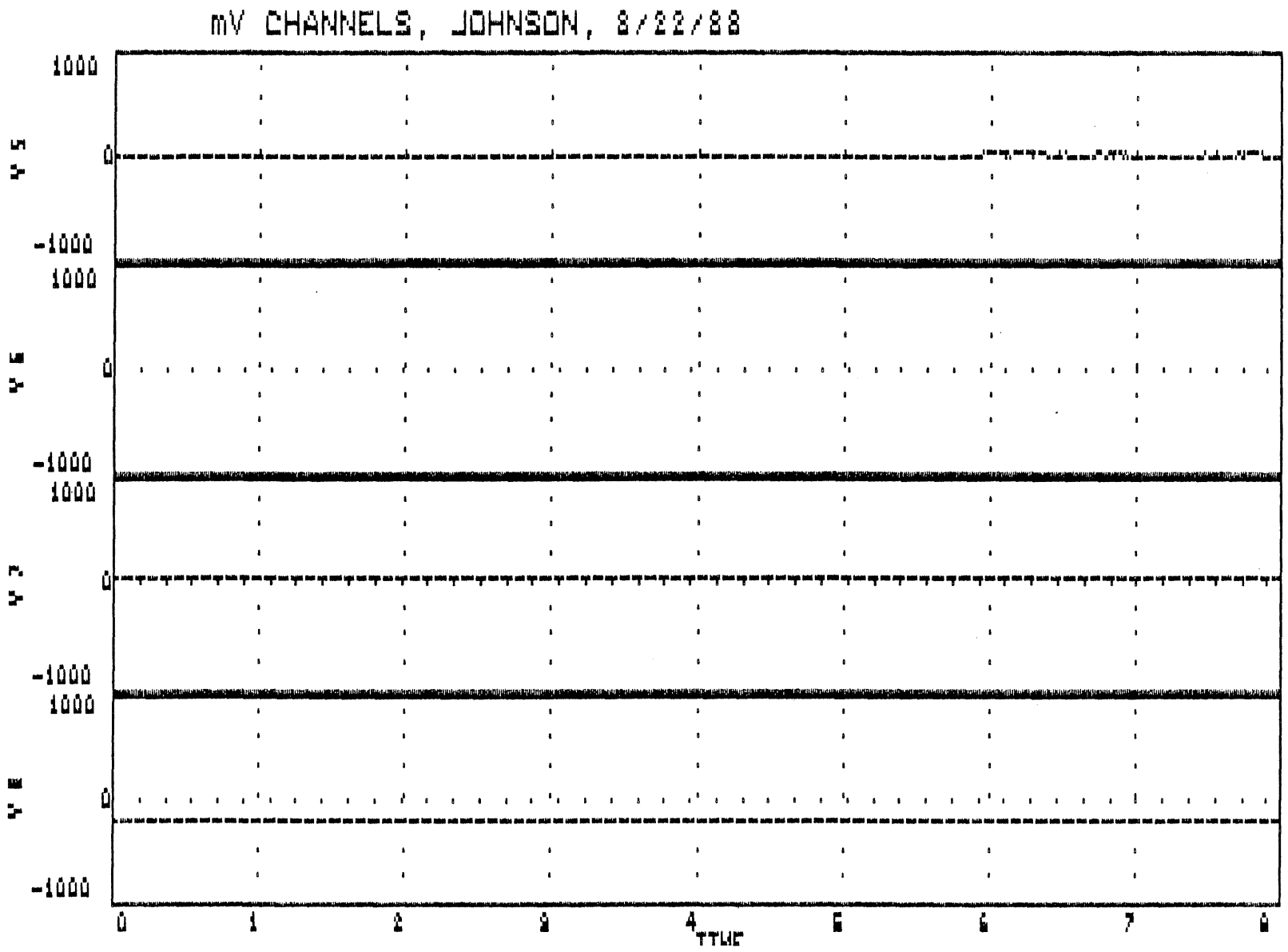

mV CHANNELS, JOHNSON, 8/21/88
1000
0
-1000
E+
N-S
E-W
TIME



KEY: generator power 1755-~1915

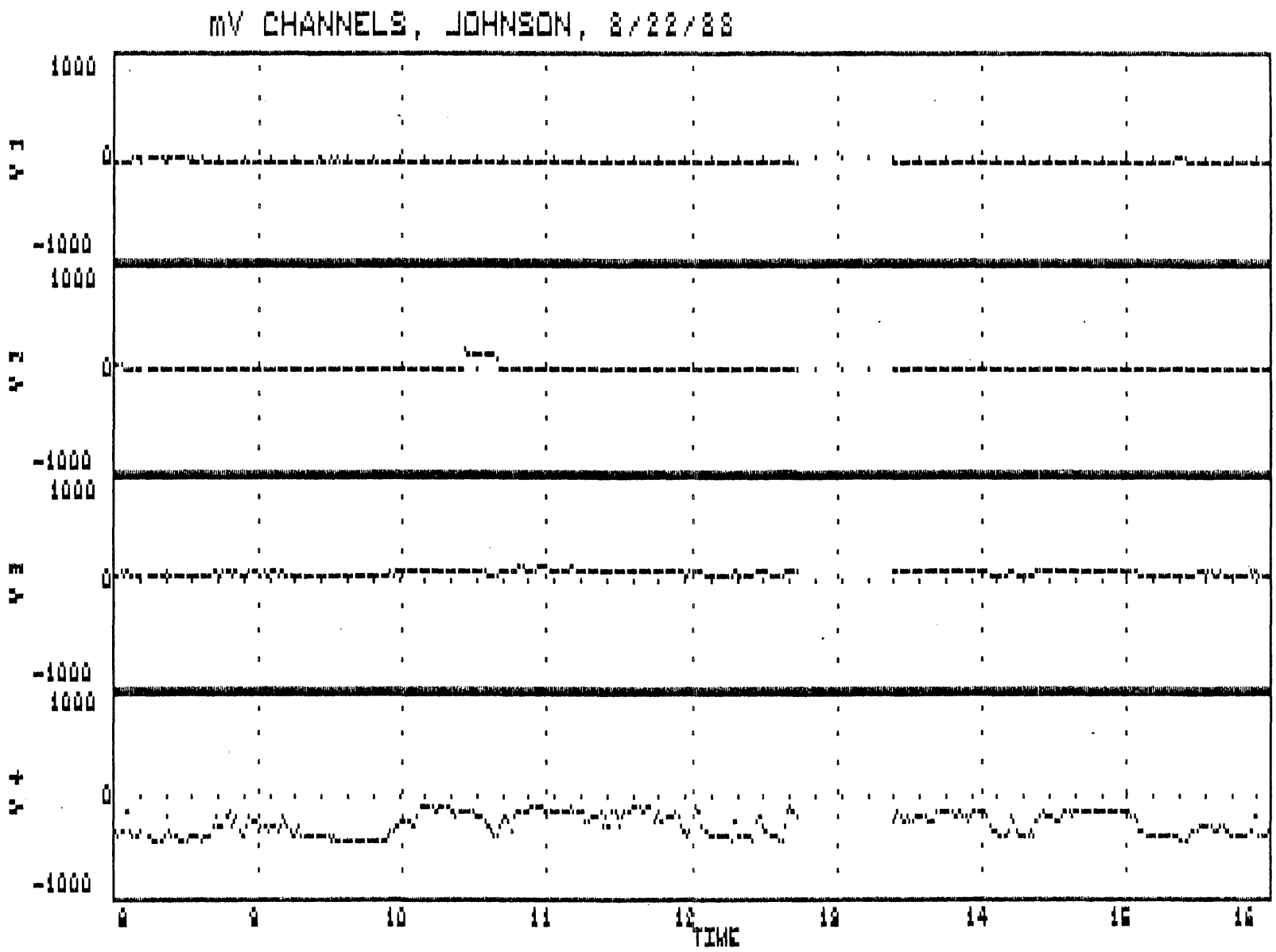
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

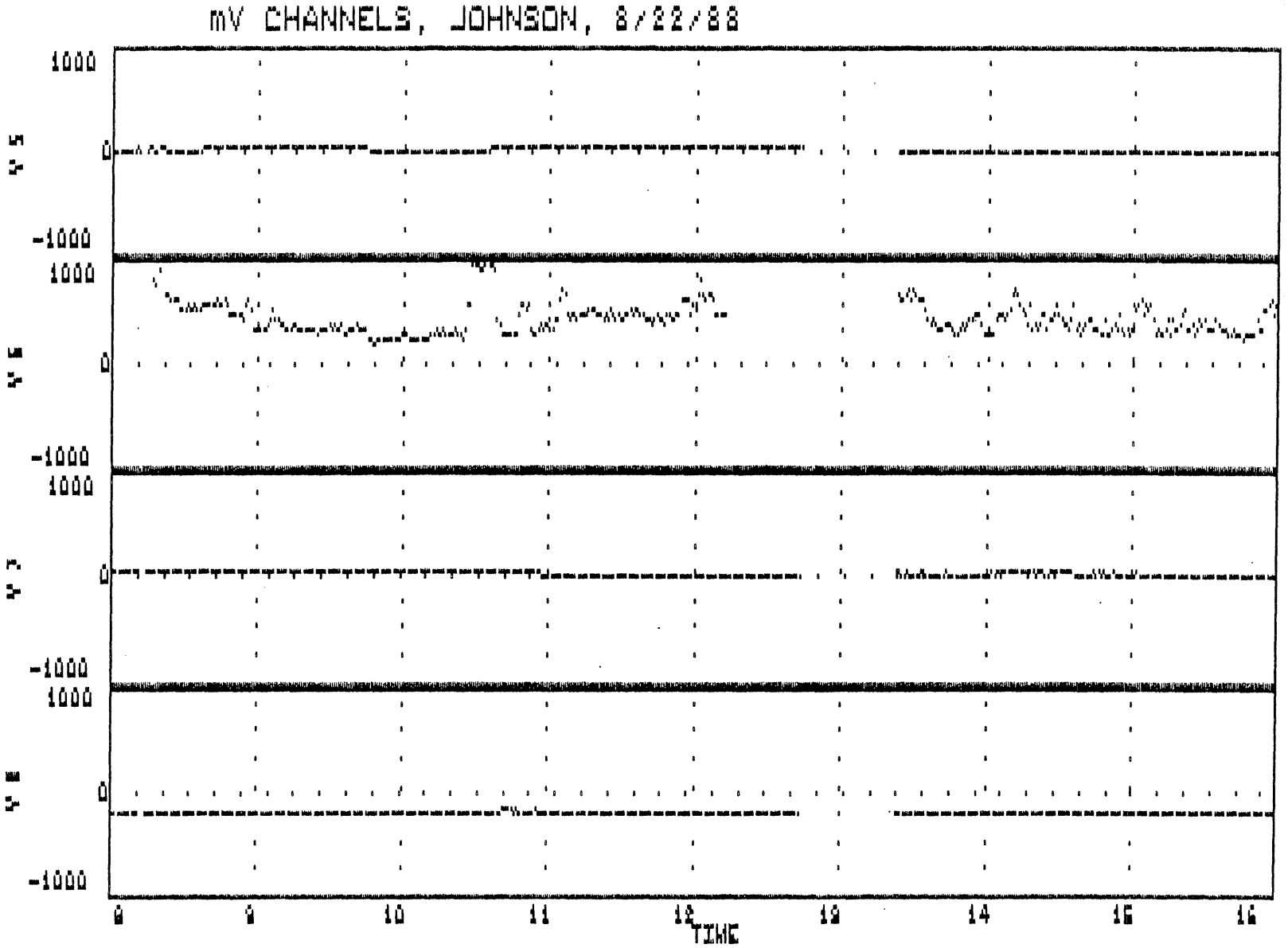

mV CHANNELS, JOHNSON, 8/22/88
1000
0
-1000
E 1
E 2
E 3
E 4
0
1
2
3
4
5
6
7
8
TIME



KEY

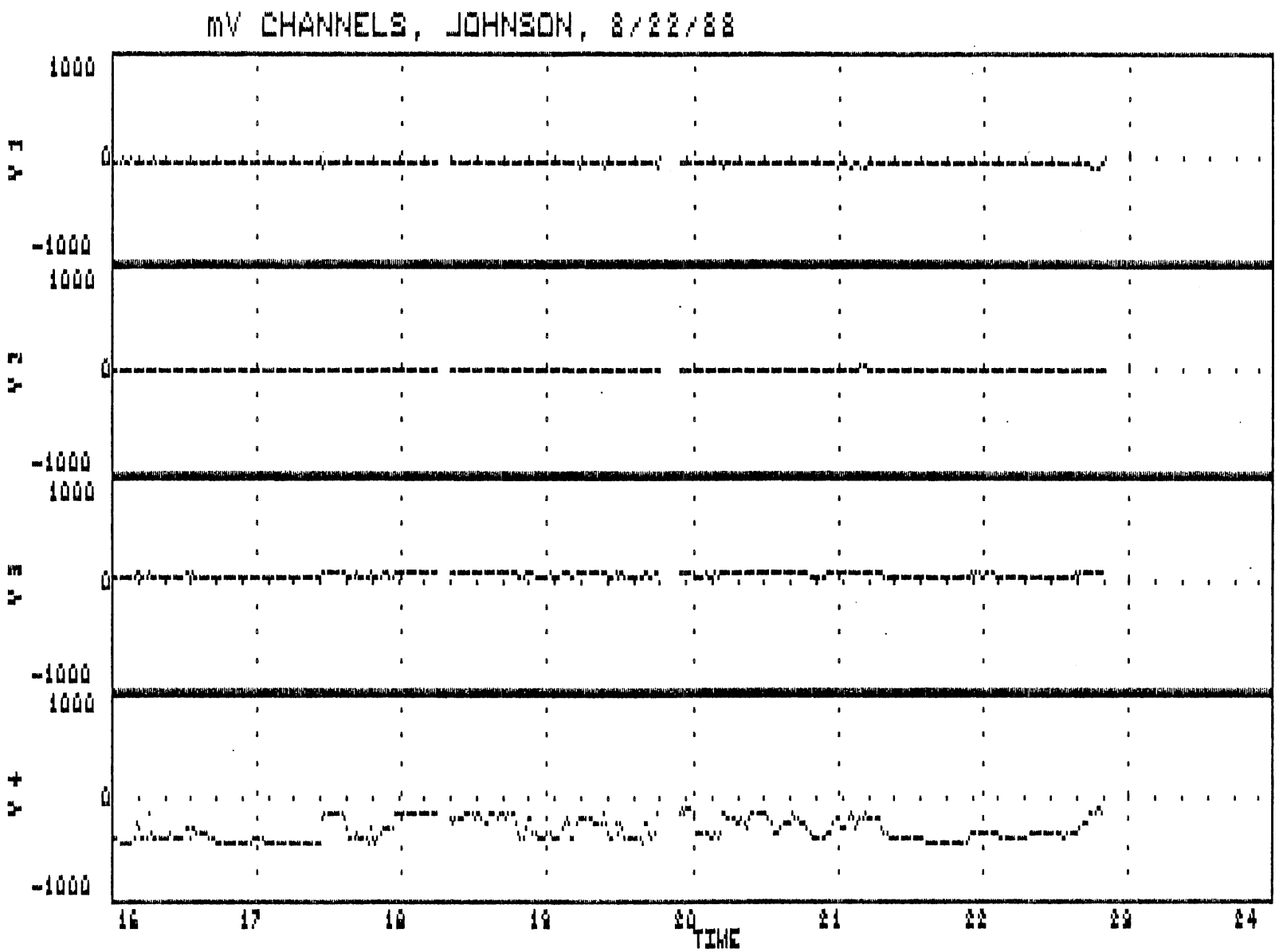
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

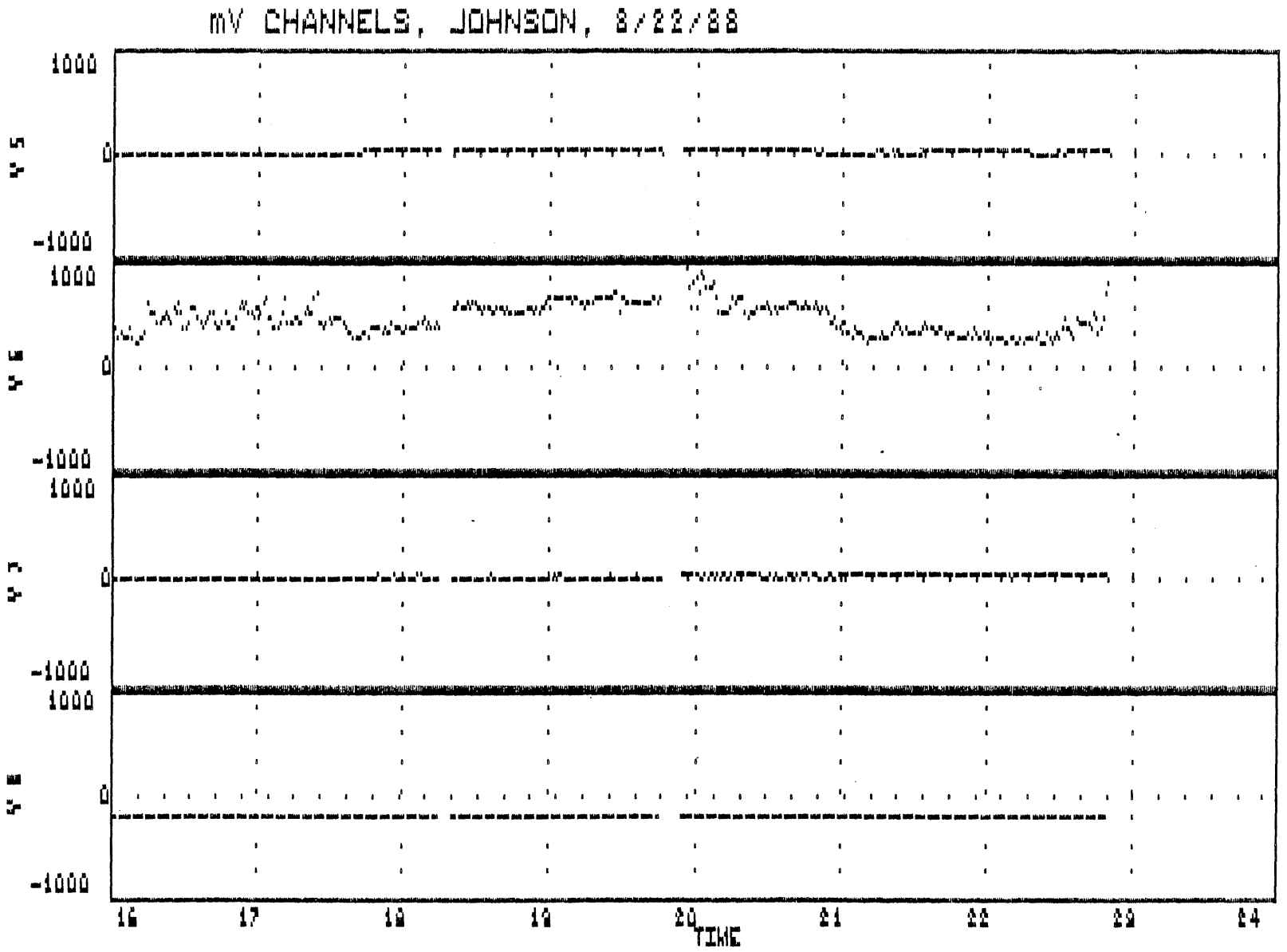

mV CHANNELS, JOHNSON, 8/22/88
1000
0
-1000
mV 1
mV 2
mV 3
mV 4
9
10
11
12
13
14
15
16
TIME



KEY

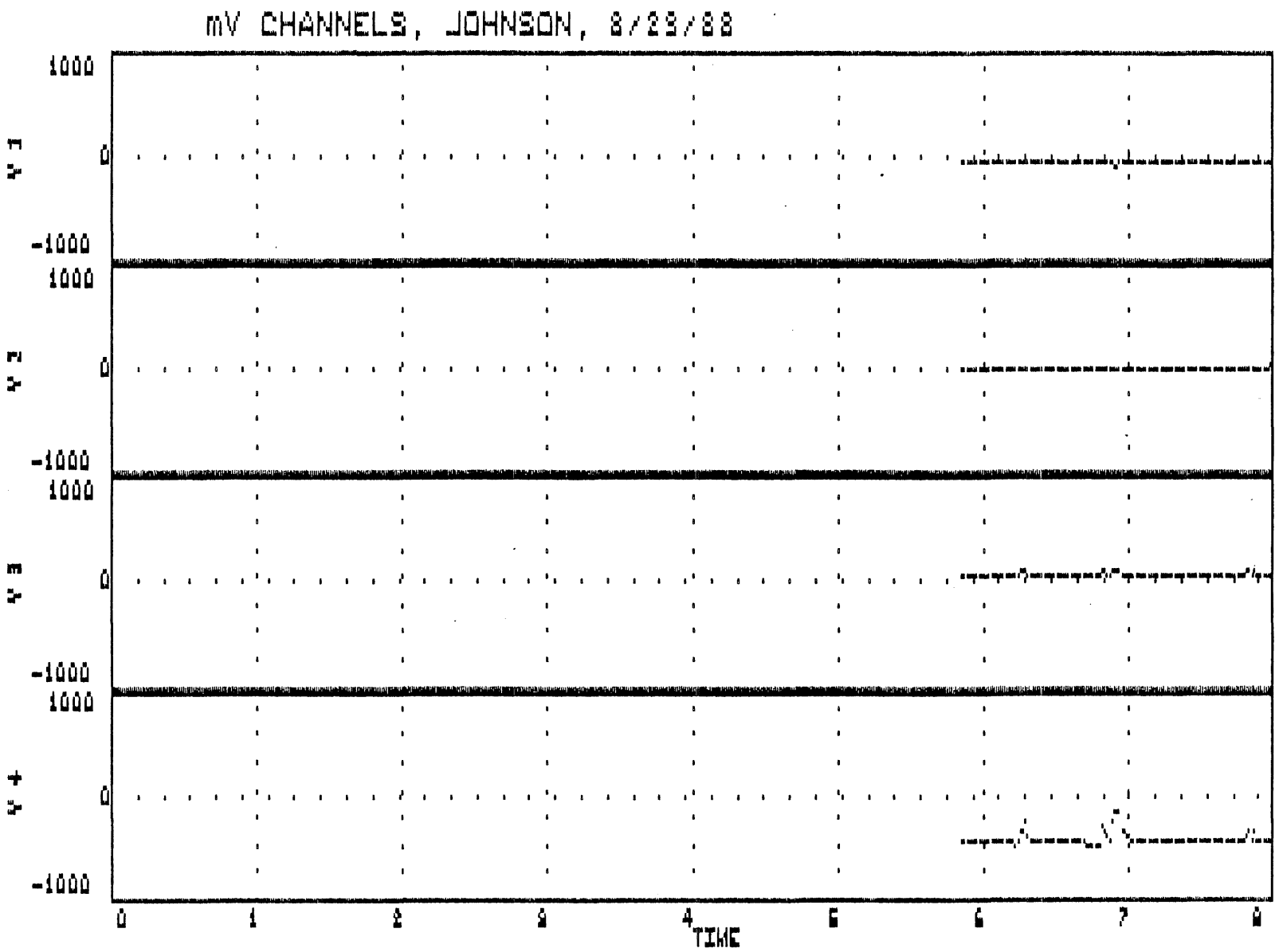
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	--
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

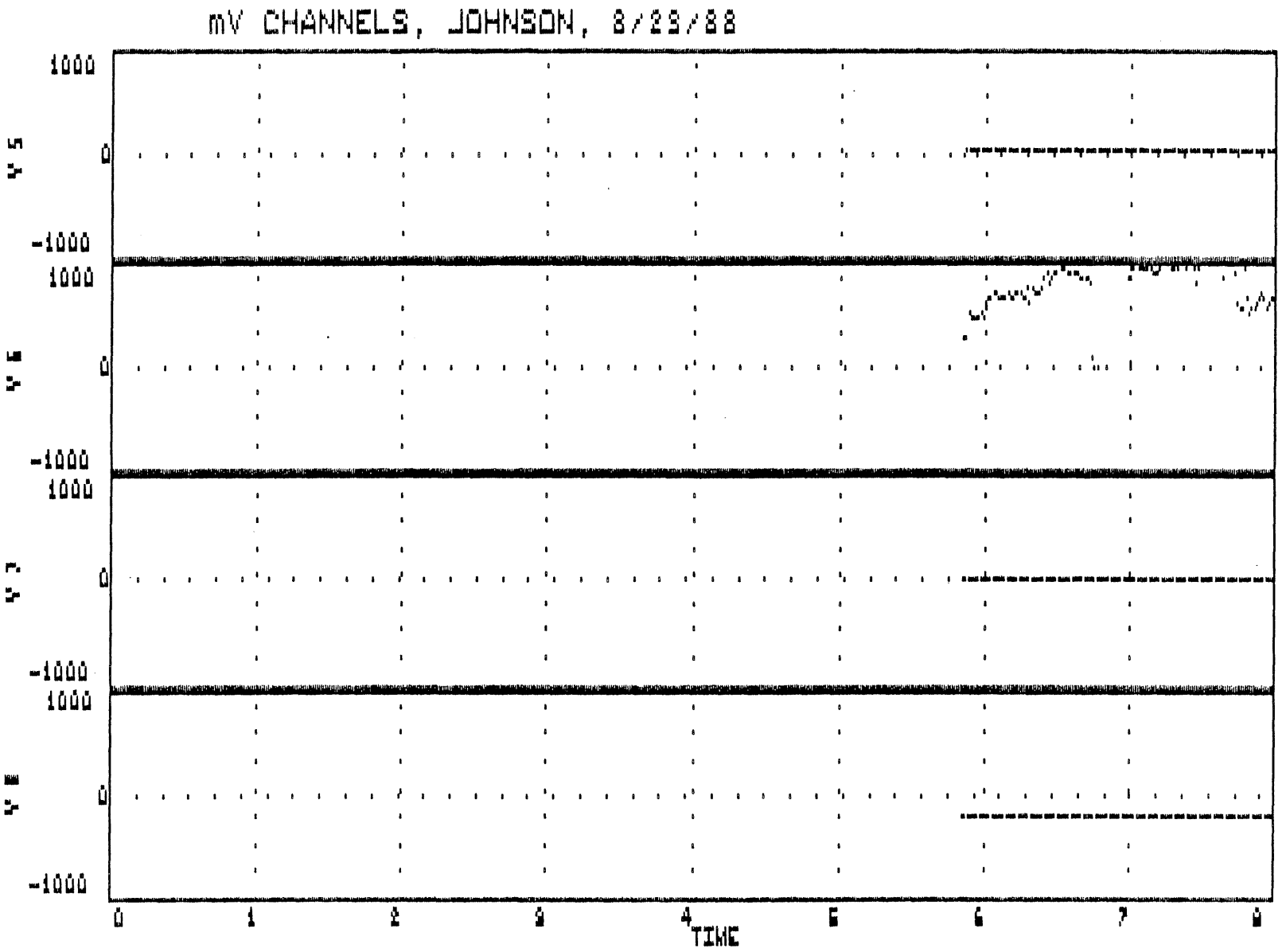

mV CHANNELS, JOHNSON, 8/22/88
1000
0
-1000
V 1
V 2
V 3
V 4
16
17
18
19
20
21
22
23
24
TIME



KEY: generator power 1818-1950

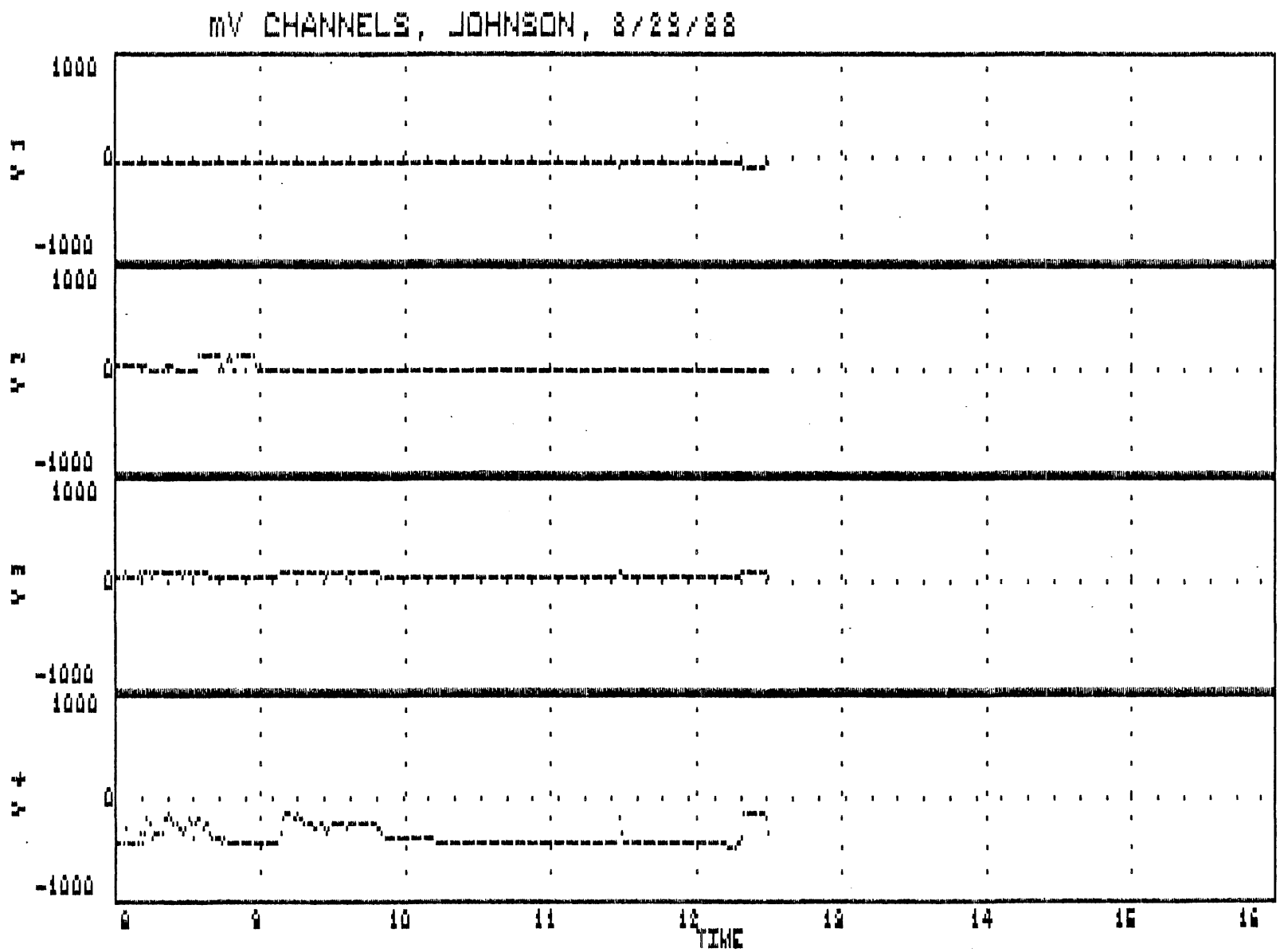
CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

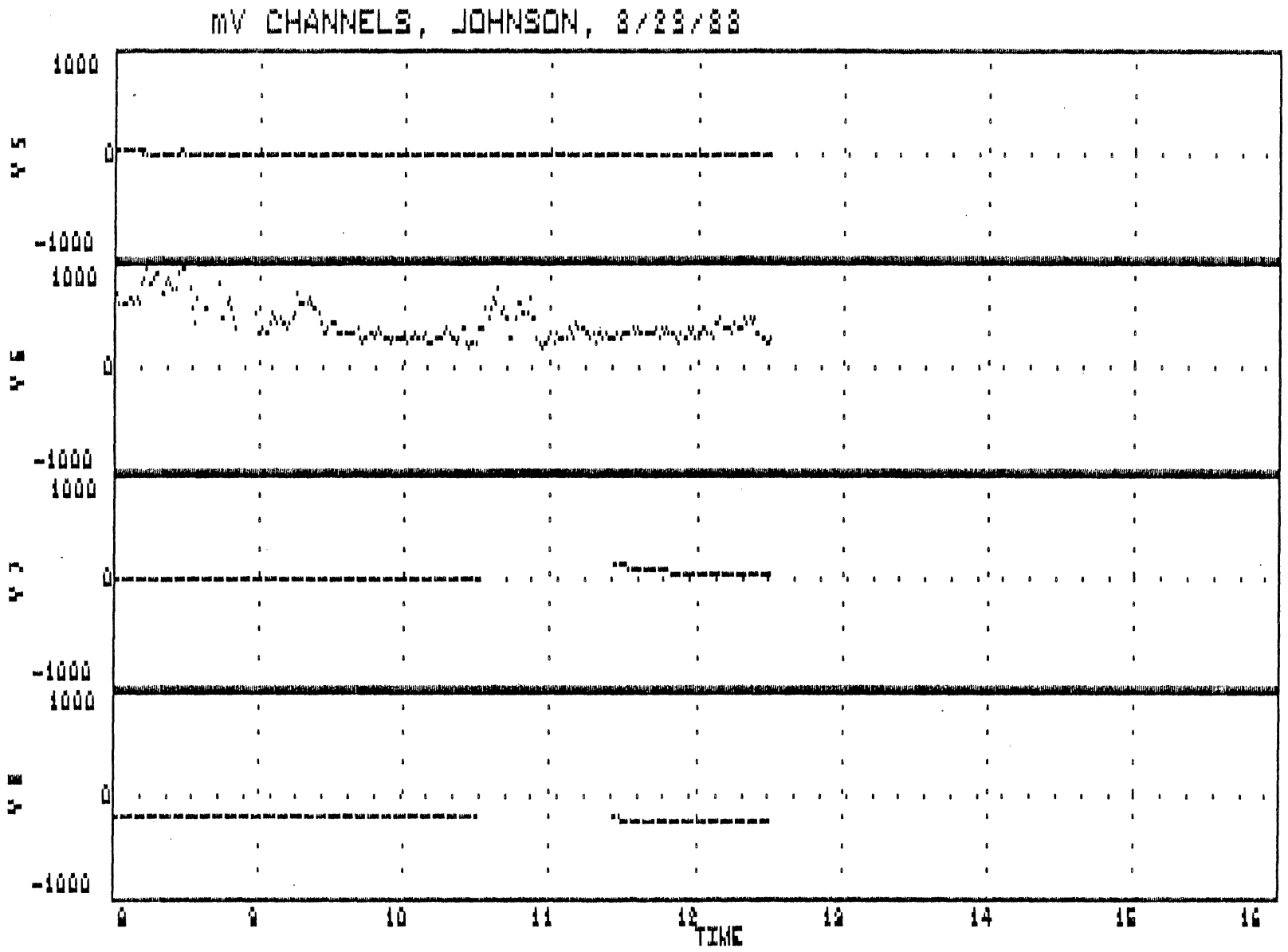

mV CHANNELS, JOHNSON, 8/23/88
1000
0
-1000
V 1
V 2
V 3
V 4
0
1
2
3
4
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	-
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A


mV CHANNELS, JOHNSON, 8/29/88
1000
0
-1000
E W
1000
0
-1000
N S
1000
0
-1000
V E
1000
0
-1000
V A
8
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	front block	rear block	V5	milkline ac/rms	front block on mat
V2	neutral ac/rms	barn ground	V6	B field (ac)	--
V3	waterline	front block	V7	reference rod B	reference rod A
V4	front block	stanchion	V8	Blackburn ground	reference rod A

Johnson Primary Data - General Observations

DC Millivolt Variables:
1. Front Contact Block to Rear Contact Block (both on mat): Simulates dc step potential across cow. This measurement was generally steady but slightly variable on occasion, ranging between -23 and -75 mV (90%tile and 10%tile).
2. Waterline to contact block on mat: This measurement was steady to slightly variable, ranging between about 100 to about 200 mV.
3. Waterline to contact block on concrete under mat: The measurement was uniformly steady within a range of 260 to 90 mV (90-10%tile).
4. Contact block on concrete under mat to stanchion: This measurement was the most variable of the dc potentials measured. The pattern of variation could be characterized as "occasionally variable between upper and lower bounds with no apparent correlation to events". The range was -170 to -511 mV (90-10%tile).
5. Milkline to contact block on mat: This potential varied smoothly between about 100 and 200 mV.
6. Remote reference rod A to remote reference rod B: This dc potential was relatively steady, ranging between 75 and -17 mV (90-10%tile).
7. Blackburn ground to remote reference rod A: Steady, range was -160 to -243 mV (90-10%tile).

AC (true RMS) Millivolt Variables:
1. Outlet neutral to barn ground: This stray voltage measurement was effectively zero except for a very occasional, brief, and unexplained excursion to about 200 mV. (The Blackburn system seemed to work well).
2. Milkline to contact block on mat: This ac potential ranged from about 0 to about 100 or 200 mV ac in a smoothly varying manner.

DC Electric field: Extensive efforts were made to detect a dc electric field in the center isle of this barn. Under most conditions, no field was detectable (<1 V/m). On occasion, however, the field mill responded to dust blowing through the barn during silo unloading.

AC Magnetic field: This measurement indicated the presence of an ac magnetic field which varied in a complicated manner (much more so that at the Borgerding farm). It is suggested that this variable be looked at more closely in any subsequent analysis of this data base. No attempt is justifiable here based on a mere visual interpretation of strip chart graphs.

No systematic anomalies were noted in the primary data base with regard to milking activities.

No identifiable shifts in any of the readings in the primary data base were noticed in response to switching to generator power (or back to line power).

Shifts in measurement levels were noted when the Blackburn system was turned off and then back on later. These shifts were in the following variables:

1. DC mV, waterline to contact block on concrete.
2. AC mV, milkline to contact block on mat.
3. DC mV, remote reference rods A to B.
4. DC mV, Blackburn ground to remote reference rod A.

These shifts were small but consistently present at on/off times.

Weather variables: The following table presents the distribution of weather variables over the Borgerding monitoring period.

Variable	90%tile	50%tile	10%tile
Temp(degF)	83	69	60
Bar Pres	29.9	29.8	29.7
Wind(mph)	7	3	0
Rel Hum	90	74	59

UMM

PRIMARY

DATA

FILE

8/26/88 to 9/6/88

----------NCSS Editor----------

Data Base Name C:\EMD\UMM

No.	Variable	Rows	Vlab	Label
1	DATE	35		
2	TIM	35		
3	V1	35		CH#1 (mV)
4	V2	35		CH#2 (mV)
5	V3	35		CH#3 (mV)
6	V4	35		CH#4 (mV)
7	V5	35		CH#5 (mV)
8	V6	35		CH#6 (mV)
9	V7	35		CH#7 (mV)
10	V8	35		CH#8 (mV)
11	T	35		TEMPERATURE (deg C)
12	BP	35		BAROMETRIC PRESSURE (in.H2O)
13	WD	35		WIND DIRECTION (deg)
14	WS	35		WIND SPEED (mph)
15	P	35		PRECIPITATION TOTAL (in.)
16	RH	35		RELATIVE HUMIDITY (%)
17	TIME	0		DECIMAL TIME
18	C18	0		
19	C19	0		
20	C20	0		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

Detail Report

Variable: V1	CH#1 (mV)		
Mean - Average	-243.1	No. observations	14904
Lower 95% c.i.limit	-269.4583	No. missing values	5572
Upper 95% c.i.limit	-216.7416	Sum of frequencies	9332
Adj sum of squares	1.574868E+10	Sum of observations	-2268609
Standard deviation	1299.146	Std.error of mean	13.4484
Variance	1687780	T-value for mean=0	-18.0765
Coef. of variation	-5.344081	T prob level	0.0000
Skewness	-2.470117	Kurtosis	8.014555
Normality Test Value	0.507	Reject if > 0.993(10%)	0.992(5%)
100-%tile (Maximum)	4095	90-%tile	287
75-%tile	147	10-%tile	-63
50-%tile (Median)	-28	Range	9095
25-%tile	-53	75th-25th %tile	200
0-%tile (Minimum)	-5000		

Variable: V2	CH#2 (mV)		
Mean - Average	-36.29934	No. observations	14904
Lower 95% c.i.limit	-39.88942	No. missing values	1
Upper 95% c.i.limit	-32.70925	Sum of frequencies	14903
Adj sum of squares	7.451282E+08	Sum of observations	-540969
Standard deviation	223.611	Std.error of mean	1.831709
Variance	50001.89	T-value for mean=0	-19.8172
Coef. of variation	-6.160196	T prob level	0.0000
Skewness	-6.130953	Kurtosis	38.26276
Normality Test Value	0.774	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	83	90-%tile	43
75-%tile	25	10-%tile	-61
50-%tile (Median)	-3	Range	2350
25-%tile	-25	75th-25th %tile	50
0-%tile (Minimum)	-2267		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

Detail Report

Variable: V3 CH#3 (mV)

Mean - Average	92.41938	No. observations	14904
Lower 95% c.i.limit	89.86707	No. missing values	1
Upper 95% c.i.limit	94.9717	Sum of frequencies	14903
Adj sum of squares	3.766091E+08	Sum of observations	1377326
Standard deviation	158.9729	Std.error of mean	1.302226
Variance	25272.38	T-value for mean=0	70.97032
Coef. of variation	1.720125	T prob level	0.0000
Skewness	8.296198E-02	Kurtosis	20.27606
Normality Test Value	0.620	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	1984	90-%tile	163
75-%tile	155	10-%tile	14
50-%tile (Median)	139	Range	2397
25-%tile	91	75th-25th %tile	64
0-%tile (Minimum)	-413		

Variable: V4 CH#4 (mV)

Mean - Average	495.8518	No. observations	14904
Lower 95% c.i.limit	493.2058	No. missing values	1
Upper 95% c.i.limit	498.4978	Sum of frequencies	14903
Adj sum of squares	4.047646E+08	Sum of observations	7389680
Standard deviation	164.8083	Std.error of mean	1.350026
Variance	27161.76	T-value for mean=0	367.2906
Coef. of variation	.332374	T prob level	0.0000
Skewness	-2.78471	Kurtosis	11.34992
Normality Test Value	0.793	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	1586	90-%tile	562
75-%tile	556	10-%tile	488
50-%tile (Median)	542	Range	2914
25-%tile	529	75th-25th %tile	27
0-%tile (Minimum)	-1328		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

Detail Report

Variable: V5	CH#5 (mV)		
Mean - Average	-12.1365	No. observations	14904
Lower 95% c.i.limit	-13.46715	No. missing values	552
Upper 95% c.i.limit	-10.80584	Sum of frequencies	14352
Adj sum of squares	9.493594E+07	Sum of observations	-174183
Standard deviation	81.3344	Std.error of mean	.6789191
Variance	6615.284	T-value for mean=0	-17.8762
Coef. of variation	-6.701637	T prob level	0.0000
Skewness	-10.81644	Kurtosis	247.6446
Normality Test Value	0.839	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	1762	90-%tile	12
75-%tile	10	10-%tile	-62
50-%tile (Median)	6	Range	3599
25-%tile	-33	75th-25th %tile	43
0-%tile (Minimum)	-1837		

Variable: V6	CH#6 (mV)		
Mean - Average	273.7692	No. observations	14904
Lower 95% c.i.limit	269.4161	No. missing values	1
Upper 95% c.i.limit	278.1223	Sum of frequencies	14903
Adj sum of squares	1.095528E+09	Sum of observations	4079982
Standard deviation	271.1374	Std.error of mean	2.22102
Variance	73515.48	T-value for mean=0	123.2628
Coef. of variation	.9903868	T prob level	0.0000
Skewness	-2.159607	Kurtosis	10.21813
Normality Test Value	0.586	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	644	90-%tile	521
75-%tile	453	10-%tile	8
50-%tile (Median)	418	Range	3066
25-%tile	31	75th-25th %tile	422
0-%tile (Minimum)	-2422		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

Detail Report

Detail Report

Variable: V7	CH#7 (mV)		
Mean - Average	-17.26706	No. observations	14904
Lower 95% c.i.limit	-21.76265	No. missing values	1
Upper 95% c.i.limit	-12.77147	Sum of frequencies	14903
Adj sum of squares	1.168409E+09	Sum of observations	-257331
Standard deviation	280.011	Std.error of mean	2.293709
Variance	78406.16	T-value for mean=0	-7.528009
Coef. of variation	-16.21648	T prob level	0.0000
Skewness	-2.784755	Kurtosis	10.79125
Normality Test Value	0.804	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	1993	90-%tile	109
75-%tile	83	10-%tile	-43
50-%tile (Median)	36	Range	3246
25-%tile	-2	75th-25th %tile	85
0-%tile (Minimum)	-1253		

Variable: V8	CH#8 (mV)		
Mean - Average	57.89409	No. observations	14904
Lower 95% c.i.limit	55.90139	No. missing values	1015
Upper 95% c.i.limit	59.88679	Sum of frequencies	13889
Adj sum of squares	1.993878E+08	Sum of observations	804091
Standard deviation	119.82	Std.error of mean	1.016703
Variance	14356.84	T-value for mean=0	56.94299
Coef. of variation	2.069642	T prob level	0.0000
Skewness	5.109088	Kurtosis	67.64314
Normality Test Value	0.592	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	2652	90-%tile	118
75-%tile	103	10-%tile	-87
50-%tile (Median)	81	Range	4325
25-%tile	16	75th-25th %tile	87
0-%tile (Minimum)	-1673		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

Detail Report

Variable: T TEMPERATURE (deg C)

Mean - Average	61.38596	No. observations	14904
Lower 95% c.i.limit	61.20817	No. missing values	1
Upper 95% c.i.limit	61.56376	Sum of frequencies	14903
Adj sum of squares	1827458	Sum of observations	914835
Standard deviation	11.07392	Std.error of mean	9.071197E-02
Variance	122.6317	T-value for mean=0	676.713
Coef. of variation	.1803983	T prob level	0.0000
Skewness	.2239632	Kurtosis	-.8166021
Normality Test Value	0.921	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	87	90-%tile	77
75-%tile	70	10-%tile	47
50-%tile (Median)	61	Range	47
25-%tile	53	75th-25th %tile	17
0-%tile (Minimum)	40		

Variable: BP BAROMETRIC PRESSURE (in.H20)

Mean - Average	29.98157	No. observations	14904
Lower 95% c.i.limit	29.97979	No. missing values	1
Upper 95% c.i.limit	29.98335	Sum of frequencies	14903
Adj sum of squares	184.058	Sum of observations	446815.3
Standard deviation	.1111361	Std.error of mean	9.103706E-04
Variance	1.235123E-02	T-value for mean=0	32933.37
Coef. of variation	3.706813E-03	T prob level	0.0000
Skewness	-.5447387	Kurtosis	-.593025
Normality Test Value	0.951	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	30.2	90-%tile	30.11
75-%tile	30.07	10-%tile	29.81
50-%tile (Median)	29.99	Range	.5400009
25-%tile	29.92	75th-25th %tile	.1499996
0-%tile (Minimum)	29.66		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

Detail Report

Variable: WD	WIND DIRECTION (deg)		
Mean - Average	151.7782	No. observations	14904
Lower 95% c.i.limit	150.3601	No. missing values	1
Upper 95% c.i.limit	153.1962	Sum of frequencies	14903
Adj sum of squares	1.162513E+08	Sum of observations	2261950
Standard deviation	88.32356	Std.error of mean	.723502
Variance	7801.052	T-value for mean=0	209.7827
Coef. of variation	.5819254	T prob level	0.0000
Skewness	.399272	Kurtosis	-1.039755
Normality Test Value	0.926	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	360	90-%tile	280
75-%tile	240	10-%tile	50
50-%tile (Median)	130	Range	350
25-%tile	90	75th-25th %tile	150
0-%tile (Minimum)	10		

Variable: WS	WIND SPEED (mph)		
Mean - Average	2.016641	No. observations	14904
Lower 95% c.i.limit	1.968202	No. missing values	1
Upper 95% c.i.limit	2.06508	Sum of frequencies	14903
Adj sum of squares	135647.9	Sum of observations	30054
Standard deviation	3.017062	Std.error of mean	2.471425E-02
Variance	9.102662	T-value for mean=0	81.59832
Coef. of variation	1.496083	T prob level	0.0000
Skewness	2.292192	Kurtosis	6.201446
Normality Test Value	0.829	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	23	90-%tile	6
75-%tile	2	10-%tile	0
50-%tile (Median)	1	Range	23
25-%tile	0	75th-25th %tile	2
0-%tile (Minimum)	0		

----------Descriptive Statistics----------

Data Base Name C:\EMD\UMM

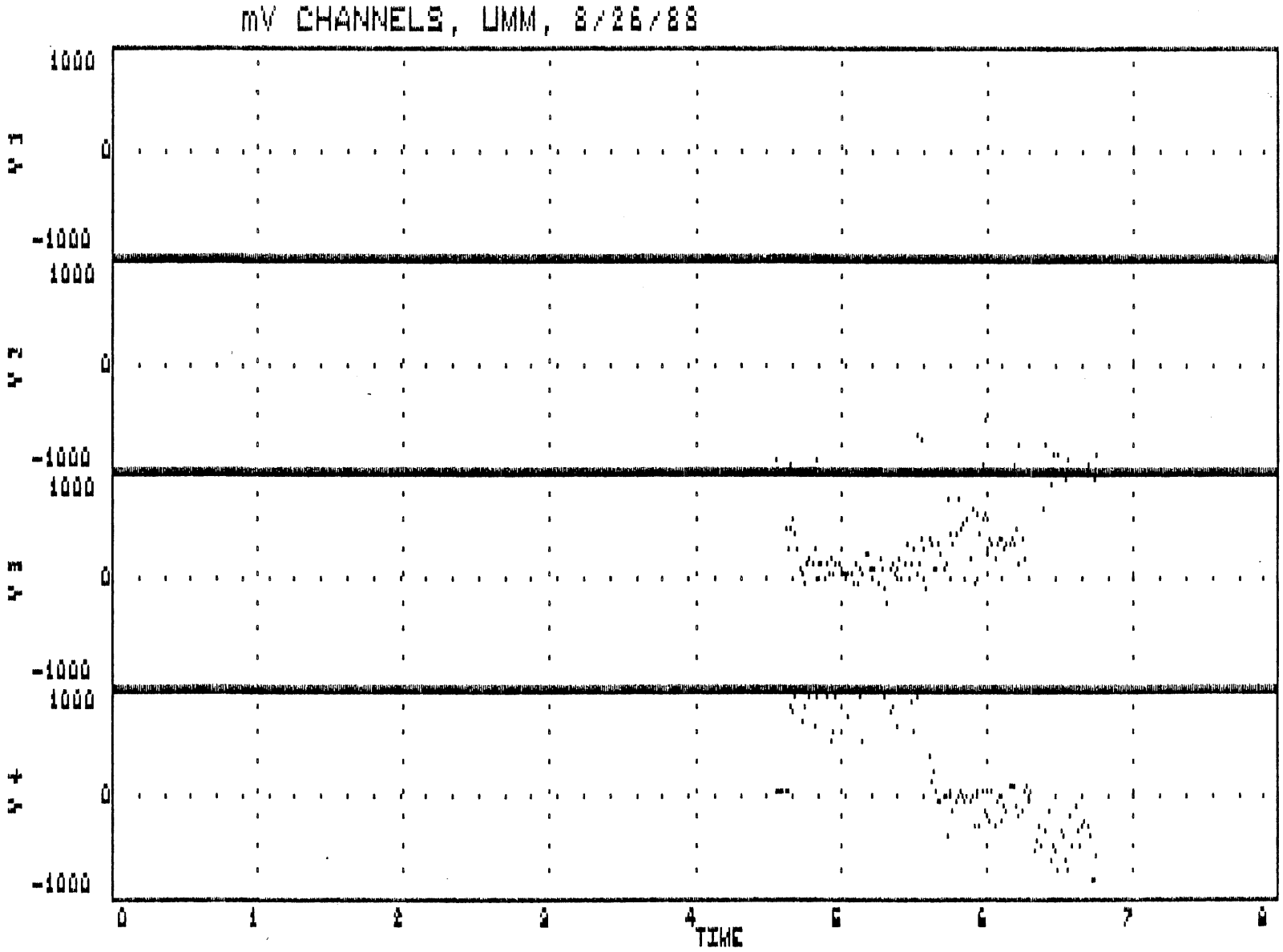
Detail Report

Variable: P PRECIPITATION TOTAL (in.)

Mean - Average	1.354157E-02	No. observations	14904
Lower 95% c.i.limit	1.310898E-02	No. missing values	1
Upper 95% c.i.limit	1.397415E-02	Sum of frequencies	14903
Adj sum of squares	10.81848	Sum of observations	201.81
Standard deviation	2.694392E-02	Std.error of mean	2.20711E-04
Variance	7.259748E-04	T-value for mean=0	61.35431
Coef. of variation	1.989719	T prob level	0.0000
Skewness	1.887024	Kurtosis	2.0742
100-%tile (Maximum)	.09	90-%tile	.08
75-%tile	.02	10-%tile	0
50-%tile (Median)	0	Range	.09
25-%tile	0	75th-25th %tile	.02
0-%tile (Minimum)	0		

Variable: RH RELATIVE HUMIDITY (%)

Mean - Average	54.75602	No. observations	14904
Lower 95% c.i.limit	54.46569	No. missing values	1
Upper 95% c.i.limit	55.04635	Sum of frequencies	14903
Adj sum of squares	4873101	Sum of observations	816029
Standard deviation	18.08341	Std.error of mean	.1481302
Variance	327.0099	T-value for mean=0	369.648
Coef. of variation	.3302544	T prob level	0.0000
Skewness	-.230644	Kurtosis	-.9413474
Normality Test Value	0.924	Reject if > 0.993(10%)	0.991(5%)
100-%tile (Maximum)	90	90-%tile	78
75-%tile	68	10-%tile	27
50-%tile (Median)	58	Range	72
25-%tile	41	75th-25th %tile	27
0-%tile (Minimum)	18		


mV CHANNELS, UMM, 8/26/88
1000
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-1000
V1
V2
V3
V4
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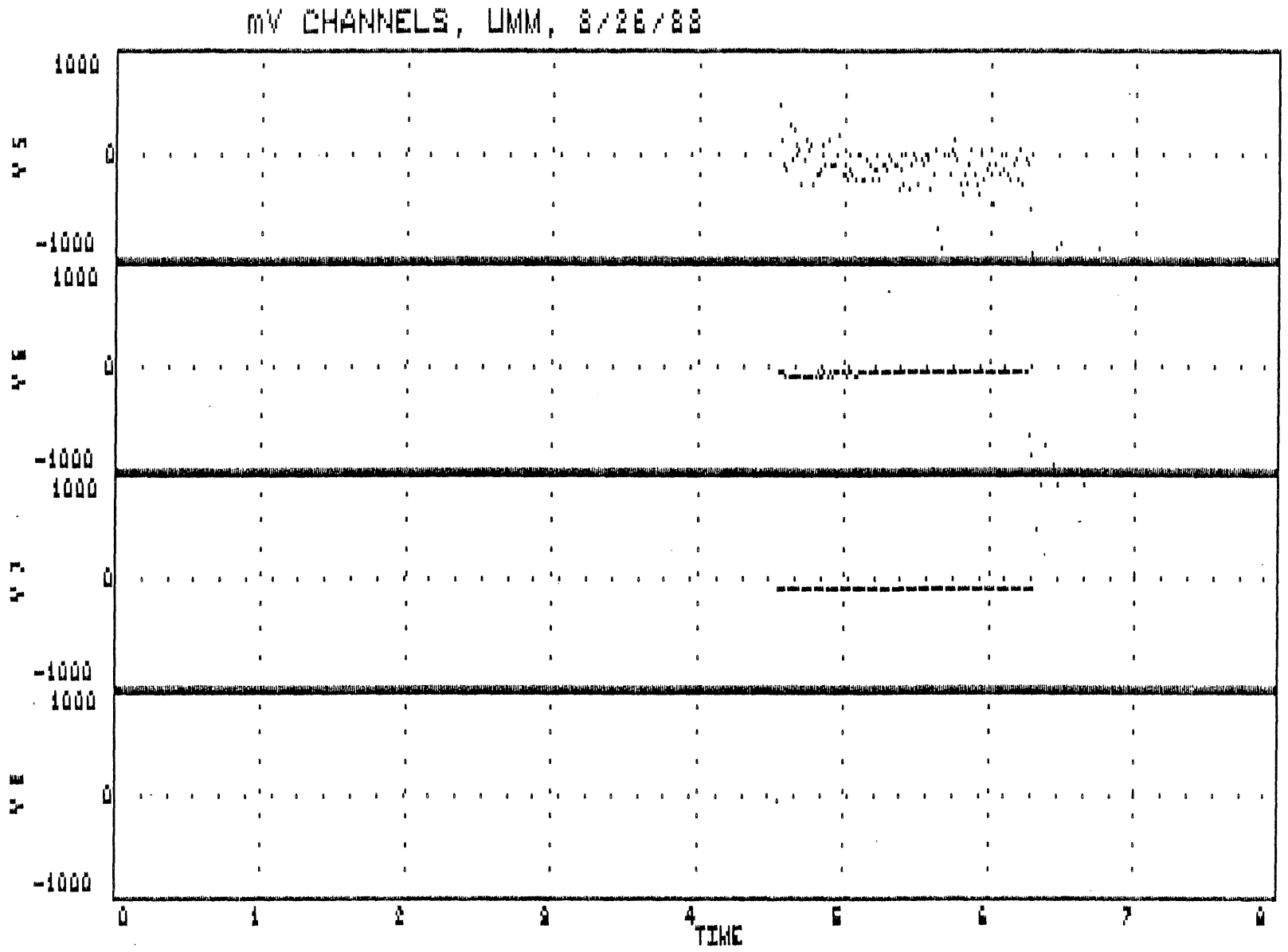
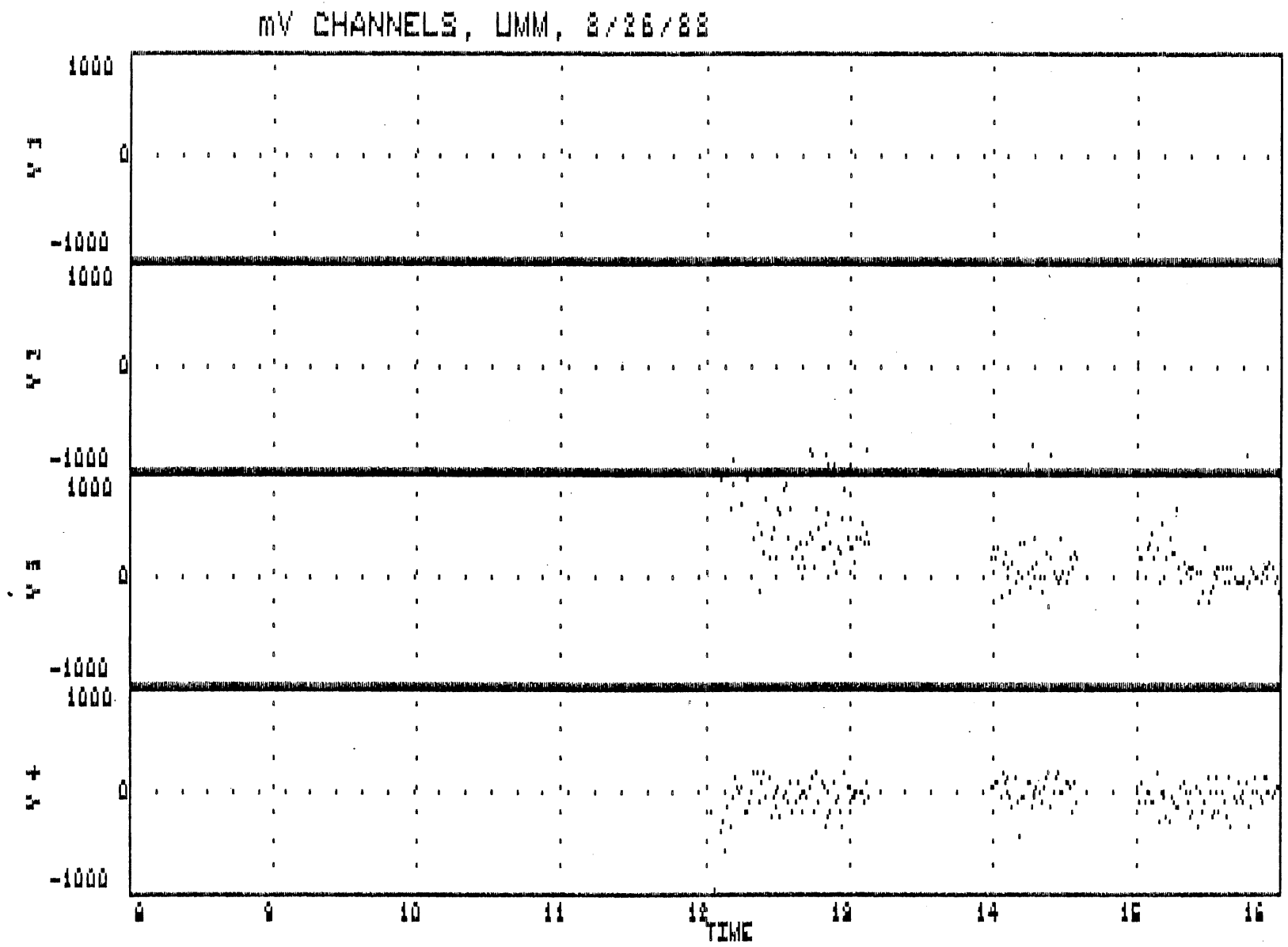
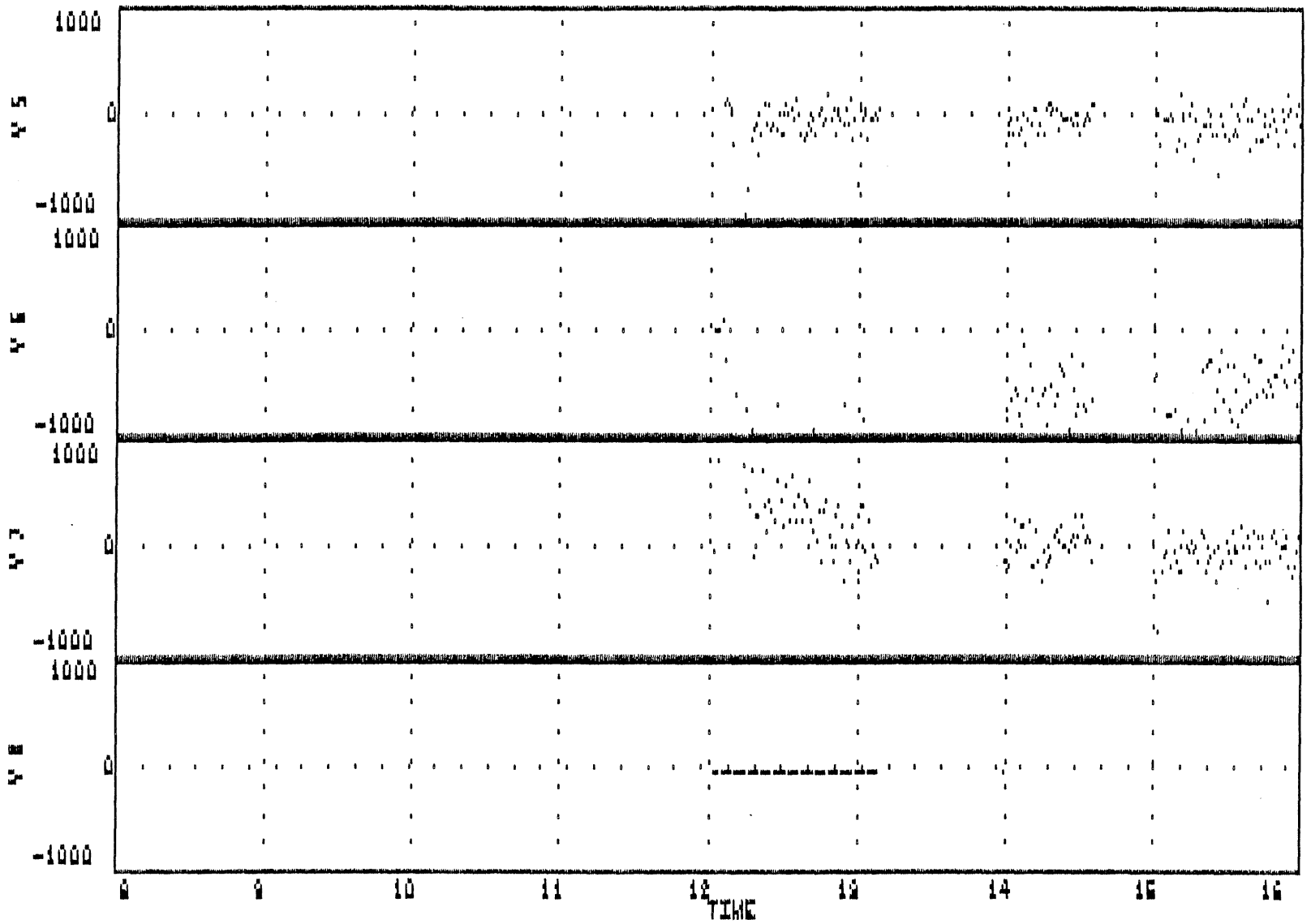
1
2
3
4
5
6
7
8
TIME



KEY

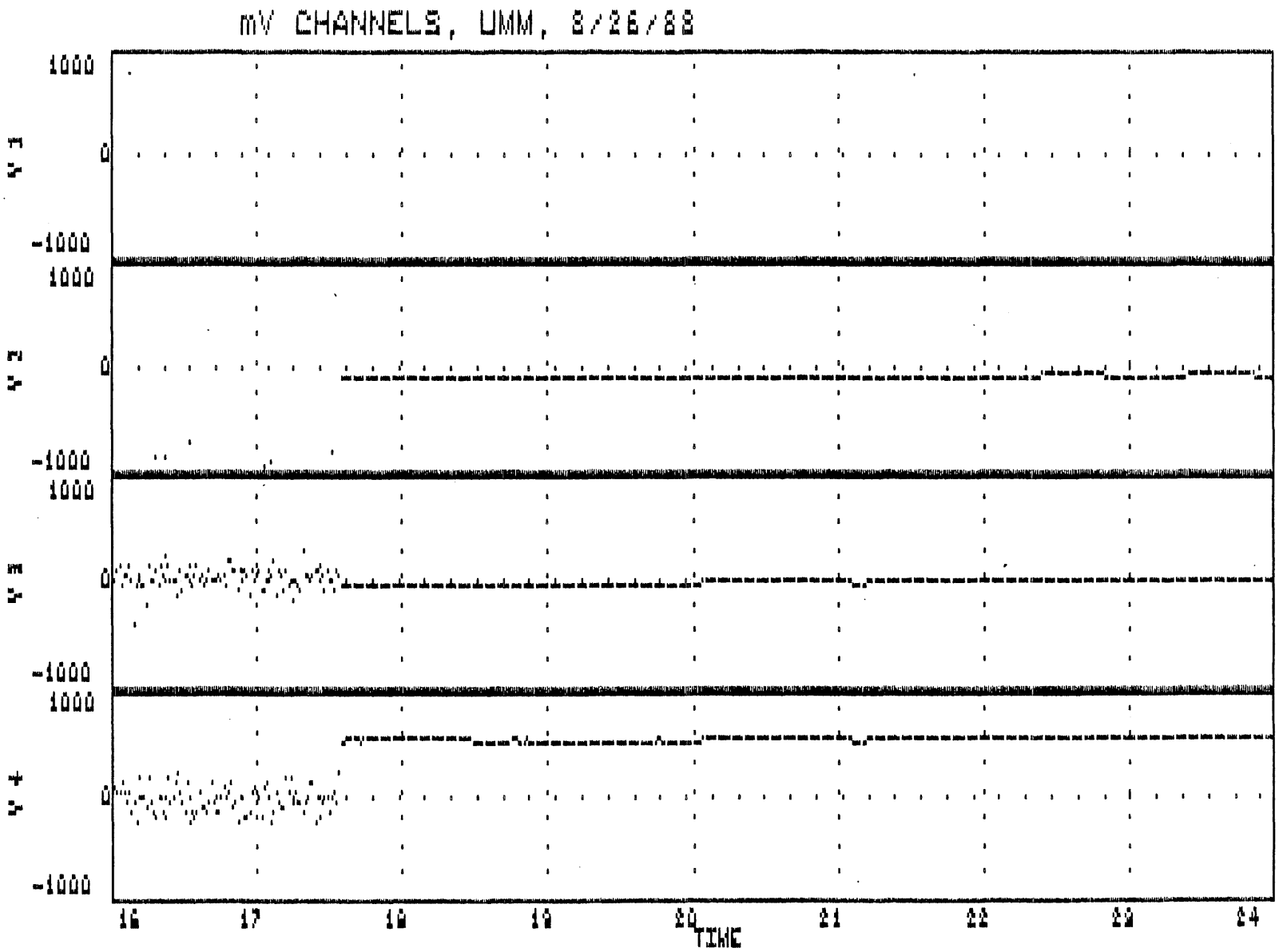
CHAN	HI	LO	CHAN	HI	LO
V1			V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8		


mV CHANNELS, UMM, 8/26/88
1000
0
-1000
E W
N S
TIME
8
9
10
11
12
13
14
15
16



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8		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1000
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-1000
mV 1
mV 2
mV 3
mV 4
16
17
18
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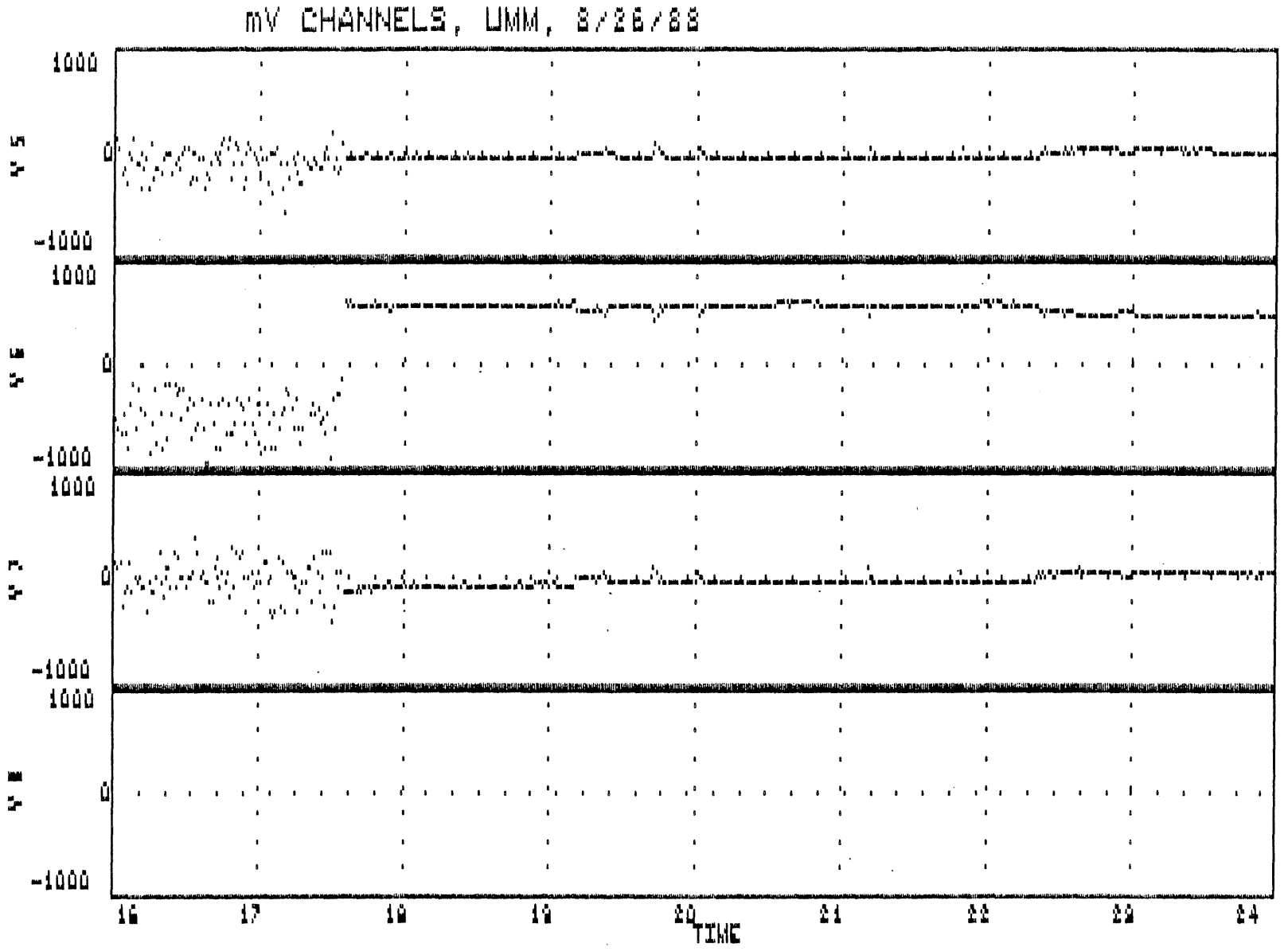
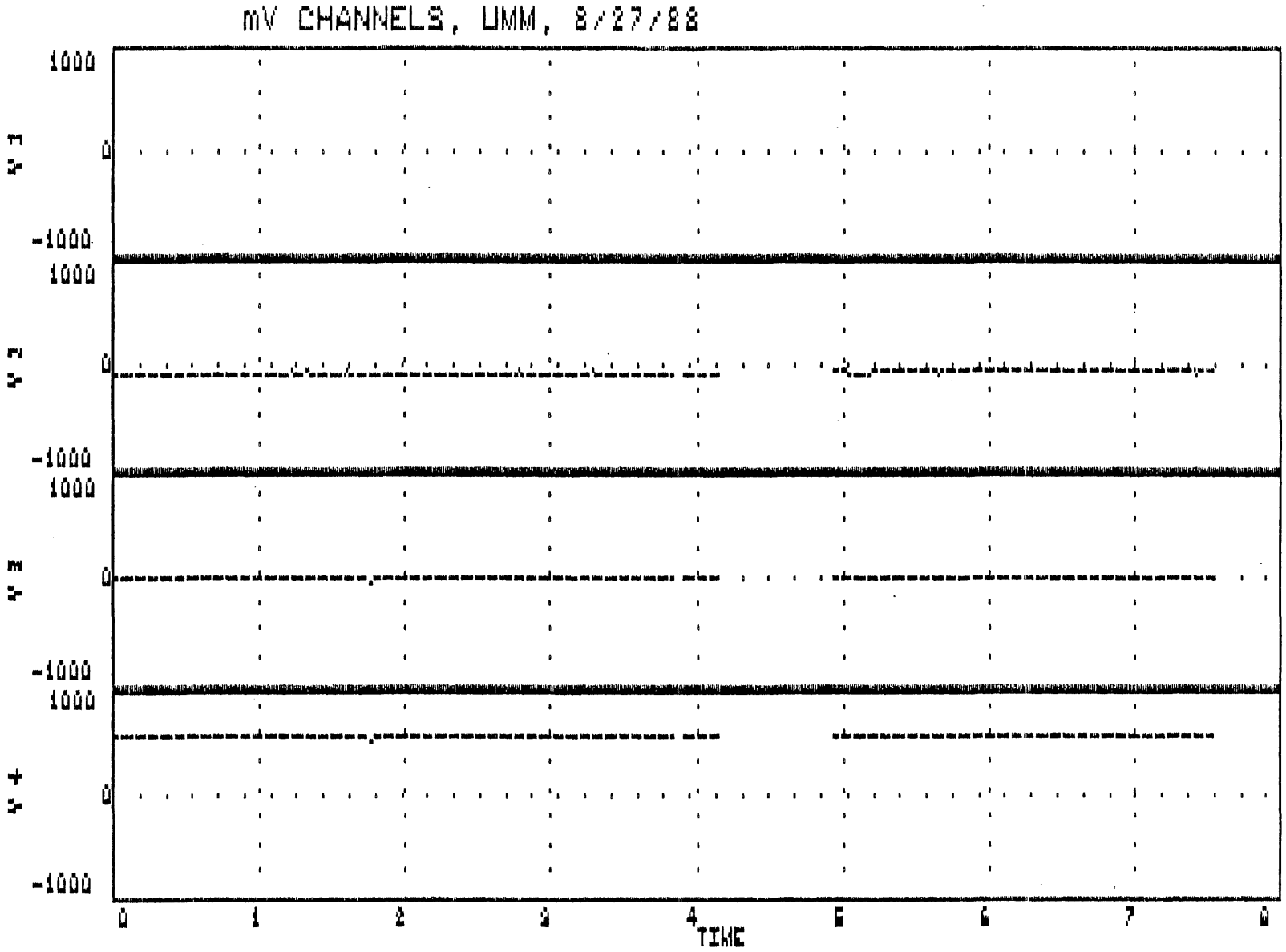
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8		


mV CHANNELS, UMM, 8/27/88
1000
0
-1000
Y 1
Y 2
Y 3
Y 4
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1
2
3
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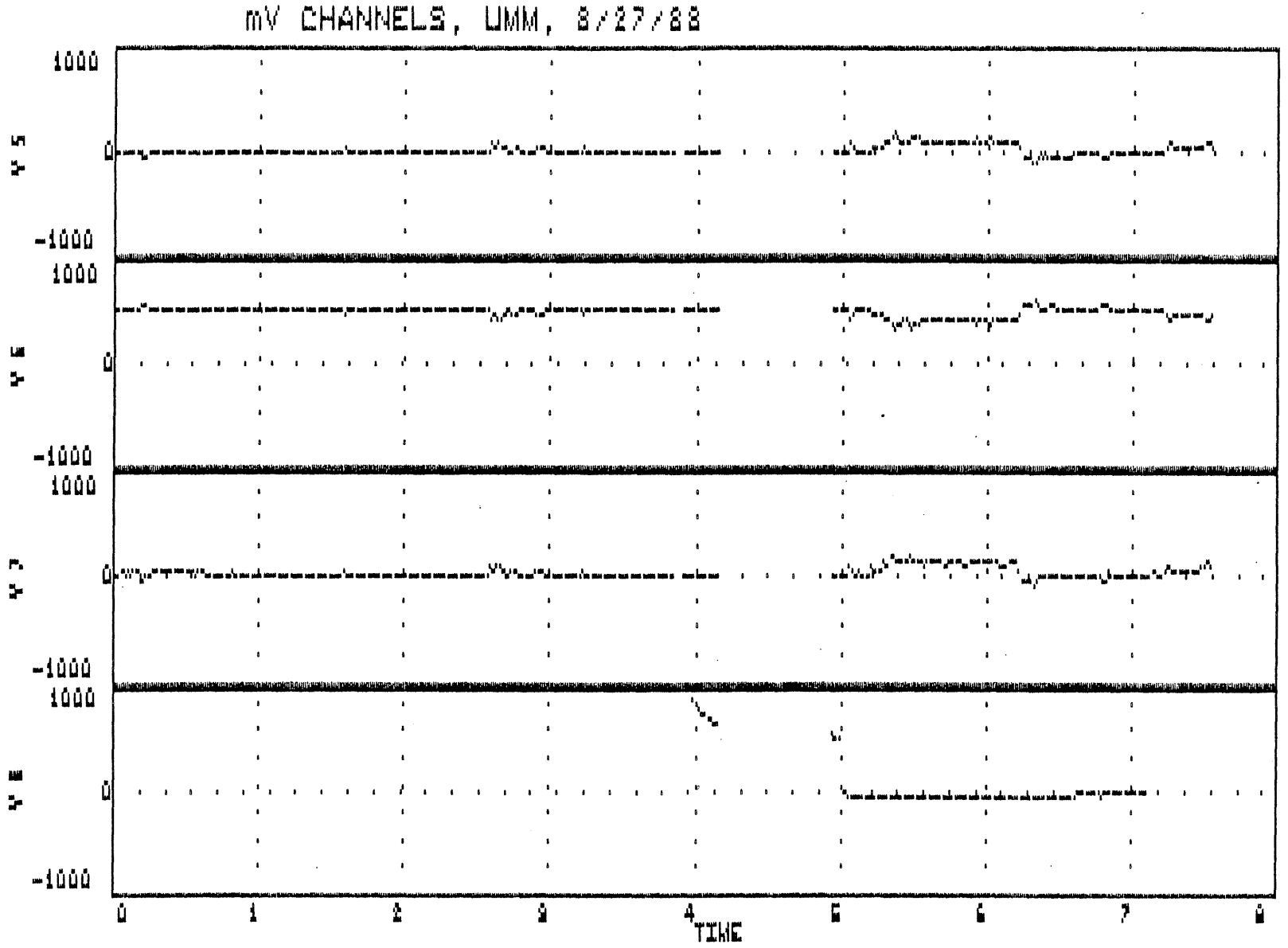
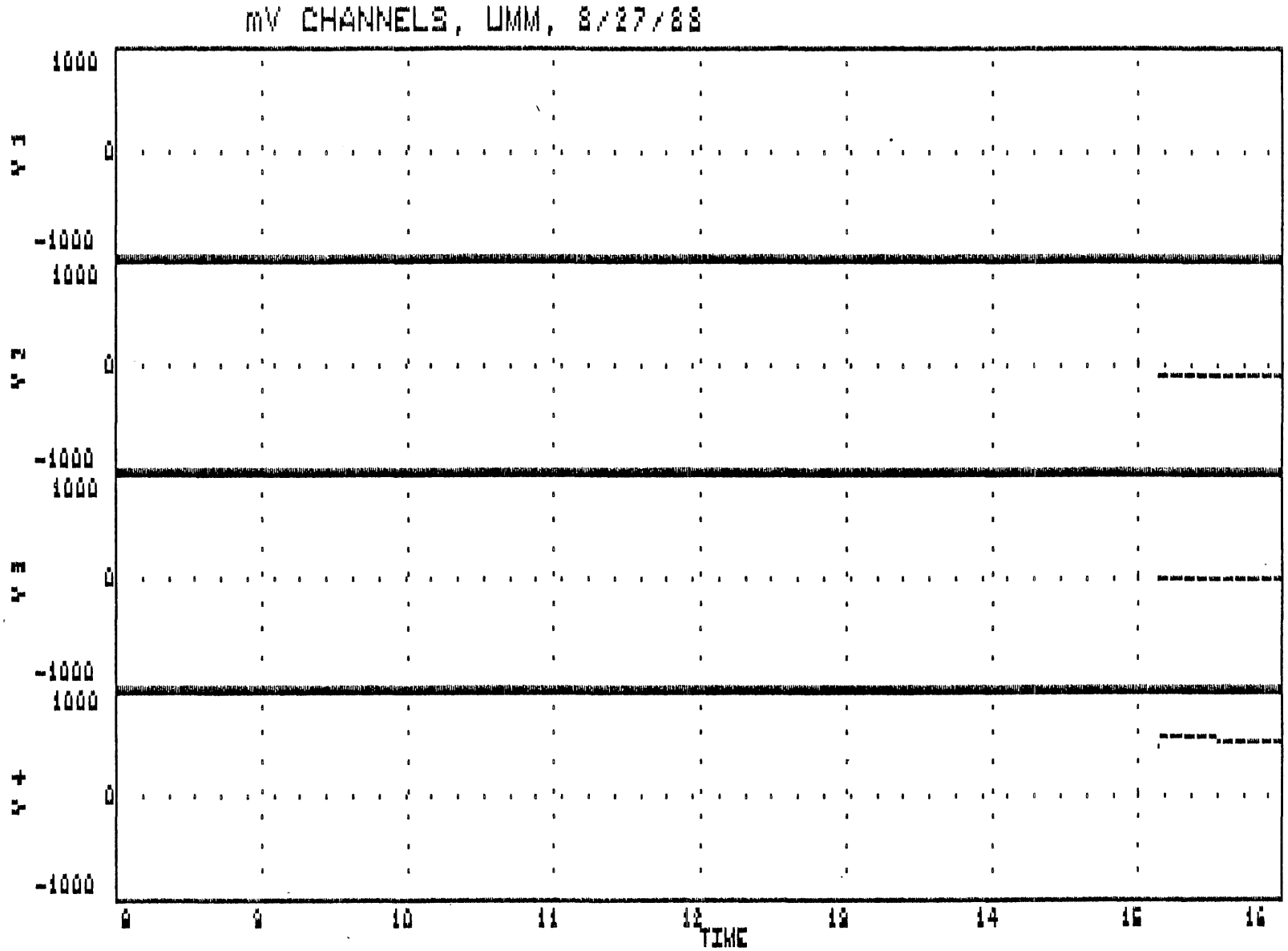
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/27/88
1000
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-1000
E-W
N-S
TIME
8
9
10
11
12
13
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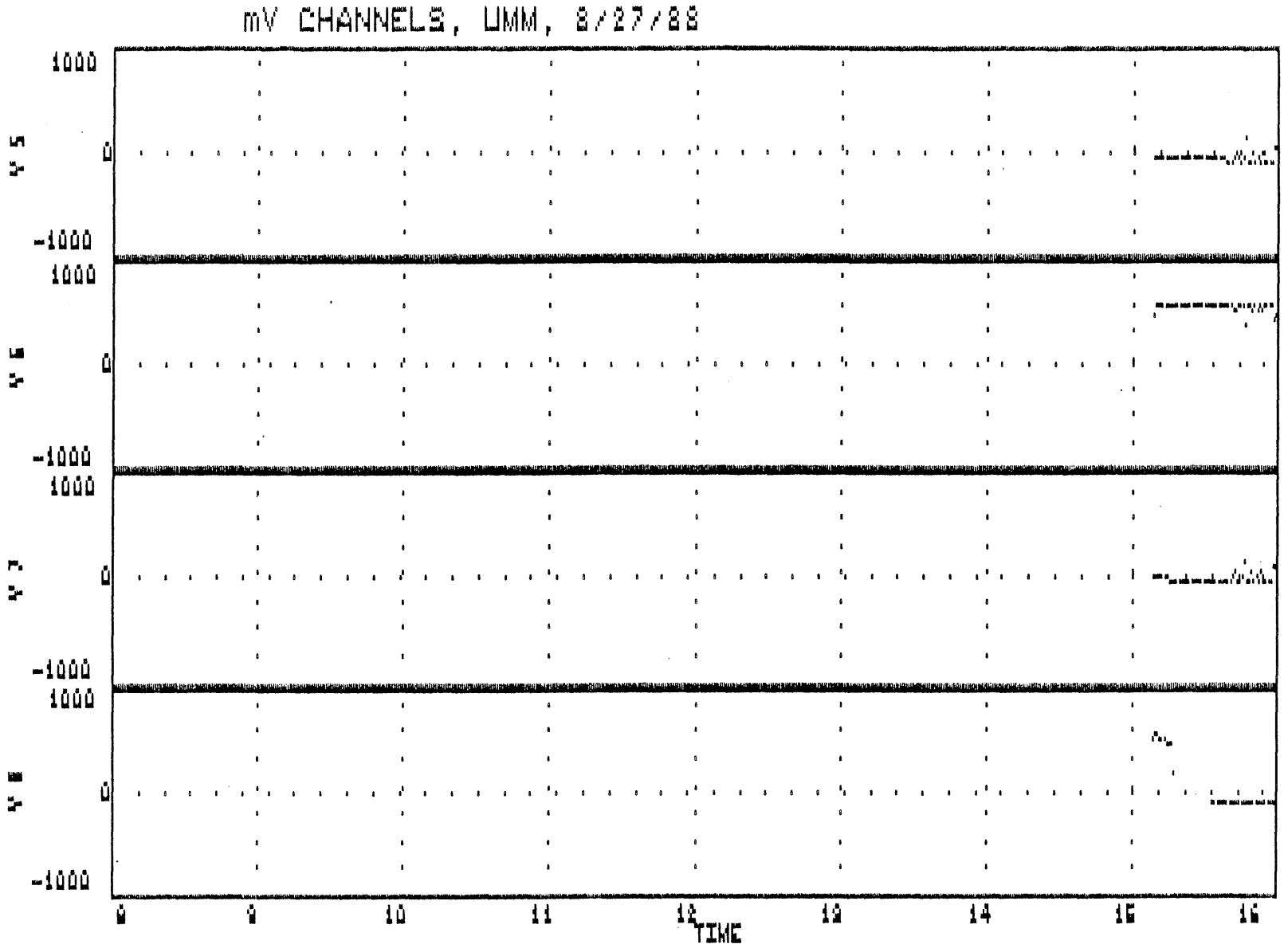
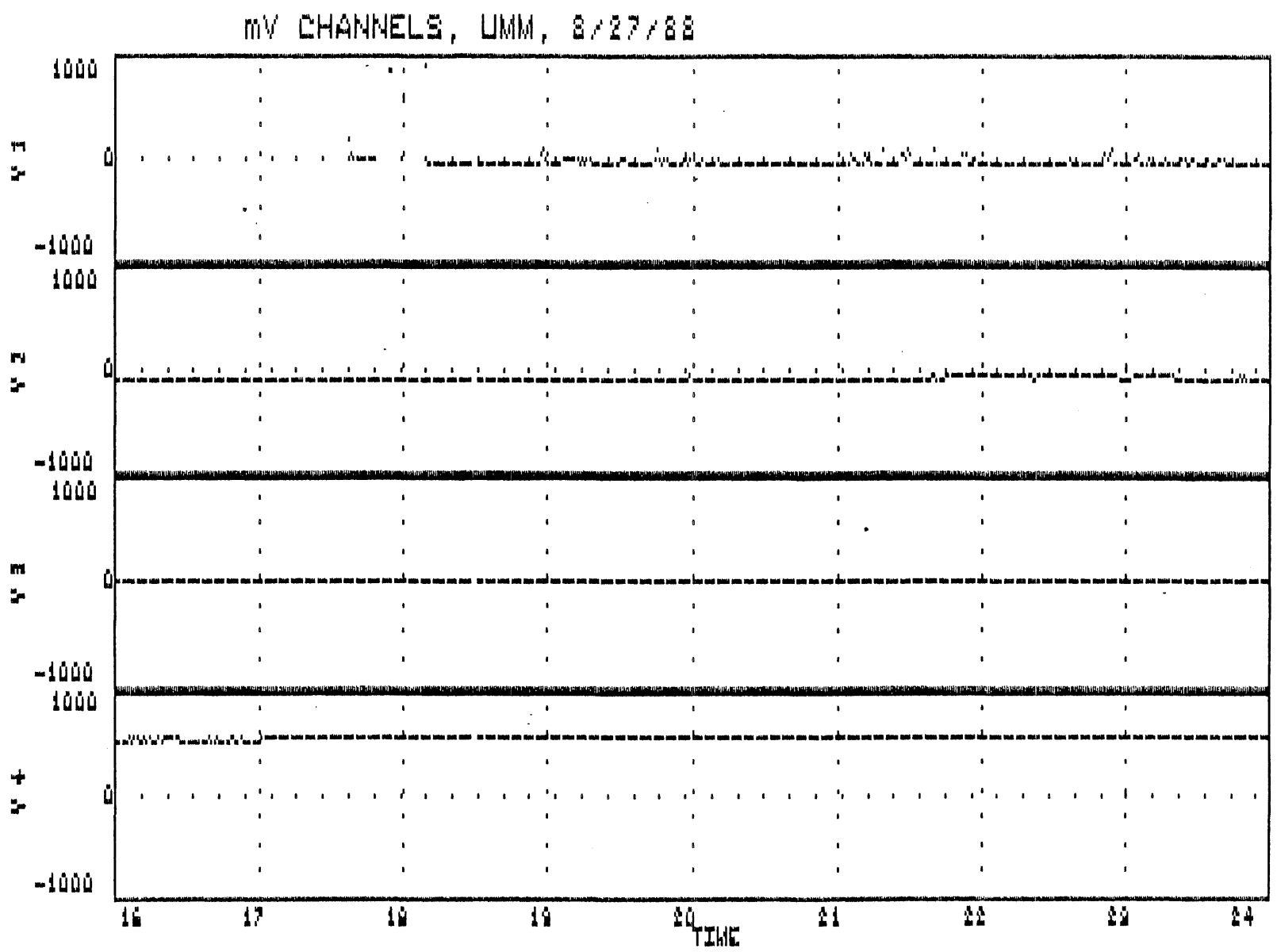
15
16



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/27/88
E-W
N-S
E-S
+-S
1000
0
-1000
16
17
18
19
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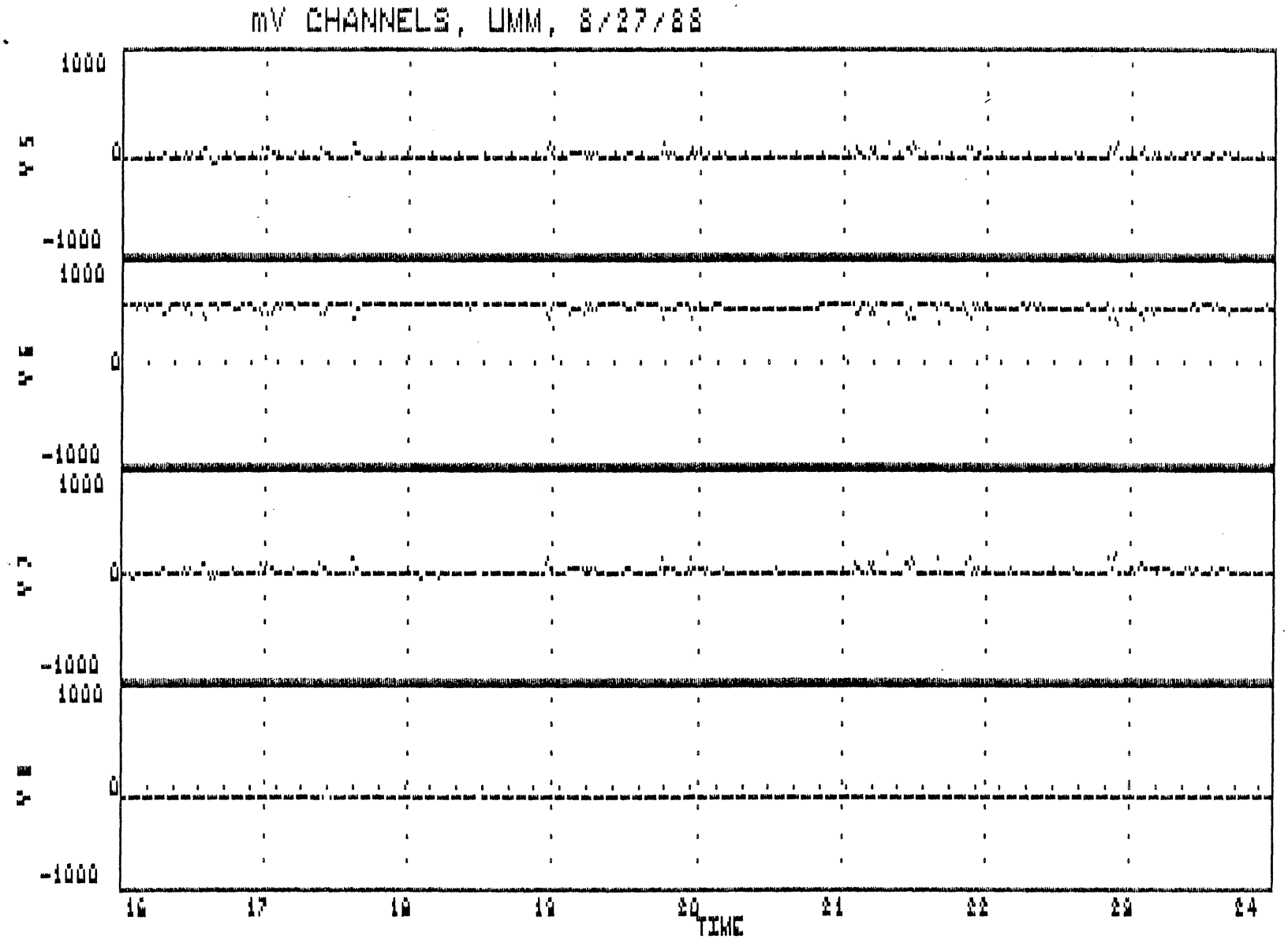
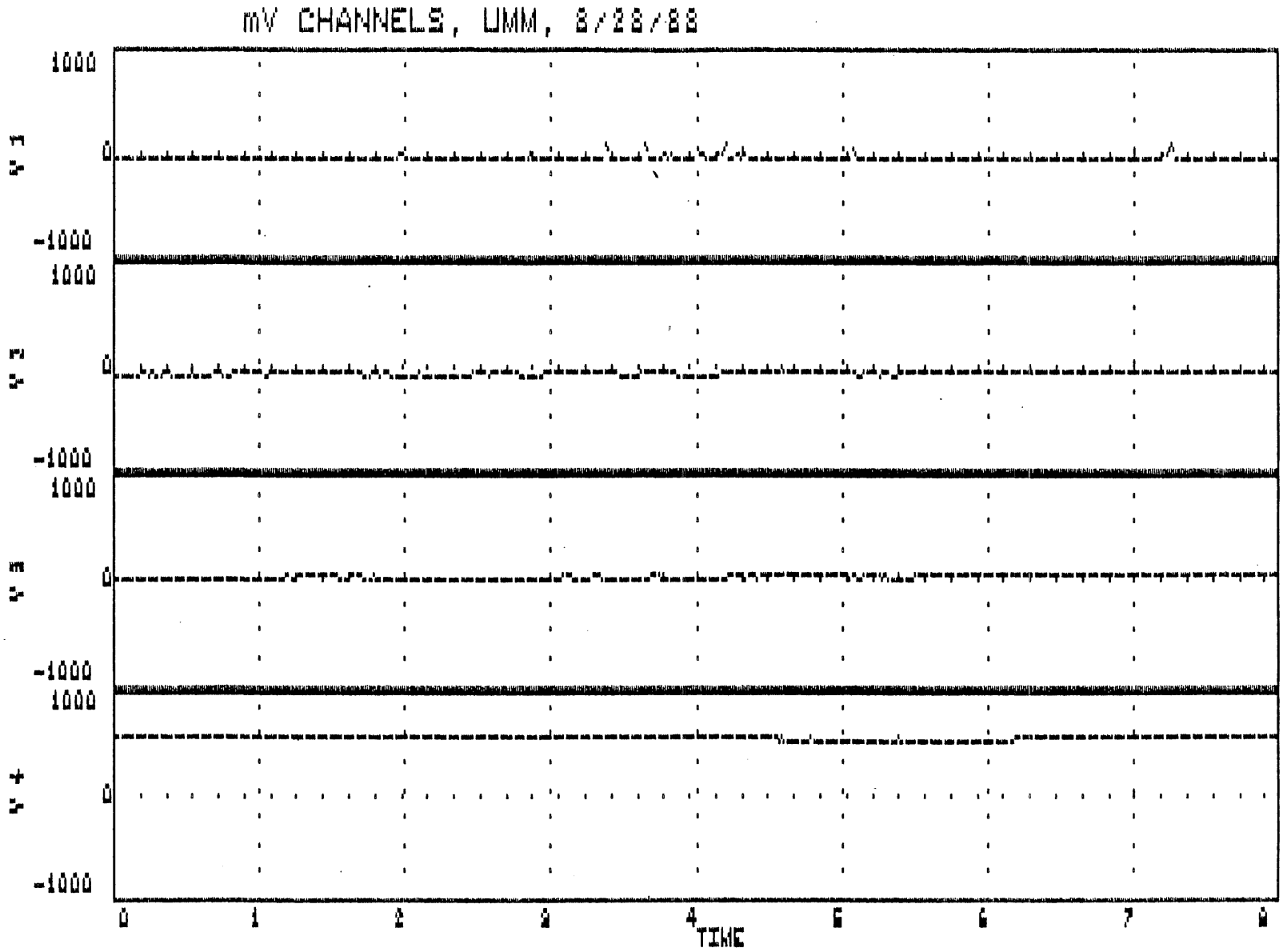
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/28/88
1000
0
-1000
E-W
1000
0
-1000
N-S
1000
0
-1000
+V
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-1000
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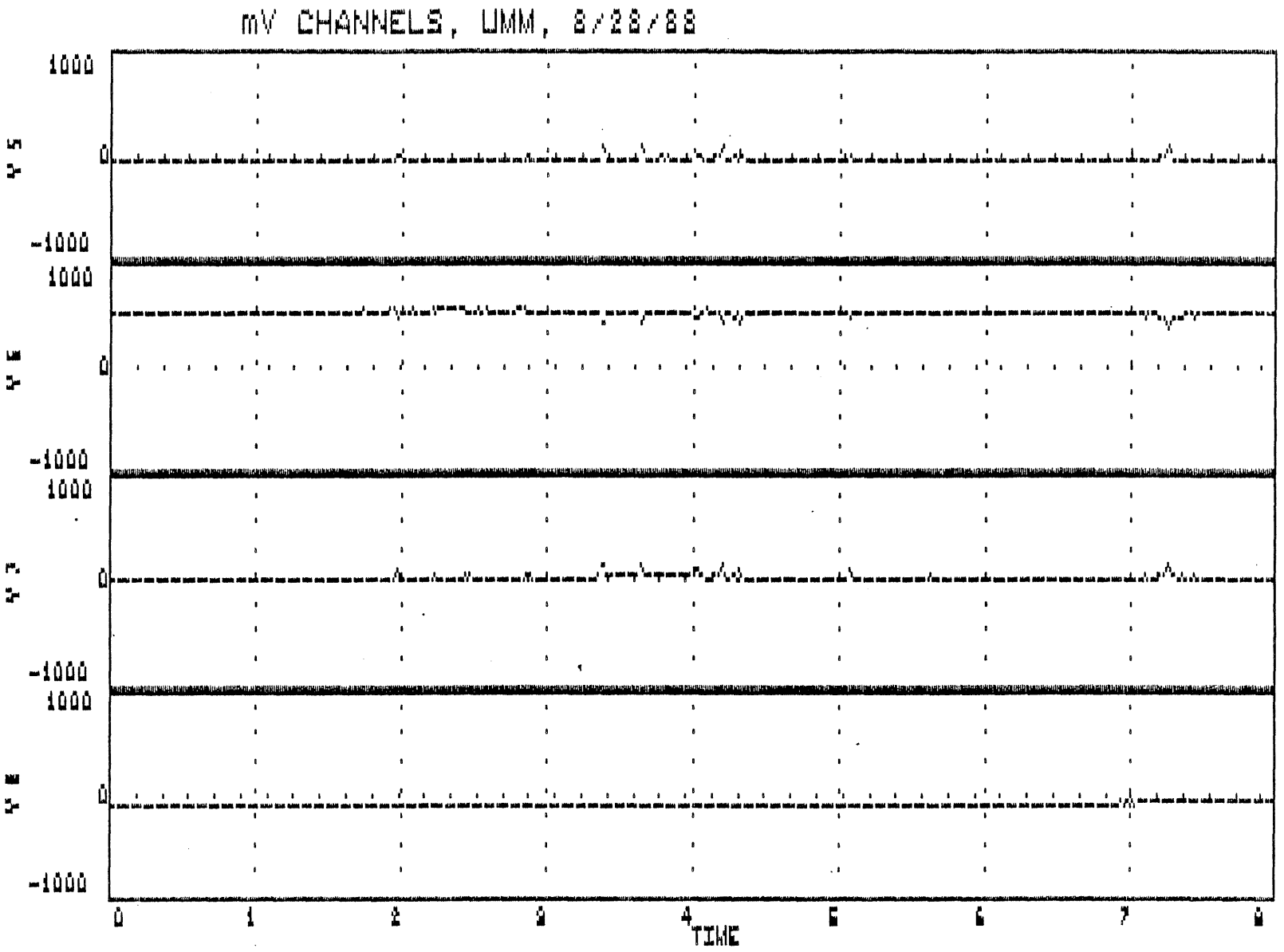
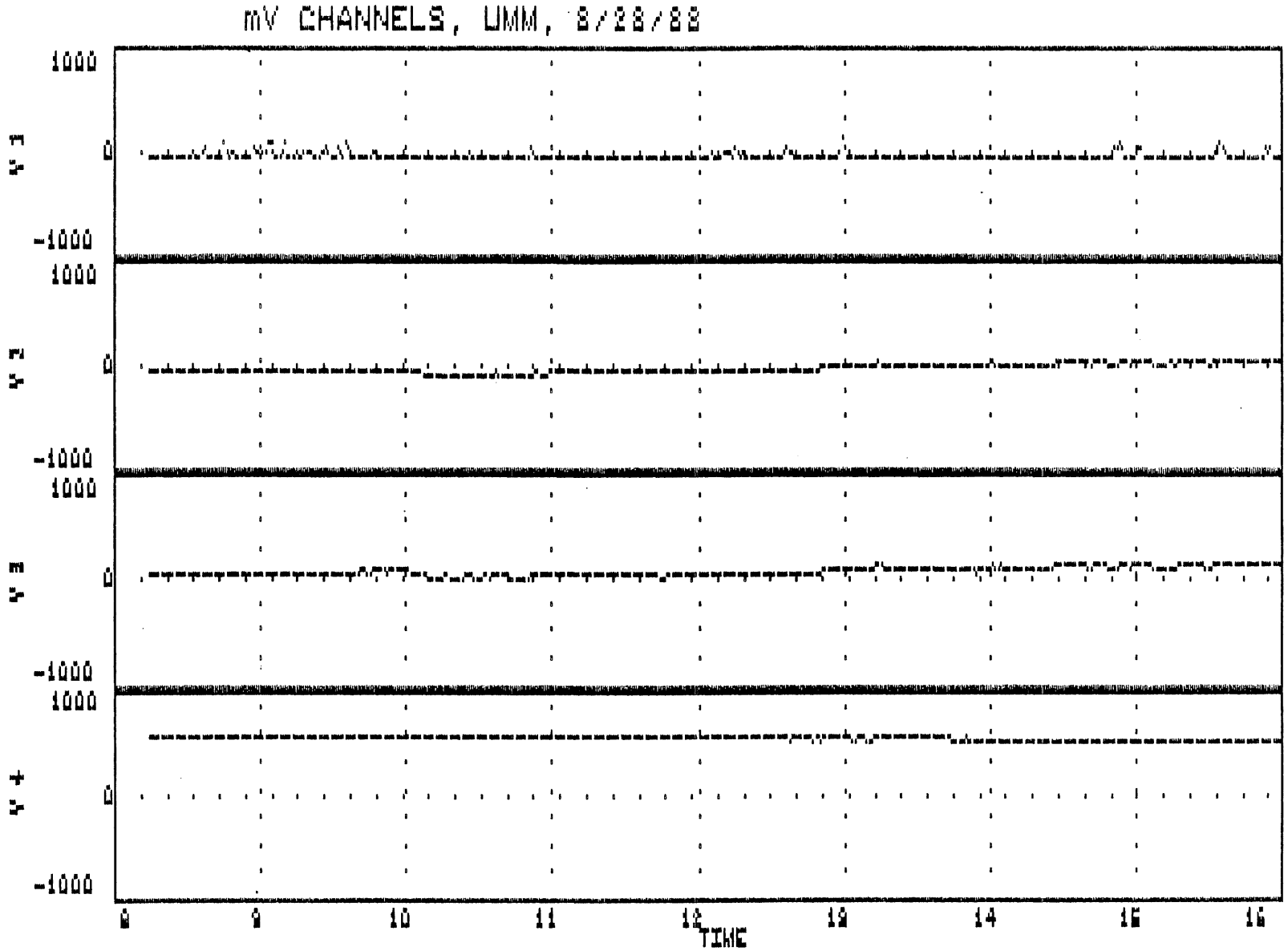
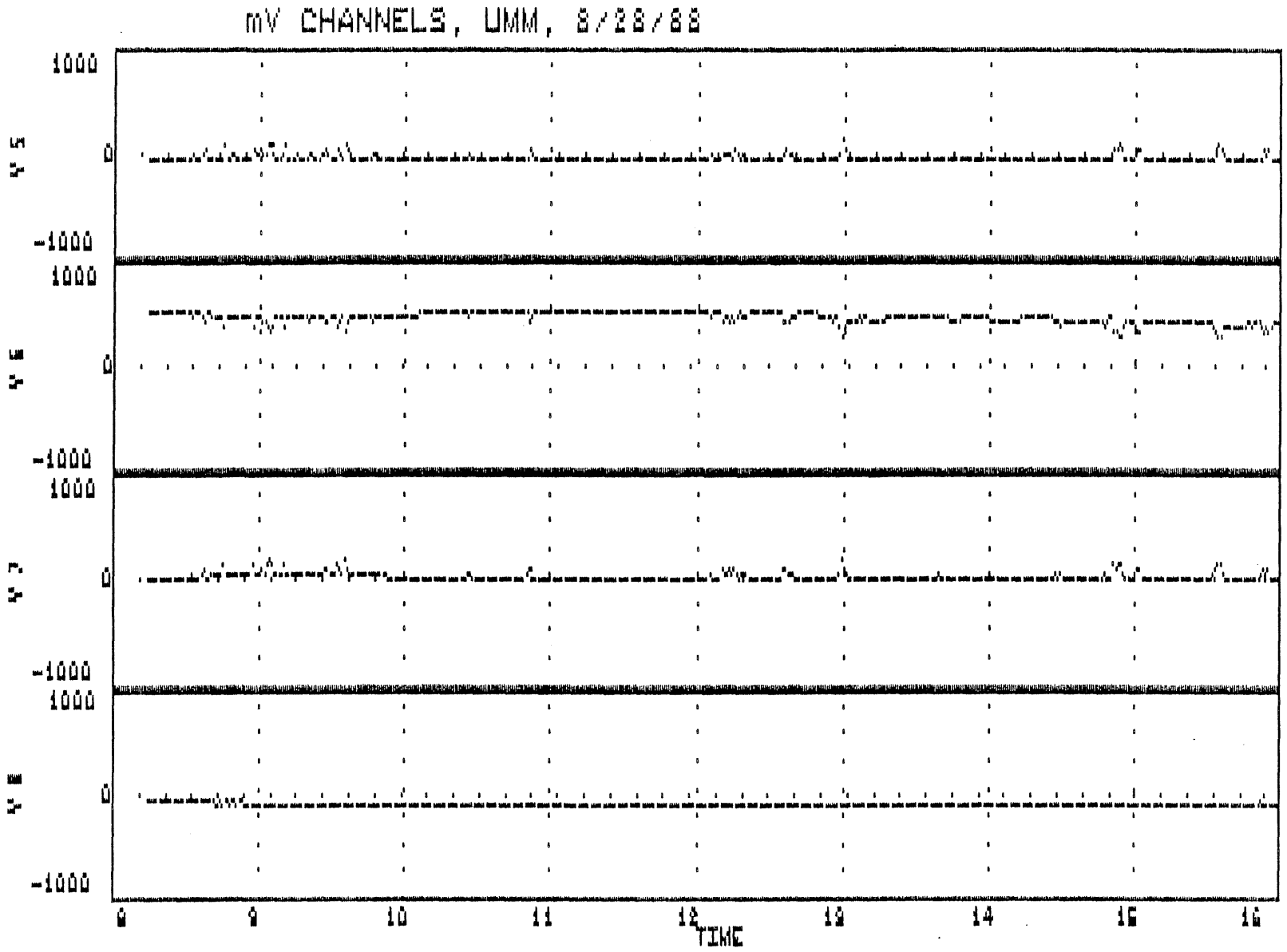
5
6
7
8
TIME



KEY

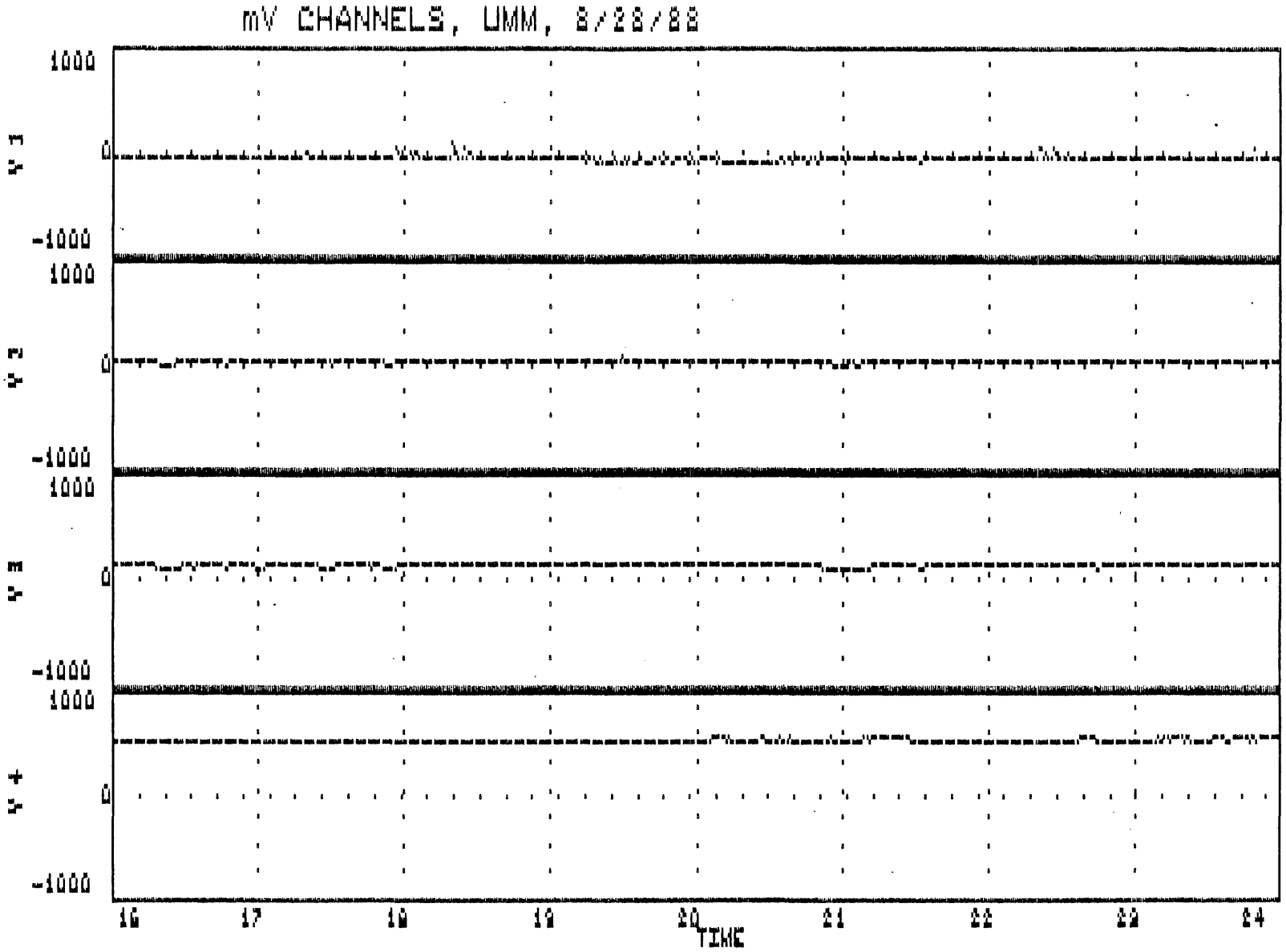
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/28/88
1000
0
-1000
E-W
N-S
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/28/88
1000
0
-1000
V 1
V 2
V 3
V 4
16
17
18
19
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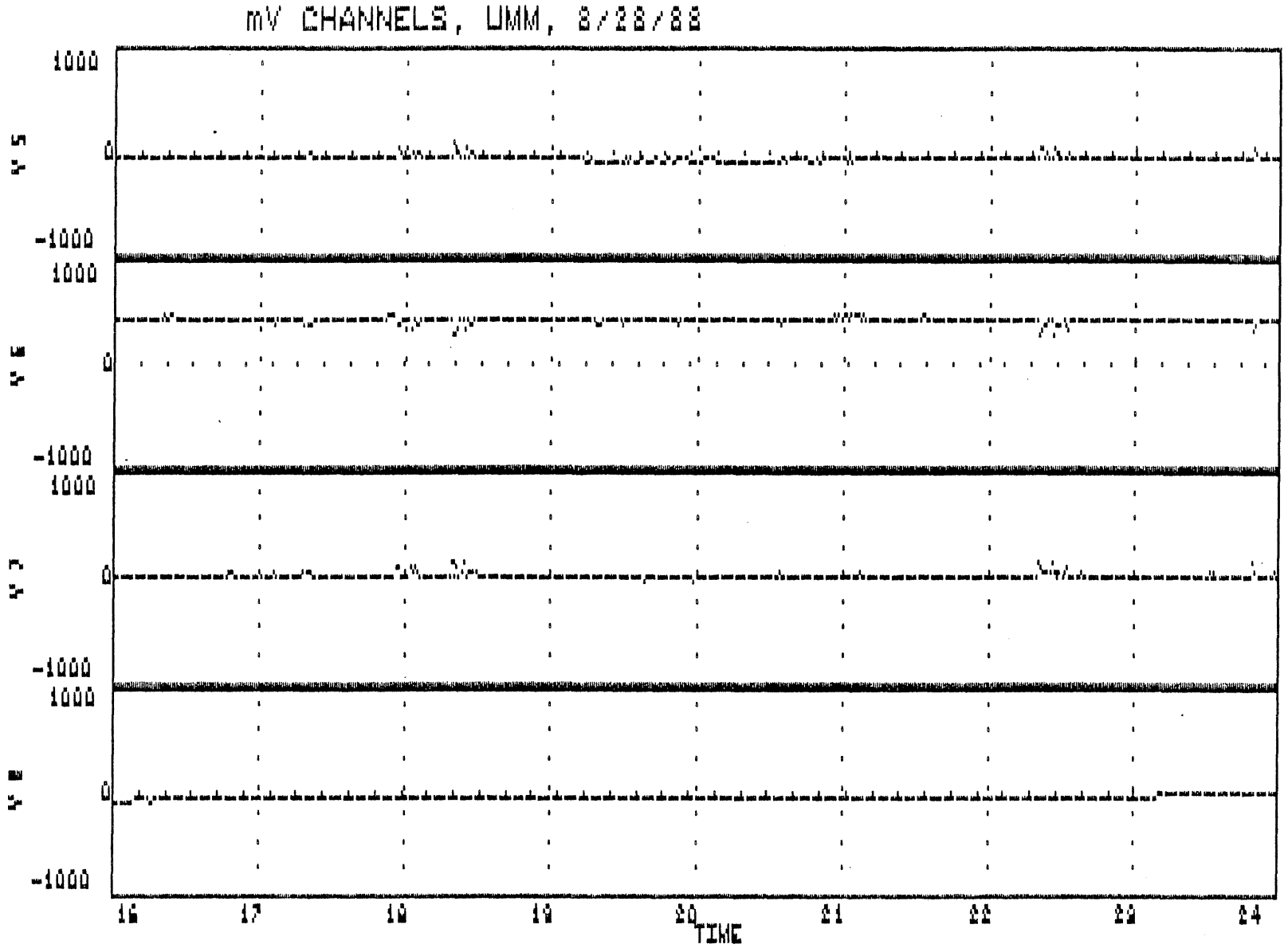
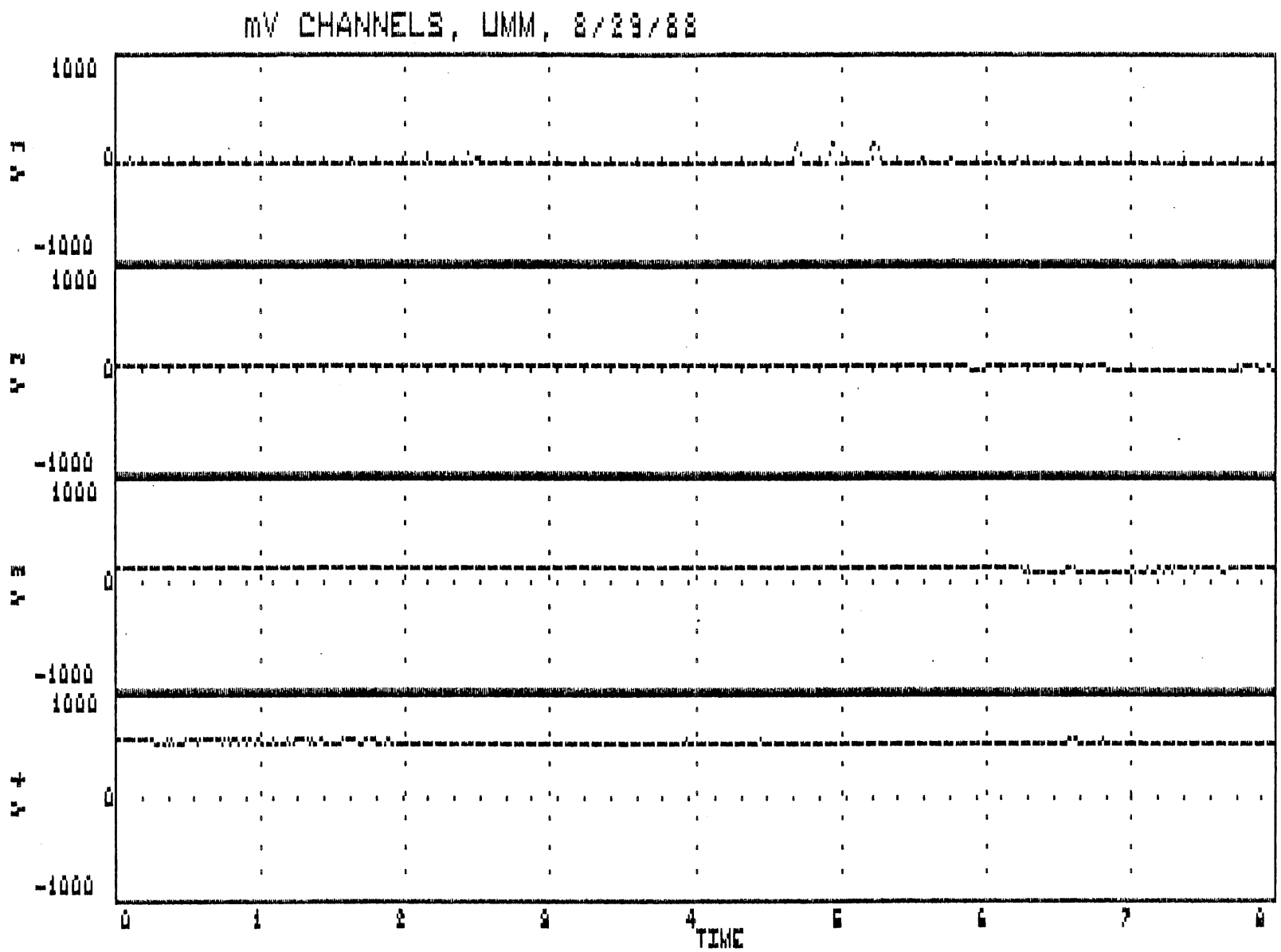
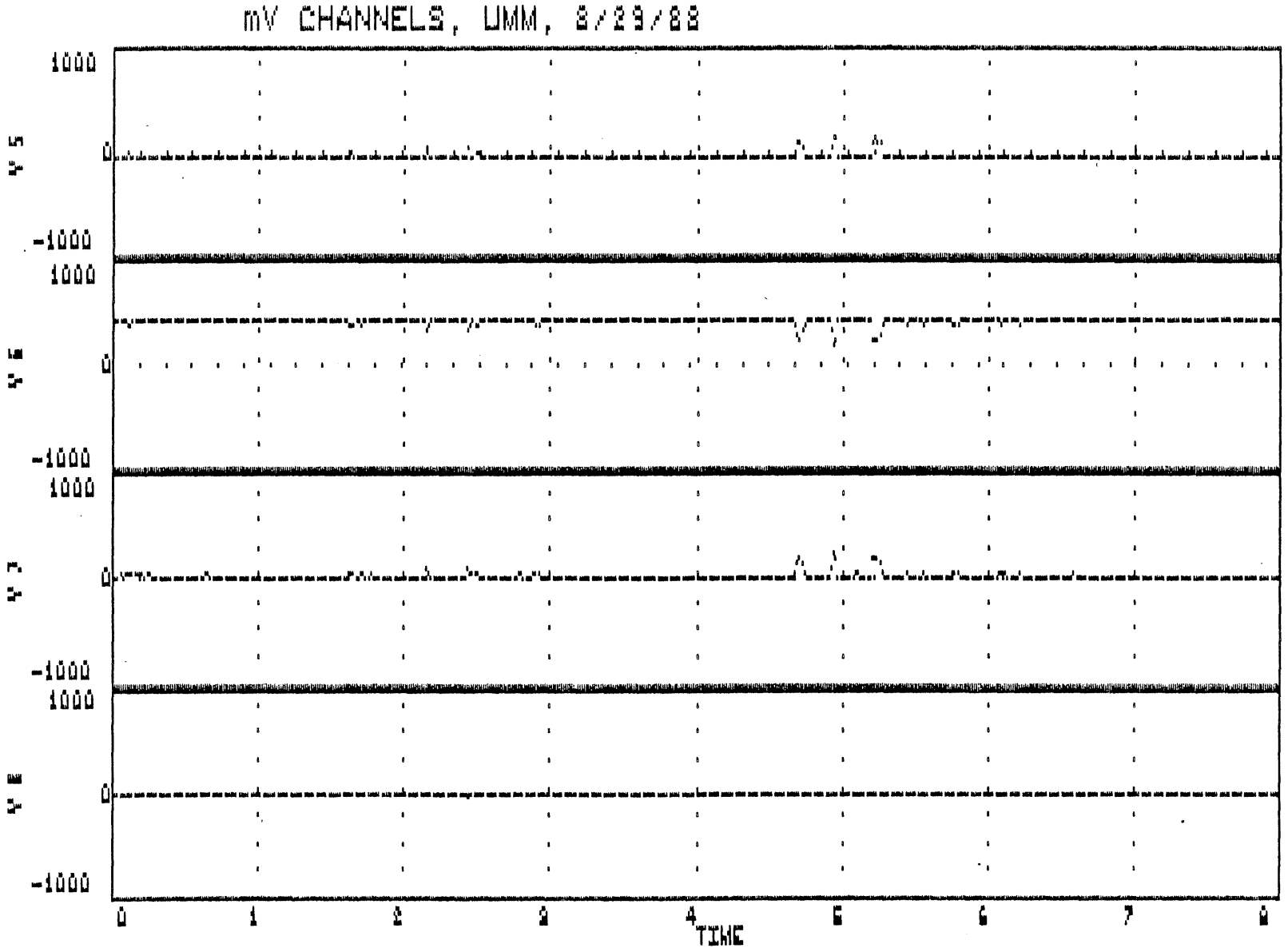
21
22
23
24
TIME



KEY

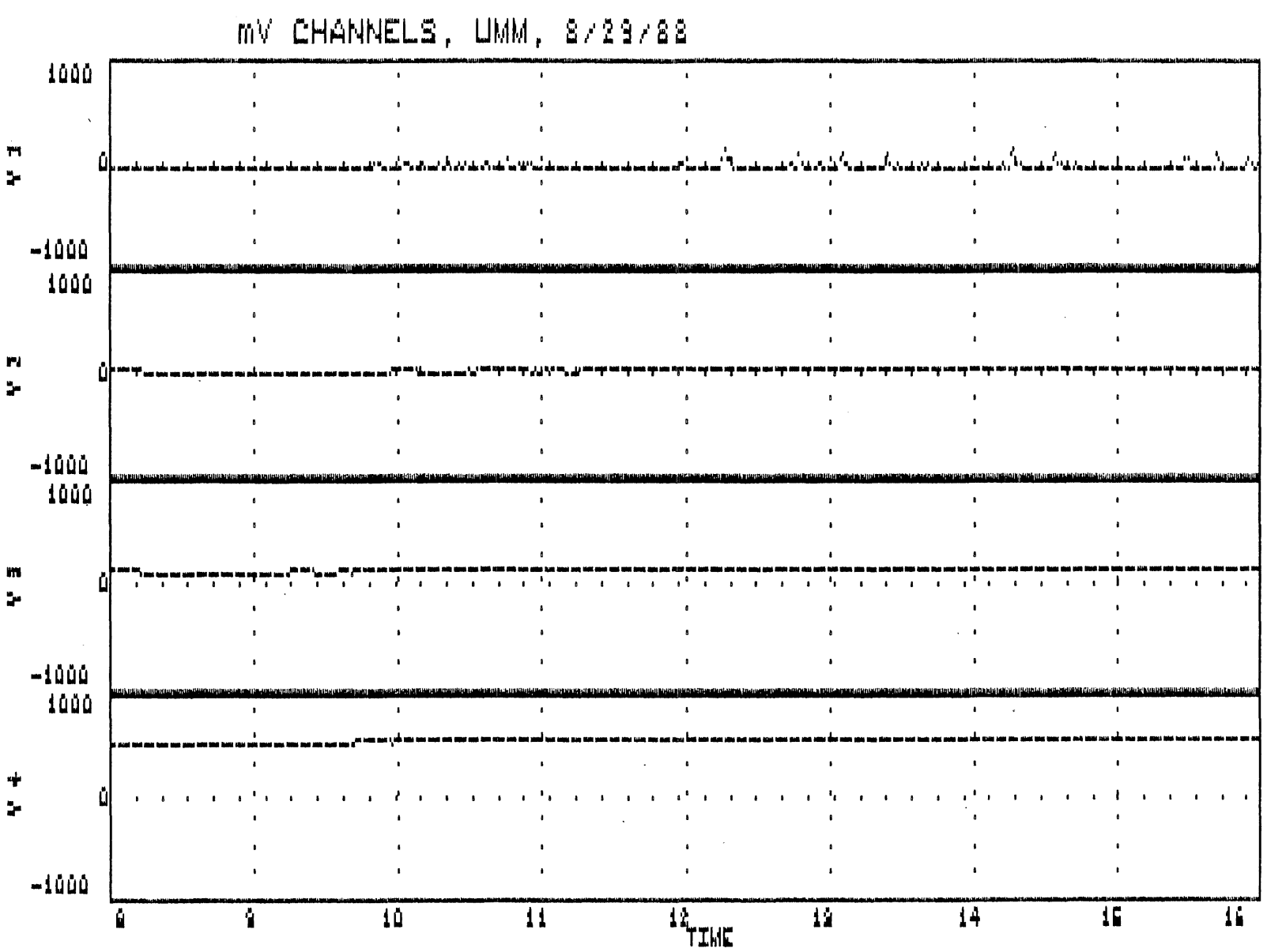
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/29/88
1000
0
-1000
1 mV
2 mV
3 mV
4 mV
0
1
2
3
4
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/23/88
1000
0
-1000
V 1
V 2
V 3
V 4
8
9
10
11
12
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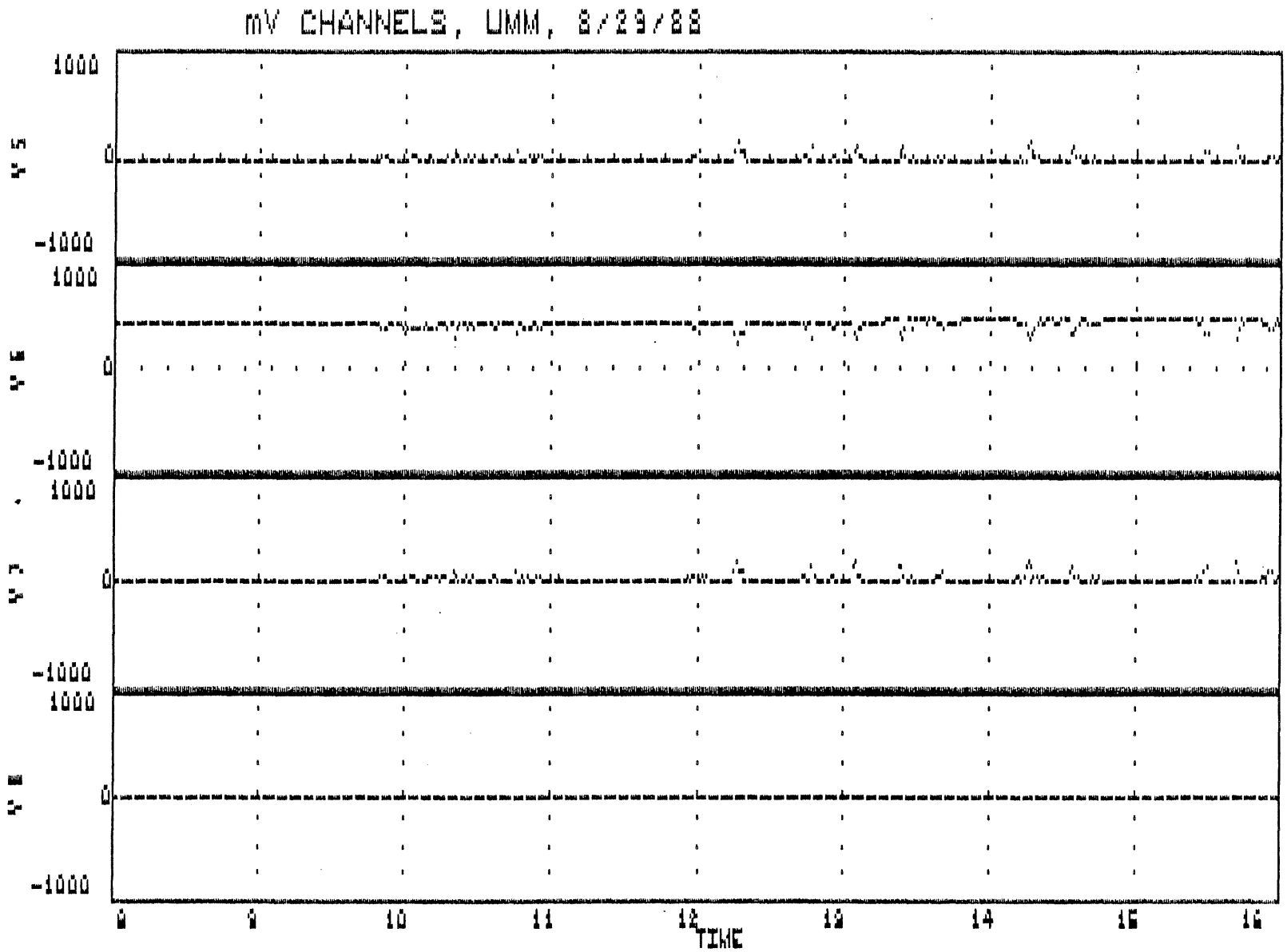
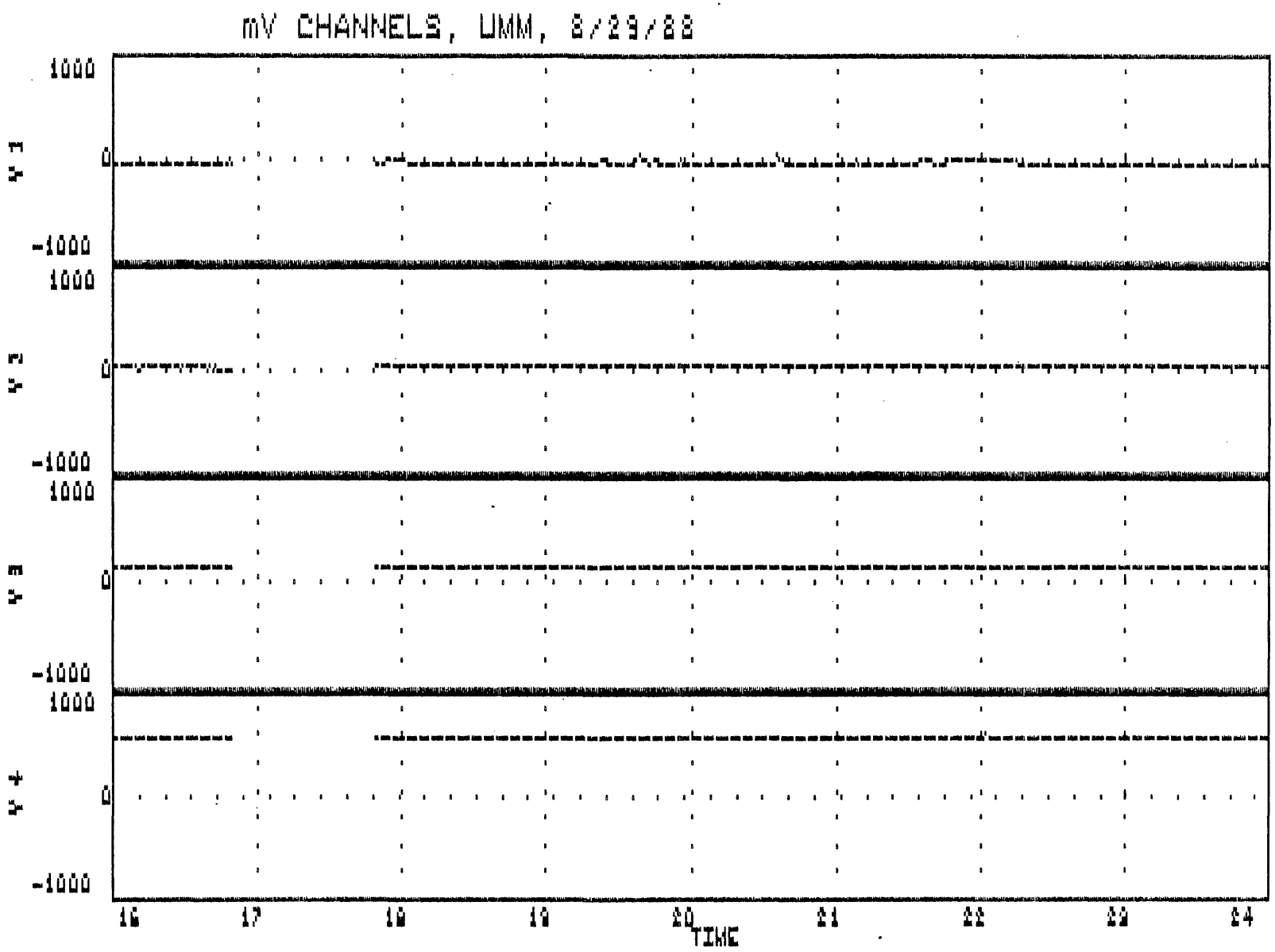
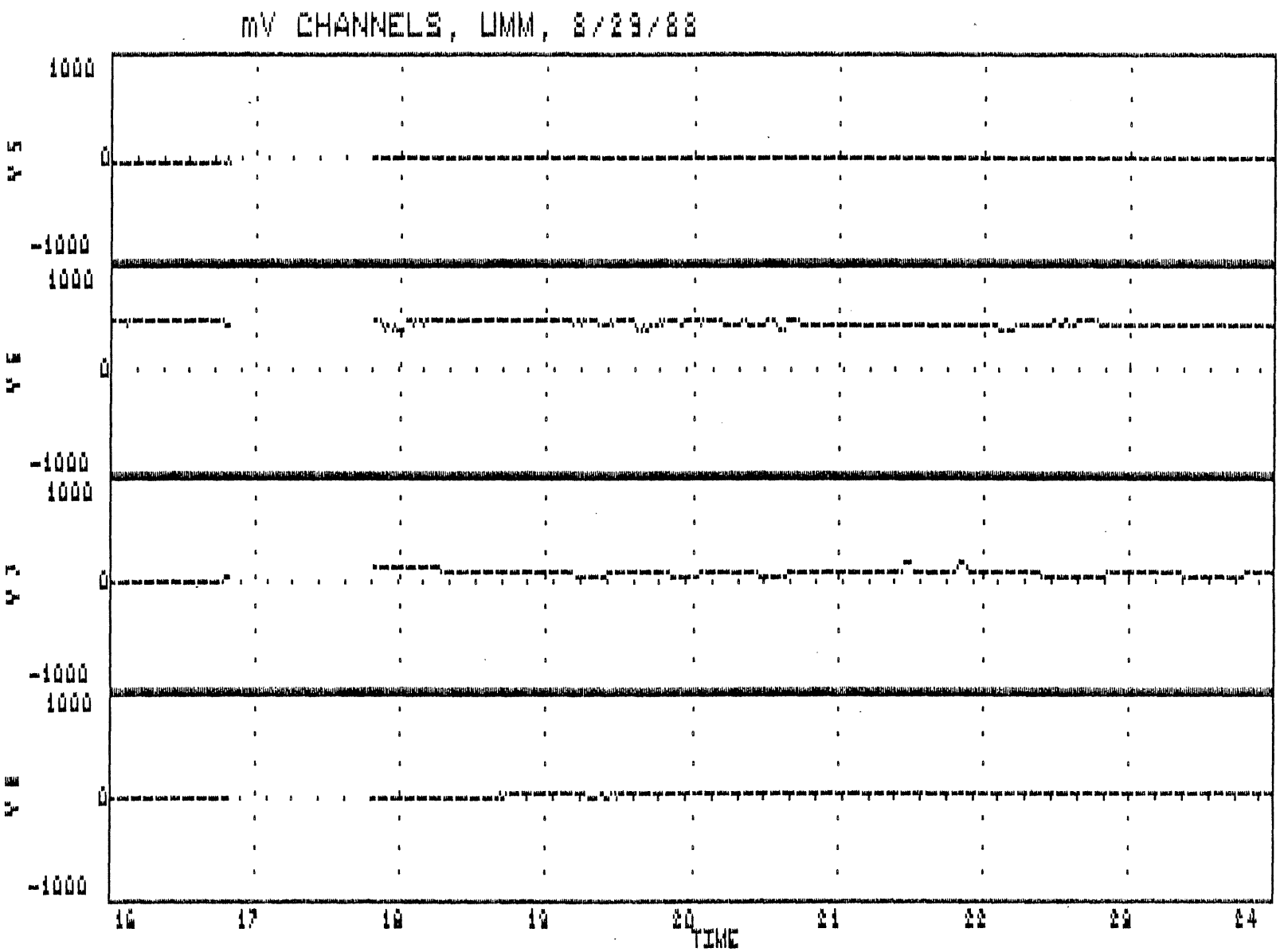
14
15
16
TIME



KEY

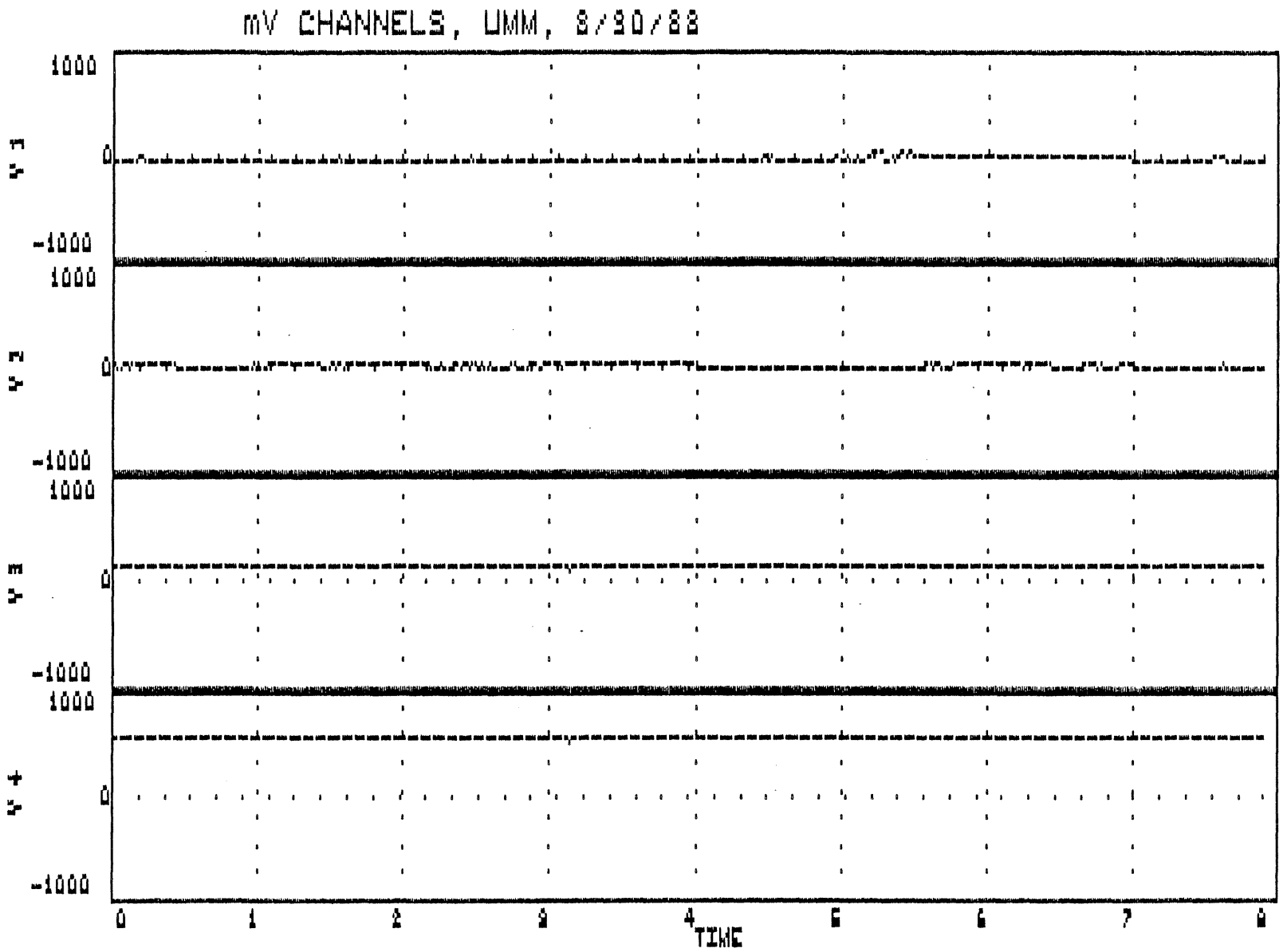
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	vacuum line	waterline
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	stanchion	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B

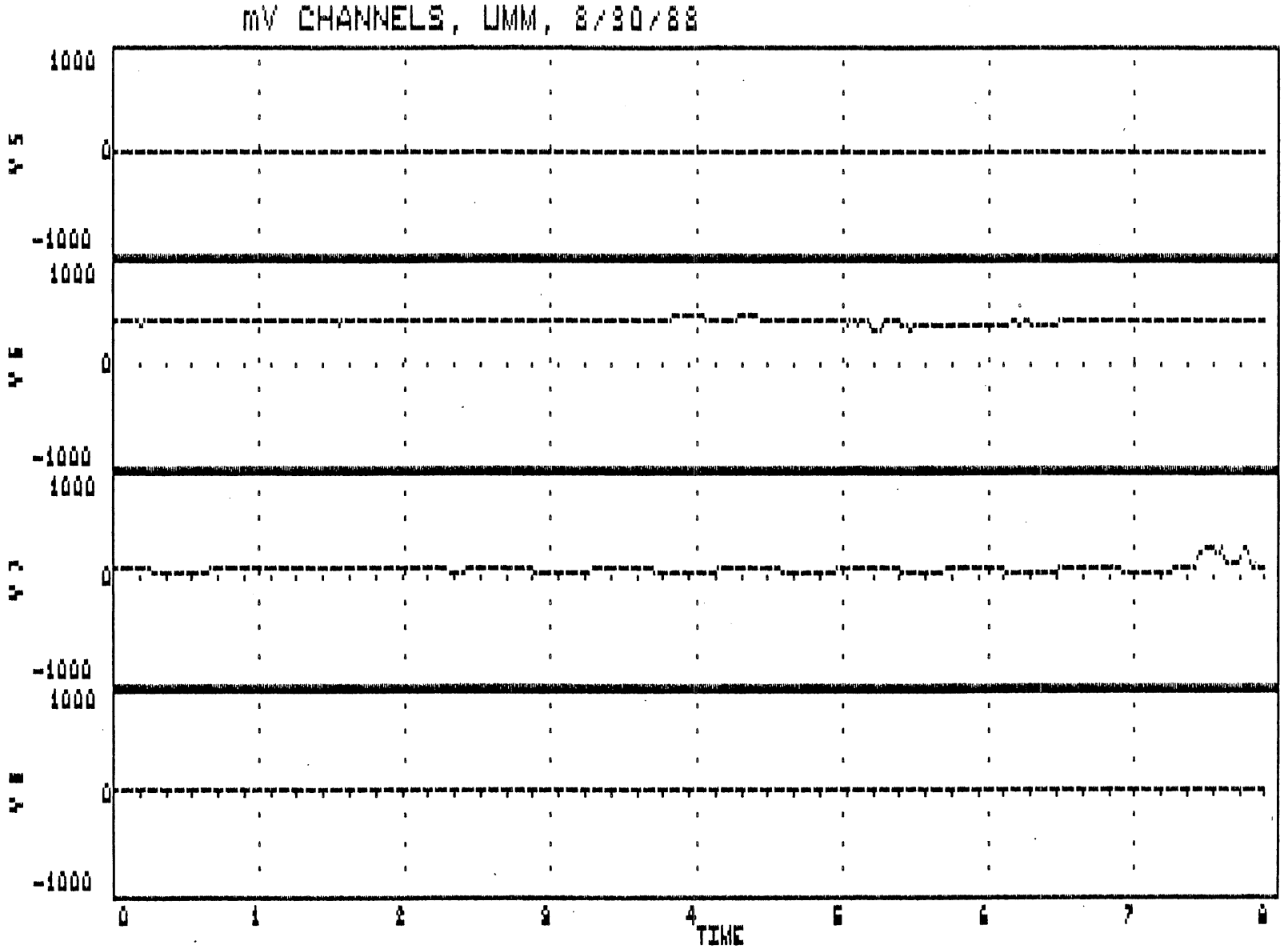

mV CHANNELS, UMM, 8/29/88
1000
0
-1000
E W
N S
TIME
16
17
18
19
20
21
22
23
24



KEY

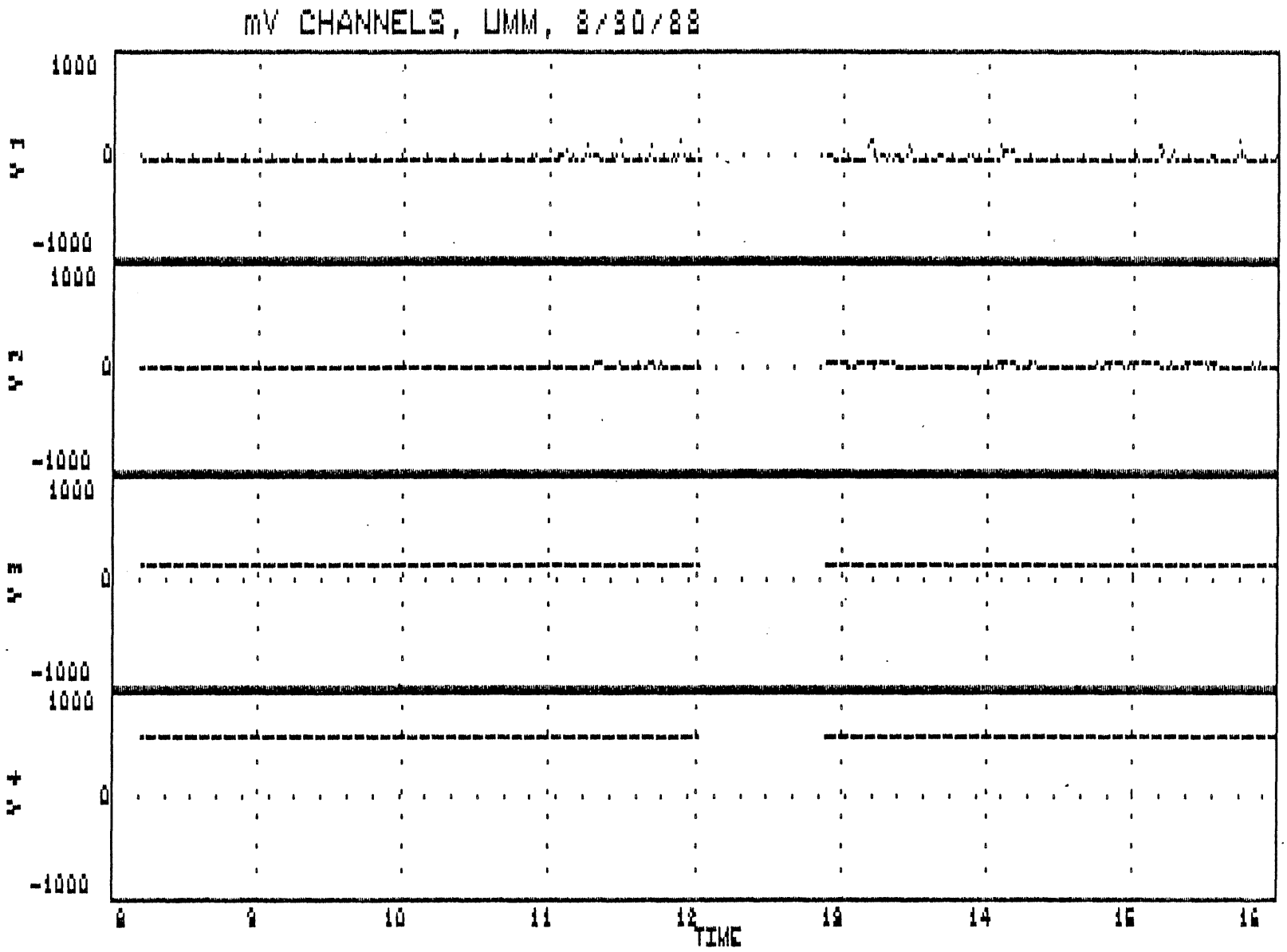
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B

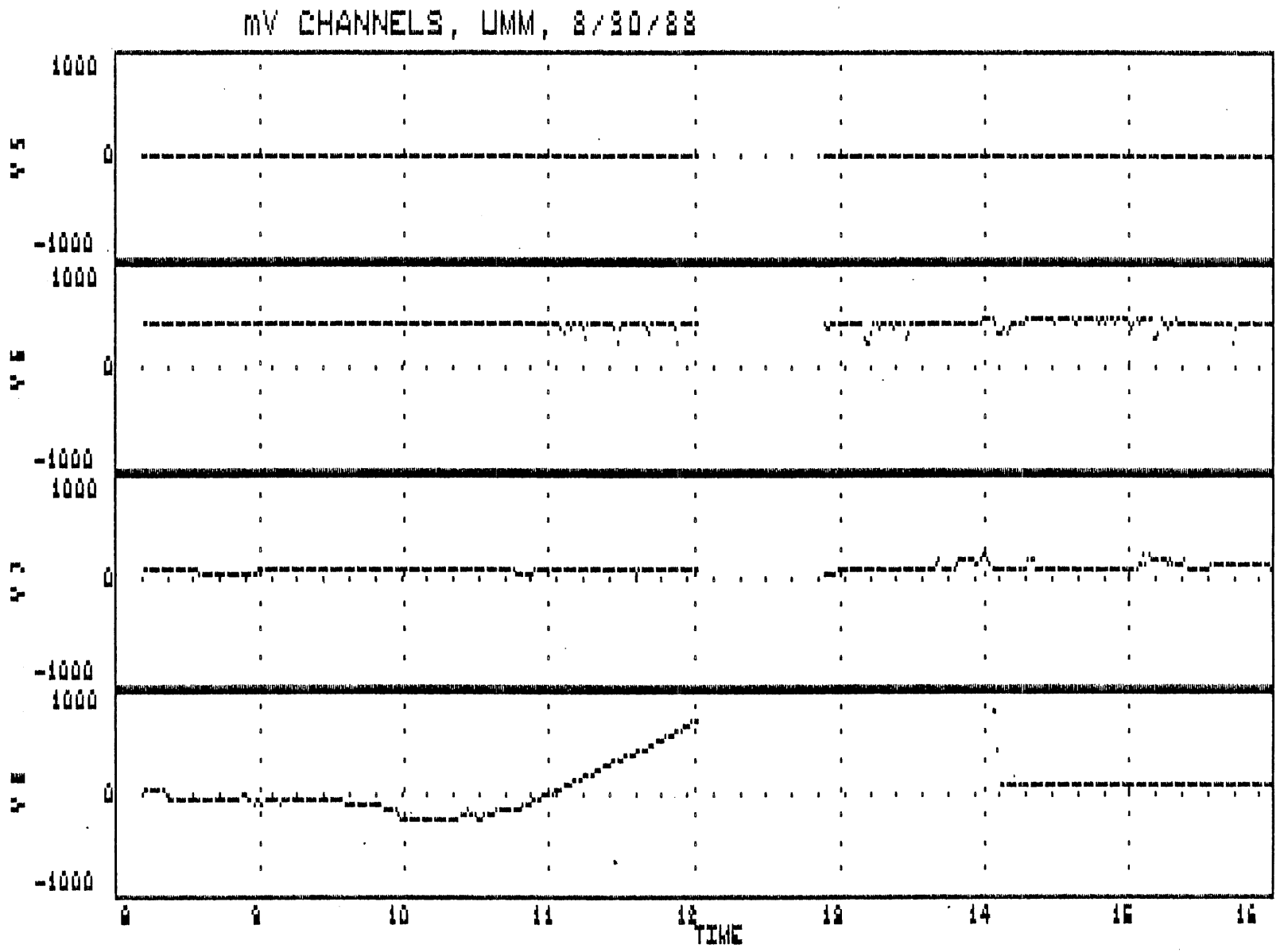

mV CHANNELS, UMM, 8/30/88
1000
0
-1000
E W
1000
0
-1000
N S
1000
0
-1000
+ V
1000
0
-1000
0
1
2
3
4
5
6
7
8
TIME



KEY

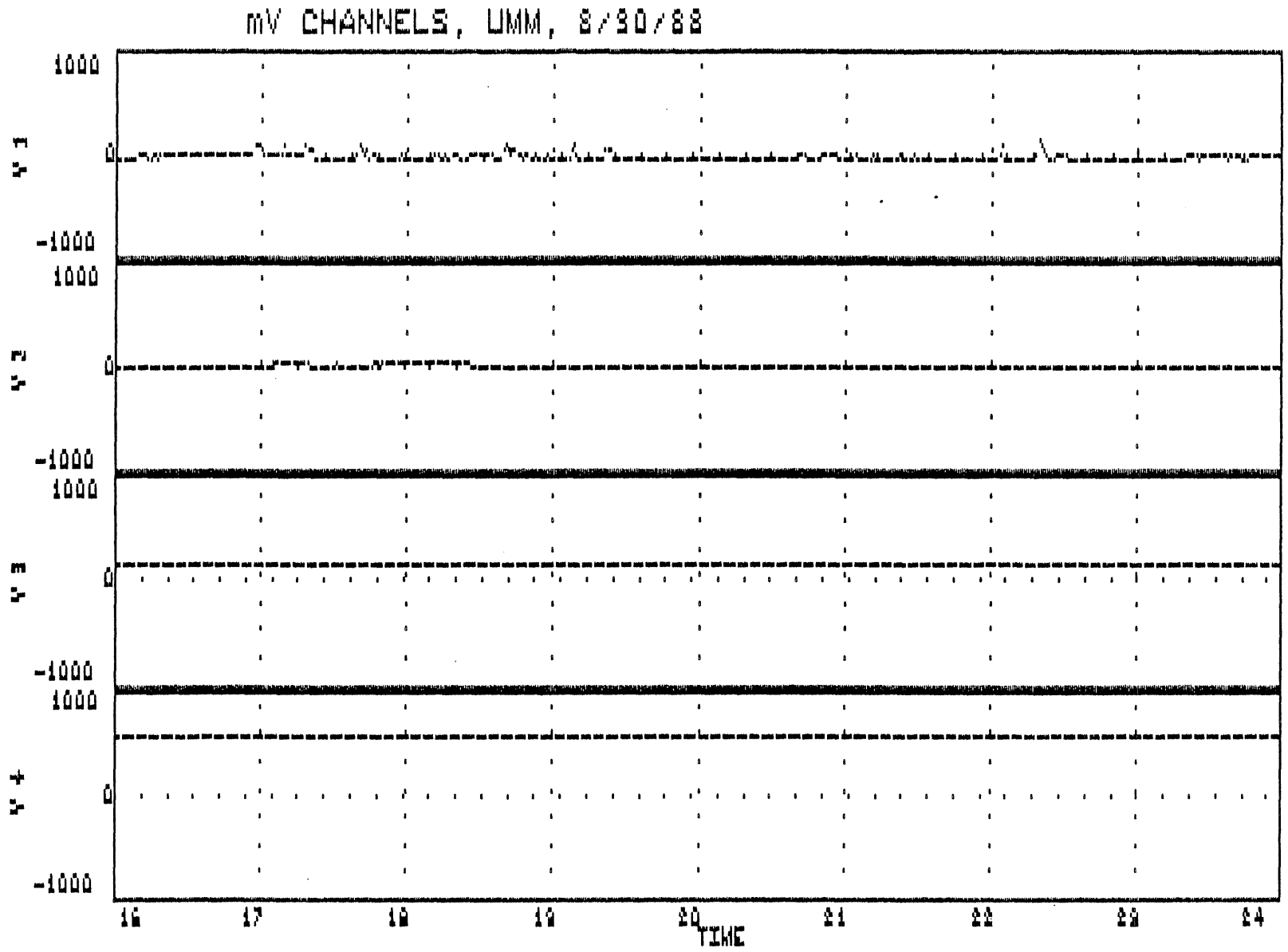
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B

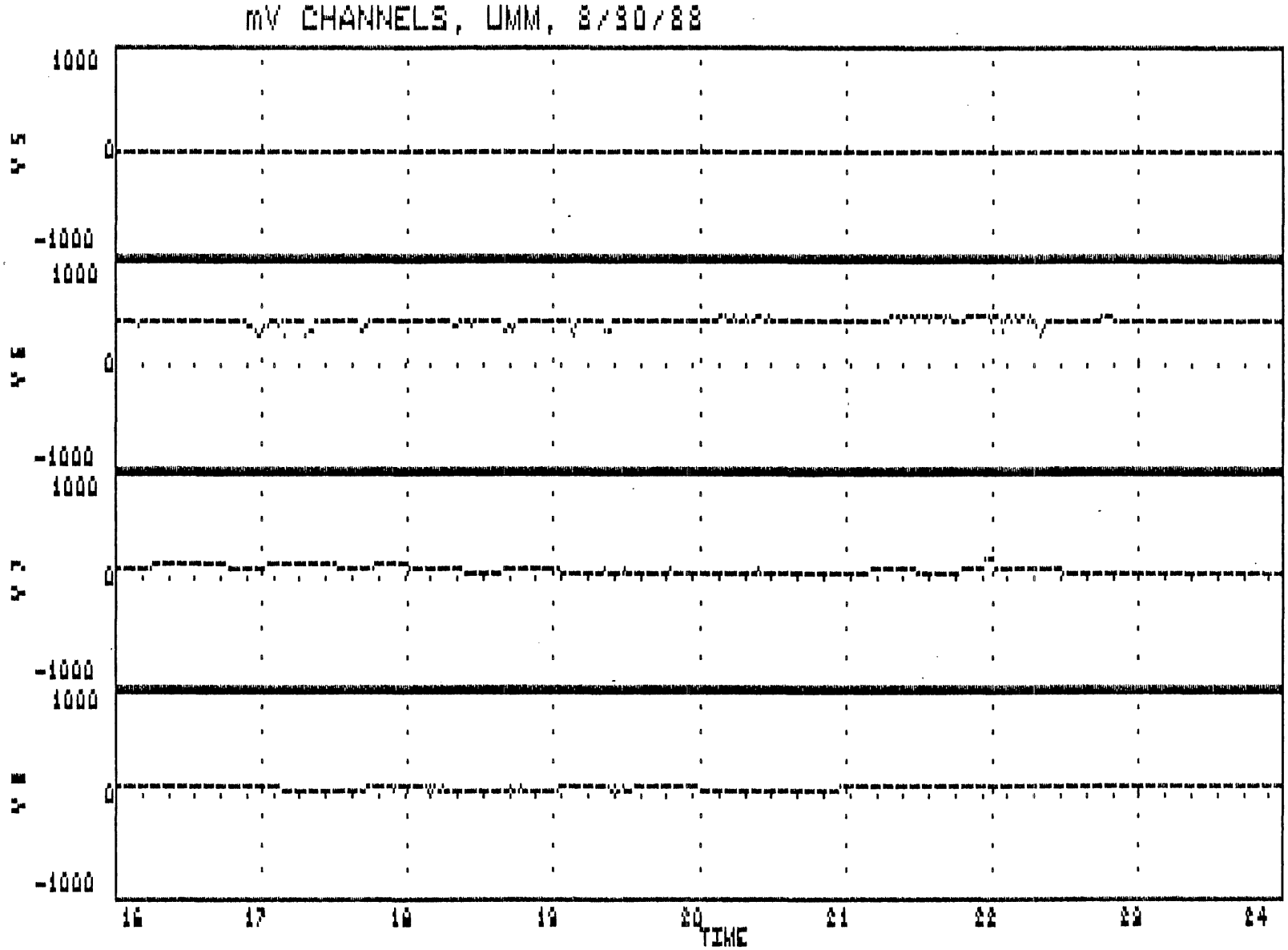

mV CHANNELS, UMM, 8/30/88
1000
0
-1000
V 1
V 2
V 3
V 4
8
9
10
11
12
13
14
15
16
TIME



KEY

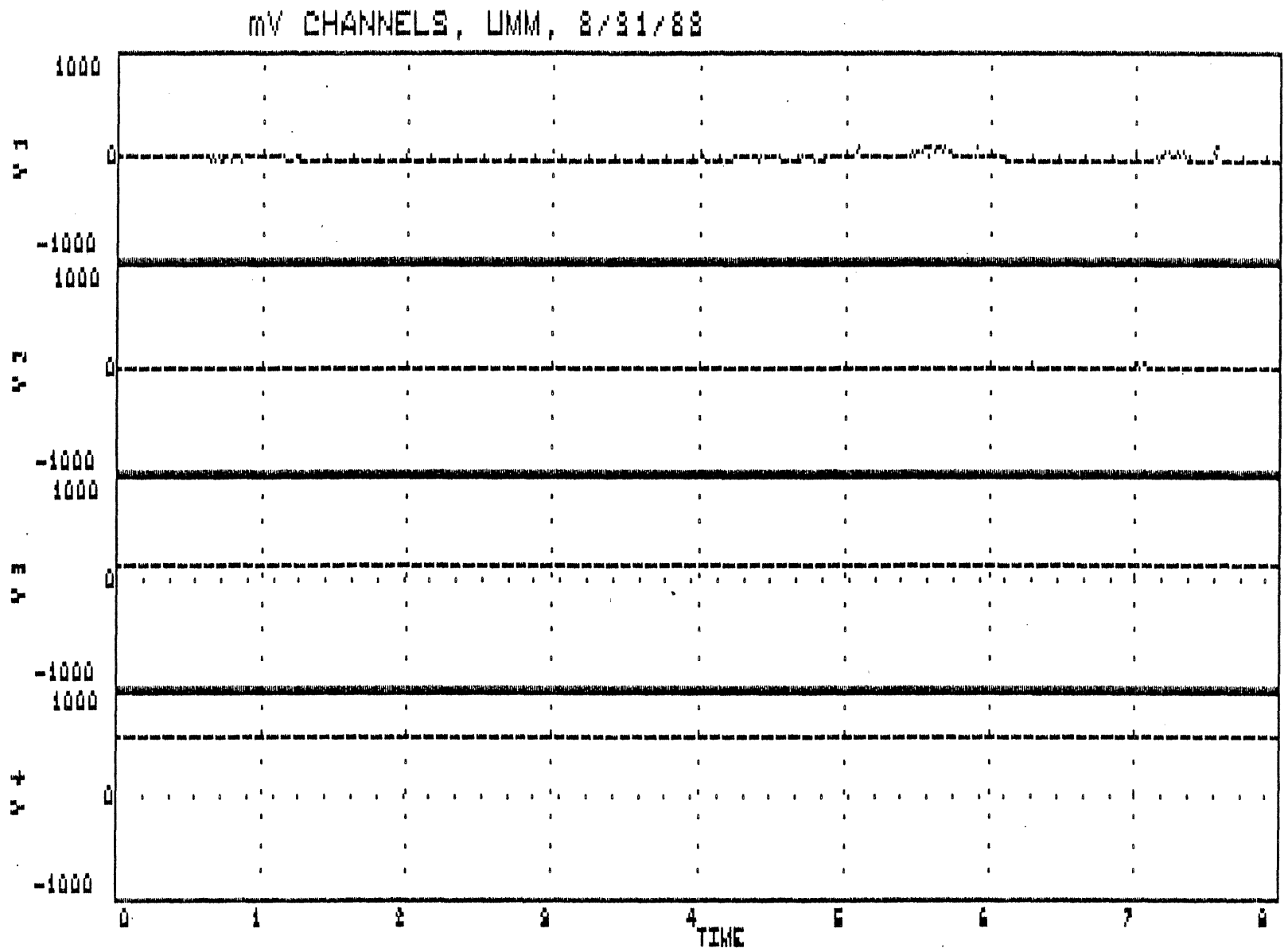
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B

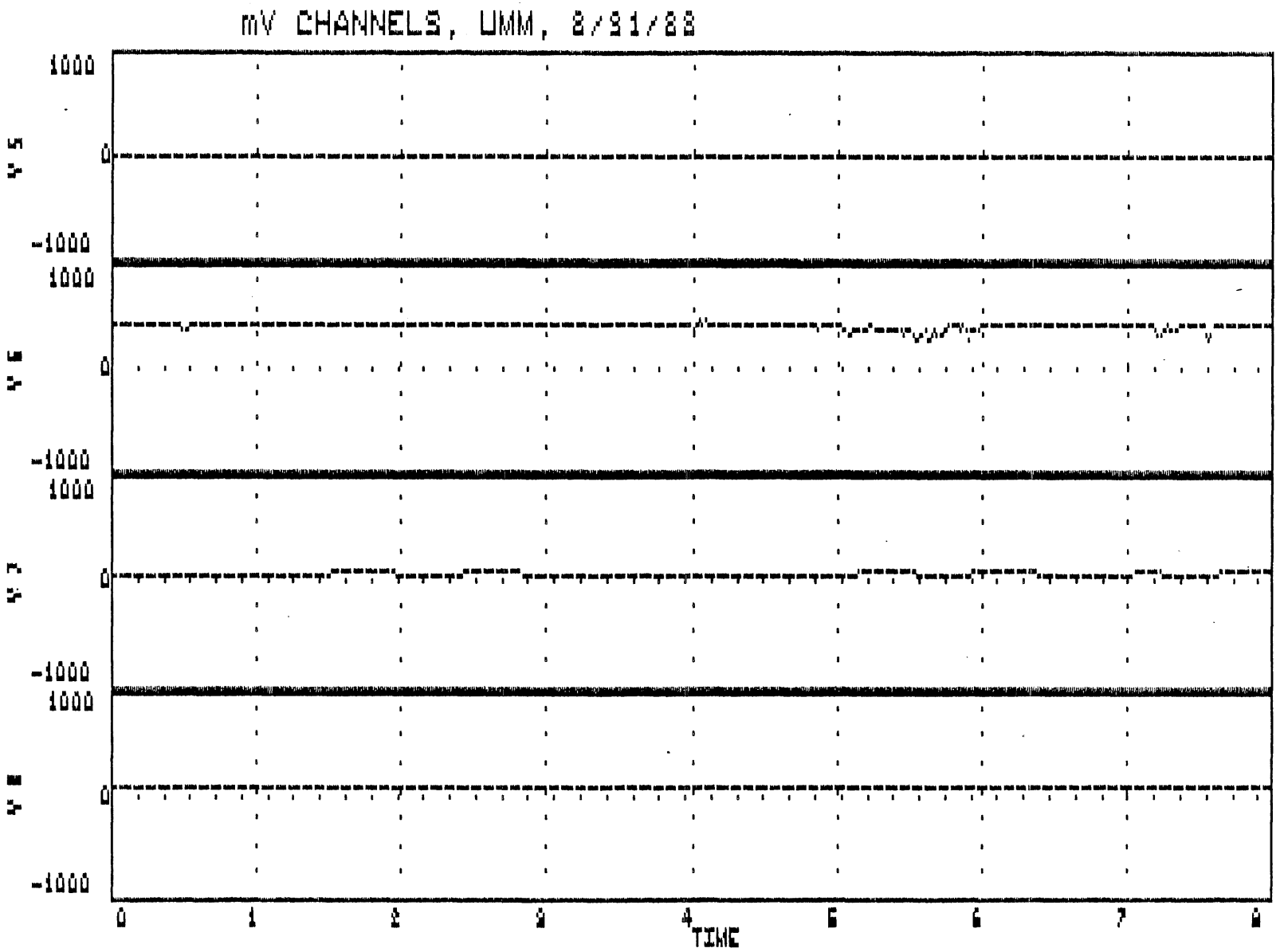

mV CHANNELS, UMM, 8/30/88
1000
0
-1000
V 1
V 2
V 3
V 4
16
17
18
19
20
21
22
23
24
TIME



KEY

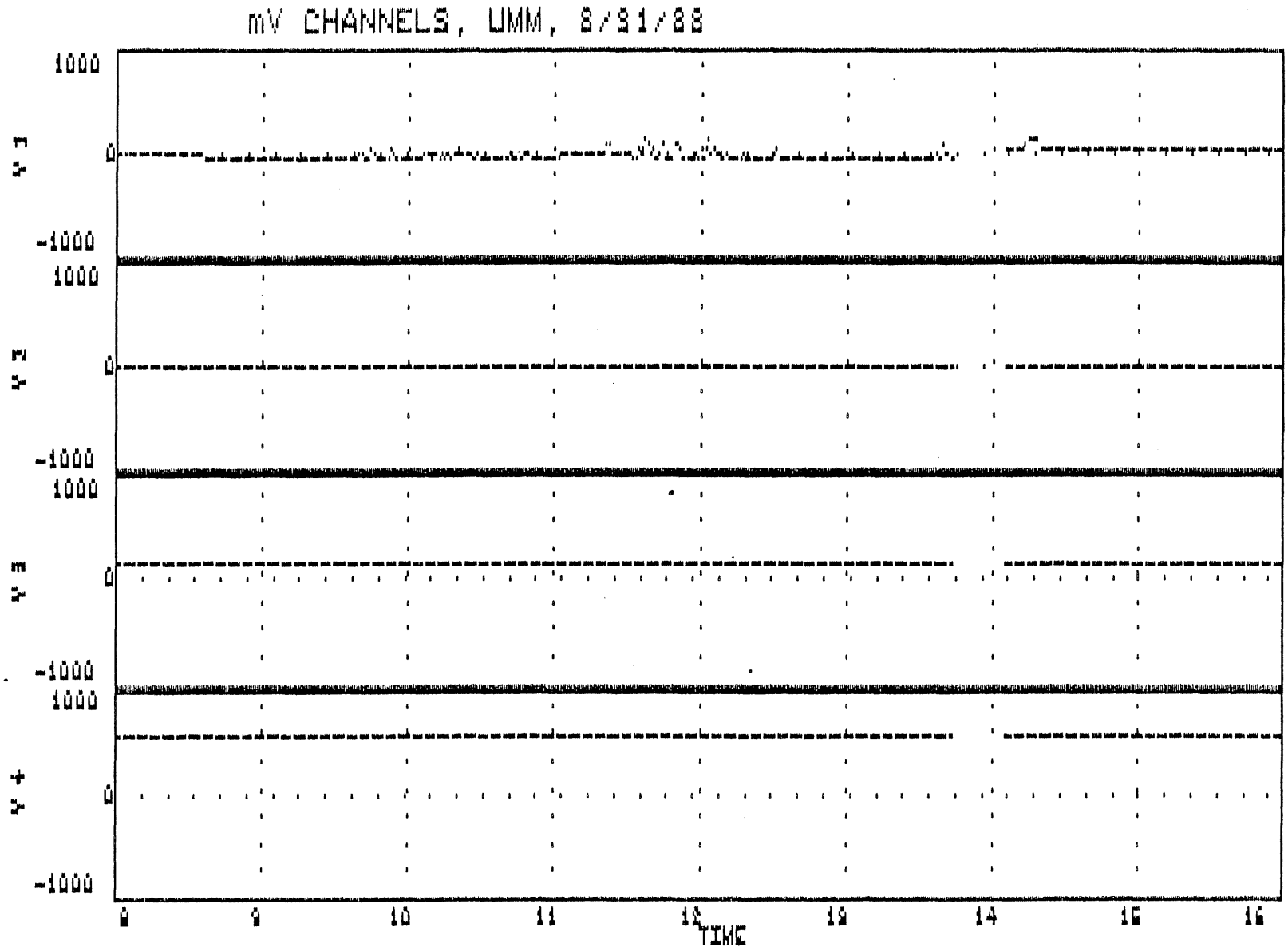
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B

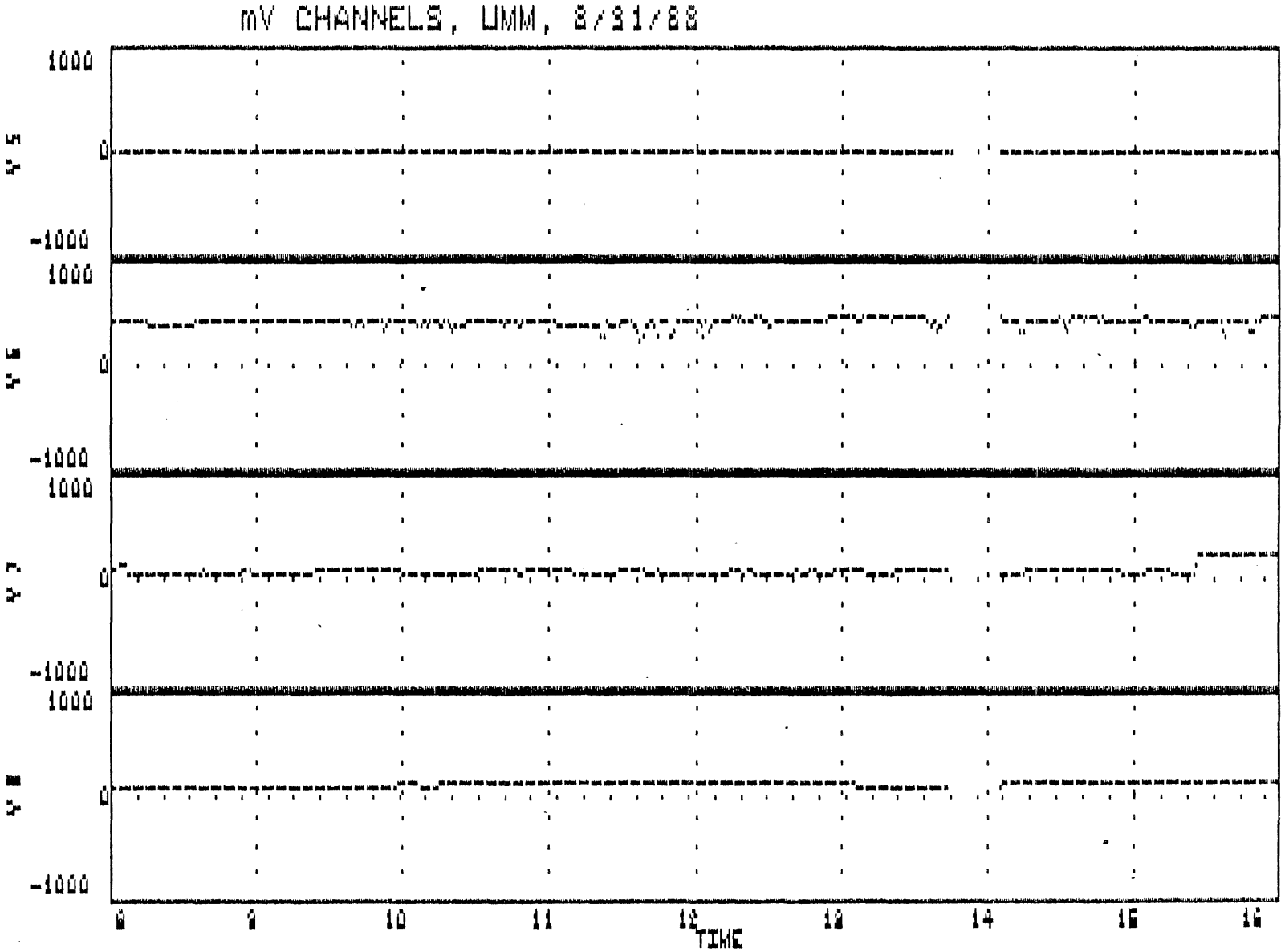

mV CHANNELS, UMM, 8/31/88
1000
0
-1000
V 1
V 2
V 3
V 4
0
1
2
3
4
5
6
7
8
TIME



KEY

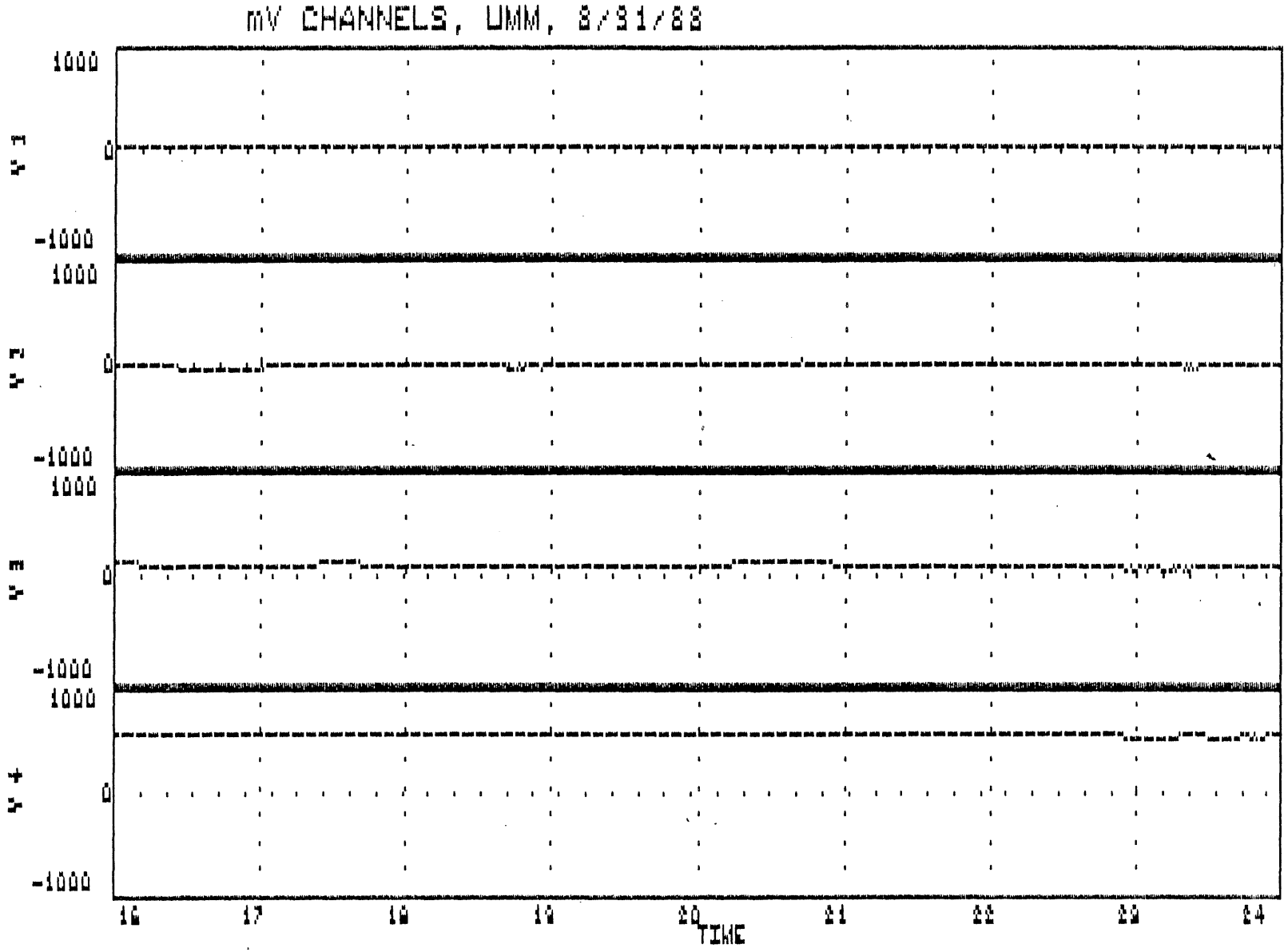
CHAN	HI	LO	CHAN	HI	LO
V1	barn ground	waterline	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B

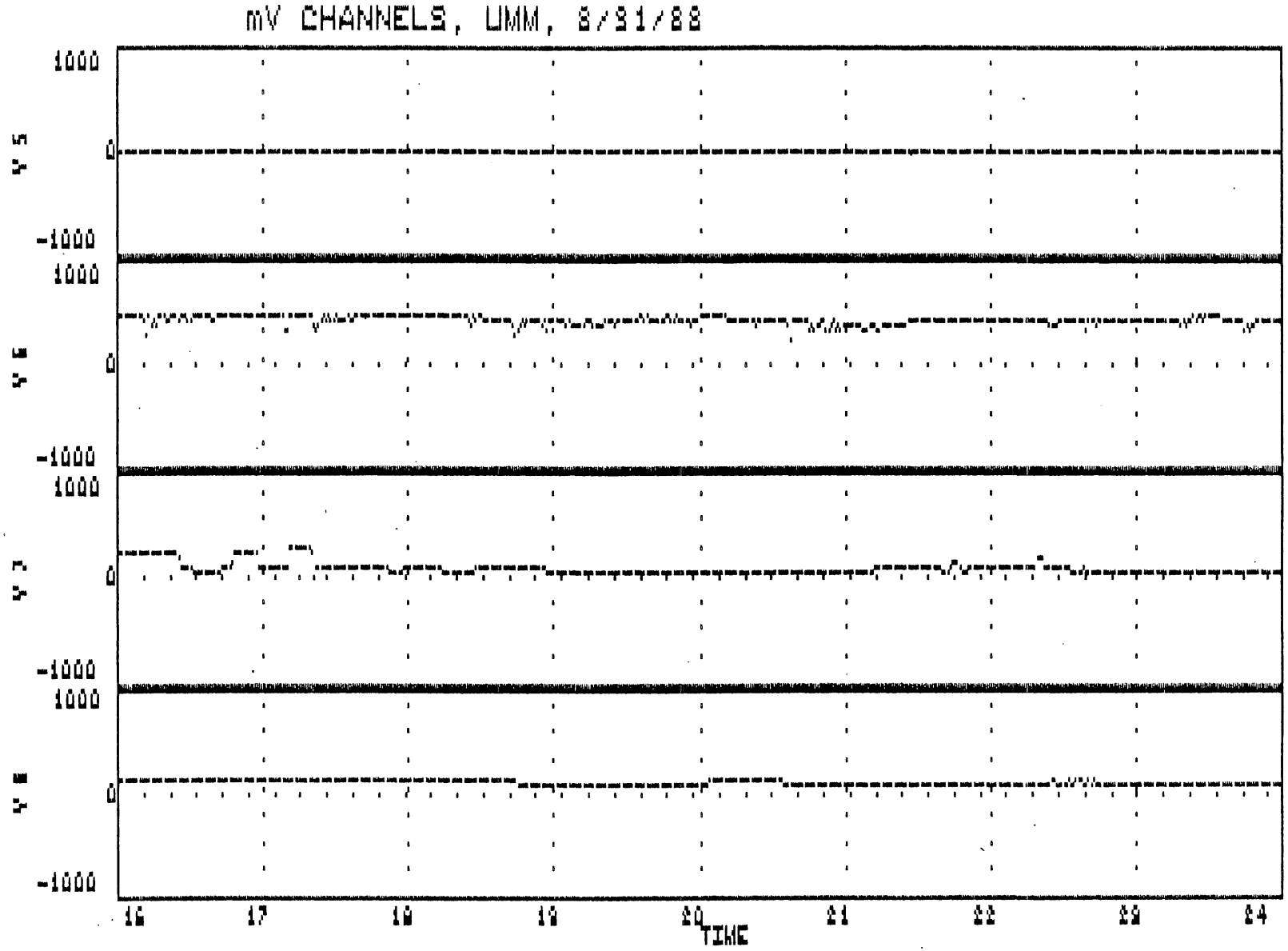

mV CHANNELS, UMM, 8/31/88
1000
0
-1000
V 1
V 2
V 3
V 4
9
10
11
12
13
14
15
16
TIME



KEY

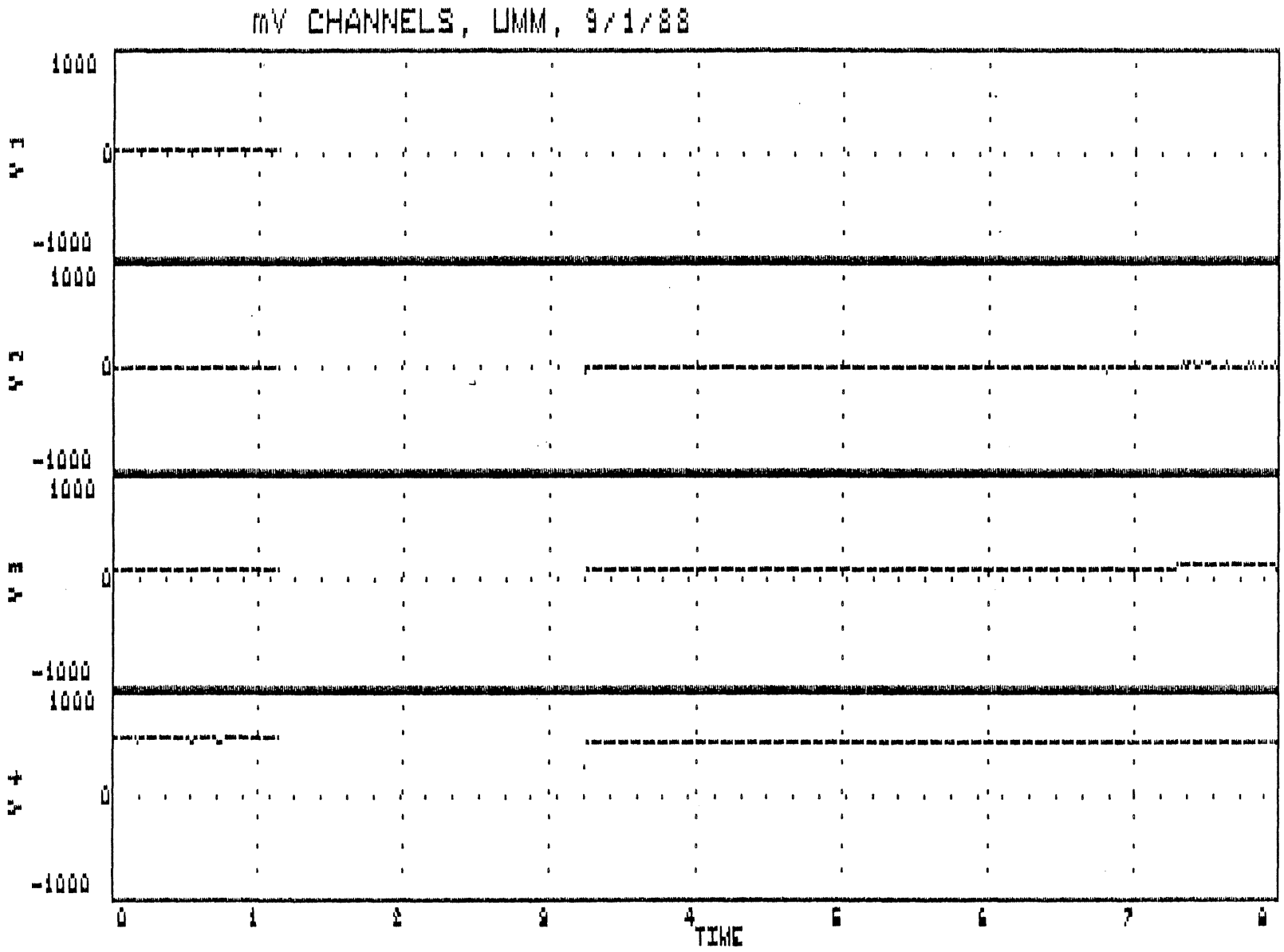
CHAN	HI	LO	CHAN	HI	LO
V1	E field (dc)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 8/31/88
1000
0
-1000
E-W
N-S
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	E field (dc)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/1/88
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-1000
V 1
V 2
V 3
V 4
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1
2
3
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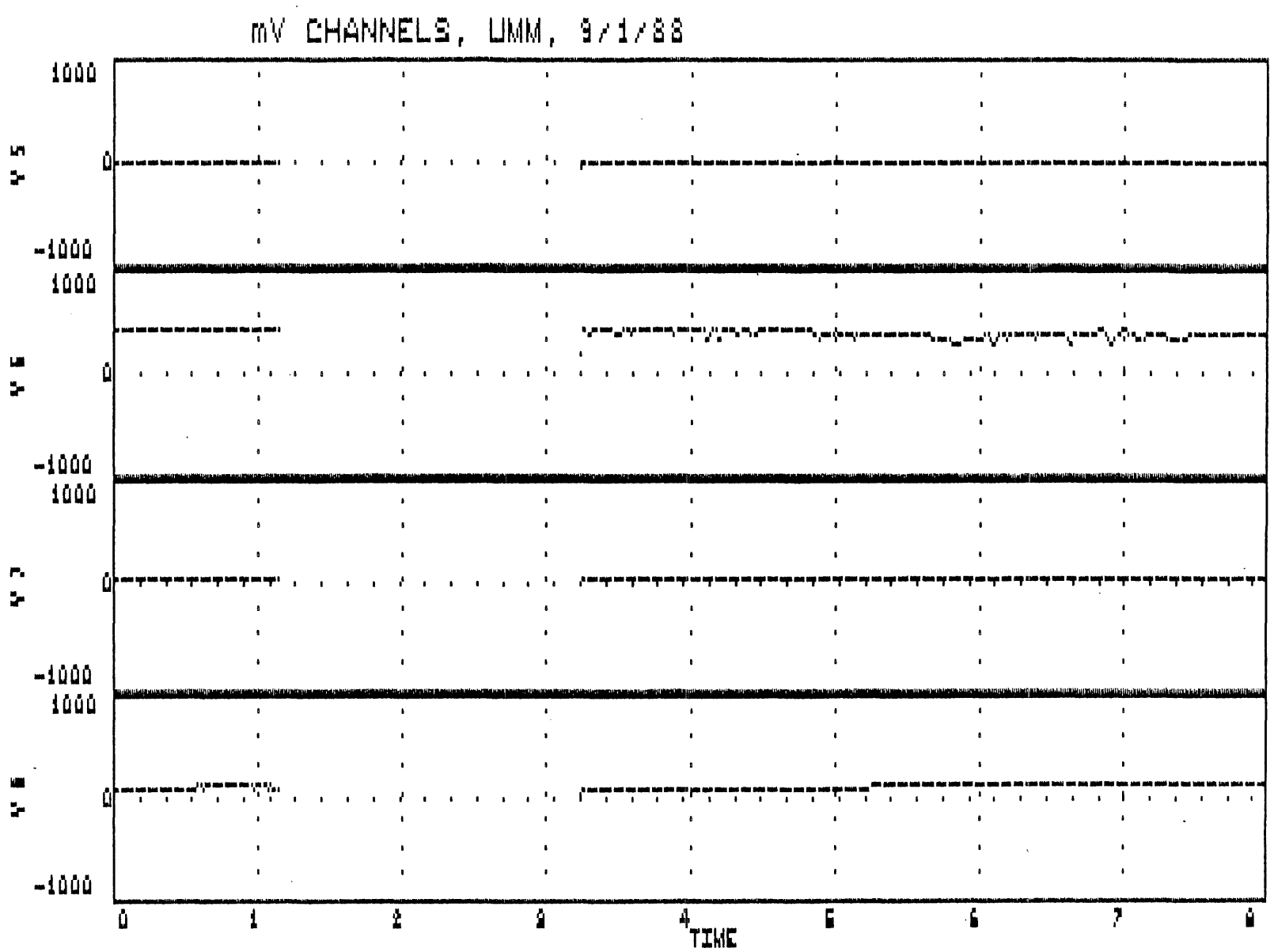
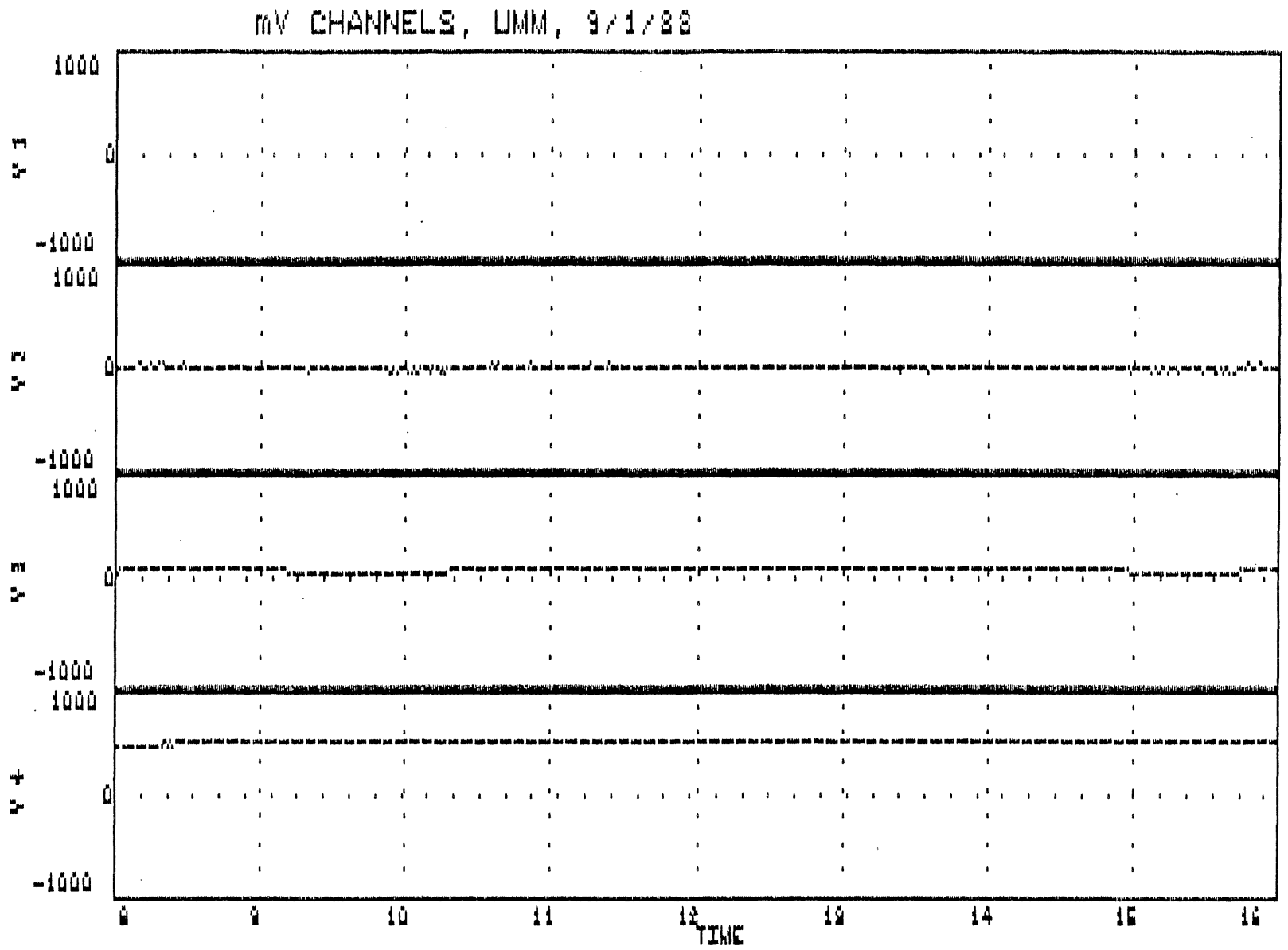
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	E field (dc)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/1/88
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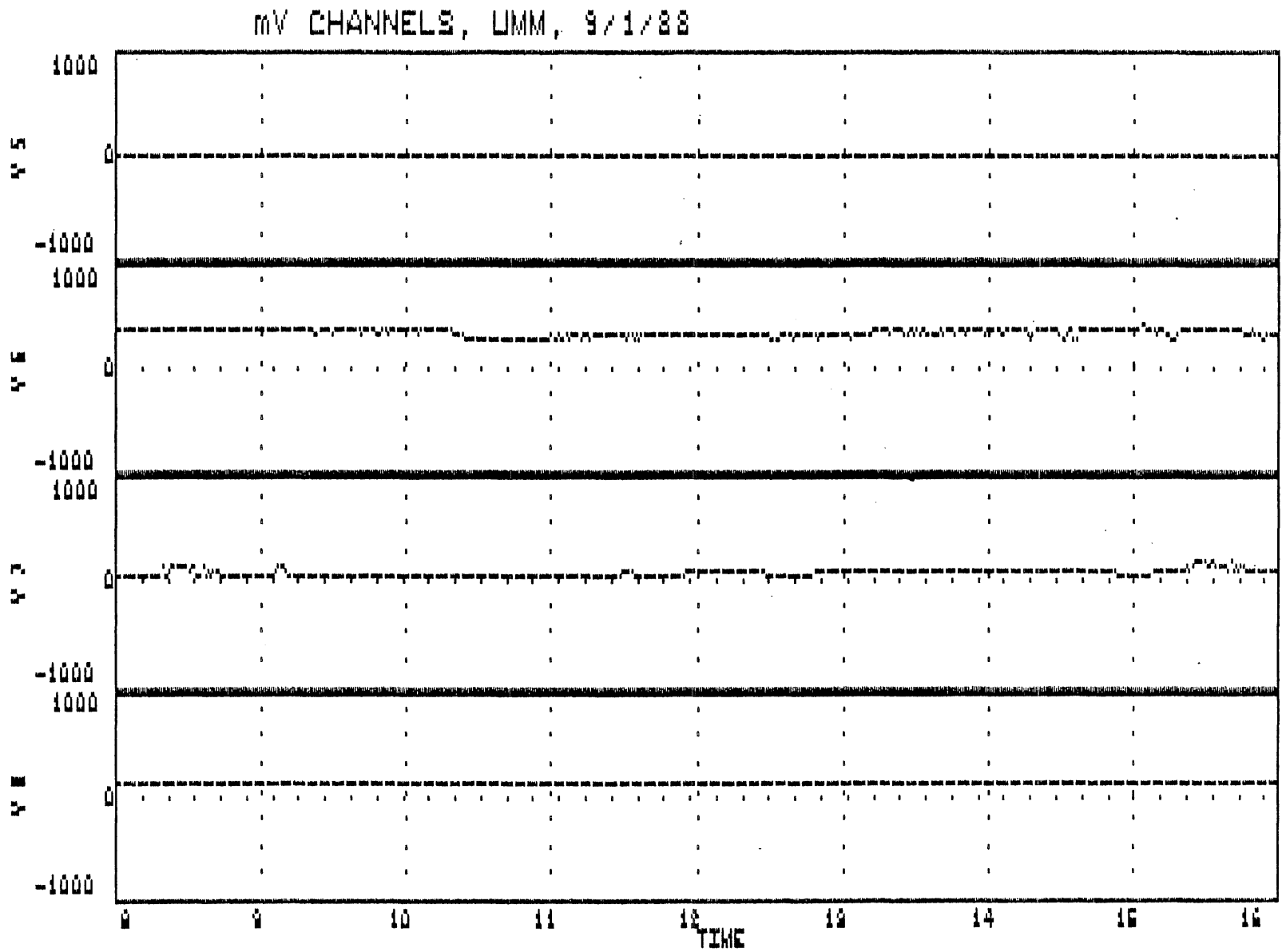
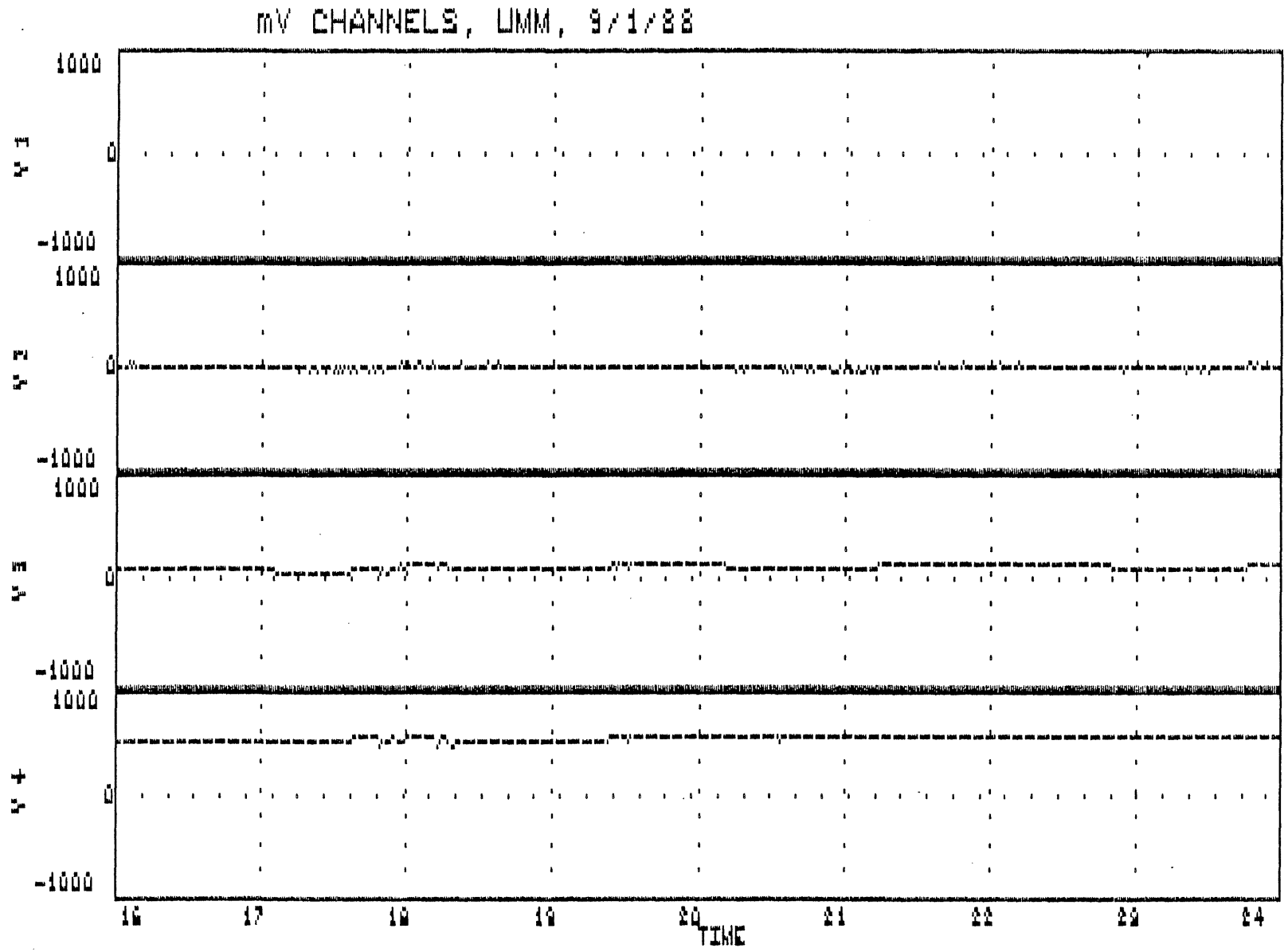
-1000
E1
E2
E3
E4
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/1/88
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-1000
E-W
1000
0
-1000
N-S
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-1000
+V
1000
0
-1000
16
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18
19
20
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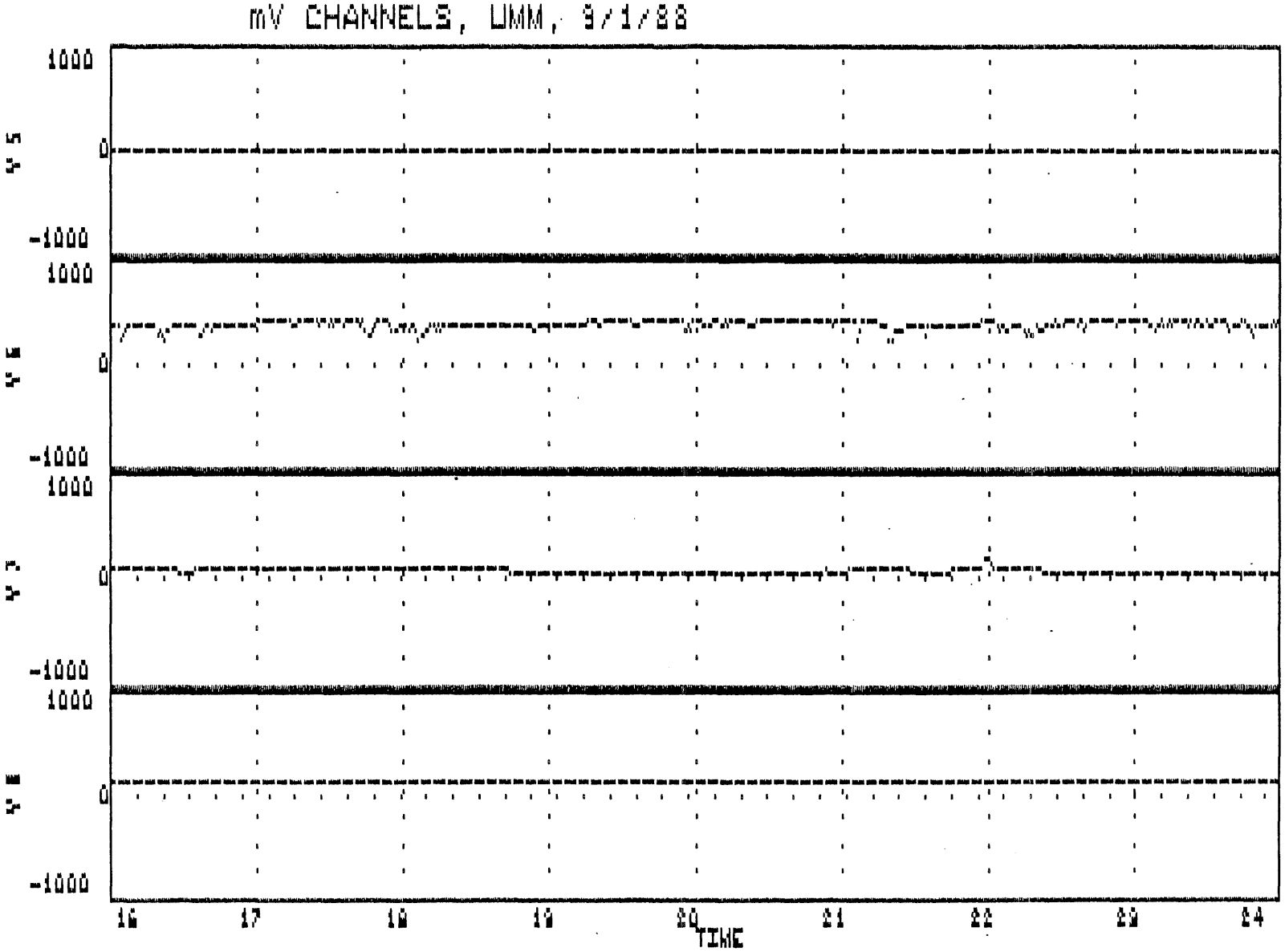
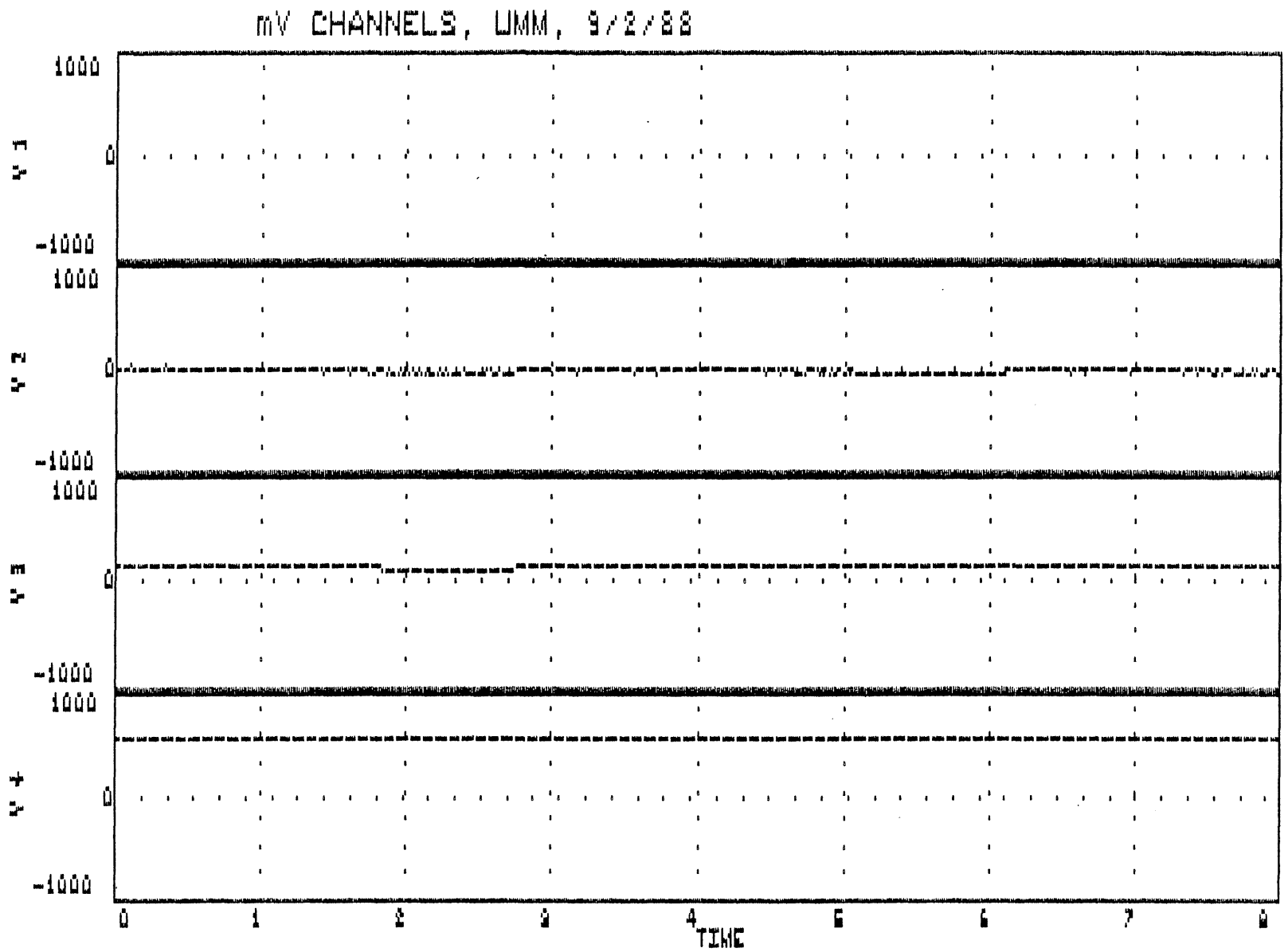
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/2/88
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-1000
Ex
1000
0
-1000
Ey
1000
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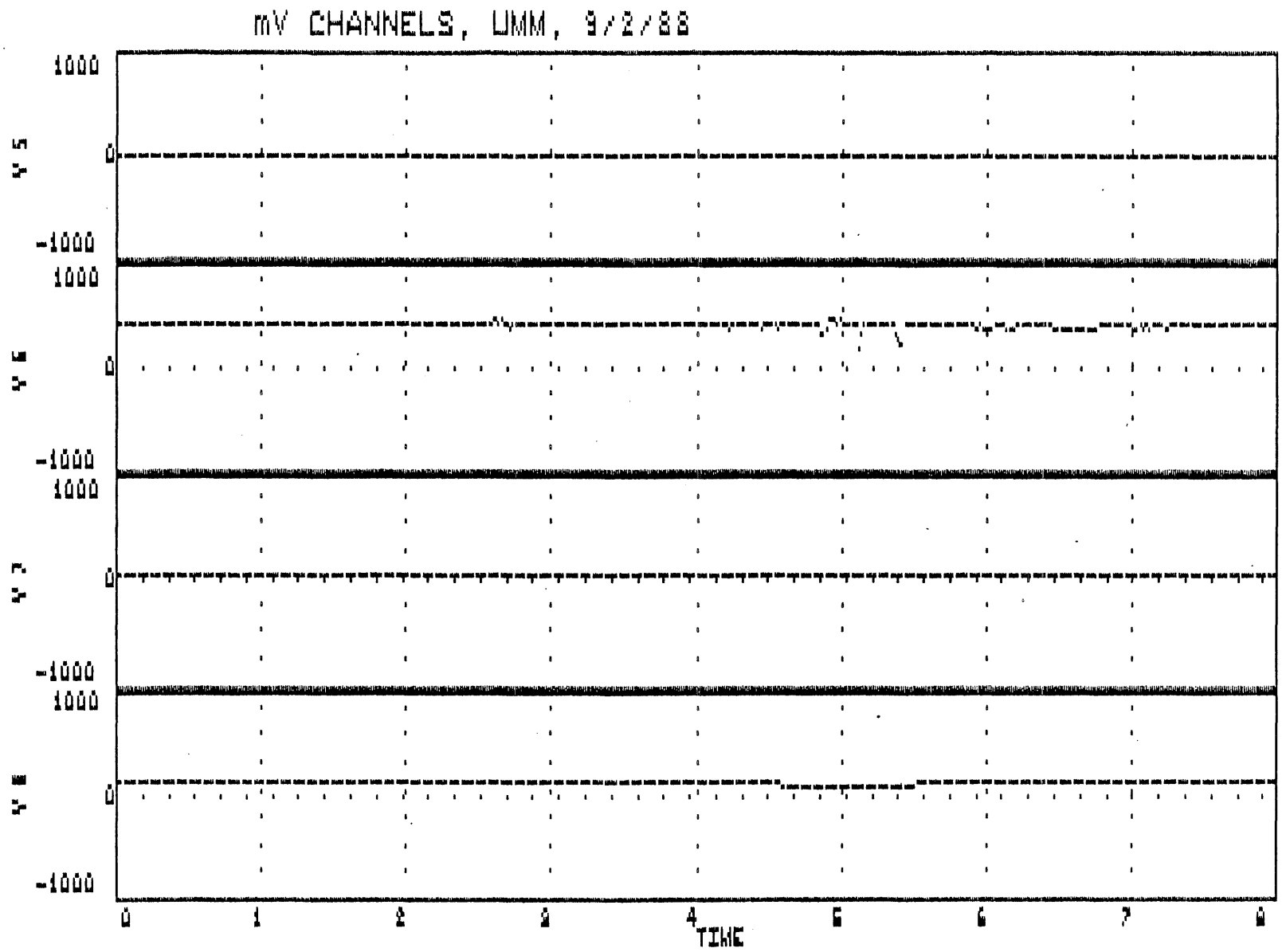
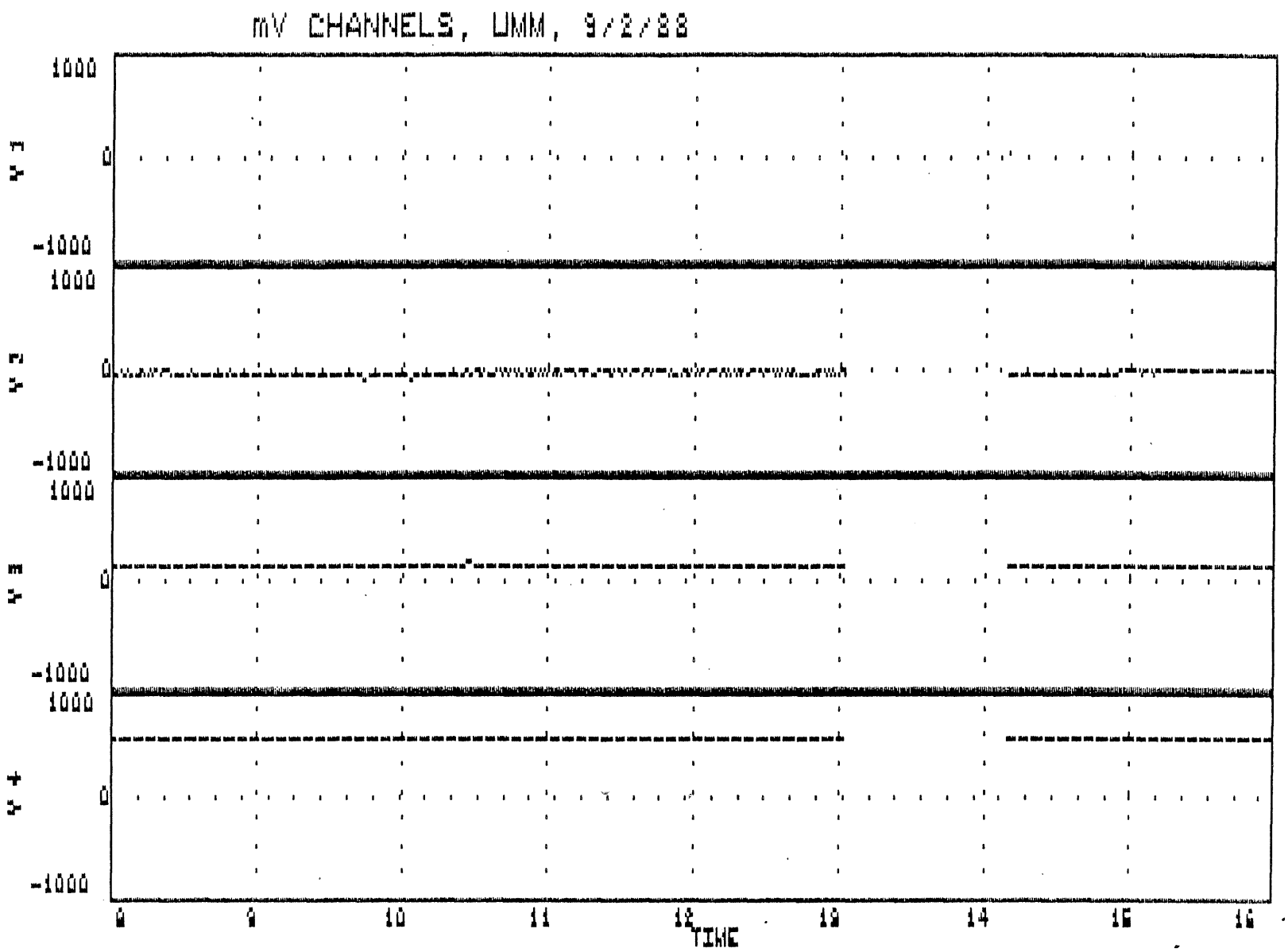
-1000
Ez
1000
0
-1000
Hx
0
1
2
3
4
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UNM, 9/2/88
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-1000
E-W
1000
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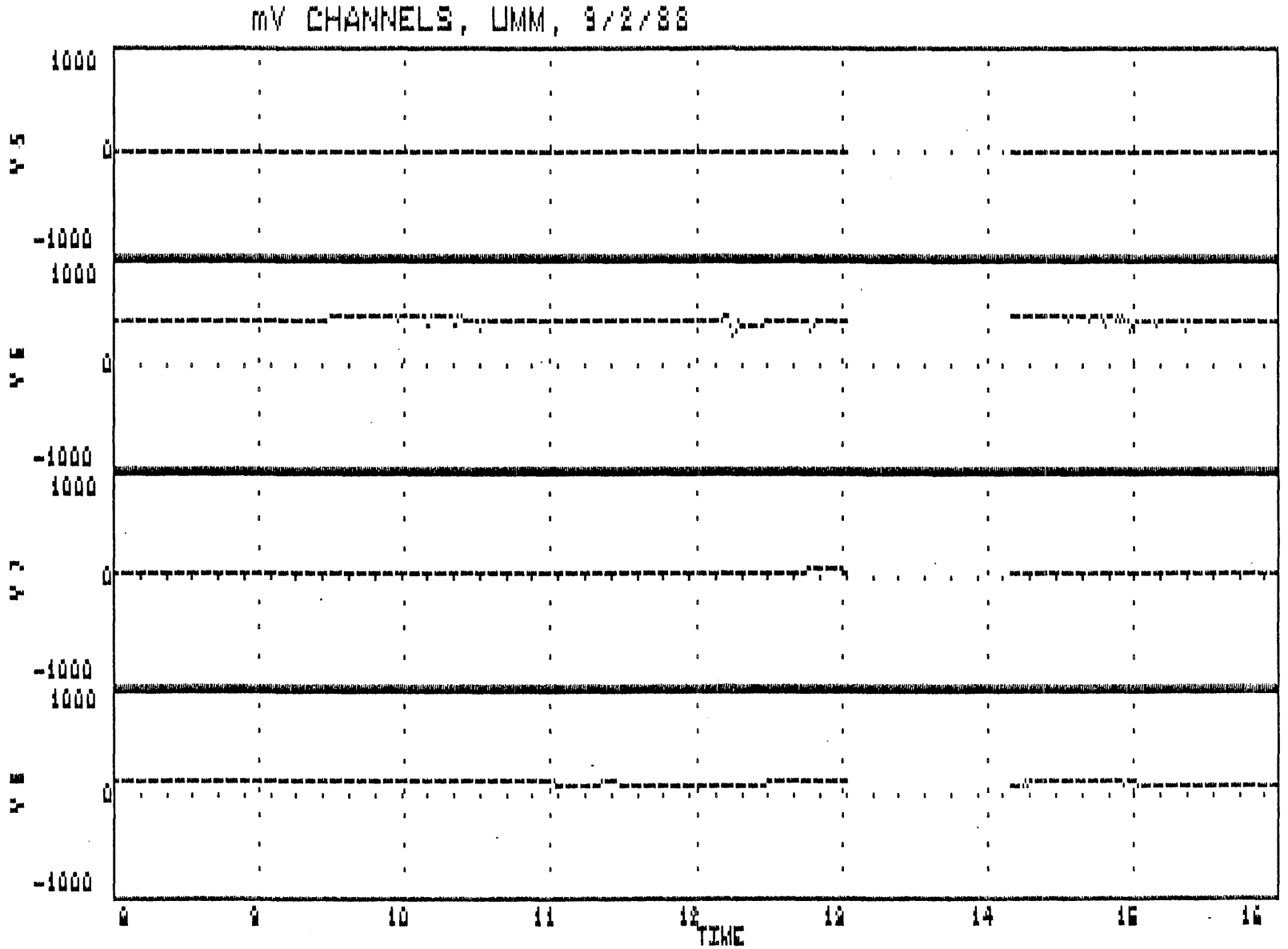
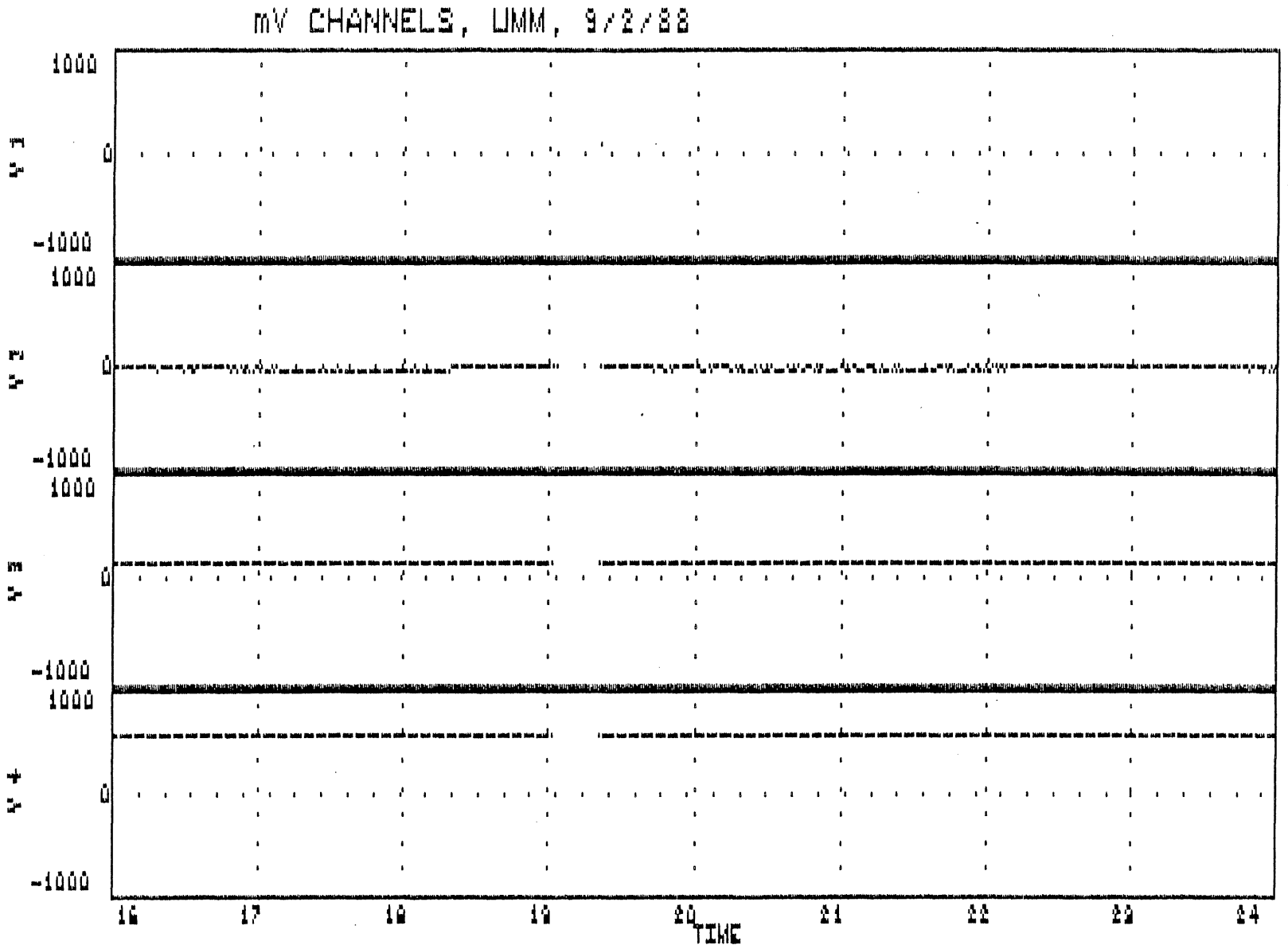
-1000
N-S
1000
0
-1000
+V
1000
0
-1000
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	front block
V3	front block	front block on mat	V7	neutral (ac/rms)	barn ground
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/2/88
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-1000
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-1000
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22
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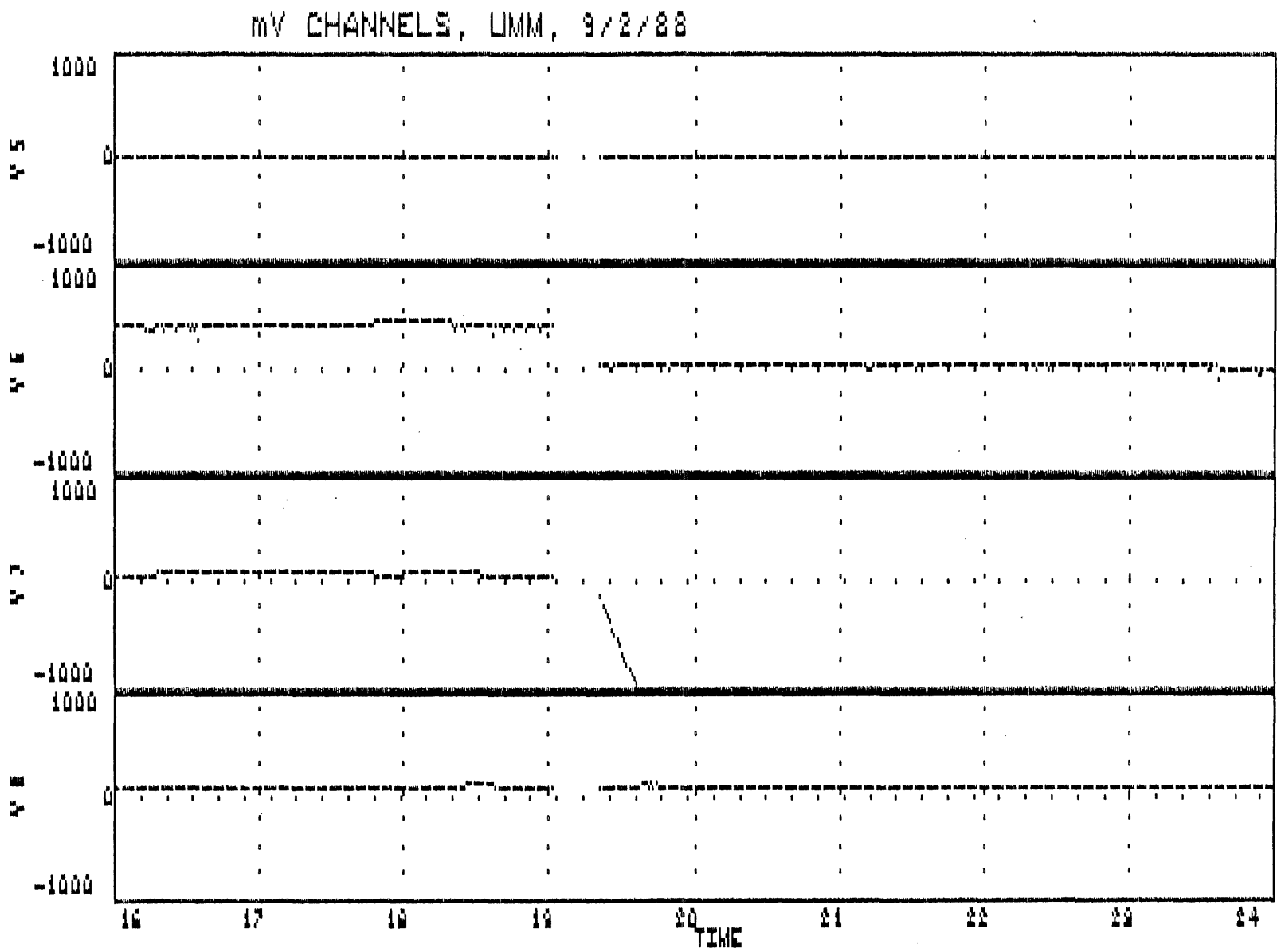
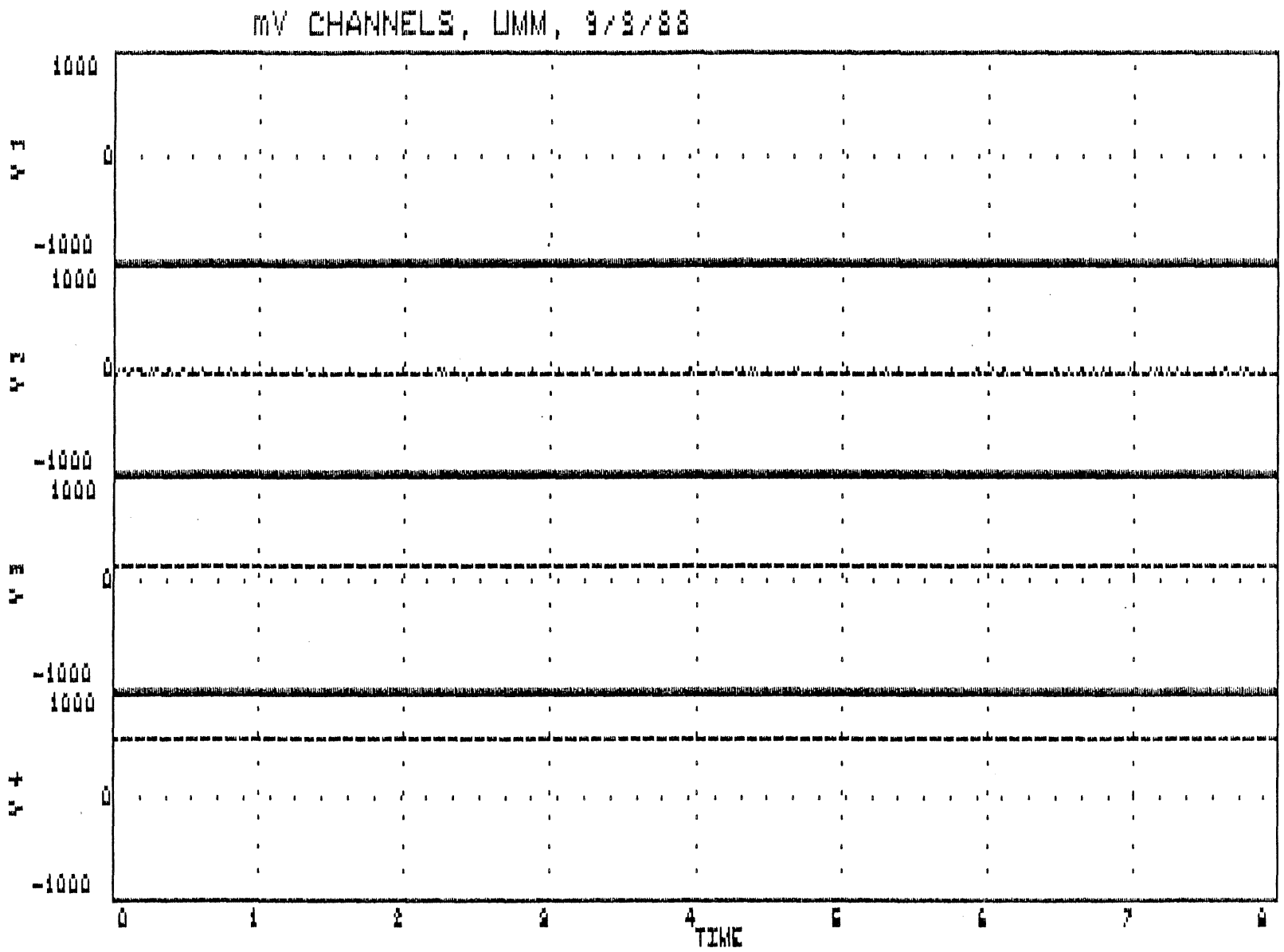
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/8/88
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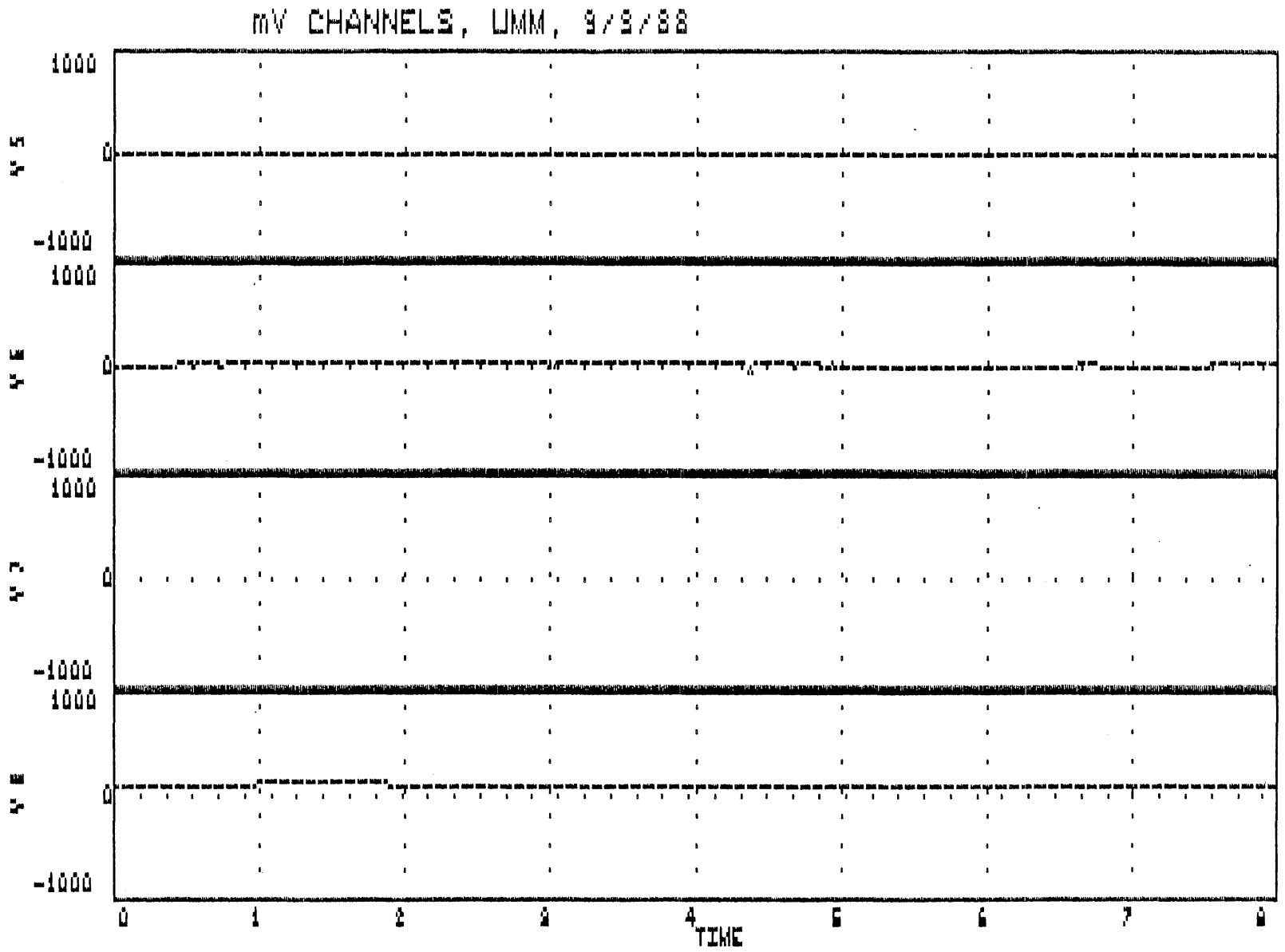
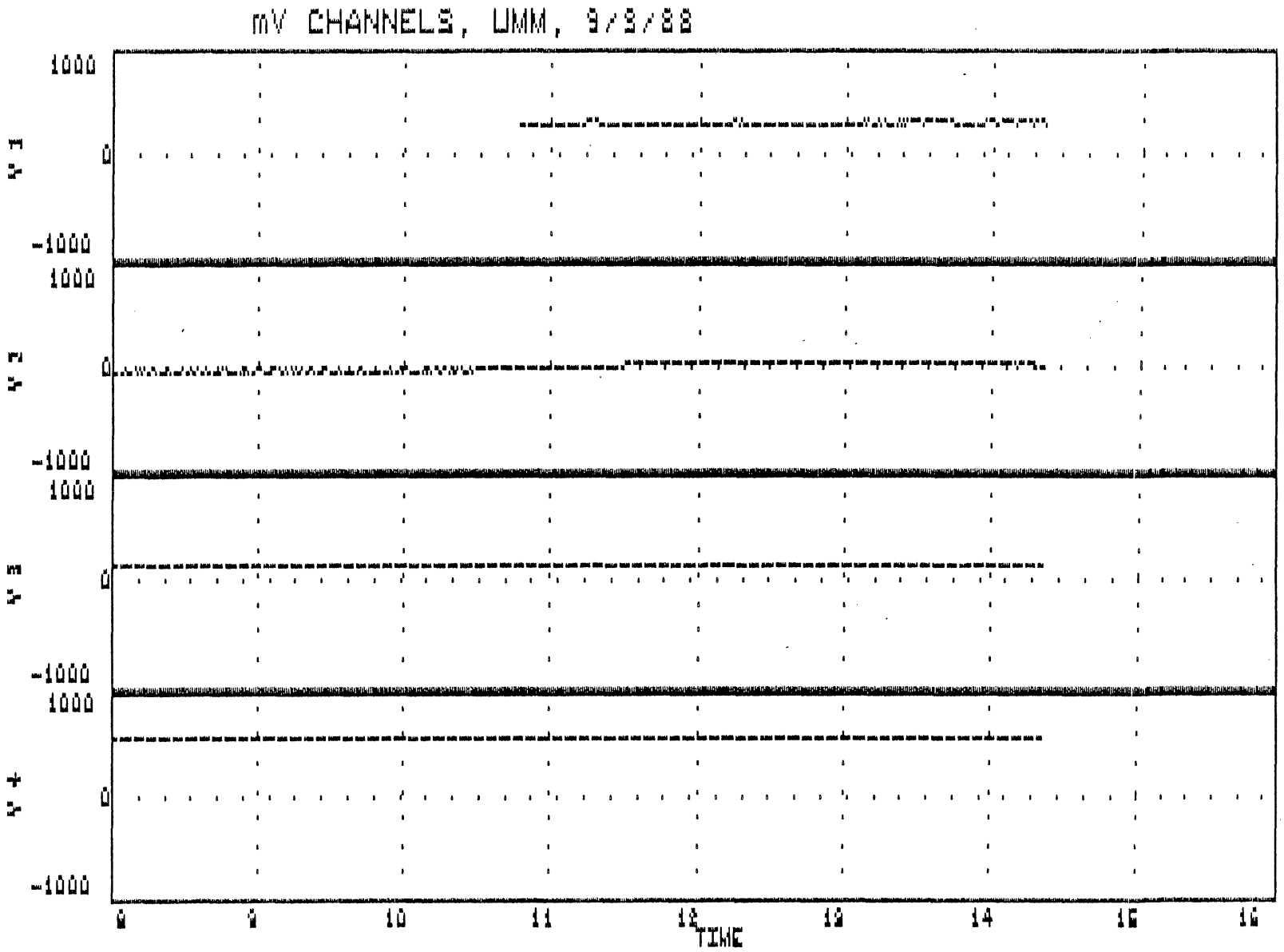
-1000
E1
E2
E3
+5
TIME
0
1
2
3
4
5
6
7
8



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7		
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/8/88
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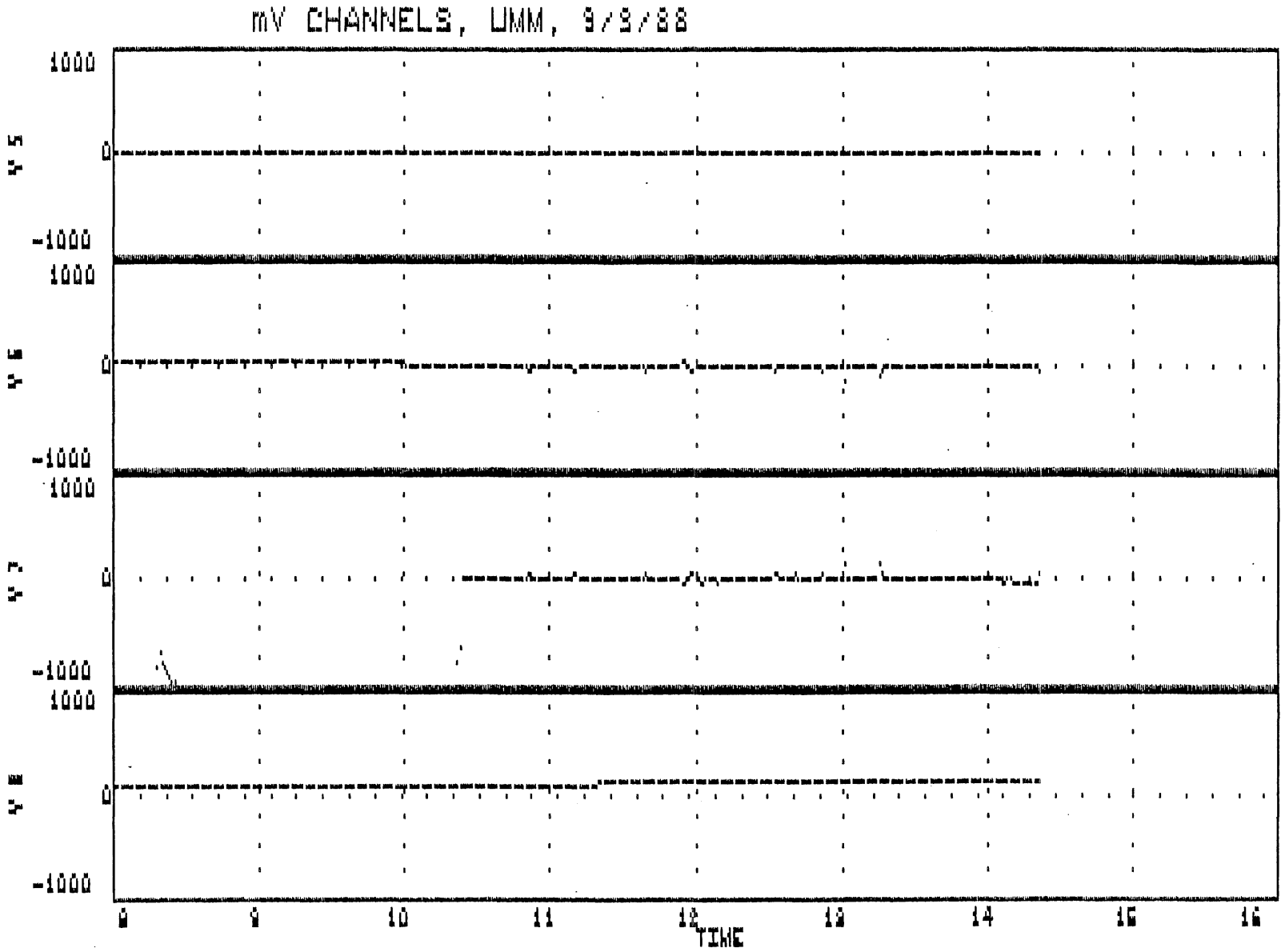
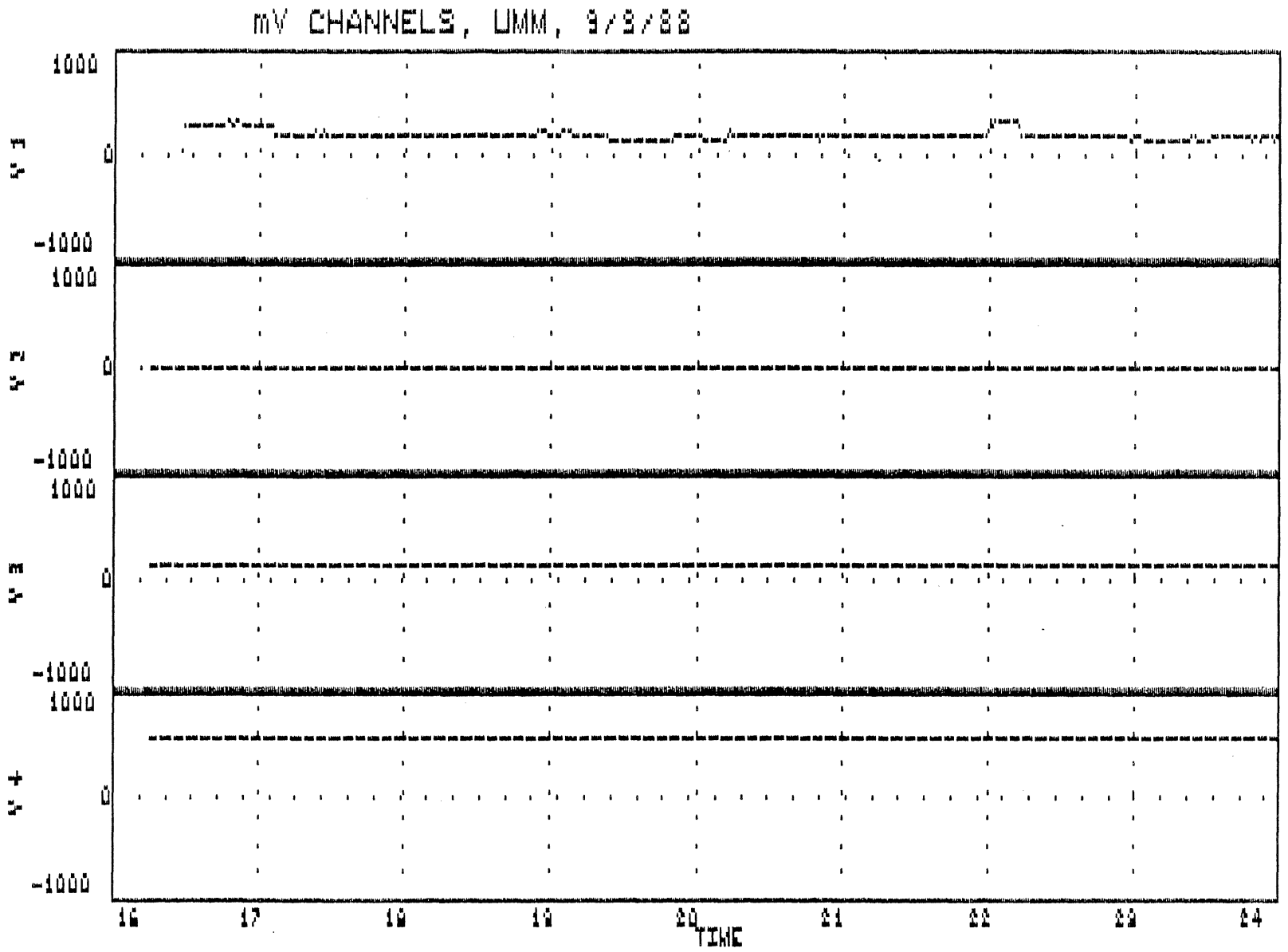
0
-1000
E W
N S
+ V
TIME
9
10
11
12
13
14
15
16



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/8/88
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-1000
V 1
V 2
V 3
V 4
16
17
18
19
20
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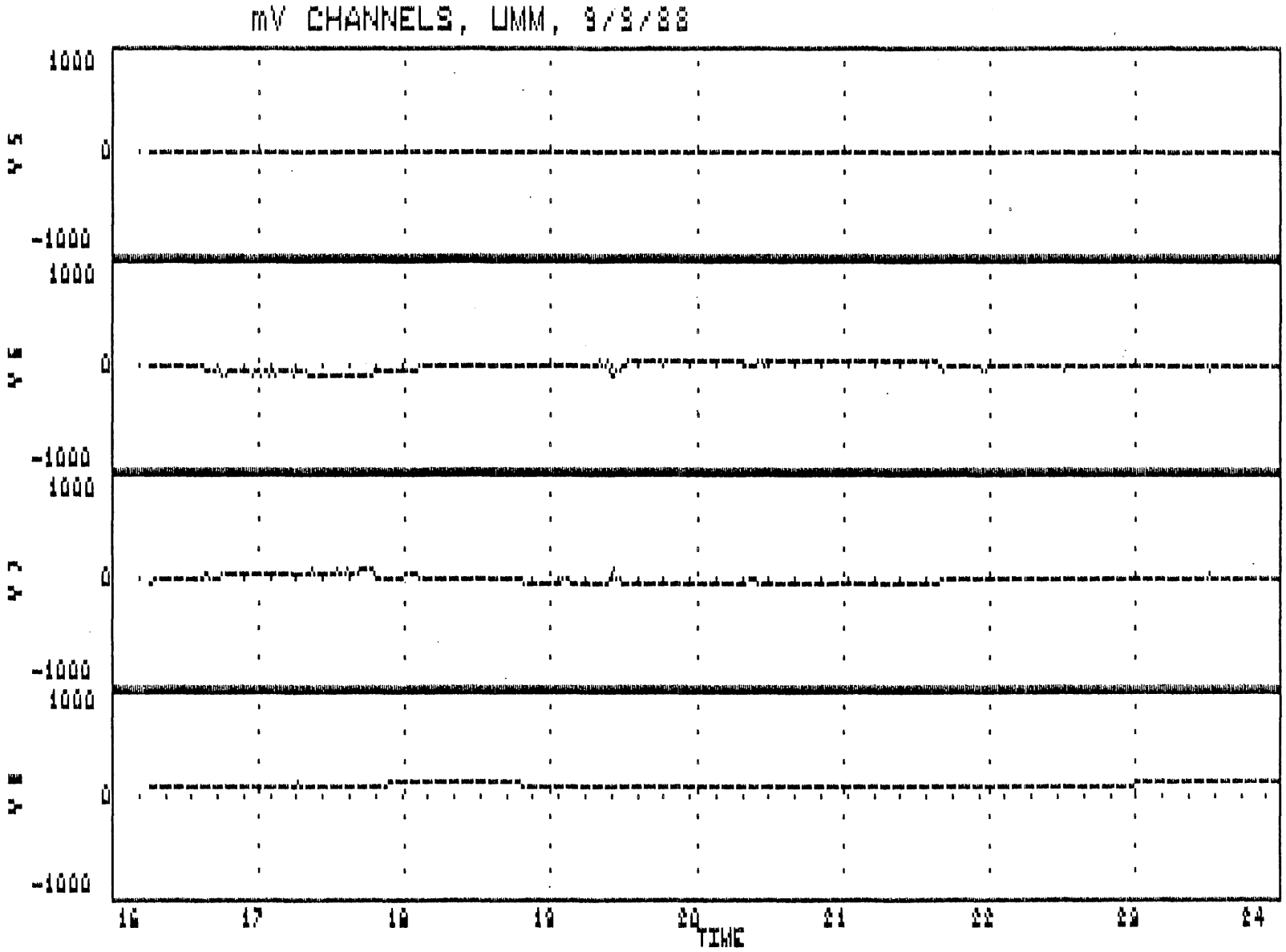
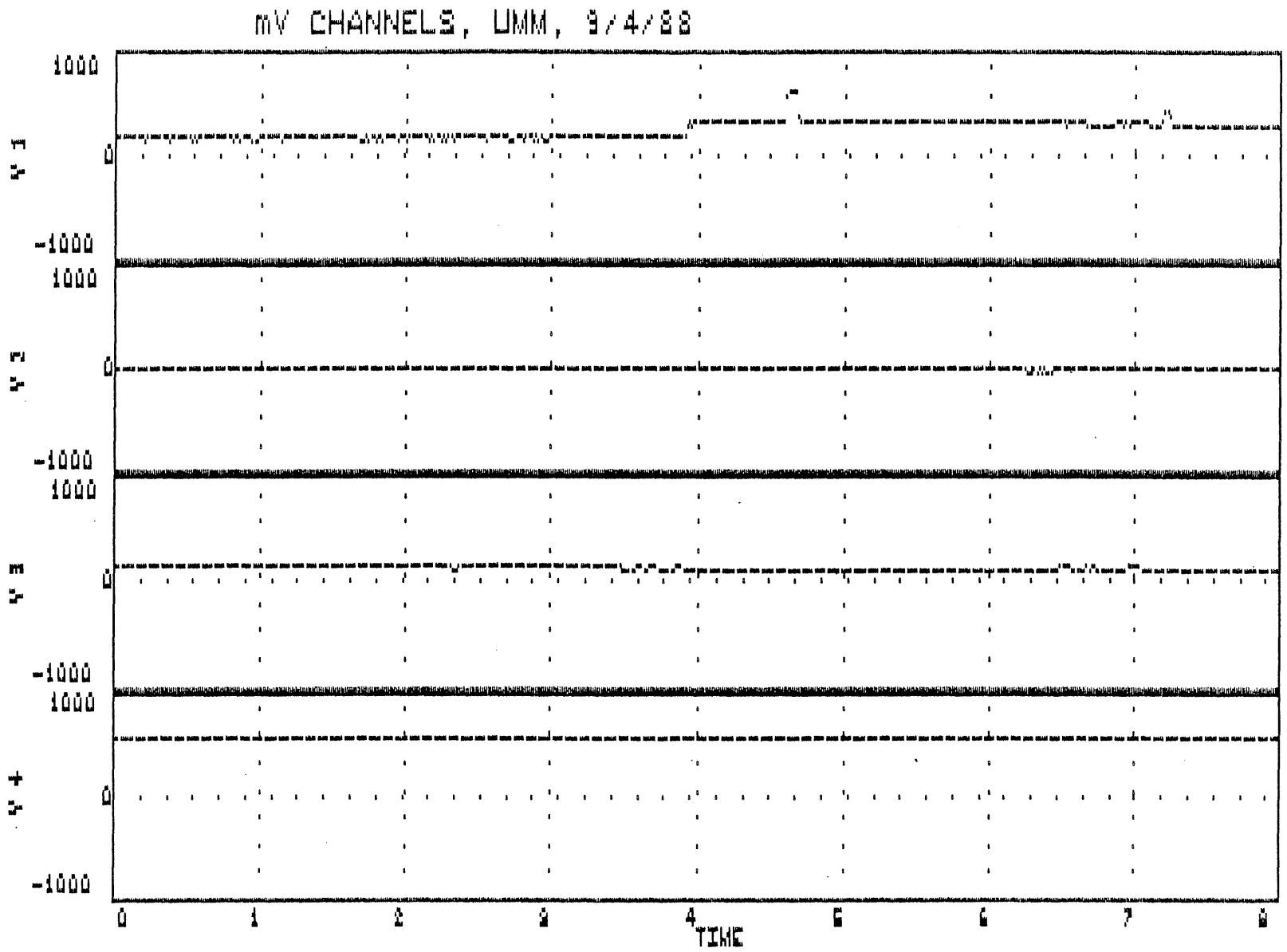
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B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-1000
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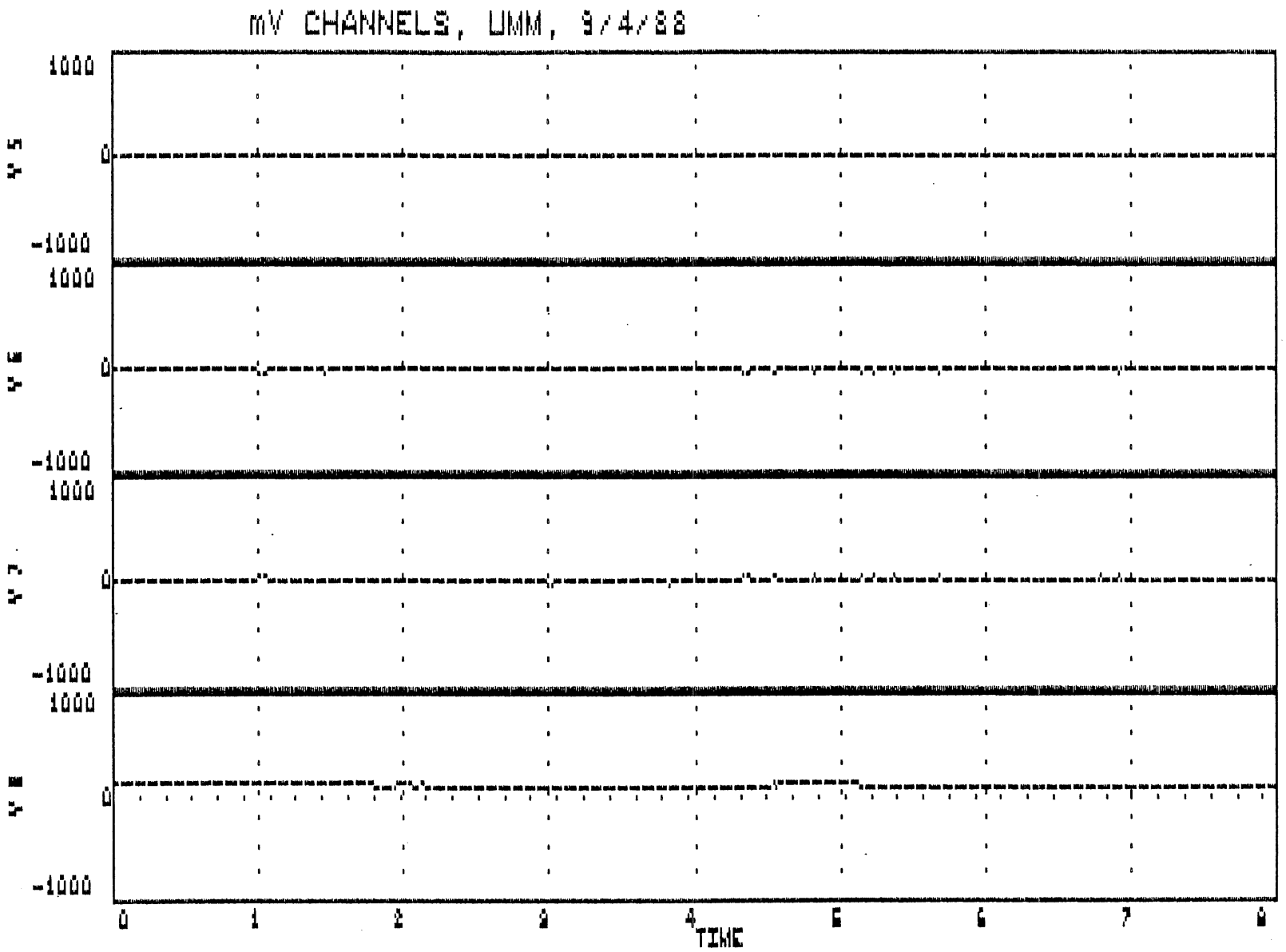
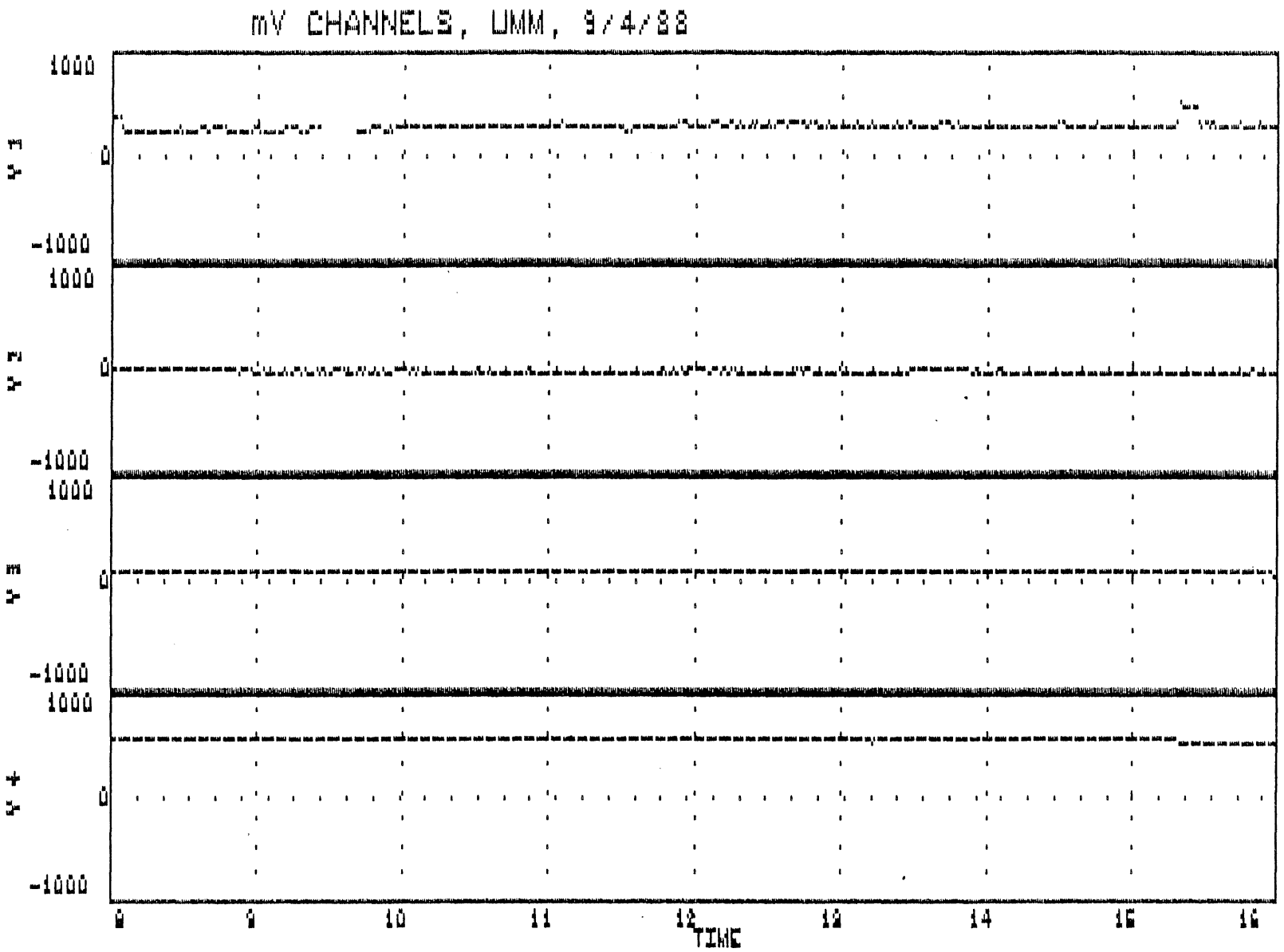
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/4/88
1000
0
-1000
CH 1
CH 2
CH 3
CH 4
8
9
10
11
12
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14
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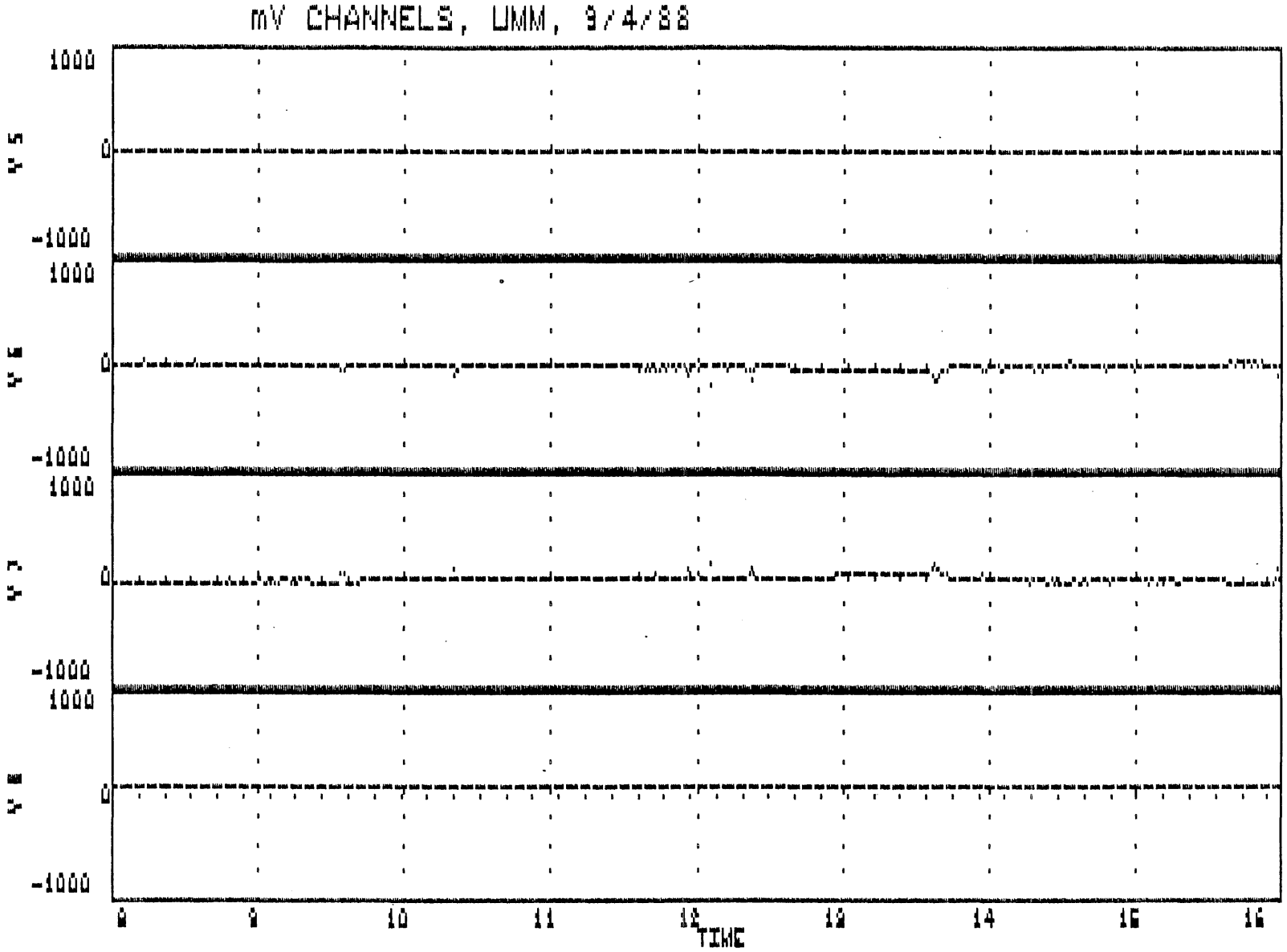
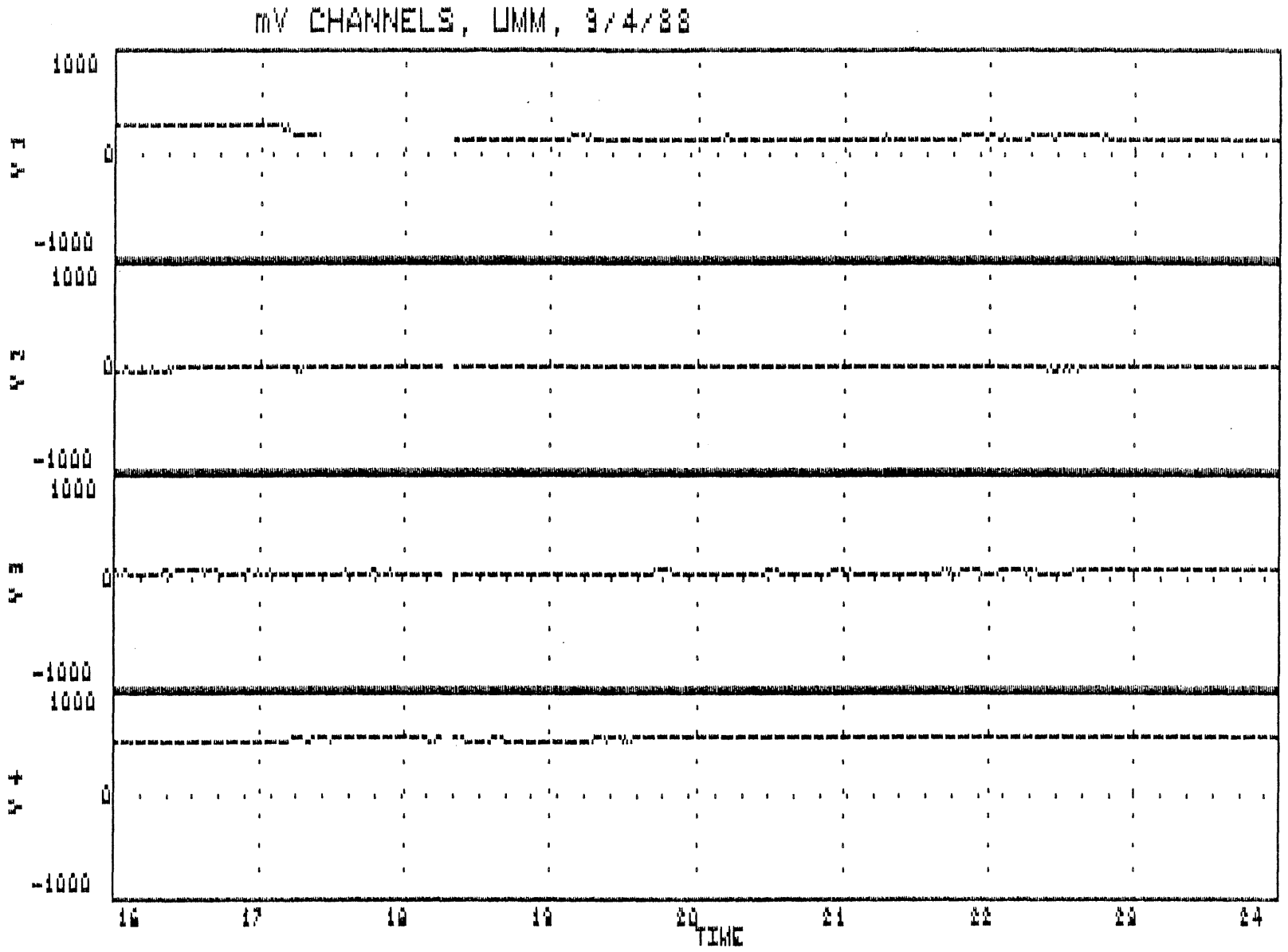
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/4/88
1000
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-1000
CH 1
CH 2
CH 3
CH 4
16
17
18
19
20
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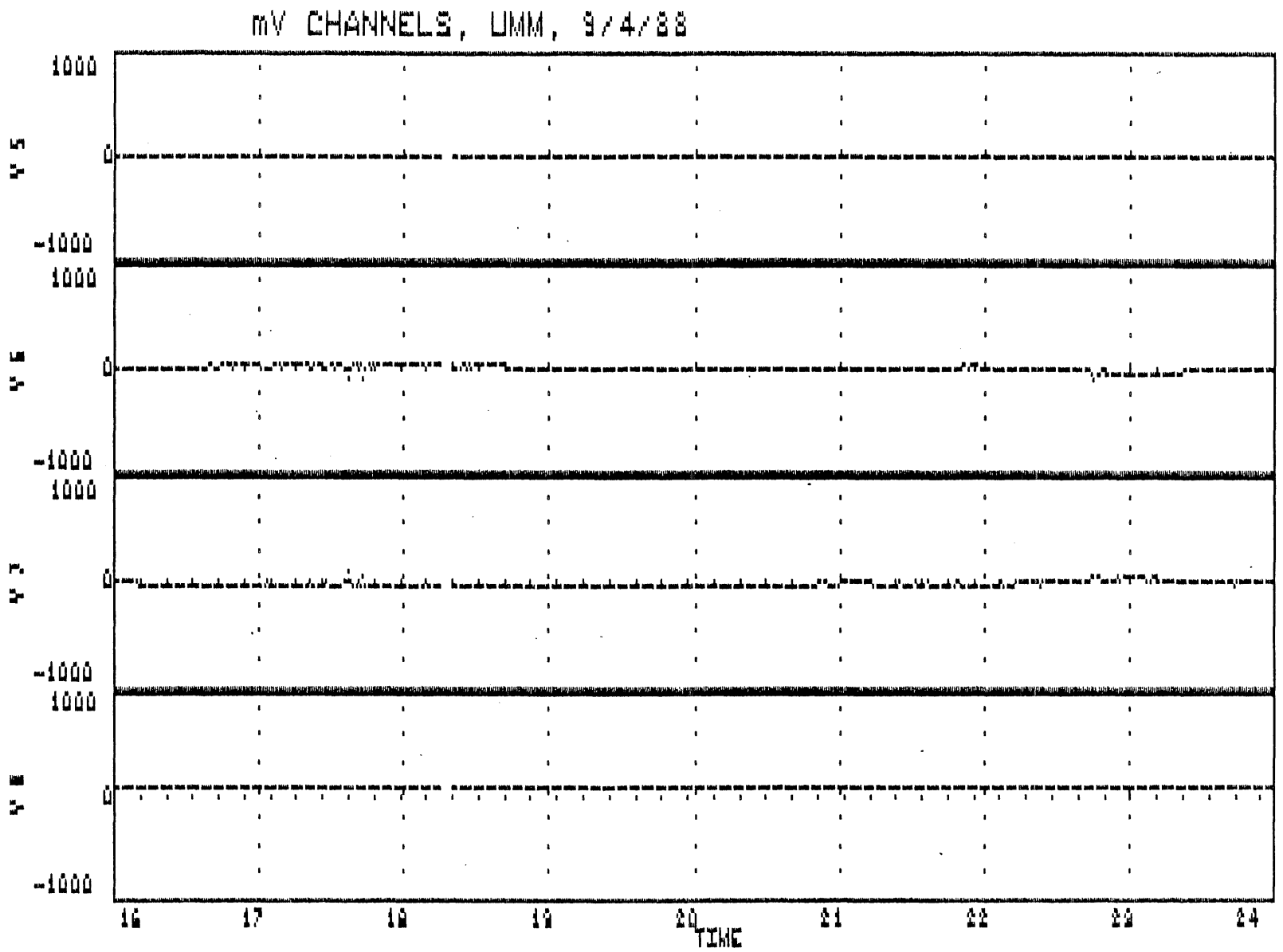
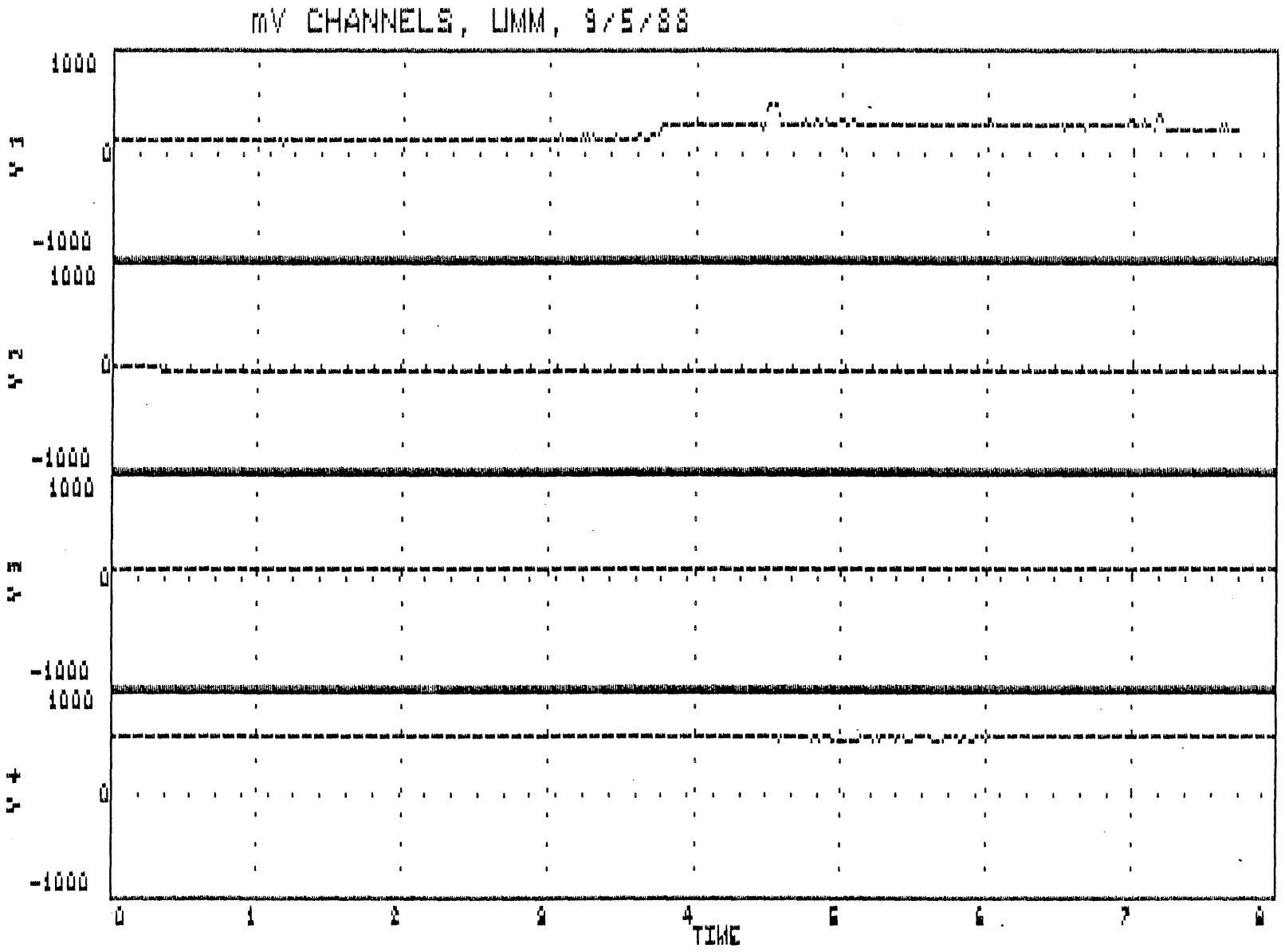
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/5/88
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-1000
E-W
N-S
TIME
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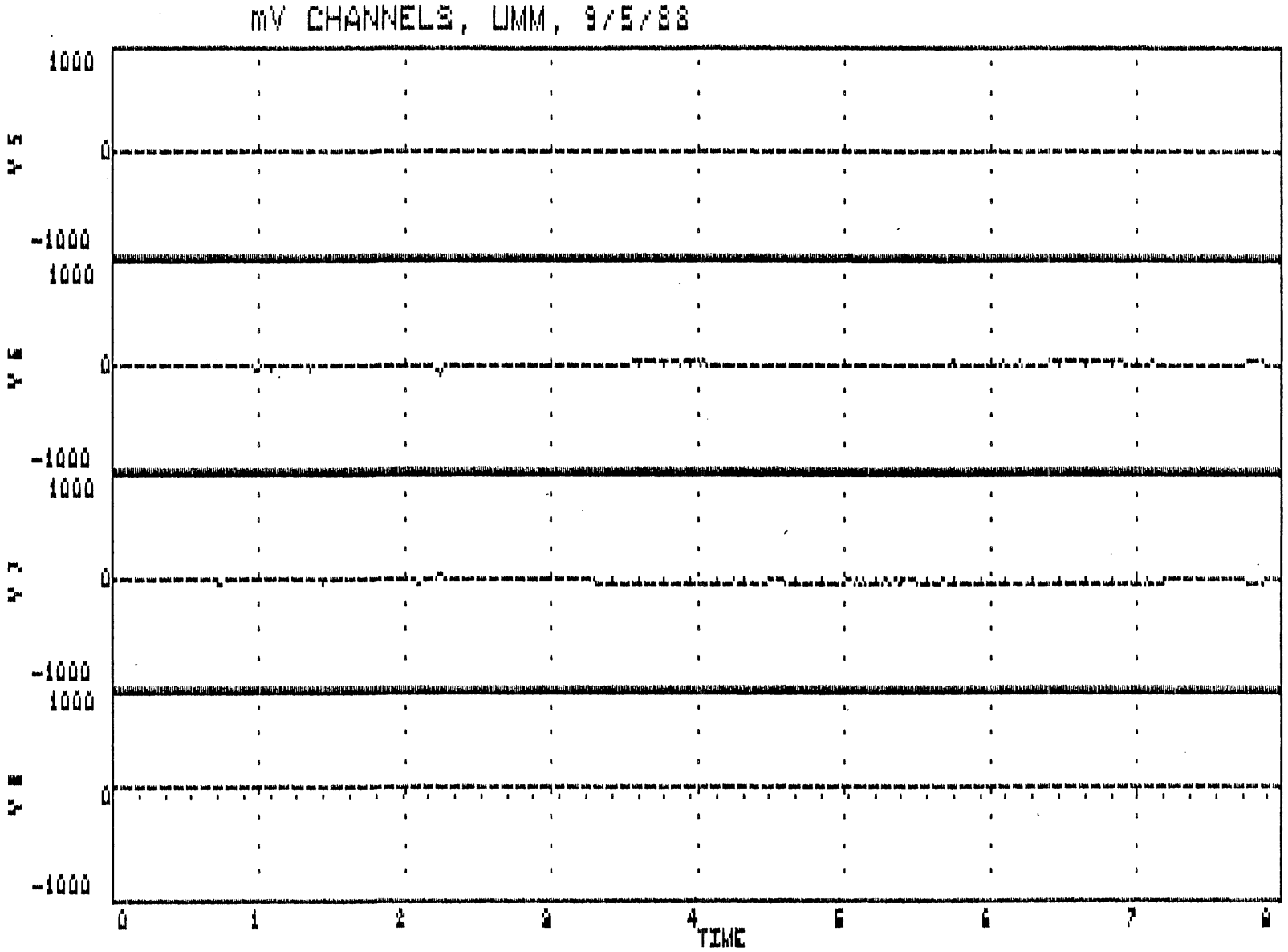
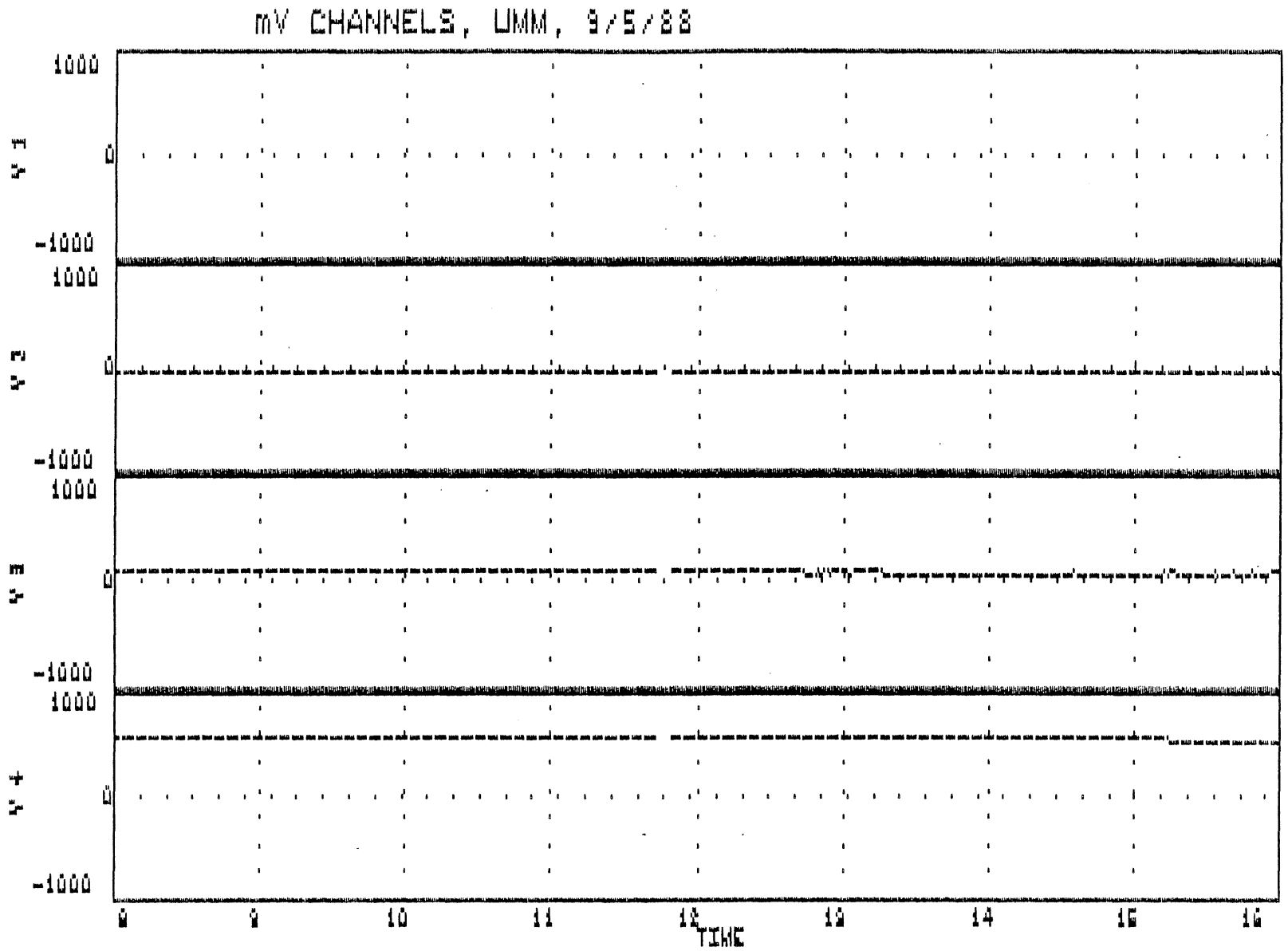


KEY

CHAN	HI	LO	CHAN	HI	LO
V1	B field (ac)	-	V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A	reference rod B


mV CHANNELS, UMM, 9/5/88
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-1000
E1
E2
E3
+5
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10
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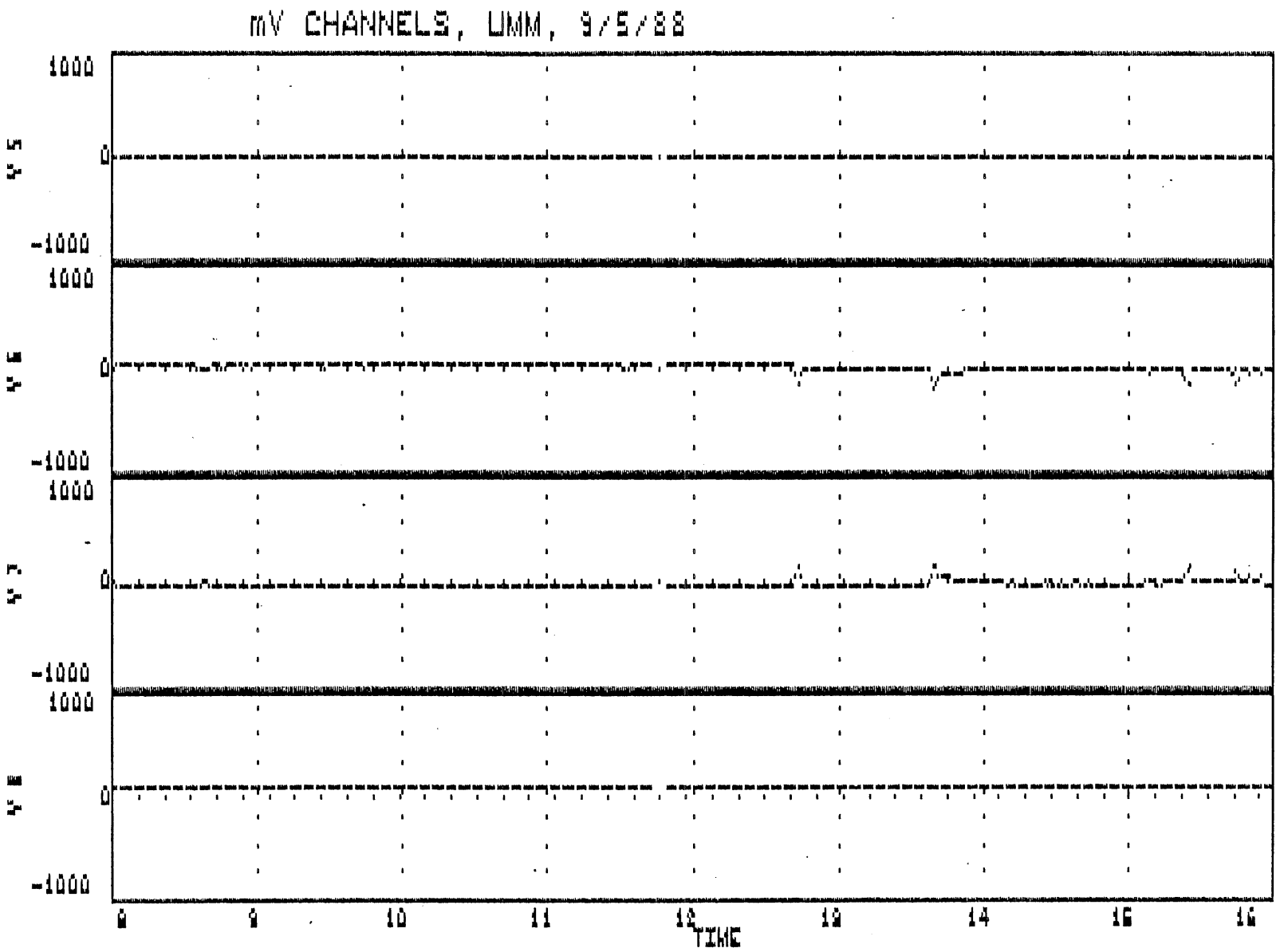
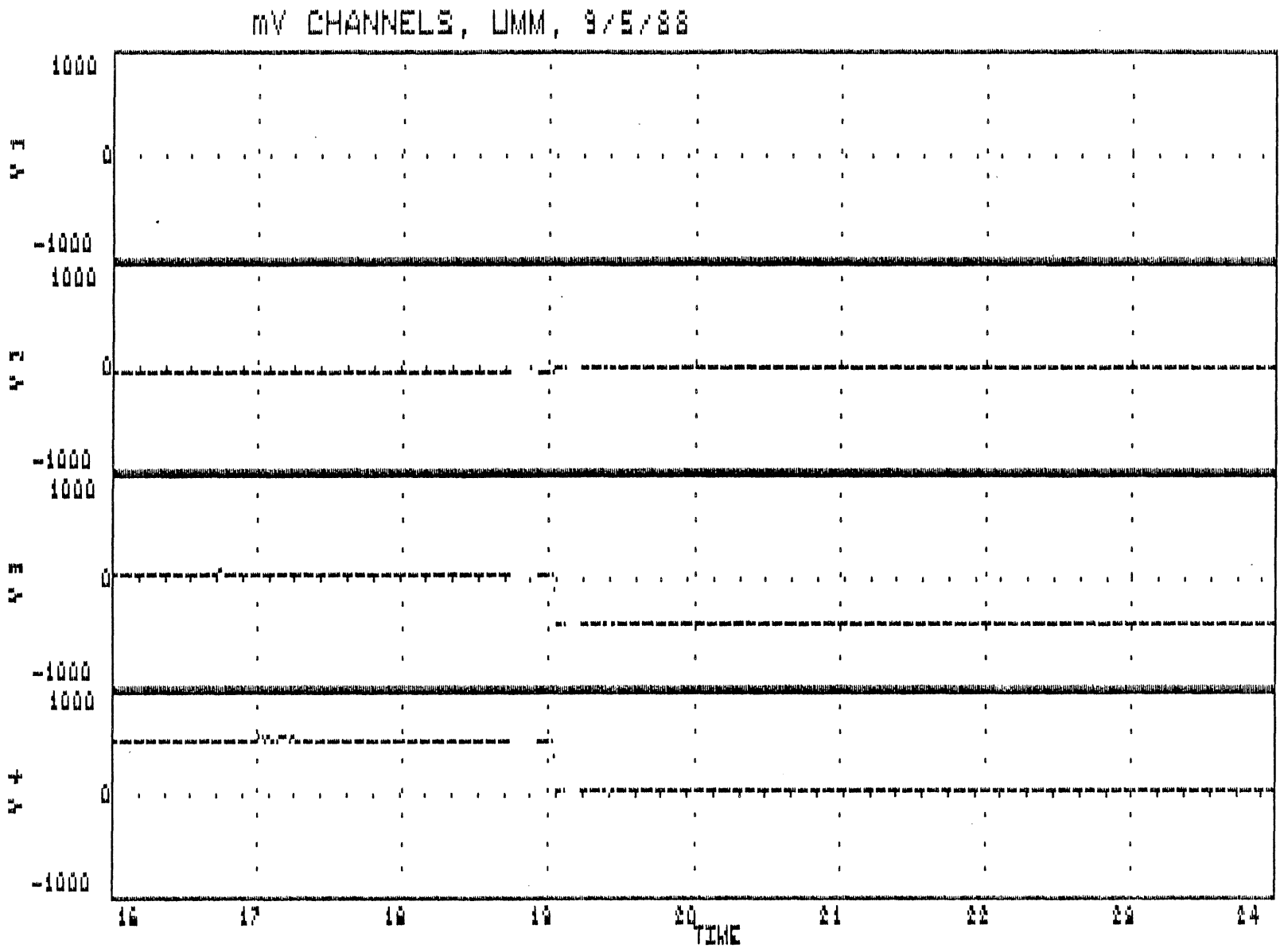
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	milkline (ac/rms)	front block on mat
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	reference rod A.	reference rod B


mV CHANNELS, UMM, 9/5/88
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-1000
E-W
N-S
TIME
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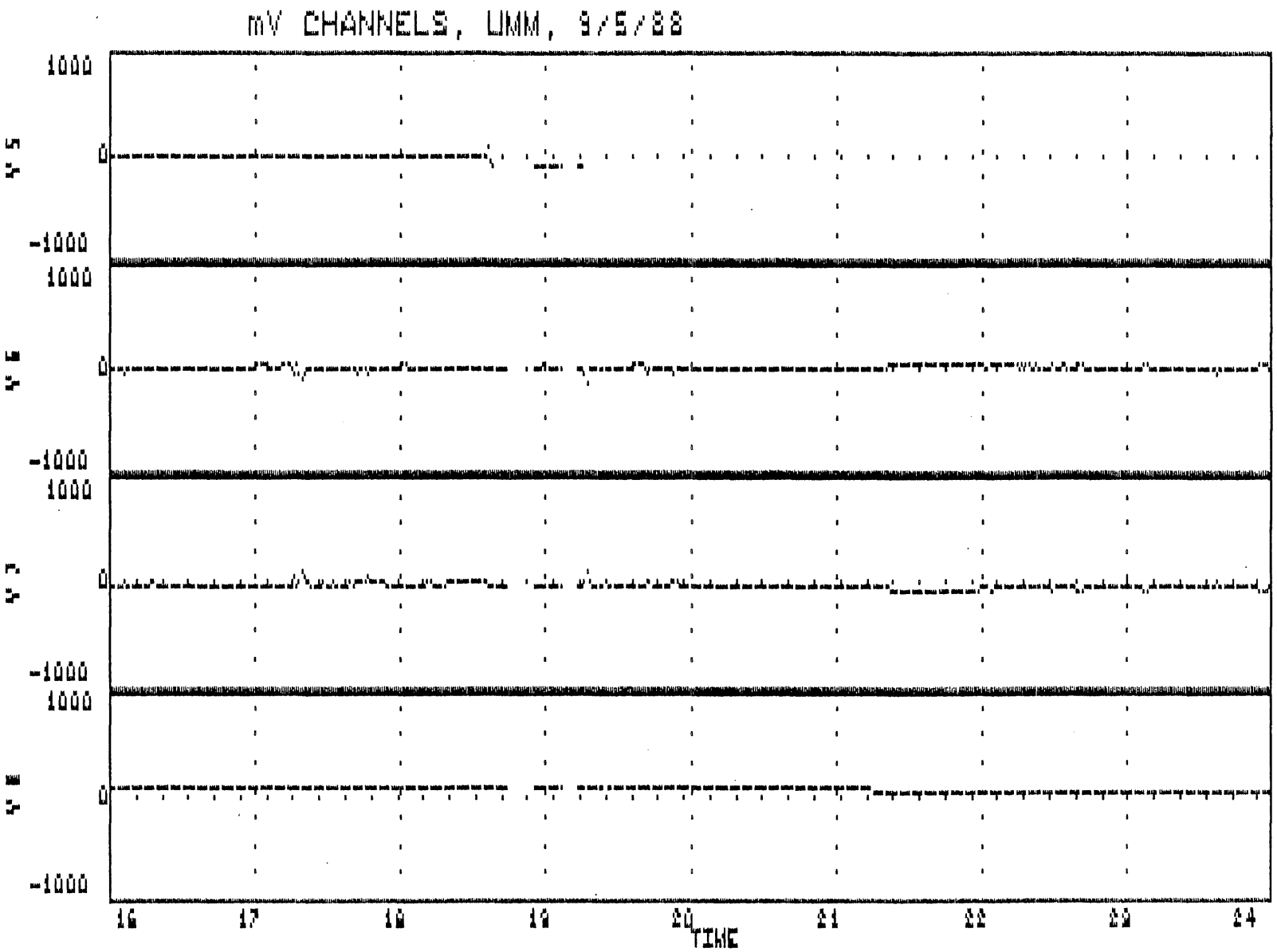
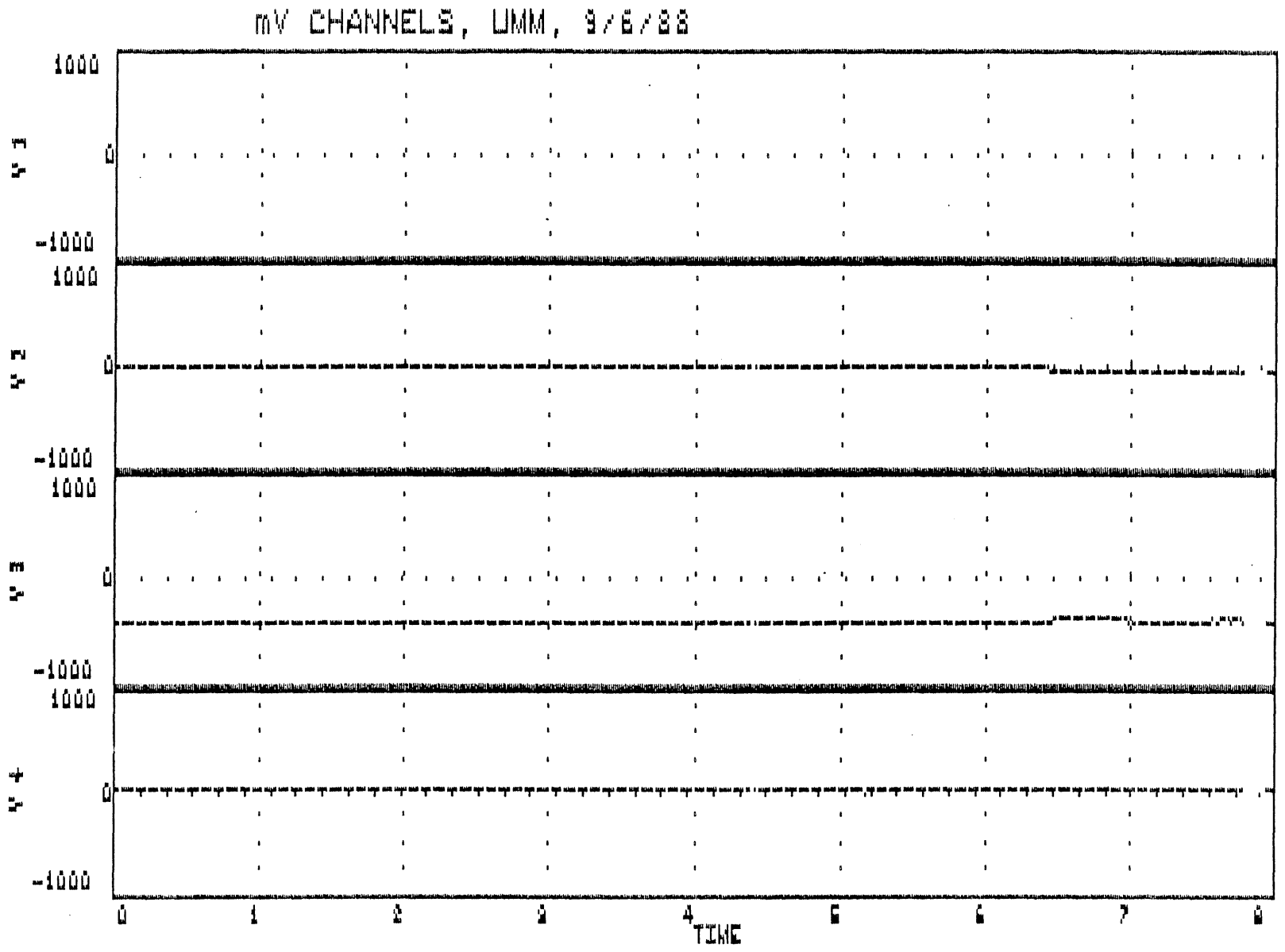


KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5		
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	ref rod A (ac/rms)	reference rod B


mV CHANNELS, UMM, 9/6/88
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-1000
E1
E2
E3
E4
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1
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4
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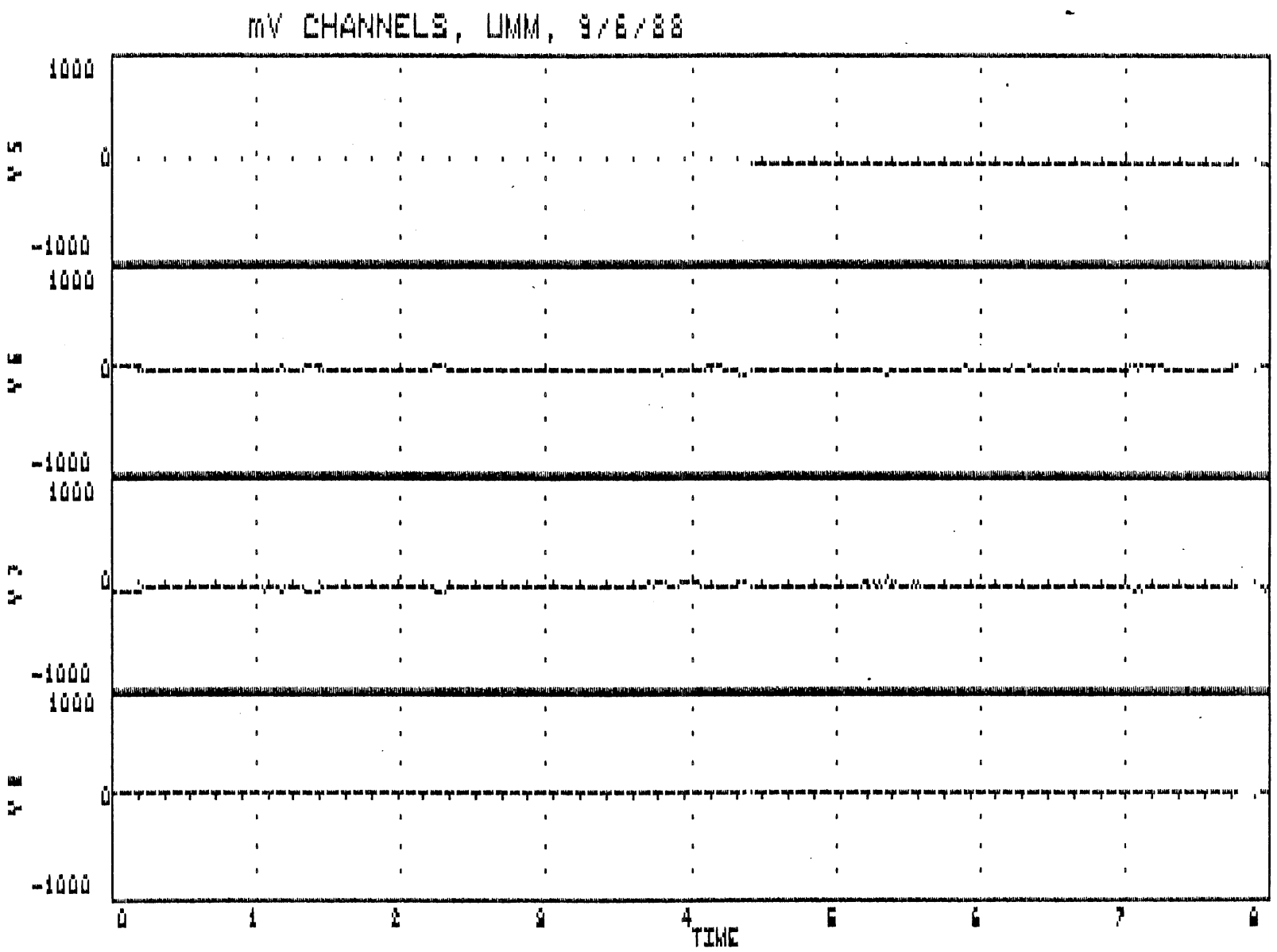
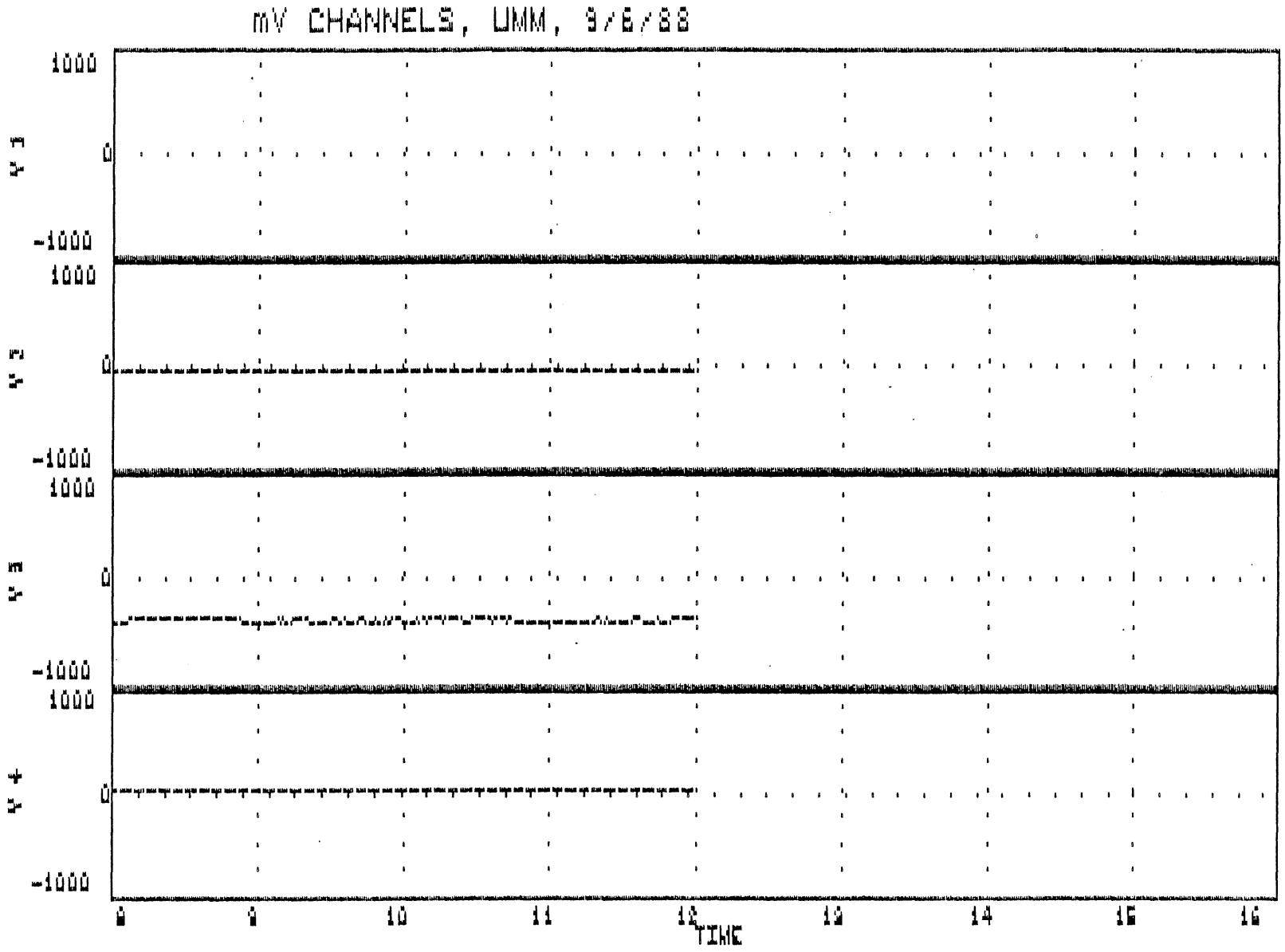
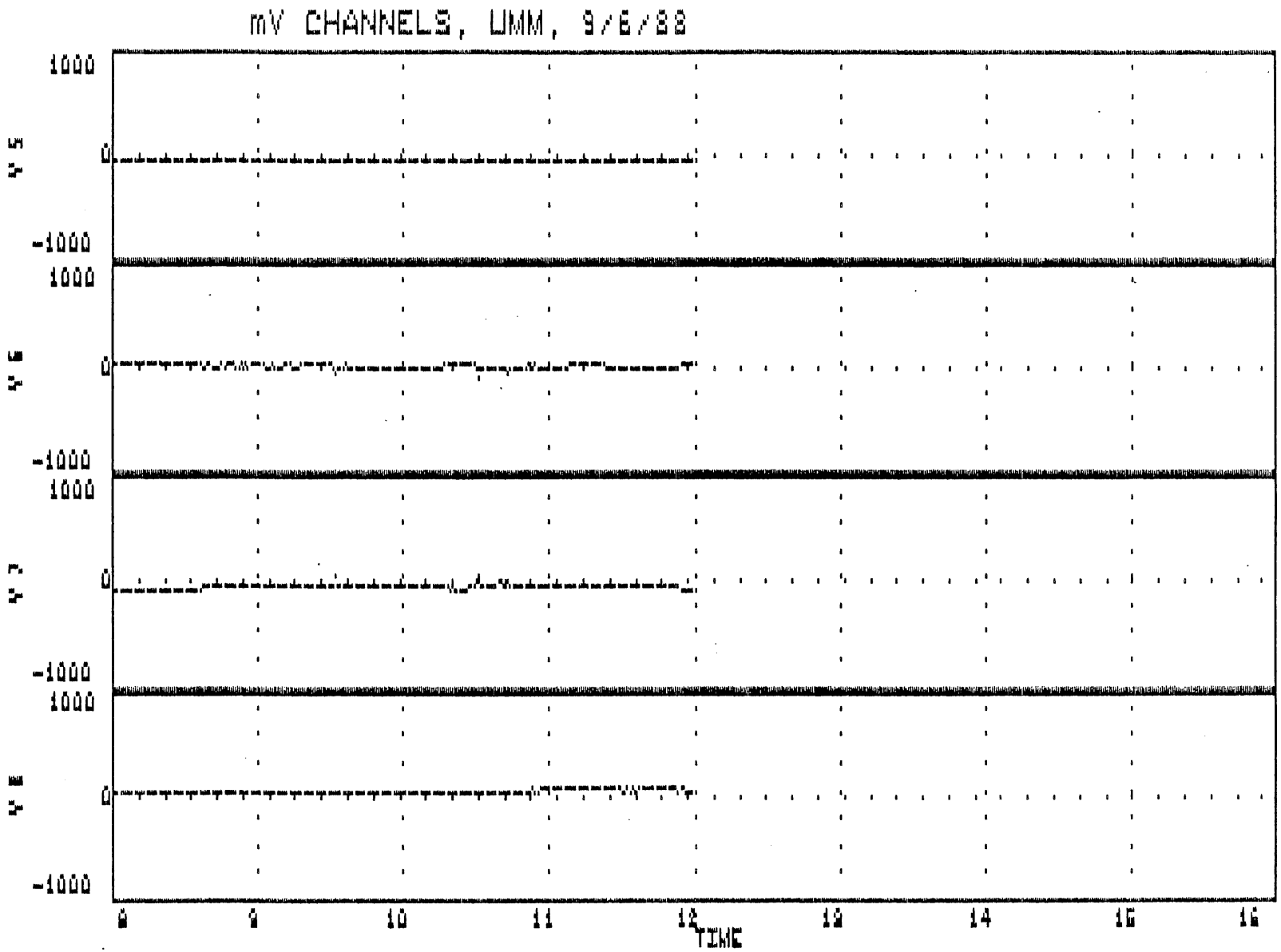
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5		
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	ref rod A (ac/rms)	reference rod B


mV CHANNELS, UMM, 9/6/88
1000
0
-1000
E1
E2
E3
E4
8
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5		
V2	front block	back block	V6	waterline	barn ground
V3	front block	front block on mat	V7	reference rod A	waterline
V4	milkline	front block on mat	V8	ref rod A (ac/rms)	reference rod B

University of Minnesota, Morris - General Observations

DC Millivolt Variables:
1. Barn ground to waterline: This potential varied between 0 and 100 mV with brief excursions to about 200 mV.
2.Front contact block to rear contact block (under mat): This potential (representing a dc step potential across concrete) was steady throughout, mostly near 0 mV but varying smoothly between about -100 and 100 mV. The 90-10%tile range was 43 to -61 mV.
3. Contact block under mat to contact block on mat: The measurement was generally steady, varying smoothly between about 0 and 100 mV. The statistical range was 163 to 14 mV (90-10%tile).
4. Milkline to contact block on mat: This dc potential was steady at approximately 500 mV throughout. The 90-10%tile range was 562 to 488 mV.
5. Vacuum line to water line: This dc potential was generally steady near 0 mV with brief excursions to 100 or 200 mV.
6. Water line to contact block under mat: Steady at 500 or 600 mV with brief excursions down to 300 or 400 mV.
7. Stanchion to water line: Steady near 0 mV with brief excursions to 100 or 200 mV.
8. Remote reference rod A to remote reference rod B: Generally steady between -100 and 100 mV. Range 118 to -87 mV (90-10%tile).
9. Water line to barn ground: Steady with brief excursions to -100 mV.
10. Remote reference rod A to waterline: Steady near 0 mV with brief excursions to 100 mV.

AC (true rms) Millivolt Variables:
1. Milkline to contact block on mat: Steady near 0 mV.
2. Outlet neutral to barn ground: Steady near 0 to 100 mV with brief excursions to 200 mV.
3. Remote reference rod A to remote reference rod B: Steady between 0 and 100 mV.

DC electric field: No dc electric field was detectable near the floor with the field mill.

AC magnetic field: As in the other barns, the ac magnetic field was measurable but small. In this barn, the structure of the data suggests a dependence on operation of nearby exhaust fans and/or fluorescent lights.

No systematic anomalies were noted in the primary data base which could be attributed to milking activities. On the other hand, structure in the data for several variables referred to by the often-used term, "brief excursions" above, suggests that small shifts in these potentials are the result of occasional operation of equipment, probably large motors such as silo unloaders and

ventilation fans.

Extreme variability in the data near the beginning of the data file coincided with an underground fault in the service to the experiment station and the resulting use of auxiliary generator power. A more thorough analysis of this portion of the data base is strongly recommended.

Weather variables: The following table presents the distribution of weather variables over the Borgerding monitoring period.

Variable	90%tile	50%tile	10%tile
Temp(degF)	77	61	47
Bar Pres	30.1	30.0	29.8
Wind(mph)	6	2	0
Rel Hum	78	58	27

KENNING

PRIMARY

DATA

FILE

9/9/88 to 9/14/88

----------NCSS Editor----------

Data Base Name C:\BMD\KEN

No.	Variable	Rows	Vlab	Label
1	DATE	6,460		
2	TIM	6,460		
3	V1	6,460		CH#1 (mV)
4	V2	6,460		CH#2 (mV)
5	V3	6,460		CH#3 (mV)
6	V4	6,460		CH#4 (mV)
7	V5	6,460		CH#5 (mV)
8	V6	6,460		CH#6 (mV)
9	V7	6,460		CH#7 (mV)
10	V8	6,460		CH#8 (mV)
11	T	6,460		TEMPERATURE (deg C)
12	BP	6,460		BAROMETRIC PRESSURE (in.H2O)
13	WD	6,460		WIND DIRECTION (deg)
14	WS	6,460		WIND SPEED (mph)
15	P	6,460		PRECIPITATION TOTAL (in.)
16	RH	6,460		RELATIVE HUMIDITY (%)
17	TIME	6,460		DECIMAL TIME
18	C18	0		
19	C19	0		
20	C20	0		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

Detail Report

Variable: V1	CH#1 (mV)		
Mean - Average	-129.1488	No. observations	6460
Lower 95% c.i.limit	-221.9323	No. missing values	6097
Upper 95% c.i.limit	-36.36526	Sum of frequencies	363
Adj sum of squares	2.944832E+08	Sum of observations	-46881
Standard deviation	901.9365	Std.error of mean	47.33939
Variance	813489.5	T-value for mean=0	-2.728146
Coef. of variation	-6.983703	T prob level	0.0064
Skewness	-5.24376	Kurtosis	25.64345
Normality Test Value	0.826	Reject if > 1.015(10%)	1.025(5%)
100-%tile (Maximum)	130	90-%tile	38
75-%tile	36	10-%tile	34
50-%tile (Median)	36	Range	5130
25-%tile	35	75th-25th %tile	1
0-%tile (Minimum)	-5000		

Variable: V2	CH#2 (mV)		
Mean - Average	134.7042	No. observations	6460
Lower 95% c.i.limit	126.9356	No. missing values	0
Upper 95% c.i.limit	142.4727	Sum of frequencies	6460
Adj sum of squares	6.555112E+08	Sum of observations	870189
Standard deviation	318.5719	Std.error of mean	3.963612
Variance	101488	T-value for mean=0	33.98521
Coef. of variation	2.364974	T prob level	0.0000
Skewness	-.29754	Kurtosis	-1.879024
Normality Test Value	0.949	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	475	90-%tile	438
75-%tile	420	10-%tile	-257
50-%tile (Median)	371	Range	757
25-%tile	-233	75th-25th %tile	653
0-%tile (Minimum)	-282		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

Detail Report

Variable: V3 CH#3 (mV)

Mean - Average	128.6311	No. observations	6460
Lower 95% c.i.limit	120.8631	No. missing values	0
Upper 95% c.i.limit	136.3991	Sum of frequencies	6460
Adj sum of squares	6.554167E+08	Sum of observations	830957
Standard deviation	318.5489	Std.error of mean	3.963327
Variance	101473.4	T-value for mean=0	32.45534
Coef. of variation	2.476453	T prob level	0.0000
Skewness	-.2978195	Kurtosis	-1.878922
Normality Test Value	0.923	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	469	90-%tile	432
75-%tile	414	10-%tile	-264
50-%tile (Median)	366	Range	758
25-%tile	-239	75th-25th %tile	653
0-%tile (Minimum)	-289		

Variable: V4 CH#4 (mV)

Mean - Average	531.9515	No. observations	6460
Lower 95% c.i.limit	524.1589	No. missing values	0
Upper 95% c.i.limit	539.7442	Sum of frequencies	6460
Adj sum of squares	6.595825E+08	Sum of observations	3436407
Standard deviation	319.5596	Std.error of mean	3.975902
Variance	102118.4	T-value for mean=0	133.7939
Coef. of variation	.6007307	T prob level	0.0000
Skewness	-.2954836	Kurtosis	-1.881513
Normality Test Value	1.677	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	872	90-%tile	837
75-%tile	820	10-%tile	145
50-%tile (Median)	769	Range	758
25-%tile	162	75th-25th %tile	658
0-%tile (Minimum)	114		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

Detail Report

Variable: V5 CH#5 (mV)

Mean - Average	522.4319	No. observations	6460
Lower 95% c.i.limit	514.6253	No. missing values	0
Upper 95% c.i.limit	530.2385	Sum of frequencies	6460
Adj sum of squares	6.619504E+08	Sum of observations	3374910
Standard deviation	320.1328	Std.error of mean	3.983032
Variance	102485	T-value for mean=0	131.1644
Coef. of variation	.6127741	T prob level	0.0000
Skewness	.1687596	Kurtosis	-1.808908
Normality Test Value	0.880	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	971	90-%tile	893.5
75-%tile	884	10-%tile	178
50-%tile (Median)	429	Range	816
25-%tile	199	75th-25th %tile	685
0-%tile (Minimum)	155		

Variable: V6 CH#6 (mV)

Mean - Average	12.07895	No. observations	6460
Lower 95% c.i.limit	10.62392	No. missing values	0
Upper 95% c.i.limit	13.53398	Sum of frequencies	6460
Adj sum of squares	2.299571E+07	Sum of observations	78030
Standard deviation	59.6679	Std.error of mean	.7423769
Variance	3560.258	T-value for mean=0	16.27064
Coef. of variation	4.939826	T prob level	0.0000
Skewness	14.63884	Kurtosis	217.4221
Normality Test Value	0.811	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	918	90-%tile	17
75-%tile	14	10-%tile	-2
50-%tile (Median)	11	Range	920
25-%tile	0	75th-25th %tile	14
0-%tile (Minimum)	-2		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

Detail Report

Variable: V7	CH#7 (mV)		
Mean - Average	36.97632	No. observations	6460
Lower 95% c.i.limit	36.79904	No. missing values	0
Upper 95% c.i.limit	37.15359	Sum of frequencies	6460
Adj sum of squares	341347.4	Sum of observations	238867
Standard deviation	7.269686	Std.error of mean	9.044809E-02
Variance	52.84833	T-value for mean=0	408.8126
Coef. of variation	.1966039	T prob level	0.0000
Skewness	-3.314844	Kurtosis	12.55149
Normality Test Value	0.760	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	57	90-%tile	42
75-%tile	41	10-%tile	30
50-%tile (Median)	39	Range	57
25-%tile	37	75th-25th %tile	4
0-%tile (Minimum)	0		

Variable: V8	CH#8 (mV)		
Mean - Average	143.8538	No. observations	6460
Lower 95% c.i.limit	140.2244	No. missing values	5988
Upper 95% c.i.limit	147.4833	Sum of frequencies	472
Adj sum of squares	762340.9	Sum of observations	67899
Standard deviation	40.23131	Std.error of mean	1.851796
Variance	1618.558	T-value for mean=0	77.6834
Coef. of variation	.279668	T prob level	0.0000
Skewness	-3.186769	Kurtosis	19.98155
Normality Test Value	0.769	Reject if > 1.011(10%)	1.019(5%)
100-%tile (Maximum)	385	90-%tile	177
75-%tile	164	10-%tile	127
50-%tile (Median)	143	Range	458
25-%tile	133	75th-25th %tile	31
0-%tile (Minimum)	-73		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

Detail Report

Variable: T TEMPERATURE (deg C)

Mean - Average	59.22167	No. observations	6460
Lower 95% c.i.limit	58.93145	No. missing values	0
Upper 95% c.i.limit	59.51189	Sum of frequencies	6460
Adj sum of squares	914880.6	Sum of observations	382572
Standard deviation	11.90144	Std.error of mean	.1480755
Variance	141.6443	T-value for mean=0	399.9423
Coef. of variation	.2009643	T prob level	0.0000
Skewness	.2278519	Kurtosis	-.7813094
Normality Test Value	0.924	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	85	90-%tile	74
75-%tile	69	10-%tile	44
50-%tile (Median)	60	Range	46
25-%tile	50	75th-25th %tile	19
0-%tile (Minimum)	39		

Variable: BP BAROMETRIC PRESSURE (in.H2O)

Mean - Average	30.08061	No. observations	6460
Lower 95% c.i.limit	30.07833	No. missing values	0
Upper 95% c.i.limit	30.08289	Sum of frequencies	6460
Adj sum of squares	56.35911	Sum of observations	194320.7
Standard deviation	.0934113	Std.error of mean	1.162206E-03
Variance	8.725671E-03	T-value for mean=0	25882.34
Coef. of variation	3.105366E-03	T prob level	0.0000
Skewness	7.509704E-02	Kurtosis	-.3908675
Normality Test Value	0.956	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	30.34	90-%tile	30.2
75-%tile	30.15	10-%tile	29.96
50-%tile (Median)	30.08	Range	.5100002
25-%tile	30.01	75th-25th %tile	.1399994
0-%tile (Minimum)	29.83		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

Detail Report

Variable: WD WIND DIRECTION (deg)

Mean - Average	201.1951	No. observations	6460
Lower 95% c.i.limit	198.1516	No. missing values	0
Upper 95% c.i.limit	204.2385	Sum of frequencies	6460
Adj sum of squares	1.006084E+08	Sum of observations	1299720
Standard deviation	124.8057	Std.error of mean	1.552809
Variance	15576.46	T-value for mean=0	129.5684
Coef. of variation	.6203219	T prob level	0.0000
Skewness	-.1609998	Kurtosis	-1.453688
Normality Test Value	0.948	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	360	90-%tile	350
75-%tile	320	10-%tile	20
50-%tile (Median)	170	Range	350
25-%tile	100	75th-25th %tile	220
0-%tile (Minimum)	10		

Variable: WS WIND SPEED (mph)

Mean - Average	2.164087	No. observations	6460
Lower 95% c.i.limit	2.098293	No. missing values	0
Upper 95% c.i.limit	2.22988	Sum of frequencies	6460
Adj sum of squares	47018.07	Sum of observations	13980
Standard deviation	2.698049	Std.error of mean	3.356862E-02
Variance	7.279466	T-value for mean=0	64.46755
Coef. of variation	1.246738	T prob level	0.0000
Skewness	1.622015	Kurtosis	2.792439
Normality Test Value	0.866	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	18	90-%tile	6
75-%tile	3	10-%tile	0
50-%tile (Median)	1	Range	18
25-%tile	0	75th-25th %tile	3
0-%tile (Minimum)	0		

----------Descriptive Statistics----------

Data Base Name C:\BMD\KEN

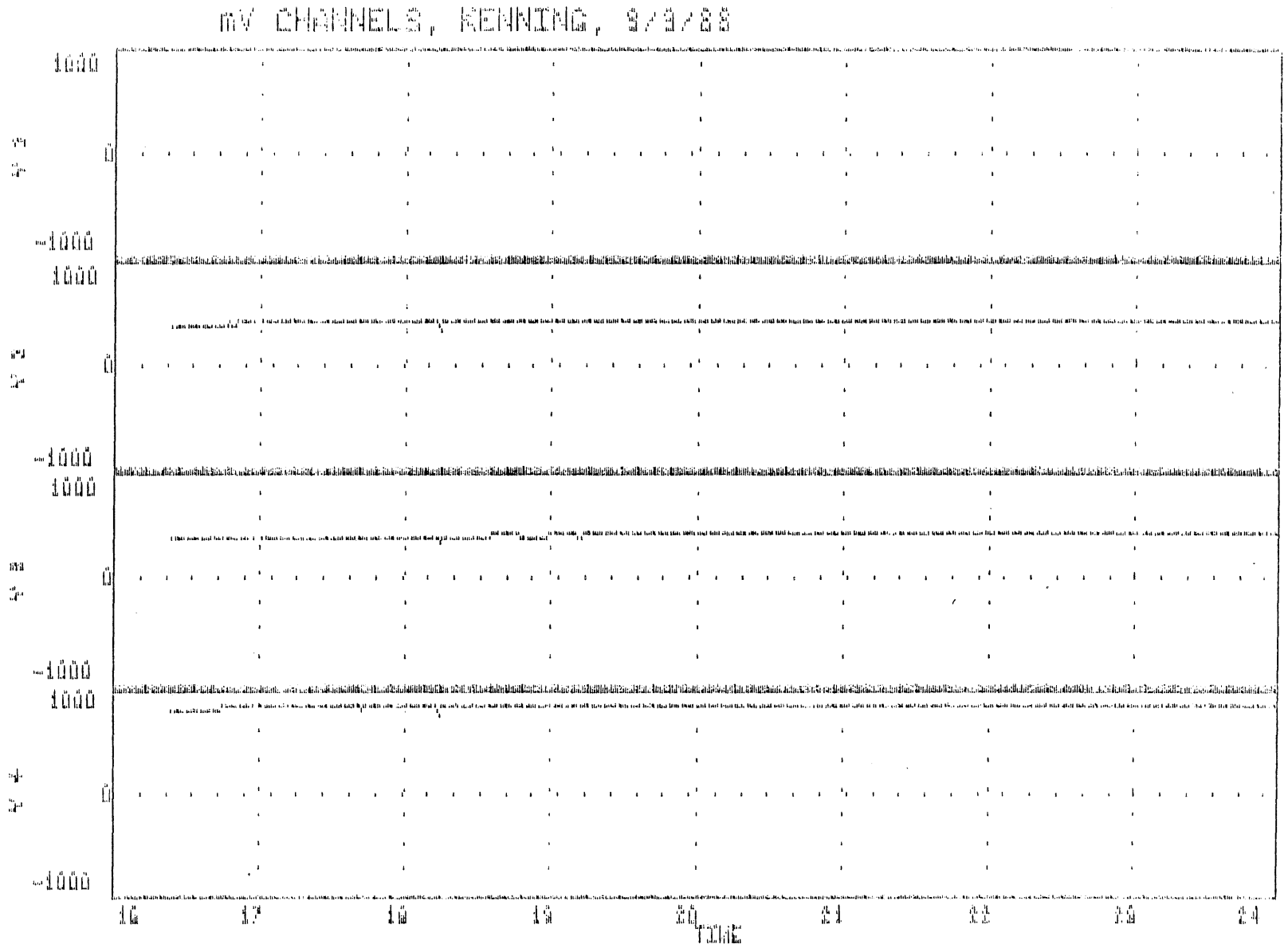
Detail Report

Variable: P PRECIPITATION TOTAL (in.)

Mean - Average	1.756656E-02	No. observations	6460
Lower 95% c.i.limit	1.708626E-02	No. missing values	0
Upper 95% c.i.limit	1.804687E-02	Sum of frequencies	6460
Adj sum of squares	2.505746	Sum of observations	113.48
Standard deviation	1.969636E-02	Std.error of mean	2.450584E-04
Variance	3.879465E-04	T-value for mean=0	71.68316
Coef. of variation	1.121241	T prob level	0.0000
Skewness	.2487254	Kurtosis	-1.926102
100-%tile (Maximum)	.04	90-%tile	.04
75-%tile	.04	10-%tile	0
50-%tile (Median)	0	Range	.04
25-%tile	0	75th-25th %tile	.04
0-%tile (Minimum)	0		

Variable: RH RELATIVE HUMIDITY (%)

Mean - Average	57.34582	No. observations	6460
Lower 95% c.i.limit	56.93189	No. missing values	0
Upper 95% c.i.limit	57.75975	Sum of frequencies	6460
Adj sum of squares	1861047	Sum of observations	370454
Standard deviation	16.97446	Std.error of mean	.2111931
Variance	288.1325	T-value for mean=0	271.5326
Coef. of variation	.2960018	T prob level	0.0000
Skewness	7.272703E-02	Kurtosis	-.8869471
Normality Test Value	0.937	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	89	90-%tile	82
75-%tile	70	10-%tile	36
50-%tile (Median)	55	Range	71
25-%tile	43	75th-25th %tile	27
0-%tile (Minimum)	18		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-1000
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-1000
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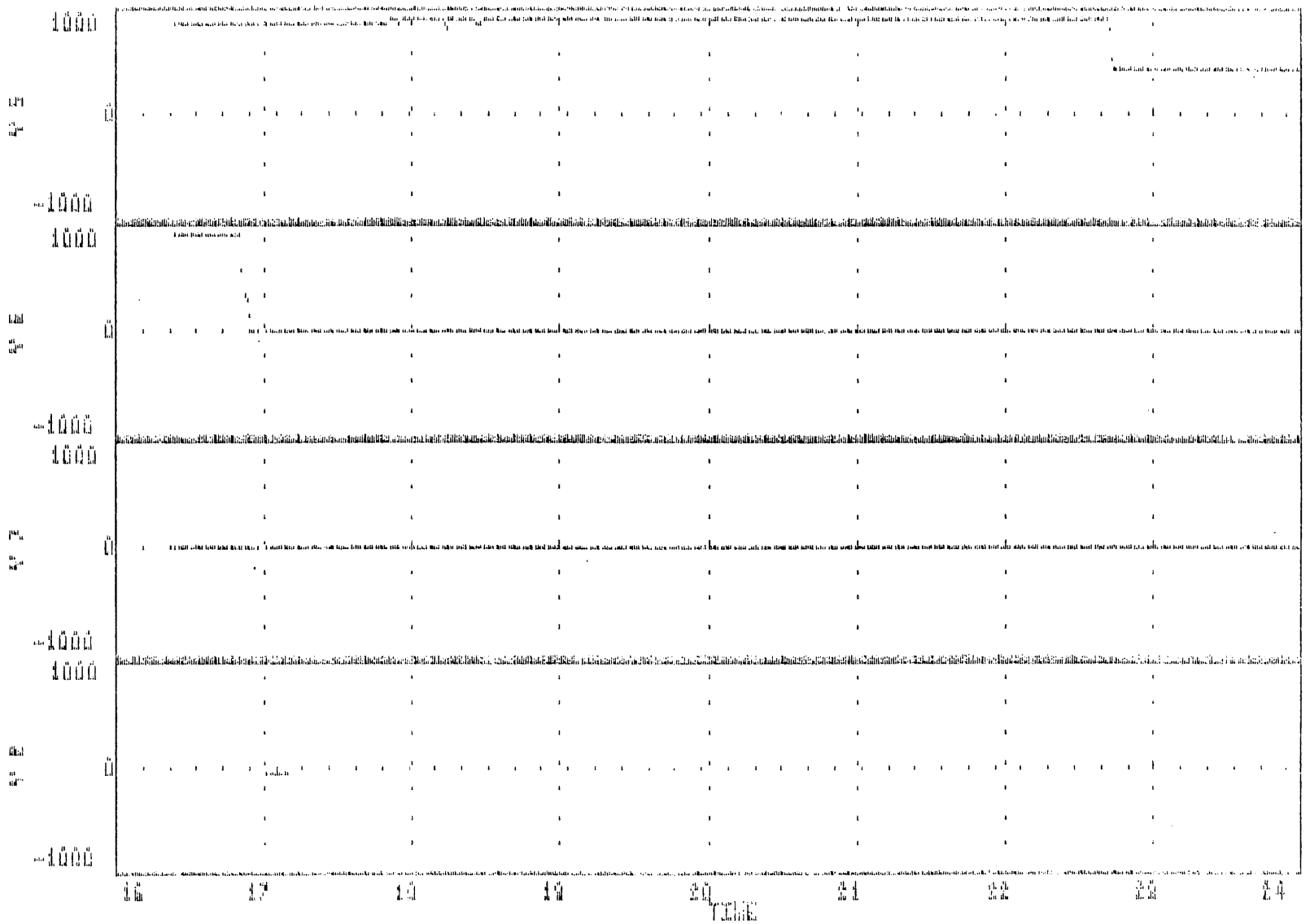
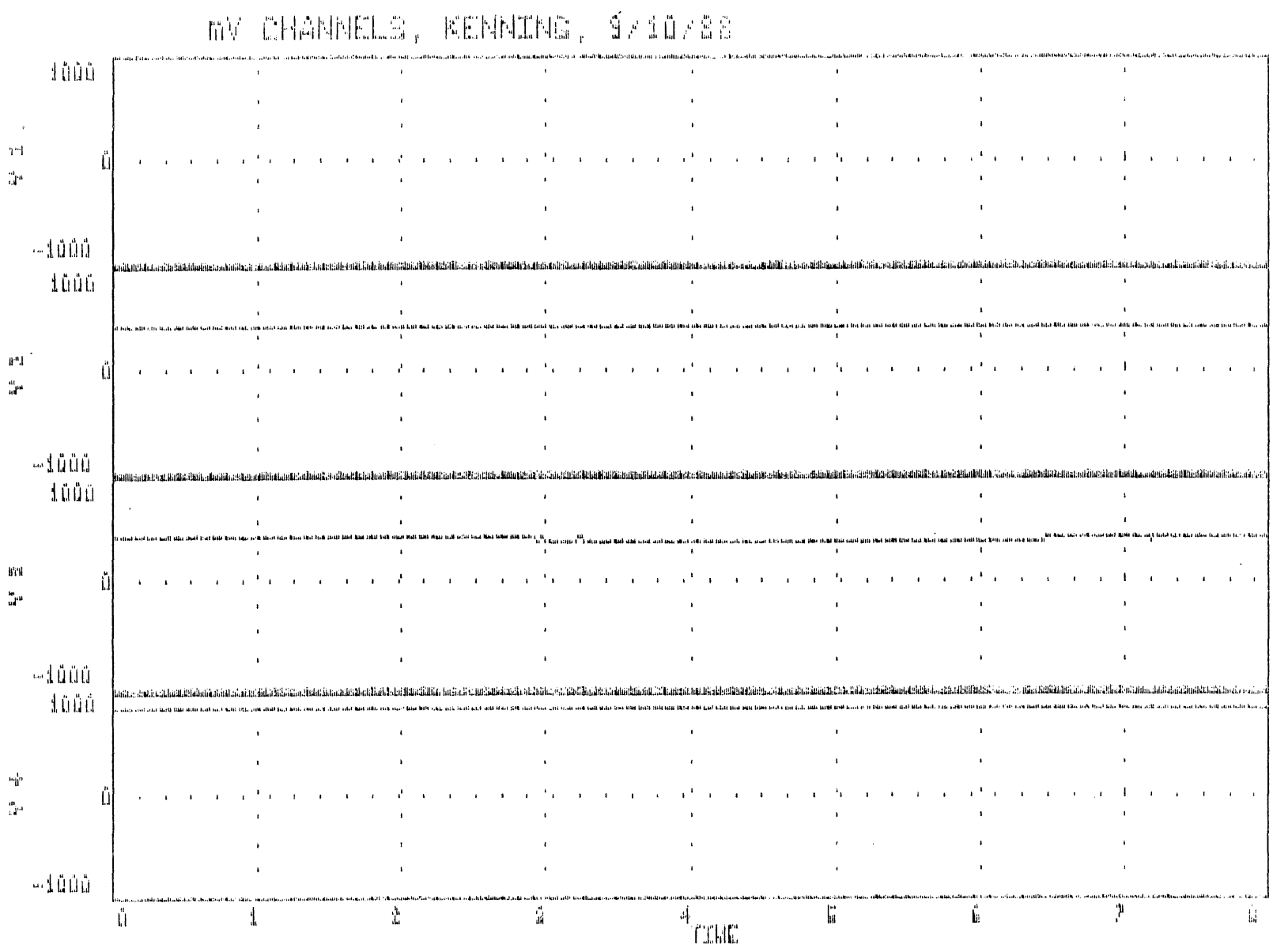
16
17
18
19
20
21
22
23
24
Time



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	reference rod A	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		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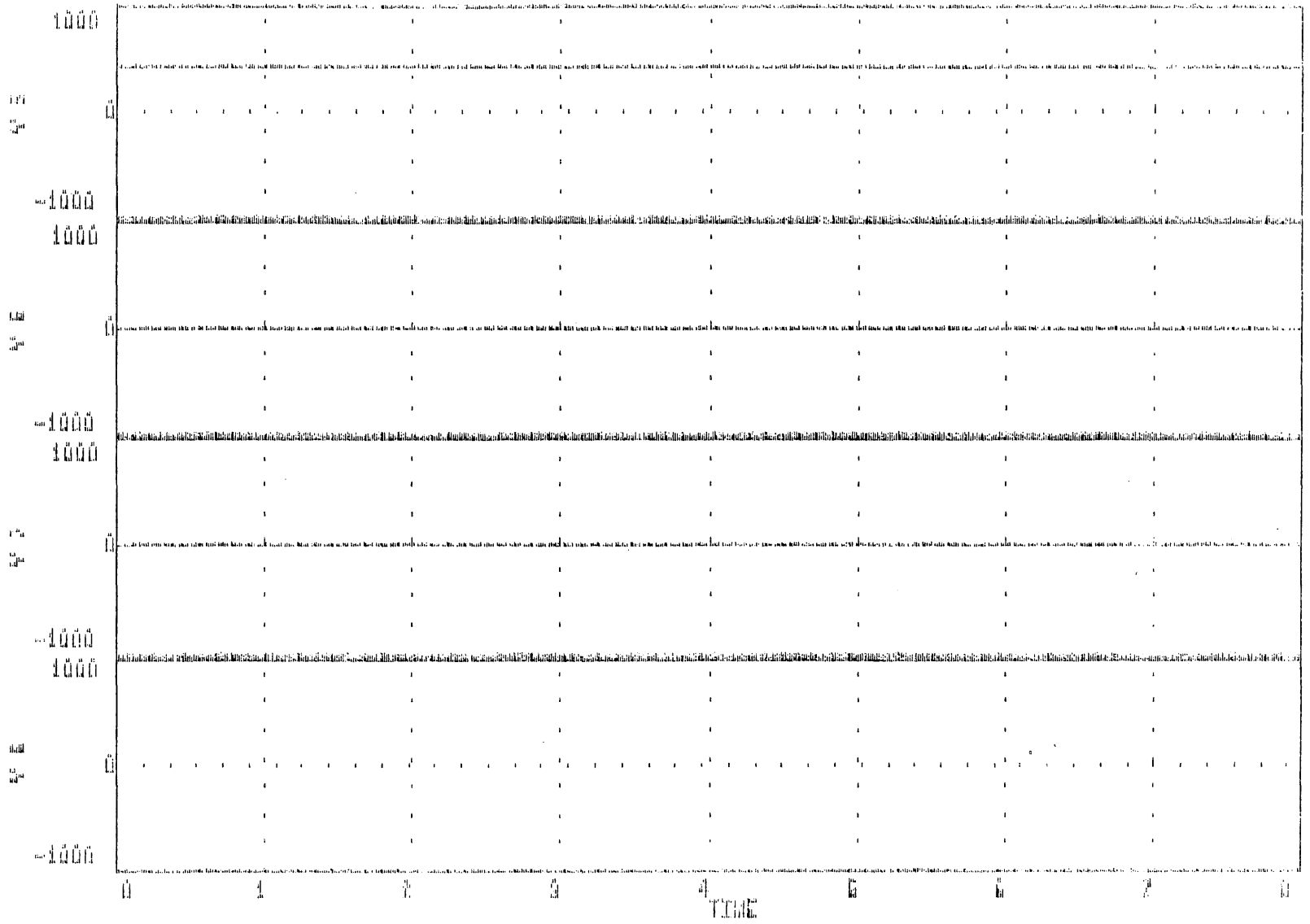
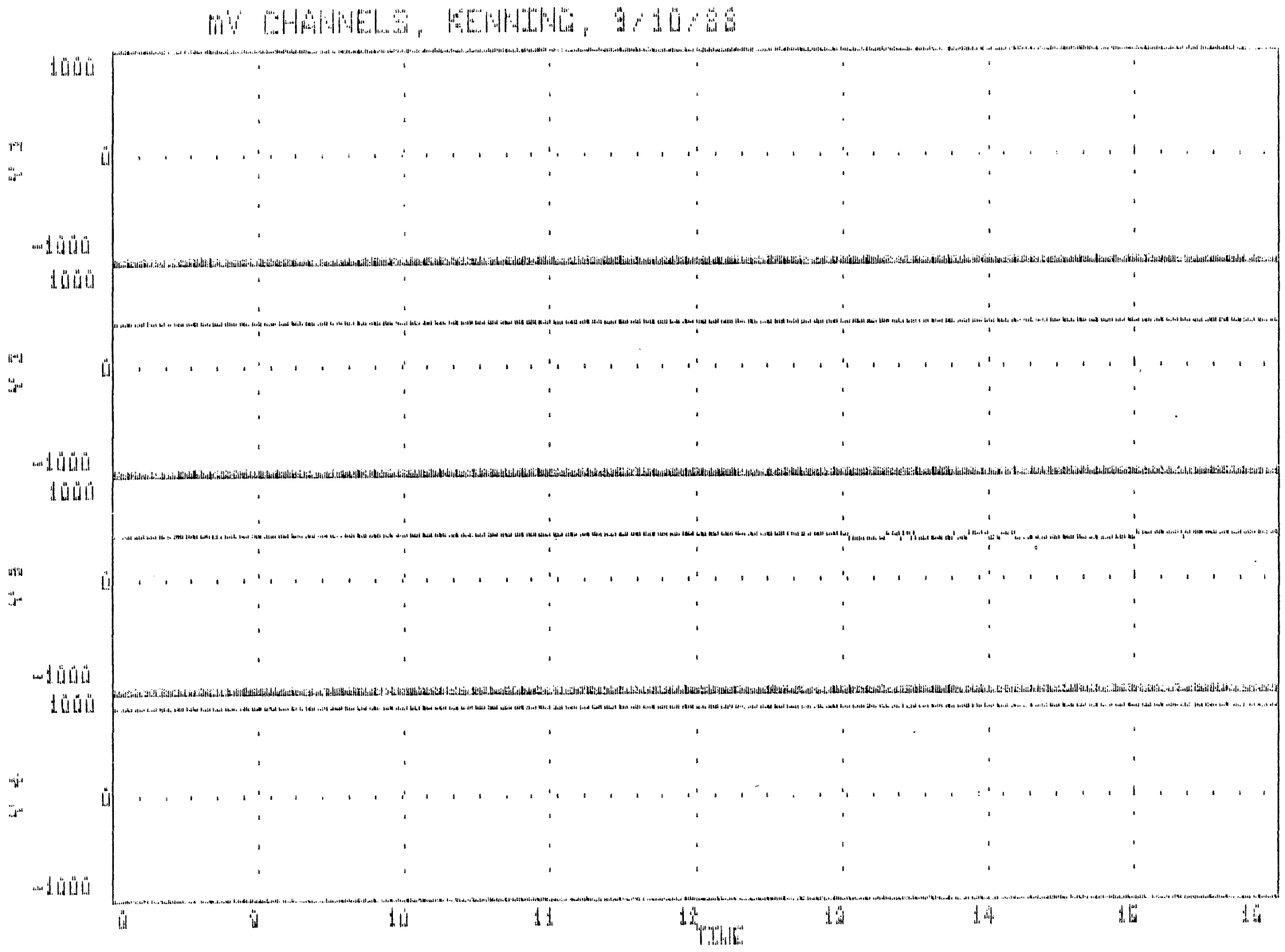
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	reference rod A	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		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-1000
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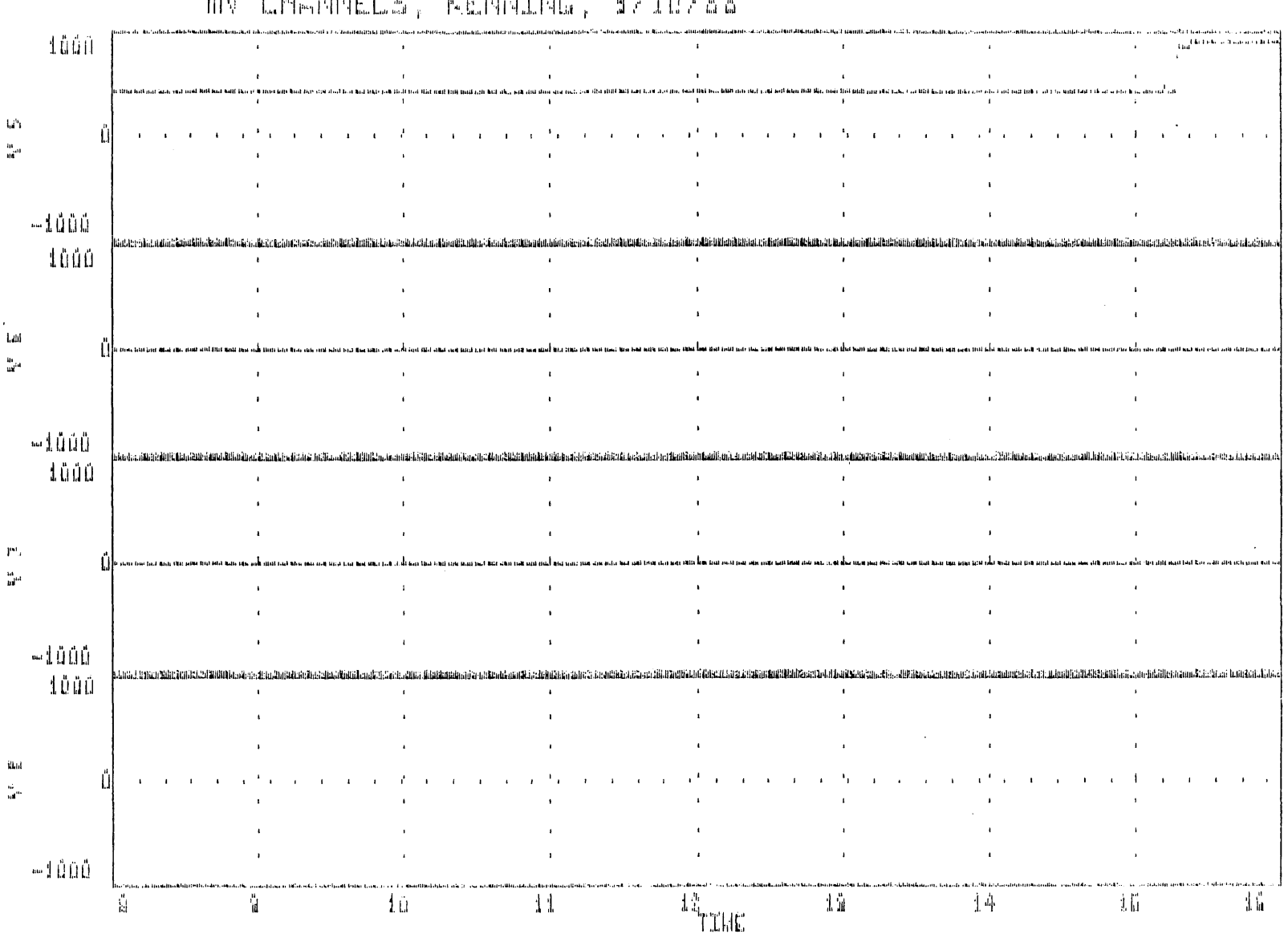
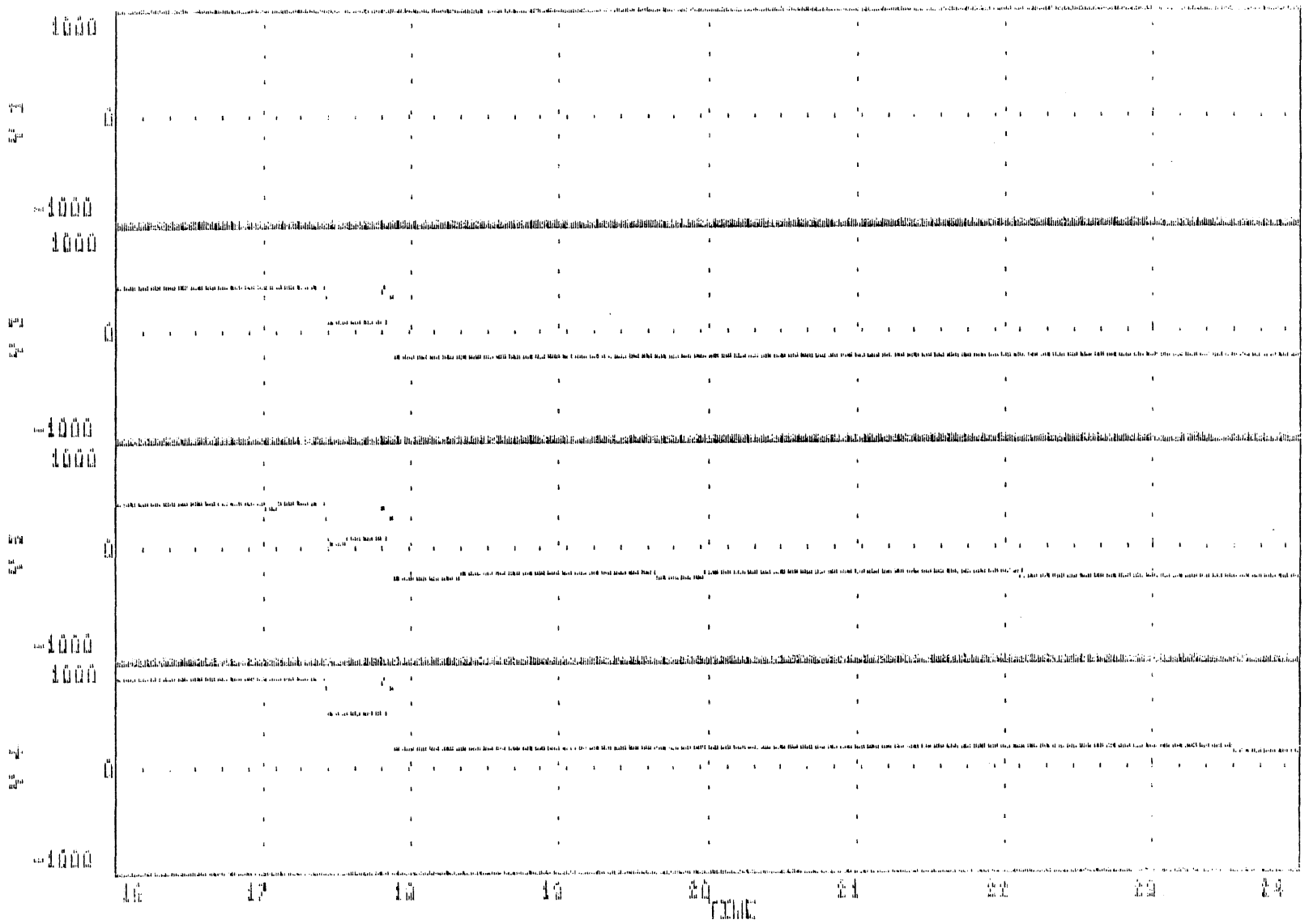
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	reference rod A	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


mV CHANNELS, KENNING, 9/10/88
1000
0
-1000
1000
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-1000
1000
0
-1000
1000
0
-1000
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18
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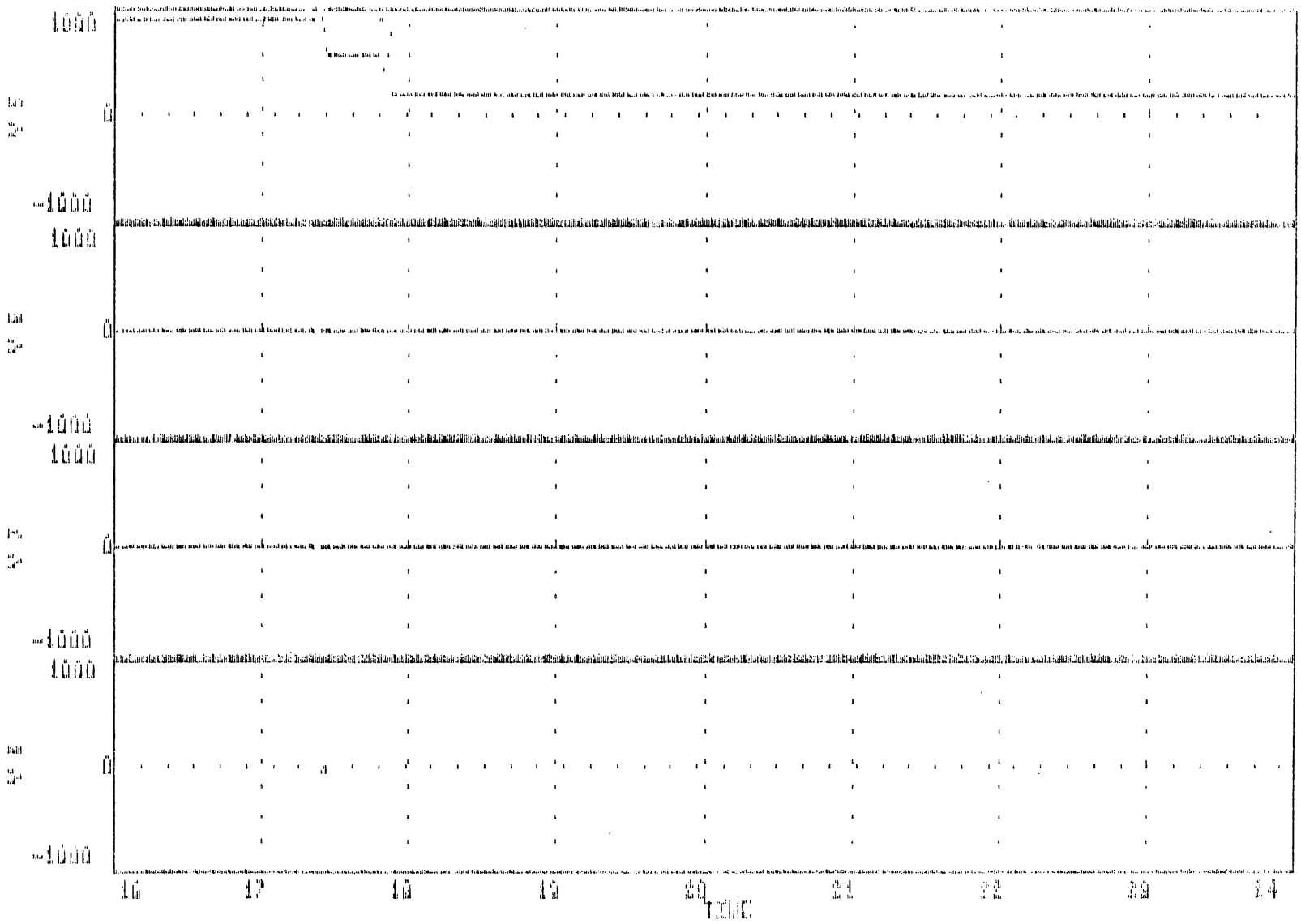
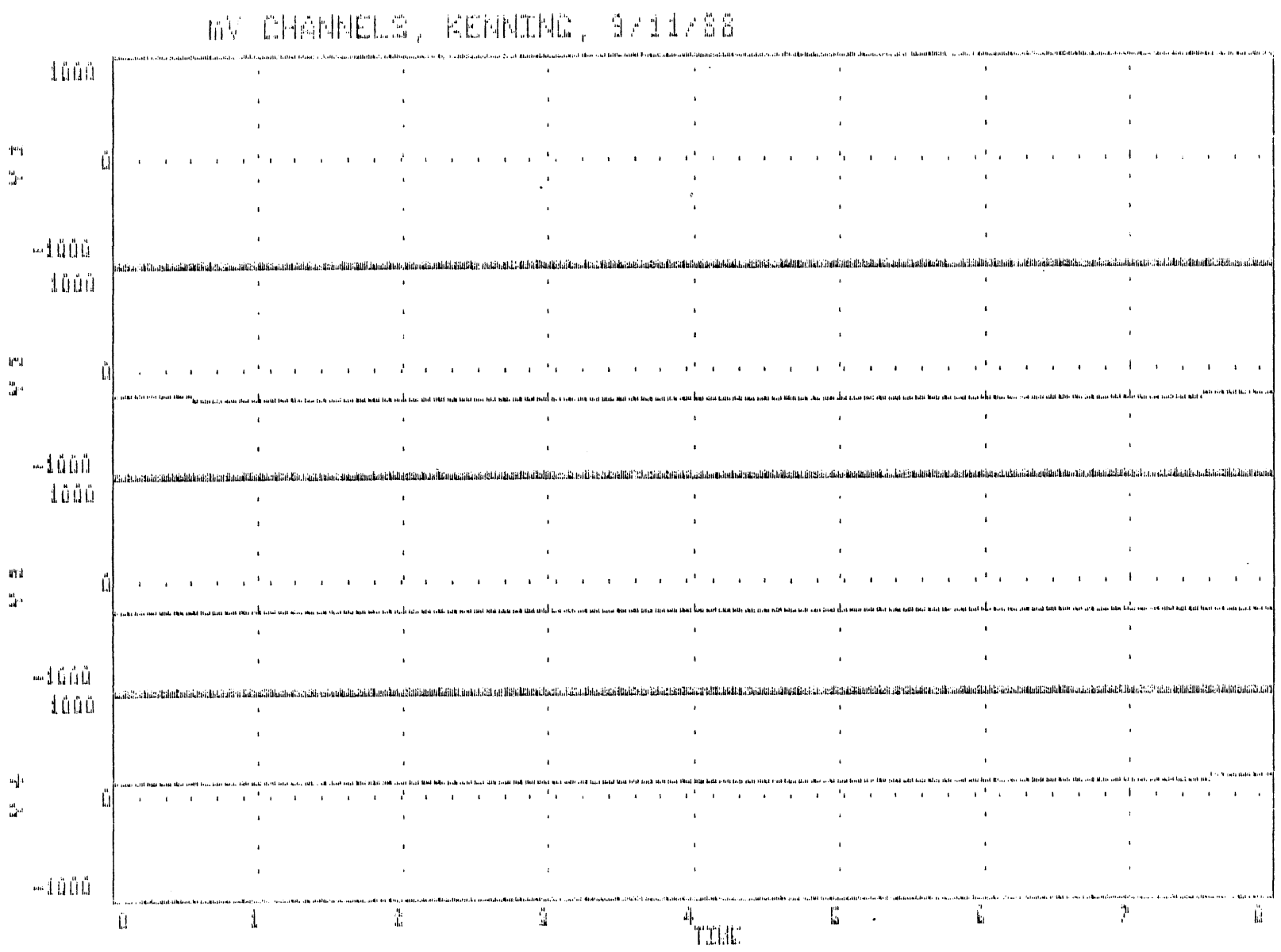
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		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-1000
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-1000
1000
0
-1000
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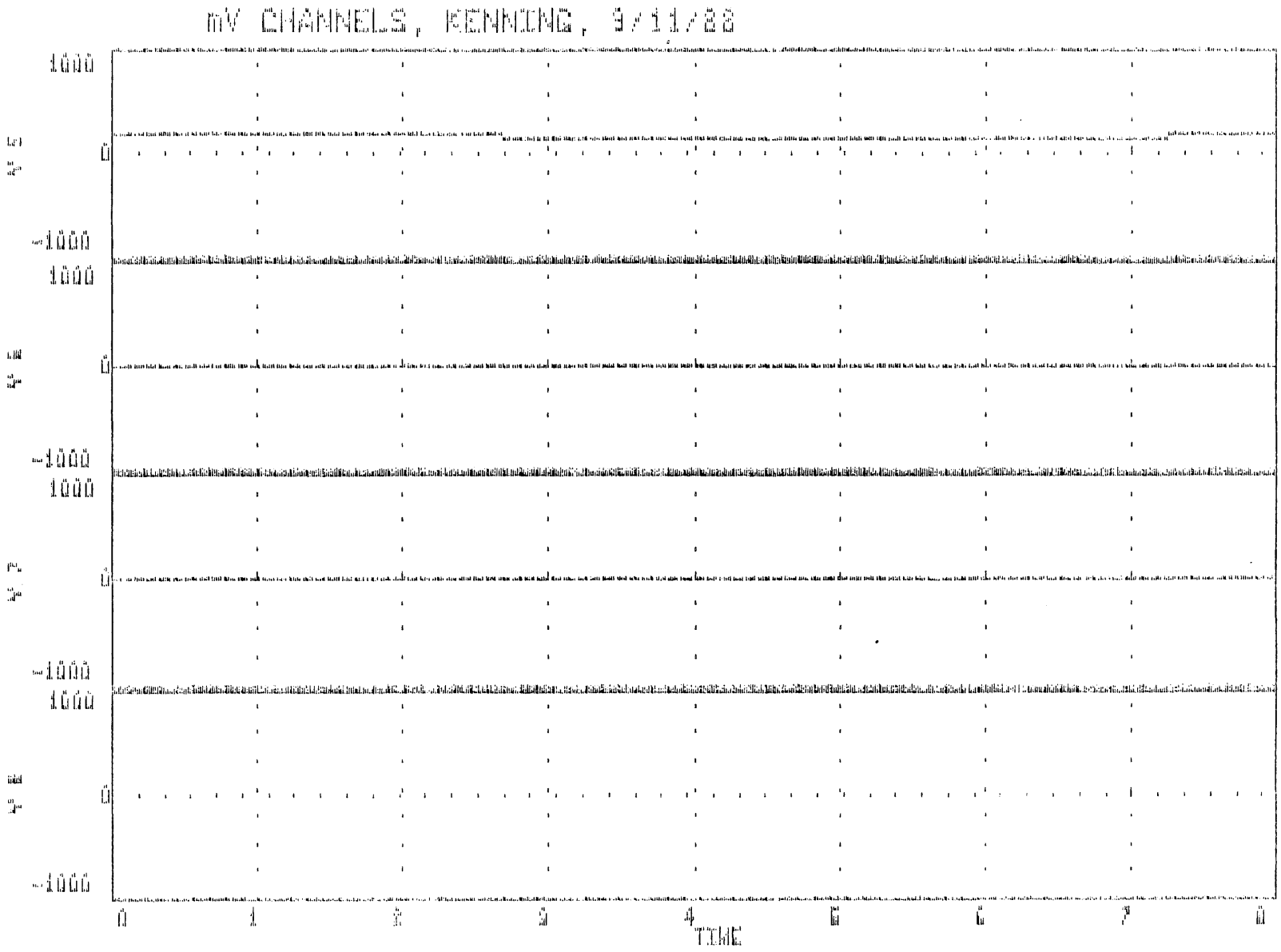
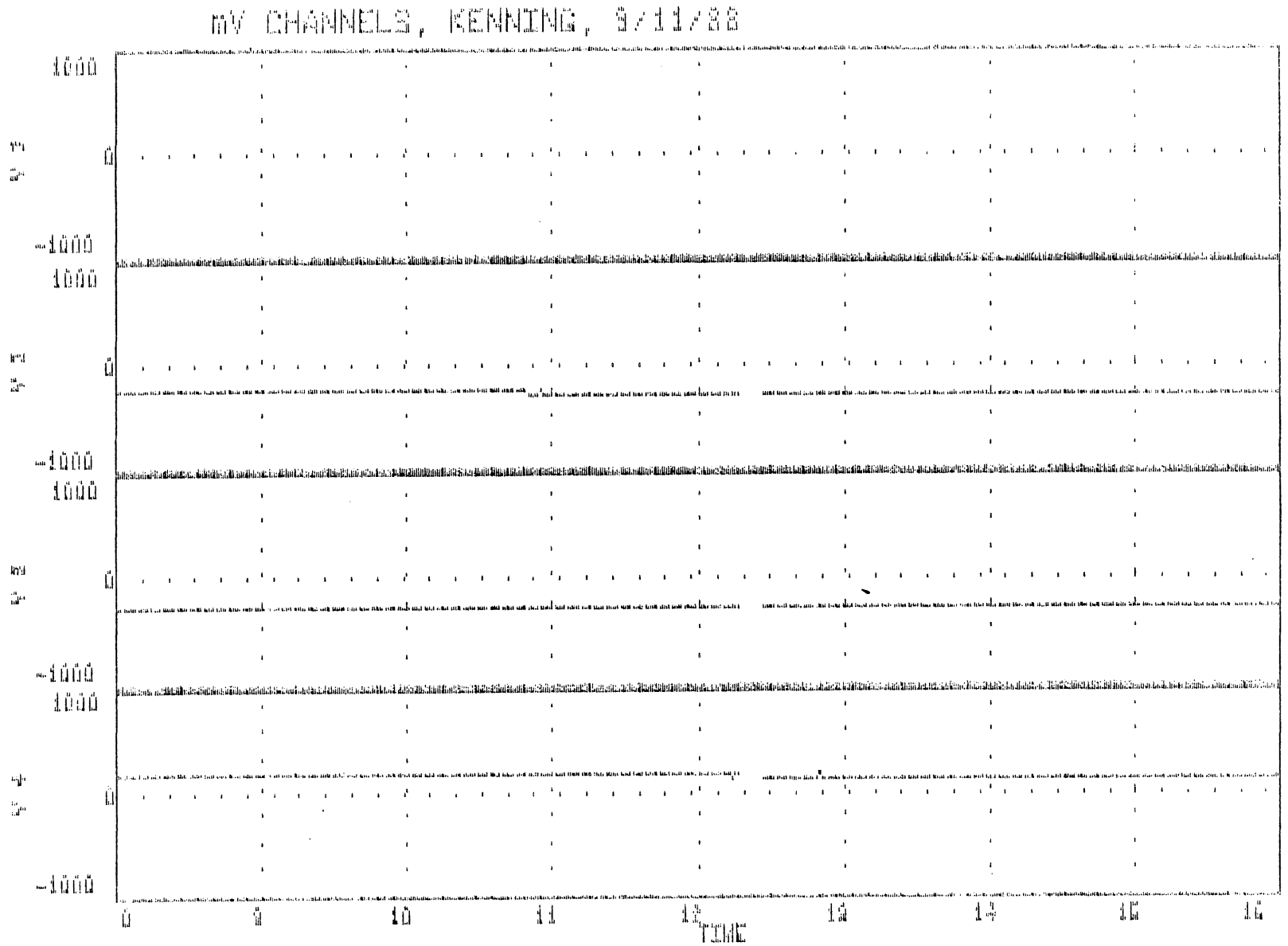
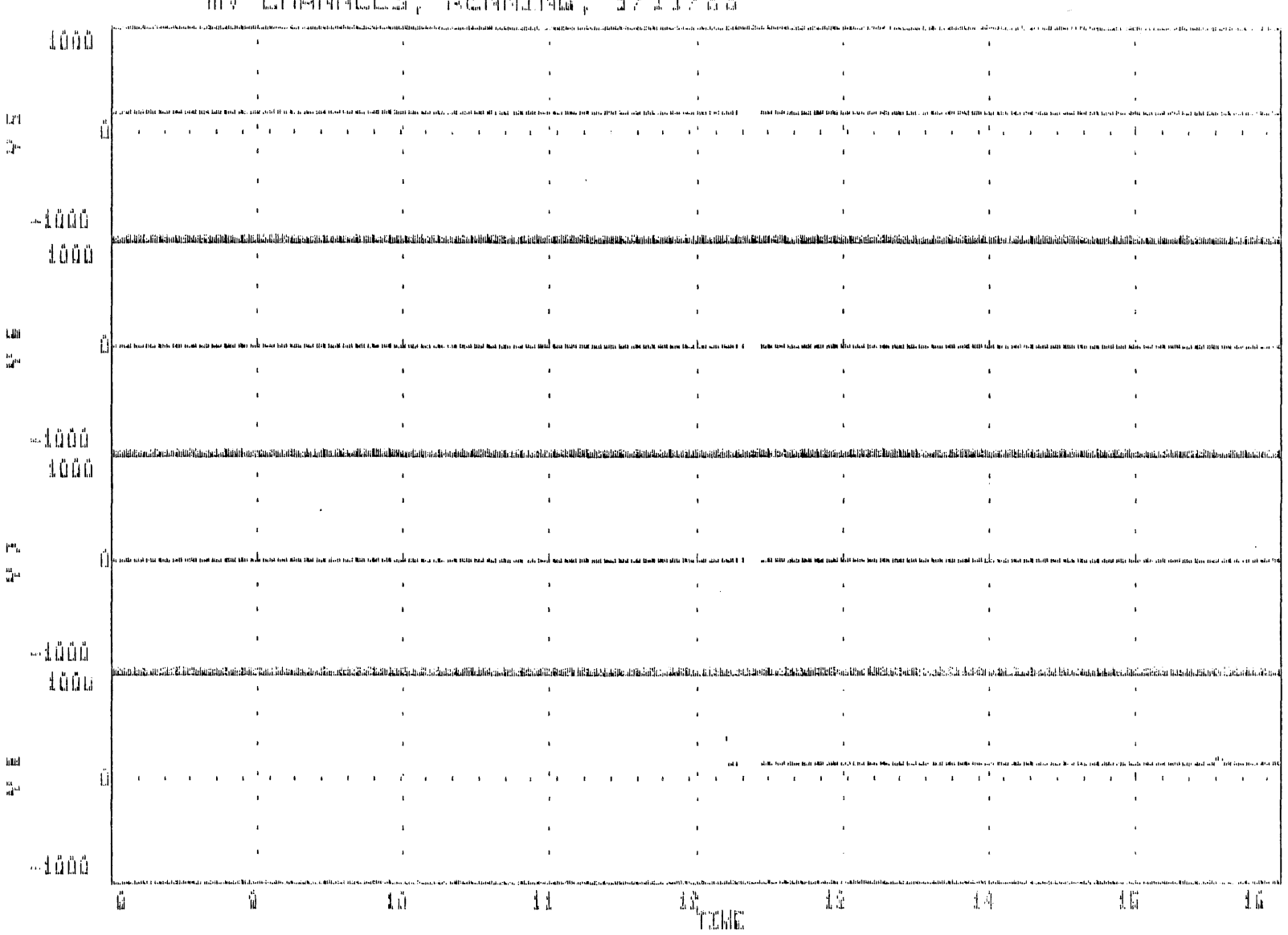
5
6
7
8
TIME



KEY

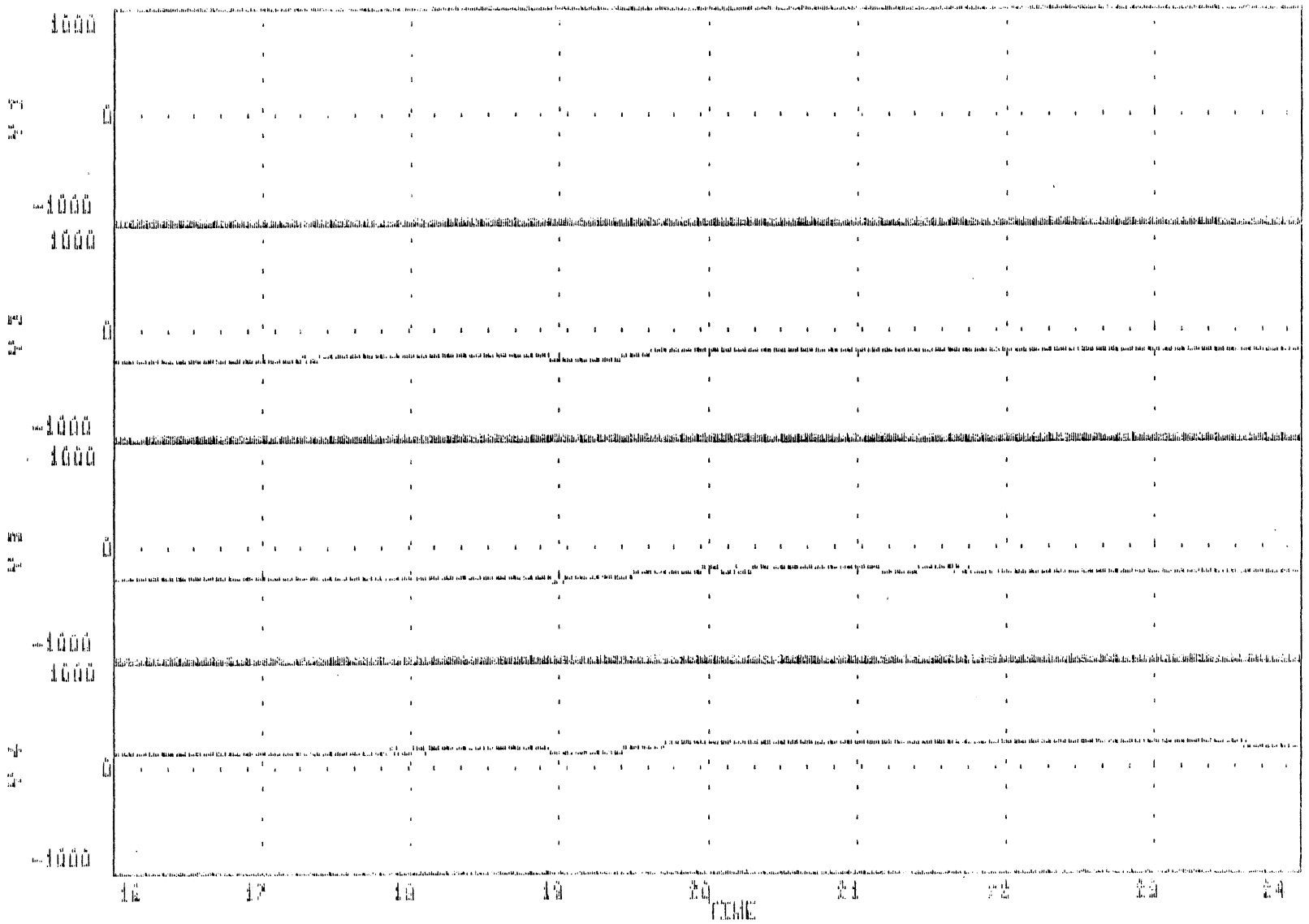
CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


mV CHANNELS, KENNING, 9/11/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
0
9
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8	B field (ac)	-


mV CHANNELS, PENNING, 9/11/88
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-1000
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-1000
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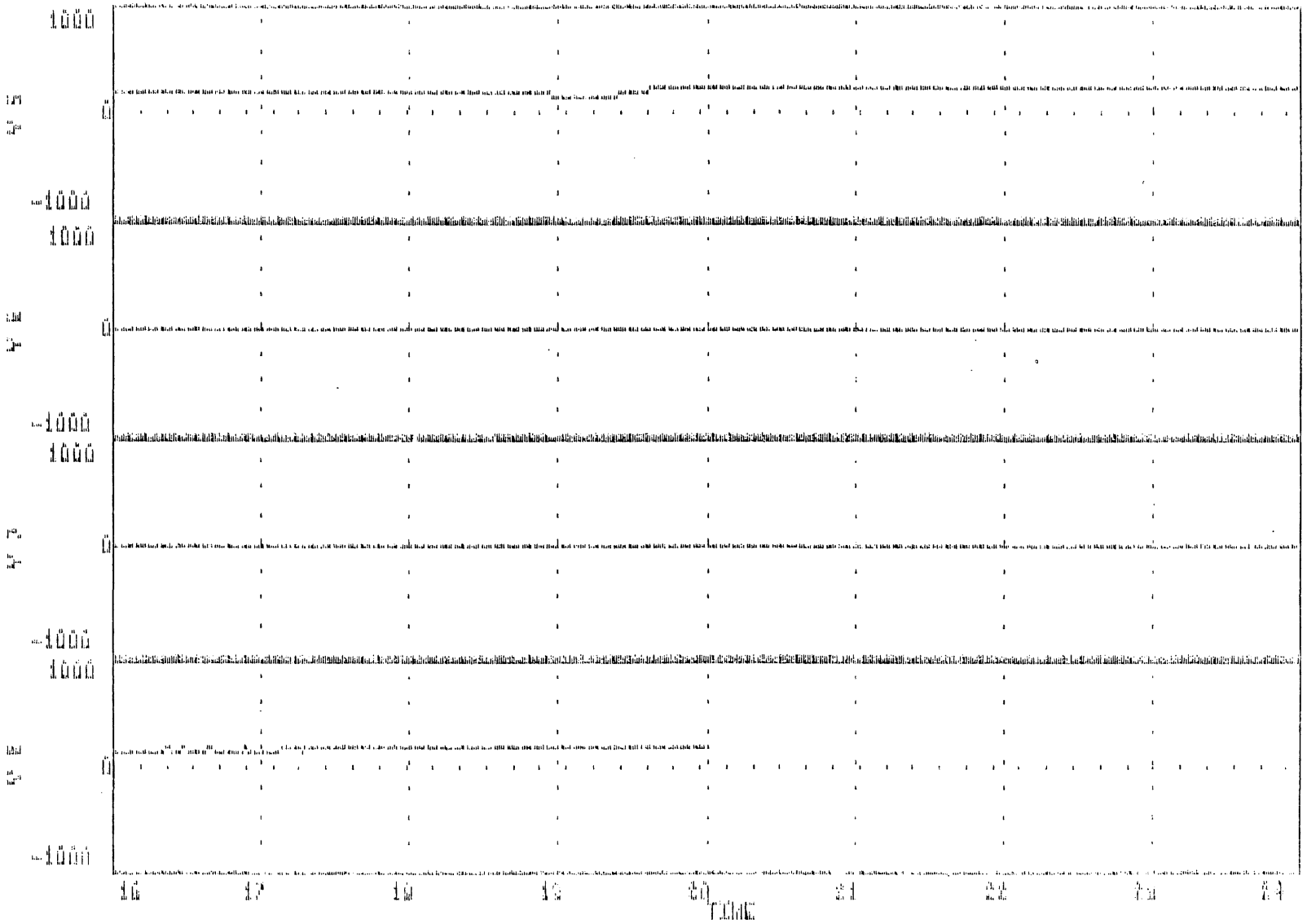
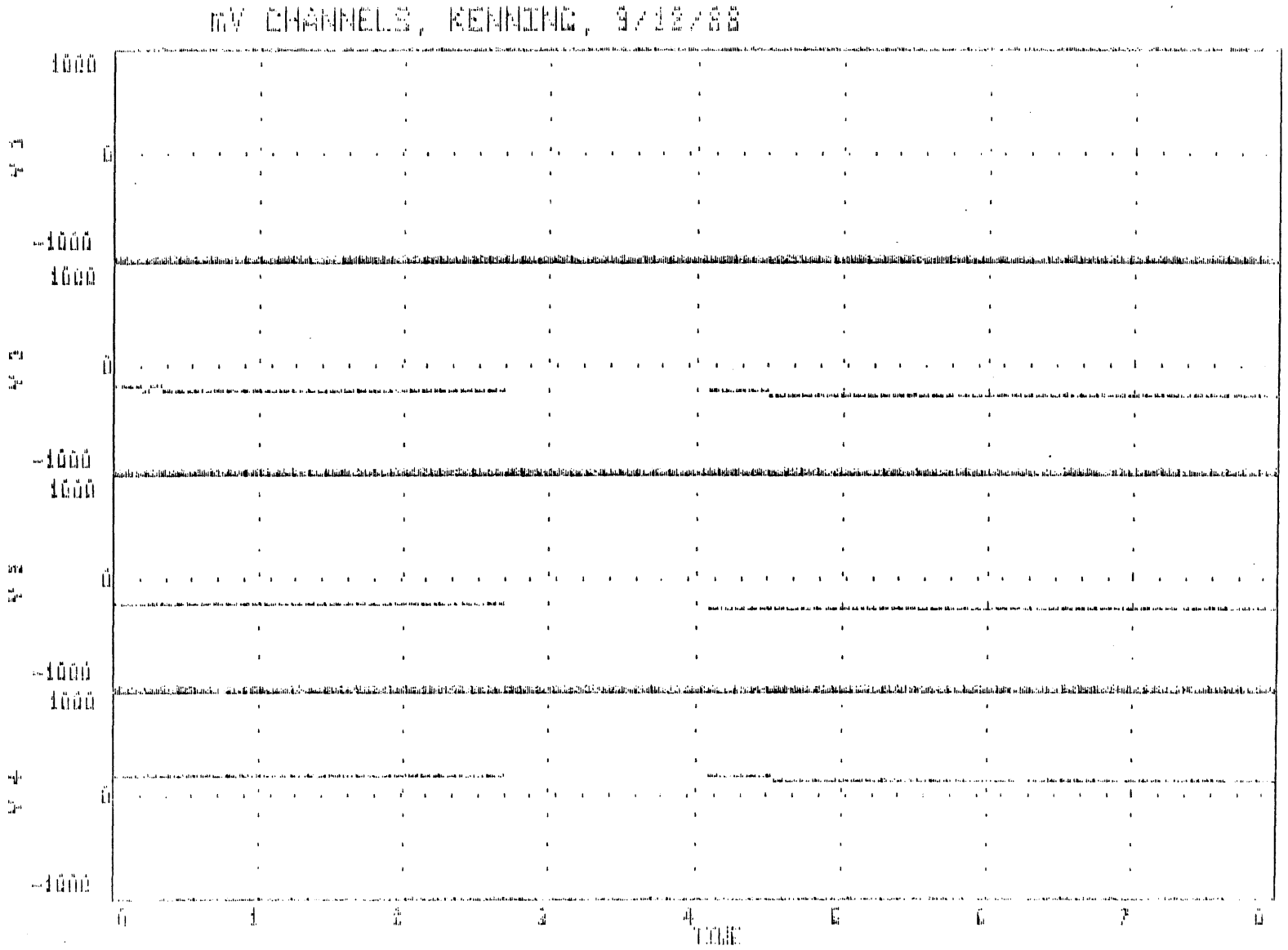
0
-1000
16
17
18
19
20
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8	B field (ac)	-


mV CHANNELS, KENNING, 9/12/88
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0
-1000
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0
-1000
1000
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-1000
1000
0
-1000
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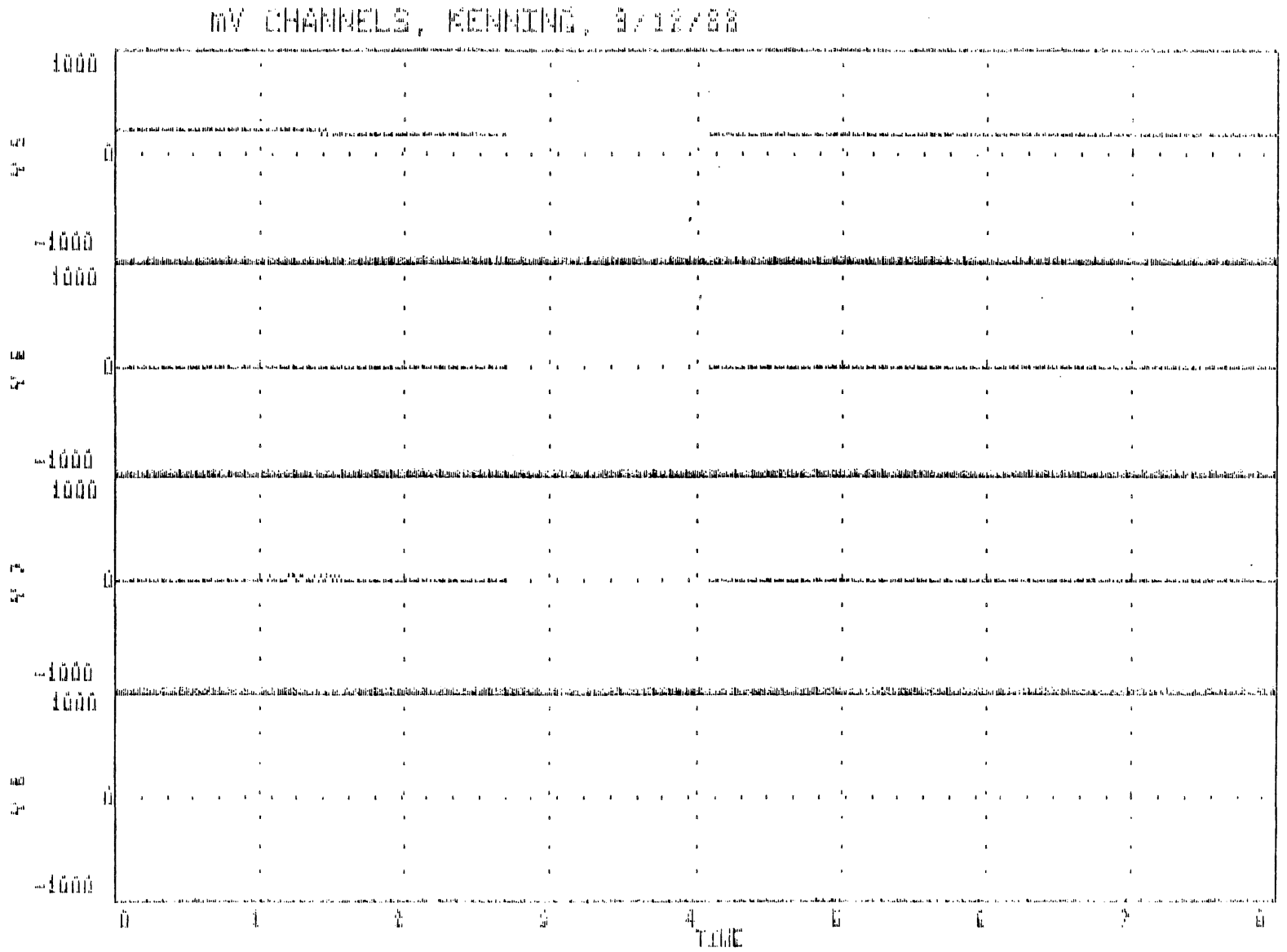
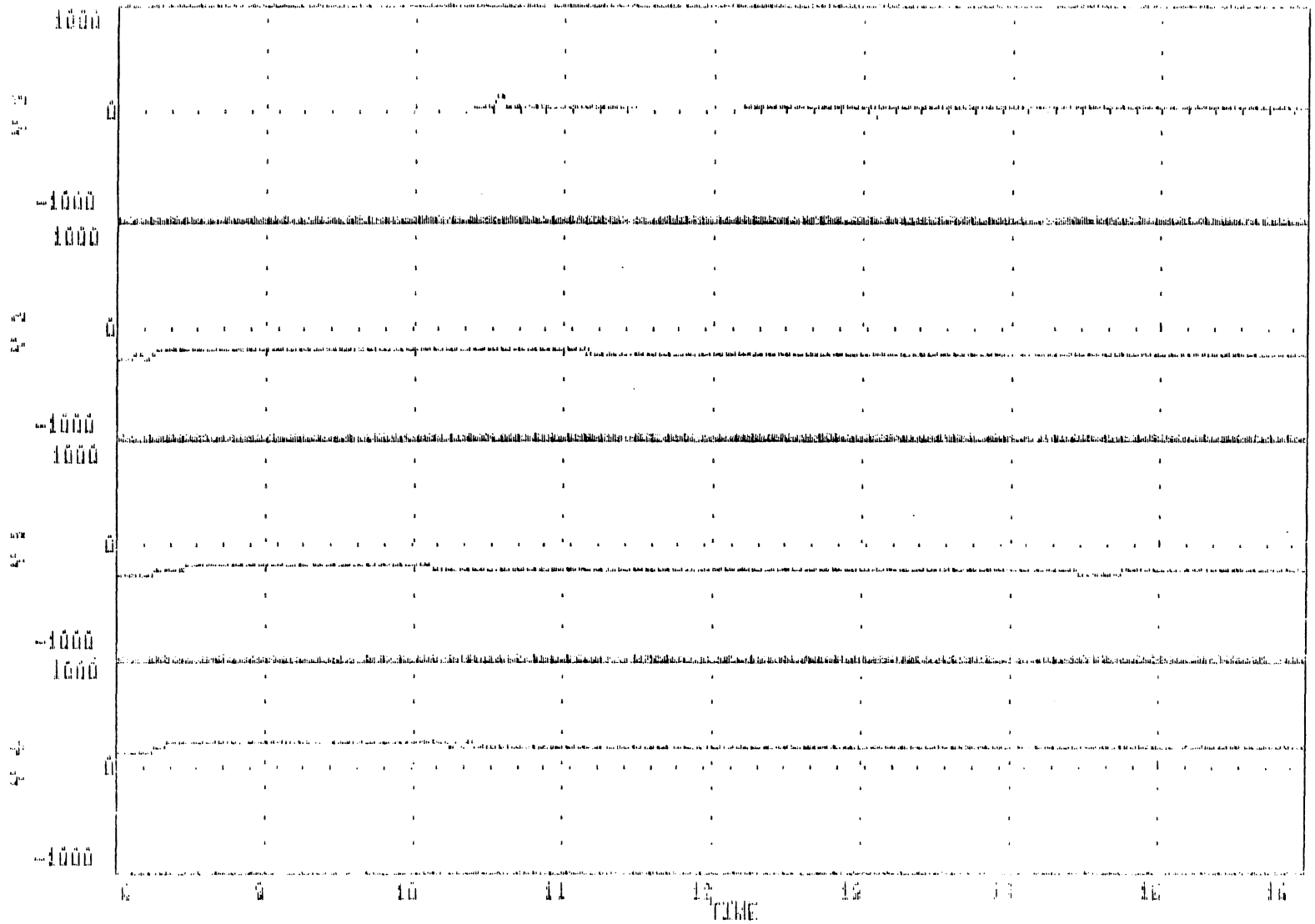
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


mV CHANNELS, REMAND, 3/18/88
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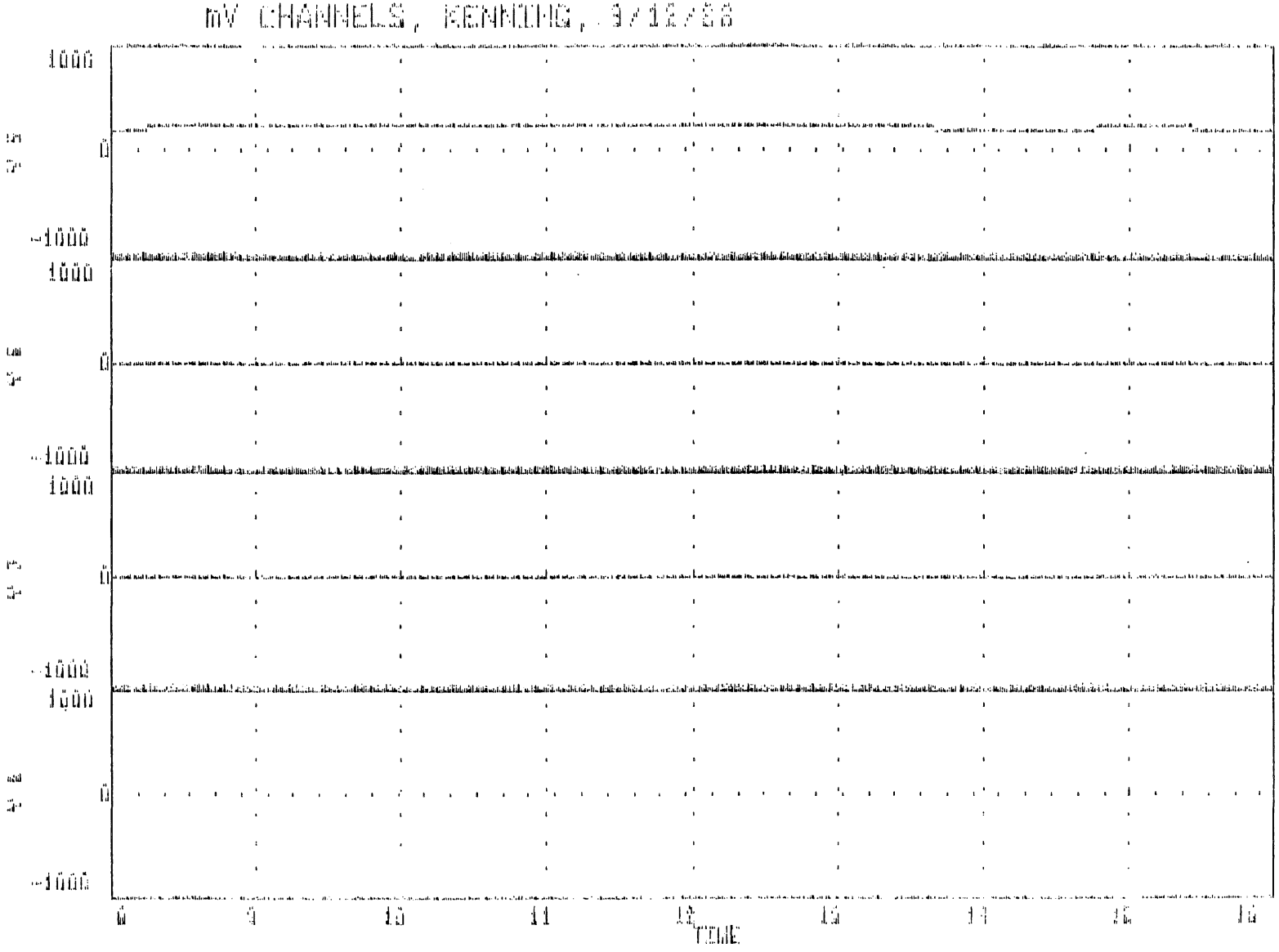
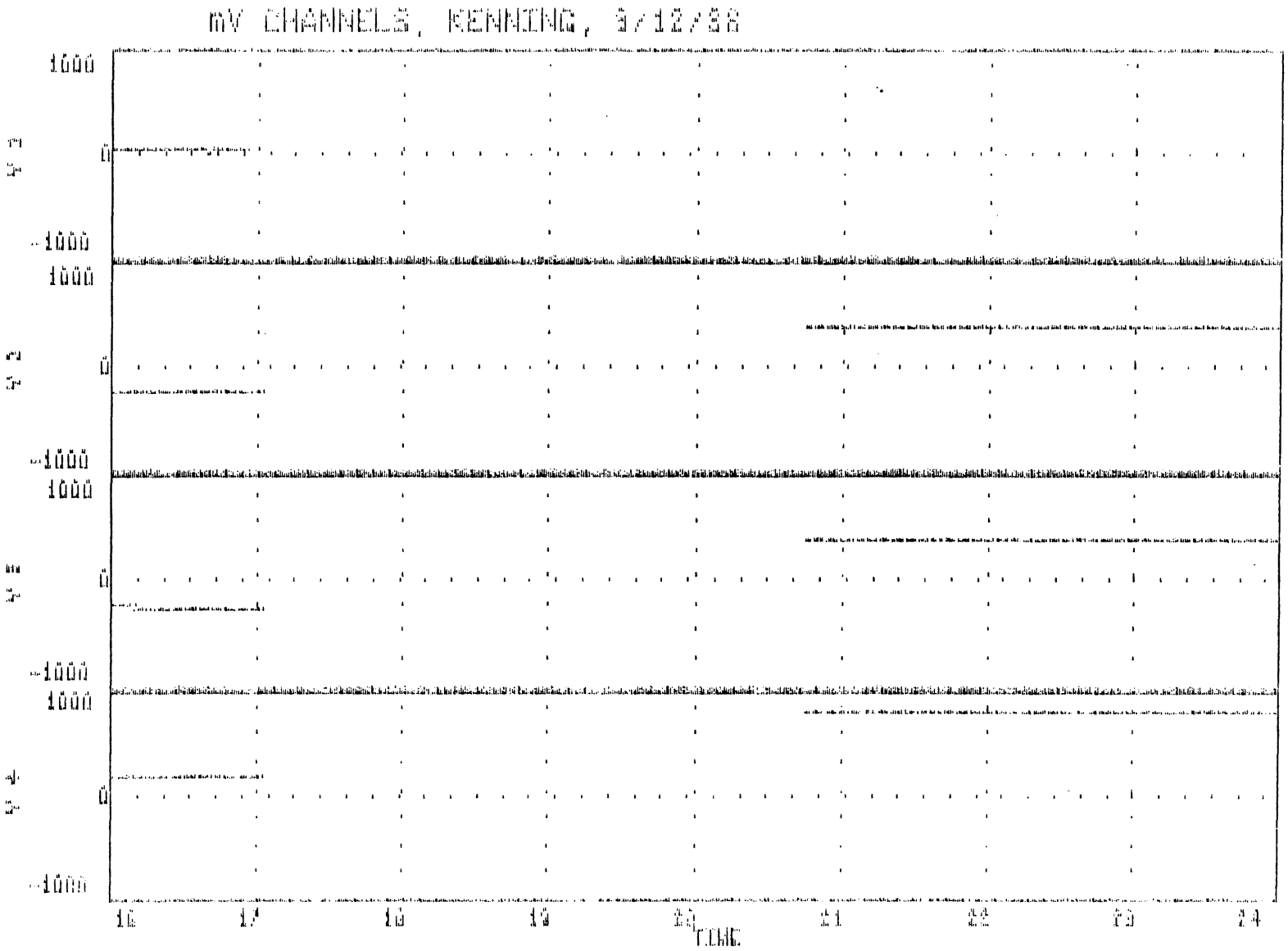
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1	E field (dc)	-	V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


mV CHANNELS, RENNING, 3/12/88
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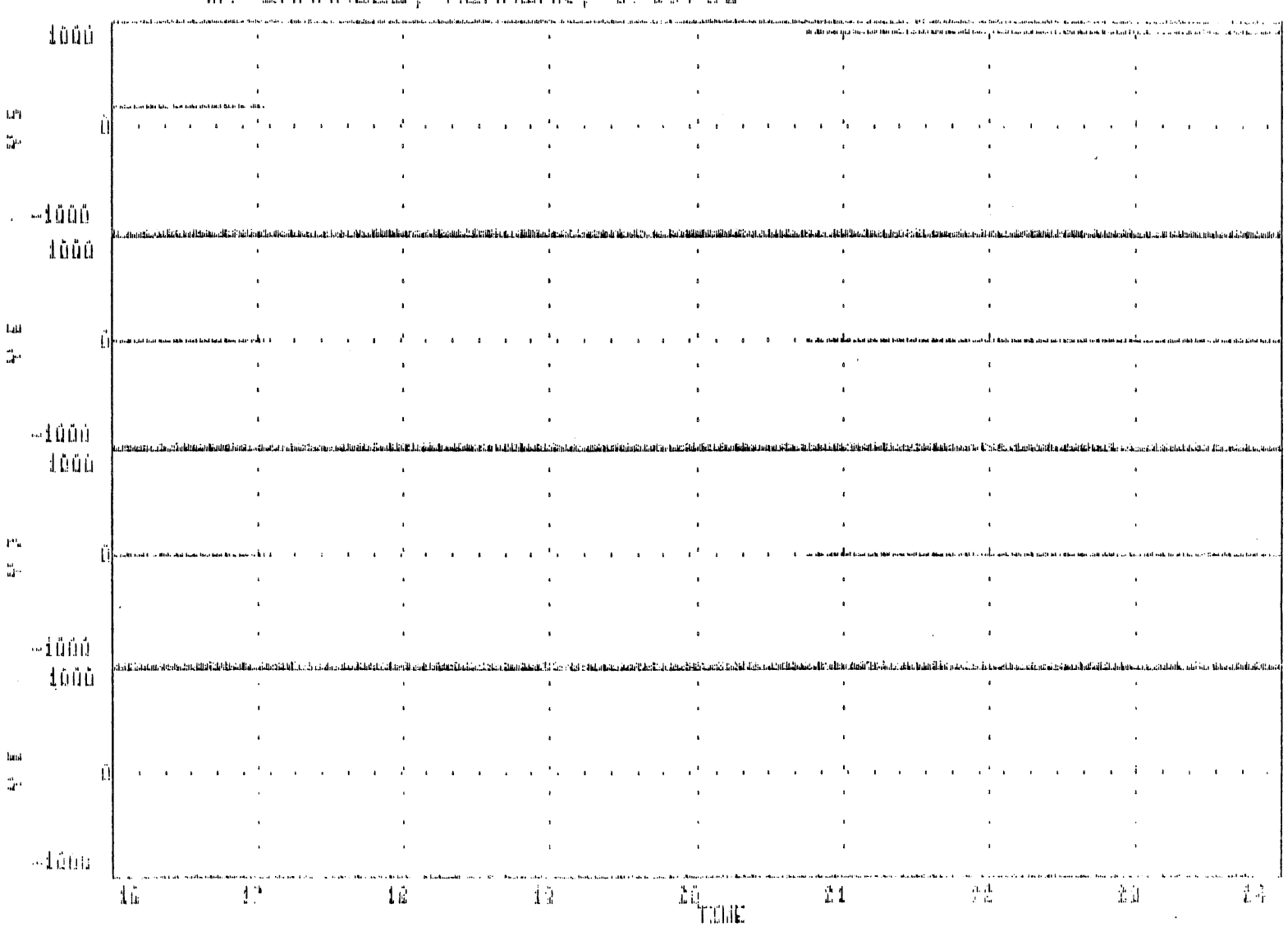
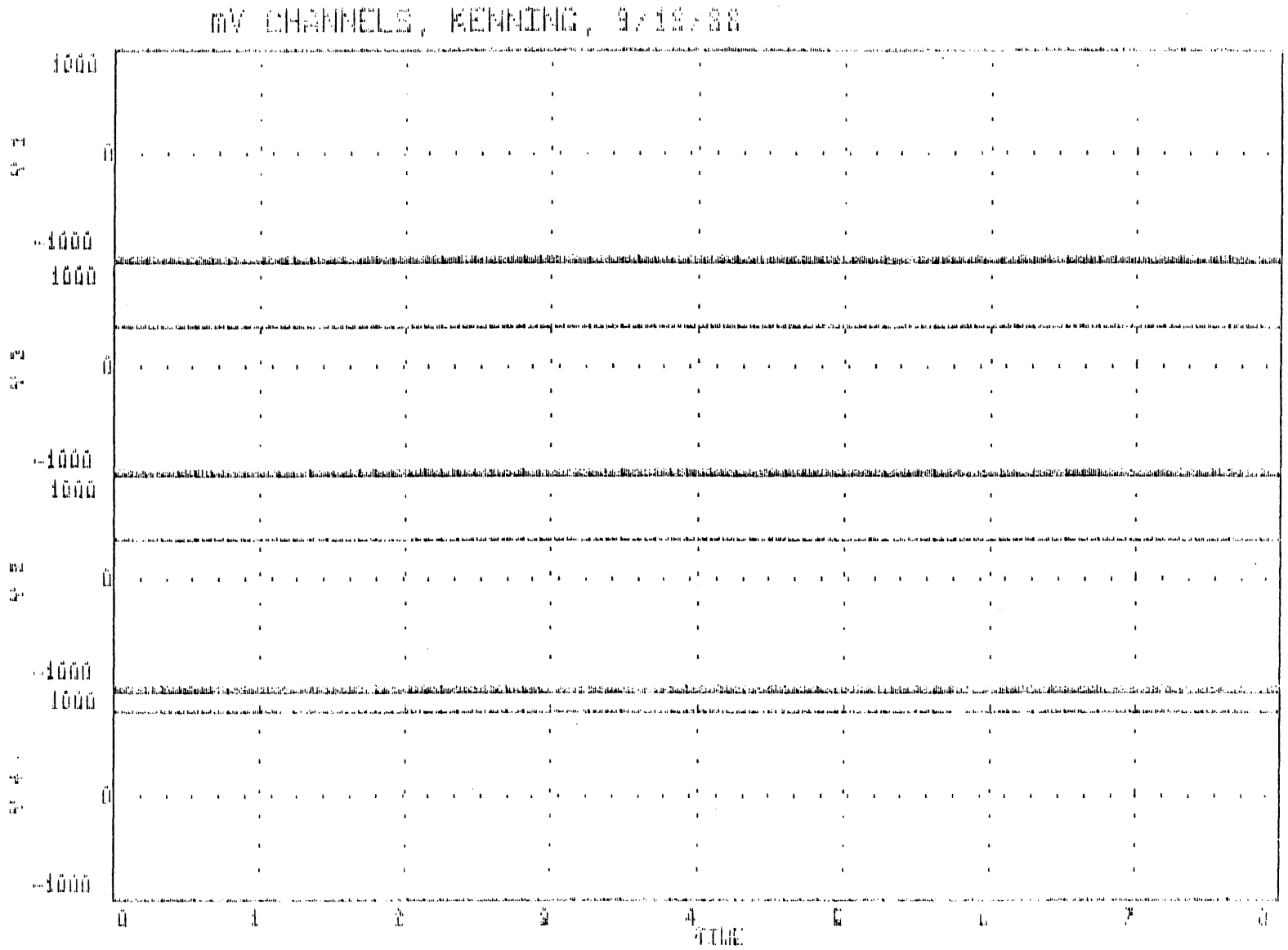
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
TIME



KEY

CHAN	HI	LO
V1	E field (dc)	-
V2	feeder	block on floor
V3	milkline	block on floor
V4	ceiling mesh	block on floor

CHAN	HI	LO
V5	ref rod A via 11Ω	block on floor
V6	ref rod A (ac/rms)	barn ground
V7	S wire (ac/rms)	reference rod A
V8		


mV CHANNELS, KENNING, 9/19/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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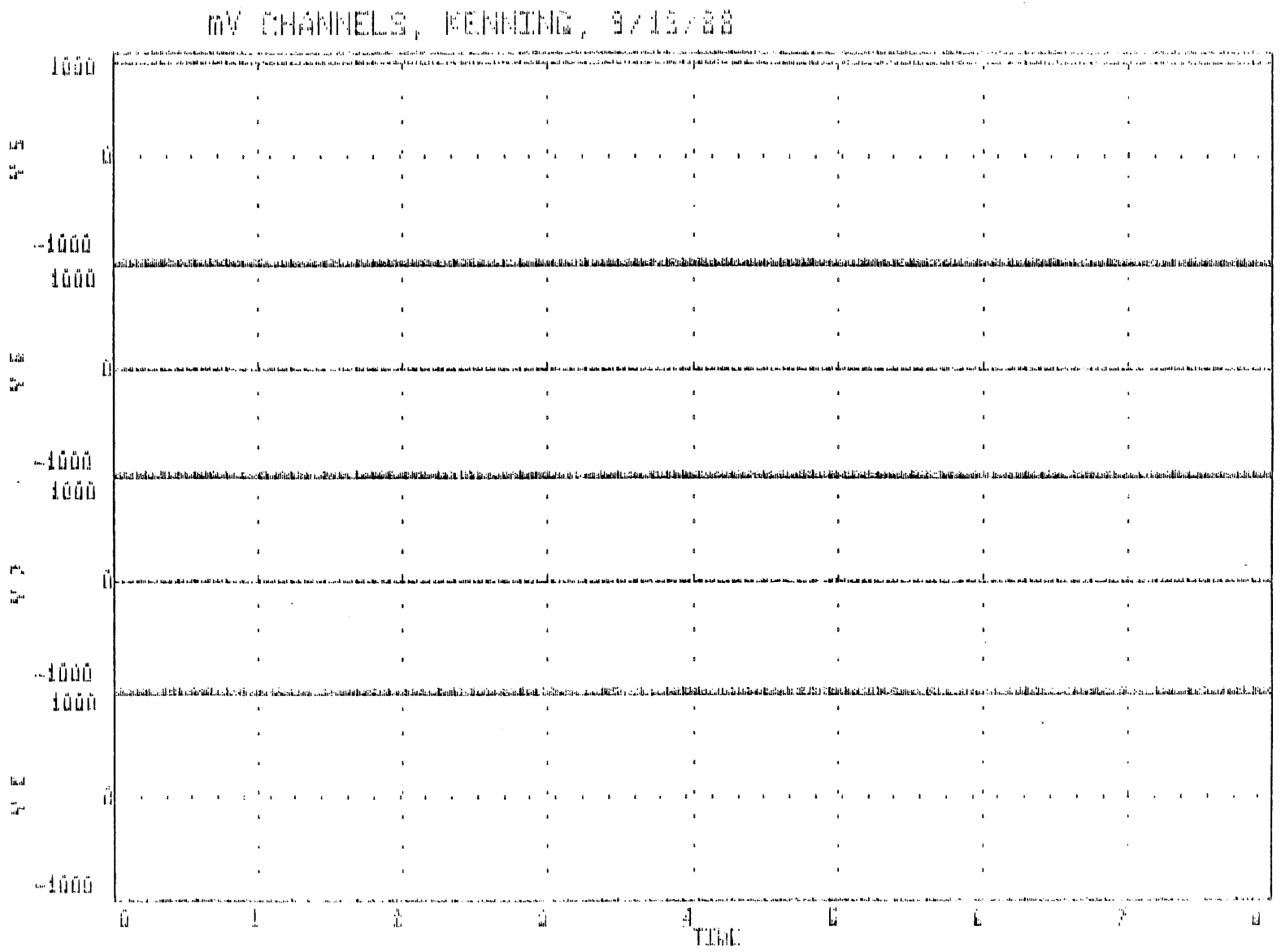
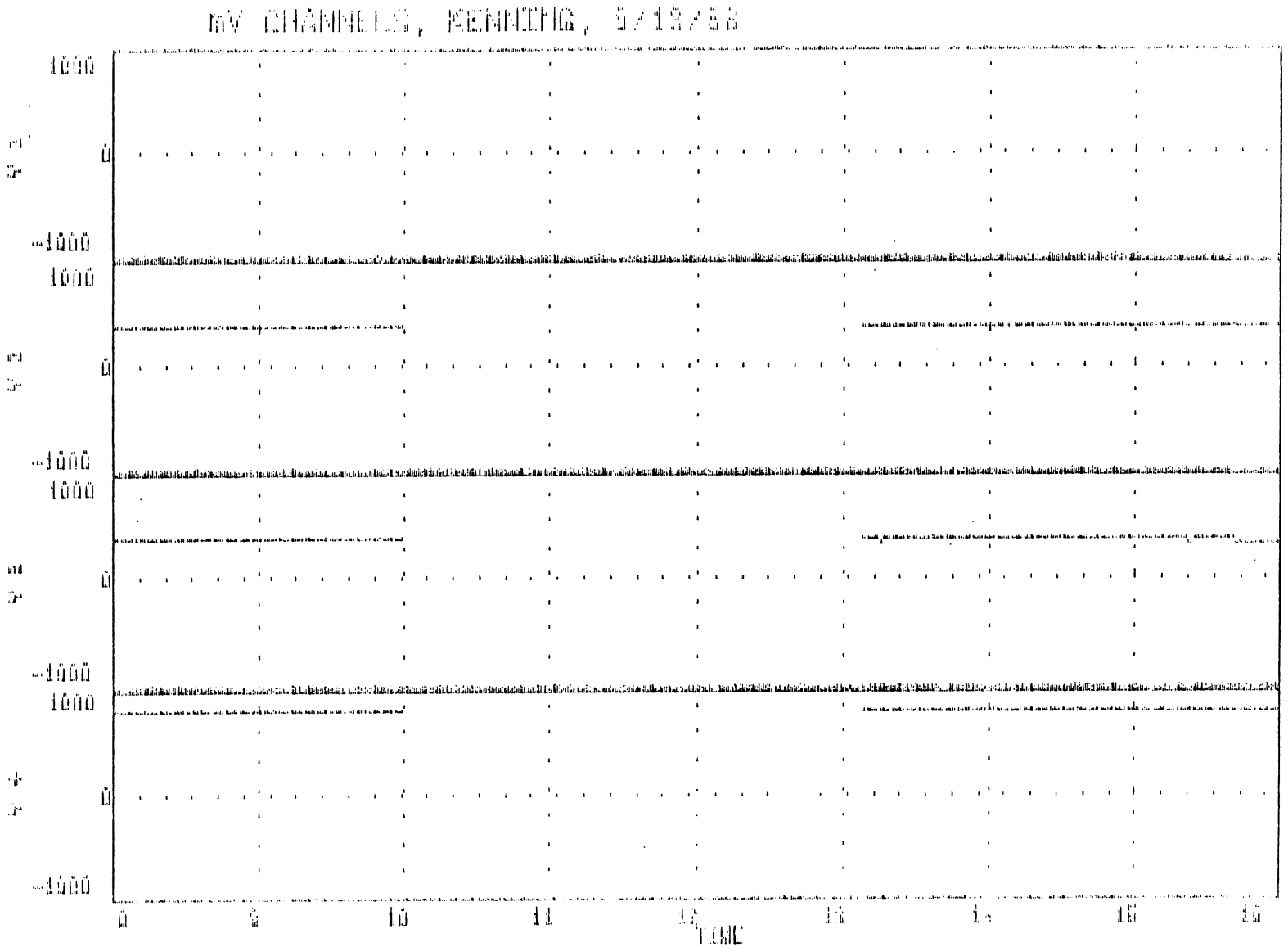
1
2
3
4
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 11k	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


MV CHANNELS, KENNING, 9/13/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
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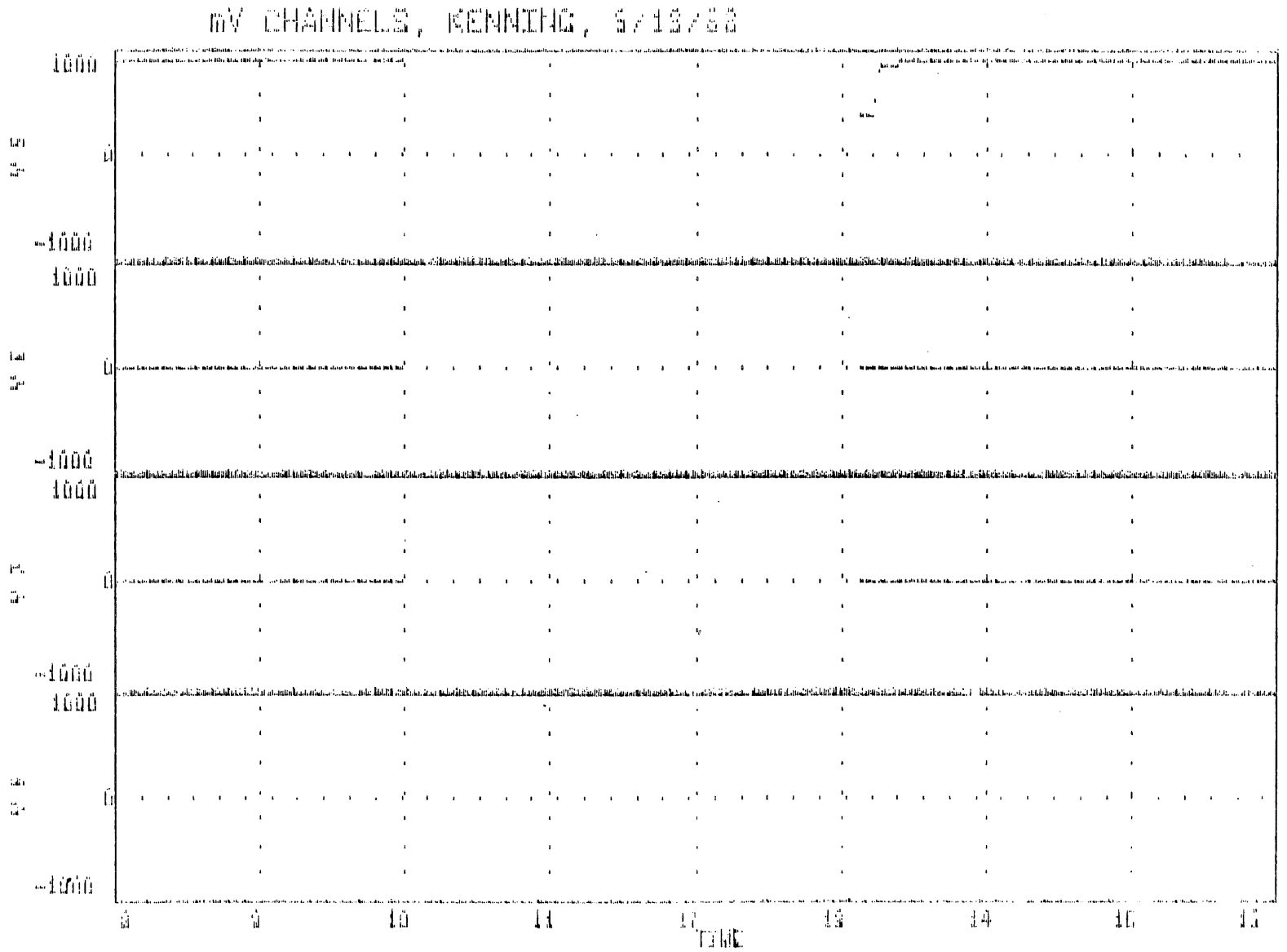
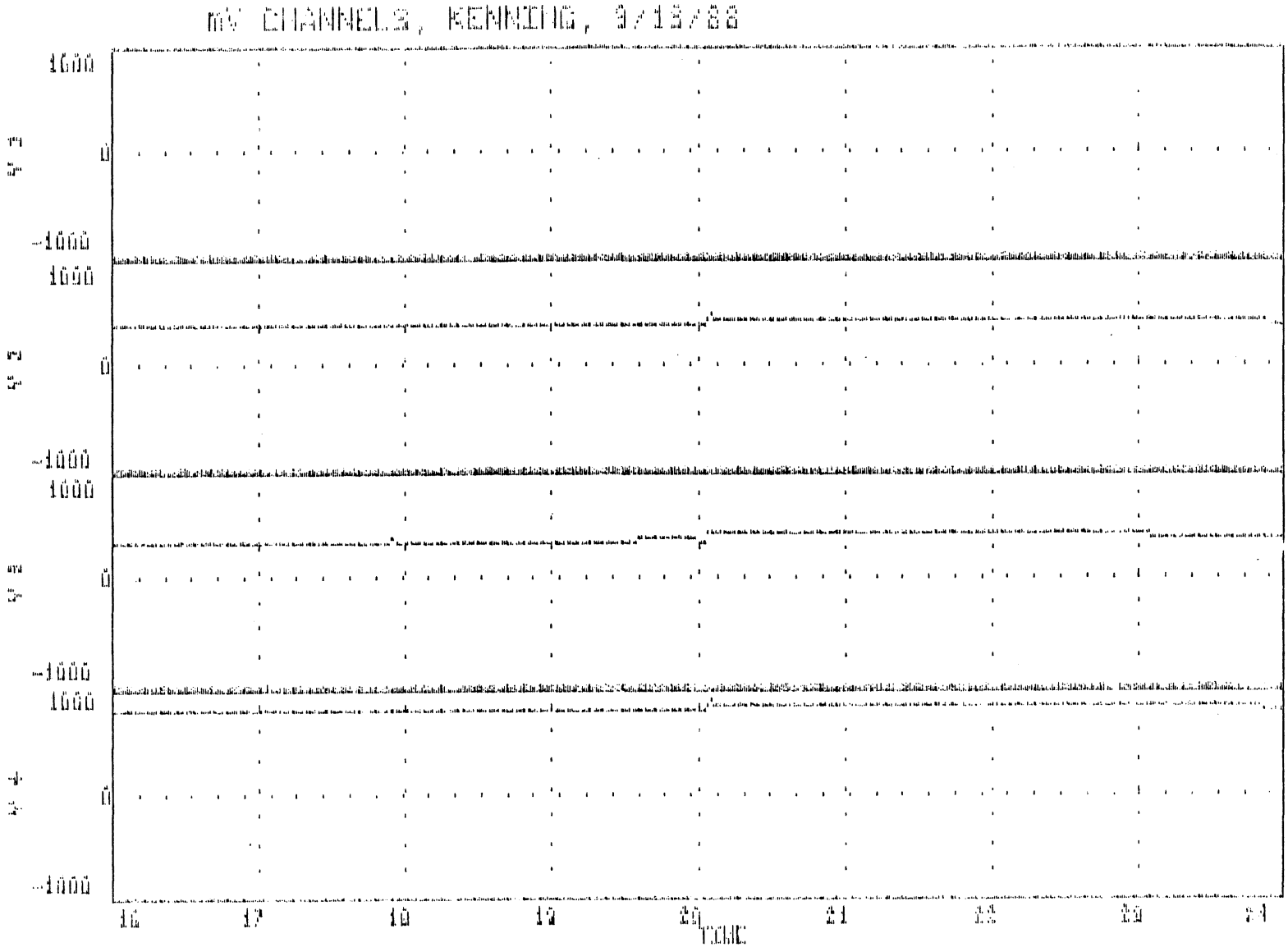
5
10
11
12
13
14
15
16
TIME



KEY

CHAN	HI	LO
V1		
V2	feeder	block on floor
V3	milkline	block on floor
V4	ceiling mesh	block on floor

CHAN	HI	LO
V5	ref rod A via 1kΩ	block on floor
V6	ref rod A (ac/rms)	barn ground
V7	S wire (ac/rms)	reference rod A
V8		


mV CHANNELS, KENNING, 9/13/88
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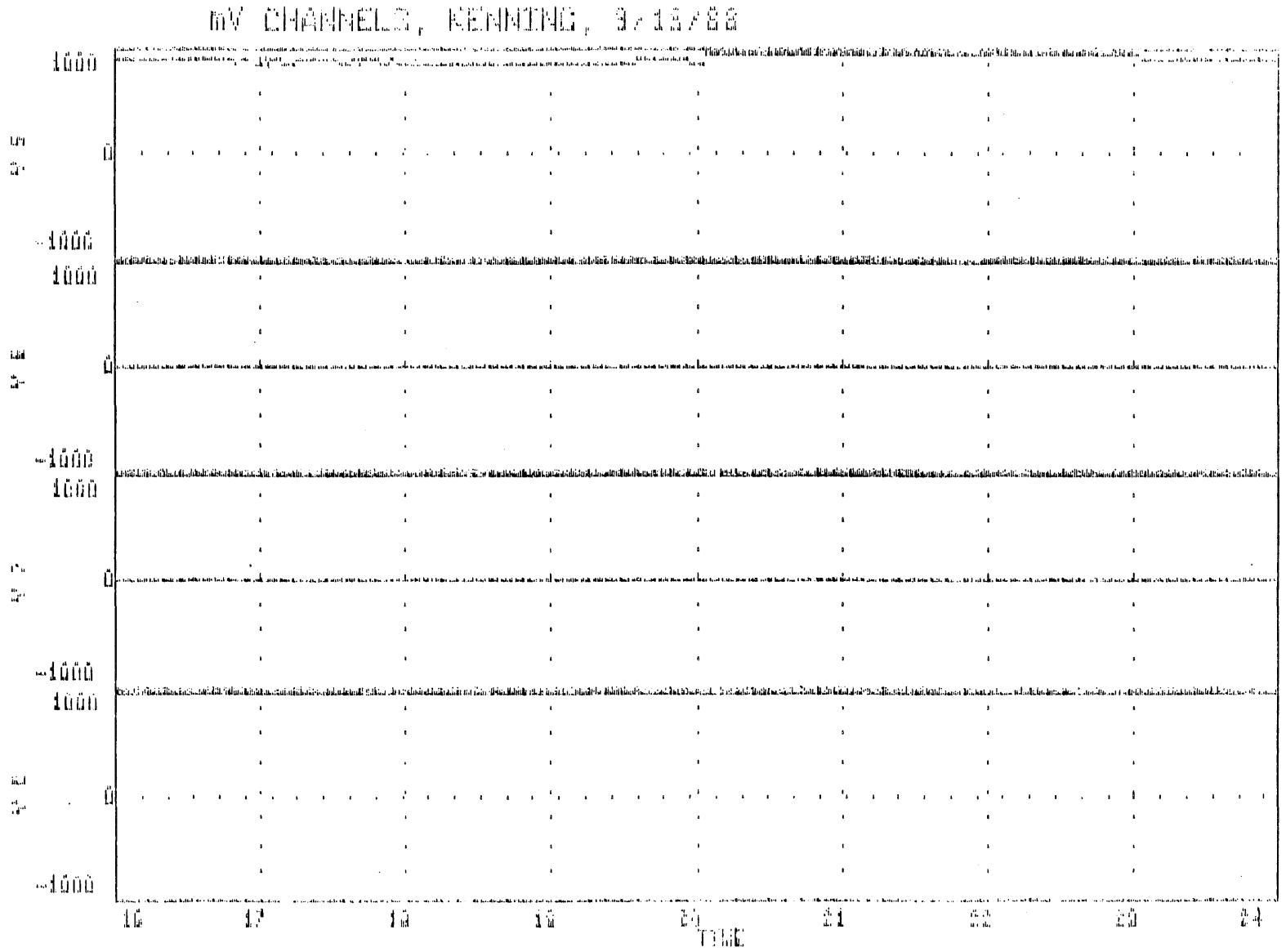
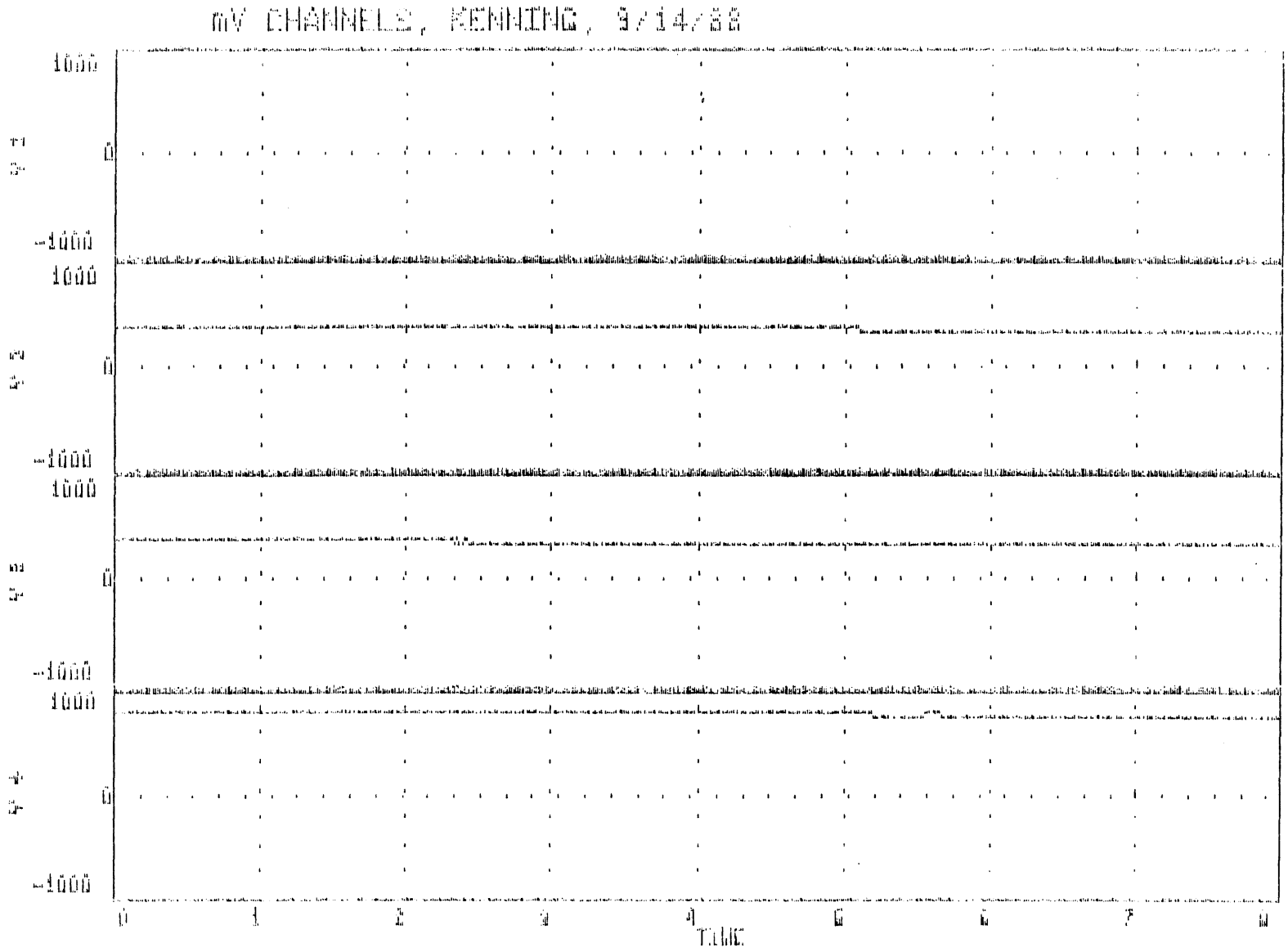
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
16
17
18
19
20
21
22
23
24
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via lit	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


mV CHANNELS, PENNING, 9/14/88
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-1000
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-1000
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0
-1000
1000
0
-1000
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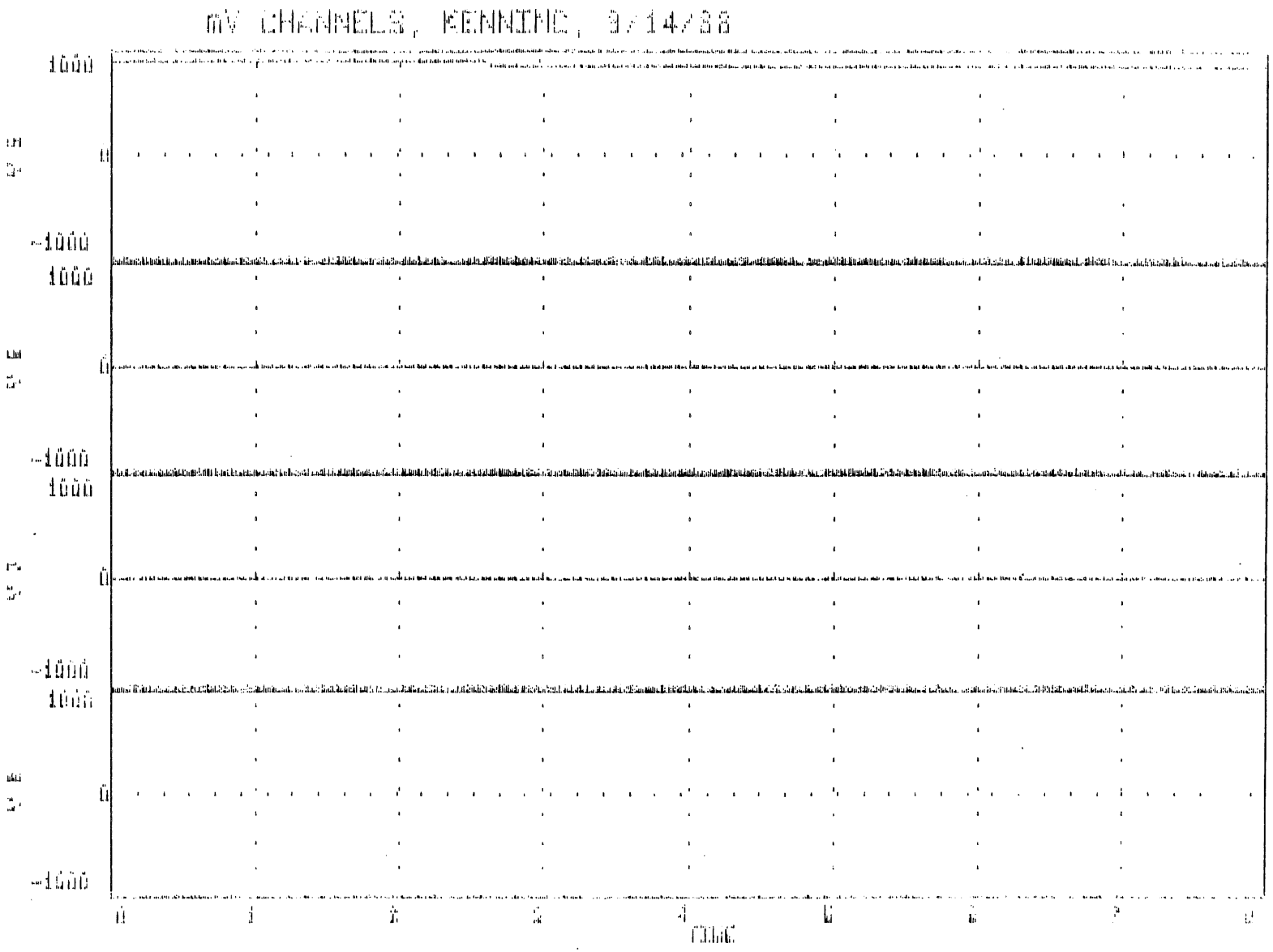
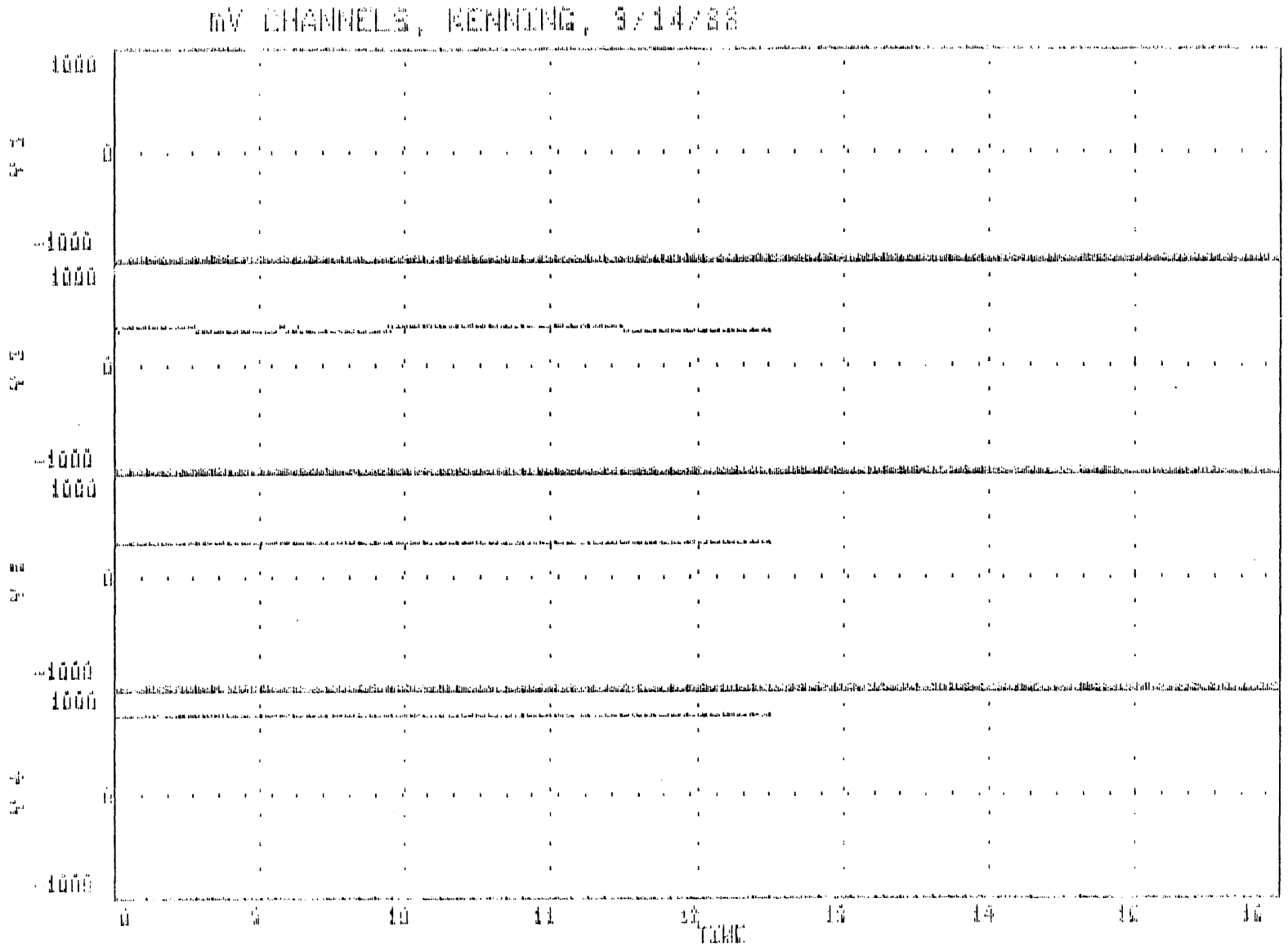
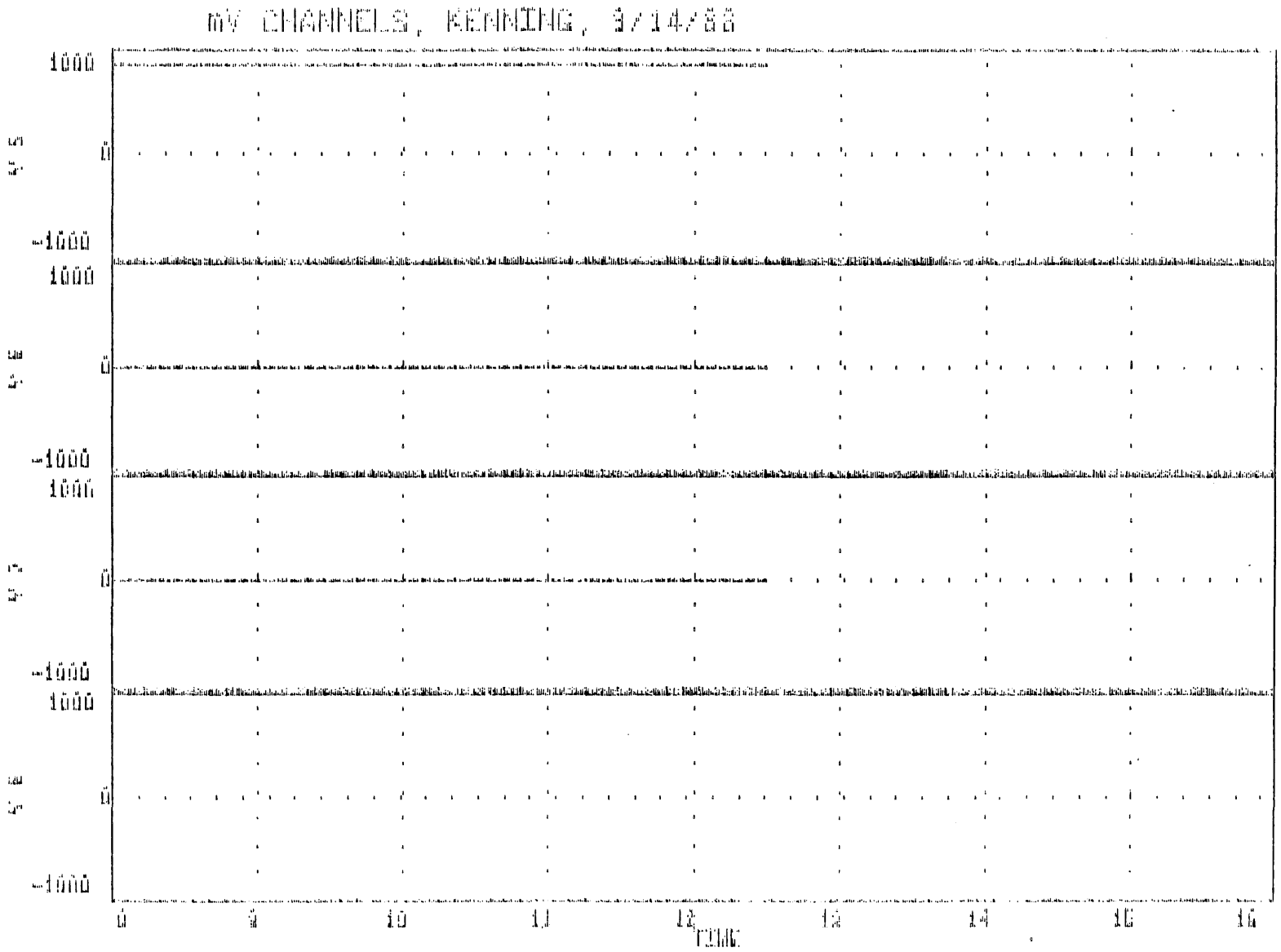
5
6
7
8
TIME



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via IHU	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		


mV CHANNELS, KENNING, 9/14/88
1000
0
-1000
1000
0
-1000
1000
0
-1000
1000
0
-1000
TIME
10
11
12
13
14
15
16



KEY

CHAN	HI	LO	CHAN	HI	LO
V1			V5	ref rod A via 1kΩ	block on floor
V2	feeder	block on floor	V6	ref rod A (ac/rms)	barn ground
V3	milkline	block on floor	V7	S wire (ac/rms)	reference rod A
V4	ceiling mesh	block on floor	V8		

Kenning Primary Data - General Observations

DC Millivolt Variables:

1. Feeder cup to contact block on floor: Steady at about 500 mV, then about -200 mV, then about 400 mV.
2. Milk line to contact block on floor: Steady at about 500 mV, then about -200 mV, then steady between about 400 and 500 mV.
3. Ceiling mesh to contact block on floor: Steady at about 800 mV, then about 100 to 200 mV, then about 800 mV.
4. Remote reference rod A to contact block on floor (through 1kö): Steady at about 100 mV, then about 800 mV.

AC (true rms) Millivolt Variables:

1. Remote reference rod A to barn ground: Steady near 0 mV throughout. Range 17 to -2 mV (90-10%tile).
2. South overhead wire to remote reference rod A: Steady near 0 mV throughout. Range 42 to 30 mV (90-10%tile).

DC electric field. Undetectable with field mill.

AC magnetic field. Low level and steady near center of stall.

No systematic anomalies were noted in the primary data base with regard to milking activities.

An explanation for the shift in all steady readings of dc potential involving the contact block on the floor remains unresolved.

Weather variables: The following table presents the distribution of weather variables over the Borgerding monitoring period.

Variable	90%tile	50%tile	10%tile
Temp(degF)	74	60	44
Bar Pres	30.2	30.1	30.0
Wind(mph)	6	1	0
Rel Hum	82	55	36

AC MAGNETIC FIELD DATA

Spatial surveys of the ac magnetic field in each barn are presented on the following pages (3.289 to 3.328). Each ac magnetic field data file consists of a number of records, each describing the ac magnetic field at a 2-meter grid point in the barn in terms of its x and y position, the three components of the magnetic field and a vector addition representing the ac magnetic field strength each for (typically) two (or more) contrasting conditions such as linear/flat, milking/not, barn power on/off, etc. The reader should already be familiar with the methodology of this measurement described earlier on p. 3.6.

To assist the reader through this section, the first analysis will be described here. The first analysis called BOR01 is presented beginning on 3.291. It is noted here that several variables contributed to the analysis (refer specifically to the "Labels" in the list for a description. The magnetic field is a vector requiring three orthogonal measurements to be made. It is seen that variable No. 1 is the north/south (N/S) component (comp) of the magnetic field (Bac) measured in the linear (LIN) mode. Variables 1 to 6 are the magnetic field components in linear and flat modes. Variables 7 and 8 are the horizontal grid point at which the measurements were made. Variables 9 and 10 are the vector sums of the respective components of the magnetic field in the linear and flat modes. Variable 11 represents the difference between linear and flat readings as a fraction of the flat reading. Variable 12 is a position index useful in later graphic presentation of this data. Following on pp. 3.292 and 3.293 is a printout of the data just described. Then, as is typical of further analyses to follow, a map of this data is presented to give the reader a visual presentation of how the ac magnetic field varies inside the barn. For example, a map of the linear readings is presented as a spike plot on 3.291. Here the reader may be confused by the lack of resolution of the majority of points. In this example the presence of one very large spike suppresses the rest. In such cases, an attempt was made to resolve this difficulty by including another type of plot such as that on 3.294 which shows the data in a different manner (here as a linear scan through the four lines in the barn, leaving the one or two over-dominant points to lie off scale on the graph).

Typically, data were collected to provide a contrast between different conditions in the barn. In each case, labels on the graphs aid the reader in deciding what the applicable condition was and what contrast is possible with the data. As in previous sections of this data base presentation, it is primarily the data itself which is displayed rather than a detailed analysis of that data.

----------NCSS Editor----------

Date/Time 09-01-1988 12:49:44
Data Base Name C:BOR01
Description Data base created at 12:20:46 on 09-01-1988

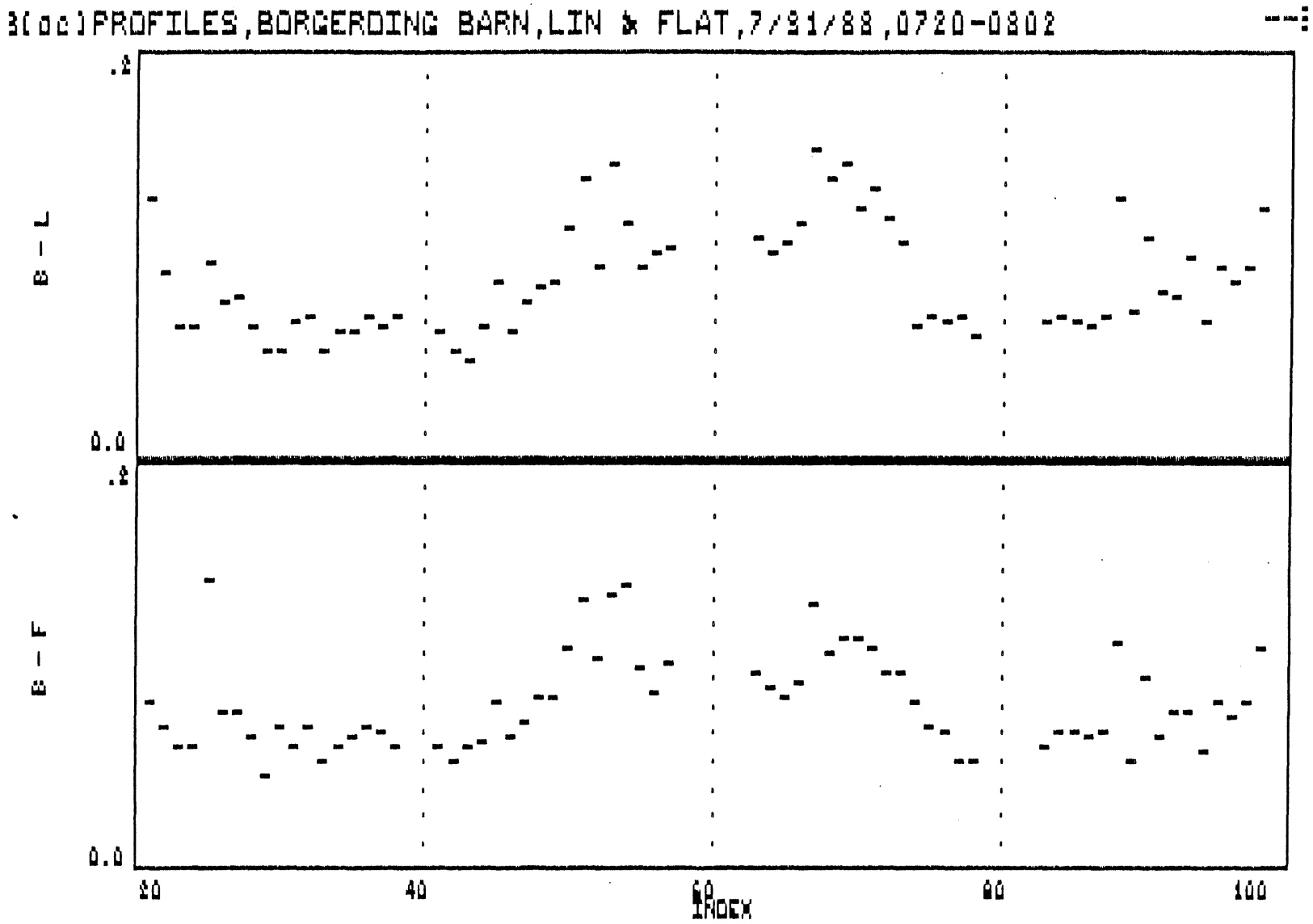
No.	Variable	Rows	Vlab	Label
1	U-L	72		N/S B(ac) COMP, LIN
2	V-L	72		E/W B(ac) COMP, LIN
3	W-L	72		U/D B(ac) COMP, LIN
4	U-F	72		N/S B(ac) COMP, FLAT
5	V-F	72		E/W B(ac) COMP, FLAT
6	W-F	72		U/D B(ac) COMP, FLAT
7	X	72		N/S POSITION IN BARN
8	Y	72		E/W POSITION IN BARN
9	B-L	0		B(ac), (mG), LINEAR MODE
10	B-F	0		B(ac), (mG), FLAT MODE
11	L-F/F	0		[B(ac)LIN-B(ac)FLAT]/[B(ac)FLAT]
12	INDEX	0		LINEAR INDEX OF POSITON IN BARN

B(ac), BORGERDING BARN, 7/31/88,~0720-0802, LINEAR AND FLAT MODE COMPARISON

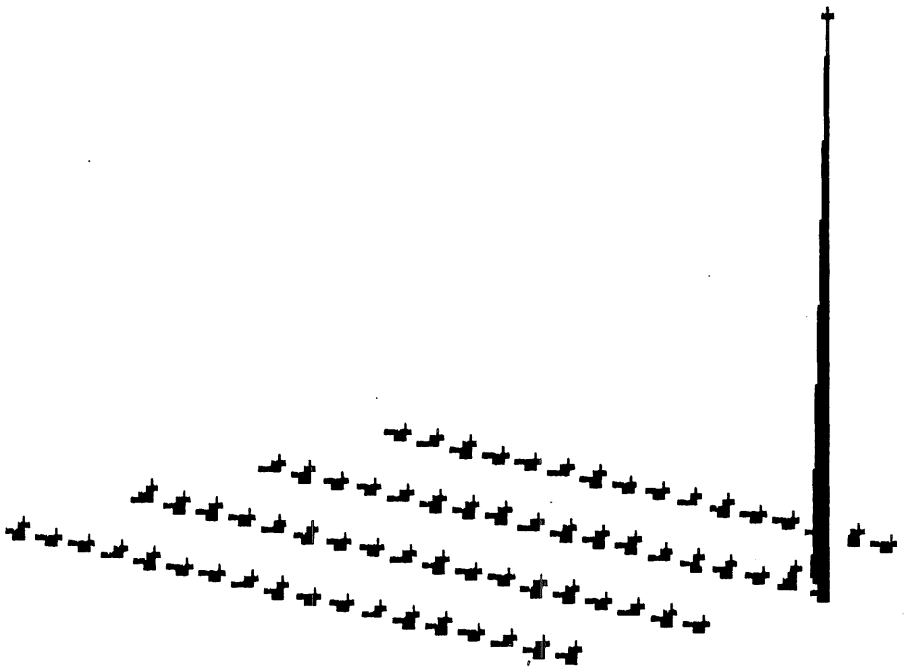
	U-L	V-L	W-L	U-F	V-F	W-F	X	Y	B-L	B-F	L-F/F	IND EX
1	0.09	0.06	0.07	0.05	0.06	0.03	2	2	0.13	0.08	-0.54	21
2	0.06	0.05	0.05	0.03	0.05	0.04	2	4	0.09	0.07	-0.31	22
3	0.03	0.03	0.05	0.02	0.04	0.04	2	6	0.07	0.06	-0.09	23
4	0.03	0.03	0.05	0.02	0.03	0.05	2	8	0.07	0.06	-0.06	24
5	0.09	0.03	0.02	0.09	0.02	0.11	2	10	0.10	0.14	0.32	25
6	0.03	0.01	0.07	0.03	0.02	0.07	2	12	0.08	0.08	0.02	26
7	0.03	0.02	0.07	0.03	0.02	0.07	2	14	0.08	0.08	0.00	27
8	0.03	0.05	0.03	0.03	0.05	0.03	2	16	0.07	0.07	0.00	28
9	0.03	0.03	0.03	0.02	0.03	0.03	2	18	0.05	0.05	-0.11	29
10	0.03	0.03	0.03	0.03	0.04	0.05	2	20	0.05	0.07	0.27	30
11	0.02	0.04	0.05	0.02	0.03	0.05	2	22	0.07	0.06	-0.09	31
12	0.03	0.04	0.05	0.03	0.04	0.05	2	24	0.07	0.07	0.00	32
13	0.02	0.03	0.04	0.02	0.03	0.04	2	26	0.05	0.05	0.00	33
14	0.02	0.03	0.05	0.02	0.03	0.05	2	28	0.06	0.06	0.00	34
15	0.02	0.03	0.05	0.03	0.03	0.05	2	30	0.06	0.07	0.06	35
16	0.03	0.04	0.05	0.03	0.04	0.05	2	32	0.07	0.07	0.00	36
17	0.03	0.03	0.05	0.02	0.04	0.05	2	34	0.07	0.07	0.02	37
18	0.03	0.04	0.05	0.02	0.03	0.05	2	36	0.07	0.06	-0.15	38
19	0.16	0.11	0.13	0.16	0.11	0.11	4	36	0.23	0.22	-0.05	58
20	0.03	0.06	0.08	0.02	0.07	0.07	4	34	0.10	0.10	-0.03	57
21	0.02	0.04	0.09	0.02	0.03	0.08	4	32	0.10	0.09	-0.15	56
22	0.03	0.04	0.08	0.02	0.04	0.09	4	30	0.09	0.10	0.06	55
23	0.02	0.07	0.09	0.04	0.10	0.09	4	28	0.12	0.14	0.18	54
24	0.02	0.06	0.13	0.02	0.06	0.12	4	26	0.14	0.14	-0.07	53
25	0.02	0.02	0.09	0.01	0.03	0.10	4	24	0.09	0.10	0.10	52
26	0.04	0.02	0.13	0.02	0.01	0.13	4	22	0.14	0.13	-0.04	51
27	0.03	0.01	0.11	0.04	0.02	0.10	4	20	0.11	0.11	-0.04	50
28	0.03	0.02	0.08	0.02	0.02	0.08	4	18	0.09	0.08	-0.03	49
29	0.02	0.02	0.08	0.02	0.02	0.08	4	16	0.08	0.08	0.00	48
30	0.03	0.04	0.06	0.03	0.03	0.06	4	14	0.08	0.07	-0.06	47
31	0.02	0.03	0.05	0.03	0.03	0.05	4	12	0.06	0.07	0.06	46
32	0.05	0.04	0.06	0.04	0.04	0.06	4	10	0.09	0.08	-0.06	45
33	0.03	0.03	0.05	0.03	0.04	0.04	4	8	0.07	0.06	-0.02	44
34	0.02	0.02	0.04	0.02	0.03	0.05	4	6	0.05	0.06	0.21	43
35	0.02	0.03	0.04	0.02	0.03	0.04	4	4	0.05	0.05	0.00	42
36	0.03	0.02	0.05	0.02	0.04	0.04	4	2	0.06	0.06	-0.03	41
37	4.00	1.00	13.00	2.50	2.00	13.00	6	2	13.64	13.39	-0.02	61
38	0.34	0.09	0.13	0.44	0.08	0.10	6	4	0.37	0.46	0.18	62
39	0.04	0.06	0.08	0.04	0.04	0.08	6	6	0.11	0.10	-0.10	63
40	0.04	0.06	0.07	0.04	0.04	0.07	6	8	0.10	0.09	-0.12	64
41	0.04	0.07	0.07	0.03	0.04	0.07	6	10	0.11	0.09	-0.24	65
42	0.02	0.08	0.08	0.02	0.04	0.08	6	12	0.11	0.09	-0.25	66
43	0.02	0.12	0.09	0.02	0.10	0.08	6	14	0.15	0.13	-0.17	67
44	0.03	0.10	0.09	0.04	0.06	0.08	6	16	0.14	0.11	-0.28	68
45	0.02	0.11	0.09	0.04	0.07	0.08	6	18	0.14	0.11	-0.26	69
46	0.02	0.10	0.07	0.01	0.08	0.08	6	20	0.12	0.11	-0.09	70

B(ac), BORGERDING BARN, 7/31/88,~0720-0802, LINEAR AND FLAT MODE COMPARISON

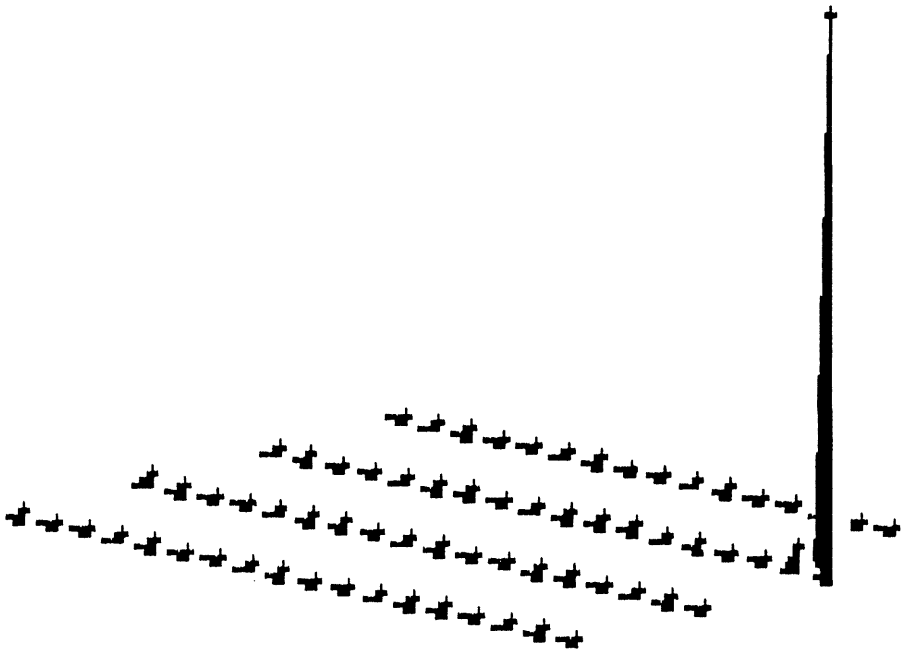
	U-L	V-L	W-L	U-F	V-F	W-F	X	Y	B-L	B-F	L-F/F	INDEX
47	0.04	0.09	0.09	0.02	0.07	0.08	6	22	0.13	0.11	-0.23	71
48	0.03	0.08	0.08	0.03	0.06	0.07	6	24	0.12	0.10	-0.21	72
49	0.04	0.07	0.07	0.03	0.06	0.07	6	26	0.11	0.10	-0.10	73
50	0.03	0.05	0.03	0.03	0.07	0.03	6	28	0.07	0.08	0.20	74
51	0.03	0.05	0.04	0.03	0.05	0.04	6	30	0.07	0.07	0.00	75
52	0.02	0.04	0.05	0.02	0.04	0.05	6	32	0.07	0.07	0.00	76
53	0.03	0.04	0.05	0.02	0.03	0.04	6	34	0.07	0.05	-0.31	77
54	0.02	0.04	0.04	0.02	0.03	0.04	6	36	0.06	0.05	-0.11	78
55	.	.	.	.	.	.	8	2	.	.	.	81
56	.	.	.	.	.	.	8	4	.	.	.	82
57	0.07	0.06	0.08	0.07	0.06	0.06	8	36	0.12	0.11	-0.11	98
58	0.03	0.04	0.08	0.02	0.04	0.07	8	34	0.09	0.08	-0.14	97
59	0.03	0.04	0.07	0.02	0.04	0.06	8	32	0.09	0.07	-0.15	96
60	0.03	0.04	0.08	0.04	0.04	0.06	8	30	0.09	0.08	-0.14	95
61	0.02	0.04	0.05	0.01	0.04	0.04	8	28	0.07	0.06	-0.17	94
62	0.04	0.04	0.08	0.03	0.02	0.07	8	26	0.10	0.08	-0.24	93
63	0.02	0.03	0.07	0.03	0.04	0.06	8	24	0.08	0.08	-0.01	92
64	0.03	0.03	0.07	0.03	0.03	0.05	8	22	0.08	0.07	-0.25	91
65	0.06	0.04	0.08	0.05	0.04	0.07	8	20	0.11	0.09	-0.14	90
66	0.01	0.02	0.07	0.01	0.02	0.05	8	18	0.07	0.05	-0.34	89
67	0.06	0.03	0.11	0.04	0.03	0.10	8	16	0.13	0.11	-0.15	88
68	0.02	0.06	0.03	0.01	0.06	0.03	8	14	0.07	0.07	-0.03	87
69	0.01	0.05	0.04	0.01	0.05	0.04	8	12	0.06	0.06	0.00	86
70	0.02	0.04	0.05	0.02	0.04	0.05	8	10	0.07	0.07	0.00	85
71	0.03	0.05	0.04	0.02	0.05	0.04	8	8	0.07	0.07	-0.05	84
72	0.02	0.04	0.05	0.02	0.04	0.04	8	6	0.07	0.06	-0.12	83


3(oc)PROFILES,BORGERDING BARN,LIN & FLAT,7/21/88,0720-0802
E - L
E - F
.2
0.0
.2
0.0
20
40
60
80
100
INDEX

B[oc] PROFILE, LINEAR, BORGERDING BARN, 7/31/88,~0720



B(oc) PROFILE, FLAT, BORGERDING BARN, 7/31/88,~0720



----------NCSS Editor----------

Date/Time 09-01-1988 15:24:21
Data Base Name C:BOR02
Description Data base created at 19:14:56 on 08-03-1988

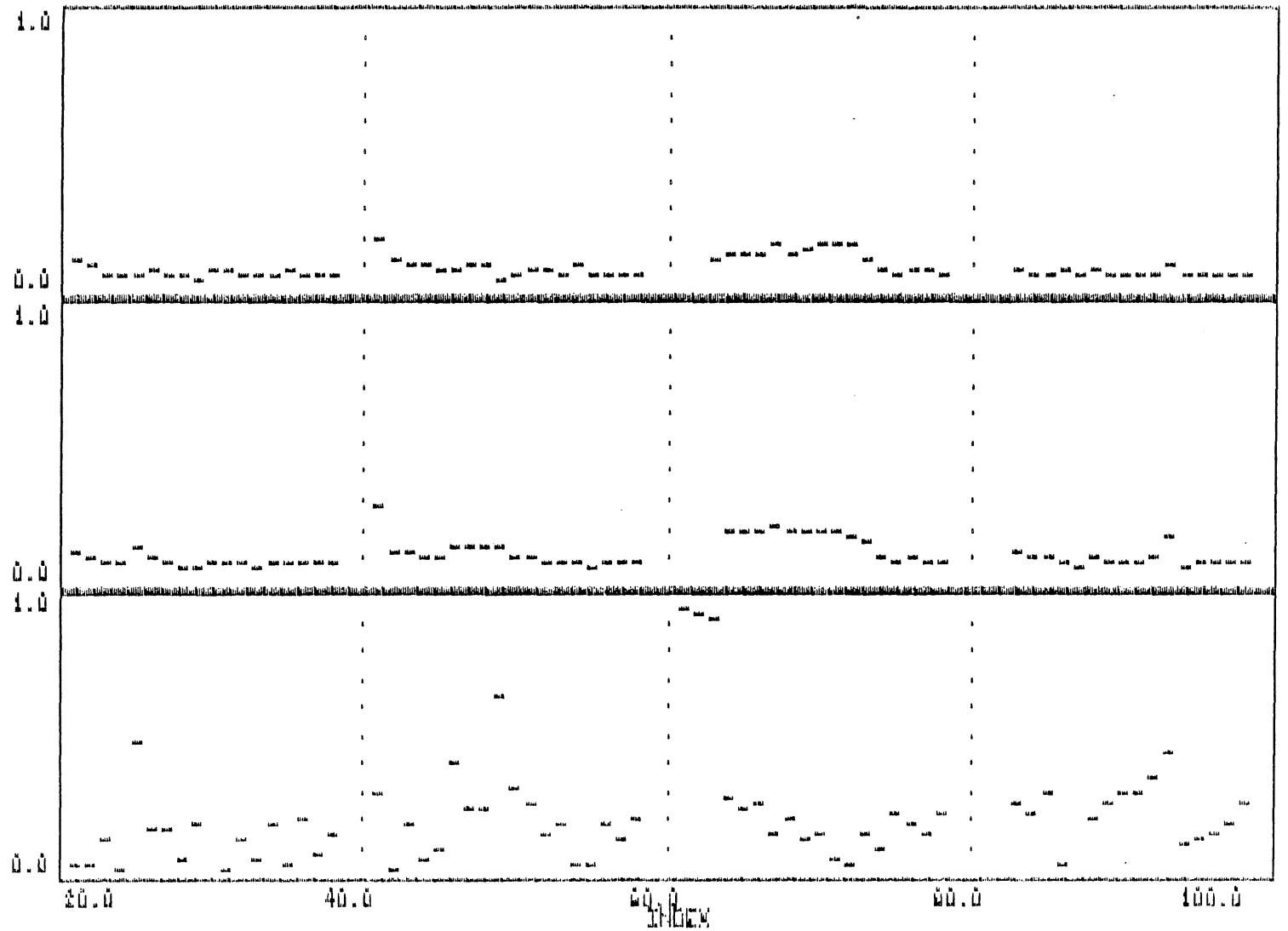
No.	Variable	Rows	Vlab	Label
1	U-L-NM	72		N/S MAG FLD COMP, LIN, NOT MILKING
2	V-L-NM	72		E/W MAG FLD COMP, LIN, NOT MILKING
3	W-L-NM	72		U/D MAG FLD COMP, LIN, NOT MILKING
4	U-L-M	72		N/S MAG FLD COMP, LIN, WHILE MILKING
5	V-L-M	72		E/W MAG FLD COMP, LIN, WHILE MILKING
6	W-L-M	72		U/D MAG FLD COMP, LIN, WHILE MILKING
7	X	72		N/S POSITION IN BARN
8	Y	72		E/W POSITION IN BARN
9	B-NM	72		MAG FLD (mG), LIN, NOT MILKING
10	B-M	72		MAG FLD (mG), LIN, WHILE MILKING
11	M-NM	72		(BM-BNM)/BNM
12	INDEX	72		LINEAR INDEX OF POSITION

	U-L-N-M	V-L-N-M	W-L-N-M	U-L-M	V-L-M	W-L-M	X	Y	B-L-M	B-M	T-M	V-M
1 Row	0.08	0.08	0.07	0.08	0.06	0.07	2	2	0.12	0.13	0.14	22
2 Row	0.06	0.07	0.05	0.07	0.05	0.06	2	4	0.10	0.10	0.12	22
3 Row	0.05	0.03	0.04	0.04	0.04	0.06	2	6	0.07	0.08	0.14	22
4 Row	0.04	0.04	0.05	0.03	0.04	0.06	2	8	0.08	0.08	0.14	22
5 Row	0.04	0.04	0.05	0.08	0.02	0.12	2	10	0.08	0.12	0.15	22
6 Row	0.05	0.04	0.05	0.04	0.01	0.09	2	12	0.08	0.11	0.15	22
7 Row	0.05	0.04	0.04	0.04	0.02	0.05	2	14	0.08	0.09	0.14	22
8 Row	0.05	0.04	0.04	0.04	0.05	0.08	2	16	0.08	0.07	0.13	22
9 Row	0.02	0.04	0.03	0.02	0.05	0.04	2	18	0.05	0.11	0.13	22
10 Row	0.05	0.04	0.05	0.04	0.05	0.08	2	20	0.08	0.08	0.11	22
11 Row	0.04	0.05	0.05	0.03	0.05	0.06	2	22	0.08	0.09	0.10	22
12 Row	0.04	0.05	0.04	0.04	0.05	0.06	2	24	0.08	0.09	0.12	22
13 Row	0.04	0.05	0.04	0.03	0.04	0.05	2	26	0.08	0.07	0.07	22
14 Row	0.03	0.04	0.04	0.03	0.04	0.06	2	28	0.06	0.08	0.11	22
15 Row	0.04	0.05	0.05	0.03	0.04	0.06	2	30	0.08	0.08	0.14	22
16 Row	0.03	0.05	0.04	0.04	0.04	0.07	2	32	0.07	0.07	0.11	22
17 Row	0.04	0.05	0.04	0.03	0.03	0.07	2	34	0.08	0.08	0.13	22
18 Row	0.04	0.05	0.04	0.04	0.04	0.07	2	36	0.08	0.09	0.12	22
19 Row	0.18	0.07	0.04	0.20	0.13	0.15	4	2	0.20	0.25	0.10	22
20 Row	0.04	0.10	0.07	0.03	0.06	0.09	4	4	0.13	0.13	0.04	22
21 Row	0.04	0.06	0.07	0.06	0.06	0.09	4	6	0.10	0.11	0.11	22
22 Row	0.04	0.06	0.07	0.04	0.05	0.07	4	8	0.10	0.09	0.12	22
23 Row	0.04	0.06	0.06	0.03	0.07	0.07	4	10	0.09	0.11	0.13	22
24 Row	0.03	0.05	0.06	0.02	0.07	0.12	4	12	0.08	0.14	0.10	22
25 Row	0.03	0.08	0.08	0.03	0.04	0.12	4	14	0.10	0.14	0.14	22
26 Row	0.05	0.08	0.08	0.05	0.03	0.13	4	16	0.11	0.14	0.15	22
27 Row	0.02	0.04	0.02	0.06	0.02	0.12	4	18	0.05	0.14	0.14	22
28 Row	0.04	0.04	0.05	0.04	0.02	0.10	4	20	0.08	0.11	0.13	22
29 Row	0.04	0.05	0.05	0.04	0.02	0.10	4	22	0.08	0.11	0.13	22
30 Row	0.03	0.05	0.05	0.05	0.03	0.07	4	24	0.08	0.09	0.11	22
31 Row	0.03	0.04	0.04	0.03	0.02	0.07	4	26	0.06	0.08	0.11	22
32 Row	0.07	0.04	0.05	0.05	0.03	0.07	4	28	0.09	0.08	0.14	22
33 Row	0.04	0.05	0.03	0.03	0.03	0.06	4	30	0.07	0.07	0.14	22
34 Row	0.04	0.04	0.03	0.04	0.03	0.06	4	32	0.06	0.08	0.13	22
35 Row	0.04	0.05	0.03	0.04	0.04	0.06	4	34	0.07	0.08	0.11	22
36 Row	0.03	0.03	0.04	0.04	0.04	0.07	4	36	0.07	0.08	0.11	22
37 Row	1.00	1.20	7.50	6.00	2.00	10.50	6	2	7.78	11.50	0.71	22
38 Row	1.30	1.20	1.20	1.80	1.00	2.00	6	4	2.14	2.69	0.71	22
39 Row	0.08	0.08	0.08	0.60	0.60	1.00	6	6	0.13	1.31	0.71	22
40 Row	0.04	0.09	0.09	0.06	0.13	0.13	6	8	0.13	0.15	0.28	22
41 Row	0.05	0.10	0.09	0.05	0.14	0.12	6	10	0.14	0.13	0.28	22
42 Row	0.04	0.10	0.09	0.04	0.13	0.13	6	12	0.14	0.13	0.28	22
43 Row	0.04	0.15	0.09	0.05	0.16	0.13	6	14	0.18	0.21	0.28	22
44 Row	0.04	0.11	0.09	0.06	0.13	0.12	6	16	0.15	0.15	0.27	22
45 Row	0.04	0.12	0.10	0.06	0.13	0.12	6	18	0.16	0.17	0.14	22

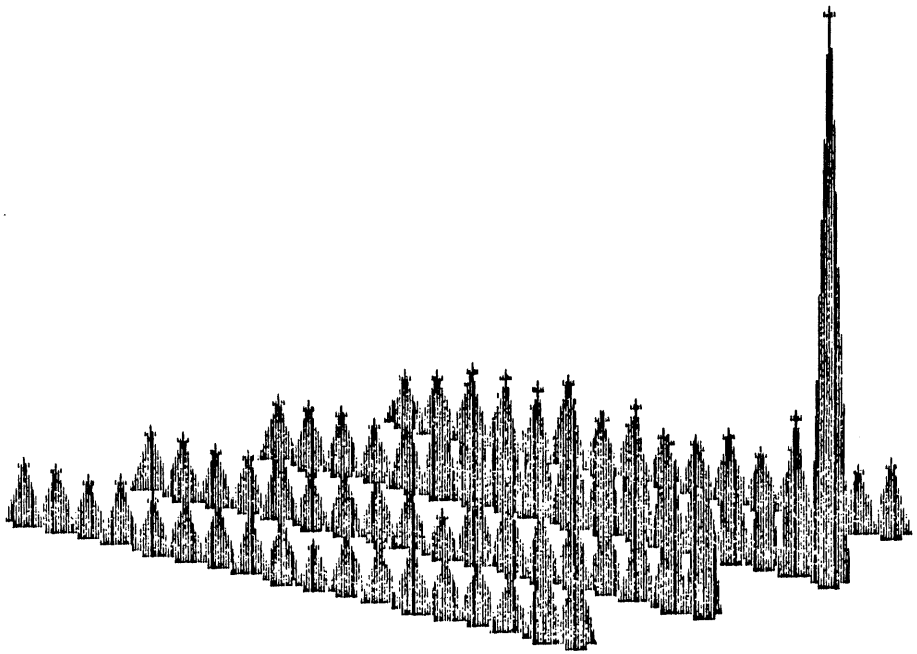
BENETTI FIELD DATA DRESSING BARN, 7/30/88,1.3 M SPACE FLOOR, PIGS 1W & WET

		U	V	W	U	V	U	X	Y	S	T	T	T
		-	-	-	-	-	-			-	-	-	-
		L	L	L	L	L	L			N	M	N	M
		I	I	I	I	I	I			M		N	E
		N	N	N	M	M	M						N
		M	M	M									
46	Row	0.04	0.13	0.10	0.05	0.15	0.12	6	30	0.17	0.20	0.18	1.
47	Row	0.04	0.13	0.11	0.04	0.13	0.13	6	32	0.17	0.15	0.21	1.
48	Row	0.05	0.13	0.10	0.05	0.14	0.10	6	24	0.17	0.18	0.14	1.
49	Row	0.05	0.09	0.07	0.04	0.10	0.10	6	26	0.11	0.13	0.13	1.
50	Row	0.04	0.07	0.04	0.04	0.07	0.06	6	28	0.09	0.10	0.12	1.
51	Row	0.03	0.05	0.04	0.03	0.05	0.07	6	30	0.07	0.07	0.11	1.
52	Row	0.03	0.05	0.06	0.04	0.05	0.07	6	32	0.06	0.11	0.07	1.
53	Row	0.03	0.06	0.05	0.04	0.04	0.07	6	34	0.06	0.11	0.08	1.
54	Row	0.03	0.04	0.05	0.03	0.05	0.07	6	36	0.07	0.11	0.12	1.
55	Row	.	.	.	.	.	.	8	2	.	.	.	1.
56	Row	.	.	.	.	.	.	8	4	.	.	.	1.
57	Row	0.05	0.05	0.06	0.08	0.04	0.09	8	6	0.09	0.11	0.07	1.
58	Row	0.04	0.04	0.05	0.05	0.02	0.08	8	8	0.06	0.10	0.10	1.
59	Row	0.04	0.04	0.04	0.05	0.03	0.08	8	10	0.07	0.10	0.09	1.
60	Row	0.05	0.05	0.05	0.04	0.02	0.07	8	12	0.09	0.08	0.11	1.
61	Row	0.03	0.03	0.05	0.03	0.03	0.05	8	14	0.07	0.07	0.11	1.
62	Row	0.05	0.04	0.05	0.05	0.04	0.08	8	16	0.06	0.10	0.11	1.
63	Row	0.03	0.04	0.04	0.04	0.03	0.07	8	18	0.06	0.09	0.11	1.
64	Row	0.03	0.04	0.04	0.04	0.04	0.07	8	20	0.06	0.09	0.11	1.
65	Row	0.03	0.04	0.04	0.04	0.04	0.07	8	22	0.06	0.10	0.11	1.
66	Row	0.02	0.03	0.05	0.03	0.04	0.06	8	24	0.06	0.10	0.12	1.
67	Row	0.06	0.04	0.08	0.13	0.04	0.12	8	26	0.10	0.12	0.14	1.
68	Row	0.03	0.05	0.02	0.03	0.06	0.02	8	28	0.04	0.11	0.11	1.
69	Row	0.02	0.05	0.04	0.03	0.05	0.05	8	30	0.07	0.13	0.11	1.
70	Row	0.03	0.04	0.05	0.03	0.05	0.06	8	32	0.07	0.08	0.11	1.
71	Row	0.03	0.04	0.05	0.04	0.05	0.06	8	34	0.07	0.09	0.11	1.
72	Row	0.03	0.03	0.04	0.03	0.04	0.06	8	36	0.06	0.08	0.11	1.

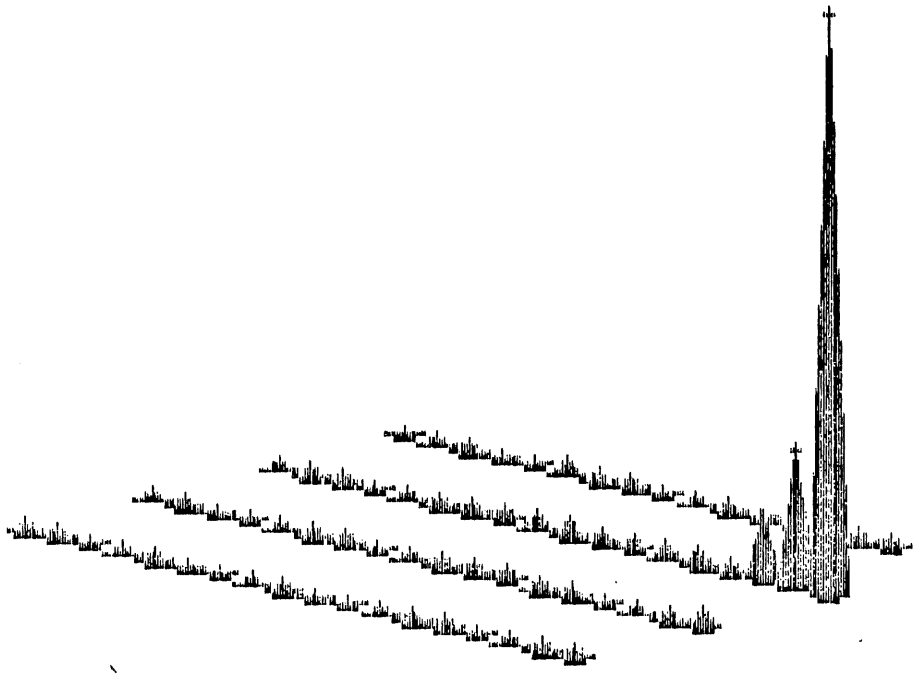
AGNETIC FIELD PROFILES, BORDERING BARN, MILKING AND NOT



MMAG FLO PROFILE, BORGERDING BARN, 7/30/88,LIN,NOT MILKING

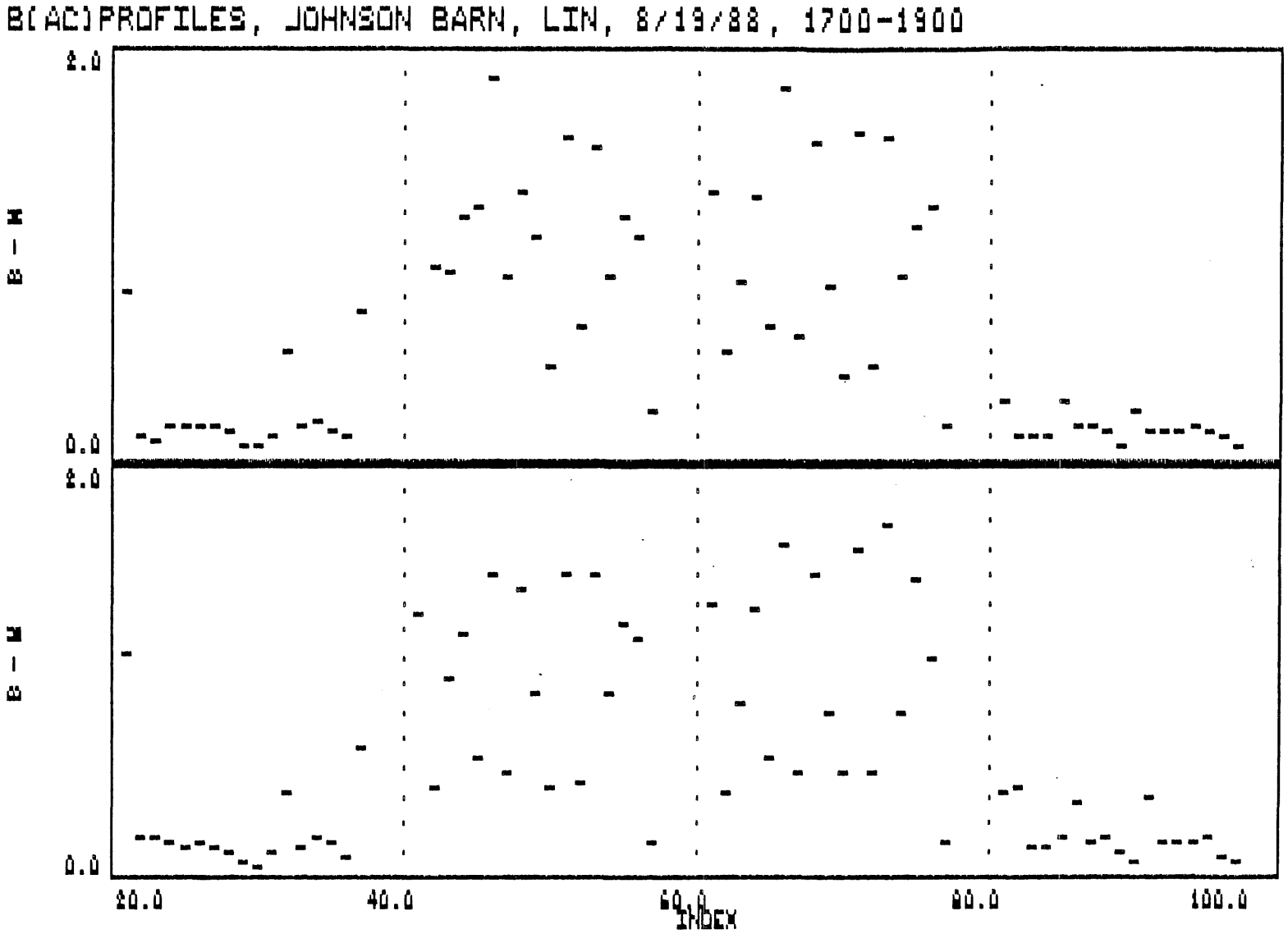


MAG FLD PROFILE OF BORGERDING BARN, 7/30/88,LIN, MILKING

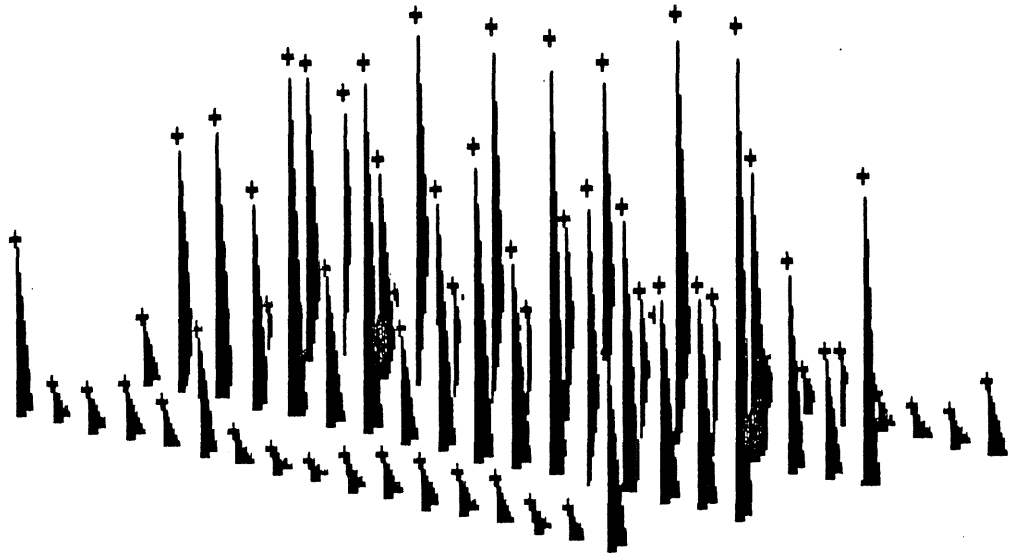


B(AC), JOHNSON BARN, 8/19/88,~1700-1900, NOT MILKING AND MILKING

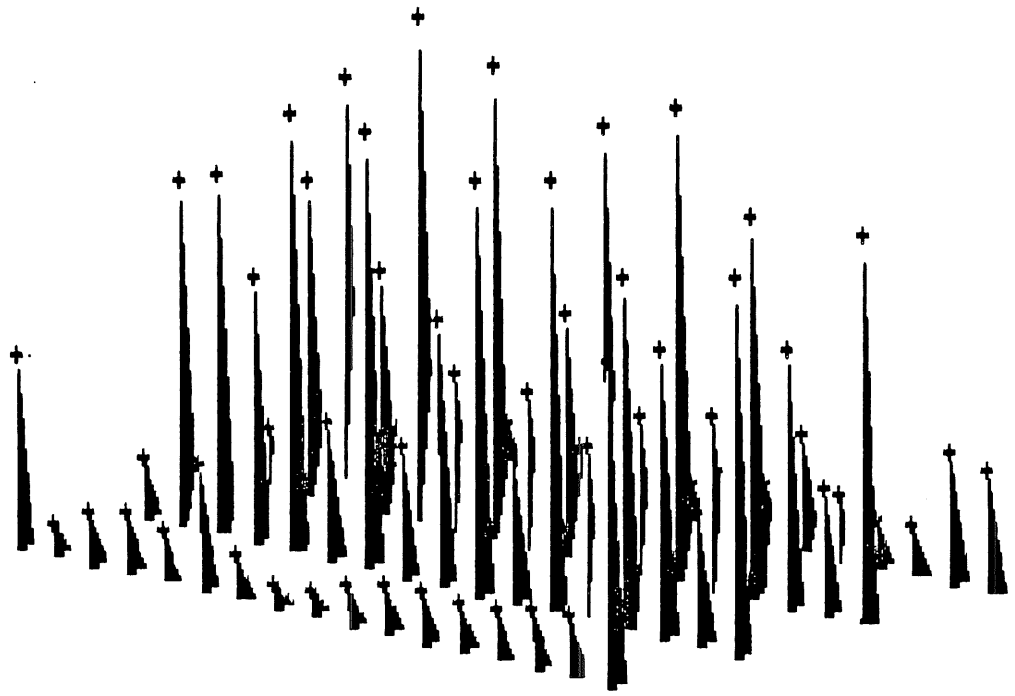
	U-N	V-N	W-N	U-M	V-M	W-M	X	Y	B-N	B-M	M-N/N	INDEX
47 Row	1.00	0.90	0.80	0.70	1.00	1.20	26	6	1.57	1.71	0.09	73
48 Row	0.40	0.70	0.40	0.10	0.70	0.40	28	6	0.90	0.81	-0.10	74
49 Row	0.30	1.10	0.08	0.10	1.20	0.80	30	6	1.14	1.45	0.26	75
50 Row	0.20	1.00	0.70	0.10	0.80	0.70	32	6	1.24	1.07	-0.14	76
51 Row	0.10	0.10	0.10	0.10	0.10	0.10	34	6	0.17	0.17	0.00	77
52 Row	0.18	0.10	0.20	0.32	0.10	0.23	2	8	0.29	0.41	0.42	81
53 Row	0.02	0.08	0.10	0.14	0.30	0.30	4	8	0.13	0.45	2.45	82
54 Row	0.06	0.08	0.06	0.04	0.06	0.14	6	8	0.12	0.16	0.35	83
55 Row	0.06	0.10	0.06	0.06	0.09	0.10	8	8	0.13	0.15	0.12	84
56 Row	0.18	0.18	0.12	0.12	0.12	0.12	10	8	0.28	0.21	-0.26	85
57 Row	0.06	0.14	0.08	0.24	0.24	0.16	12	8	0.17	0.38	1.18	86
58 Row	0.08	0.14	0.06	0.02	0.12	0.14	14	8	0.17	0.19	0.08	87
59 Row	0.12	0.06	0.06	0.10	0.14	0.10	16	8	0.15	0.20	0.35	88
60 Row	0.04	0.04	0.04	0.08	0.10	0.04	18	8	0.07	0.13	0.94	89
61 Row	0.18	0.12	0.12	0.02	0.06	0.06	20	8	0.25	0.09	-0.65	90
62 Row	0.04	0.12	0.08	0.32	0.20	0.14	22	8	0.15	0.40	1.69	91
63 Row	0.04	0.12	0.08	0.04	0.14	0.08	24	8	0.15	0.17	0.11	92
64 Row	0.14	0.06	0.04	0.16	0.06	0.06	26	8	0.16	0.18	0.15	93
65 Row	0.08	0.14	0.06	0.08	0.14	0.08	28	8	0.17	0.18	0.05	94
66 Row	0.08	0.12	0.04	0.12	0.14	0.04	30	8	0.15	0.19	0.26	95
67 Row	0.10	0.06	0.06	0.08	0.04	0.04	32	8	0.13	0.10	-0.25	96
68 Row	0.06	0.04	0.04	0.02	0.06	0.04	34	8	0.08	0.07	-0.09	97


B(AC)PROFILES, JOHNSON BARN, LIN, 8/19/88, 1700-1900
4.0
0.0
B - M
4.0
0.0
B - M
20.0
40.0
60.0
80.0
100.0
INDEX

B(AC) PROFILE, JOHNSON BARN, LIN, NOT MILKING, 8/19/88,~1700



B(AC) PROFILE, JOHNSON BARN, LIN, MILKING, 8/19/88,~1800



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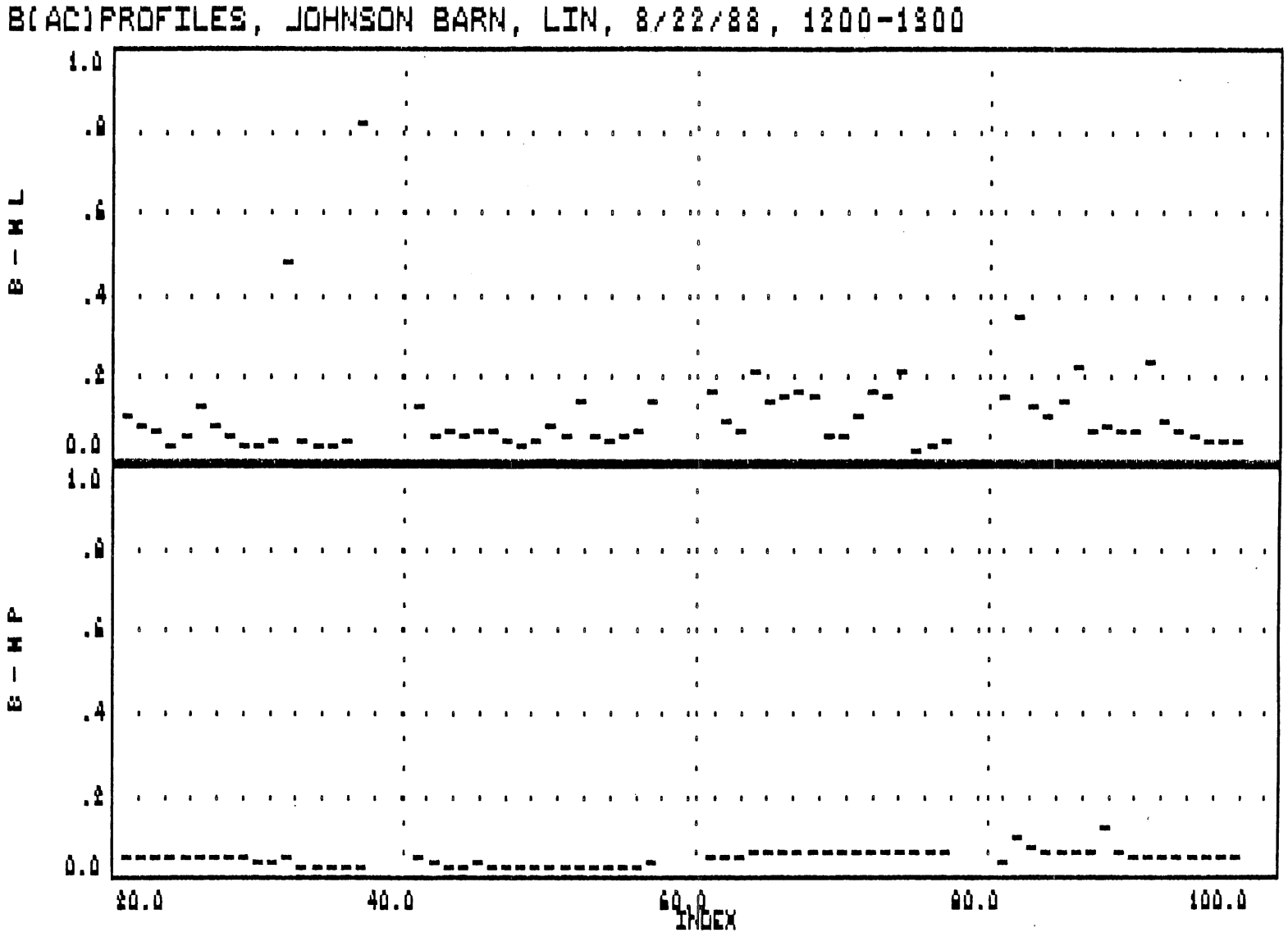
Date/Time 08-15-1988 09:40:34
Data Base Name C:JOH03
Description Data base created at 07:55:11 on 08-15-1988

No.	Variable	Rows	Vlab	Label
1	U-NL	68		N/S B(AC) COMP, LIN, NO FL LIGHTS
2	V-NL	68		E/W B(AC) COMP, LIN, NO FL LIGHTS
3	W-NL	68		U/D B(AC) COMP, LIN, NO FL LIGHTS
4	U-NP	68		N/S B(AC) COMP, LIN, NO POWER
5	V-NP	68		E/W B(AC) COMP, LIN, NO POWER
6	W-NP	68		U/D B(AC) COMP, LIN, NO POWER
7	X	68		N/S POSITION IN BARN
8	Y	68		E/W POSITION IN BARN
9	B-NL	68		B(AC), (mG), LIN, NO FL LIGHTS
10	B-NP	68		B(AC), (mG), LIN NO POWER
11	NL-NP/NP	68		(BNL-BNP)/BNP
12	INDEX	68		LINEAR INDEX OF POSITION IN BARN
13	C13	0		
14	C14	0		
15	C15	0		
16	C16	0		
17	C17	0		
18	C18	0		

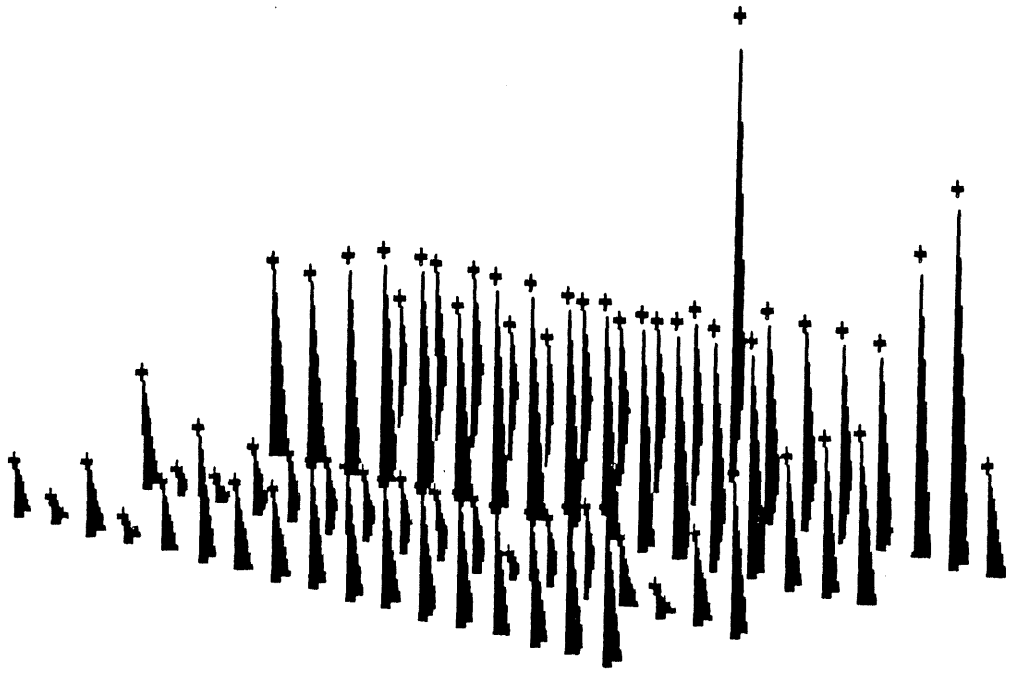
B(AC), JOHNSON BARN, 8/22/88,~1200-1300, NO FL LIGHTS AND NO POWER

	U-NL	V-NL	W-NL	U-NP	V-NP	W-NP	X	Y	B-NL	B-NP	NL-NP/NP	INDEX
1 Row	0.03	0.04	0.10	0.01	0.03	0.04	2	2	0.11	0.05	-0.54	21
2 Row	0.02	0.02	0.08	0.02	0.02	0.04	4	2	0.08	0.05	-0.42	22
3 Row	0.04	0.02	0.06	0.01	0.02	0.04	6	2	0.07	0.05	-0.39	23
4 Row	0.01	0.02	0.03	0.01	0.02	0.04	8	2	0.04	0.05	0.22	24
5 Row	0.01	0.02	0.06	0.01	0.02	0.04	10	2	0.06	0.05	-0.28	25
6 Row	0.08	0.06	0.08	0.01	0.02	0.04	12	2	0.13	0.05	-0.64	26
7 Row	0.04	0.04	0.06	0.01	0.02	0.04	14	2	0.08	0.05	-0.44	27
8 Row	0.02	0.04	0.04	0.01	0.02	0.04	16	2	0.06	0.05	-0.24	28
9 Row	0.02	0.02	0.02	0.01	0.02	0.04	18	2	0.03	0.05	0.32	29
10 Row	0.02	0.02	0.02	0.01	0.02	0.03	20	2	0.03	0.04	0.08	30
11 Row	0.02	0.04	0.02	0.01	0.02	0.03	22	2	0.05	0.04	-0.24	31
12 Row	0.18	0.42	0.16	0.01	0.02	0.04	24	2	0.48	0.05	-0.91	32
13 Row	0.02	0.02	0.04	0.01	0.01	0.03	26	2	0.05	0.03	-0.32	33
14 Row	0.02	0.02	0.02	0.01	0.01	0.02	28	2	0.03	0.02	-0.29	34
15 Row	0.02	0.02	0.02	0.01	0.01	0.03	30	2	0.03	0.03	-0.04	35
16 Row	0.02	0.04	0.02	0.01	0.01	0.02	32	2	0.05	0.02	-0.50	36
17 Row	0.21	0.70	0.38	0.02	0.01	0.02	34	2	0.82	0.03	-0.96	37
18 Row	0.04	0.04	0.12	0.01	0.01	0.05	2	4	0.13	0.05	-0.61	41
19 Row	0.02	0.02	0.06	0.02	0.01	0.03	4	4	0.07	0.04	-0.44	42
20 Row	0.04	0.02	0.06	0.01	0.01	0.02	6	4	0.07	0.02	-0.67	43
21 Row	0.02	0.04	0.04	0.01	0.01	0.03	8	4	0.06	0.03	-0.45	44
22 Row	0.04	0.02	0.06	0.02	0.01	0.03	10	4	0.07	0.04	-0.50	45
23 Row	0.04	0.06	0.02	0.01	0.01	0.03	12	4	0.07	0.03	-0.56	46
24 Row	0.02	0.02	0.04	0.01	0.01	0.02	14	4	0.05	0.02	-0.50	47
25 Row	0.02	0.02	0.02	0.01	0.01	0.03	16	4	0.03	0.03	-0.04	48
26 Row	0.04	0.02	0.02	0.01	0.01	0.03	18	4	0.05	0.03	-0.32	49
27 Row	0.02	0.02	0.08	0.01	0.01	0.03	20	4	0.08	0.03	-0.61	50
28 Row	0.02	0.02	0.06	0.01	0.01	0.03	22	4	0.07	0.03	-0.50	51
29 Row	0.06	0.10	0.08	0.01	0.01	0.03	24	4	0.14	0.03	-0.77	52
30 Row	0.04	0.04	0.02	0.01	0.01	0.03	26	4	0.06	0.03	-0.45	53
31 Row	0.04	0.02	0.02	0.01	0.01	0.03	28	4	0.05	0.03	-0.32	54
32 Row	0.02	0.02	0.06	0.01	0.01	0.02	30	4	0.07	0.02	-0.63	55
33 Row	0.02	0.04	0.06	0.01	0.01	0.02	32	4	0.07	0.02	-0.67	56
34 Row	0.06	0.10	0.08	0.01	0.01	0.04	34	4	0.14	0.04	-0.70	57
35 Row	0.08	0.06	0.14	0.02	0.01	0.05	2	6	0.17	0.05	-0.68	61
36 Row	0.04	0.02	0.08	0.03	0.01	0.04	4	6	0.09	0.05	-0.44	62
37 Row	0.04	0.06	0.01	0.01	0.02	0.04	6	6	0.07	0.05	-0.37	63
38 Row	0.06	0.06	0.20	0.01	0.03	0.06	8	6	0.22	0.07	-0.69	64
39 Row	0.04	0.04	0.14	0.01	0.03	0.06	10	6	0.15	0.07	-0.55	65
40 Row	0.02	0.06	0.14	0.01	0.03	0.06	12	6	0.15	0.07	-0.56	66
41 Row	0.04	0.08	0.14	0.01	0.03	0.06	14	6	0.17	0.07	-0.59	67
42 Row	0.01	0.08	0.14	0.01	0.03	0.06	16	6	0.16	0.07	-0.58	68
43 Row	0.02	0.04	0.04	0.01	0.03	0.06	18	6	0.06	0.07	0.13	69

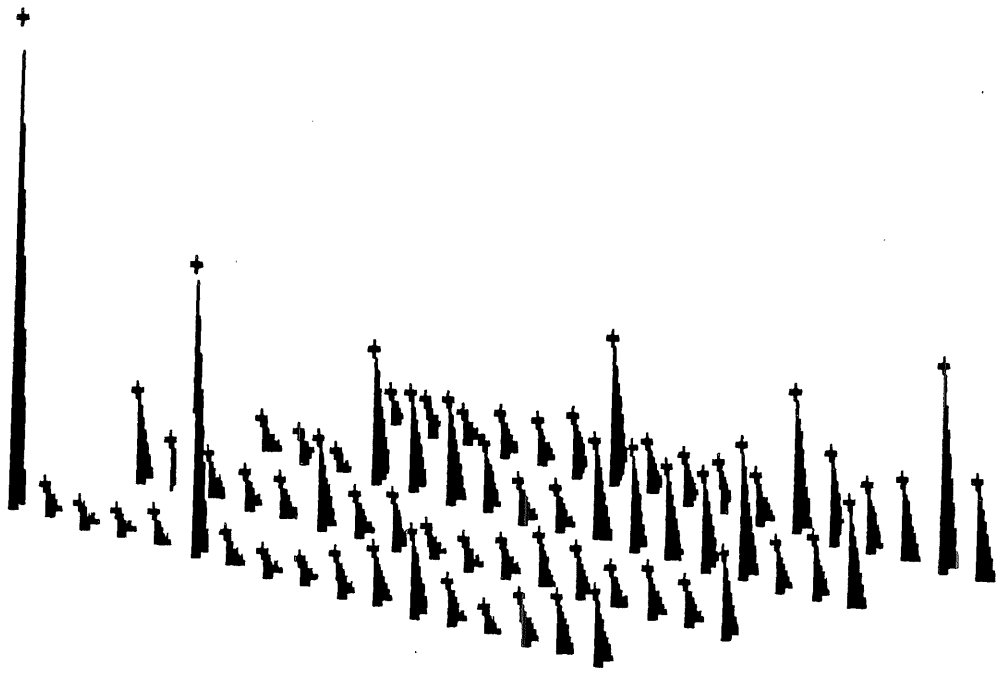
												P / N P	X
44	Row	0.02	0.04	0.04	0.01	0.03	0.06	20	6	0.06	0.07	0.13	70
45	Row	0.04	0.06	0.08	0.01	0.03	0.06	22	6	0.11	0.07	-0.37	71
46	Row	0.02	0.04	0.16	0.01	0.03	0.05	24	6	0.17	0.06	-0.64	72
47	Row	0.01	0.02	0.16	0.01	0.03	0.06	26	6	0.16	0.07	-0.58	73
48	Row	0.04	0.06	0.20	0.01	0.03	0.06	28	6	0.21	0.07	-0.68	74
49	Row	0.01	0.01	0.02	0.01	0.02	0.06	30	6	0.02	0.06	1.61	75
50	Row	0.01	0.01	0.04	0.01	0.03	0.05	32	6	0.04	0.06	0.39	76
51	Row	0.02	0.02	0.04	0.01	0.03	0.05	34	6	0.05	0.06	0.21	77
52	Row	0.06	0.10	0.11	0.01	0.01	0.04	2	8	0.16	0.04	-0.74	81
53	Row	0.18	0.20	0.22	0.02	0.09	0.03	4	8	0.35	0.10	-0.72	82
54	Row	0.06	0.06	0.10	0.05	0.04	0.05	6	8	0.13	0.08	-0.38	83
55	Row	0.06	0.06	0.06	0.02	0.05	0.03	8	8	0.10	0.06	-0.41	84
56	Row	0.06	0.06	0.12	0.02	0.05	0.03	10	8	0.15	0.06	-0.58	85
57	Row	0.08	0.14	0.16	0.02	0.05	0.03	12	8	0.23	0.06	-0.73	86
58	Row	0.02	0.04	0.06	0.02	0.05	0.03	14	8	0.07	0.06	-0.18	87
59	Row	0.04	0.06	0.04	0.04	0.11	0.03	16	8	0.08	0.12	0.47	88
60	Row	0.04	0.04	0.04	0.01	0.05	0.03	18	8	0.07	0.06	-0.15	89
61	Row	0.04	0.06	0.02	0.01	0.05	0.02	20	8	0.07	0.05	-0.27	90
62	Row	0.16	0.14	0.12	0.01	0.05	0.01	22	8	0.24	0.05	-0.79	91
63	Row	0.06	0.04	0.06	0.01	0.05	0.02	24	8	0.09	0.05	-0.42	92
64	Row	0.04	0.04	0.04	0.01	0.04	0.02	26	8	0.07	0.05	-0.34	93
65	Row	0.04	0.04	0.02	0.01	0.04	0.02	28	8	0.06	0.05	-0.24	94
66	Row	0.02	0.04	0.02	0.01	0.05	0.02	30	8	0.05	0.05	0.12	95
67	Row	0.02	0.04	0.02	0.01	0.05	0.02	32	8	0.05	0.05	0.12	96
68	Row	0.01	0.04	0.02	0.01	0.04	0.02	34	8	0.05	0.05	0.00	97


B(AC) PROFILES, JOHNSON BARN, LIN, 8/22/88, 1200-1300
B - H L
B - H P
1.0
.8
.6
.4
.2
0.0
20.0
40.0
60.0
80.0
100.0
INDEX

B(AC) PROFILE, JOHNSON BARN, LIN, NO POWER, 8/22/88,~1300



B(AC) PROFILE, JOHNSON BARN, LIN, NO FL LIGHTS,8/22/88,~1200



NCSS Editor

Date/Time 09-03-1988 11:27:31
Data Base Name C:UMM01
Description Data base created at 16:45:52 on 09-02-1988

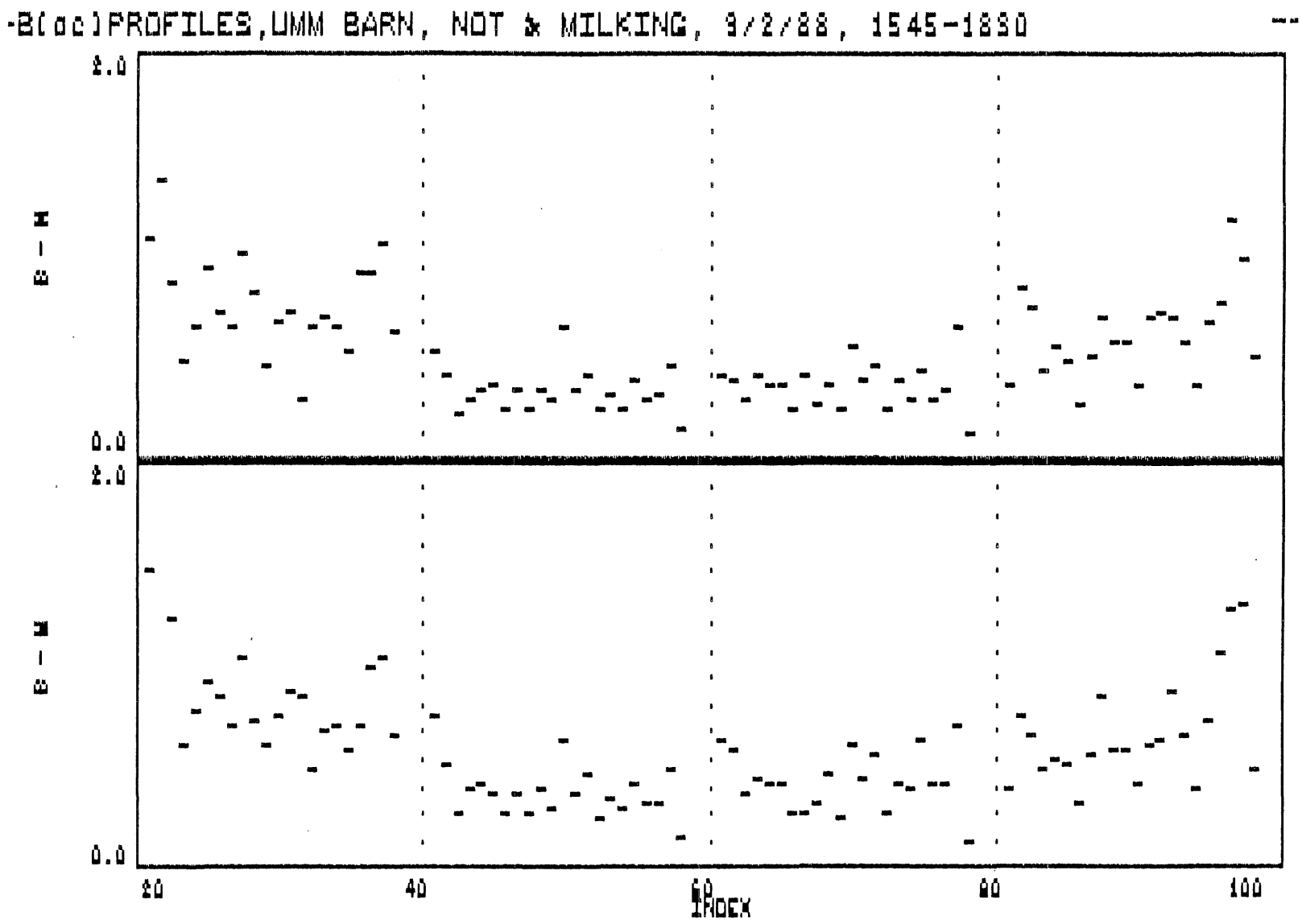
No.	Variable	Rows	Vlab	Label
1	U-N	88		N/S B(ac) COMP, LIN,NOT MILKING
2	V-N	88		E/W B(ac) COMP, LIN, NOT MILKING
3	W-N	88		U/D B(ac) COMP, LIN, NOT MILKING
4	U-M	88		N/S B(ac) COMP, LIN, MILKING
5	V-M	88		E/W B(ac) COMP, LIN, MILKING
6	W-M	88		U/D B(ac) COMP, LIN, MILKING
7	X	88		N/S POSITION IN BARN
8	Y	88		E/W POSITION IN BARN
9	B-N	88		B(ac), (mG), LIN, NOT MILKING
10	B-M	88		B(ac), (mG), LIN, MILKING
11	M-N/N	88		(BM-BN)/BN
12	INDEX	88		LINEAR INDEX OF POSITION IN BARN
13	C13	0		
14	C14	0		
15	C15	0		
16	C16	0		

B(ac), UMM BARN, 9/2/88,~1545-1830, NOT AND MILKING COMPARISON, FL/LITES ON

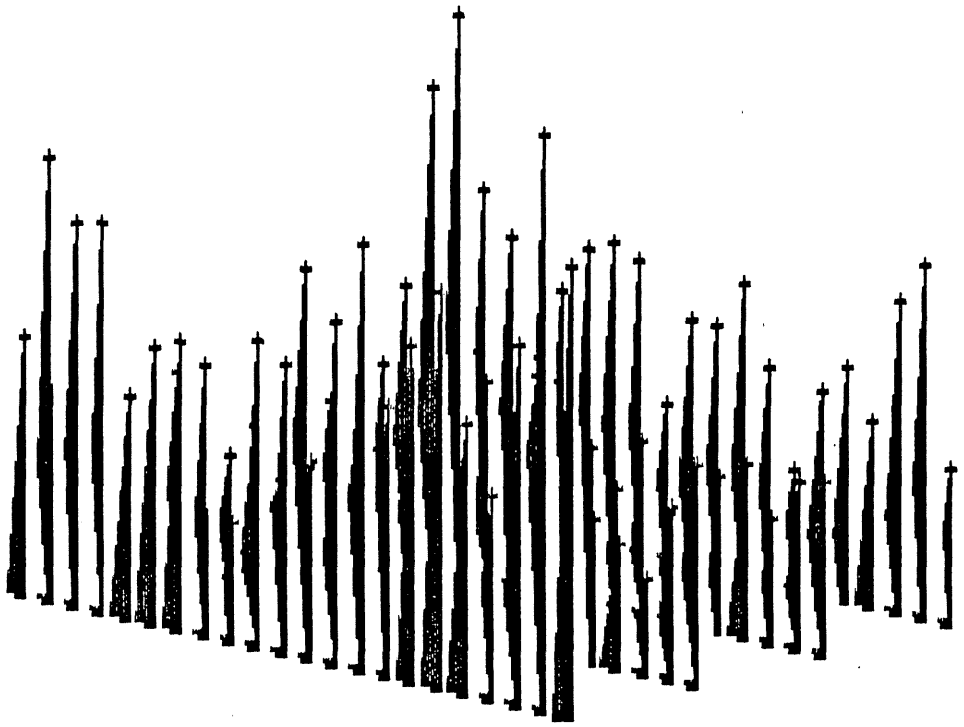
	U-N	V-N	W-N	U-M	V-M	W-M	X	Y	B-N	B-M	M-N/N	INDEX
1	0.98	0.32	0.32	1.40	0.24	0.38	2	2	1.08	1.47	0.36	20.8
2	0.92	0.24	1.00	1.80	0.20	1.20	4	2	1.38	2.17	0.57	21.6
3	0.58	0.22	0.60	0.98	0.26	0.70	6	2	0.86	1.23	0.43	22.5
4	0.16	0.26	0.38	0.12	0.32	0.50	8	2	0.49	0.61	0.24	23.3
5	0.18	0.30	0.54	0.30	0.36	0.62	10	2	0.64	0.78	0.21	24.1
6	0.34	0.34	0.82	0.32	0.24	0.84	12	2	0.95	0.93	-0.02	24.9
7	0.20	0.24	0.66	0.20	0.30	0.78	14	2	0.73	0.86	0.18	25.7
8	0.36	0.18	0.50	0.40	0.18	0.56	16	2	0.64	0.71	0.11	26.5
9	0.90	0.30	0.38	0.92	0.24	0.42	18	2	1.02	1.04	0.02	27.4
10	0.20	0.52	0.60	0.24	0.36	0.60	20	2	0.82	0.74	-0.10	28.2
11	0.34	0.10	0.30	0.48	0.10	0.38	22	2	0.46	0.62	0.34	29.0
12	0.28	0.26	0.56	0.34	0.34	0.58	24	2	0.68	0.75	0.11	29.8
13	0.36	0.38	0.50	0.50	0.40	0.60	26	2	0.72	0.88	0.21	30.6
14	0.10	0.12	0.24	0.80	0.10	0.30	28	2	0.29	0.86	2.00	31.5
15	0.08	0.40	0.50	0.12	0.34	0.34	30	2	0.65	0.50	-0.23	32.3
16	0.42	0.32	0.44	0.40	0.36	0.42	32	2	0.69	0.68	-0.01	33.1
17	0.58	0.10	0.28	0.60	0.18	0.34	34	2	0.65	0.71	0.09	33.9
18	0.14	0.28	0.42	0.16	0.32	0.46	36	2	0.52	0.58	0.11	34.7
19	0.76	0.32	0.42	0.28	0.40	0.50	38	2	0.93	0.70	-0.24	35.5
20	0.78	0.34	0.34	0.86	0.40	0.28	40	2	0.92	0.99	0.08	36.4
21	0.28	0.58	0.84	0.46	0.66	0.68	42	2	1.06	1.05	-0.00	37.2
22	0.32	0.32	0.42	0.40	0.32	0.42	44	2	0.62	0.66	0.07	38.0
23	0.34	0.30	0.26	0.40	0.46	0.45	2	4	0.52	0.76	0.45	40.8
24	0.18	0.20	0.30	0.20	0.32	0.36	4	4	0.40	0.52	0.29	41.6
25	0.08	0.10	0.18	0.08	0.12	0.22	6	4	0.22	0.26	0.19	42.5
26	0.24	0.10	0.14	0.30	0.14	0.20	8	4	0.30	0.39	0.31	43.3
27	0.06	0.24	0.22	0.08	0.26	0.32	10	4	0.33	0.42	0.27	44.1
28	0.04	0.22	0.30	0.04	0.22	0.30	12	4	0.37	0.37	0.00	44.9
29	0.06	0.12	0.20	0.08	0.14	0.22	14	4	0.24	0.27	0.13	45.7
30	0.28	0.06	0.16	0.30	0.10	0.20	16	4	0.33	0.37	0.14	46.5
31	0.14	0.08	0.18	0.16	0.10	0.20	18	4	0.24	0.27	0.14	47.4
32	0.12	0.20	0.24	0.18	0.22	0.26	20	4	0.33	0.39	0.15	48.2
33	0.16	0.12	0.20	0.14	0.16	0.22	22	4	0.28	0.31	0.08	49.0
34	0.40	0.44	0.26	0.34	0.46	0.26	24	4	0.65	0.63	-0.03	49.8
35	0.10	0.24	0.20	0.08	0.28	0.22	26	4	0.33	0.36	0.11	50.6
36	0.38	0.12	0.14	0.38	0.18	0.18	28	4	0.42	0.46	0.08	51.5
37	0.04	0.14	0.18	0.04	0.16	0.20	30	4	0.23	0.26	0.12	52.3
38	0.02	0.22	0.22	0.04	0.26	0.24	32	4	0.31	0.36	0.14	53.1
39	0.08	0.18	0.16	0.08	0.21	0.20	34	4	0.25	0.30	0.19	53.9
40	0.08	0.30	0.22	0.08	0.34	0.22	36	4	0.38	0.41	0.08	54.7
41	0.12	0.20	0.18	0.10	0.22	0.20	38	4	0.29	0.31	0.06	55.5
42	0.12	0.20	0.20	0.10	0.24	0.20	40	4	0.31	0.33	0.07	56.4
43	0.34	0.24	0.20	0.34	0.28	0.20	42	6	0.46	0.48	0.05	77.2
44	0.06	0.08	0.10	0.06	0.08	0.12	44	6	0.14	0.16	0.10	78.0
45	0.34	0.16	0.16	0.48	0.22	0.33	2	6	0.41	0.62	0.52	60.8
46	0.06	0.16	0.36	0.14	0.26	0.50	4	6	0.40	0.58	0.46	61.6

B(ac), UMM BARN, 9/2/88,~1545-1830, NOT AND MILKING COMPARISON, FL/LITES ON

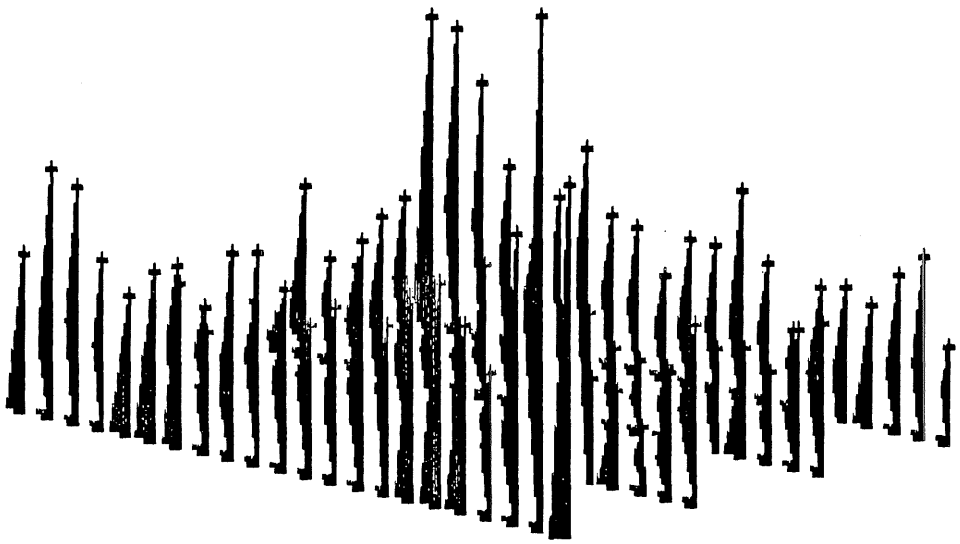
	U-N	V-N	W-N	U-M	V-M	W-M	X	Y	B-N	B-M	M-N/N	INDEX
47	0.08	0.10	0.26	0.10	0.16	0.32	6	6	0.29	0.37	0.28	62.5
48	0.30	0.14	0.24	0.30	0.18	0.28	8	6	0.41	0.45	0.10	63.3
49	0.08	0.20	0.30	0.10	0.24	0.32	10	6	0.37	0.41	0.12	64.1
50	0.04	0.22	0.30	0.04	0.24	0.34	12	6	0.37	0.42	0.12	64.9
51	0.08	0.12	0.20	0.08	0.16	0.22	14	6	0.25	0.28	0.15	65.7
52	0.36	0.12	0.16	0.04	0.16	0.22	16	6	0.41	0.27	-0.33	66.5
53	0.14	0.16	0.18	0.18	0.18	0.20	18	6	0.28	0.32	0.16	67.4
54	0.18	0.20	0.24	0.22	0.26	0.30	20	6	0.36	0.45	0.26	68.2
55	0.16	0.10	0.14	0.12	0.10	0.18	22	6	0.23	0.24	0.01	69.0
56	0.32	0.34	0.28	0.40	0.36	0.30	24	6	0.54	0.62	0.13	69.8
57	0.10	0.24	0.30	0.13	0.28	0.32	26	6	0.40	0.44	0.12	70.6
58	0.42	0.12	0.16	0.50	0.12	0.20	28	6	0.47	0.55	0.19	71.5
59	0.08	0.16	0.18	0.08	0.16	0.20	30	6	0.25	0.27	0.06	72.3
60	0.02	0.30	0.24	0.06	0.32	0.24	32	6	0.38	0.40	0.05	73.1
61	0.08	0.20	0.18	0.16	0.31	0.20	34	6	0.28	0.40	0.43	73.9
62	0.06	0.34	0.28	0.20	0.55	0.26	36	6	0.44	0.64	0.44	74.7
63	0.12	0.20	0.16	0.20	0.31	0.20	38	6	0.28	0.42	0.48	75.5
64	0.14	0.26	0.14	0.16	0.36	0.14	40	6	0.33	0.42	0.28	76.4
65	0.48	0.32	0.28	0.60	0.31	0.22	42	6	0.64	0.71	0.11	77.2
66	0.04	0.06	0.10	0.06	0.06	0.10	44	6	0.12	0.13	0.06	78.0
67	0.14	0.18	0.28	0.18	0.20	0.28	2	8	0.36	0.39	0.08	80.8
68	0.70	0.20	0.42	0.58	0.22	0.44	4	8	0.84	0.76	-0.10	81.6
69	0.54	0.30	0.40	0.58	0.14	0.28	6	8	0.74	0.66	-0.10	82.5
70	0.20	0.20	0.32	0.22	0.22	0.38	8	8	0.43	0.49	0.15	83.3
71	0.22	0.28	0.42	0.18	0.22	0.46	10	8	0.55	0.54	-0.02	84.1
72	0.24	0.18	0.38	0.26	0.14	0.42	12	8	0.48	0.51	0.06	84.9
73	0.10	0.12	0.22	0.10	0.14	0.26	14	8	0.27	0.31	0.16	85.7
74	0.44	0.10	0.24	0.48	0.08	0.28	16	8	0.51	0.56	0.10	86.5
75	0.48	0.32	0.38	0.68	0.40	0.30	18	8	0.69	0.84	0.22	87.4
76	0.24	0.20	0.48	0.28	0.30	0.42	20	8	0.57	0.59	0.03	88.2
77	0.24	0.30	0.44	0.26	0.32	0.42	22	8	0.58	0.59	0.01	89.0
78	0.20	0.18	0.24	0.18	0.24	0.28	24	8	0.36	0.41	0.14	89.8
79	0.40	0.32	0.46	0.30	0.34	0.40	26	8	0.69	0.60	-0.12	90.6
80	0.70	0.10	0.12	0.60	0.10	0.14	28	8	0.72	0.62	-0.13	91.5
81	0.30	0.46	0.42	0.40	0.36	0.70	30	8	0.69	0.88	0.28	92.3
82	0.26	0.32	0.40	0.30	0.30	0.50	32	8	0.57	0.66	0.14	93.1
83	0.24	0.20	0.18	0.30	0.18	0.20	34	8	0.36	0.40	0.12	93.9
84	0.20	0.42	0.50	0.18	0.38	0.60	36	8	0.68	0.73	0.07	94.7
85	0.74	0.16	0.18	0.90	0.40	0.40	38	8	0.78	1.06	0.37	95.5
86	0.86	0.54	0.60	0.92	0.64	0.60	40	8	1.18	1.27	0.08	96.4
87	0.20	0.56	0.80	0.24	0.80	1.00	42	8	1.00	1.30	0.31	97.2
88	0.32	0.20	0.34	0.30	0.24	0.30	44	8	0.51	0.49	-0.04	98.0


-B(oc)PROFILES,UMM BARN, NOT & MILKING, 9/2/88, 1545-1830
2.0
0.0
M - B
2.0
0.0
M - B
20
40
60
80
100
INDEX

B[oc] PROFILE,LINEAR,NOT MILKING,UMM BARN, 9/2/88,~1545-1830



B(oc) PROFILE,LINEAR,MILKING,UMM BARN, 9/2/88,~1545-1830



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Date/Time 09-03-1988 12:29:37
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Description Data base created at 12:16:37 on 09-03-1988

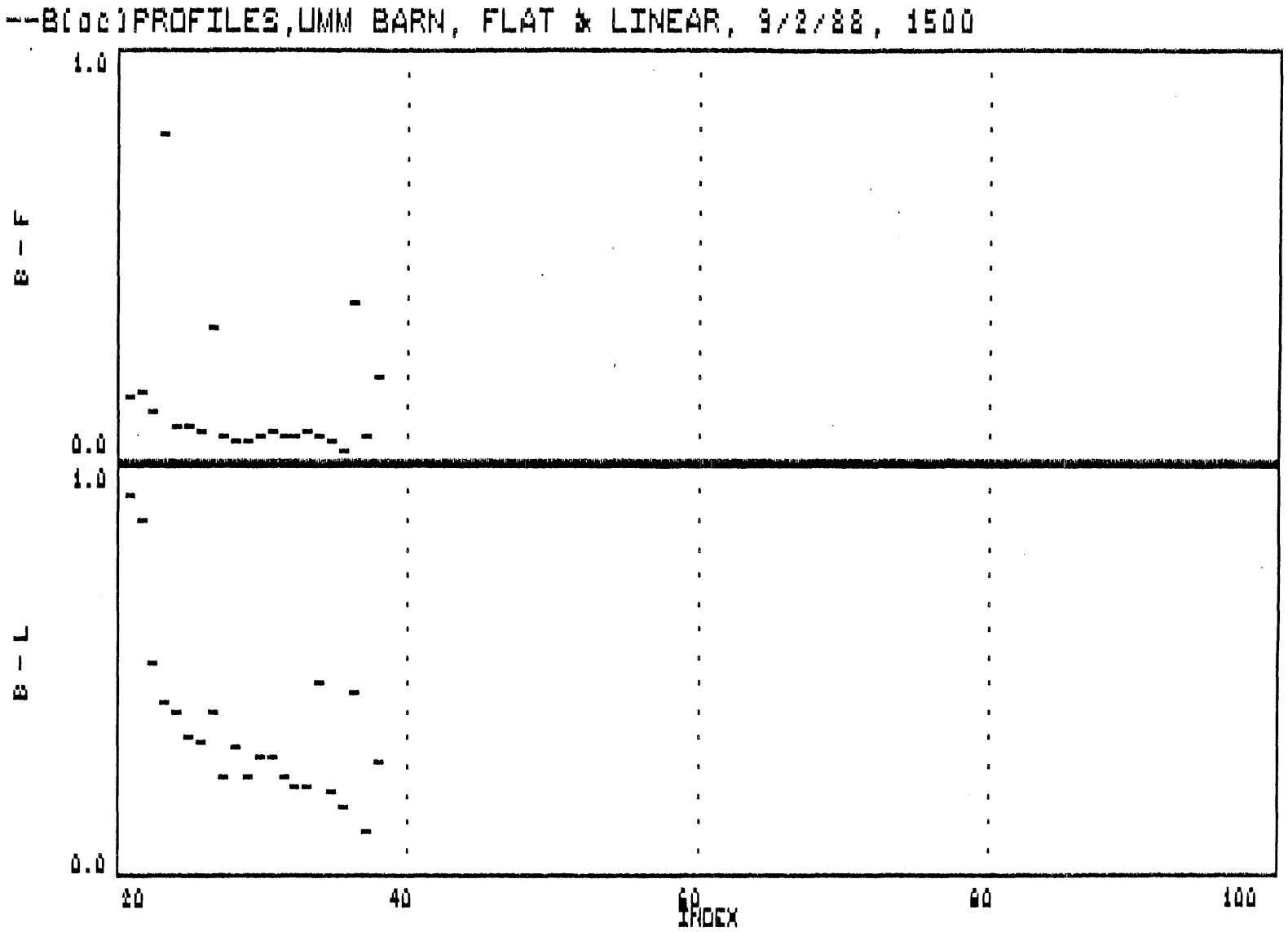
No.	Variable	Rows	Vlab	Label
1	U-F	22		N/S B(ac) COMP, FLAT, NOT MILKING
2	V-F	22		E/W B(ac) COMP, FLAT, NOT MILKING
3	W-F	22		U/D B(ac) COMP, FLAT, NOT MILKING
4	U-L	22		N/S B(ac) COMP, LIN, NOT MILKING
5	V-L	22		E/W B(ac) COMP, LIN, NOT MILKING
6	W-L	22		U/D B(ac) COMP, LIN, NOT MILKING
7	X	88		N/S POSITION IN BARN
8	Y	88		E/W POSITION IN BARN
9	B-F	0		B(ac), (mG), FLAT, NOT MILKING
10	B-L	0		B(ac), (mG), LIN, NOT MILKING
11	L-F/F	0		(BL-BF)/BF
12	INDEX	88		LINEAR INDEX OF POSITION IN BARN

B(ac), UMM BARN, 9/2/88,~1500, FLAT AND LINEAR COMPARISON, FL/LITES OFF

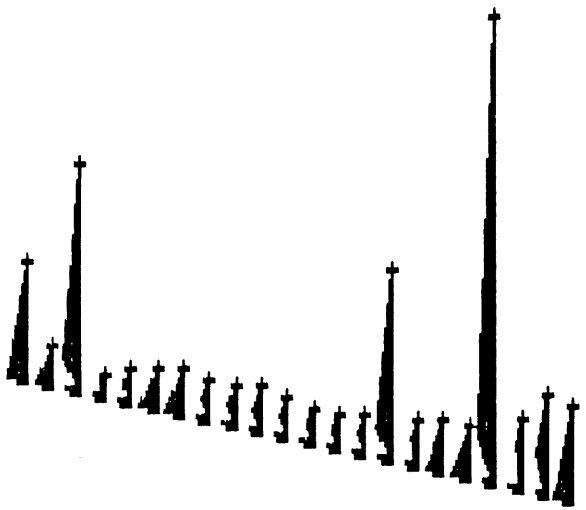
	U - F	V - F	W - F	U - L	V - L	W - L	X	Y	B - F	B - L	L - F / F	INDEX
1	0.14	0.04	0.06	0.88	0.12	0.28	2	2	0.16	0.93	4.91	20.8
2	0.10	0.06	0.12	0.52	0.08	0.70	4	2	0.17	0.88	4.23	21.6
3	0.06	0.06	0.08	0.24	0.22	0.40	6	2	0.12	0.52	3.42	22.5
4	0.02	0.02	0.80	0.08	0.12	0.40	8	2	0.80	0.43	-0.47	23.3
5	0.02	0.02	0.08	0.10	0.10	0.38	10	2	0.08	0.41	3.78	24.1
6	0.02	0.02	0.08	0.06	0.10	0.32	12	2	0.08	0.34	3.01	24.9
7	0.02	0.04	0.06	0.08	0.10	0.30	14	2	0.07	0.33	3.36	25.7
8	0.30	0.08	0.10	0.30	0.10	0.24	16	2	0.33	0.40	0.22	26.5
9	0.02	0.02	0.06	0.02	0.04	0.24	18	2	0.07	0.24	2.68	27.4
10	0.02	0.02	0.04	0.06	0.20	0.24	20	2	0.05	0.32	5.49	28.2
11	0.02	0.02	0.04	0.06	0.08	0.22	22	2	0.05	0.24	3.93	29.0
12	0.02	0.02	0.06	0.10	0.08	0.26	24	2	0.07	0.29	3.37	29.8
13	0.02	0.04	0.06	0.10	0.14	0.24	26	2	0.07	0.30	2.95	30.6
14	0.02	0.02	0.06	0.08	0.08	0.22	28	2	0.07	0.25	2.73	31.5
15	0.02	0.02	0.06	0.06	0.06	0.20	30	2	0.07	0.22	2.28	32.3
16	0.02	0.04	0.06	0.06	0.12	0.18	32	2	0.07	0.22	2.00	33.1
17	0.02	0.02	0.06	0.40	0.04	0.26	34	2	0.07	0.48	6.22	33.9
18	0.02	0.02	0.04	0.04	0.10	0.18	36	2	0.05	0.21	3.28	34.7
19	0.02	0.01	0.02	0.10	0.02	0.14	38	2	0.03	0.17	4.77	35.5
20	0.20	0.30	0.12	0.14	0.38	0.18	40	2	0.38	0.44	0.17	36.4
21	0.02	0.02	0.06	0.04	0.02	0.10	42	2	0.07	0.11	0.65	37.2
22	0.18	0.04	0.08	0.12	0.22	0.12	44	2	0.20	0.28	0.38	38.0
23	.	.	.	.	.	.	2	4	.	.	.	40.8
24	.	.	.	.	.	.	4	4	.	.	.	41.6
25	.	.	.	.	.	.	6	4	.	.	.	42.5
26	.	.	.	.	.	.	8	4	.	.	.	43.3
27	.	.	.	.	.	.	10	4	.	.	.	44.1
28	.	.	.	.	.	.	12	4	.	.	.	44.9
29	.	.	.	.	.	.	14	4	.	.	.	45.7
30	.	.	.	.	.	.	16	4	.	.	.	46.5
31	.	.	.	.	.	.	18	4	.	.	.	47.4
32	.	.	.	.	.	.	20	4	.	.	.	48.2
33	.	.	.	.	.	.	22	4	.	.	.	49.0
34	.	.	.	.	.	.	24	4	.	.	.	49.8
35	.	.	.	.	.	.	26	4	.	.	.	50.6
36	.	.	.	.	.	.	28	4	.	.	.	51.5
37	.	.	.	.	.	.	30	4	.	.	.	52.3
38	.	.	.	.	.	.	32	4	.	.	.	53.1
39	.	.	.	.	.	.	34	4	.	.	.	53.9
40	.	.	.	.	.	.	36	4	.	.	.	54.7
41	.	.	.	.	.	.	38	4	.	.	.	55.5
42	.	.	.	.	.	.	40	4	.	.	.	56.4
43	.	.	.	.	.	.	42	4	.	.	.	57.2
44	.	.	.	.	.	.	44	4	.	.	.	58.0
45	.	.	.	.	.	.	2	6	.	.	.	60.8
46	.	.	.	.	.	.	4	6	.	.	.	61.6

B(ac), UMM BARN, 9/2/88,~1500, FLAT AND LINEAR COMPARISON, FL/LITES OFF

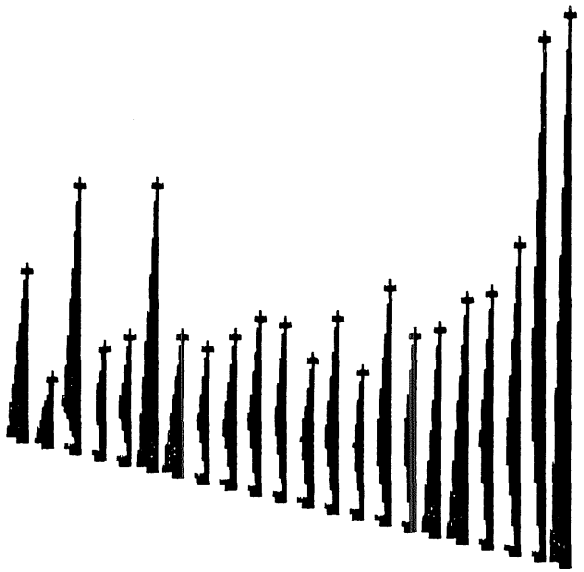
	U-F	V-F	W-F	U-L	V-L	W-L	X	Y	B-F	B-L	L-F/F	INDEX
47	.	.	.	.	.	.	6	6	.	.	.	62.5
48	.	.	.	.	.	.	8	6	.	.	.	63.3
49	.	.	.	.	.	.	10	6	.	.	.	64.1
50	.	.	.	.	.	.	12	6	.	.	.	64.9
51	.	.	.	.	.	.	14	6	.	.	.	65.7
52	.	.	.	.	.	.	16	6	.	.	.	66.5
53	.	.	.	.	.	.	18	6	.	.	.	67.4
54	.	.	.	.	.	.	20	6	.	.	.	68.2
55	.	.	.	.	.	.	22	6	.	.	.	69.0
56	.	.	.	.	.	.	24	6	.	.	.	69.8
57	.	.	.	.	.	.	26	6	.	.	.	70.6
58	.	.	.	.	.	.	28	6	.	.	.	71.5
59	.	.	.	.	.	.	30	6	.	.	.	72.3
60	.	.	.	.	.	.	32	6	.	.	.	73.1
61	.	.	.	.	.	.	34	6	.	.	.	73.9
62	.	.	.	.	.	.	36	6	.	.	.	74.7
63	.	.	.	.	.	.	38	6	.	.	.	75.5
64	.	.	.	.	.	.	40	6	.	.	.	76.4
65	.	.	.	.	.	.	42	6	.	.	.	77.2
66	.	.	.	.	.	.	44	6	.	.	.	78.0
67	.	.	.	.	.	.	2	8	.	.	.	80.8
68	.	.	.	.	.	.	4	8	.	.	.	81.6
69	.	.	.	.	.	.	6	8	.	.	.	82.5
70	.	.	.	.	.	.	8	8	.	.	.	83.3
71	.	.	.	.	.	.	10	8	.	.	.	84.1
72	.	.	.	.	.	.	12	8	.	.	.	84.9
73	.	.	.	.	.	.	14	8	.	.	.	85.7
74	.	.	.	.	.	.	16	8	.	.	.	86.5
75	.	.	.	.	.	.	18	8	.	.	.	87.4
76	.	.	.	.	.	.	20	8	.	.	.	88.2
77	.	.	.	.	.	.	22	8	.	.	.	89.0
78	.	.	.	.	.	.	24	8	.	.	.	89.8
79	.	.	.	.	.	.	26	8	.	.	.	90.6
80	.	.	.	.	.	.	28	8	.	.	.	91.5
81	.	.	.	.	.	.	30	8	.	.	.	92.3
82	.	.	.	.	.	.	32	8	.	.	.	93.1
83	.	.	.	.	.	.	34	8	.	.	.	93.9
84	.	.	.	.	.	.	36	8	.	.	.	94.7
85	.	.	.	.	.	.	38	8	.	.	.	95.5
86	.	.	.	.	.	.	40	8	.	.	.	96.4
87	.	.	.	.	.	.	42	8	.	.	.	97.2
88	.	.	.	.	.	.	44	8	.	.	.	98.0


--B(oc)PROFILES,UMM BARN, FLAT & LINEAR, 9/2/88, 1500
1.0
B - F
0.0
1.0
B - L
0.0
20
40
60
80
100
INDEX

B[oc] PROFILE, FLAT, UMM BARN, 9/2/88,~1500



B[oc] PROFILE, LINEAR, UMM BARN, 9/2/88,*1500



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Data Base Name C:\EMD\JKEN03

No.	Variable	Rows	Vlab	Label
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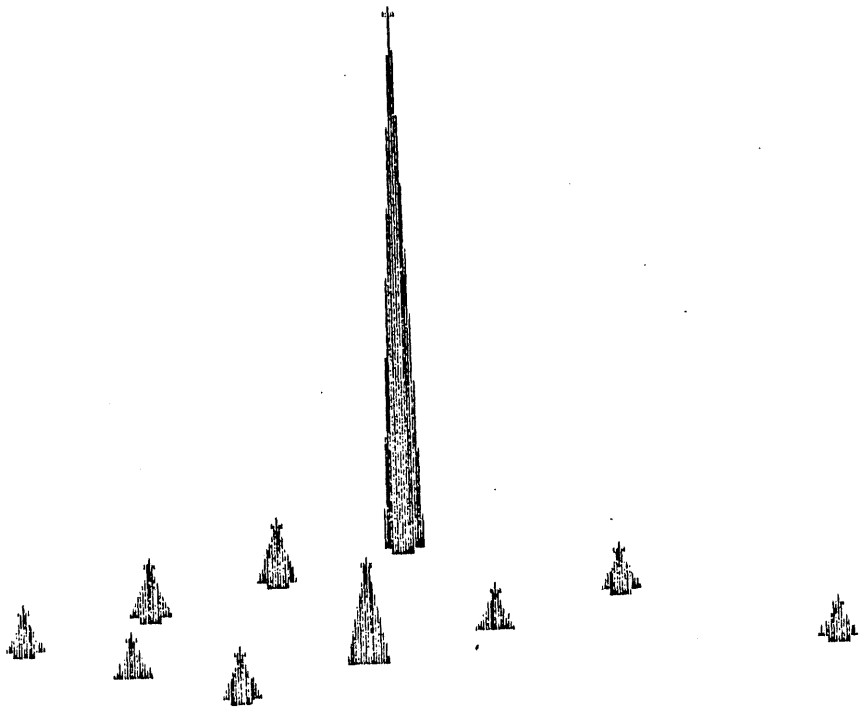
2	V-L-OFF	10		E/W B(ac) COMP, LIN, EQUIP OFF
3	W-L-OFF	10		U/D B(ac) COMP, LIN, EQUIP OFF
4	U-F-OFF	10		N/S B(ac) COMP, FLAT, EQUIP OFF
5	V-F-OFF	10		E/W B(ac) COMP, FLAT, EQUIP OFF
6	W-F-OFF	10		U/D B(ac) COMP, FLAT, EQUIP OFF
7	U-L-ON	10		N/S B(ac) COMP, LIN, EQUIP ON
8	V-L-ON	10		E/W B(ac) COMP, LIN, EQUIP ON
9	W-L-ON	10		U/D B(ac) COMP, LIN, EQUIP ON
10	U-F-ON	10		N/S B(ac) COMP, FLAT, EQUIP ON
11	V-F-ON	10		E/W B(ac) COMP, FLAT, EQUIP ON
12	W-F-ON	10		U/D B(ac) COMP, FLAT, EQUIP ON
13	X	10		N/S POSITION IN BARN
14	Y	10		E/W POSITION IN BARN
15	B-L-OFF	10		B(ac), (mG), LIN, EQUIP OFF
16	B-F-OFF	10		B(ac), (mG), FLAT, EQUIP OFF
17	B-L-ON	10		B(ac), (mG), LIN, EQUIP ON
18	B-F-ON	10		B(ac), (mG), FLAT, EQUIP ON
19	C19	0		
20	INDEX	10		LINEAR INDEX OF POSITION IN BARN

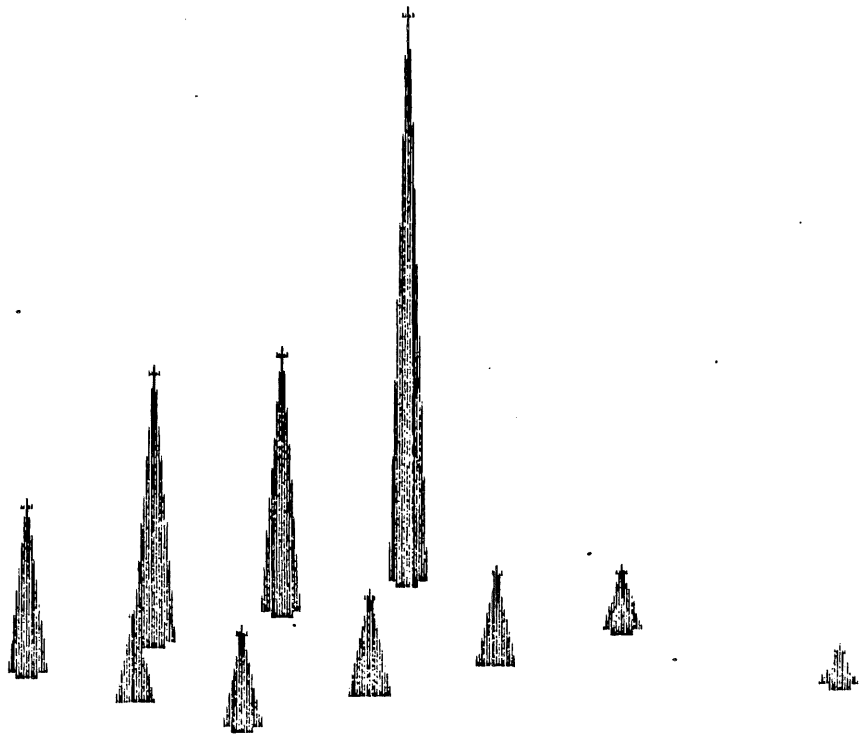
B(ac), KEN BARN, 9/14/88,~1340-1430, LIN & FLAT, EQUIP ON & EQUIP OFF

	U	V	W	U	V	W	U	V	W	U	V	W	X	Y	B	B	B	B	I
	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	N
	L	L	L	F	F	F	L	L	L	F	F	F			L	F	L	F	D
	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	E
	O	O	O	O	O	O	O	O	O	O	O	O			O	O	O	O	X
	F	F	F	F	F	F	N	N	N	N	N	N			F	F	N	N	
	F	F	F	F	F	F									F	F			
1	.01	.02	.04	.01	.01	.04	.02	.02	.04	.00	.00	.04	0	6	.04	.04	.04	.04	0
2	.02	.01	.05	.03	.02	.04	.02	.04	.07	.02	.04	.06	1	6	.05	.05	.08	.07	1
3	.01	.02	.05	.01	.02	.05	.04	.06	.10	.02	.04	.05	1	4	.05	.05	.12	.06	2
4	.03	.02	.13	.03	.02	.13	.02	.02	.13	.01	.01	.12	1	2	.13	.13	.13	.12	3
5	.01	.00	.06	.00	.00	.06	.04	.04	.11	.02	.02	.08	1	0	.06	.06	.12	.08	4
6	.01	.01	.05	.01	.01	.05	.05	.03	.10	.01	.02	.07	2	0	.05	.05	.11	.07	5
7	.01	.09	.06	.01	.01	.05	.12	.16	.12	.10	.12	.12	2	0	.10	.05	.23	.19	6
8	.01	.01	.07	.01	.01	.07	.08	.20	.31	.06	.14	.30	2	2	.07	.07	.37	.33	7
9	.01	.04	.19	.04	.01	.07	.04	.20	.29	.06	.16	.24	2	4	.19	.08	.33	.29	8
10	.12	.60	.10	.34	.60	.24	.22	.72	.17	.16	.80	.16	2	6	.62	.73	.77	.83	9

Block PROFILE, FLAT, EQUIP OFF, KENNING BARN, 9/14/88,-1400



B[0d] PROFILE, LIN, EQUIP ON, KENNING BARN, 9/14/88,~1400



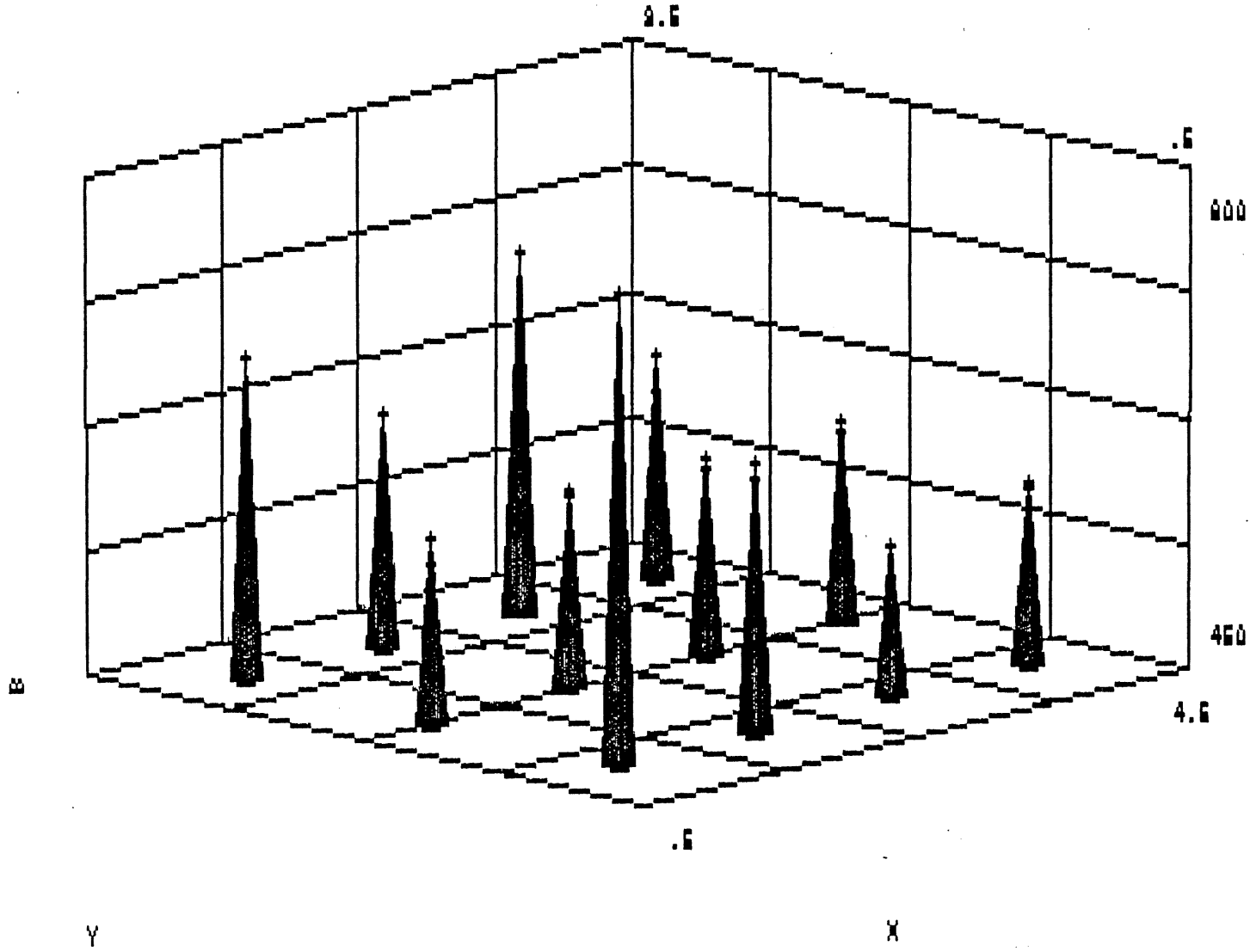
DC MAGNETIC FIELD DATA

The reader is referred to p. 3.6 for a description of the measurement of the dc magnetic field in a stall in each barn visited. This data is presented here in a form similar to that of the previous section on ac magnetic field data. As an example, data from a Borgerding stall is listed on 3.330. The position coordinates X, Y, and Z refer to the 1/2 m grid points in the stall. B-U, B-V, and B-W are the dc magnetic field components at this position, B is the vector sum (ie., the field value), omega and phi are azimuth- and dip-angles of the field vector. Again, as in the ac case, a spike graph is used (3.331) to give the reader a profile of the dc field in the stall. Enough information is presented in the plot title to identify the farm, stall and date of measurement. Descriptive statistics are presented in a form already familiar to the reader from previous sections to warrant saying no more about them here.

B(DC), BORGERDING BARN, STALL 5TH FM NW, FLOOR & 1M, 0900, 8/19/88

	X	Y	Z	B U	B V	B W	B	OMEGA	PHI
1 Row	1	1	1	131	-402	655	779	-72	57
2 Row	1	2	1	7	-206	540	578	-89	69
3 Row	1	3	1	-111	-396	538	677	74	52
4 Row	2	1	1	-16	-282	560	627	86	63
5 Row	2	2	1	-12	-211	548	587	86	68
6 Row	2	3	1	-48	-166	516	544	73	71
7 Row	3	1	1	-146	-55	511	534	20	73
8 Row	3	2	1	-42	-190	547	580	77	70
9 Row	3	3	1	-239	-511	419	702	64	36
10 Row	4	1	1	-10	-143	558	576	86	75
11 Row	4	2	1	0	-190	558	589	.	71
12 Row	4	3	1	21	-244	554	605	-86	66
13 Row	1	1	2	87	144	459	488	58	69
14 Row	1	2	2	54	-171	531	560	-73	71
15 Row	1	3	2	168	-153	543	588	-43	67
16 Row	2	1	2	-9	-298	562	636	88	62
17 Row	2	2	2	34	-203	547	584	-81	69
18 Row	2	3	2	208	-173	552	614	-40	63
19 Row	3	1	2	-1	-124	541	555	89	77
20 Row	3	2	2	23	-182	560	589	-83	71
21 Row	3	3	2	62	-84	627	635	-54	80
22 Row	4	1	2	7	-172	547	573	-88	72
23 Row	4	2	2	13	-177	554	581	-86	72
24 Row	4	3	2	7	-178	553	580	-88	72

B(DC), BORGERDING BARN, STALL 5TH FM NW, 8/19/88, 0900



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Description Data base created at 22:31:26 on 08-11-1988

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2	Y	24		
3	Z	24		
4	BU	24		
5	BV	24		
6	BW	24		
7	B	24		B-FIELD MAGNITUDE
8	OMEGA	24		B-DEV
9	PSI	24		B-DIP
10	C10	0		
11	C11	0		
12	C12	0		
13	C13	0		
14	C14	0		
15	C15	0		

B(DC), JOHNSON BARN, NW STALL, FLOOR & 1M, 1100, 8/18/88

		X	Y	Z	B U	B V	B W	B	OMEGA	PSI
1	Row	1	1	1	-603	-255	385	759	22	30
2	Row	1	2	1	-92	-178	584	617	62	71
3	Row	1	3	1	-542	-191	435	720	19	37
4	Row	2	1	1	-75	-160	493	523	64	70
5	Row	2	2	1	-63	-190	504	542	71	68
6	Row	2	3	1	-62	-176	510	543	70	69
7	Row	3	1	1	224	-211	396	501	-44	52
8	Row	3	2	1	15	-234	492	545	-87	64
9	Row	3	3	1	192	-10	419	461	-3	65
10	Row	4	1	1	-539	-261	405	722	25	34
11	Row	4	2	1	-52	-232	519	570	77	65
12	Row	4	3	1	-60	-142	525	547	67	73
13	Row	1	1	2	370	-77	305	485	-12	38
14	Row	1	2	2	107	-116	460	486	-48	71
15	Row	1	3	2	50	-158	285	329	-73	59
16	Row	2	1	2	72	-61	272	287	-41	70
17	Row	2	2	2	60	-134	444	467	-66	71
18	Row	2	3	2	35	-350	418	546	-85	49
19	Row	3	1	2	24	-142	331	360	-81	66
20	Row	3	2	2	35	-137	446	467	-76	72
21	Row	3	3	2	46	-145	535	556	-73	74
22	Row	4	1	2	16	-129	338	362	-83	68
23	Row	4	2	2	-13	-130	456	474	84	74
24	Row	4	3	2	26	-110	502	514	-77	77

----------Descriptive Statistics----------

Date/Time 08-12-1988 07:16:19
Data Base Name C:JOH01
Description Data base created at 22:31:26 on 08-11-1988

Detail Report

Variable: B B-FIELD MAGNITUDE

Mean - Average	515.9583	No. observations	24
Lower 95% c.i.limit	467.0101	No. missing values	0
Upper 95% c.i.limit	564.9066	Sum of frequencies	24
Adj sum of squares	309117	Sum of observations	12383
Standard deviation	115.9304	Std.error of mean	23.6642
Variance	13439.87	T-value for mean=0	21.80333
Coef. of variation	.2246895	T prob level	0.0000
Skewness	.1965546	Kurtosis	.4075215
Normality Test Value	1.093	Reject if > 1.182(10%)	1.289(5%)
100-%tile (Maximum)	759	90-%tile	720
75-%tile	551.5	10-%tile	360
50-%tile (Median)	518.5	Range	472
25-%tile	467	75th-25th %tile	84.5
0-%tile (Minimum)	287		

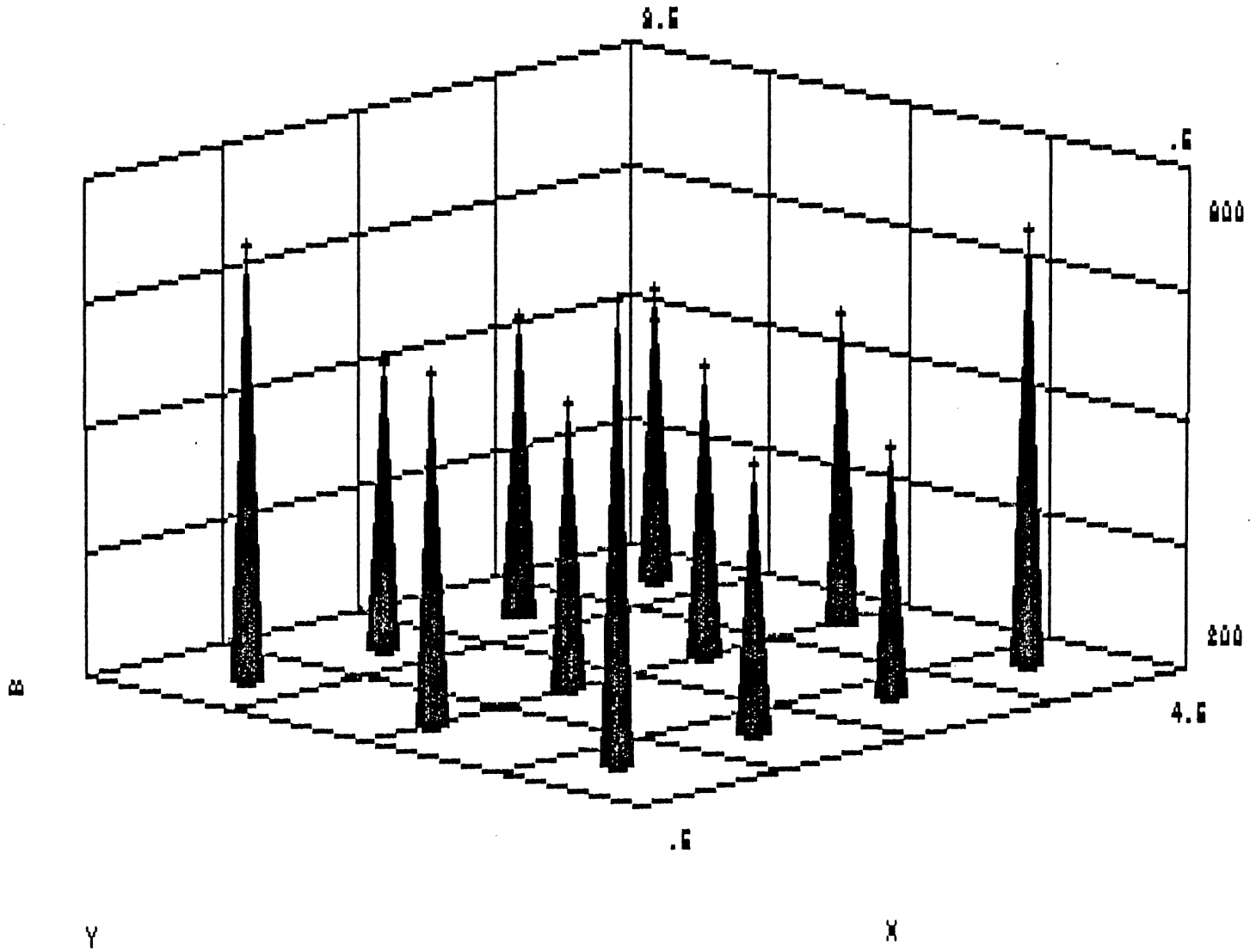
287----------Line Plot / Box Plot----------75
1 1 2 121 2 1 11 231 1 1 2
----------[XXXXXXXmXXXXX]----------

Distribution & Histogram

Variable: B

Bin	Lower	Upper	Count	Prcnt	Total	Prcnt	Histogram
1	400	450	0	0.0	0	0.0	:
2	450	500	6	25.0	6	25.0	:******
3	500	550	8	33.3	14	58.3	:********
4	550	600	2	8.3	16	66.7	:**
5	600	650	1	4.2	17	70.8	:*
6	650	700	0	0.0	17	70.8	:
7	700	750	2	8.3	19	79.2	:**
8	750	800	1	4.2	20	83.3	:*
9	800	850	0	0.0	20	83.3	:
10	850	900	0	0.0	20	83.3	:
0	Values out of range		4	16.7			:

B(DC), JOHNSON BARN, NW STALL, 8/18/88, 1100



----------NCSS Editor----------

Date/Time 09-04-1988 18:46:20
Data Base Name C:UMM03
Description Data base created at 18:28:38 on 09-04-1988

No.	Variable	Rows	Vlab	Label
1	X	24		
2	Y	24		
3	Z	24		
4	BU	24		
5	BV	24		
6	BW	24		
7	B	24		B(dc), (mG)
8	OMEGA	24		B-DEV
9	PHI	24		B-DIP
10	C10	0		
11	C11	0		
12	C12	0		
13	C13	0		
14	C14	0		
15	C15	0		

B(DC), UMM BARN, SE STALL, FLOOR & 1M, 1800, 9/4/88

		X	Y	Z	B U	B V	B W	B	OMEGA	PHI
1	Row	1	1	1	-150	-36	380	410	13	67
2	Row	1	2	1	-213	-214	394	496	45	52
3	Row	1	3	1	-330	-119	457	576	19	52
4	Row	2	1	1	-70	-222	488	540	72	64
5	Row	2	2	1	-140	-150	470	512	46	66
6	Row	2	3	1	-107	-125	420	451	49	68
7	Row	3	1	1	64	-510	576	771	-83	48
8	Row	3	2	1	-65	-33	578	582	26	82
9	Row	3	3	1	82	7	409	417	4	78
10	Row	4	1	1	-153	-360	628	739	66	58
11	Row	4	2	1	-12	-56	650	652	77	84
12	Row	4	3	1	-130	-69	525	545	27	74
13	Row	1	1	2	530	97	347	640	10	32
14	Row	1	2	2	130	-160	380	432	-51	61
15	Row	1	3	2	245	-417	200	523	-60	22
16	Row	2	1	2	207	-120	455	514	-31	62
17	Row	2	2	2	100	-168	423	465	-60	65
18	Row	2	3	2	165	-260	405	508	-58	52
19	Row	3	1	2	108	-198	514	561	-62	66
20	Row	3	2	2	66	-180	496	531	-70	68
21	Row	3	3	2	64	-192	465	507	-72	66
22	Row	4	1	2	83	-205	513	558	-68	66
23	Row	4	2	2	42	-182	526	558	-78	70
24	Row	4	3	2	53	-185	503	538	-75	69

----------Descriptive Statistics----------

Date/Time 09-04-1988 18:40:54
Data Base Name C:UMM03
Description Data base created at 18:28:38 on 09-04-1988

Detail Report

Variable: B	B(dc), (mG)		
Mean - Average	542.75	No. observations	24
Lower 95% c.i.limit	505.1272	No. missing values	0
Upper 95% c.i.limit	580.3727	Sum of frequencies	24
Adj sum of squares	182620.5	Sum of observations	13026
Standard deviation	89.1068	Std.error of mean	18.18885
Variance	7940.022	T-value for mean=0	29.83971
Coef. of variation	.1641765	T prob level	0.0000
Skewness	.9789789	Kurtosis	1.277246
Normality Test Value	1.368	Reject if > 1.182(10%)	1.289(5%)
100-%tile (Maximum)	771	90-%tile	652
75-%tile	568.5	10-%tile	432
50-%tile (Median)	534.5	Range	361
25-%tile	501.5	75th-25th %tile	67
0-%tile (Minimum)	410		

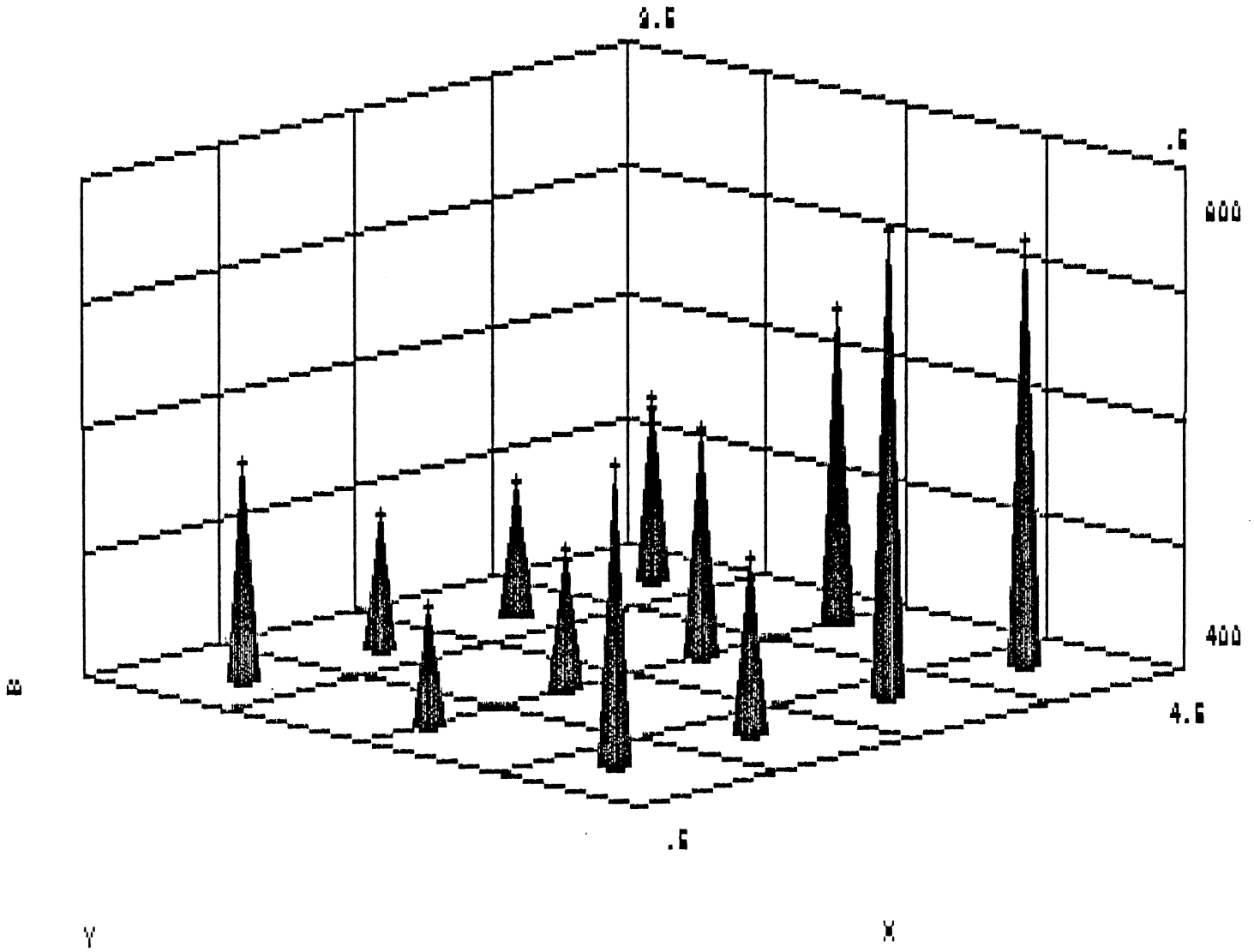
410----------Line Plot / Box Plot----------77:
1 1 1 1 1 1 22 1 1 21 21 11 1 1 1
[XXXXXXmXaXXXX]

Distribution & Histogram

Variable: B

Bin	Lower	Upper	Count	Prcnt	Total	Prcnt	Histogram
1	400	450	3	12.5	3	12.5	:***
2	450	500	3	12.5	6	25.0	:***
3	500	550	9	37.5	15	62.5	:*********
4	550	600	5	20.8	20	83.3	:*****
5	600	650	1	4.2	21	87.5	:*
6	650	700	1	4.2	22	91.7	:*
7	700	750	1	4.2	23	95.8	:*
8	750	800	1	4.2	24	100.0	:*
9	800	850	0	0.0	24	100.0	:
10	850	900	0	0.0	24	100.0	:

B(OC), UMM BARN, SE STALL, 9/4/88, 1800



----------NCSS Editor----------

Date/Time 09-12-1988 04:15:14
Data Base Name C:JKEN01
Description Data base created at 04:05:00 on 09-12-1988

No.	Variable	Rows	Vlab	Label
1	X	20		
2	Y	20		
3	Z	20		
4	BU	20		
5	BV	20		
6	BW	20		
7	B	0		B(dc), (mG)
8	OMEGA	0		B-DEV
9	PHI	0		B-DIF
10	C10	0		
11	C11	0		
12	C12	0		

B(DC), KENNING BARN, SOUTH CENTRAL STALL, FLOOR & 1M, 1300, 9/12/88

		X	Y	Z	B U	B V	B W	B	OMEGA	PHI
1	Row	1	1	1	164	141	696	728	40	72
2	Row	1	2	1	368	-285	134	484	-38	16
3	Row	2	1	1	155	29	1133	1143	10	82
4	Row	2	2	1	-264	-284	368	534	47	43
5	Row	3	1	1	114	-731	849	1126	-82	48
6	Row	3	2	1	-130	-139	570	600	46	71
7	Row	4	1	1	-54	-212	762	792	75	73
8	Row	4	2	1	43	25	813	814	30	86
9	Row	5	1	1	-40	-131	689	702	73	78
10	Row	5	2	1	42	90	739	745	64	82
11	Row	1	1	2	130	-4	230	264	-2	60
12	Row	1	2	2	51	-1	456	458	-2	83
13	Row	2	1	2	-77	-24	291	301	17	74
14	Row	2	2	2	-264	63	238	360	-14	41
15	Row	3	1	2	-104	72	140	188	-35	47
16	Row	3	2	2	-321	-155	148	385	25	22
17	Row	4	1	2	3	62	114	129	87	61
18	Row	4	2	2	18	-125	312	336	-82	67
19	Row	5	1	2	19	-3	230	230	-9	85
20	Row	5	2	2	35	82	240	256	66	69

Descriptive Statistics

Date/Time 09-12-1988 04:24:58
Data Base Name C:JKENO1
Description Data base created at 04:05:00 on 09-12-1988

Detail Report

Variable: B B(dc), (mG)

Mean - Average	528.75	No. observations	20
Lower 95% c.i.limit	390.3926	No. missing values	0
Upper 95% c.i.limit	667.1074	Sum of frequencies	20
Adj sum of squares	1661082	Sum of observations	10575
Standard deviation	295.6778	Std.error of mean	66.11556
Variance	87425.35	T-value for mean=0	7.997361
Coef. of variation	.5592015	T prob level	0.0000
Skewness	.7096573	Kurtosis	-.245572
Normality Test Value	1.049	Reject if > 1.216(10%)	1.357(5%)
100-%tile (Maximum)	1143	90-%tile	970
75-%tile	736.5	10-%tile	209
50-%tile (Median)	471	Range	1014
25-%tile	282.5	75th-25th %tile	454
0-%tile (Minimum)	129		

129----------Line Plot / Box Plot----------114
1 1 1 2 1 1 1 1 1 1 1 1 1 1 1 1
------[XXXXXXXXXXXXXmXXXXaXXXXXXXXXXXXXXX]----------

Distribution & Histogram

Variable: B

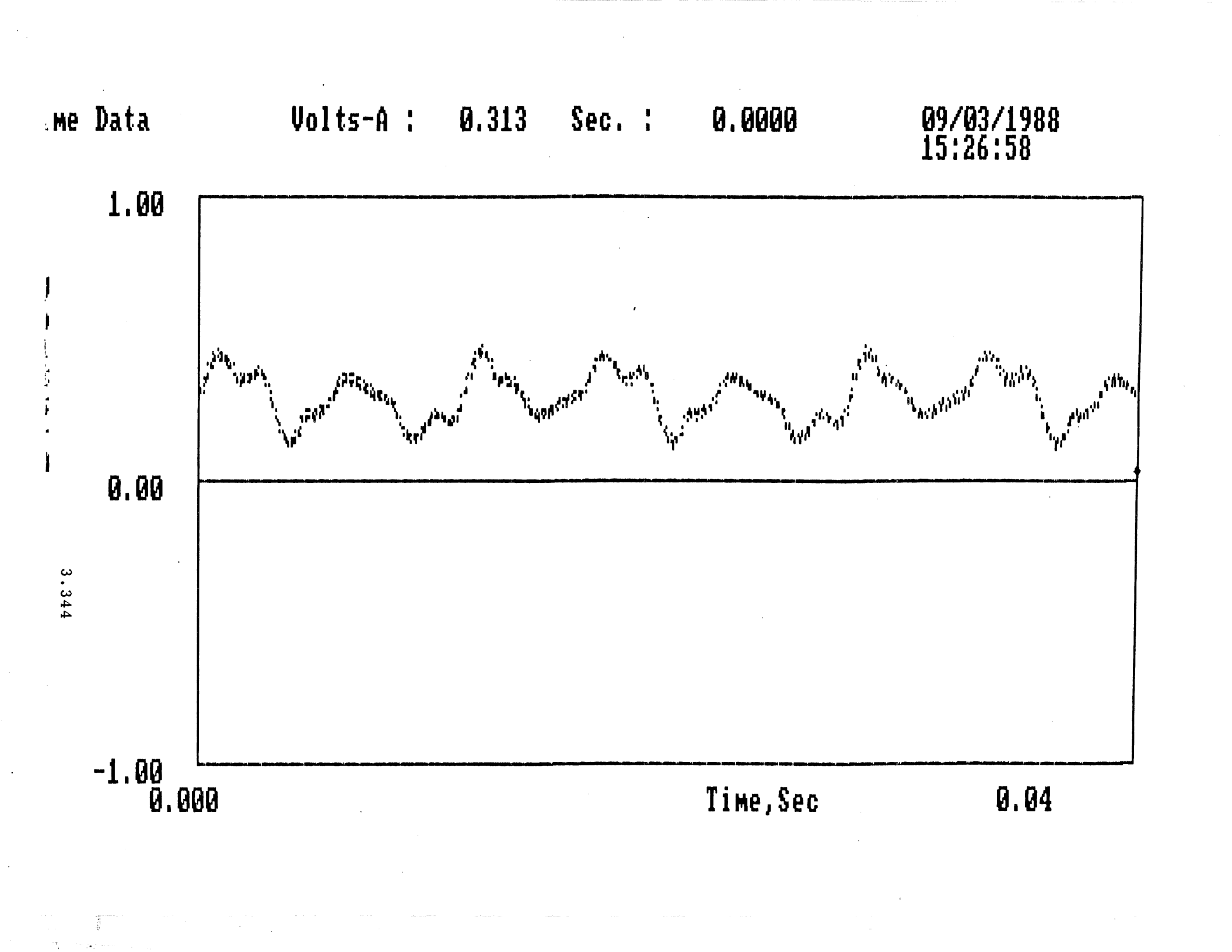
Bin	Lower	Upper	Count	Prcnt	Total	Prcnt	Histogram
1	0	100	0	0.0	0	0.0	:
2	100	200	2	10.0	2	10.0	:**
3	200	300	3	15.0	5	25.0	:***
4	300	400	4	20.0	9	45.0	:****
5	400	500	2	10.0	11	55.0	:**
6	500	600	1	5.0	12	60.0	:*
7	600	700	1	5.0	13	65.0	:*
8	700	800	4	20.0	17	85.0	:****
9	800	900	1	5.0	18	90.0	:*
10	900	1000	0	0.0	18	90.0	:
11	1000	1100	0	0.0	18	90.0	:
12	1100	1200	2	10.0	20	100.0	:**
13	1200	1300	0	0.0	20	100.0	:

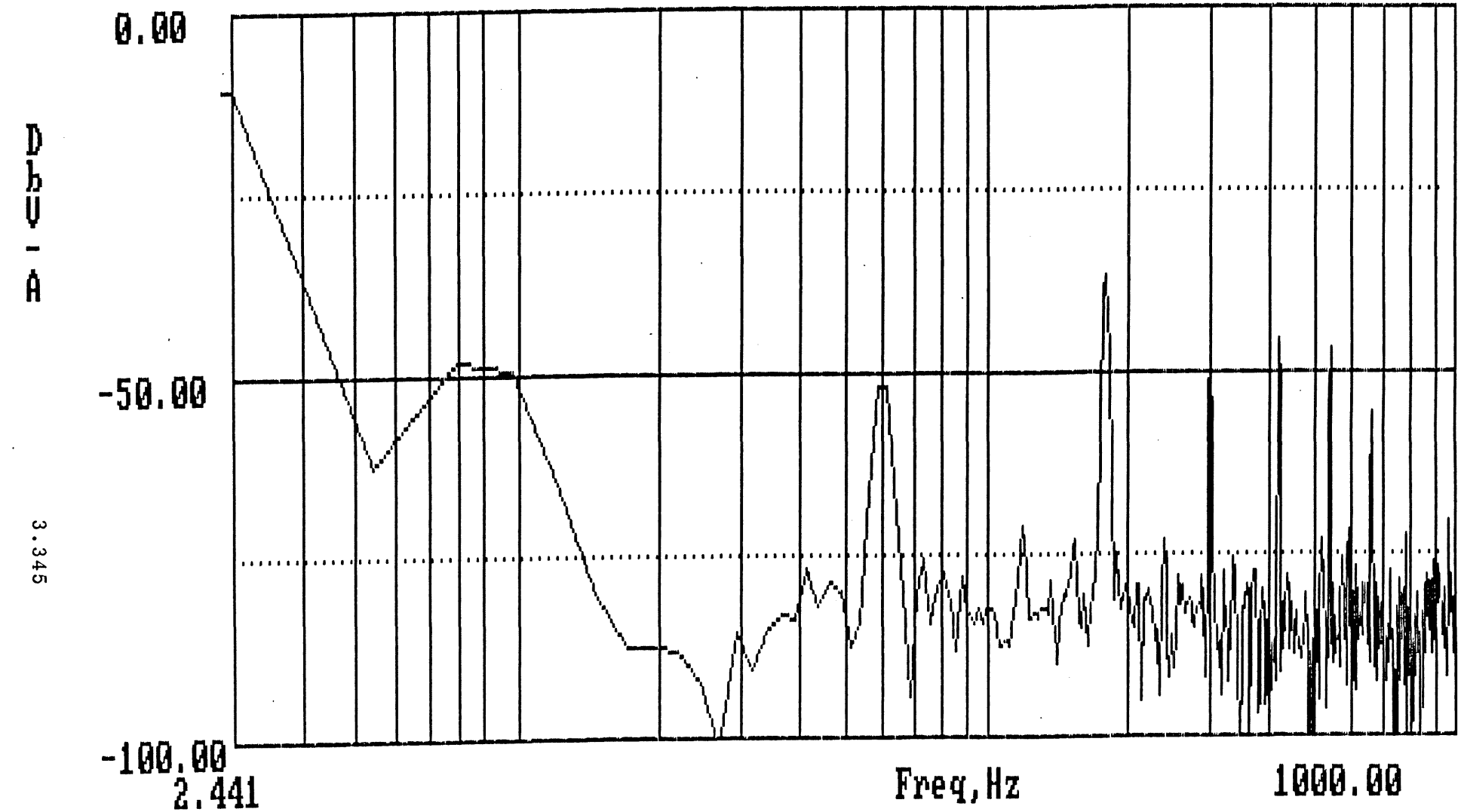
SPECTRAL

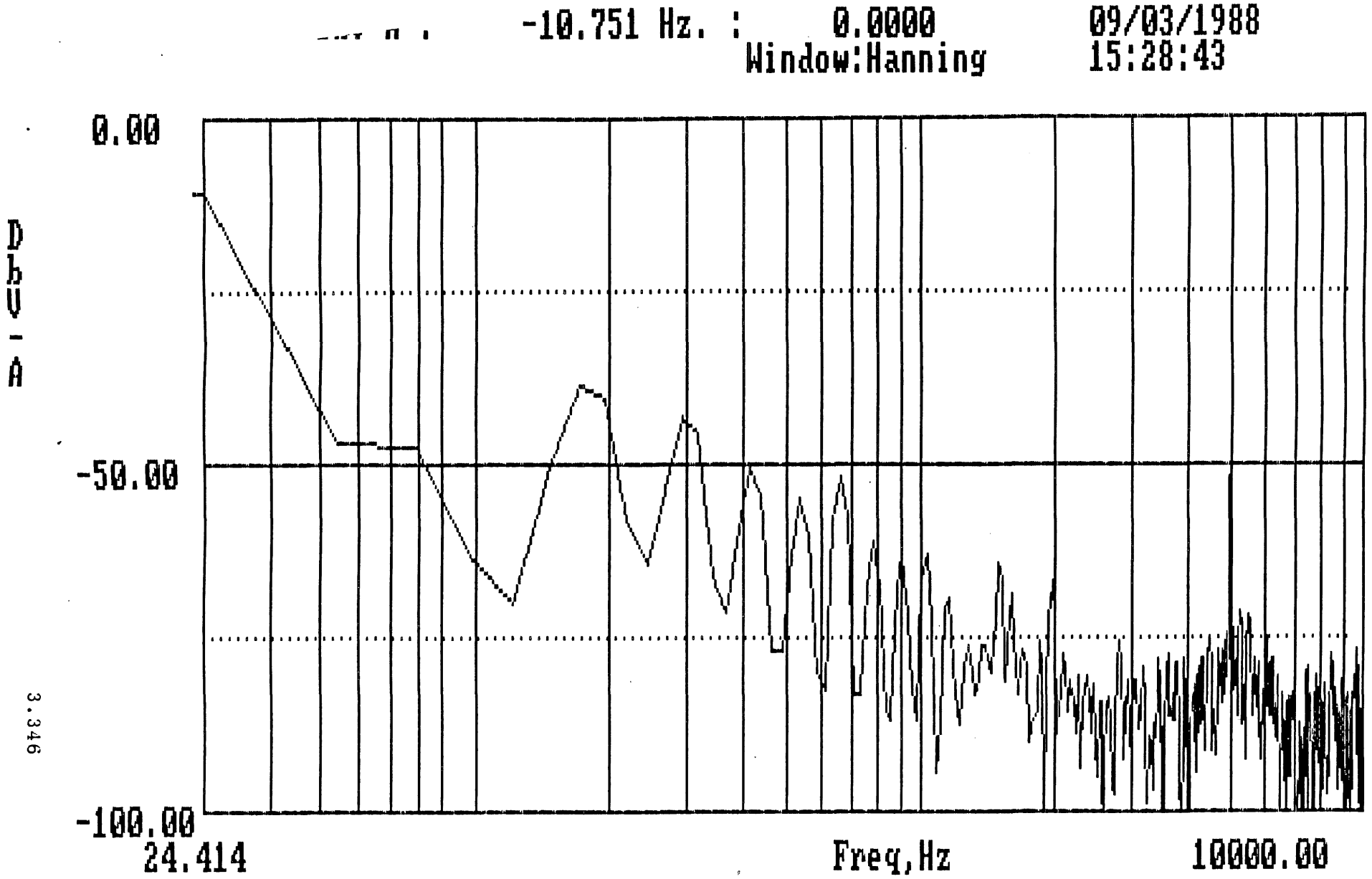
ANALYSIS

DATA: AN EXAMPLE

A data base consisting of spectral data was obtained for each farm to document the frequency components present in the ac voltage component superimposed upon the dc potential at each contact point monitored in the barn in producing the primary data base. An example of this data follows in the form of three graphs. The first graph presents a snapshot of the ac+dc waveform at the contact point (p. 3.344). The second graph is a plot of the ac potential in dBV (decibel volts, $20\log_{10}V$) vs. frequency up to 1 kHz (p. 3.345). The third graph plots the same type of information as the second but is the result of a second calculation of the Fourier transform which extends the frequency spectrum to 10 kHz (p. 3.346). These frequency plots enable the reader to determine the dominant frequency components present in the waveform graph. This is done by noting the frequencies at which relative maxima occur in the frequency graphs. Hard copy of these graphs can be produced when the data files are transformed to account for a linear offset imposed upon the data by the equipment used to make the measurement.


me Data
Volts-A : 0.313
Sec. : 0.0000
09/03/1988
15:26:58
1.00
0.00
-1.00
0.000
Time,Sec
0.04


Spectra A
DbV-A :
-86.786 Hz. :
500.4883
Window:Hanning
09/03/1988
15:30:58
0.00
-50.00
-100.00
DbV - A
3.345
2.441
Freq,Hz
1000.00


-10.751 Hz. : 0.0000
09/03/1988
Window:Hanning
15:28:43
0.00
-50.00
-100.00
DbV - A
24.414
Freq,Hz
10000.00

4. HERD MANAGEMENT

Management aspects of dairy production were reviewed by Daniel Moscho of Milaca, MN. He was asked to provide an overview of each study farm relevant to his daily experience with other dairies and to note differences in operations which may contribute to low productivities. His general comments based on site visits made during the fall of 1988 and information gained through dialogue with farm operators follow in this record on a farm specific basis.

An aspect of this study which proved largely inaccessible was productivity concerns related to herd genetics. Except for the University of Minnesota at Morris, farm records are often incomplete usually representing only parents of the current generation. All farms studied cull readily for non performance. The Harold Johnson farm showed a sixty seven percent replacement rate in 1987 which demands a large supply of on farm produced replacement heifers. Bruce Johnson indcated that it is very difficult to keep track of genetic histories when such a large percentage of animals fail annually, a condition which he attributes to the environment of their barn.

Borgerding: Management

Production:

1. 16,000 pound herd average.
2. No cows at 100 pounds during peak.

Feed Program:

1. Intakes appear good, very little cleaning of managers required. Operator might consider feeding more forage.
2. Grain feeding rates are about average. Owner indicates he can't feed more because cows get mastitis. Cows maybe somewhat short of protein.
3. Mineral supplements appear normal.

Forages:

1. Forage quality is good.
2. Haylage is 18%.
3. Hay is good.

Cows:

1. Animals are small to average in size and appear comfortable. The stalls are clean.
2. Animals are in generally good condition. Body condition score is 4-5 at calving.

Mastitis:

SSC is 600,000, the operator should try to identify the source of this problem.

Metabolic Problems:

1. Operator reports few problem with milk fever, retained

placentas, displaced stomachs, cystic ovaries or uterine infections.

General Comments:

1. Operator uses no vaccines - this is a concern.
2. Heifers are on corn silage ration, are in nice condition and of average size.
3. Operator reports major reproduction, production problems with cows that won't settle.

Ration: (10-28-88)

Haylage	- 36 lbs.	Calcium	- 2.6 oz.
Hay	- 6.5 lbs.	Humates	- 2 oz.
Mineral	- 6.5 oz.	Lack Pack	- 1 oz.
Salt	- 1.3 oz.	D.E.	- 1/16 oz.

Johnson: Management

Production:

1. Currently near 18,000 lb. herd average up from previous year near 16,000. Current production is similar to where this operation was at in the early 1980's.

Feed Program:

1. Operator does not clean managers which can affect feed intakes. He finds that feed intake follows milk production on a short term basis.
2. Rations are not balanced and mineral mix was designed by the operator, this could be a problem but performance in the herd has improved.

Forages:

1. Good quality.
2. Hay and haylage are typically about 18% protein.

Cows:

1. Average size and clean.
2. Hooves are long, animals are kept in barn until dry.
3. Animals are thin. Body score condition 2-3.

Mastitis:

1. SSC is 100,000 - 200,000

Metabolic Problems:

1. Milk fever, displaced stomachs, retained placentas and cystic ovaries are occassional problems, but almost every cow has an uterine infection after calving.

General Comments:

1. Vaccines - uses Triangle III at 6 months, 12 months and at breeding. Gives Lepto yearly.
2. Owners experience reproduction problems with odd cycles and poor conception rates.

Morris: Management

Production:

1. Milk production is difficult to evaluate because of experimental conditions where feed quality and quantity are the variables being tested against production.

Feed Program:

1. Varies with experiment, but at generally predicted rate of 7% above intake.
2. General feeding is appropriate for 18,000 pounds, but herd average is closer to 16,000 pounds.

Forages:

1. Varies with trial.

Cows:

1. Breeding is for animals to freshen in the fall and to hold late heifer over for a year, if too small to breed to be fresh in the fall.
2. Cows are average in size. Comfort and barn conditions are excellent.

Metabolic Problems:

1. No excess problems reported.

Kenning: Management

Production:

1. Current production is at 13,500 pounds. Cows don't hold peak production and best production is at 80 pounds.

Feed Program:

1. Cows are fed both forages at the same time which allows eating one type, but not the other.
2. There is a distinct possibility that this herd is short on protein. Current soy protein is approximate for about 45 lbs. of milk, cows have free choice grain in parlor, but without control as to the amount fed individual cows. The amount of grain fed may be excessive. I did not see cows with a body score condition of 5 which would be expected based on the amount of grain being fed.

Forages:

1. Hay and corn silage looked good.

Cows:

1. Size is average. Animals don't appear to be in the condition they should be as according to the amount of corn they are fed.
2. Operator should watch for use of free stalls because

cows didn't appear to using the stalls as much as they should and should also check for adequacy of ventilation in loafing area.

Mastitis:

1. SSC is 440,000.

Metabolic Problems:

1. Operator reports general problems that are cyclical or seasonal.

General Comments:

1. The use of vaccines was discontinued because of decreased milk production following injections.

SUMMARY:

The preceding section describes on a farm by farm basis what was observed visiting these dairies and gained through discussions with the farm owner/operator. It is important to realize these comments are not those which would be represented by the operator's participation in a herd management program. Specific information descriptive of feed quality is included in section 5 of this report and was completed independent of the work described here.

These observations are based on the regular annual experience of the consultant with about one hundred dairies located in central Minnesota. The objective of this work was to note differences in operation of the study farms and general characteristics of the diary farm experience in Minnesota. Additional efforts were made to record differences in management practices between study farms. The preceding outline format is intended to benefit contrasts the reader may make in that regard. No specific information was available to support these contrast in terms of days in milk, average body weight groupings or forage fiber analysis as may be related to feed intakes. The study farms cannot be envisioned as experimental units defined to fit the needs of a research inquiry but rather are operating dairy farms in Minnesota demanding that the research inquiry be fitted to and limited by practical experience on these farms.

The following general comments are made as subject to the preceding qualifications:

The Borgerding farm appears well managed with a good feed program and obvious attention to cow comfort and facilities maintenance. I have no specific information or recommendation related to the high somatic cell counts.

The Johnson farm has a good forage program and reports low somatic cell counts. The amount of protein being fed appears to exceed that required for the current production of this herd. Over extended periods of time high protein intakes could affect reproduction. The cows are thin and feed intakes are low.

The University of Minnesota at Morris dairy facility is clearly an experimental unit and as such it is difficult to contrast herd characteristics with those of a typical diary farm. Experimental trials conducted in cows groups may significantly benefit or detract from overall herd performance. The breeding program may also yield 3 year old heifers in either their first or second lactation with consequent effects on production.

The Kenning farm feed and ration program looks good but the overall cow condition is less than what should be expected for the amount of grain being fed. Grain is not weighed and the cows have equivalent access to both hay and corn silage at the same time which makes it difficult to index specific cow performance relative to feed intake.

COW

PRODUCTION

DATA

----------NCSS Editor----------

Data Base Name C:\EMD\MPROD

No.	Variable	Rows	Vlab	Label
1	YEAR	156		
2	MONTH	156		
3	YR.MO	0		DECIMAL YEAR
4	B#COW	131		NUMBER OF COWS, BORGERDING
5	BAVG	131		AVG LB MILK/COW/DAY, BORGERDING
6	J#COW	156		NUMBER OF COWS, JOHNSON
7	JAVG	156		AVG LB MILK/COW/DAY, JOHNSON
8	K#COW	144		NUMBER OF COWS, KENNING
9	KAVG	144		AVG LB MILK/COW/DAY, KENNING
10	U#COW	150		NUMBER OF COWS, UMM
11	UAVG	150		AVG LB MILK/COW/DAY, UMM
12	C12	0		
13	C13	0		
14	C14	0		
15	C15	0		
16	C16	0		

----------Descriptive Statistics----------

Data Base Name C:\EMD\MPROD

Detail Report

Variable: B#COW NUMBER OF COWS, BORGERDING

Mean - Average	51.89583	No. observations	131
Lower 95% c.i.limit	51.68904	No. missing values	35
Upper 95% c.i.limit	52.10263	Sum of frequencies	96
Adj sum of squares	98.95834	Sum of observations	4982
Standard deviation	1.020621	Std.error of mean	.1041667
Variance	1.041667	T-value for mean=0	498.2
Coef. of variation	1.966672E-02	T prob level	0.0000
Skewness	-9.797959	Kurtosis	96
100-%tile (Maximum)	52	90-%tile	52
75-%tile	52	10-%tile	52
50-%tile (Median)	52	Range	10
25-%tile	52	75th-25th %tile	0
0-%tile (Minimum)	42		

Variable: BAVG AVG LB MILK/COW/DAY, BORGERDING

Mean - Average	41.95833	No. observations	131
Lower 95% c.i.limit	40.43442	No. missing values	35
Upper 95% c.i.limit	43.48224	Sum of frequencies	96
Adj sum of squares	5373.834	Sum of observations	4028
Standard deviation	7.521081	Std.error of mean	.7676172
Variance	56.56667	T-value for mean=0	54.6605
Coef. of variation	.1792512	T prob level	0.0000
Skewness	-.2058436	Kurtosis	-1.697716E-02
Normality Test Value	0.985	Reject if > 1.053(10%)	1.082(5%)
100-%tile (Maximum)	63	90-%tile	52
75-%tile	47	10-%tile	33
50-%tile (Median)	42	Range	40
25-%tile	36.5	75th-25th %tile	10.5
0-%tile (Minimum)	23		

ata Base Name C:\EMD\MPROD

ariable: J#COW NUMBER OF COWS, JOHNSON

Mean - Average	47.93706	No. observations	156
Lower 95% c.i.limit	47.52873	No. missing values	13
pper 95% c.i.limit	48.3454	Sum of frequencies	143
dj sum of squares	866.4336	Sum of observations	6855
tandard deviation	2.470151	Std.error of mean	.2065644
ariance	6.101645	T-value for mean=0	232.0684
Coef. of variation	5.152904E-02	T prob level	0.0000
Skewness	-.358895	Kurtosis	-1.897939
100-%tile (Maximum)	50	90-%tile	50
75-%tile	50	10-%tile	45
50-%tile (Median)	50	Range	5
25-%tile	45	75th-25th %tile	5
0-%tile (Minimum)	45		

ariable: JAVG AVG LB MILK/COW/DAY, JOHNSON

ean - Average	53.77622	No. observations	156
Lower 95% c.i.limit	52.06205	No. missing values	13
pper 95% c.i.limit	55.4904	Sum of frequencies	143
dj sum of squares	15268.84	Sum of observations	7690
tandard deviation	10.36952	Std.error of mean	.8671432
ariance	107.527	T-value for mean=0	62.01539
oef. of variation	.1928273	T prob level	0.0000
Skewness	-.1682464	Kurtosis	-.6776743
ormality Test Value	0.935	Reject if > 1.037(10%)	1.058(5%)
100-%tile (Maximum)	77	90-%tile	67
75-%tile	61	10-%tile	39
50-%tile (Median)	55	Range	44
25-%tile	47	75th-25th %tile	14
0-%tile (Minimum)	33		

Data Base Name C:\EMD\MPROD

Variable: K#COW NUMBER OF COWS, KENNING

Mean - Average	56.41379	No. observations	144
Lower 95% c.i.limit	55.25764	No. missing values	86
Upper 95% c.i.limit	57.56995	Sum of frequencies	58
Adj sum of squares	1102.069	Sum of observations	3272
Standard deviation	4.397106	Std.error of mean	.5773683
Variance	19.33454	T-value for mean=0	97.7085
Coef. of variation	7.794382E-02	T prob level	0.0000
Skewness	-.3471382	Kurtosis	-.6904571
Normality Test Value	0.948	Reject if > 1.083(10%)	1.127(5%)
100-%tile (Maximum)	65	90-%tile	62
75-%tile	60	10-%tile	51
50-%tile (Median)	57	Range	19
25-%tile	54	75th-25th %tile	6
0-%tile (Minimum)	46		

Variable: KAVG AVG LB MILK/COW/DAY, KENNING

Mean - Average	40.22414	No. observations	144
Lower 95% c.i.limit	39.25143	No. missing values	86
Upper 95% c.i.limit	41.19685	Sum of frequencies	58
Adj sum of squares	780.0862	Sum of observations	2333
Standard deviation	3.699422	Std.error of mean	.4857579
Variance	13.68572	T-value for mean=0	82.80697
Coef. of variation	.0919702	T prob level	0.0000
Skewness	.3179086	Kurtosis	-.3067311
Normality Test Value	0.976	Reject if > 1.083(10%)	1.127(5%)
100-%tile (Maximum)	49	90-%tile	45.5
75-%tile	43	10-%tile	36
50-%tile (Median)	40	Range	16
25-%tile	38	75th-25th %tile	5
0-%tile (Minimum)	33		

ata Base Name C:\EMD\MPROD

Detail Report

variable: U#COW NUMBER OF COWS, UMM

Mean - Average	53.41667	No. observations	150
ower 95% c.i.limit	48.27739	No. missing values	138
pper 95% c.i.limit	58.55594	Sum of frequencies	12
Adj sum of squares	720.9167	Sum of observations	641
tandard deviation	8.095547	Std.error of mean	2.336983
Variance	65.53788	T-value for mean=0	22.85711
Coef. of variation	.1515547	T prob level	0.0000
kewness	-.4768188	Kurtosis	-1.961262
ormality Test Value	0.832	Reject if > 1.357(10%)	1.719(5%)
100-%tile (Maximum)	61	90-%tile	60
75-%tile	60	10-%tile	42
50-%tile (Median)	59	Range	19
25-%tile	45.5	75th-25th %tile	14.5
0-%tile (Minimum)	42		

ariable: UAVG AVG LB MILK/COW/DAY, UMM

Mean - Average	52.5	No. observations	150
ower 95% c.i.limit	45.57485	No. missing values	138
pper 95% c.i.limit	59.42515	Sum of frequencies	12
Adj sum of squares	1309	Sum of observations	630
tandard deviation	10.90871	Std.error of mean	3.149074
variance	119	T-value for mean=0	16.67157
Coef. of variation	.207785	T prob level	0.0000
kewness	-.0814314	Kurtosis	-1.650349
ormality Test Value	1.018	Reject if > 1.357(10%)	1.719(5%)
100-%tile (Maximum)	66	90-%tile	66
75-%tile	63	10-%tile	38
50-%tile (Median)	52	Range	29
25-%tile	43	75th-25th %tile	20
0-%tile (Minimum)	37		

HERD AVERAGE MILK PRODUCTION RECORDS, 1976-1988

YEAR	MONTH	BOW #	BAVG	JOW #	JAVG	KOW #	KAVG	UOW #	UAVG
76	1	*	*	45	40	*	*	*	*
76	2	*	*	45	51	*	*	*	*
76	3	*	*	45	59	*	*	*	*
76	4	*	*	45	52	*	*	*	*
76	5	*	*	45	50	*	*	*	*
76	6	*	*	45	51	*	*	*	*
76	7	*	*	45	49	*	*	*	*
76	8	*	*	45	39	*	*	*	*
76	9	*	*	45	38	*	*	*	*
76	10	*	*	45	47	*	*	*	*
76	11	*	*	45	46	*	*	*	*
76	12	*	*	45	55	*	*	*	*
77	1	*	*	45	62	*	*	*	*
77	2	*	*	45	53	*	*	*	*
77	3	*	*	45	57	*	*	*	*
77	4	*	*	45	54	*	*	*	*
77	5	*	*	45	51	*	*	*	*
77	6	*	*	45	41	*	*	*	*
77	7	*	*	45	36	*	*	*	*
77	8	*	*	45	34	*	*	*	*
77	9	*	*	45	33	*	*	*	*
77	10	*	*	45	46	*	*	*	*
77	11	*	*	45	52	*	*	*	*
77	12	52	36	45	59	*	*	*	*
78	1	52	38	45	59	*	*	*	*
78	2	52	36	45	56	*	*	*	*
78	3	52	40	45	64	*	*	*	*
78	4	52	38	45	56	*	*	*	*
78	5	52	35	45	51	*	*	*	*
78	6	52	33	45	46	*	*	*	*
78	7	52	31	45	41	*	*	*	*
78	8	52	25	45	34	*	*	*	*
78	9	52	23	45	34	*	*	*	*
78	10	52	29	45	48	*	*	*	*
78	11	52	33	45	52	*	*	*	*
78	12	*	*	45	55	*	*	*	*
79	1	*	*	45	56	*	*	*	*
79	2	*	*	45	47	*	*	*	*
79	3	*	*	45	49	*	*	*	*
79	4	*	*	45	54	*	*	*	*
79	5	*	*	45	57	*	*	*	*
79	6	*	*	45	50	*	*	*	*
79	7	*	*	45	43	*	*	*	*
79	8	*	*	45	40	*	*	*	*
79	9	*	*	45	39	*	*	*	*
79	10	*	*	45	53	*	*	*	*

..ERD AVERAGE MILK PRODUCTION RECORDS, 1976-1988

Y E A R	M O N T H	B # C O W	B A V G	J # C O W	J A V G	K # C O W	K A V G	U # C O W	U A V G
.9	11	*	*	45	63	*	*	*	*
79	12	52	49	45	71	*	*	*	*
0	1	52	52	45	69	*	*	*	*
0	2	52	47	45	66	*	*	*	*
80	3	52	48	45	62	*	*	*	*
°0	4	52	42	45	56	*	*	*	*
0	5	52	45	45	56	*	*	*	*
-0	6	52	41	45	50	*	*	*	*
80	7	52	36	45	43	*	*	*	*
0	8	52	31	45	40	*	*	*	*
0	9	52	35	45	33	*	*	*	*
80	10	52	46	45	36	*	*	*	*
80	11	52	46	45	47	*	*	*	*
0	12	52	52	50	61	*	*	*	*
∪1	1	52	63	50	68	*	*	*	*
81	2	52	54	50	55	*	*	*	*
1	3	52	51	50	60	*	*	*	*
1	4	52	46	50	57	*	*	*	*
81	5	52	46	50	58	*	*	*	*
°1	6	52	39	50	56	*	*	*	*
1	7	52	33	50	53	*	*	*	*
∂1	8	52	29	50	42	*	*	*	*
81	9	52	25	50	35	*	*	*	*
1	10	52	34	50	48	*	*	*	*
1	11	52	39	50	55	*	*	*	*
81	12	52	27	50	67	*	*	*	*
^2	1	52	47	50	77	*	*	*	*
2	2	52	43	50	68	*	*	*	*
82	3	52	52	50	70	*	*	*	*
82	4	52	46	50	64	*	*	*	*
2	5	52	45	50	67	*	*	*	*
-2	6	52	49	50	57	*	*	*	*
82	7	52	48	50	49	*	*	*	*
~2	8	52	40	50	45	*	*	*	*
2	9	52	35	50	39	*	*	*	*
82	10	52	40	50	39	*	*	*	*
82	11	52	40	50	55	*	*	*	*
2	12	52	44	50	70	*	*	*	*
∪3	1	52	55	50	68	*	*	*	*
83	2	52	47	50	63	*	*	*	*
3	3	52	53	50	68	48	43	*	*
3	4	52	52	50	62	52	46	*	*
83	5	52	54	50	60	58	47	*	*
83	6	52	49	50	56	60	46	*	*
3	7	52	46	50	49	62	42	*	*
∪3	8	52	40	50	38	58	39	*	*

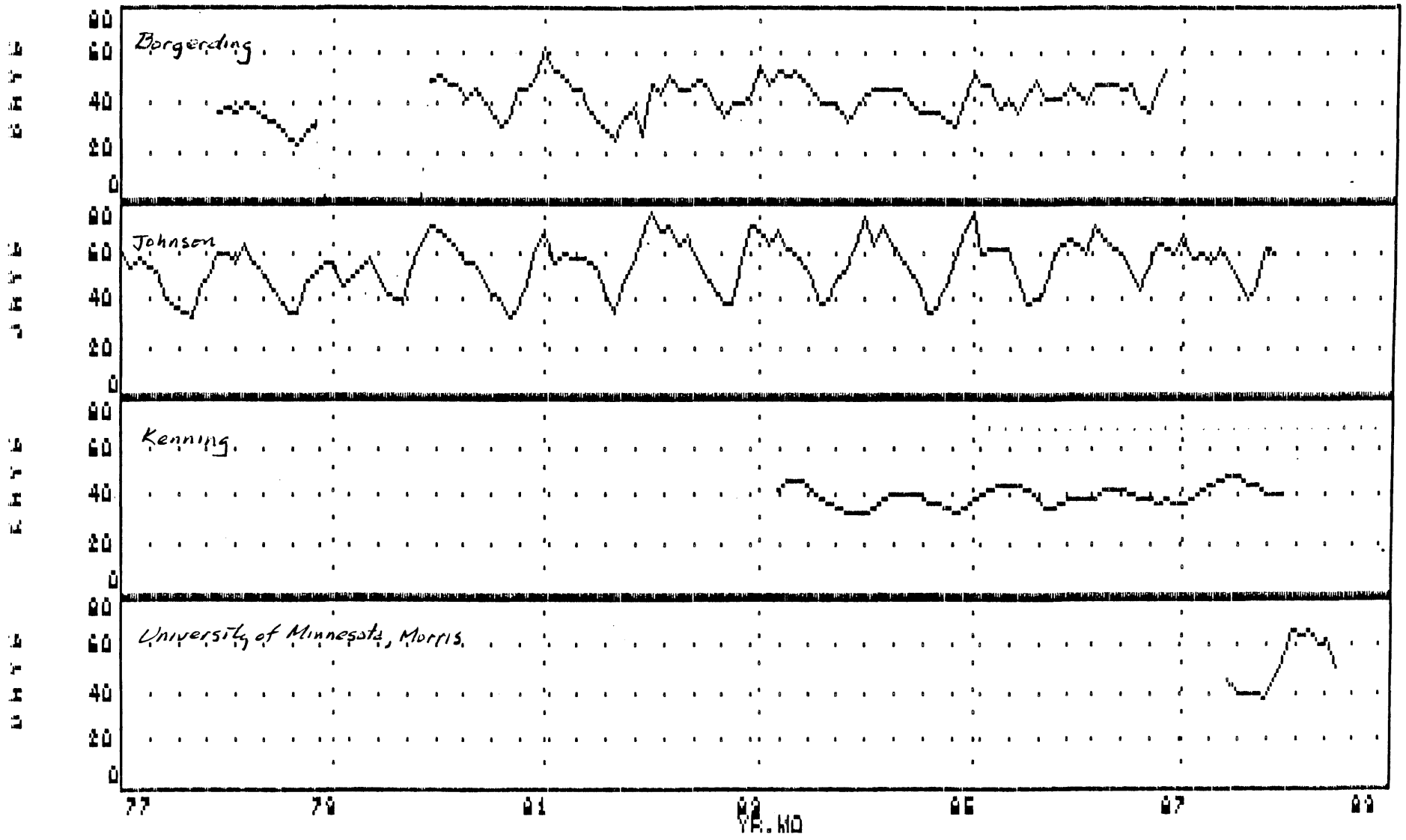
HERD AVERAGE MILK PRODUCTION RECORDS, 1976-1988

YEAR	MONTH	BOW #	BAVG	JOW #	JAVG	KOW #	KAVG	UOW #	UAVG
83	9	52	40	50	40	56	37	*	*
83	10	52	38	50	49	59	36	*	*
83	11	52	33	50	54	60	34	*	*
83	12	52	39	50	64	62	33	*	*
84	1	52	43	50	74	54	34	*	*
84	2	52	46	50	64	54	36	*	*
84	3	52	46	50	70	58	39	*	*
84	4	52	45	50	63	62	40	*	*
84	5	52	45	50	58	65	40	*	*
84	6	52	40	50	51	63	40	*	*
84	7	52	36	50	47	60	40	*	*
84	8	52	37	50	34	61	37	*	*
84	9	52	36	50	36	61	37	*	*
84	10	52	33	50	47	60	36	*	*
84	11	52	30	50	58	59	34	*	*
84	12	52	42	50	68	59	36	*	*
85	1	52	51	50	76	56	39	*	*
85	2	52	47	50	60	54	40	*	*
85	3	52	47	50	61	55	43	*	*
85	4	52	39	50	61	60	44	*	*
85	5	52	41	50	61	60	45	*	*
85	6	52	36	50	49	59	44	*	*
85	7	52	43	50	38	58	42	*	*
85	8	52	49	50	41	54	41	*	*
85	9	52	42	50	44	53	36	*	*
85	10	42	41	50	57	52	36	*	*
85	11	52	42	50	64	52	37	*	*
85	12	52	48	50	66	55	39	*	*
86	1	52	44	50	64	62	39	*	*
86	2	52	40	50	59	61	39	*	*
86	3	52	47	50	70	59	39	*	*
86	4	52	47	50	65	55	42	*	*
86	5	52	47	50	61	57	43	*	*
86	6	52	46	50	59	62	42	*	*
86	7	52	48	50	52	60	41	*	*
86	8	52	38	50	45	60	39	*	*
86	9	52	37	50	54	54	39	*	*
86	10	52	48	50	63	51	38	*	*
86	11	52	53	50	61	50	39	*	*
86	12	*	*	50	60	46	38	*	*
87	1	*	*	50	67	51	38	*	*
87	2	*	*	50	57	49	39	*	*
87	3	*	*	50	59	48	42	*	*
87	4	*	*	50	56	51	44	*	*
87	5	*	*	50	61	51	47	*	*
87	6	*	*	50	55	51	49	60	46

..ERD AVERAGE MILK PRODUCTION RECORDS, 1976-1988

YEAR	MONTH	BOW # COV	BOW AVG	JAW # COV	JAW AVG	KAW # COV	KAW AVG	KUW # COV	KUW AVG
.7	7	*	*	50	48	54	48	59	40
87	8	*	*	50	41	57	44	*	*
`7	9	*	*	50	47	59	44	46	39
7	10	*	*	50	62	55	41	45	37
87	11	*	*	50	59	54	40	42	46
87	12	*	*	*	*	56	41	42	53
8	1	*	*	*	*	*	*	47	66
8	2	*	*	*	*	*	*	59	64
88	3	*	*	*	*	*	*	61	66
`8	4	*	*	*	*	*	*	60	60
8	5	*	*	*	*	*	*	60	62
88	6	*	*	*	*	*	*	60	51
88	7	*	*	*	*	*	*	*	*
8	8	*	*	*	*	*	*	*	*
.8	9	*	*	*	*	*	*	*	*
88	10	*	*	*	*	*	*	*	*
8	11	*	*	*	*	*	*	*	*
8	12	*	*	*	*	*	*	*	*

HERD AVERAGE MILK PRODUCTION, FOUR FARMS, 1976-1988



1. Borgerding, Johnson and Kenning production are based on pounds of milk sold per month with daily production based on estimated average number of cows
2. University of Minnesota Morris production is DHIA record

ANIMAL HEALTH AND PHYSIOLOGIC SURVEY ON LIVESTOCK PRODUCTIVITIES

Daniel P. Hartsell, D.V.M.
Alexandria Veterinary Clinic
Alexandria, Minnesota
December, 1988

5. ANIMAL PHYSIOLOGY AND HEALTH

The principal purpose of the research reported here was to examine nutritional problems including water quality and obvious managerial problems as a possible explanation of the various health and milk quality problems experienced by the Harold Johnson, Art Borgerding and Joe Kenning farms in the past attributed to "stray voltage." The University of Minnesota at Morris Dairy Experiment Station (UMMES) was chosen as a comparison herd that as far as I know has not had problems attributed to "stray voltage." The water quality was tested by the Alexandria Veterinary Clinic, P.A. laboratory. Measured are pH, total hardness, magnesium, nitrates, sulfate, iron, calcium, copper and coliform bacteria. Along with the report is a water-test interpretation sheet. The nutritional status of the herd was evaluated by first running a nutrient analyis of the available feed stuffs. This is done through the Hach instrumentation method used by the Alexandria Veterinary Clinic laboratory. The amounts of each ingredient fed to the average cow in the herd for the average amount of milk and butterfat produced was then entered into the DALEX nutritional program along with the nutrient values of each ingredient and computed. The computer program determines the amount of protein, energy, calcium and phosphorous, etc. in the ration and whether it is adequate for the amount of milk to be produced. The DALEX nutritional program is a purchased commercial software that is used by Pro-Health Feeds, Inc., a nutritional consulting and feed business owned and operated by the Alexandria Veterinary Clinic, P.A. of which I am an owner.

Included in the research was to draw blood samples in each herd from cows determined by the owner or herdsman to be healthy with no apparent problems and unthrifty animals that had either obvious health problems or milk quality problems. We tried to get half of the samples from first calf heifers (young cows) and half from older mature cows. The blood work performed was PROTEIN ELECTROPHORESIS which measures a fraction of the gama globulins and blood albumin. We tried to evaluate a portion of each animal's immunity through this blood test. An animal's immunity is two-fold: humoral and cell-meditated. The cell meditated portion is impossible to measure and the humoral, which consists of circulating antibodies' can only be partially evaluated by protein electrophoresis. This is a very crude way to measure a very complex system such as the immune system and is in no way very specific. Broad generalities can sometimes be noticed and we were looking for possible patterns that may be consistent. These, however, can not point a finger at any one definite cause. The laboratory used was Wolff Laboratories, Inc., 9025 Penn Avenue South, Minneapolis, Minnesota 55431. The reason for this choice was simply that they charged $2.00 less per sample than the University of Minnesota Diagnostic Lab.

After the results of the protein electrophoresis were obtained, I sent copies to Dr. Glen Wolff of Wolff Laboratories and to Dr. Doug Worss of the University of Minnesota Department of Veterinary Pathobiology. They were kind enough to send me

their interpretations of the blood electrophoresis results with some additional background information which is included in the report.
Following is an evaluation of each herd:

HAROLD JOHNSON: A very well managed 50 cow herd of Holsteins that in the past has had very severe voltage problems. The cows appeared healthy and were either eating or chewing cud. Approximately 20% of the cows had swollen hock joints or front legs with only one cow appearing lame.

The only water characteristic considered out of normal range was the pH which was 6.2, but this is not very far away from the norm of 6.8 to 7.5.

The ration for the average cow producing 50# milk with a 3.8% butterfat according to the computer printout is sufficient for energy, protein, calcium and phosphorous. Johnson is feeding more protein than necessary and feed is higher in calcium than the NRC recommends, but for stressed animals this is not out of line.

The blood protein electrophoresis pattern shows no significant patterns or differences between so called healthy cows with no apparent problems and unthrifty cows. For the most part the sampled cows were very close to the normal values established by Wolff Laboratories. Apparently good management and nutrition are able to compensate for some environmental problems.

ART BORGERDING: A well managed Holstein herd that over the years has had quite a few health and production problems with no obvious cause. Voltage is suspected as being at least in part responsible. It is interesting to note that in the past Borgerding was able to temporarily clear up these problems by cutting the ground cables along the power distribution line to his farm. This, however, has posed some legal ramifications which have precluded him from continuing this practice. The farm is within half a mile of the center of the city of Freeport which may be a reason why more current is found here. As a result Borgerding has used many different techniques including radionics and hydrogen peroxide treatments with varying degrees of success in order to insure the health of the herd.

The water quality report reveals no significant problems and the ration is balanced adequately for the average cow.

The blood electrophoresis readings however show a very significant lack of albumin and an elevation of globulin, indicating stress from chronic inflamation or a nutritional problem or both. The computer does not feel that the cows could eat the amount of dry matter required to produce 50# milk as stated on the printout. The printout feels that the expected D.M. (dry matter) intake is a pound and a half less than what is required to give the average cow a balanced ration. As a result they may not be getting the proper amount of protein or energy or calcium which are not in abundance at this level. The albumin

levels were significantly lower for both healthy cows and unthrifty cows with not much difference between the two. This may point to a nutritional inadequacy. The globulin levels on the whole seemed more significantly raised on the so called unthrifty cows from the healthy animals but not in every case and the reason for this can only be specualted on.

This set of data can only stimulate a desire for an indepth study with further information to figure out the problems in the herd.

JOE KENNING: A very interesting farm and many of us are familiar with the problems Kenning has faced in the past. At one time he had great production from his dairy cows and swine herd and over the last ten years has had to live with ever increasing problems. Kenning is very ingenious and energetic and has gotten the power company to move a distribution line that was crossing over his farm. He has an isolated neutral and completely balanced load. He has a unique way of measuring ground current which consists of a ground reference in respect to a reference in the air. He records the high spikes 3-4 times daily and has logged these out over several years. This with a graph of his somatic cell counts in his milk often show some interesting relationships. The somatic cell count (SCC) of the milk is a measure of milk quality and sometimes an indicator of mastitis. A higher SCC is less desirable and if too high renders the milk unsaleable. Kenning can show that an increase in his SCC is most always preceded by an increase in ground current.

Kenning's ingenious way of compensating for ground current is by placing problem cows on a semi-trailer which is about 5 feet off the ground and insulated from ground contacts. The cows spend the time between milkings on this trailer and he has been able to get them into better health because of this.

At the time of my visit he had 3 cows in the trailer which we blood tested and are tube numbers: 11, 12 and 13.

Nutritionally Kenning's feed ration was balanced and quite adequate for the average cow. The water is extremely hard, consisting of a very high iron, calcium and magnesium content. However, it was negative for any bacteria. This may or may not have an effect on the palatability of the water, but I don't think it is high enough to affect the nutritional balance of the ration.

The blood work revealed chronic inflamation which does not surprise anyone. We can only speculate at the cause of this immune stimulation. It is very interesting to note that every cow considered healthy and with no apparent problems (test tube #2, 5, 6, 7 and the 3 trailer cows which had had problems, but were in a different environment) all showed lower globulin levels than the average for the herd. Most of them are higher than the established Wolff lab norm but much lower than the 13 cows average. All problem cows showed very high globulin levels. This would indicate that the environment change in the trailer may be

a factor in reducing the level of immune stimulation showing up on the globulin level.

The University of Minnesota at Morris Dairy Experiment Station is a well managed dairy with only one problem: despite having good food and expert professional consultants available, the rolling herd average has never been much higher than 16,000# per cow. The reason for this remains a mystery to me, but may be related to the poor water quality. The water test revealed very hard water with a very high calcium, magnesium, iron and sulfate content. This however, should be possible to correct with water equipment. The water apparently has had no effect on the blood electrophoresis picture which fell mostly within normal limits. No patterns or consistency levels could be differentiated between healthy or unthrifty cows or between older and young cows. As far as I can detect, the UMM Dairy herd is in pretty good shape, managed well and has no major health problems.

This report is a crude set of data attempting to put some rhyme or reason to some very complex problems in three herds that have had stray voltage problems. I can only conclude that the data warrants additional study in this area because I feel that these herds are typical of very many herds throughout my practice area and throughout the state. It is clinical impression on my part that some of these herds which show similar health problems may indeed have electrical etiologies. I feel that this chronic immune stimulation may in turn lead to eventual immune deficiency in certain cows which would explain why these cows fail to respond to conventional treatment. In any sense the problem is frustrating to me as a veterinary practitioner and the incidence in my area seems to be on the rise and is at least in part responsible for the failure of many dairy herds to make a profit.

It is my desire that further money be appropriated to study more indepth this menace to the state's agriculture.

Respectfully submitted,

Daniel P. Hartsell, D.V.M.
December, 1988.

*** Specific lab analysis reports for individual cows ***
*** are available from Dataright, Inc. relevant to ***
*** Dr. Hartzell's analysis. ***

Borgerding:

Albumin:
Range: 2.3 - 3.1 g/dl
Average: 2.65 g/dl

Globulin:
Range: 2.7 - 5.2 g/dl
Average: 4.13 g/dl

Protein Electrophoresis Tracing:
The major globulin fraction is in the IgG & IgM fraction.

Johnson:

Albumin:
Range: 2.4 - 3.9 g/dl
Average: 3.42 g/dl

Globulin:
Range: 2.9 - 5.6 g/dl
Average: 3.67 g/dl

Protein Electrophoresis Tracing:
The major globulin fraction is in the IgG & IgM fraction.

UM Morris:

Albumin:
Range: 3.1 - 3.8 g/dl
Average: 3.38 g/dl

Globulin:
Range: 3.4 - 4.9 g/dl
Average: 4.0 g/dl

Protein Electrophoresis Tracing:
The major globulin fraction is in the IgG & IgM fraction.

Kenning:

Albumin:
Range: 1.8 - 3.3 g/dl
Average: 2.66 g/dl

Globulin:
Range: 3.6 - 8.0 g/dl
Average: 5.05 g/dl

Protein Electrophoresis Tracing:
The major globulin fraction is in the IgG & IgM fraction.

Serum Protein Interpretation:

Serum abnormalities can be affected by other factors than disease. The changes which can alter serum protein are:

1. Age. Older animals, especially the dairy cow, tend to have elevated globulins. This is probably due to mastitis, metritis etc. and is related to the number of lactations. Animals with three or more lactations generally exceed the "normal".

2. Hormonal. Unless administered not likely a factor.

3. Pregnancy & Lactation. Early in pregnancy generally albumin decreases and globulin increases. In the cow globulins increase markedly several months prior to calving and then drop rapidly approximately one month before calving, most likely entering the mammary gland when colostrum is formed.

4. Nutritional. Poor quality, inadequate amounts of feed or feeding methods can alter albumin. The globulin fraction is affected only in extreme cases and unlikely in any dairy herd. Nutrition is probably the most important factor in albumin levels in the dairy herd.

5. Stress. Temperature extremes and severe trauma etc. can result in lower albumin levels. Dehydration is the only known reason for an increased albumin.

Interpretation of the specific herds:

Borgerding:

The range and average of the albumins in this herd is low, hypoalbuminemia. with only one animal normal was this individual of a different age or at a different stage of lactation? The significance si a generalized nutrition problem or a cause for not eating properly - stray voltage?

Johnson:

The albumin range would indicate a problem, but involves only one animal which probably should be excluded. More significant is the high values, why the possible dehydration?

UM Morris:

This herd tends to fall within normal limits.

Kenning:

This farm indicates hypoalbuminemia. The globulins are elevated indicating a herd with chronic inflammation.

Summary:

Serum protein elevation rarely reveals a specific diagnosis. The abnormal does allow identification of types of disease and offers a direction for further investigation.

In the above herds the low albumins are certainly worthy of in-depth work-up for maximum production. The chronic inflammation revealed falls into the same catagory. None of the herds have any indication of immune suppression, however, it should be understood, it is not an evaluation of the entire immune system. In my opinion it is an accurate marker in most cases of immuno-deficiency.

PRO-HEALTH FEEDS, INC.

710 3rd Avenue West • Alexandria, MN 56308
762-8112 or 1-800-642-6263

RT BORGERDING
ID LACTATION

, 1988

	40# MILK 3.8 % FAT 1300 LBS.	50# MILK 3.8 % FAT 1300 LBS.	60# MILK 3.8 % FAT 1300 LBS.	70# MILK 3.8 % FAT 1300 LBS.	80# MILK 3.8 % FAT 1300 LBS.
NGREDIENTS					
05 HAYLAGE/CORN SIL	23.00	23.00	23.00	23.00	23.00
108 OATLAGE/CORN SIL	6.00	6.00	6.00	6.00	6.00
700 CORN	16.00	18.00	20.00	22.00	26.00
00 ALFALFA HAY	3.00	3.00	3.00	3.00	3.00
300 44% SOY	2.00	4.00	6.00	8.00	10.00
400 DICAL 18.5P	.24	.29	.30	.35	.40
506 TRACE MIN SALT	.05	.05	.05	.05	.05
520 MAGNESIUM OXIDE	.02	.02	.02	.02	.02
424 SODIUM BICARB	.10	.10	.10	.10	.10
526 ZINPRO	.01	.01	.01	.01	.01
601 MULTIVIT ADE PAK	.01	.01	.01	.01	.01
TOTAL LBS. FEED	50.43	54.48	58.49	62.54	68.59
ESTIMATED WT. CHANGE					
EXPECTED D.M. INTAKE	34.62	37.42	40.22	43.01	45.81
RATION D. M. (LBS.)	35.42	38.96	42.46	46.00	51.24
NET ENERGY LACT.	24.00	27.23	30.46	33.69	38.45
PROTEIN (LBS.)	4.55	5.57	6.58	7.60	8.74
CALCIUM (GRAMS)	138	146	150	159	167
PHOSPHORUS (GRAMS)	61	74	83	96	110
LBS. MILK POTENTIAL					
NET ENERGY LACT.	41	51	61	71	85
PROTEIN	40	52	64	75	89
CALCIUM	74	79	82	87	93
PHOSPHORUS	40	52	61	73	86
MILK PRICE ($/100LBS)					
VALUE MILK ($)					
COST FEED ($)	2.92	3.25	3.55	3.88	4.33
FEED COST/100LB MILK	7.30	6.37	5.82	5.46	5.09
RETURN OVER FEED ($)	-2.92	-3.25	-3.55	-3.88	-4.33
NUTRIENT ANALYSIS (%DM)					
1 DRY MATTER	70.24	71.51	72.59	73.55	74.70
2 PROTEIN, CRUDE	12.85	14.29	15.50	16.51	17.07
3 FAT	1.56	1.60	1.63	1.66	1.74
4 FIBER	21.33	19.85	18.63	17.58	16.20
5 CALCIUM	.86	.83	.78	.76	.72
6 CA TO P	2.24	1.97	1.80	1.65	1.51
7 PHOSPHORUS	.39	.42	.44	.46	.48
8 POTASSIUM	.91	.84	.79	.74	.68
9 MAGNESIUM	.16	.16	.16	.15	.15

*FIGURES ARE ESTIMATES AND ARE BASED ON THE BEST INFORMATION AVAILABLE. *
*PERFORMANCE OF ANIMALS WILL BE AFFECTED BY ENVIRONMENT, GENETICS, WEATHER *
*AND OTHER PARAMETERS. NO GUARANTEE OF ANIMAL PERFORMANCE CAN BE MADE. *
*ALEXANDRIA VETERINARY CLINIC NUTRITION SERVICE, ALEXANDRIA MN. 612-762 8112 *

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F.B. LEDERMANN, D.V.M. - D.P. HARTSELL, D.V.M.
ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

FEED ANALYSIS REPORT

CLIENT NAME: Art Bargending

DATE RECEIVED: 8-17-88

DATE ANALYSIS DONE: 8-23-88

TYPE OF SAMPLE: Shelled Corn

ASSIGNED #: 63088

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE % 14.85	NE-LACTATION MCAL/LB .90
DRY MATTER % 85.15	TDN %
CRUDE PROTEIN % 7.99	MAGNESIUM % .02
HDP PROTEIN %	CALCIUM % —
AVAILABLE PROTEIN %	PHOSPHOROUS % .21
A.D.FIBER % 3.16	POTASSIUM % .07
ENE MCAL/100 lb	

COMMENTS:

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ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-6112

FEED ANALYSIS REPORT

CLIENT NAME: Art Borgendorf

DATE RECEIVED: 8-17-88

DATE ANALYSIS DONE: 8-23-88

TYPE OF SAMPLE: Haylage / Corn Silage

ASSIGNED #: 58088

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE % 36.82	NE-LACTATION MCAL/LB .59
DRY MATTER % 63.18	TDN %
CRUDE PROTEIN % 14.89	MAGNESIUM % .25
HDP PROTEIN % 1.48	CALCIUM % 1.36
AVAILABLE PROTEIN % 13.41	PHOSPHOROUS % .23
A.D.FIBER % 37.13	POTASSIUM % 1.55
ENE MCAL/100 lb	

COMMENTS: Nitrate 1100ppm

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ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

FEED ANALYSIS REPORT

CLIENT NAME: Art Borgerding

DATE RECEIVED: 8-17-88

DATE ANALYSIS DONE: 8-23-88

TYPE OF SAMPLE: Cutlage/Corn Silage

ASSIGNED #: 57088

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE % 59.76	NE-LACTATION MCAL/LB .66
DRY MATTER % 40.24	TDN %
CRUDE PROTEIN % 11.00	MAGNESIUM % .17
HDP PROTEIN % .63	CALCIUM % .25
AVAILABLE PROTEIN % 10.37	PHOSPHOROUS % .30
A.D.FIBER % 32.47	POTASSIUM % 1.83
ENE MCAL/100 lb	

COMMENTS: Nitrates 300 ppm

Alexandria Veterinary Clinic-LAB

Water Submission Form and Report

Sampling Instructions

Water sample must be taken correctly to obtain reliable results:

1) Flame faucet opening with Benzene burner or wooden match to kill surface bacteria
2) Open faucet and let run into pail for 5 minutes
3) Open sample bottle, being careful not to touch the lip of the bottle or inside of the bottle cover, and fill to the top with water
4) Take sample just before bringing into lab or refrigerate immediately

---

Name Art Borgerding Address _____

Phone _____

Date sample submitted 8-17-88 Date Reported _____ By _____

LAB RESULTS

pH 6.5

Iron bacteria _____ mg/l

Coliforms screening Neg.

Total hardness 25 gr/gal _____ mg/l

presumptive _____ col/100 cc

Magnesium _____ mg/l

confirmed _____ col/100 cc

Nitrates 0 mg/l

Sulfates 53 mg/l

Copper 0 - mg/l

Iron 3.8 mg/l

Calcium 20 gr/gal

Allow 2 - 3 days of Lab time for results to be completed

Comments:

Technician TCP

PRO-HEALTH FEEDS, INC.

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762-8112 or 1-800-642-6263

HAROLD JOHNSON
MID LACTATION

NOV. 28, 1988

	40# MILK 3.8 % FAT 1300 LBS.	50# MILK 3.8 % FAT 1300 LBS.	60# MILK 3.8 % FAT 1300 LBS.	70# MILK 3.8 % FAT 1300 LBS.	80# MILK 3.8 % FAT 1300 LBS.
INGREDIENTS					
104 HAYLAGE	30.00	30.00	30.00	30.00	30.00
100 ALFALFA HAY	5.00	5.00	5.00	5.00	5.00
210 OATS	2.00	2.00	2.00	2.00	2.00
300 44% SOY	4.91	6.34	7.77	9.18	8.94
206 HM EAR CORN	8.00	10.00	12.00	14.00	18.00
400 DICAL 18.5P	.04	.08	.13	.17	.25
406 TRACE MIN SALT	.05	.05	.05	.05	.05
425 SELENIUM PX .02%	.01	.01	.01	.01	.01
426 ZINPRO	.02	.02	.02	.02	.02
424 SODIUM BICARB	.30	.30	.30	.30	.30
TOTAL LBS. FEED	50.33	53.80	57.28	60.73	64.57
ESTIMATED WT. CHANGE	-.18	-.64	-1.10	-1.57	-2.21
EXPECTED D.M. INTAKE	34.62	37.42	40.22	43.01	45.81
RATION D. M. (LBS.)	34.60	37.35	40.11	42.85	45.58
NET ENERGY LACT.	23.21	25.41	27.62	29.80	31.58
PROTEIN (LBS.)	6.58	7.35	8.13	8.89	9.07
CALCIUM (GRAMS)	153	159	167	173	181
PHOSPHORUS (GRAMS)	61	71	83	93	104
LBS. MILK POTENTIAL					
NET ENERGY LACT.	40	50	60	70	80
PROTEIN	64	73	82	91	93
CALCIUM	84	88	92	96	101
PHOSPHORUS	40	50	60	70	80
MILK PRICE ($/100LBS)					
VALUE MILK ($)					
COST FEED ($)	2.89	3.18	3.48	3.78	3.91
FEED COST/100LB MILK	7.23	6.36	5.80	5.40	4.89
RETURN OVER FEED ($)	-2.89	-3.18	-3.48	-3.78	-3.91
NUTRIENT ANALYSIS (%DM)					
1 DRY MATTER	68.75	69.43	70.03	70.56	70.59
2 PROTEIN, CRUDE	19.02	19.69	20.26	20.75	19.90
3 FAT	1.68	1.58	1.49	1.41	1.32
4 FIBER	24.22	22.70	21.39	20.26	19.01
5 CALCIUM	.98	.94	.92	.89	.88
6 CA TO P	2.50	2.22	2.01	1.85	1.74
7 PHOSPHORUS	.39	.42	.46	.48	.50
8 POTASSIUM	1.84	1.71	1.61	1.51	1.42
9 MAGNESIUM	.19	.19	.18	.18	.18
10 ADF FIBER	28.04	27.01	26.12	25.35	24.85

****
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ROUTE #7, BOX 12; ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

FEED ANALYSIS REPORT

CLIENT NAME: Harold Johnson

DATE RECEIVED: 8-17-88

DATE ANALYSIS DONE: 8-24-88

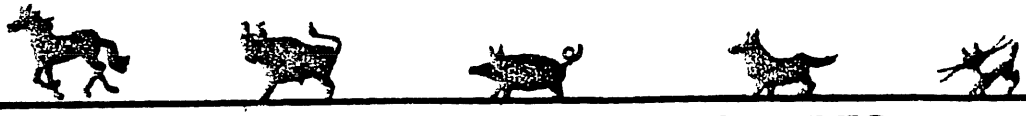
TYPE OF SAMPLE: High Moisture Ear Corn

ASSIGNED #: 60058

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE % 28.35	NE-LACTATION MCAL/LB .69
DRY MATTER % 71.65	TDN %
CRUDE PROTEIN % 10.04	MAGNESIUM % .12
HDP PROTEIN %	CALCIUM % -
AVAILABLE PROTEIN %	PHOSPHOROUS % .35
A.D.FIBER % 17.06	POTASSIUM % .04
ENE MCAL/100 lb	

COMMENTS:



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ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

FEED ANALYSIS REPORT

CLIENT NAME: Harold Johnson

DATE RECEIVED: 8-17-88

DATE ANALYSIS DONE: 8-23-88

TYPE OF SAMPLE: Haylage

ASSIGNED #: 59088

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE % 40.55	NE-LACTATION MCAL/LB .62
DRY MATTER % 59.45	TDN %
CRUDE PROTEIN % 17.77	MAGNESIUM % .25
HDP PROTEIN % 1.20	CALCIUM % 1.32
AVAILABLE PROTEIN % 16.57	PHOSPHORCUS % .30
A.D.FIBER % 35.54	POTASSIUM % 3.08
ENE MCAL/100 lb	

COMMENTS: Nitrate 500ppm

Alexandria Veterinary Clinic-LAB

Water Submission Form and Report

Sampling Instructions

Water sample must be taken correctly to obtain reliable results:

1) Flame faucet opening with Benzene burner or wooden match to kill surface bacteria
2) Open faucet and let run into pail for 5 minutes
3) Open sample bottle, being careful not to touch the lip of the bottle or inside of the bottle cover, and fill to the top with water
4) Take sample just before bringing into lab or refrigerate immediately

---

Name Harold Johnson Address _____

Phone _____

Date sample submitted 8-17-88 Date Reported _____ By _____

LAB RESULTS

pH 6.2

Iron bacteria Neg mg/l

Coliforms screening Neg

Total hardness 15 gr/gal mg/l

presumptive _____ col/100 cc

Magnesium 6 gr/gal mg/l

confirmed _____ col/100 cc

Nitrates _____ mg/l

Sulfates <50 mg/l

Copper Neg - mg/l

Iron 1.6 mg/l

Calcium 12 gr/gal

Allow 2 - 3 days of Lab time for results to be completed

Comments:

Technician KCP

Alexandria Veterinary Clinic-LAB

Water Submission Form and Report

Sampling Instructions

Water sample must be taken correctly to obtain reliable results:

1) Flame faucet opening with Benzene burner or wooden match to Kill surface bacteria
2) Open faucet and let run into pail for 5 minutes
3) Open sample bottle, being careful not to touch the lip of the bottle or inside of the bottle cover, and fill to the top with water
4) Take sample just before bringing into lab or refrigerate immediately

---

Name Hoff Morris Address _____

Phone _____

Date sample submitted 9-1-88 Date Reported _____ By _____

LAB RESULTS

pH 6.8

Iron bacteria _____ mg/l

Coliforms screening Neg

Total hardness 45gr/gal 675 mg/l

presumptive _____ col/100 cc

Magnesium 17gr/gal 255 mg/l

confirmed _____ col/100 cc

Nitrates 0 mg/l

Sulfates 380 mg/l

Copper 0 - mg/l

Iron 3.5 mg/l

Calcium 28gr/gal 420 mg/l

Allow 2 - 3 days of Lab time for results to be completed

Comments:

Technician YCP

PRO-HEALTH FEEDS, INC.

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762-8112 or 1-800-642-6263

JOE KENNING — NOV. 4, 1988
ID LACTATION

	50# MILK 3.8 % FAT 1350 LBS.	60# MILK 3.8 % FAT 1350 LBS.	70# MILK 3.8 % FAT 1350 LBS.	80# MILK 3.8 % FAT 1350 LBS.	90# MILK 3.8 % FAT 1350 LBS.
INGREDIENTS					
12 CORN SILAGE	62.66	58.70	56.01	58.93	50.05
00 ALFALFA HAY	11.00	11.34	11.00	11.00	11.00
201 HI MOIST CORN	15.00	15.00	16.82	18.00	18.00
700 44% SOY	2.97	5.05	7.71	10.00	15.61
55 CUST SIL MINERAL	.54	.69	.72	.80	.89
TOTAL LBS. FEED	92.17	90.78	92.26	98.73	95.55
STIMATED WT. CHANGE					
XPECTED D.M. INTAKE	38.32	41.12	43.92	46.71	49.51
RATION D. M. (LBS.)	39.87	41.12	43.93	47.71	50.51
ET ENERGY LACT.	29.56	30.85	33.74	37.01	40.28
ROTEIN (LBS.)	5.46	6.31	7.49	8.66	10.89
CALCIUM (GRAMS)	111	129	135	148	163
PHOSPHORUS (GRAMS)	72	83	94	106	125
LBS. MILK POTENTIAL					
NET ENERGY LACT.	57	61	70	80	90
PROTEIN	50	60	74	88	114
CALCIUM	56	68	72	80	90
PHOSPHORUS	50	60	70	81	99
ILK PRICE ($/100LBS)					
ALUE MILK ($)					
COST FEED ($)	3.32	3.66	4.09	4.57	5.28
EED COST/100LB MILK	6.64	6.10	5.84	5.71	5.87
ETURN OVER FEED ($)	-3.32	-3.66	-4.09	-4.57	-5.28
NUTRIENT ANALYSIS (%DM)					
1 DRY MATTER	43.25	45.29	47.62	48.32	52.86
2 PROTEIN, CRUDE	13.69	15.35	17.05	18.15	21.36
3 FAT	2.57	2.48	2.43	2.37	2.20
4 FIBER	20.53	19.80	18.36	17.72	16.24
5 CALCIUM	.62	.70	.68	.68	.71
6 CA TO P	1.53	1.56	1.43	1.39	1.30
7 PHOSPHORUS	.40	.45	.47	.49	.55
8 POTASSIUM	1.45	1.40	1.30	1.24	1.13
9 MAGNESIUM	.19	.19	.19	.19	.19
10 ADF FIBER	21.52	20.82	19.49	18.97	17.62
1 NDF FIBER	27.63	26.86	25.19	24.53	22.99
3 NET ENERGY,LACT	74.15	75.03	76.81	77.57	79.75
16 TDN	73.67	74.42	76.09	76.81	78.76
7 ROUGHAGE DM	.17	.18	.18	.18	.19
0 VITAMIN A (IU/LB)	2031.75	2517.18	2458.44	2515.41	2643.29

****
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ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

FEED ANALYSIS REPORT

CLIENT NAME: Joe Kenning

DATE RECEIVED: 9-20-88

DATE ANALYSIS DONE: 9-27-88

TYPE OF SAMPLE: Corn Silage

ASSIGNED #: 71098

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE %	74.07	NE-LACTATION MCAL/LB	.65
DRY MATTER %	25.93	TDN %	66.09
CRUDE PROTEIN %	10.28	MAGNESIUM %	.33
HDP PROTEIN %	.34	CALCIUM %	.34
AVAILABLE PROTEIN %	9.94	PHOSPHOROUS %	.23
A.D.FIBER %	31.18	POTASSIUM %	1.61
ENE MCAL/100 lb	53.97		

COMMENTS: Nitrate <100ppm

ALEXANDRIA VETERINARY CLINIC

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ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

FEED ANALYSIS REPORT

CLIENT NAME: Joe Kenning

DATE RECEIVED: 9-20-88

DATE ANALYSIS DONE: 9-27-88

TYPE OF SAMPLE: Alfalfa Hay

ASSIGNED #: 72098

ALL RESULTS REPORTED ON A DRY MATTER BASIS

MOISTURE % 12.57	NE-LACTATION MCAL/LB .66
DRY MATTER % 82.43	TDN % 64.17
CRUDE PROTEIN % 16.47	MAGNESIUM % .24
HDP PROTEIN % _____	CALCIUM % .83
AVAILABLE PROTEIN % _____	PHOSPHOROUS % .31
A.D.FIBER % 32.31	POTASSIUM % 2.94
ENE MCAL/100 lb 54.52	

COMMENTS: _____

Alexandria Veterinary Clinic-LAB

Water Submission Form and Report

Sampling Instructions

Water sample must be taken correctly to obtain reliable results:

1) Flame faucet opening with Benzene burner or wooden match to kill surface bacteria
2) Open faucet and let run into pail for 5 minutes
3) Open sample bottle, being careful not to touch the lip of the bottle or inside of the bottle cover, and fill to the top with water
4) Take sample just before bringing into lab or refrigerate immediately

---

Name Joe Kenning Address _____

Phone _____ Stray Voltage Research

Date sample submitted 9-20-88 Date Reported _____ By _____

LAB RESULTS

pH 6.1

Iron bacteria _____ mg/l

Coliforms screening Negative

Total hardness 14gr/gal 210 mg/l

presumptive _____ col/100 cc

Magnesium 5gr/gal 75 mg/l

confirmed _____ col/100 cc

Nitrates 0 mg/l

Sulfates <50 mg/l

Copper 0 - mg/l

Iron 5 mg/l

Calcium 9 gr/gal 135mg/l

Allow 2 - 3 days of Lab time for results to be completed

Comments:

Technician TCP

ALEXANDRIA VETERINARY CLINIC

PROFESSIONAL ASSOCIATION

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ROUTE #7, BOX 12, ALEXANDRIA, MINNESOTA 56308 DIAL 612-762-8112

WATER TEST INTERPRETATIONS

pH - Normal is 6.8-7.5 - pH levels of less than 6.8 enhance normal digestion and improves chlorination. However, if too acidic, palatability is reduced and increased corrosion of pipes and equipment could occur.

Iron Bacteria - Presence gives cold water a rotten-egg odor. Chlorination will solve the problem.

Total Hardness - 0-60mg/l is sott 61-180mg/l is hard and over 180 is very hard. Refers to mineral content of calcium and magnesium salts. Softness will remove these salts.

Calcium and Magnesium - is part of hardness test. If most of hardness is due to magnesium or calcium, it may affect the nutritional balance of dry feeds.

Nitrates - Over 10mg/l is considered unsafe for young animals and humans. Over 100mg/l is unsafe for older animals and humans. Indicates sanitation problem in water system usually coming from sewer or manure storage seeping into well water. May mean digging a new well to correct.

Sulfates - Over 250mg/l may begin to cause mild diarrheas in young animals or humans unaccustomed to the water. Higher levels (1000-2000) can cause laxative effect in older animals as well. Sulfate combines with sodium and magnesium to form laxative salt. Can be corrected with water equipment.

Iron - U.S. Public Health recommends an upper level of .3mg/l. Not toxic above this but accounts for Iron taste, staining of clothes in washing and increased iron bacteria in water lines and drinking cups. Can be filtered (also some removed by softeners).

Coliforms - Levels in excess of 2.2 per 100cc are contaminated by sewage, surface water, etc. and corrective measures should be taken. Continuous chlorination may be the solution. Positive coliform water should be re-tested at a later date. Improper sampling technique can cause false positives.

Copper - .5mg/l is the upper limit recommended by National Academy of Science. Sheep are most sensitive to high levels of copper.

Sources:
Water Analysis Handbook DR/3 and DREl/5.
Water Quality for Animals, J. B. Herrick, Iowa State University, Ames Iowa 50011.

6. SOILS

Soil characteristics and fertility levels may affect dairy herd performance as an aspect of management practice related to feedstock quality and quantity. Efforts were made to define this aspect of operation of the study farms in an effort to improve the completeness of the overall project research and an additional data set for between farm contrasts.

Soils on study farms were sampled October 11-22, 1988 by Virgil Jons of Agassiz Crop Consultants, Moorhead, Minnesota. Soils were sampled late in the season to accommodate cropping practices and allow access with a four wheel drive vehicle equiped with a soil probe. Sampling procedures were in accord with recommendations of the soils analysis laboratory at North Dakota State University, Fargo, North Dakota and all analytical work was completed at that facility.

Sample representation on a per field basis is substantially the result of the experience of the consultant and his ability to make soils fertility recommendations which prove economically successful to farmers. Approximately, 20 bulk samples representing 0-6 inch and 6-24 inch depths were collected from each field. (See photos G-10, G-11)

Bulk samples were mixed in field, dried within 24 hours of collection and submitted for analysis. Soil sampling and analysis procedures were as described in Research Report No. 8, Department of Soil Science, North Dakota State University and Recommended Chemical Soil Test Proceedures, North Central Regional Publication No. 221 (Revised).

The consultant has reviewed all soil fertility recommendations and agrees with recommendations made by the analytical laboratory for each field and crop sequence specified.

On all farms, an effort was made to represent fields where the crop production principally represented the feed intakes for the dairy herd. In this regard, it should be noted that soil fertility is generally high on all farms where dairy profitability problems exist.

For several fields and several farms, fertility levels were sufficient to support the yield goals for the next years crop. In all cases where high fertility levels were encountered, it was found this resulted from a continuing attention to the management of soil fertility rather than specific and recent fertility supplements.

Specific results and recommendations follow on a per farm and per field basis.

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To
Art Borgerding
Dataright Inc
RR 4 Box 241
Pilaca, MN 56353

Copy to:
Virgil L Jons
3007 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 13732
Date Received: 10-13-88
Date Reported: 10-28-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'	Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
88-3	M	6	9	16			22	170							10		

INTERPRETATION OF SOIL TESTS

Very Low (Response) | Low (Likely Response) | Medium (Possible Response) | High (No Response)

SOIL TEXTURE — Your soil has a MEDIUM texture.
pH — The soil in this field is NEUTRAL
NITROGEN — Alfalfa are legume and supply their own nitrogen.
PHOSPHORUS — PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP
POTASSIUM — KKKKKKKKKKKKKKKKKKKKKKKKKKKKK

RECOMMENDATIONS

For a 6 ton/acre yield goal of Alfalfa, apply:

0 lbs of N per acre.
45 lbs of P2O5 per acre.
120 lbs of K2O per acre.

MANURE: CATTLE AND HOG MANURE VARY IN COMPOSITION BUT ON THE AVERAGE THE ABOVE RECOMMENDATION CAN BE REDUCED BY 12 LB OF N, 5 LB OF P2O5 AND 10 LB OF K2O FOR EACH TON OF MANURE APPLIED PER ACRE. POULTRY AND SHEEP MANURE CONTAIN ABOUT TWICE AS MANY NUTRIENTS AS CATTLE AND HOG MANURE.

LEGUMES WHICH HAVE BEEN WELL INOCULATED AND ARE WELL NODULATED ARE NOT LIKELY TO RESPOND TO APPLIED NITROGEN FERTILIZER. RESPONSE SOMETIMES OCCURS TO NITROGEN UNDER HIGH YIELD SITUATIONS.

SOIL TESTING METHODS

pH in water; NO_3-N (lb/acre) by electrode; OM (%) by Walkley-Black; P (lb/acre) by 1N ammonium acetate; soluble salts (mmhos/cm) in 1:1 soil: water; Zn, Fe, Cu & Mn (ppm) by DTPA; SO_4-S (lb/acre) by monobasic calcium phosphate.

CUSTOMER'S COPY

For additional information contact your County Extension Agent:

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Art Borgerding
Datamight Inc
P O Box 341
Milaca, MN 56353

Copy to:
Virgil L Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 10774
Date Received: 10-13-98
Date Reported: 12-29-98

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'	Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Other
AB-4	M	6.3	14	71			37	205							14		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE		Your soil has a MEDIUM texture.		
pH		The soil in this field is SLIGHTLY ACID		
NITROGEN		Alfalfa are legume and supply their own nitrogen.		
PHOSPHORUS		PPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPPP		
POTASSIUM		KKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKKK		

RECOMMENDATIONS

For a 5 ton/acre yield goal of Alfalfa, apply:

0 lbs of N per acre,
30 lbs of P2O5 per acre,
90 lbs of K2O per acre.

MANURE: CATTLE AND HOG MANURE VARY IN COMPOSITION BUT ON THE AVERAGE THE ABOVE RECOMMENDATION CAN BE REDUCED BY 10 LB OF N, 5 LB OF P2O5 AND 10 LB OF K2O FOR EACH TON OF MANURE APPLIED PER ACRE. POULTRY AND SHEEP MANURE CONTAIN ABOUT TWICE AS MANY NUTRIENTS AS CATTLE AND HOG MANURE.

LEGUMES WHICH HAVE BEEN WELL INOCULATED AND ARE WELL NODULATED ARE NOT LIKELY TO RESPOND TO APPLIED NITROGEN FERTILIZER. RESPONSE SOMETIMES OCCURS TO NITROGEN UNDER HIGH YIELD SITUATIONS.

SOIL TESTING METHODS

pH in water; NO_3-N (lb/acre) by electrode; OM (%) by Walkley-Black; P (lb/acre) by 1N ammonium acetate; soluble salts (mmhos/cm) in 1:1 soil: water; Zn, Fe, Cu & Mn (ppm) by DTPA; SO_4-S (lb/acre) by monobasic calcium phosphate.

For additional information contact your County Extension Agent:

CUSTOMER'S COPY

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Pat Borgerding
Osbaright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil L Jens
2037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 13776
Date Received: 10-13-88
Date Reported: 10-20-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
88-9	M	6.2	75	180				21	180			1.7				14		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is SLIGHTLY ACID			
NITROGEN	NNNN

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To: Mr. Bergendine
Dataright Inc
PO Box 241
Milaca, MN 56353

Copy to: Virgil L Jons
3037 16th Ave E
Moorhead, MN 56560

County: Mi[illegible]sota
Lab No.: 13778
Date Received: 10-17-88
Date Reported: 10-19-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	[illegible]
12-1	M	6.5	7	16				14	165							3		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is SLIGHTLY ACID			
NITROGEN	Alfalfa are legume and supply their own nitrogen.			
PHOSPHORUS	PPPPPPPPPPPPPPPPPPPPP			
POTASSIUM	KKKKKKKKKKKKKKKKKKKKKKKKK			

RECOMMENDATIONS

For a 6 ton/acre yield goal of Alfalfa, apply:

0 lbs of N per acre,
75 lbs of P_2O_5 per acre,
120 lbs of K_2O per acre.

MANURE: CATTLE AND HOG MANURE VARY IN COMPOSITION BUT ON THE AVERAGE THE ABOVE RECOMMENDATION CAN BE REDUCED BY 10 LB OF N, 5 LB OF P_2O_5 AND 10 LB OF K_2O FOR EACH TON OF MANURE APPLIED PER ACRE. POULTRY AND SHEEP MANURE CONTAIN ABOUT TWICE AS MANY NUTRIENTS AS CATTLE AND HOG MANURE.

LEGUMES WHICH HAVE BEEN WELL INOCULATED AND ARE WELL NODULATED ARE NOT LIKELY TO RESPOND TO APPLIED NITROGEN FERTILIZER. RESPONSE SOMETIMES OCCURS TO NITROGEN UNDER HIGH YIELD SITUATIONS.

SOIL TESTING METHODS

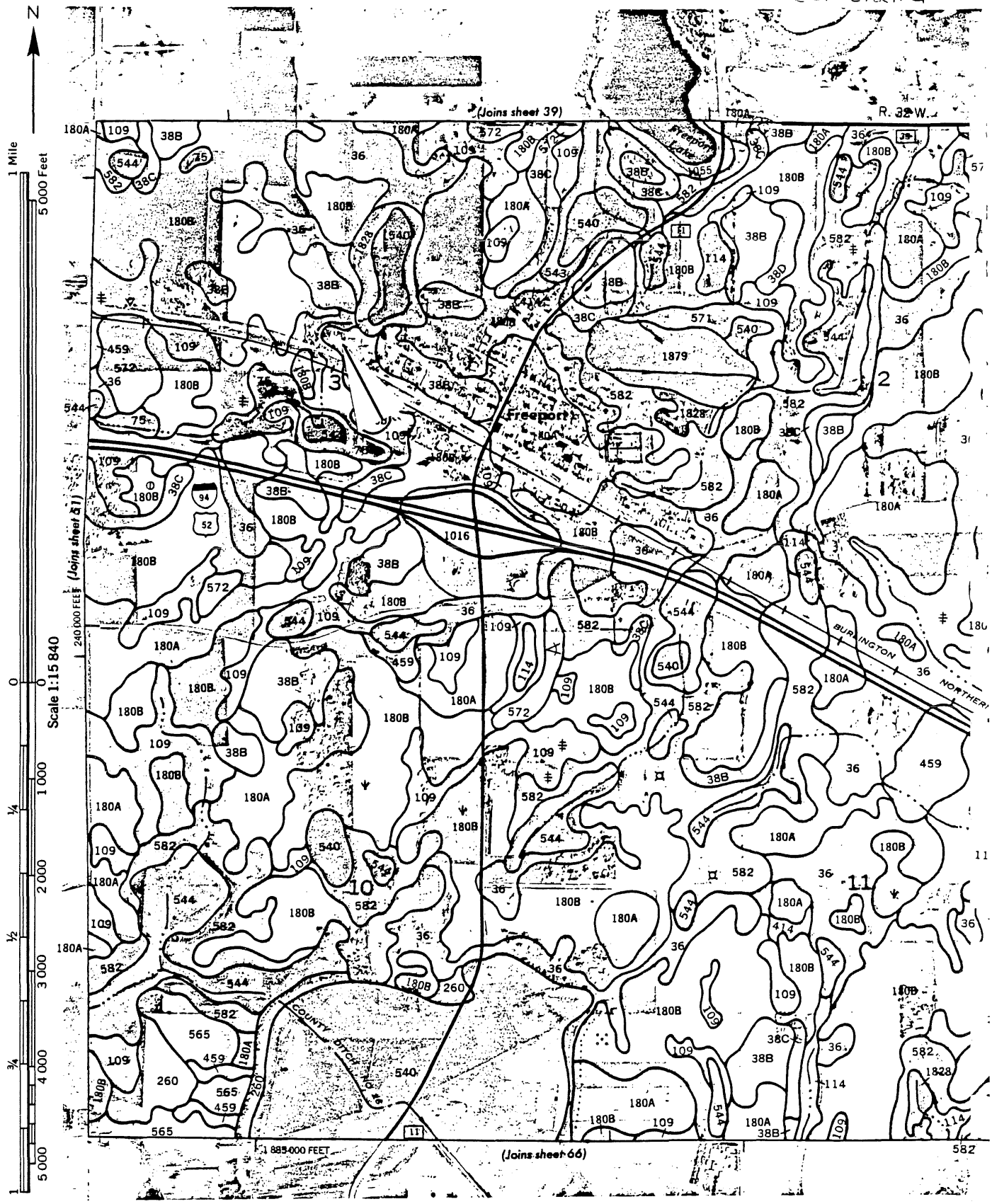
pH in water; NO_3-N (lb/acre) by electrode; OM (%) by Walkley-Black; P (lb/acre) by 1N ammonium acetate; soluble salts (mmhos/cm) in 1:1 soil: water; Zn, Fe, Cu & Mn (ppm) by DTPA; SO_4-S (lb/acre) by monobasic calcium phosphate.

For additional information contact your County Extension Agent:

CUSTOMER'S COPY

STEARNS COUNTY,

Forthcoming



This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEARNS COUNTY, MINNESOTA NO.

SOIL LEGEND

Map symbols consist of numbers or a combination of numbers and a letter. The initial number represents the kind of soil. A capital letter following these numbers indicates the class of slope. Symbols without a slope letter are for nearly level soils, soils named for higher categories of "Soil Taxonomy," or miscellaneous areas.

SYMBOL	NAME
5A	Dakota loam, 0 to 2 percent slopes
5B	Dakota loam, 2 to 6 percent slopes
7A	Hubbard loamy sand, 0 to 2 percent slopes
7B	Hubbard loamy sand, 2 to 6 percent slopes
7C	Hubbard loamy sand, 6 to 12 percent slopes
25	Becker fine sandy loam
32B	Nebish sandy loam, 2 to 8 percent slopes
32C	Nebish sandy loam, 8 to 15 percent slopes
32E	Nebish sandy loam, 15 to 25 percent slopes
32F	Nebish sandy loam, 25 to 40 percent slopes
35	Blue Earth mucky silt loam
36	Flom loam
38B	Waukon loam, 2 to 6 percent slopes
38C	Waukon loam, 6 to 12 percent slopes
38D	Waukon loam, 12 to 18 percent slopes
41A	Estherville sandy loam, 0 to 2 percent slopes
41B	Estherville sandy loam, 2 to 6 percent slopes
41C	Estherville sandy loam, 6 to 12 percent slopes
69B	Fedji loamy sand, 2 to 6 percent slopes
72	Shooker loam
75	Bluffton loam
109	Cordova loam
114	Glencoe loam
119B	Pomroy fine sand, 1 to 8 percent slopes
125	Beltrami loam
129	Cylinder loam
133B	Dalbo loam, 2 to 8 percent slopes
142	Nokay fine sandy loam
144B	Flak sandy loam, 4 to 8 percent slopes
144C	Flak sandy loam, 8 to 15 percent slopes
144E	Flak sandy loam, 15 to 25 percent slopes
155B	Chetek sandy loam, 1 to 6 percent slopes
156A	Fairhaven loam, 0 to 2 percent slopes
156B	Fairhaven loam, 2 to 6 percent slopes
159B	Anoka loamy sand, 2 to 8 percent slopes
163B	Brainerd fine sandy loam, 1 to 4 percent slopes
179B	Langola loamy sand, 1 to 4 percent slopes
180A	Gonvick loam, 1 to 2 percent slopes
180B	Gonvick loam, 2 to 4 percent slopes
181	Litchfield loamy sand
183	Dassel sandy loam
200B	Holdingford sandy loam, 4 to 8 percent slopes
200C	Holdingford sandy loam, 8 to 15 percent slopes
204B	Cushing sandy loam, 2 to 8 percent slopes
204C	Cushing sandy loam, 8 to 15 percent slopes
204E	Cushing sandy loam, 15 to 25 percent slopes
207B	Nymore loamy sand, 2 to 8 percent slopes
207C	Nymore loamy sand, 8 to 15 percent slopes
207E	Nymore loamy sand, 15 to 25 percent slopes
218	Watab loamy fine sand
233B	Growton sandy loam, 1 to 4 percent slopes
236	Vallers loam
255	Mayer loam
260	Dueim loamy sand
261	Isan loamy sand
281	Darfur coarse sandy loam
292B	Alstad sandy loam, 1 to 4 percent slopes
318	Mayer loam, depressional
325	Prebish sandy loam, depressional
327A	Dickman sandy loam, 0 to 2 percent slopes
327B	Dickman sandy loam, 2 to 6 percent slopes
392	Biscay loam
399	Biscay loam, depressional
406B	Dorset sandy loam, 2 to 8 percent slopes
406C	Dorset sandy loam, 8 to 15 percent slopes
406E	Dorset sandy loam, 15 to 25 percent slopes

SYMBOL	NAME
413	Osakis loam
414	Hamel loam
421B	Ves loam, 2 to 6 percent slopes
421C	Ves loam, 6 to 12 percent slopes
446A	Normania loam, 1 to 3 percent slopes
446B	Normania loam, 3 to 5 percent slopes
453B	DeMontreville loamy sand, 2 to 8 percent slopes
453C	DeMontreville loamy sand, 8 to 15 percent slopes
454B	Mahtomedi loamy coarse sand, 2 to 8 percent slopes
454C	Mahtomedi loamy coarse sand, 8 to 15 percent slopes
454E	Mahtomedi loamy coarse sand, 15 to 25 percent slopes
454F	Mahtomedi loamy coarse sand, 25 to 40 percent slopes
459	Corunna loam
461B	Koronis loam, 2 to 6 percent slopes
461C	Koronis loam, 6 to 12 percent slopes
465	Kalmarville sandy loam, frequently flooded
511	Marcellon loam
525	Muskego muck
540	Seelyeville muck
541	Rifle mucky peat
543	Markey muck
544	Cathro muck
565	Eckvoll loamy sand
566	Regal loam
571	Coriff loam
572	Lowlein sandy loam
582	Roliss loam
591B	Doland silt loam, 1 to 6 percent slopes
597	Tara silt loam
611C	Hawick loamy sand, 6 to 12 percent slopes
611D	Hawick loamy sand, 12 to 40 percent slopes
639A	Ridgeport sandy loam, 0 to 2 percent slopes
639B	Ridgeport sandy loam, 2 to 6 percent slopes
804D	Koronis-Estherville complex, 12 to 25 percent slopes
807D	Koronis-Sunburg complex, 12 to 25 percent slopes
848	Urban land-Osakis complex
850	Urban land-Dassel complex
865B	Urban land-Hubbard complex, 1 to 8 percent slopes
873	Prebish-Nokay complex
875B	Estherville-Hawick complex, 2 to 6 percent slopes
954C	Ves-Storden loams, 6 to 12 percent slopes
954D	Ves-Storden loams, 12 to 18 percent slopes
999B	Ves-Estherville complex, 2 to 6 percent slopes
999C	Ves-Estherville complex, 6 to 12 percent slopes
999D	Ves-Estherville complex, 12 to 25 percent slopes
1013	Pits, quarry
1015	Psamments, sloping
1016	Udorthents, loamy
1018	Udifluvents, frequently flooded
1029	Pits, gravel
1055	Histosols and Haplaquolls, ponded
1064	Rock outcrop-Lithic Eutrocrepts complex
1805	Blue Earth Variant, mucky silt loam
1825C	Seelyeville muck, sloping
1828	Glencoe muck
1842F	Cushing and Flak sandy loams, steep
1843C	Cushing-DeMontreville complex, 8 to 15 percent slopes
1843E	Cushing-DeMontreville complex, 15 to 25 percent slopes
1879	Seelyeville muck, calcareous
1880	Martisco mucky silt loam
1892	Prebish fine sandy loam
1902B	Jewett silt loam, 2 to 8 percent slopes

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Harold Johnson
Detaright Inc
RT 1 Box 241
Ulaca, MN 56352

Copy to:
Virgil Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 12742
Date Received: 10-12-93
Date Reported: 10-22-93

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
[illegible]	M	6.1	130	620				136	850			3.0				22		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE			Your soil has a MEDIUM texture.	
pH			The soil in this field is SLIGHTLY ACID	
NITROGEN		NNNN

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To

Harold Johnson
Datamight Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:

Virgil Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 18744
Date Received: 10-12-88
Date Reported: 10-28-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-3'
HI-3	M	5.6	115	337				132	600			1.1				54		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is MODERATELY ACID			
NITROGEN	NNNN

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Harold Johnson
Dakaright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 13746
Date Received: 10-13-88
Date Reported: 10-29-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
4039	M	6.0	15	86				136	520							36		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is MODERATELY ACID			
NITROGEN	Alfalfa are legume and supply their own nitrogen.			
PHOSPHORUS	PPPP

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Harold Johnson
Dayright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 12748
Date Received: 10-13-88
Date Reported: 10-20-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-6'
4338	M	6.2	10	16				100	400							21		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is SLIGHTLY ACID			
NITROGEN	Alfalfa are legume and supply their own nitrogen.			
PHOSPHORUS	PPPP

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Harold Johnson
Dataright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil Jons
3037 16th Ave S
Moorhead, MN 56560

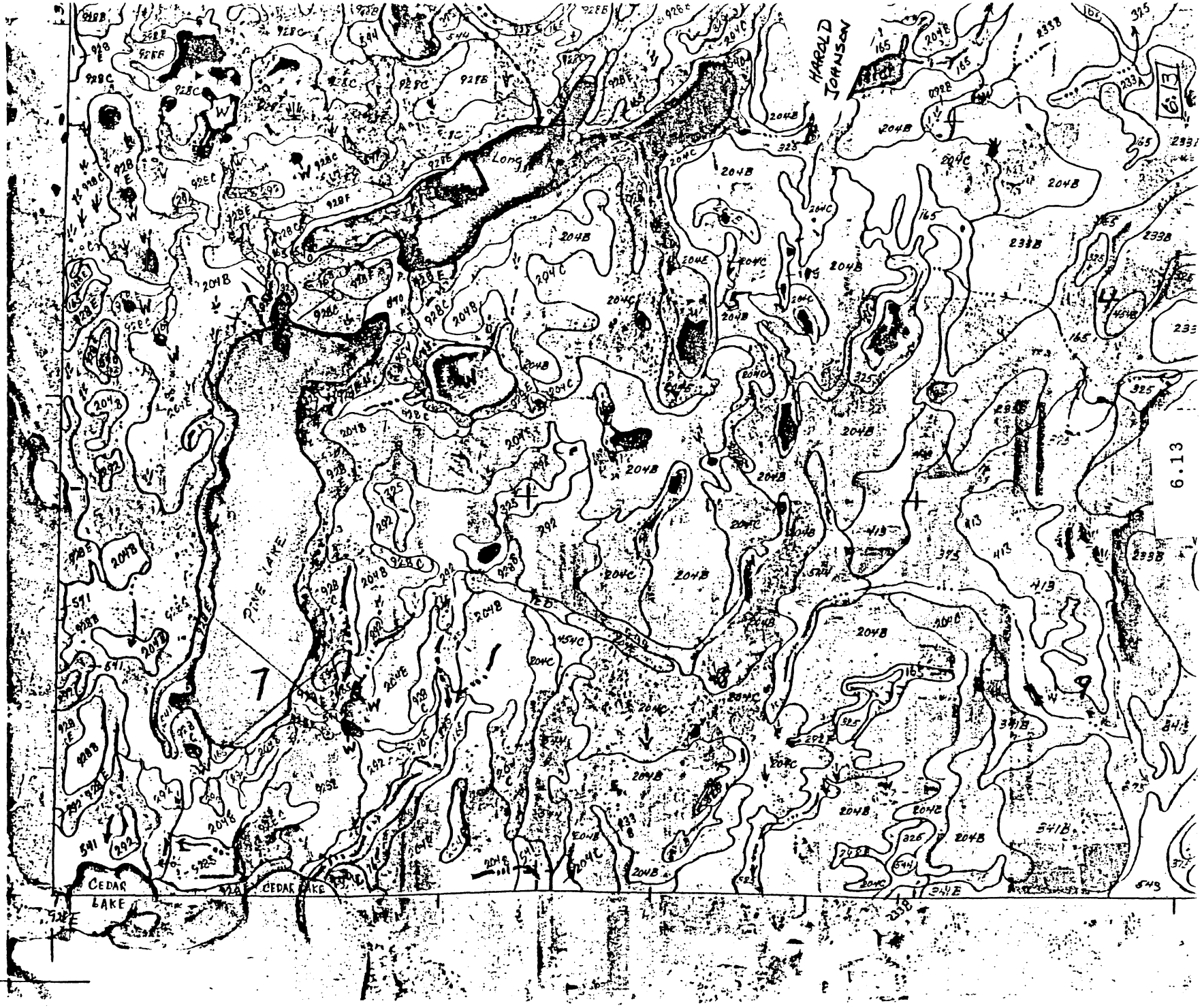
County: Minnesota
Lab No.: 13750
Date Received: 10-13-88
Date Reported: 10-28-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chlor- ride 0-2'
H.I-4	M	6.9	10	16				136	380							19		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is NEUTRAL			
NITROGEN	Alfalfa are legume and supply their own nitrogen.			
PHOSPHORUS	PPPP


HAROLD JOHNSON
PINE LAKE
CEDAR LAKE
CEDAR LAKE
6.13

ESOTA

FINAL CORRELATED LEGEND - MORRISON COUNTY

Publication symbol	Approved map unit name
7A	Hubbard loamy sand, 0 to 2 percent slopes
7B	Hubbard loamy sand, 2 to 6 percent slopes
12C	Emmert gravelly loamy sand, 6 to 12 percent slopes
12D	Emmert gravelly loamy sand, 12 to 40 percent slopes
25	Becker fine sandy loam
119B	Formoy loamy fine sand, 1 to 6 percent slopes
119C	Formoy loamy fine sand, 6 to 12 percent slopes
142	Lokay loam
144B	Flak sandy loam, 4 to 8 percent slopes
144C	Flak sandy loam, 8 to 15 percent slopes
144E	Flak sandy loam, 15 to 25 percent slopes
152B	Milaca fine sandy loam, 4 to 8 percent slopes
152C	Milaca fine sandy loam, 8 to 15 percent slopes.
155B	Chetek sandy loam, 2 to 8 percent slopes
155C	Chetek sandy loam, 8 to 15 percent slopes
158B	Zimmerman loamy fine sand, 1 to 4 percent slopes
161	Isanti fine sandy loam
163B	Brainerd sandy loam, 1 to 4 percent slopes
164B	Mora fine sandy loam, 1 to 4 percent slopes
165	Parent loam
166	Nonneby loam
182A	Oesterle sandy loam, 0 to 1 percent slopes
182B	Oesterle sandy loam, 1 to 3 percent slopes
200B	Holdingford sandy loam, 4 to 8 percent slopes
200C	Holdingford sandy loam, 8 to 15 percent slopes
202	Keehan loamy sand
204B	Cushing fine sandy loam, 4 to 8 percent slopes
204C	Cushing fine sandy loam, 8 to 15 percent slopes
204E	Cushing fine sandy loam, 15 to 25 percent slopes
217	Mahnomen mucky loamy fine sand
218	Watab loamy fine sand
233A	Grouton sandy loam, 0 to 2 percent slopes
233B	Grouton sandy loam, 2 to 4 percent slopes
260	Duelm loamy sand
261	Loam sandy loam
264B	Freeon silt loam, 1 to 4 percent slopes
265	Soderville loamy fine sand
266	Freer silt loam
292	Alstad loam
302B	Mosholt silt loam, 1 to 4 percent slopes
325	Prebish loam
328B	Sartell loamy fine sand, 1 to 6 percent slopes
328C	Sartell loamy fine sand, 6 to 12 percent slopes
337	Warman loam
341A	Arville sandy loam, 0 to 2 percent slopes
341B	Arville sandy loam, 2 to 6 percent slopes
375	Forada loam
413	Osakis loam
454B	Mahtomedi loamy sand, 2 to 8 percent slopes
454C	Mahtomedi loamy sand, 8 to 15 percent slopes
454E	Mahtomedi loamy sand, 15 to 25 percent slopes
454F	Mahtomedi loamy sand, 25 to 45 percent slopes
458A	Menahga loamy sand, 0 to 2 percent slopes
458B	Menahga loamy sand, 2 to 8 percent slopes
458C	Menahga loamy sand, 8 to 15 percent slopes
458E	Menahga loamy sand, 15 to 25 percent slopes
458F	Menahga loamy sand, 25 to 45 percent slopes
540	Seelyeville muck
541	Rifle muck
543	Markey muck
544	Cathro muck
549	Greenwood peat
623A	Pierz sandy loam, 0 to 2 percent slopes
623B	Pierz sandy loam, 2 to 6 percent slopes
835	Brainerd-Rock outcrop complex
928B	Cushing-Mahtomedi-Demontreville complex, 2 to 8 percent slopes
928C	Cushing-Mahtomedi-Demontreville complex, 8 to 15 percent slopes
928E	Cushing-Mahtomedi-Demontreville complex, 15 to 25 percent slopes
928F	Cushing-Mahtomedi-Demontreville complex, 25 to 45 percent slopes
1015	Peasants, nearly level
1016	Udorthents, loamy
1030	Pits, gravel-Udorthents complex
1934	Bowstring muck
1946	Perdue-Winterfield complex
1973	Keehan-Isan complex
1976B	Brainerd sandy loam, 1 to 4 percent slopes, stony
1977E	Mora fine sandy loam, 1 to 4 percent slopes, stony
1978	Lokay loam, stony
1979	Parent loam, stony
1980	Nonneby loam, stony
1998	Warman Variant silty clay loam

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To
U of M/Morris
Datarighť Inc
RR 4 Box 341
Milaca, MN 56353

Copy to:
Virgil L. Jons
2037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 17988
Date Received: 10-24-88
Date Reported: 12-23-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
M-1	M	7.6	29	101				35	130			1.2						

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is SLIGHTLY BASIC			
NITROGEN	NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN			
PHOSPHORUS	PPPP

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
U of M/Morris
Cataright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil L Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 17930
Date Received: 10-24-88
Date Reported: 10-28-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
M-2	M	7.4	7	22				29	415			1.9						

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a MEDIUM texture.			
pH	The soil in this field is SLIGHTLY BASIC			
NITROGEN	Alfalfa are legume and supply their own nitrogen.			
PHOSPHORUS	PPPP

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
U of M/Morris
Dataright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil L Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 17938
Date Received: 10-24-88
Date Reported: 10-26-88

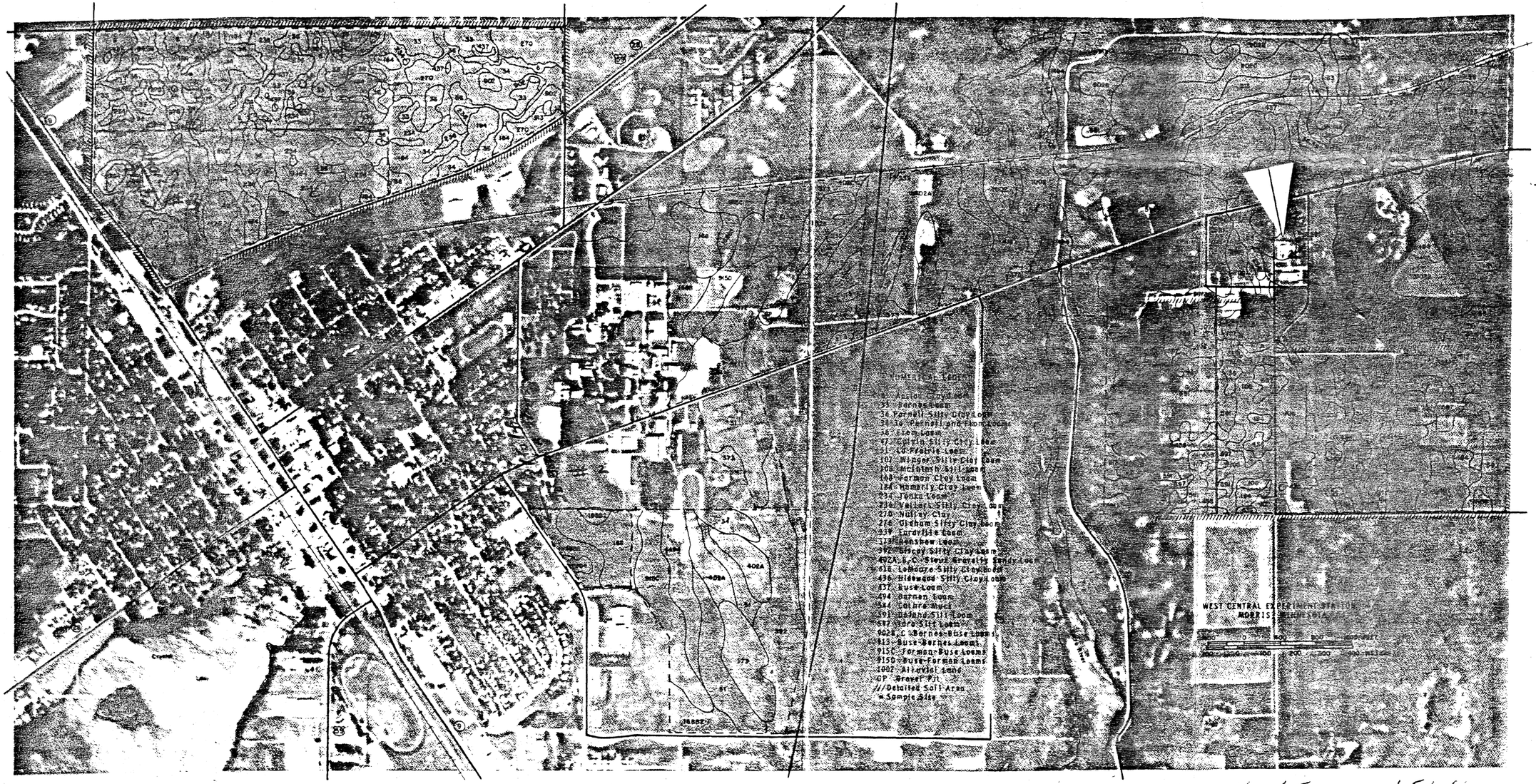
SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
M-3	F	7.8	42	234				14	385			0.7						

INTERPRETATION OF SOIL TESTS

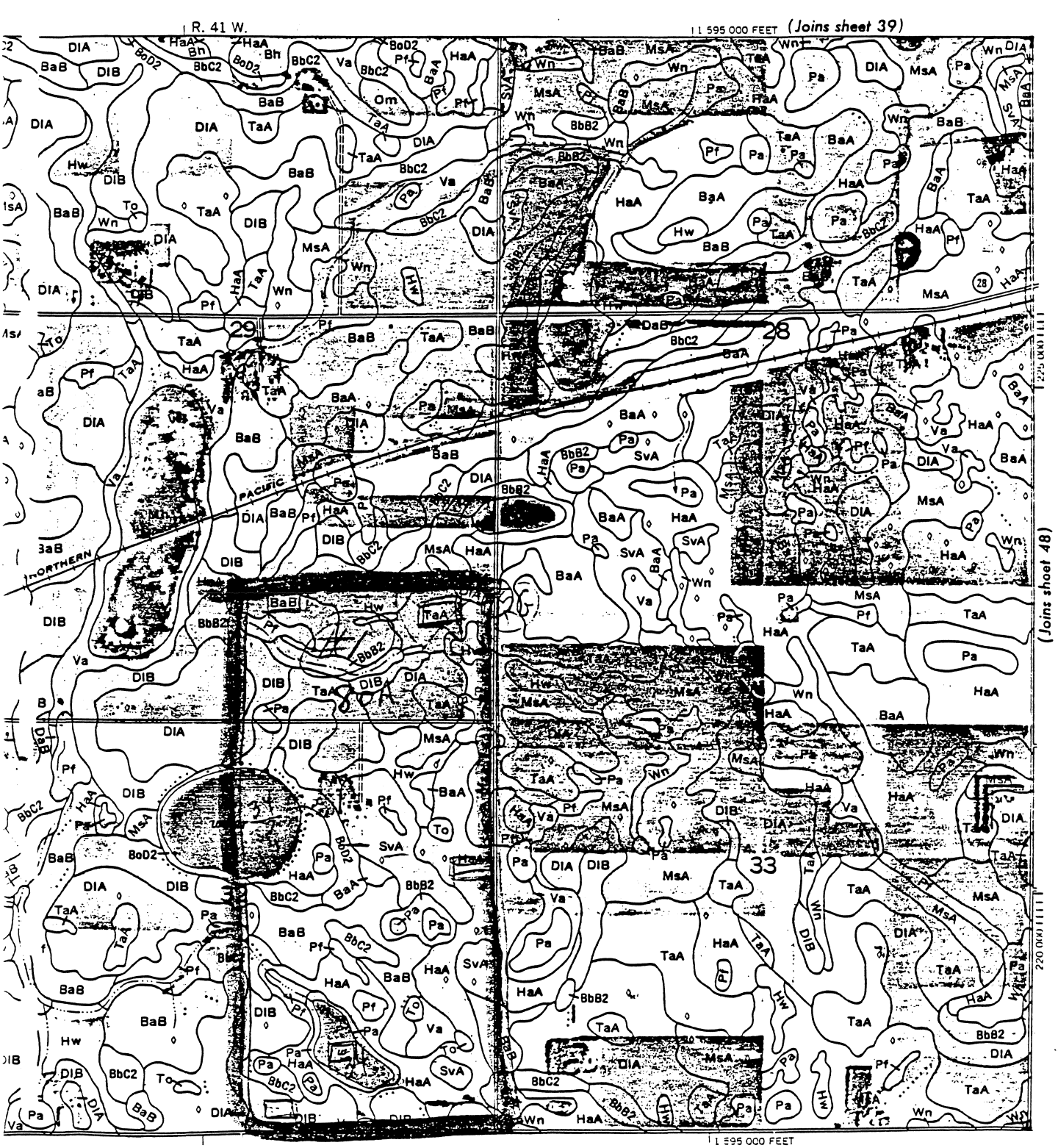
	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a FINE texture.			
pH	The soil in this field is SLIGHTLY BASIC			
NITROGEN	NNNN

Detailed Soil Map West Central Experiment Station, Morris, Minnesota



Soil County Survey Map
for M-1

Agricultural Experiment Station
University of Minnesota
Soil Series 102



Frames Township

Morris Township

Scale 1:15 840

0 ½ Mile

1 000 0 5 000 Feet

6.19

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Joe Kenning
Tabaright Inn
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil L Jons
2027 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 13734
Date Received: 10-12-88
Date Reported: 10-19-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	0-2'	2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	6-24"	Chloride 0-2'
JV-1	S	6.2	10	16				94	420							41		

INTERPRETATION OF SOIL TESTS

Very Low (Response) | Low (Likely Response) | Medium (Possible Response) | High (No Response)

SOIL TEXTURE — Your soil has a COARSE texture.
pH — The soil in this field is SLIGHTLY ACID
NITROGEN — Alfalfa are legume and supply their own nitrogen.
PHOSPHORUS — PPPP

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To
Joe Kenning
Dataright Inc
RR 4 Box 84
Milaca, MN 56353

Copy to:
Virgil L Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 12726
Date Received: 10-12-88
Date Reported: 10-28-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'	Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
IK-3	S	6.3	6	10			46	300							12		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a COARSE texture.			
pH	The soil in this field is SLIGHTLY ACID			
NITROGEN	Alfalfa are legume and supply their own nitrogen.			
PHOSPHORUS	PPPP

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To:
Joe Kenning
Dataright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil L Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 12738
Date Received: 10-12-88
Date Reported: 10-20-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'		Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
JK-3	S	5.6	37	136				32	215			1.1				17		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a COARSE texture.			
pH	The soil in this field is MODERATELY ACID			
NITROGEN	NNNN

SOIL TEST REPORT

NORTH DAKOTA STATE UNIVERSITY • SOIL TESTING LAB • FARGO, NORTH DAKOTA 58105

To
Joe Kenning
Dataright Inc
RR 4 Box 241
Milaca, MN 56353

Copy to:
Virgil L Jons
3037 16th Ave S
Moorhead, MN 56560

County: Minnesota
Lab No.: 13740
Date Received: 10-13-88
Date Reported: 10-20-88

SOIL TEST RESULTS

Sample Number	Soil Texture	Soil pH	Nitrogen NO_3-N 0-6"	Nitrogen NO_3-N 0-2'	Nitrogen NO_3-N 2-4'	Organic Matter	Phosphorus P	Potassium K	Soluble Salts 0-6"	Soluble Salts 6-24"	Zinc Zn	Iron Fe	Manganese Mn	Copper Cu	Sulfur SO_4-S 0-6"	Sulfur SO_4-S 6-24"	Chloride 0-2'
JK-4	S	6.8	34	154			71	310			1.1				14		

INTERPRETATION OF SOIL TESTS

	Very Low (Response)	Low (Likely Response)	Medium (Possible Response)	High (No Response)
SOIL TEXTURE	Your soil has a COARSE texture.			
PH	The soil in this field is NEUTRAL			
NITROGEN	NNNN

STEARNS COUNTY

Kenning

6.24

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

STEARNS COUNTY, MINNESOTA-NO. 142

7. KENNING 1987 OVERHEAD WIRE AND MILK PRODUCTION DATA

Joe Kenning and Francis Kettner have maintained a continuous record of ac and dc voltages from suspended, isolated, overhead wires to earth ground for the past several years on their farm near St. Augusta, Minnesota. The wires are 17 ga "Sterling" electric fence wire insulated on either end and suspended thirty to fifty feet above ground over a distance of about 100 feet. This record can be intensely variable even under fair weather conditions and Kenning believes it is related to the performance of his dairy herd. An effort was made here to contrast this record with production statistics as recorded during 1987 by converting the electrical analog record to hourly numerical format and creating a database supporting statistical contrasts. This data is presented here in graphical format as it may assist more detailed statistical analysis.

Overhead Wire Data Reduction

The original data of Vac and Vdc (volts ac & dc) on insulated overhead wires exists as a two-pen strip chart record annotated with daily time marks, scale references and assorted comments. This data was transcribed into 1-hour averages complimented by maximum and minimum values for each hour and a comment code indicating the following conditions: data good, full scale max, full scale min, data obscure, data missing, equipment not working. These hourly data were time stamped with month, day and hour and recorded on paper forms.

The 1-hour data were entered into a statistical analysis data base for reduction and analysis. To insure that nothing was missed on the strip chart records, a second examination was made by an independent editor to verify chart scales and good vs suspect data. An accurate record of chart scale values was entered into the data base. Periods of obviously bad data were accounted for by transforming the appropriate chart scale data as "missing". Then the six columns of chart-relative data were scaled accordingly to produce the actual data (Vac avg, Vac max, Vac min, Vdc avg, Vdc max, Vdc min) reflecting the editor's determination of "missing data" status. The original comment data were then interpreted and used to further recode missing data, thus accounting for the original transcriber's determination of "missing data" status. As a rule, if any of the three data (avg, max or min) were deemed full scale, obscure, out or missing, all three were recoded as missing for that hour. In transforming the unscaled chart data, it was assumed that each of the chart pens was set to 0 at the right side of the chart paper (labelled "100" on the chart form).

Statistical information was then obtained for this reduced data and used to set the scale for plots of the 1-hour average data. These plots represent 1-month summaries of the hour data. The range of the data as plotted was set from zero to a value inclusive of 90% of the available good data points. Missing data

Strip Chart Notes:

The following is a list of annotations exclusive of scale notes and time marks.

Date	Annotation
4/8-4/9	AC battery low Power off to fix pole
4/22	Burn in failure dc channel repaired 4/22/87 1:48pm on line
5/16	Wind shaking pole
5/17	New pen
5/18	Put on 2V scale
5/26	AC 2V scale
6/10	Illinois earthquake
8/4	Bat out
8/16	DC back on line 900 PM 8-16-87, .5VDC
8/20	Changed to 2VDC scale
9/10	Changed to .1V scale
9/27	AC uncalibrated
9/29	Recalibrated

Strip Chart Scales:

The following is a complete list of range (scale) changes as noted on the strip chart records.

Date	Time	AC	DC
4/1/87	bof	1V	5V
4/22			.5
5/18	11	2	
5/26		1	
8/20	15		2
9/10	15		.1
9/26	15		.2
9/27	12	.5	
11/18	21	1	
11/20	06	5	
11/20	23	.5	
1/2/88	eof	.5	.2

Editor Notes:

The following list of notes applies to the second and independent scan of the strip chart records.

Date	Note
4/8-4/9	ac data unreliable (acdu): ~0 then hi, "ac battery low", "power off to fix pole". delete
4/8-4/22	dc data unreliable (dcdu): either missing or not sensitive enough, "burn in failure dc channel repaired 4/22/87". delete
5/17	acdu: unexplained scale changes. delete
6/15-6/16	acdu: <0 intermittantly from hi. delete
6/19-6/20	acdu: <0 intermittantly from hi. delete
6/22-6/23	acdu: <0 intermittantly from hi. delete dcdu: low, then max erratically. delete
7/1	acdu: ditto dcdu: ditto
7/9-7/10	acdu: ditto dcdu: ditto
7/12	dcdu: steady "0" < 0(chart). delete
7/30-8/4	acdu: unexplained scale changes. delete
7/30-8/16	dcdu: dc down, :dc back on line 900 pm 8-16-87" delete
8/16-	dc trace extremely variable. questionable but did not delete
9/10	dc scale change from 2V to .1V resulted in smaller and more stable trace. ?
9/27-9/29	acdu: "ac uncalibrated". "recalibrated". delete
10/1	dcdu: erratic and <0. continues for days. no action
11/20	ac scale change from 5V to .5V resulted in no apparent change in trace. ? no action taken dcdu: erratic, peak to peak. delete
12/1-12/3	acdu: value degrades to 0, then suddenly recovers. is battery failing? delete
12/1-	dc trace seems to be zeroed on 1st major division. not documented. ? no action

Editor's Observations Concerning General Data Quality

The following comments apply to the quality of the strip chart record itself, exclusive of the quality of the measurement(s).

1. There are no annotated strip chart calibrations for pen zero or span (scale).

2. There are no apparent unannotated strip chart calibrations for pen zero or span.

3. Several segments of suspect data are not annotated.

4. Some annotated scale changes did not result in appropriate trace changes.

5. Character of traces changes dramatically but are not annotated. (eg: 8/16)

6. Notes on equipment failures do not indicate when problem likely began. (eg: battery failures)

7. Strip chart time base is only fair, but notes on time are adequate to lock in data to time within $\pm$1 hour.

It should be stated that the validity of this strip chart data record is in question because of the above discrepencies in record-keeping practices. However, the spirit of this analysis is purely exploratory in nature. A detailed view of the physical significance of this data is not even in hand. Therefore, the accuracy of the data or its exact meaning could perhaps be discounted for the present time without proving fatal to the effort if the sole purpose of the analysis is to test for a statistical association between Vac and Vdc on overhead wires and dairy herd behavior/production. If such an association does exist, further and more careful measurements can be made to produce data deserving of more confidence.

```
Date/Time       01-26-1989  19:10:25
Data Base Name C:\EMD\WIRE
Description     Data base created at 18:00:22 on 01-23-1989

No. Variable    Rows Vlab      Label
  1 MONTH      6,630
  2 DAY        6,630
  3 HOUR       6,630
  4 ACAV       6,630
  5 ACLO       6,630
  6 ACHI       6,630
  7 DCAV       6,630
  8 DCLO       6,630
  9 DCHI       6,630
 10 COMMENT    6,630
 11 DAY.HR     6,630
 12 ACSCALE    6,630
 13 DCSCALE    6,630
 14 MO.DA      6,630
 15 VAC        6,630
 16 LOACV      6,630
 17 HIACV      6,630
 18 VDC        6,630
 19 LODCV      6,630
 20 HIDCV      6,630
 21 ACCOM      6,630
 22 DCCOM      6,630
 23 VAC        6,630           TEMPORARY PLOT FILE
 24 VDC        6,630           TEMPORARY PLOT FILE
```

----------Descriptive Statistics----------

Detail Report

Variable: VAC

Mean - Average	.2154735	No. observations	6630
Lower 95% c.i.limit	.211448	No. missing values	981
Upper 95% c.i.limit	.2194991	Sum of frequencies	5649
Adj sum of squares	134.5948	Sum of observations	1217.21
Standard deviation	.1543714	Std.error of mean	2.053908E-03
Variance	2.383053E-02	T-value for mean=0	104.909
Coef. of variation	.7164285	T prob level	0.0000
Skewness	5.473127	Kurtosis	37.21887
Normality Test Value	0.696	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	1.98	90-%tile	.29
75-%tile	.22	10-%tile	.14
50-%tile (Median)	.18	Range	1.98
25-%tile	.16	75th-25th %tile	.06
0-%tile (Minimum)	0		

Variable: LOACV

Mean - Average	.1974008	No. observations	6630
Lower 95% c.i.limit	.1938625	No. missing values	1036
Upper 95% c.i.limit	.200939	Sum of frequencies	5594
Adj sum of squares	101.9643	Sum of observations	1104.26
Standard deviation	.1350211	Std.error of mean	1.805262E-03
Variance	1.823069E-02	T-value for mean=0	109.3474
Coef. of variation	.6839947	T prob level	0.0000
Skewness	5.540962	Kurtosis	40.44828
Normality Test Value	0.686	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	1.88	90-%tile	.27
75-%tile	.21	10-%tile	.125
50-%tile (Median)	.17	Range	1.88
25-%tile	.15	75th-25th %tile	5.999999E-02
0-%tile (Minimum)	0		

Detail Report

Variable: HIACV

Mean - Average	.230681	No. observations	6630
Lower 95% c.i.limit	.2261358	No. missing values	1035
Upper 95% c.i.limit	.2352262	Sum of frequencies	5595
Adj sum of squares	168.3192	Sum of observations	1290.66
Standard deviation	.1734625	Std.error of mean	2.319025E-03
Variance	3.008923E-02	T-value for mean=0	99.47324
Coef. of variation	.7519584	T prob level	0.0000
Skewness	5.251709	Kurtosis	34.33653
Normality Test Value	0.677	Reject if > 0.994(10%)	0.994(5%)
100-%tile (Maximum)	1.9	90-%tile	.31
75-%tile	.23	10-%tile	.145
50-%tile (Median)	.18	Range	1.9
25-%tile	.165	75th-25th %tile	.065
0-%tile (Minimum)	0		

Variable: VDC

Mean - Average	3.874179E-02	No. observations	6630
Lower 95% c.i.limit	4.473144E-03	No. missing values	3768
Upper 95% c.i.limit	7.301044E-02	Sum of frequencies	2862
Adj sum of squares	2503.14	Sum of observations	110.879
Standard deviation	.9353705	Std.error of mean	1.748432E-02
Variance	.874918	T-value for mean=0	2.215801
Coef. of variation	24.14371	T prob level	0.0267
Skewness	53.47715	Kurtosis	2860.536
Normality Test Value	0.707	Reject if > 0.997(10%)	0.998(5%)
100-%tile (Maximum)	50.055	90-%tile	.038
75-%tile	.026	10-%tile	.01
50-%tile (Median)	.018	Range	50.055
25-%tile	.01	75th-25th %tile	.016
0-%tile (Minimum)	0		

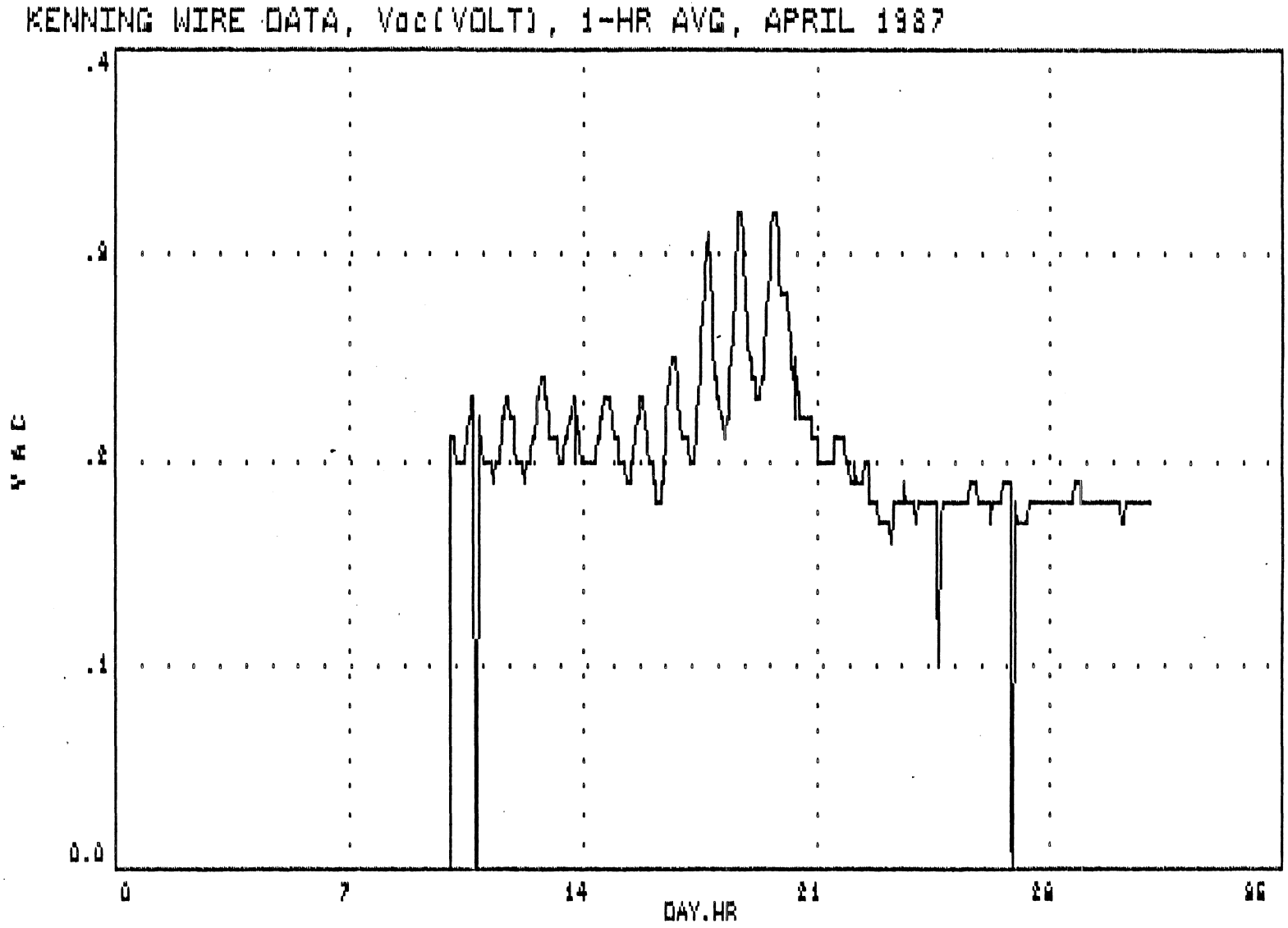
Detail Report

Variable: LODCV

Mean - Average	1.104132E-02	No. observations	6630
Lower 95% c.i.limit	1.064624E-02	No. missing values	3774
Upper 95% c.i.limit	1.143639E-02	Sum of frequencies	2856
Adj sum of squares	.3312991	Sum of observations	31.534
Standard deviation	1.077227E-02	Std.error of mean	2.01571E-04
Variance	1.160417E-04	T-value for mean=0	54.77632
Coef. of variation	.9756324	T prob level	0.0000
Skewness	5.323169	Kurtosis	95.19632
Normality Test Value	0.983	Reject if > 0.997(10%)	0.998(5%)
100-%tile (Maximum)	.255	90-%tile	.024
75-%tile	.015	10-%tile	0
50-%tile (Median)	.01	Range	.255
25-%tile	.005	75th-25th %tile	.01
0-%tile (Minimum)	0		

Variable: HIDCV

Mean - Average	.0401879	No. observations	6630
Lower 95% c.i.limit	2.645412E-02	No. missing values	3772
Upper 95% c.i.limit	5.392167E-02	Sum of frequencies	2858
Adj sum of squares	400.9184	Sum of observations	114.857
Standard deviation	.3746044	Std.error of mean	7.007156E-03
Variance	.1403285	T-value for mean=0	5.735265
Coef. of variation	9.321324	T prob level	0.0000
Skewness	53.0174	Kurtosis	2826.332
Normality Test Value	0.666	Reject if > 0.997(10%)	0.998(5%)
100-%tile (Maximum)	20.004	90-%tile	.06
75-%tile	.04	10-%tile	.013
50-%tile (Median)	.026	Range	20.004
25-%tile	.017	75th-25th %tile	.023
0-%tile (Minimum)	0		


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, APRIL 1987
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.2
.1
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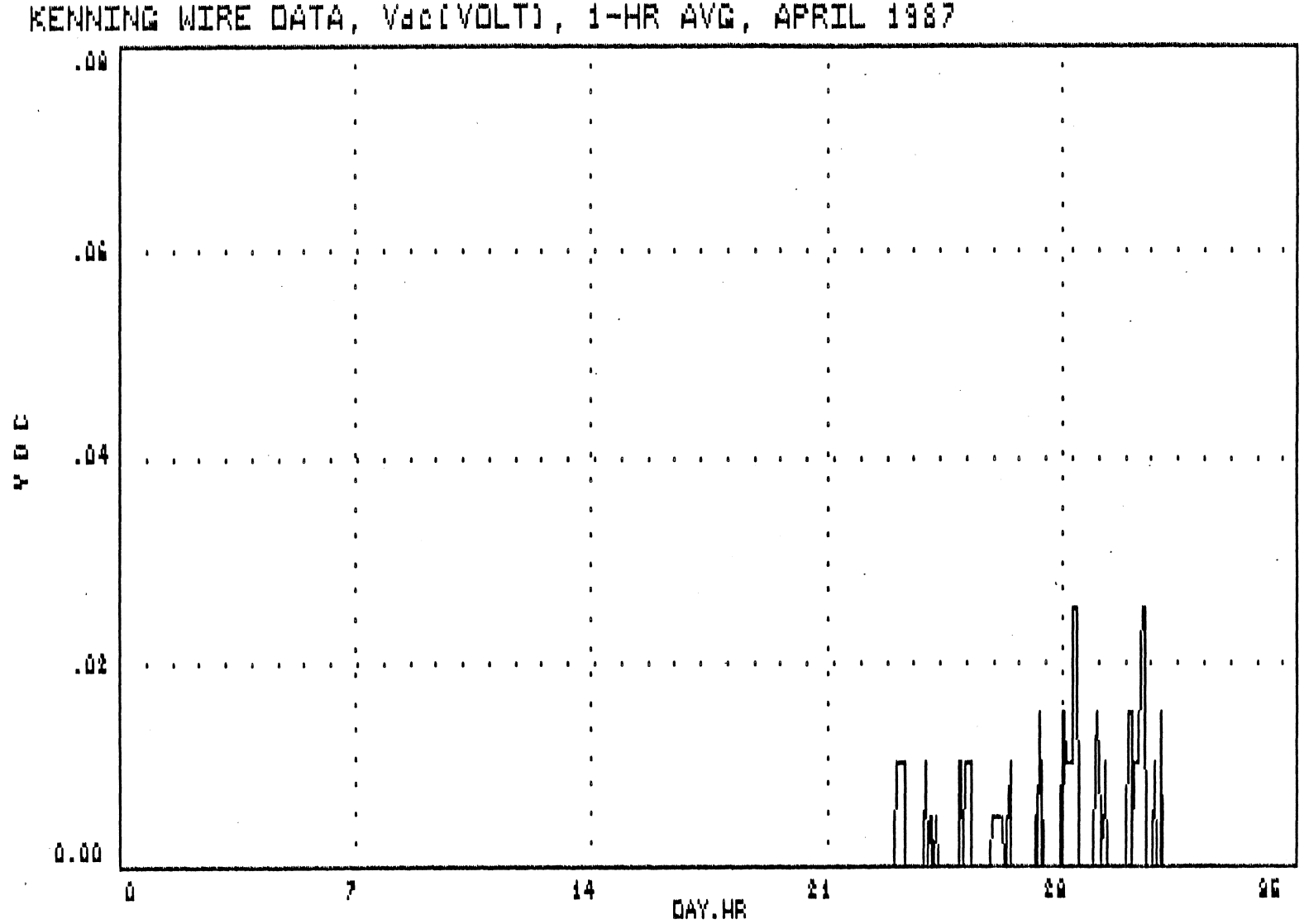
VOLTS
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, APRIL 1987
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0.00
Vdc
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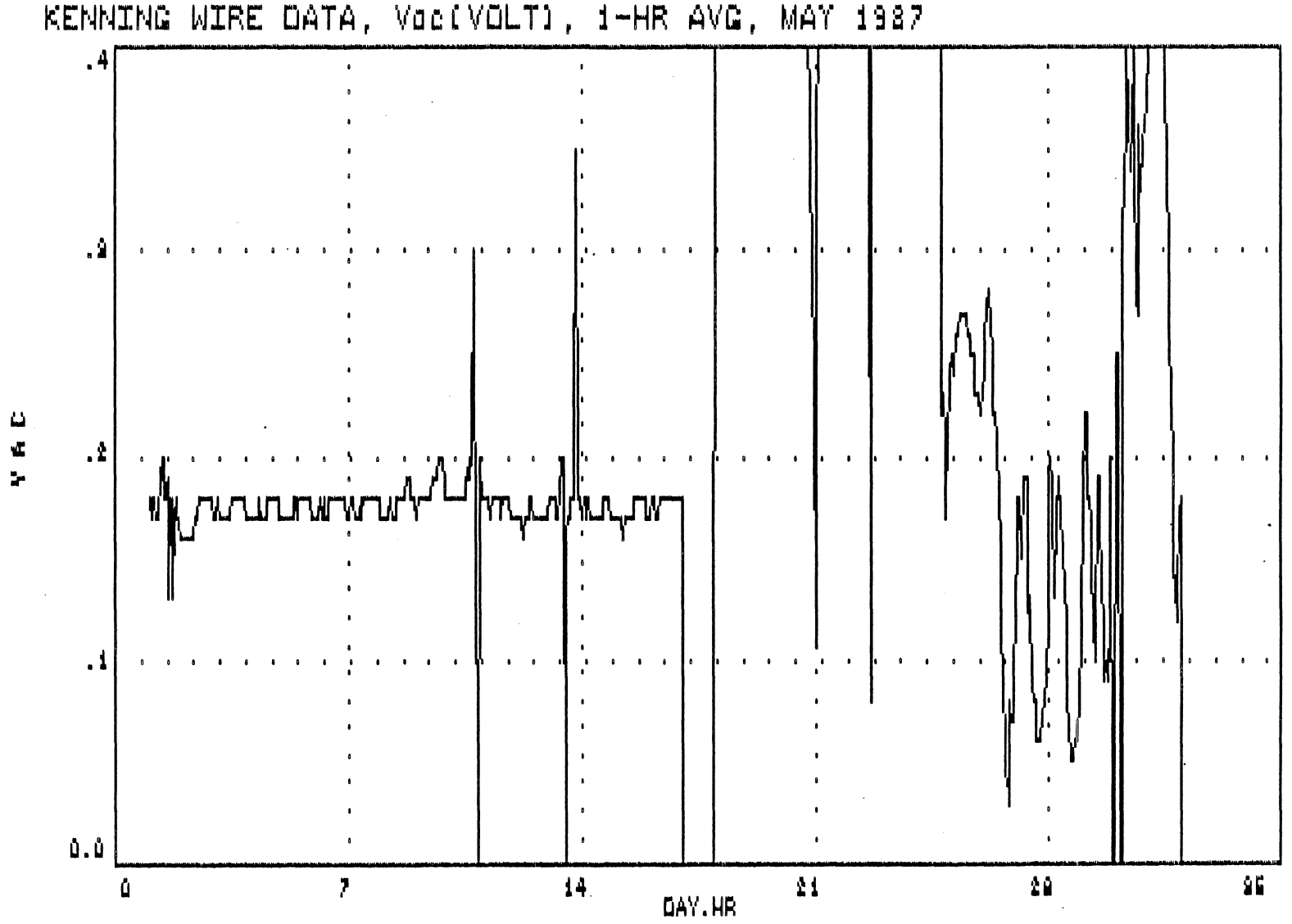
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, MAY 1987
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VOC
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7
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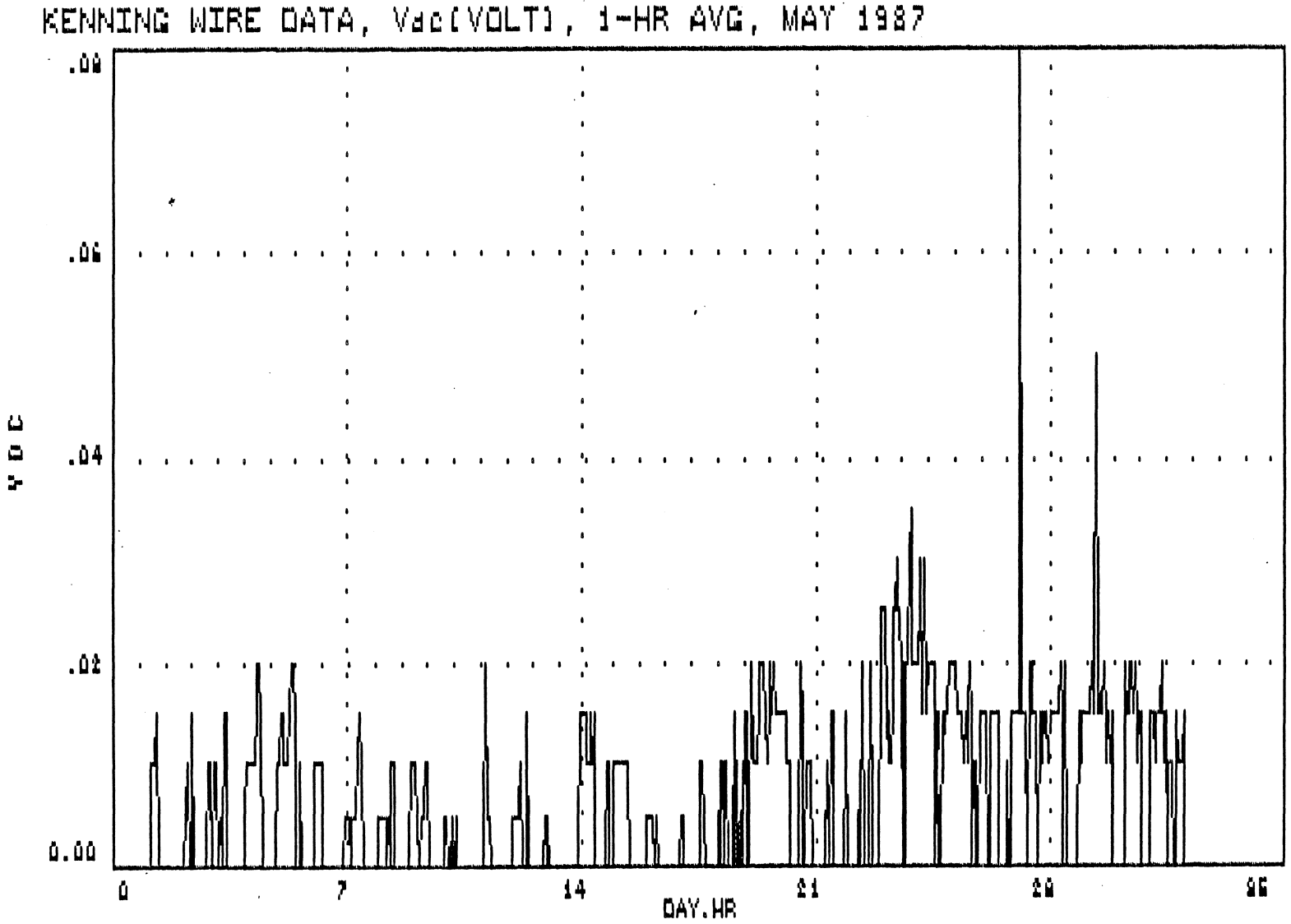
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, MAY 1987
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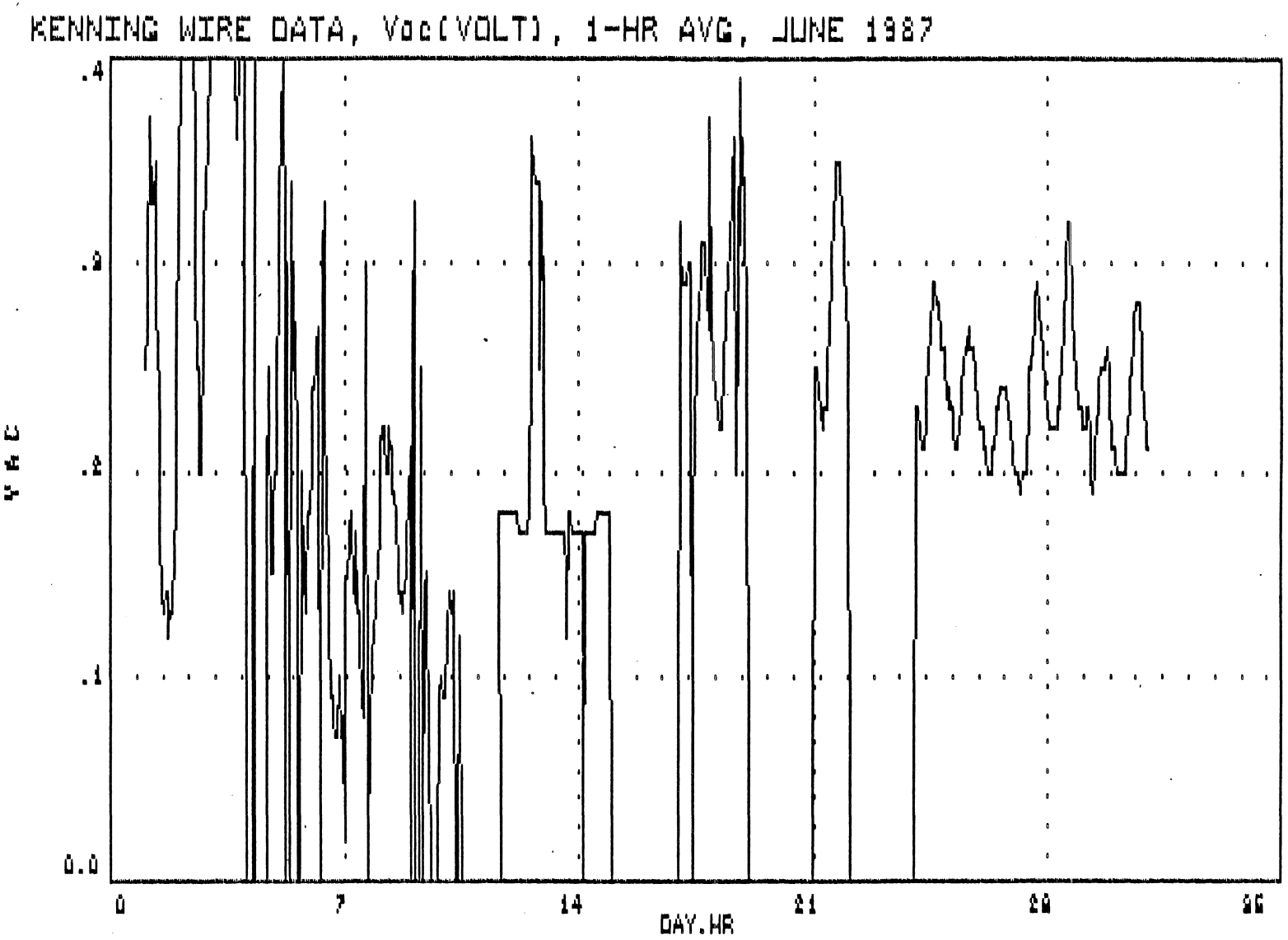
.06
.04
.02
0.00
VDC
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, JUNE 1987
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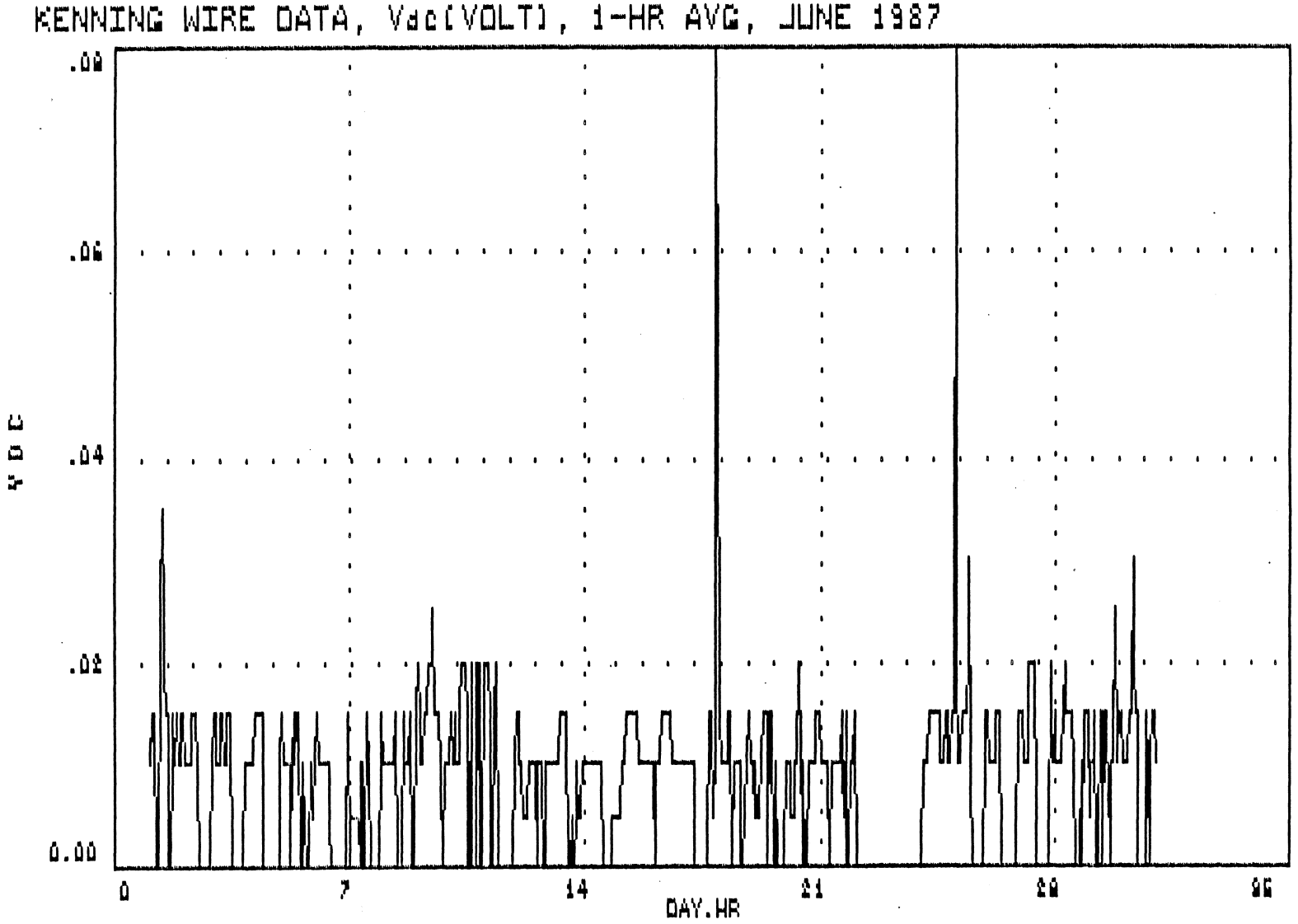
VOLTS
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vac(VOLT), 1-HR AVG, JUNE 1987
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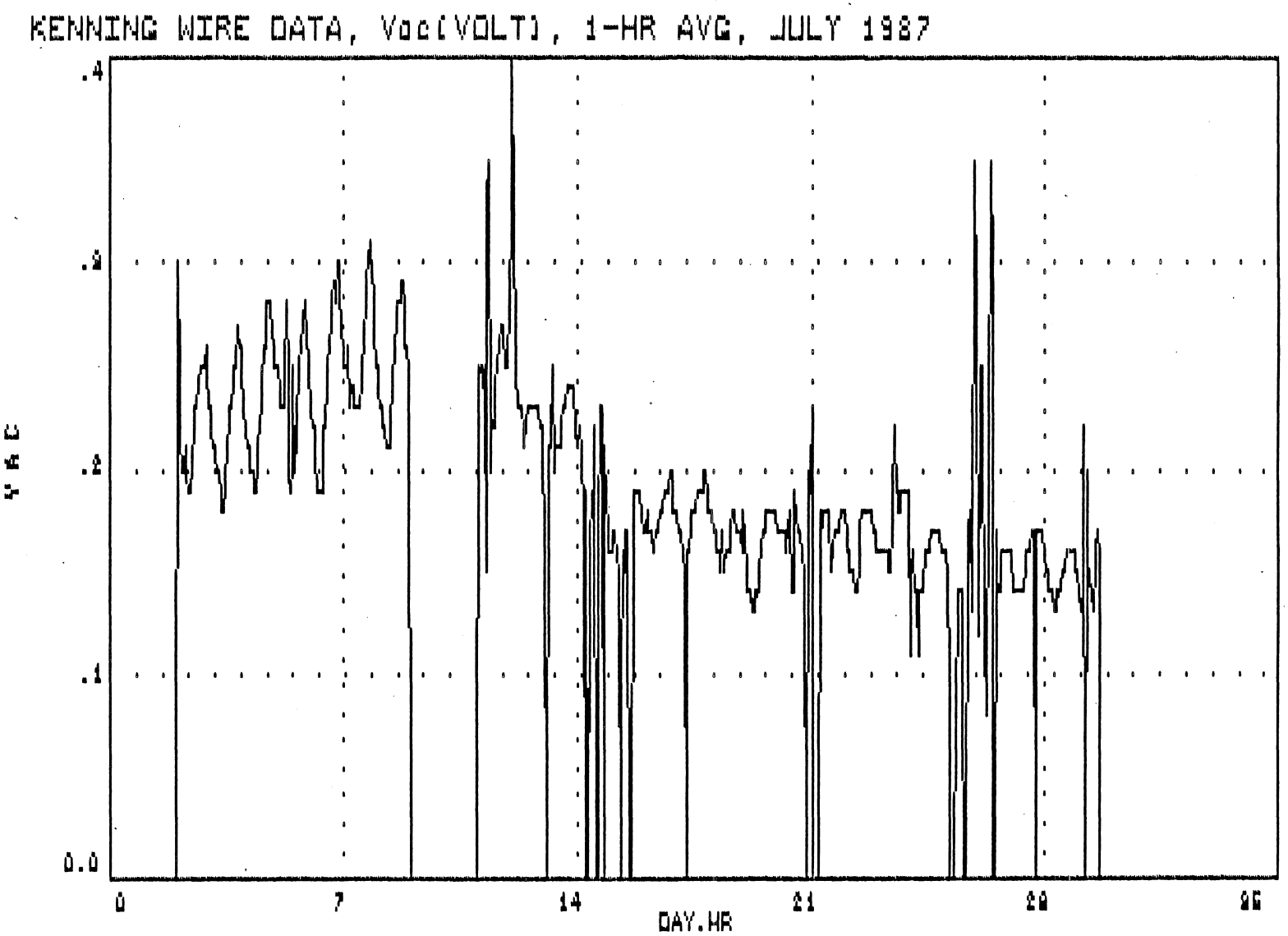
.02
0.00
Vac
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, JULY 1987
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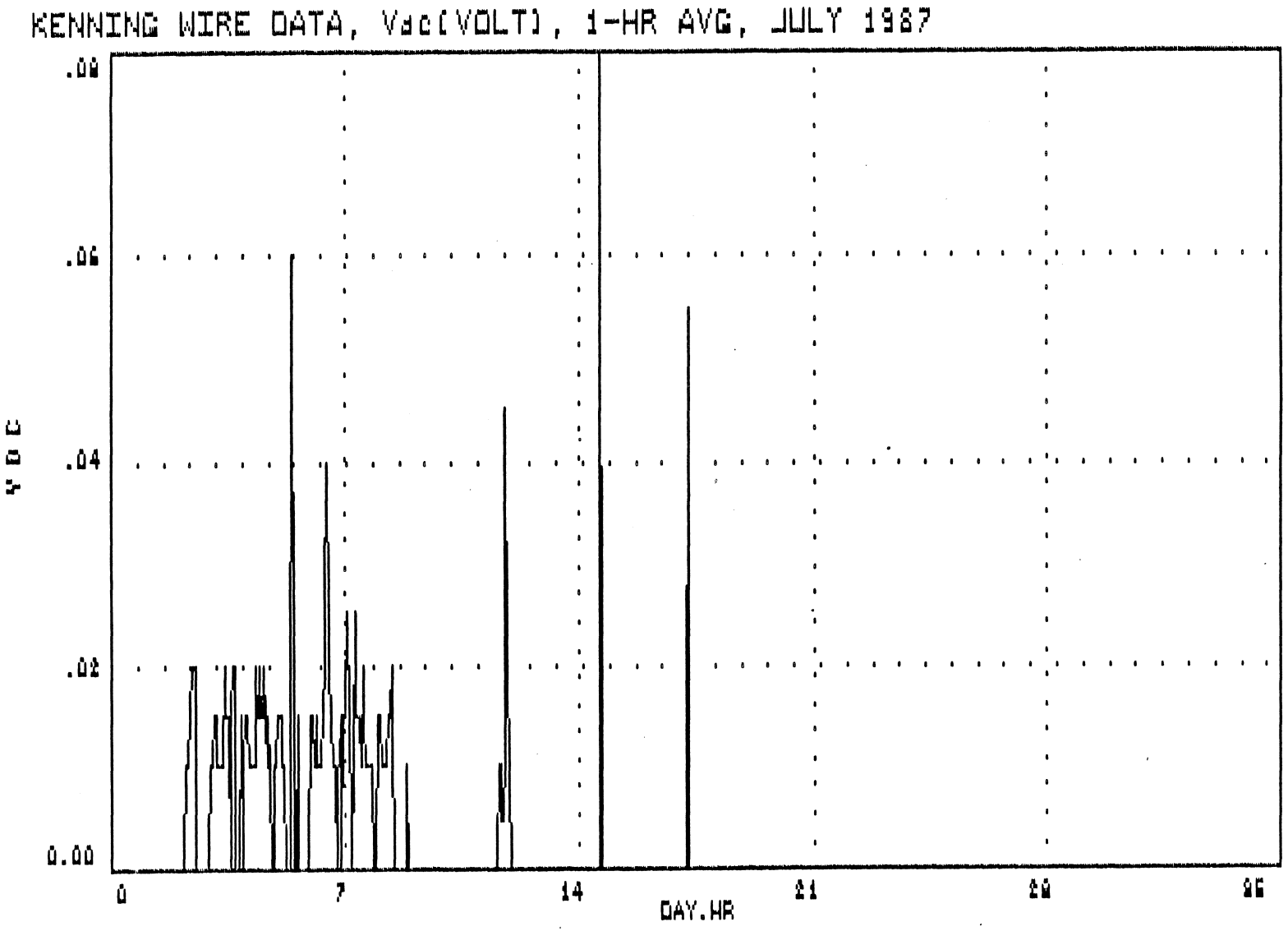
.1
0.0
VOLTS
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, JULY 1987
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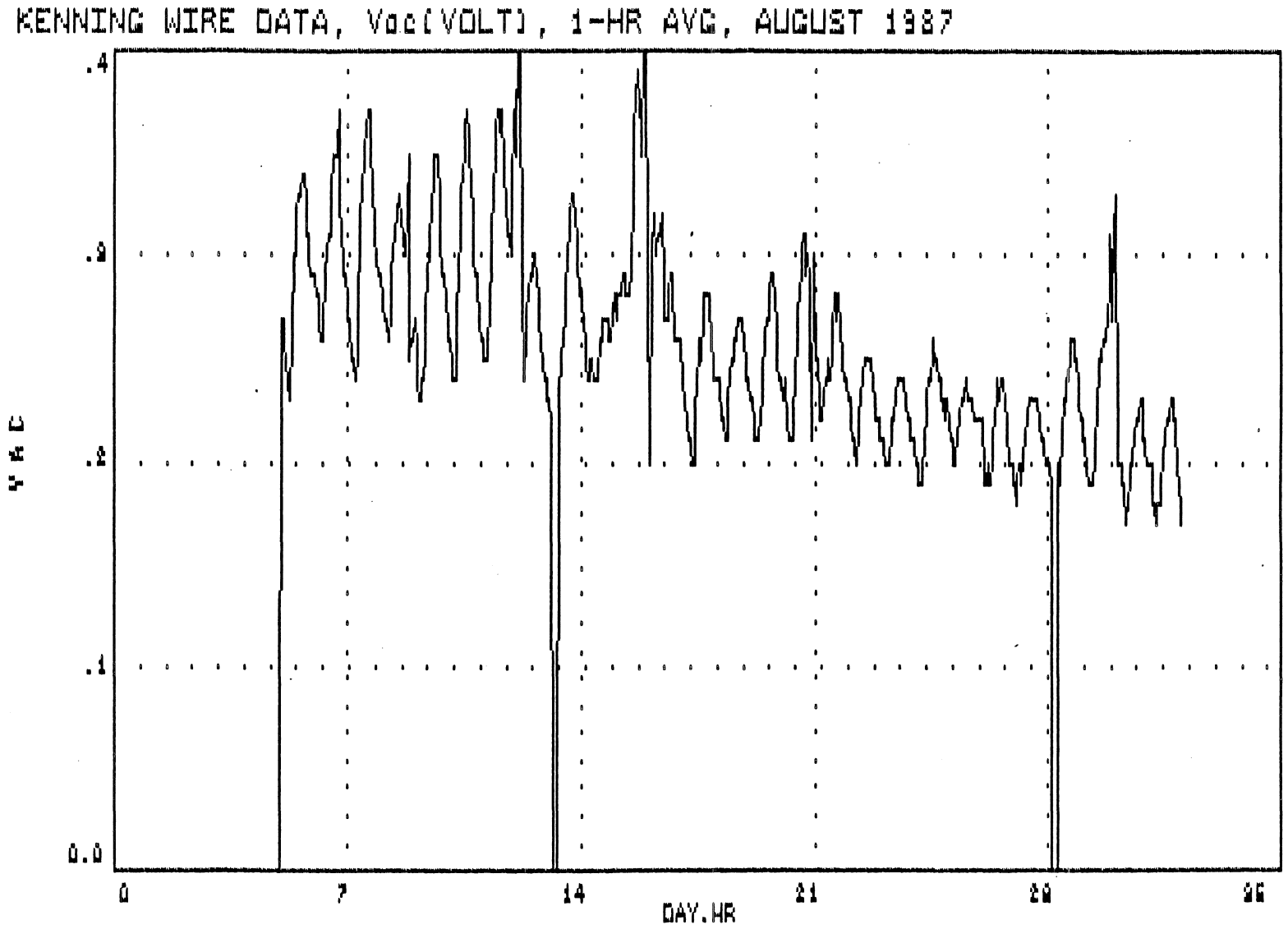
.06
.04
.02
0.00
Vdc
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, AUGUST 1987
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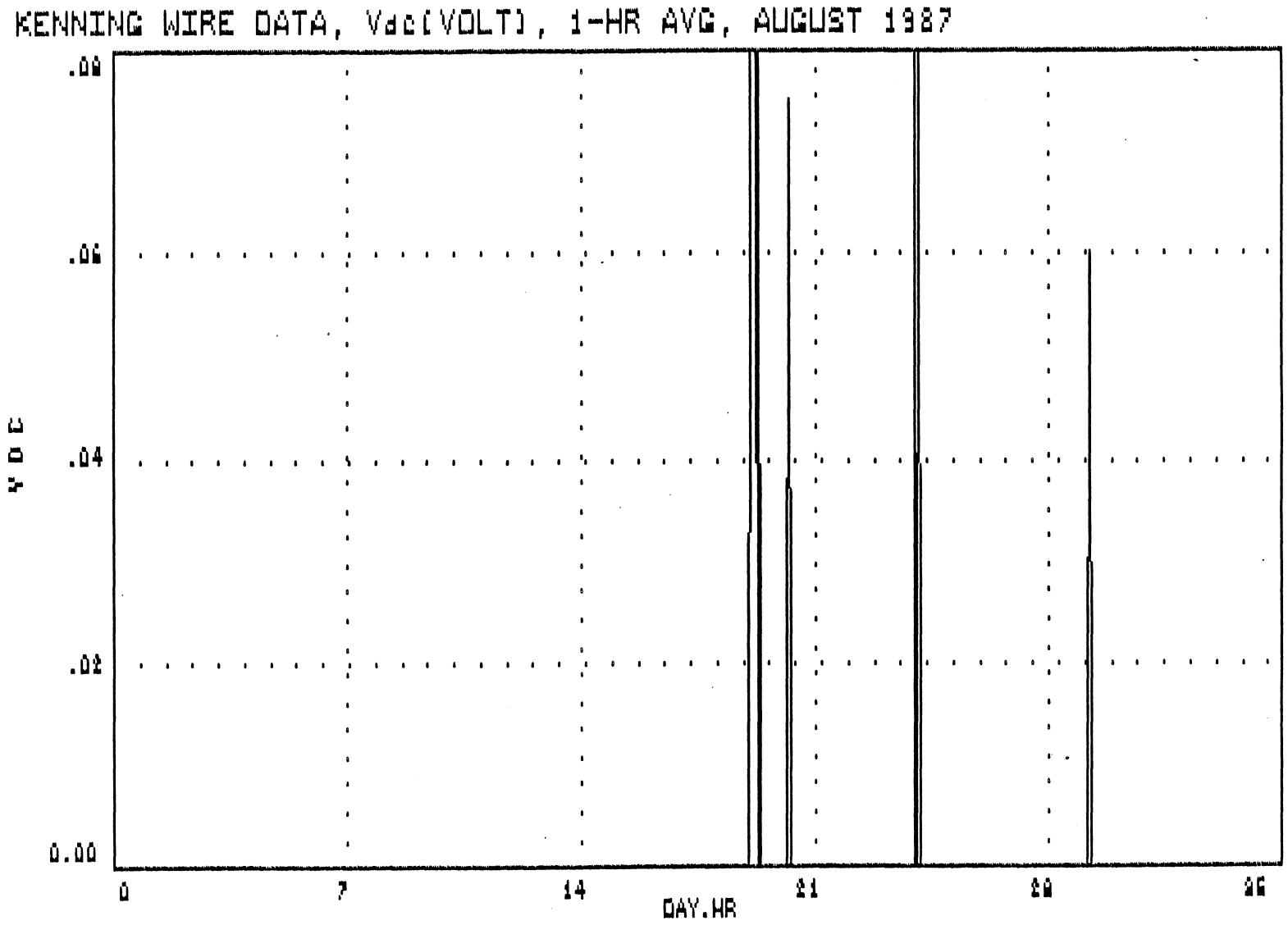
.1
0.0
VOC
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, AUGUST 1987
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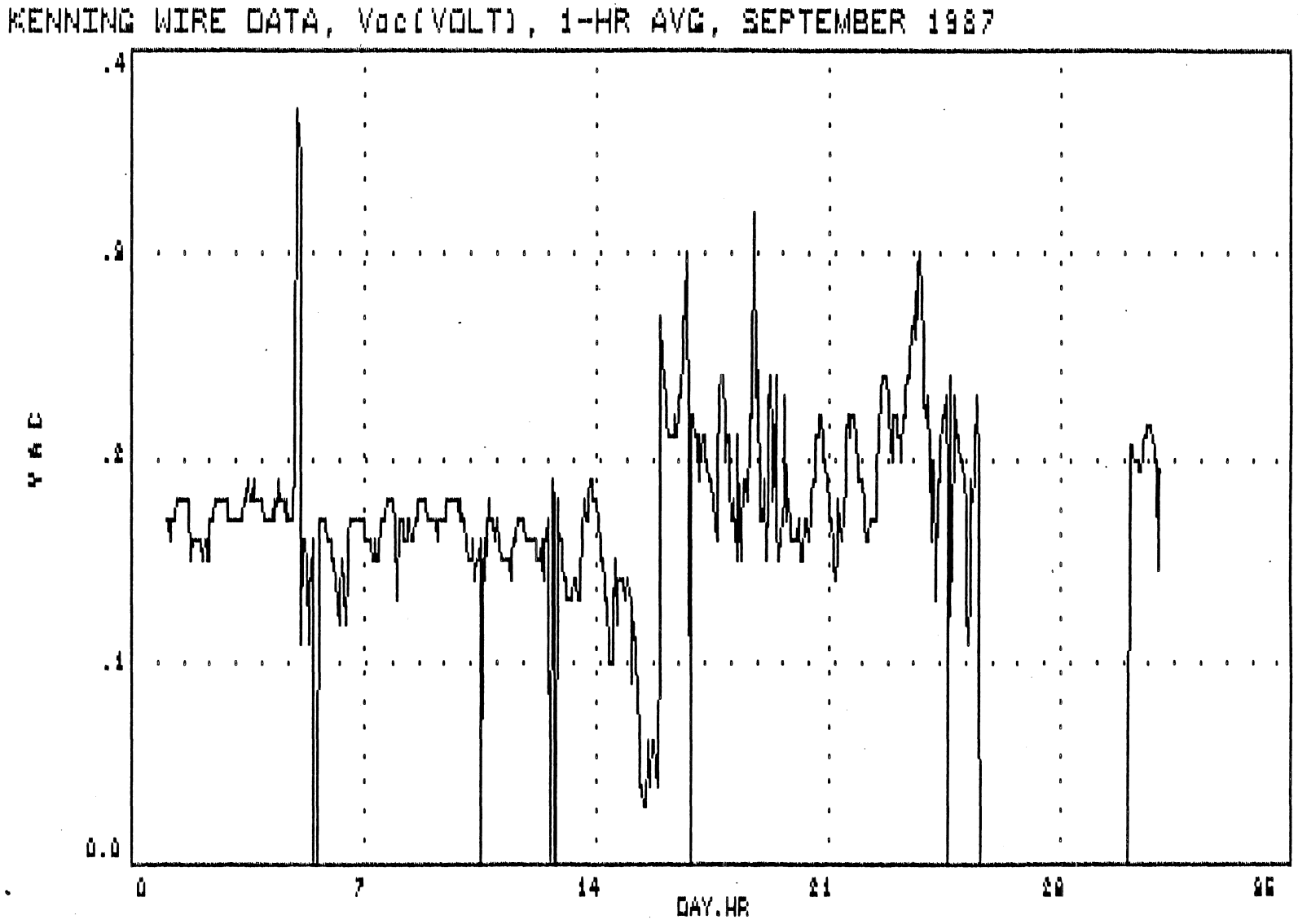
.06
.04
.02
0.00
VDC
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, SEPTEMBER 1987
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.3
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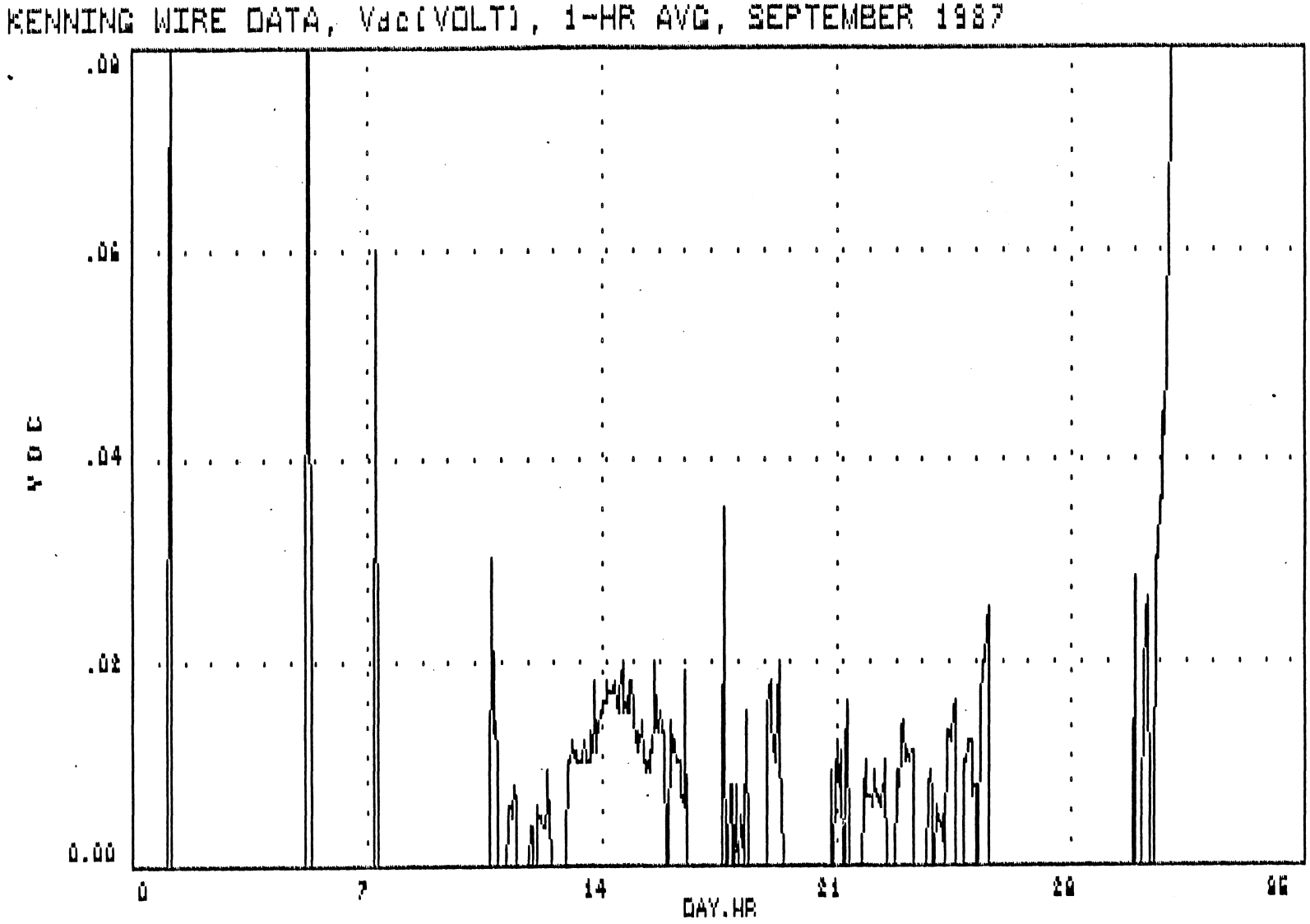
.1
0.0
VOLTS
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, SEPTEMBER 1987
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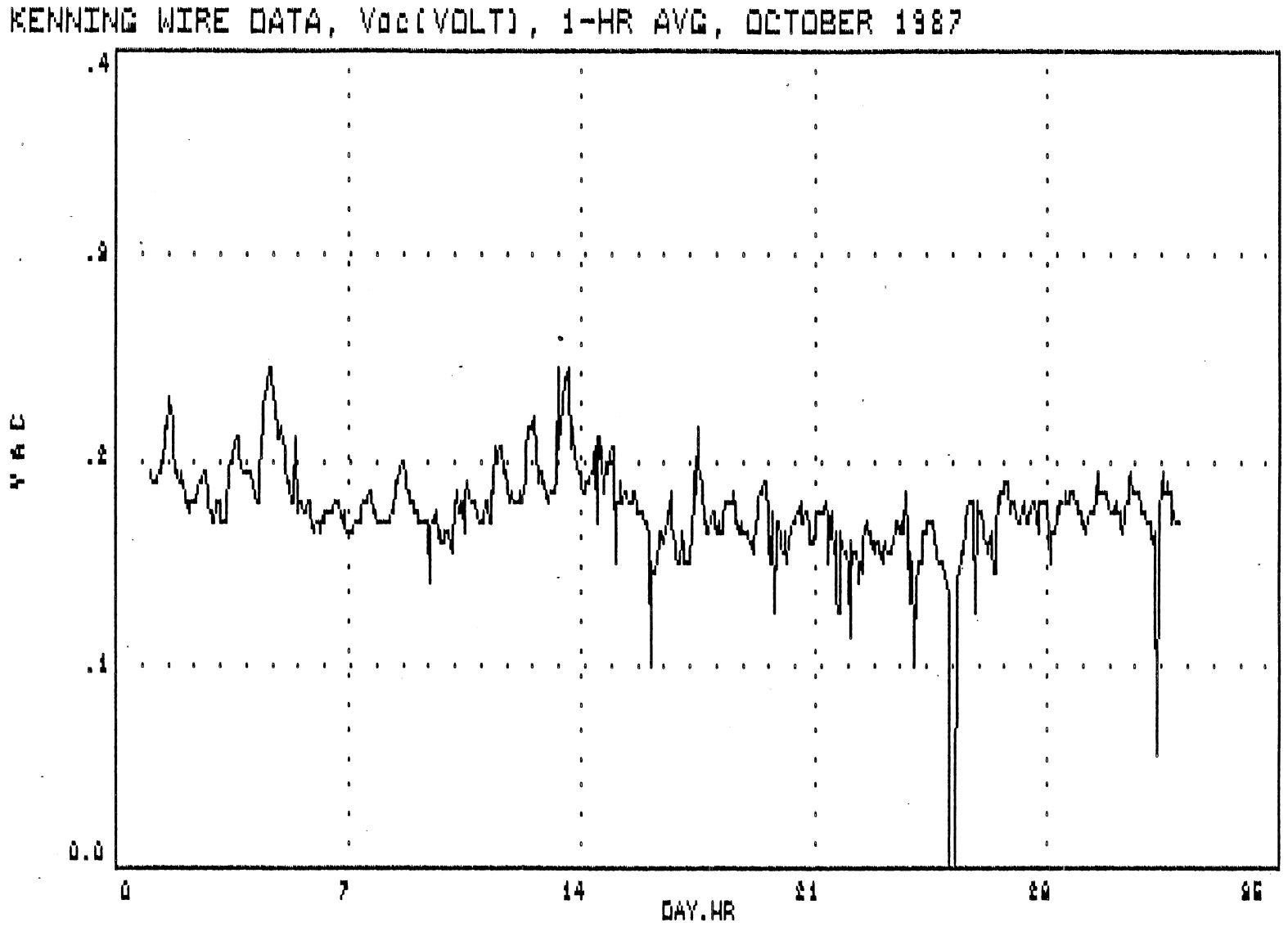
.02
0.00
Vdc
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, OCTOBER 1987
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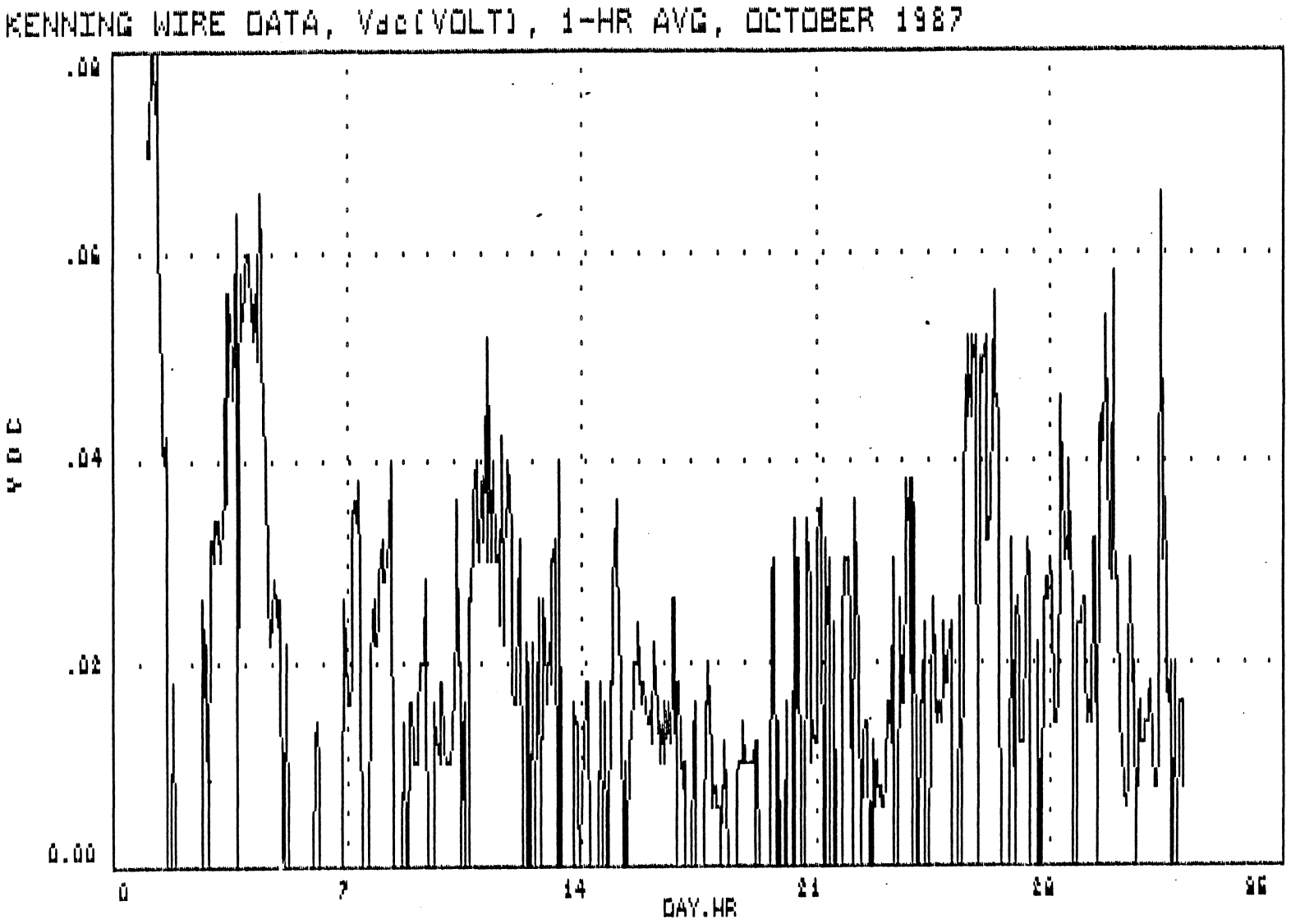
.1
0.0
VAC
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, OCTOBER 1987
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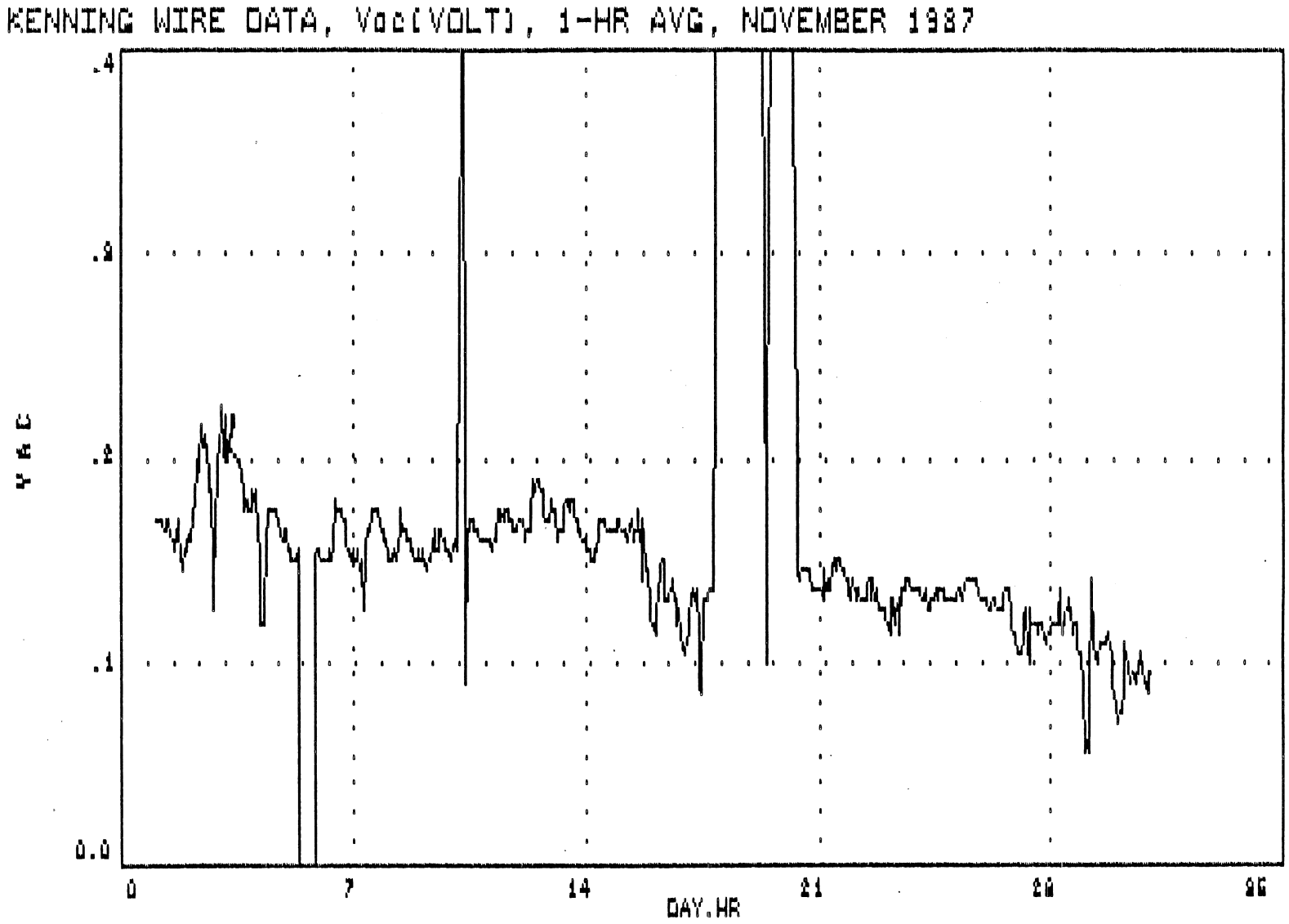
.02
0.00
Vdc
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, NOVEMBER 1987
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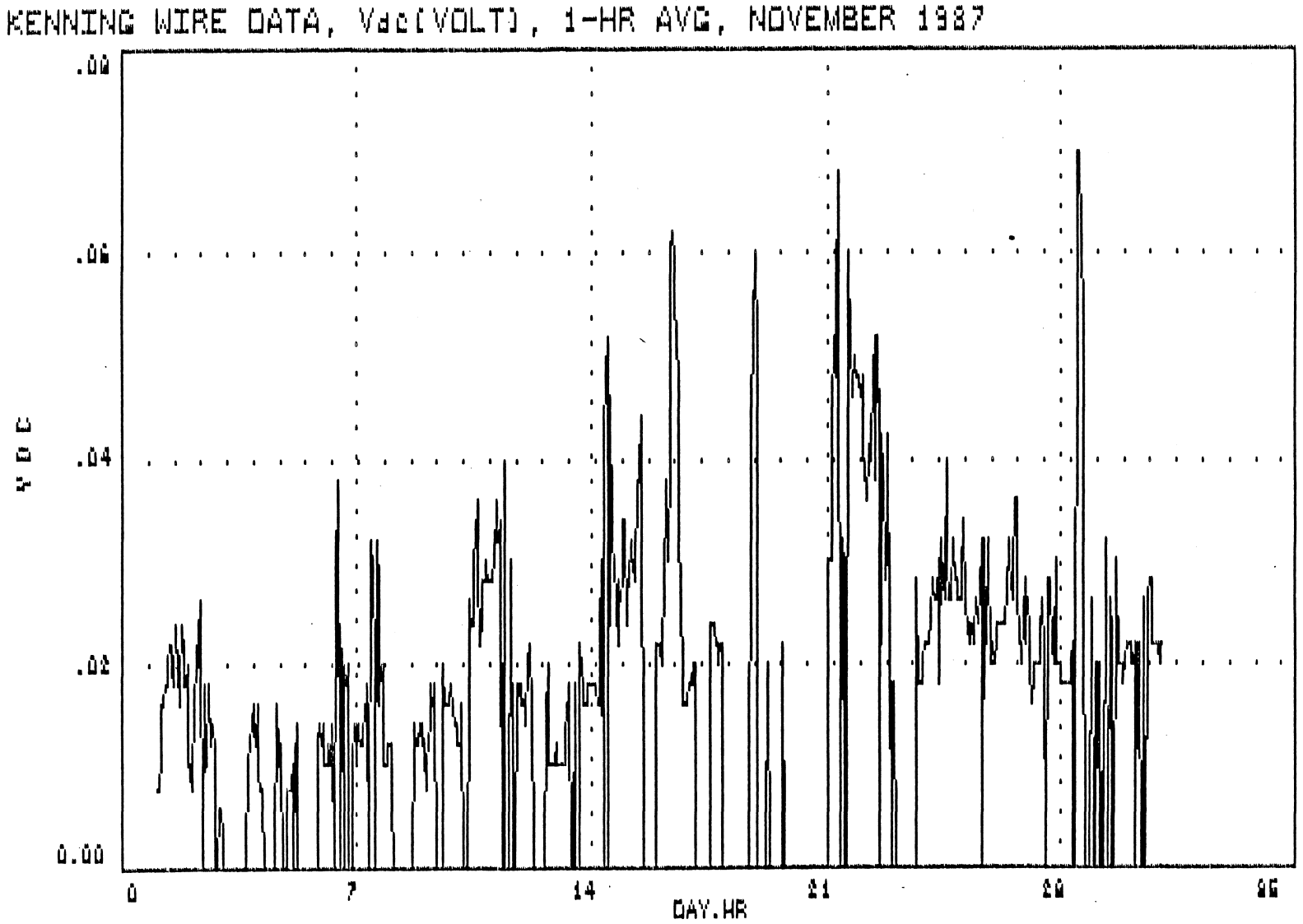
.3
.2
.1
0.0
VOLTS
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Vdc(VOLT), 1-HR AVG, NOVEMBER 1987
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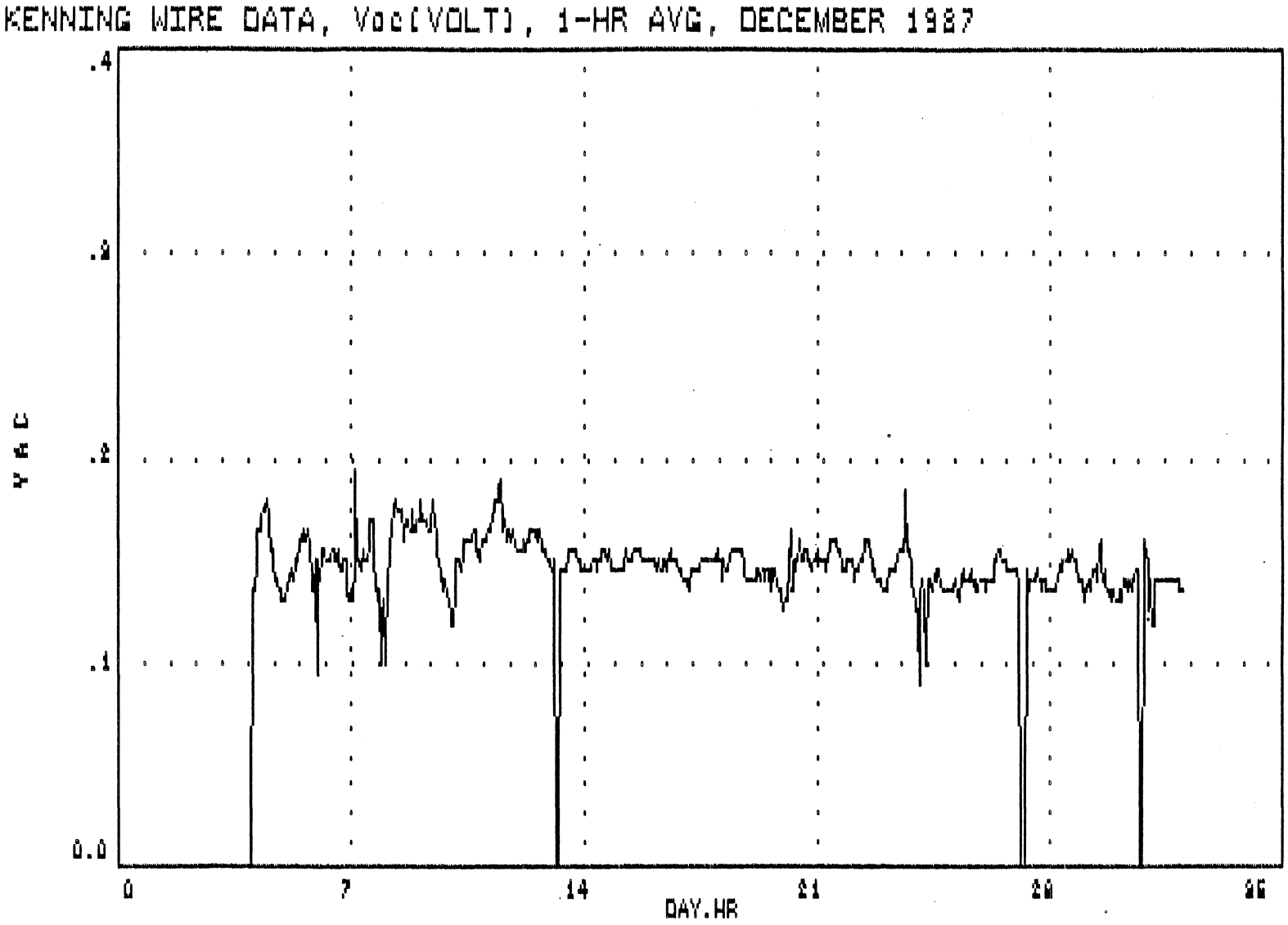
.06
.04
.02
0.00
VOLTS
0
7
14
21
28
DAY.HR


KENNING WIRE DATA, Voc(VOLT), 1-HR AVG, DECEMBER 1987
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.3
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.1
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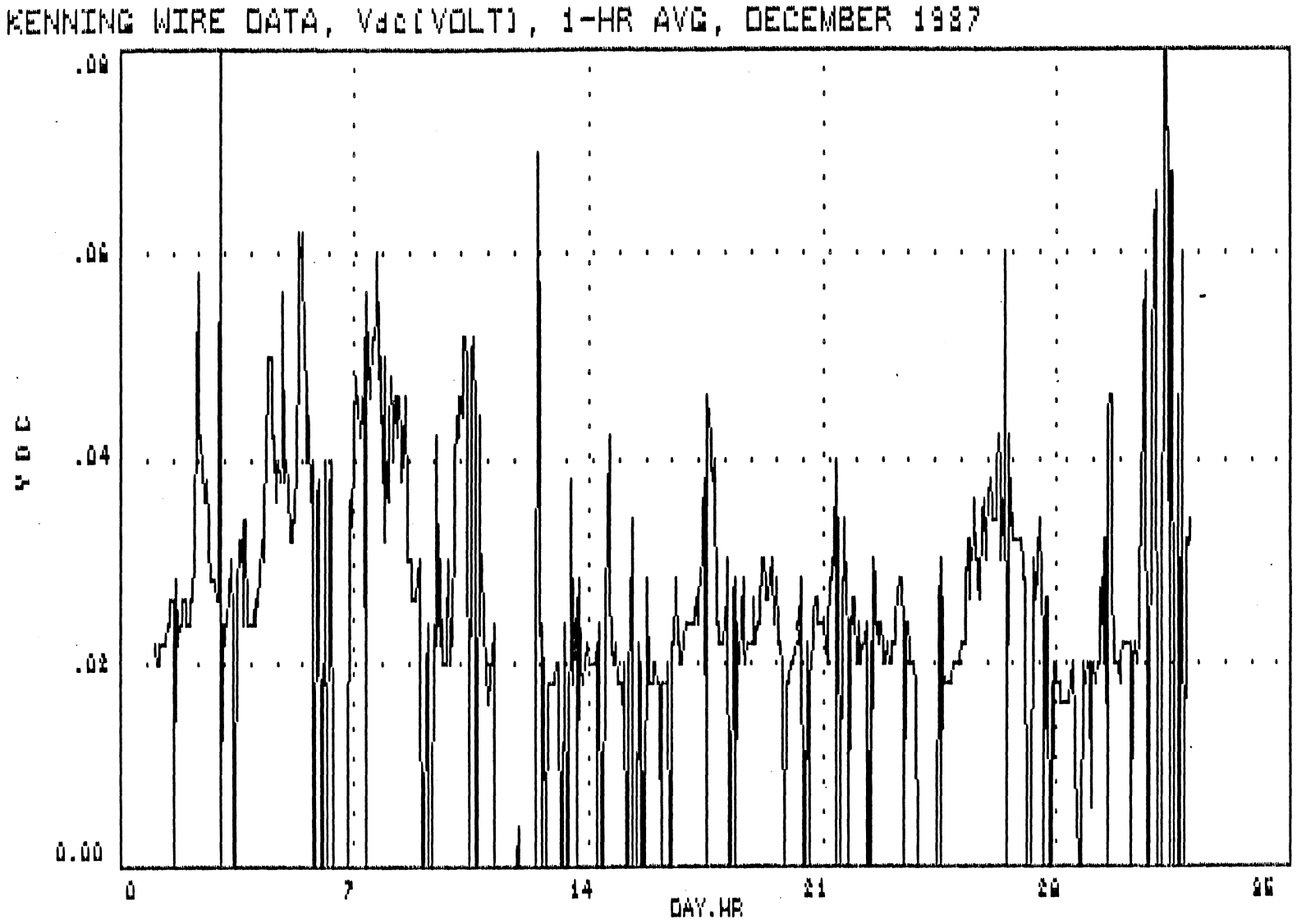
VOC
0
7
14
21
28
DAY.HR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.08
.06
.04
.02
0.00
Vdc
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21
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DAY.HR

Kenning Milk Production Data Base

A daily milk production data base was constructed from data for four cows*. Data include: month, date, am milk weight, pm milk weight, difference (am-pm), and total (am+pm) for each of the four cows, then a herd average milk weight (over four cows) and the range of day weights expressed as a per cent of herd average (meant to represent variability). Statistics and graphs of this data follow:

*Two of the four cows (#042 and #225) were kept for a time on an elevated trailer which Kenning believes mitigates certain production problems. The other two cows (#202 and #220) were kept on the ground. It should be noted that the cows were placed on the trailer several months into their lactation cycle; the maximum benefit appears to occur if the cow is put on the trailer at the time it comes fresh (Francis Kettner, personal communication). The relevent history of the four cows is as follows.

Cow #	042	202	220	225
Date Fresh	12/5/86	12/20/86	12/21/86	11/23/86
Date on Trailer	5/31/87	-	-	5/31/87
Date off Trailer	9/30/87	-	-	10/7/87

Data Base Name C:\EMD\MILK

No.	Variable	Rows	Vlab	Label
1	MONTH	360		
2	DAY	360		
3	MON.DAY	360		DECIMAL DATE
4	042AMWT	360		AM MILK WT FOR COW #042
5	042PMWT	360		PM MILK WT FOR COW #042
6	042WTDIF	360		AM-PM MILK WT FOR COW #042
7	042WTTOT	360		AM+PM MILK WT FOR COW #042
8	202AMWT	360		AM MILK WT FOR COW #202
9	202PMWT	360		PM MILK WT FOR COW #202
10	202WTDIF	360		AM-PM MILK WT FOR COW #202
11	202WTTOT	360		AM+PM MILK WT FOR COW #202
12	220AMWT	360		AM MILK WT FOR COW #220
13	220PMWT	360		PM MILK WT FOR COW #220
14	220WTDIF	360		AM-PM MILK WT FOR COW #220
15	220WTTOT	360		AM+PM MILK WT FOR COW #220
16	225AMWT	360		AM MILK WT FOR COW #225
17	225PMWT	360		PM MILK WT FOR COW #225
18	225WTDIF	360		AM-PM MILK WT FOR COW #225
19	225WTTOT	360		AM+PM MILK WT FOR COW #225
20	HERDAVG	360		HERD AVG MILK WT (4 COWS)
21	RNG/AVG	360		RANGE OF COW TOTAL MILK WT / HERDAVG
22	C22	0		
23	C23	0		
24	C24	0		

----------Descriptive Statistics----------

Data Base Name C:\EMD\MILK

Detail Report

Variable: 042AMWT AM MILK WT FOR COW #042

Mean - Average	23.37051	No. observations	360
Lower 95% c.i.limit	22.68419	No. missing values	4
Upper 95% c.i.limit	24.05682	Sum of frequencies	356
Adj sum of squares	15496.48	Sum of observations	8319.9
Standard deviation	6.606969	Std.error of mean	.3501687
Variance	43.65204	T-value for mean=0	66.74071
Coef. of variation	.2827055	T prob level	0.0000
Skewness	-.6417384	Kurtosis	-.6142349
Normality Test Value	1.000	Reject if > 1.015(10%)	1.025(5%)
100-%tile (Maximum)	36	90-%tile	31
75-%tile	27.5	10-%tile	12
50-%tile (Median)	25	Range	26.5
25-%tile	19.125	75th-25th %tile	8.375
0-%tile (Minimum)	9.5		

Variable: 042PMWT PM MILK WT FOR COW #042

Mean - Average	23.37924	No. observations	360
Lower 95% c.i.limit	22.69766	No. missing values	5
Upper 95% c.i.limit	24.06082	Sum of frequencies	355
Adj sum of squares	15197.29	Sum of observations	8299.63
Standard deviation	6.552114	Std.error of mean	.3477501
Variance	42.9302	T-value for mean=0	67.23
Coef. of variation	.2802535	T prob level	0.0000
Skewness	-.7099908	Kurtosis	-.5562601
Normality Test Value	1.057	Reject if > 1.015(10%)	1.025(5%)
100-%tile (Maximum)	36	90-%tile	30.25
75-%tile	28	10-%tile	12
50-%tile (Median)	25.5	Range	27.25
25-%tile	19	75th-25th %tile	9
0-%tile (Minimum)	8.75		

Data Base Name C:\EMD\MILK

Detail Report

Variable: 042WTDIF AM-PM MILK WT FOR COW #042

Mean - Average	9.090909E-03	No. observations	360
Lower 95% c.i.limit	-.2791903	No. missing values	8
Upper 95% c.i.limit	.2973721	Sum of frequencies	352
Adj sum of squares	2672.923	Sum of observations	3.2
Standard deviation	2.759559	Std.error of mean	.147085
Variance	7.615164	T-value for mean=0	6.180719E-02
Coef. of variation	303.5515	T prob level	0.9507
Skewness	-.0692541	Kurtosis	4.092278
Normality Test Value	1.094	Reject if > 1.015(10%)	1.026(5%)
100-%tile (Maximum)	12	90-%tile	3
75-%tile	1.25	10-%tile	-3
50-%tile (Median)	0	Range	26.75
25-%tile	-1.4	75th-25th %tile	2.65
0-%tile (Minimum)	-14.75		

Variable: 042WTTOT AM+PM MILK WT FOR COW #042

Mean - Average	46.77139	No. observations	360
Lower 95% c.i.limit	45.42612	No. missing values	8
Upper 95% c.i.limit	48.11667	Sum of frequencies	352
Adj sum of squares	58206.95	Sum of observations	16463.53
Standard deviation	12.87757	Std.error of mean	.6863767
Variance	165.8318	T-value for mean=0	68.14246
Coef. of variation	.27533	T prob level	0.0000
Skewness	-.7903206	Kurtosis	-.5811305
Normality Test Value	1.090	Reject if > 1.015(10%)	1.026(5%)
100-%tile (Maximum)	66	90-%tile	60.5
75-%tile	55	10-%tile	24.125
50-%tile (Median)	51	Range	47
25-%tile	38.5	75th-25th %tile	16.5
0-%tile (Minimum)	19		

Data Base Name C:\EMD\MILK

Detail Report

Variable: 202AMWT AM MILK WT FOR COW #202

Mean - Average	30.60049	No. observations	360
Lower 95% c.i.limit	29.8545	No. missing values	55
Upper 95% c.i.limit	31.34648	Sum of frequencies	305
Adj sum of squares	13432.05	Sum of observations	9333.15
Standard deviation	6.647133	Std.error of mean	.3806137
Variance	44.18438	T-value for mean=0	80.39776
Coef. of variation	.2172231	T prob level	0.0000
Skewness	-1.09524	Kurtosis	.6510823
Normality Test Value	1.331	Reject if > 1.018(10%)	1.029(5%)
100-%tile (Maximum)	43.5	90-%tile	37
75-%tile	35	10-%tile	18.5
50-%tile (Median)	32.5	Range	36.5
25-%tile	27.5	75th-25th %tile	7.5
0-%tile (Minimum)	7		

Variable: 202PMWT PM MILK WT FOR COW #202

Mean - Average	29.63431	No. observations	360
Lower 95% c.i.limit	28.9319	No. missing values	56
Upper 95% c.i.limit	30.33672	Sum of frequencies	304
Adj sum of squares	11830.55	Sum of observations	9008.83
Standard deviation	6.248578	Std.error of mean	.3583805
Variance	39.04473	T-value for mean=0	82.68951
Coef. of variation	.2108562	T prob level	0.0000
Skewness	-.9794024	Kurtosis	.2227071
Normality Test Value	1.345	Reject if > 1.018(10%)	1.029(5%)
100-%tile (Maximum)	46	90-%tile	35.5
75-%tile	34	10-%tile	19
50-%tile (Median)	31.625	Range	34.25
25-%tile	27	75th-25th %tile	7
0-%tile (Minimum)	11.75		

Data Base Name C:\EMD\MILK
Description Data base created at 08:12:44 on 01-01-1980

Detail Report

Variable: 202WTDIF AM-PM MILK WT FOR COW #202

Mean - Average	1.065351	No. observations	360
Lower 95% c.i.limit	.5698819	No. missing values	61
Upper 95% c.i.limit	1.56082	Sum of frequencies	299
Adj sum of squares	5694.096	Sum of observations	318.54
Standard deviation	4.371236	Std.error of mean	.2527951
Variance	19.1077	T-value for mean=0	4.214287
Coef. of variation	4.103094	T prob level	0.0000
Skewness	-2.293752	Kurtosis	23.39123
Normality Test Value	0.935	Reject if > 1.018(10%)	1.030(5%)
100-%tile (Maximum)	14.75	90-%tile	5.625
75-%tile	3	10-%tile	-3.5
50-%tile (Median)	1	Range	53.75
25-%tile	-1	75th-25th %tile	4
0-%tile (Minimum)	-39		

Variable: 202WTTOT AM+PM MILK WT FOR COW #202

Mean - Average	60.22652	No. observations	360
Lower 95% c.i.limit	58.85454	No. missing values	61
Upper 95% c.i.limit	61.5985	Sum of frequencies	299
Adj sum of squares	43660.41	Sum of observations	18007.73
Standard deviation	12.10419	Std.error of mean	.7000035
Variance	146.5114	T-value for mean=0	86.03747
Coef. of variation	.2009778	T prob level	0.0000
Skewness	-1.188077	Kurtosis	.5418857
Normality Test Value	1.924	Reject if > 1.018(10%)	1.030(5%)
100-%tile (Maximum)	79.5	90-%tile	71.5
75-%tile	68	10-%tile	38.5
50-%tile (Median)	64.5	Range	55.25
25-%tile	55.5	75th-25th %tile	12.5
0-%tile (Minimum)	24.25		

Data Base Name C:\EMD\MILK

Variable: 220AMWT AM MILK WT FOR COW #220

Mean - Average	26.2824	No. observations	360
Lower 95% c.i.limit	25.31264	No. missing values	56
Upper 95% c.i.limit	27.25216	Sum of frequencies	304
Adj sum of squares	22550.27	Sum of observations	7989.85
Standard deviation	8.626897	Std.error of mean	.4947864
Variance	74.42335	T-value for mean=0	53.11868
Coef. of variation	.3282385	T prob level	0.0000
Skewness	-.889388	Kurtosis	-.3051041
Normality Test Value	1.193	Reject if > 1.018(10%)	1.029(5%)
100-%tile (Maximum)	40.5	90-%tile	35
75-%tile	32	10-%tile	11.25
50-%tile (Median)	29	Range	35
25-%tile	22.75	75th-25th %tile	9.25
0-%tile (Minimum)	5.5		

Variable: 220PMWT PM MILK WT FOR COW #220

Mean - Average	26.15633	No. observations	360
Lower 95% c.i.limit	25.24817	No. missing values	52
Upper 95% c.i.limit	27.06449	Sum of frequencies	308
Adj sum of squares	20300.86	Sum of observations	8056.15
Standard deviation	8.131825	Std.error of mean	.4633537
Variance	66.12656	T-value for mean=0	56.45004
Coef. of variation	.3108932	T prob level	0.0000
Skewness	-.8568193	Kurtosis	-.3166882
Normality Test Value	1.132	Reject if > 1.018(10%)	1.029(5%)
100-%tile (Maximum)	38.5	90-%tile	34.5
75-%tile	32	10-%tile	12
50-%tile (Median)	28.75	Range	32
25-%tile	22.25	75th-25th %tile	9.75
0-%tile (Minimum)	6.5		

Data Base Name C:\EMD\MILK

Variable: 220WTDIF AM-PM MILK WT FOR COW #220

Mean - Average	.2456478	No. observations	360
Lower 95% c.i.limit	-.1161486	No. missing values	59
Upper 95% c.i.limit	.6074443	Sum of frequencies	301
Adj sum of squares	3076.949	Sum of observations	73.94
Standard deviation	3.202576	Std.error of mean	.1845934
Variance	10.25649	T-value for mean=0	1.330751
Coef. of variation	13.03727	T prob level	0.1833
Skewness	-.3617876	Kurtosis	1.985818
Normality Test Value	1.233	Reject if > 1.018(10%)	1.030(5%)
100-%tile (Maximum)	11	90-%tile	3.75
75-%tile	2	10-%tile	-3.5
50-%tile (Median)	.5	Range	24.5
25-%tile	-1.5	75th-25th %tile	3.5
0-%tile (Minimum)	-13.5		

Variable: 220WTTOT AM+PM MILK WT FOR COW #220

Mean - Average	52.54067	No. observations	360
Lower 95% c.i.limit	50.68798	No. missing values	59
Upper 95% c.i.limit	54.39335	Sum of frequencies	301
Adj sum of squares	80684.96	Sum of observations	15814.74
Standard deviation	16.39969	Std.error of mean	.9452625
Variance	268.9499	T-value for mean=0	55.58315
Coef. of variation	.3121333	T prob level	0.0000
Skewness	-.9158948	Kurtosis	-.2666804
Normality Test Value	1.227	Reject if > 1.018(10%)	1.030(5%)
100-%tile (Maximum)	77.5	90-%tile	69.5
75-%tile	64.5	10-%tile	23.25
50-%tile (Median)	58	Range	64.5
25-%tile	45	75th-25th %tile	19.5
0-%tile (Minimum)	13		

Data Base Name C:\EMD\MILK

Variable: 225AMWT AM MILK WT FOR COW #225

Mean - Average	29.52206	No. observations	360
Lower 95% c.i.limit	29.02667	No. missing values	88
Upper 95% c.i.limit	30.01745	Sum of frequencies	272
Adj sum of squares	4709.068	Sum of observations	8030
Standard deviation	4.168529	Std.error of mean	.2527542
Variance	17.37663	T-value for mean=0	116.8015
Coef. of variation	.1412005	T prob level	0.0000
Skewness	-1.124748	Kurtosis	.9923012
Normality Test Value	1.328	Reject if > 1.020(10%)	1.033(5%)
100-%tile (Maximum)	37.5	90-%tile	33.75
75-%tile	32.375	10-%tile	23.125
50-%tile (Median)	30.5	Range	22.5
25-%tile	28	75th-25th %tile	4.375
0-%tile (Minimum)	15		

Variable: 225PMWT PM MILK WT FOR COW #225

Mean - Average	29.79544	No. observations	360
Lower 95% c.i.limit	29.3348	No. missing values	86
Upper 95% c.i.limit	30.25608	Sum of frequencies	274
Adj sum of squares	4131.832	Sum of observations	8163.95
Standard deviation	3.890362	Std.error of mean	.2350253
Variance	15.13492	T-value for mean=0	126.7754
Coef. of variation	.130569	T prob level	0.0000
Skewness	-1.308967	Kurtosis	1.72047
Normality Test Value	1.483	Reject if > 1.020(10%)	1.033(5%)
100-%tile (Maximum)	37	90-%tile	33.75
75-%tile	32.5	10-%tile	24.25
50-%tile (Median)	31	Range	22
25-%tile	28	75th-25th %tile	4.5
0-%tile (Minimum)	15		

Data Base Name C:\EMD\MILK

Detail Report

Variable: 225WTDIF AM-PM MILK WT FOR COW #225

Mean - Average	-.2924354	No. observations	360
Lower 95% c.i.limit	-.6823208	No. missing values	89
Upper 95% c.i.limit	9.744997E-02	Sum of frequencies	271
Adj sum of squares	2895.415	Sum of observations	-79.25
Standard deviation	3.274715	Std.error of mean	.1989248
Variance	10.72376	T-value for mean=0	-1.47008
Coef. of variation	-11.19808	T prob level	0.1415
Skewness	-.4712377	Kurtosis	1.951332
Normality Test Value	1.182	Reject if > 1.020(10%)	1.033(5%)
100-%tile (Maximum)	13.25	90-%tile	3.25
75-%tile	2	10-%tile	-4.5
50-%tile (Median)	0	Range	26.75
25-%tile	-1.75	75th-25th %tile	3.75
0-%tile (Minimum)	-13.5		

Variable: 225WTTOT AM+PM MILK WT FOR COW #225

Mean - Average	59.31808	No. observations	360
Lower 95% c.i.limit	58.44129	No. missing values	89
Upper 95% c.i.limit	60.19487	Sum of frequencies	271
Adj sum of squares	14642.87	Sum of observations	16075.2
Standard deviation	7.364295	Std.error of mean	.447349
Variance	54.23284	T-value for mean=0	132.5991
Coef. of variation	.1241492	T prob level	0.0000
Skewness	-1.576373	Kurtosis	2.337957
Normality Test Value	1.262	Reject if > 1.020(10%)	1.033(5%)
100-%tile (Maximum)	69.25	90-%tile	66
75-%tile	64	10-%tile	47.875
50-%tile (Median)	61.5	Range	39.25
25-%tile	57	75th-25th %tile	7
0-%tile (Minimum)	30		

Data Base Name C:\EMD\MILK

Variable: HERDAVG HERD AVG MILK WT (4 COWS)

Mean - Average	58.27199	No. observations	360
Lower 95% c.i.limit	57.35276	No. missing values	109
Upper 95% c.i.limit	59.19122	Sum of frequencies	251
Adj sum of squares	13802.69	Sum of observations	14626.27
Standard deviation	7.430394	Std.error of mean	.4690023
Variance	55.21075	T-value for mean=0	124.2467
Coef. of variation	.1275123	T prob level	0.0000
Skewness	-1.376533	Kurtosis	1.797559
Normality Test Value	1.286	Reject if > 1.022(10%)	1.035(5%)
100-%tile (Maximum)	70.37	90-%tile	65.87
75-%tile	62.81	10-%tile	46.185
50-%tile (Median)	59.93	Range	38.94
25-%tile	55.75	75th-25th %tile	7.060001
0-%tile (Minimum)	31.43		

Variable: RNG/AVG RANGE OF COW TOTAL MILK WT / HERDAVG

Mean - Average	25.09163	No. observations	360
Lower 95% c.i.limit	23.67809	No. missing values	109
Upper 95% c.i.limit	26.50518	Sum of frequencies	251
Adj sum of squares	32638.89	Sum of observations	6298
Standard deviation	11.42609	Std.error of mean	.7212085
Variance	130.5556	T-value for mean=0	34.7911
Coef. of variation	.4553746	T prob level	0.0000
Skewness	.9480029	Kurtosis	1.449726
Normality Test Value	1.224	Reject if > 1.022(10%)	1.035(5%)
100-%tile (Maximum)	67	90-%tile	41
75-%tile	30	10-%tile	12
50-%tile (Median)	24	Range	65
25-%tile	18	75th-25th %tile	12
0-%tile (Minimum)	2		

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 2WTD IF	04 2WTO T	20 2AM WT	20 2PM WT	20 2WTD IF	20 2WTO T	22 2AM WT	22 2PM WT	22 2WTD IF	22 2WTO T	22 5AM WT	22 5PM WT	22 5WTD IF	22 5WTO T	HERD AVG	RNG/AVG
1	5	*	*	*	*	*	*	*	*	*	27.50	*	*	*	33.00	*	*	*	*
1	6	32.00	32.50	-0.50	64.50	30.50	29.00	1.50	59.50	27.75	27.25	0.50	55.00	31.00	29.00	2.00	60.00	59.75	15
1	7	31.75	30.50	1.25	62.25	30.00	32.50	-2.50	62.50	30.00	29.50	0.50	59.50	31.75	29.00	2.75	60.75	61.25	4
1	8	32.50	30.00	2.50	62.50	32.50	32.00	0.50	64.50	30.50	31.50	-1.00	62.00	30.00	30.50	-0.50	60.50	62.37	6
1	9	32.50	30.00	2.50	62.50	32.50	31.00	1.50	63.50	31.50	32.00	-0.50	63.50	32.50	31.50	1.00	64.00	63.37	2
1	10	31.00	31.00	0.00	62.00	34.00	32.00	2.00	66.00	33.00	32.00	1.00	65.00	35.00	33.00	2.00	68.00	65.25	9
1	11	29.00	36.00	-7.00	65.00	29.00	35.50	-6.50	64.50	30.00	33.75	-3.75	63.75	31.00	32.00	-1.00	63.00	64.06	3
1	12	30.50	32.00	-1.50	62.50	32.50	32.00	0.50	64.50	33.00	27.50	5.50	60.50	30.00	33.00	-3.00	63.00	62.62	6
1	13	32.00	31.50	0.50	63.50	32.50	34.50	-2.00	67.00	28.00	31.00	-3.00	59.00	28.50	32.00	-3.50	60.50	62.50	12
1	14	35.00	31.00	4.00	66.00	33.00	34.00	-1.00	67.00	31.00	31.00	0.00	62.00	33.50	32.00	1.50	65.50	65.12	7
1	15	32.00	30.25	1.75	62.25	33.00	30.50	2.50	63.50	31.50	29.25	2.25	60.75	32.50	30.50	2.00	63.00	62.37	4
1	16	34.00	32.00	2.00	66.00	36.50	32.00	4.50	68.50	31.50	30.25	1.25	61.75	33.00	31.00	2.00	64.00	65.06	10
1	17	30.00	30.50	-0.50	60.50	35.00	30.00	5.00	65.00	32.00	31.00	1.00	63.00	32.00	31.50	0.50	63.50	63.00	7
1	18	29.25	30.75	-1.50	60.00	35.00	34.00	1.00	69.00	30.00	33.00	-3.00	63.00	31.50	30.00	1.50	61.50	63.37	14
1	19	33.00	30.50	2.50	63.50	38.50	33.50	5.00	72.00	34.50	31.00	3.50	65.50	36.50	32.00	4.50	68.50	67.37	12
1	20	31.50	28.50	3.00	60.00	35.50	34.75	0.75	70.25	35.00	30.50	4.50	65.50	33.50	31.50	2.00	65.00	65.18	15
1	21	29.75	33.00	-3.25	62.75	32.00	31.50	0.50	63.50	35.00	34.00	1.00	69.00	34.50	31.50	3.00	66.00	65.31	9
1	22	28.50	33.00	-4.50	61.50	37.50	30.00	7.50	67.50	34.50	32.50	2.00	67.00	34.75	33.50	1.25	68.25	66.06	10
1	23	30.25	33.50	-3.25	63.75	33.00	33.00	0.00	66.00	29.25	32.50	-3.25	61.75	32.00	32.50	-0.50	64.50	64.00	6
1	24	31.50	32.75	-1.25	64.25	37.25	34.00	3.25	71.25	33.00	34.50	-1.50	67.50	35.00	33.75	1.25	68.75	67.93	10
1	25	27.75	30.00	-2.25	57.75	35.00	39.30	-4.30	74.30	31.50	33.00	-1.50	64.50	34.00	31.50	2.50	65.50	65.51	25
1	26	29.80	30.00	-0.21	59.80	29.00	33.50	-4.50	62.50	33.30	33.25	0.04	66.55	34.30	32.00	2.29	66.30	63.78	10
1	27	31.50	30.50	1.00	62.00	33.50	36.50	-3.00	70.00	33.00	32.00	1.00	65.00	34.25	33.50	0.75	67.75	66.18	12
1	28	30.50	31.00	-0.50	61.50	33.00	30.00	3.00	63.00	32.25	30.00	2.25	62.25	35.50	33.75	1.75	69.25	64.00	12
1	29	29.75	30.25	-0.50	60.00	29.25	28.00	1.25	57.25	34.25	29.25	5.00	63.50	35.25	31.25	4.00	66.50	61.81	14
1	30	29.00	30.25	-1.25	59.25	32.00	30.00	2.00	62.00	34.25	33.00	1.25	67.25	33.25	34.50	-1.25	67.75	64.06	13
1	31	31.50	30.75	0.75	62.25	28.00	27.25	0.75	55.25	37.00	37.50	-0.50	74.50	37.50	24.25	13.25	61.75	63.43	30
2	1	31.00	34.00	-3.00	65.00	32.00	31.50	0.50	63.50	36.50	33.50	3.00	70.00	32.00	28.00	4.00	60.00	64.62	15
2	2	31.50	29.25	2.25	60.75	31.50	31.50	0.00	63.00	35.00	33.50	1.50	68.50	31.50	30.00	1.50	61.50	63.43	12
2	3	23.50	24.50	-1.00	48.00	32.00	35.00	-3.00	67.00	*	*	*	*	29.50	35.00	-5.50	64.50	*	*
2	4	26.00	22.25	3.75	48.25	31.25	29.50	1.75	60.75	25.25	27.50	-2.25	52.75	31.00	30.00	1.00	61.00	55.68	22
2	5	22.25	24.25	-2.00	46.50	31.00	30.50	0.50	61.50	28.50	29.00	-0.50	57.50	29.50	28.00	1.50	57.50	55.75	26
2	6	24.00	24.00	0.00	48.00	33.00	30.50	2.50	63.50	30.00	25.00	5.00	55.00	31.00	25.50	5.50	56.50	55.75	27
2	7	25.00	25.25	-0.25	50.25	35.50	31.75	3.75	67.25	28.00	25.75	2.25	53.75	28.75	26.50	2.25	55.25	56.62	30
2	8	25.00	26.50	-1.50	51.50	31.50	32.25	-0.75	63.75	30.50	31.00	-0.50	61.50	30.00	27.75	2.25	57.75	58.62	20
2	9	27.50	25.50	2.00	53.00	33.00	26.00	7.00	59.00	34.00	32.00	2.00	66.00	30.00	31.00	-1.00	61.00	59.75	21
2	10	27.25	29.25	-2.00	56.50	36.25	33.00	3.25	69.25	33.00	33.50	-0.50	66.50	32.25	33.00	-0.75	65.25	64.37	19
2	11	28.25	30.50	-2.25	58.75	35.50	33.00	2.50	68.50	32.00	35.50	-3.50	67.50	31.50	33.00	-1.50	64.50	64.81	15
2	12	30.00	28.00	2.00	58.00	38.50	33.00	5.50	71.50	36.00	34.00	2.00	70.00	33.75	31.50	2.25	65.25	66.18	20
2	13	29.00	29.00	0.00	58.00	35.00	35.50	-0.50	70.50	31.00	29.50	1.50	60.50	31.75	33.50	-1.75	65.25	63.56	19
2	14	30.00	31.25	-1.25	61.25	37.25	35.00	2.25	72.25	34.50	36.00	-1.50	70.50	32.50	30.00	2.50	62.50	66.62	16
2	15	31.00	31.00	0.00	62.00	38.00	34.00	4.00	72.00	34.50	34.00	0.50	68.50	23.50	20.00	3.50	43.50	61.50	46
2	16	31.00	27.50	3.50	58.50	43.50	36.00	7.50	79.50	36.25	33.50	2.75	69.75	19.25	19.00	0.25	38.25	61.50	67

1987 KENNING MILK PRODUCTION RECORD.FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 2WT DIF	04 4WT OT	20 2AM WT	20 2PM WT	20 2WT DIF	20 4WT OT	22 0AM WT	22 0PM WT	22 0WT DIF	20 0WT OT	20 5AM WT	25 5PM WT	25 5WT DIF	25 5WT OT	HERD AVG	RNG/AVG
2	17	32.50	28.00	4.50	60.50	*	34.50	*	*	34.75	32.00	2.75	66.75	23.50	25.00	-1.50	48.50	*	*
2	18	28.00	27.75	0.25	55.75	37.00	34.75	2.25	71.75	36.50	35.50	1.00	72.00	29.50	27.50	2.00	57.00	64.12	25
2	19	29.00	27.00	2.00	56.00	32.50	36.00	-3.50	68.50	36.50	30.00	6.50	66.50	29.50	28.00	1.50	57.50	62.12	20
2	20	26.75	28.25	-1.50	55.00	38.50	37.00	1.50	75.50	37.00	35.00	2.00	72.00	31.00	29.00	2.00	60.00	65.62	31
2	21	25.75	29.00	-3.25	54.75	37.00	34.50	2.50	71.50	37.00	33.25	3.75	70.25	29.50	29.00	0.50	58.50	63.75	26
2	22	29.50	28.00	1.50	57.50	39.00	36.50	2.50	75.50	36.00	37.25	-1.25	73.25	31.00	30.00	1.00	61.00	66.81	26
2	23	29.00	28.30	0.70	57.30	40.00	36.80	3.20	76.80	39.00	34.50	4.50	73.50	32.75	29.00	3.75	61.75	67.33	28
2	24	27.00	29.75	-2.75	56.75	33.50	35.00	-1.50	68.50	35.00	36.00	-1.00	71.00	31.30	32.50	-1.21	63.80	65.01	21
2	25	29.00	31.50	-2.50	60.50	38.50	36.00	2.50	74.50	35.00	35.75	-0.75	70.75	33.25	33.50	-0.25	66.75	68.12	20
2	26	30.25	30.00	0.25	60.25	37.50	36.00	1.50	73.50	35.00	38.50	-3.50	73.50	31.25	33.50	-2.25	64.75	68.00	19
2	27	30.00	30.00	0.00	60.00	36.00	33.00	3.00	69.00	37.50	37.00	0.50	74.50	32.25	32.75	-0.50	65.00	67.12	21
2	28	32.50	32.50	0.00	65.00	42.50	35.50	7.00	78.00	40.50	35.00	5.50	75.50	31.50	31.50	0.00	63.00	70.37	21
3	1	30.50	32.00	-1.50	62.50	37.00	37.00	0.00	74.00	37.00	34.50	2.50	71.50	33.00	30.50	2.50	63.50	67.87	16
3	2	30.50	28.25	2.25	58.75	35.00	34.25	0.75	69.25	33.50	33.50	0.00	67.00	33.00	31.25	1.75	64.25	64.81	16
3	3	31.00	28.00	3.00	59.00	38.50	35.00	3.50	73.50	38.50	35.00	3.50	73.50	32.00	31.50	0.50	63.50	67.37	21
3	4	27.25	30.00	-2.75	57.25	36.50	37.00	-0.50	73.50	34.00	36.50	-2.50	70.50	28.00	31.00	-3.00	59.00	65.06	24
3	5	30.00	30.00	0.00	60.00	38.50	34.50	4.00	73.00	33.00	34.50	-1.50	67.50	33.50	34.00	-0.50	67.50	67.00	19
3	6	31.00	29.50	1.50	60.50	35.50	32.00	3.50	67.50	33.25	37.00	-3.75	70.25	32.50	31.00	1.50	63.50	65.43	14
3	7	33.00	29.75	3.25	62.75	39.50	36.50	3.00	76.00	37.00	36.50	0.50	73.50	33.00	31.00	2.00	64.00	69.06	19
3	8	29.00	31.00	-2.00	60.00	33.50	32.50	1.00	66.00	35.50	35.50	0.00	71.00	29.50	32.00	-2.50	61.50	64.62	17
3	9	31.00	29.00	2.00	60.00	33.75	36.00	-2.25	69.75	37.75	35.00	2.75	72.75	30.75	32.00	-1.25	62.75	66.31	19
3	10	25.50	30.00	-4.50	55.50	33.00	35.50	-2.50	68.50	30.00	36.00	-6.00	66.00	29.00	32.50	-3.50	61.50	62.87	20
3	11	29.50	30.50	-1.00	60.00	37.00	35.00	2.00	72.00	38.25	33.50	4.75	71.75	30.00	33.00	-3.00	63.00	66.68	17
3	12	29.25	34.00	-4.75	63.25	38.50	35.25	3.25	73.75	35.50	37.25	-1.75	72.75	33.75	34.50	-0.75	68.25	69.50	15
3	13	25.00	29.50	-4.50	54.50	39.00	37.00	2.00	76.00	38.00	35.50	2.50	73.50	33.50	32.50	1.00	66.00	67.50	31
3	14	26.50	27.00	-0.50	53.50	38.50	33.50	5.00	72.00	39.50	38.00	1.50	77.50	34.50	33.00	1.50	67.50	67.62	35
3	15	27.00	26.00	1.00	53.00	37.50	37.00	0.50	74.50	31.50	38.00	-6.50	69.50	33.50	30.50	3.00	64.00	65.25	32
3	16	25.00	29.00	-4.00	54.00	39.25	37.00	2.25	76.25	35.50	37.00	-1.50	72.50	36.50	32.00	4.50	68.50	67.81	32
3	17	26.00	28.00	-2.00	54.00	37.25	39.00	-1.75	76.25	33.00	36.50	-3.50	69.50	31.50	32.25	-0.75	63.75	65.87	33
3	18	29.00	26.50	2.50	55.50	37.25	34.00	3.25	71.25	35.50	37.50	-2.00	73.00	30.00	35.50	-5.50	65.50	66.31	26
3	19	27.25	27.00	0.25	54.25	36.00	38.00	-2.00	74.00	37.00	35.00	2.00	72.00	32.50	31.50	1.00	64.00	66.06	29
3	20	25.00	27.00	-2.00	52.00	32.50	36.00	-3.50	68.50	35.00	33.50	1.50	68.50	31.00	31.50	-0.50	62.50	62.87	26
3	21	27.00	25.00	2.00	52.00	37.00	34.00	3.00	71.00	36.50	36.00	0.50	72.50	33.00	33.00	0.00	66.00	65.37	31
3	22	24.50	26.00	-1.50	50.50	35.25	30.00	5.25	65.25	33.50	33.00	0.50	66.50	32.25	32.50	-0.25	64.75	61.75	25
3	23	27.25	27.00	0.25	54.25	39.00	32.50	6.50	71.50	37.25	28.30	8.95	65.55	33.00	29.00	4.00	62.00	63.32	27
3	24	25.30	25.00	0.29	50.30	32.00	37.00	-5.00	69.00	33.50	34.50	-1.00	68.00	28.30	29.75	-1.46	58.05	61.33	30
3	25	26.00	27.50	-1.50	53.50	32.50	36.50	-4.00	69.00	31.50	33.00	-1.50	64.50	29.75	26.00	3.75	55.75	60.68	25
3	26	25.00	29.50	-4.50	54.50	33.50	33.50	0.00	67.00	35.00	33.00	2.00	68.00	28.00	25.00	3.00	53.00	60.62	24
3	27	26.00	29.00	-3.00	55.00	36.00	34.50	1.50	70.50	32.00	33.00	-1.00	65.00	29.75	31.00	-1.25	60.75	62.81	24
3	28	25.00	28.00	-3.00	53.00	35.50	31.00	4.50	66.50	34.00	31.00	3.00	65.00	32.00	28.00	4.00	60.00	61.12	22
3	29	24.50	26.00	-1.50	50.50	31.50	35.00	-3.50	66.50	31.50	30.00	1.50	61.50	30.50	29.50	1.00	60.00	59.62	26
3	30	28.50	26.00	2.50	54.50	35.50	29.50	6.00	65.00	33.00	30.00	3.00	63.00	31.50	28.50	3.00	60.00	60.62	17
3	31	27.50	29.00	-1.50	56.50	37.00	38.00	-1.00	75.00	30.50	31.00	-0.50	61.50	30.75	33.00	-2.25	63.75	64.18	28

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2A MW T	04 2P MW T	04 2W TD IF	04 2W TO T	02 2A MW T	02 2P MW T	02 2W TD IF	02 2W TO T	02 2A MW T	02 2P MW T	02 2W TD IF	02 2W TO T	02 5A MW T	02 5P MW T	02 5W TD IF	02 5W TO T	HERD AVG	RNG/AVG
4	1	24.00	28.00	-4.00	52.00	32.50	37.00	-4.50	69.50	33.00	31.50	1.50	64.50	30.00	34.00	-4.00	64.00	62.50	28
4	2	24.75	28.50	-3.75	53.25	36.00	33.00	3.00	69.00	29.00	27.00	2.00	56.00	32.00	31.50	0.50	63.50	60.43	26
4	3	24.75	25.50	-0.75	50.25	33.00	33.00	0.00	66.00	33.50	29.50	4.00	63.00	33.00	31.50	1.50	64.50	60.93	25
4	4	27.25	27.00	0.25	54.25	32.00	33.50	-1.50	65.50	35.50	32.50	3.00	68.00	31.25	32.00	-0.75	63.25	62.75	21
4	5	23.00	24.50	-1.50	47.50	31.50	36.00	-4.50	67.50	32.00	33.00	-1.00	65.00	30.50	31.00	-0.50	61.50	60.37	33
4	6	26.50	25.50	1.00	52.00	34.00	35.00	-1.00	69.00	30.50	34.00	-3.50	64.50	33.00	29.75	3.25	62.75	62.06	27
4	7	26.00	25.00	1.00	51.00	35.00	31.00	4.00	66.00	34.00	29.50	4.50	63.50	32.00	*	*	*	*	*
4	8	25.50	21.50	4.00	47.00	37.00	32.00	5.00	69.00	34.25	35.00	-0.75	69.25	30.00	27.50	2.50	57.50	60.68	36
4	9	28.00	26.00	2.00	54.00	*	33.50	*	*	*	31.75	*	*	31.50	31.55	-0.05	63.05	*	*
4	10	25.50	25.75	-0.25	51.25	33.00	34.50	-1.50	67.50	33.00	30.00	3.00	63.00	29.00	30.25	-1.25	59.25	60.25	26
4	11	24.50	25.00	-0.50	49.50	36.00	32.00	4.00	68.00	36.50	29.50	7.00	66.00	31.50	28.00	3.50	59.50	60.75	30
4	12	23.00	28.00	-5.00	51.00	*	32.50	*	*	33.25	32.00	1.25	65.25	30.75	31.00	-0.25	61.75	*	*
4	13	25.50	25.00	0.50	50.50	35.00	29.25	5.75	64.25	33.50	31.50	2.00	65.00	33.00	31.50	1.50	64.50	61.06	23
4	14	20.00	28.50	-8.50	48.50	30.50	34.50	-4.00	65.00	30.25	30.00	0.25	60.25	28.50	32.50	-4.00	61.00	58.68	28
4	15	24.50	27.25	-2.75	51.75	34.00	32.00	2.00	66.00	32.00	31.00	1.00	63.00	27.75	35.00	-7.25	62.75	60.87	23
4	16	25.25	25.50	-0.25	50.75	32.00	31.00	1.00	63.00	33.00	34.00	-1.00	67.00	29.50	30.50	-1.00	60.00	60.18	27
4	17	25.00	26.00	-1.00	51.00	34.25	29.75	4.50	64.00	32.00	28.25	3.75	60.25	28.25	28.25	0.00	56.50	57.93	22
4	18	28.00	27.50	0.50	55.50	34.50	29.00	5.50	63.50	35.25	30.00	5.25	65.25	31.50	30.50	1.00	62.00	61.56	15
4	19	26.00	25.00	1.00	51.00	34.00	32.50	1.50	66.50	30.00	32.00	-2.00	62.00	31.00	31.00	0.00	62.00	60.37	25
4	20	25.00	26.25	-1.25	51.25	34.25	32.75	1.50	67.00	32.00	27.75	4.25	59.75	32.50	31.75	0.75	64.25	60.56	26
4	21	25.00	27.00	-2.00	52.00	36.00	35.00	1.00	71.00	33.00	32.00	1.00	65.00	31.50	31.50	0.00	63.00	62.75	30
4	22	24.00	27.25	-3.25	51.25	35.00	32.25	2.75	67.25	27.50	35.00	-7.50	62.50	32.50	33.00	-0.50	65.50	61.62	25
4	23	23.25	27.00	-3.75	50.25	32.25	27.80	4.45	60.05	29.75	31.30	-1.55	61.05	30.50	31.80	-1.30	62.30	58.41	20
4	24	24.80	25.25	-0.46	50.05	33.00	35.50	-2.50	68.50	29.00	31.00	-2.00	60.00	28.80	33.50	-4.71	62.30	60.21	30
4	25	25.50	25.50	0.00	51.00	31.50	35.00	-3.50	66.50	31.50	33.00	-1.50	64.50	34.50	31.50	3.00	66.00	62.00	25
4	26	23.00	28.00	-5.00	51.00	34.25	33.00	1.25	67.25	31.00	33.00	-2.00	64.00	32.25	34.00	-1.75	66.25	62.12	26
4	27	27.25	23.50	3.75	50.75	35.25	32.25	3.00	67.50	32.00	32.00	0.00	64.00	32.00	31.50	0.50	63.50	61.43	27
4	28	26.50	23.23	3.27	49.73	32.50	32.50	0.00	65.00	30.50	29.75	0.75	60.25	32.50	32.25	0.25	64.75	59.93	25
4	29	27.50	26.00	1.50	53.50	33.50	31.50	2.00	65.00	32.00	28.75	3.25	60.75	30.50	33.50	-3.00	64.00	60.81	18
4	30	24.00	22.50	1.50	46.50	31.50	31.00	0.50	62.50	31.00	*	*	*	32.00	31.50	0.50	63.50	*	*
5	1	27.25	22.00	5.25	49.25	33.00	32.00	1.00	65.00	32.25	33.00	-0.75	65.25	32.50	31.50	1.00	64.00	60.87	26
5	2	24.00	25.50	-1.50	49.50	32.50	32.25	0.25	64.75	28.50	31.75	-3.25	60.25	32.75	31.50	1.25	64.25	59.68	25
5	3	25.75	25.00	0.75	50.75	30.50	34.25	-3.75	64.75	29.00	33.00	-4.00	62.00	30.00	31.00	-1.00	61.00	59.62	23
5	4	24.75	27.00	-2.25	51.75	33.00	33.00	0.00	66.00	28.50	37.50	-9.00	66.00	24.25	31.00	-6.75	55.25	59.75	23
5	5	24.50	24.00	0.50	48.50	32.50	33.50	-1.00	66.00	31.50	32.25	-0.75	63.75	30.50	31.50	-1.00	62.00	60.06	29
5	6	23.50	26.50	-3.00	50.00	31.00	36.50	-5.50	67.50	29.75	30.00	-0.25	59.75	32.00	32.50	-0.50	64.50	60.43	28
5	7	24.00	24.75	-0.75	48.75	34.00	34.25	-0.25	68.25	31.00	30.50	0.50	61.50	31.00	30.00	1.00	61.00	59.87	32
5	8	25.50	26.75	-1.25	52.25	35.50	32.25	3.25	67.75	32.00	33.00	-1.00	65.00	32.25	32.00	0.25	64.25	62.31	24
5	9	24.50	27.00	-2.50	51.50	35.50	*	*	*	33.50	33.00	0.50	66.50	29.50	29.00	0.50	58.50	*	*
5	10	25.50	25.00	0.50	50.50	34.00	34.00	0.00	68.00	31.25	32.00	-0.75	63.25	29.75	31.00	-1.25	60.75	60.62	28
5	11	*	26.50	*	*	33.00	32.00	1.00	65.00	31.75	33.00	-1.25	64.75	34.50	32.50	2.00	67.00	*	*
5	12	25.75	25.50	0.25	51.25	31.50	29.25	2.25	60.75	26.25	33.00	-6.75	59.25	32.50	32.75	-0.25	65.25	59.12	23
5	13	26.50	27.50	-1.00	54.00	30.00	34.00	-4.00	64.00	29.25	32.00	-2.75	61.25	33.75	32.00	1.75	65.75	61.25	19

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 2WTD IF	04 2WTT OT	20 2AM WT	20 2PM WT	20 2WTD IF	20 2WTT OT	22 0AM WT	22 0PM WT	22 0WTD IF	22 0WTT OT	22 5AM WT	22 5PM WT	22 5WTD IF	22 5WTT OT	HRD AVG	RNG/AVG
5	14	28.25	26.00	2.25	54.25	34.25	32.00	2.25	66.25	29.00	29.50	-0.50	58.50	32.50	29.50	3.00	62.00	60.25	19
5	15	23.75	24.25	-0.50	48.00	32.00	33.50	-1.50	65.50	30.00	29.00	1.00	59.00	32.00	32.00	0.00	64.00	59.12	29
5	16	26.50	*	*	*	34.50	31.50	3.00	66.00	30.75	28.00	2.75	58.75	31.50	30.75	0.75	62.25	*	*
5	17	24.50	25.50	-1.00	50.00	35.00	34.00	1.00	69.00	27.75	29.00	-1.25	56.75	30.25	31.00	-0.75	61.25	59.25	32
5	18	25.00	25.75	-0.75	50.75	*	31.25	*	*	28.00	30.25	-2.25	58.25	31.00	30.75	0.25	61.75	*	*
5	19	27.50	26.50	1.00	54.00	34.75	28.25	6.50	63.00	29.00	30.50	-1.50	59.50	30.25	32.25	-2.00	62.50	59.75	15
5	20	24.50	25.00	-0.50	49.50	33.00	30.50	2.50	63.50	30.50	28.00	2.50	58.50	32.00	30.00	2.00	62.00	58.37	23
5	21	27.00	25.00	2.00	52.00	33.25	35.00	-1.75	68.25	30.00	28.75	1.25	58.75	32.00	33.00	-1.00	65.00	61.00	26
5	22	24.50	25.75	-1.25	50.25	33.00	31.25	1.75	64.25	31.00	31.25	-0.25	62.25	35.00	30.50	4.50	65.50	60.56	25
5	23	25.00	26.00	-1.00	51.00	30.25	29.00	1.25	59.25	*	29.00	*	*	32.25	34.50	-2.25	66.75	*	*
5	24	26.00	26.50	-0.50	52.50	33.00	32.00	1.00	65.00	30.00	29.00	1.00	59.00	34.00	33.00	1.00	67.00	60.87	23
5	25	25.50	26.80	-1.30	52.30	33.00	29.50	3.50	62.50	29.00	31.00	-2.00	60.00	36.00	27.80	8.20	63.80	59.65	19
5	26	26.80	23.50	3.29	50.30	31.80	32.50	-0.71	64.30	25.50	34.00	-8.50	59.50	33.80	34.00	-0.21	67.80	60.47	28
5	27	28.00	27.00	1.00	55.00	36.25	32.00	4.25	68.25	29.50	28.00	1.50	57.50	34.00	31.50	2.50	65.50	61.56	21
5	28	25.00	23.50	1.50	48.50	32.00	30.00	2.00	62.00	*	30.00	*	*	32.50	31.75	0.75	64.25	*	*
5	29	26.25	25.00	1.25	51.25	32.75	31.50	1.25	64.25	31.00	29.00	2.00	60.00	34.00	31.75	2.25	65.75	60.31	24
5	30	27.25	22.75	4.50	50.00	32.75	31.00	1.75	63.75	30.00	28.50	1.50	58.50	33.75	31.25	2.50	65.00	59.31	25
5	31	25.50	23.50	2.00	49.00	34.50	32.00	2.50	66.50	32.50	29.25	3.25	61.75	32.75	28.75	4.00	61.50	59.68	29
6	1	24.25	25.25	-1.00	49.50	32.50	33.13	-0.64	65.63	31.00	31.00	0.00	62.00	29.25	31.50	-2.25	60.75	59.47	27
6	2	26.00	24.50	1.50	50.50	32.25	30.50	1.75	62.75	31.25	30.25	1.00	61.50	34.00	30.00	4.00	64.00	59.68	22
6	3	29.25	25.25	4.00	54.50	30.25	30.50	-0.25	60.75	32.00	30.00	2.00	62.00	32.00	27.00	5.00	59.00	59.06	12
6	4	29.00	25.75	3.25	54.75	30.00	38.25	-8.25	68.25	32.75	31.50	1.25	64.25	24.75	31.50	-6.75	56.25	60.87	22
6	5	26.25	23.75	2.50	50.00	33.75	30.00	3.75	63.75	30.50	27.25	3.25	57.75	33.00	31.00	2.00	64.00	58.87	23
6	6	28.50	30.25	-1.75	58.75	35.50	33.25	2.25	68.75	30.50	28.25	2.25	58.75	31.00	32.00	-1.00	63.00	62.31	16
6	7	27.50	30.00	-2.50	57.50	34.00	34.00	0.00	68.00	32.25	31.00	1.25	63.25	33.50	33.50	0.00	67.00	63.93	16
6	8	26.00	25.50	0.50	51.50	34.25	32.75	1.50	67.00	30.00	31.25	-1.25	61.25	29.50	32.75	-3.25	62.25	60.50	25
6	9	25.75	25.50	0.25	51.25	32.00	34.00	-2.00	66.00	28.25	27.00	1.25	55.25	33.00	30.75	2.25	63.75	59.06	24
6	10	26.50	*	*	*	36.75	31.75	5.00	68.50	31.00	29.25	1.75	60.25	*	31.25	*	*	*	*
6	11	25.00	22.50	2.50	47.50	33.25	31.00	2.25	64.25	29.25	26.00	3.25	55.25	33.50	32.50	1.00	66.00	58.25	31
6	12	24.50	26.50	-2.00	51.00	33.75	28.25	5.50	62.00	28.75	29.50	-0.75	58.25	35.25	30.75	4.50	66.00	59.31	25
6	13	25.75	23.50	2.25	49.25	34.00	34.00	0.00	68.00	30.00	28.00	2.00	58.00	30.00	30.00	0.00	60.00	58.81	31
6	14	25.50	29.25	-3.75	54.75	33.00	35.00	-2.00	68.00	29.00	27.25	1.75	56.25	30.00	26.75	3.25	56.75	58.93	22
6	15	26.25	26.00	0.25	52.25	31.50	31.50	0.00	63.00	28.75	30.50	-1.75	59.25	29.75	32.50	-2.75	62.25	59.18	18
6	16	25.00	26.00	-1.00	51.00	31.25	35.25	-4.00	66.50	28.75	26.00	2.75	54.75	23.50	34.50	%-11.00	58.00	57.56	26
6	17	24.00	25.00	-1.00	49.00	32.75	33.00	-0.25	65.75	26.00	29.00	-3.00	55.00	31.00	28.50	2.50	59.50	57.31	29
6	18	25.75	27.00	-1.25	52.75	32.75	34.00	-1.25	66.75	27.25	29.50	-2.25	56.75	30.75	32.50	-1.75	63.25	59.87	23
6	19	24.25	25.50	-1.25	49.75	36.00	*	*	*	28.00	26.25	1.75	54.25	29.75	31.50	-1.75	61.25	*	*
6	20	26.00	24.50	1.50	50.50	31.75	35.50	-3.75	67.25	28.00	27.50	0.50	55.50	30.75	30.00	0.75	60.75	58.50	28
6	21	27.50	26.50	1.00	54.00	31.00	32.50	-1.50	63.50	27.00	29.00	-2.00	56.00	27.00	33.50	-6.50	60.50	58.50	16
6	22	26.25	27.00	-0.75	53.25	33.25	30.00	3.25	63.25	29.00	29.00	0.00	58.00	28.50	32.00	-3.50	60.50	58.75	17
6	23	25.00	23.80	1.20	48.80	32.75	38.00	-5.25	70.75	26.25	24.80	1.45	51.05	31.00	28.80	2.20	59.80	57.60	38
6	24	26.80	25.50	1.29	52.30	28.50	29.50	-1.00	58.00	24.50	27.50	-3.00	52.00	28.00	31.50	-3.50	59.50	55.45	13
6	25	25.75	28.00	-2.25	53.75	35.75	32.00	3.75	67.75	25.50	26.00	-0.50	51.50	31.75	32.00	-0.25	63.75	59.18	27

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 2WT DIF	04 2WT TOT	02 2AM WT	02 2PM WT	02 2WT DIF	02 2WT TOT	02 2AM WT	02 2PM WT	02 2WT DIF	02 2WT TOT	02 5AM WT	02 5PM WT	02 5WT DIF	02 5WT TOT	HERD AVG	RNG / AVG
6	26	25.75	27.00	-1.25	52.75	31.25	31.50	-0.25	62.75	27.00	27.50	-0.50	54.50	32.00	31.00	1.00	63.00	58.25	17
6	27	26.00	25.75	0.25	51.75	35.25	29.50	5.75	64.75	28.00	26.00	2.00	54.00	31.00	27.75	3.25	58.75	57.31	22
6	28	25.75	29.00	-3.25	54.75	32.25	33.50	-1.25	65.75	25.25	29.00	-3.75	54.25	29.75	34.00	-4.25	63.75	59.62	19
6	29	25.50	25.00	0.50	50.50	32.50	30.00	2.50	62.50	*	28.00	*	*	29.50	33.75	-4.25	63.25	*	*
6	30	27.00	31.00	-4.00	58.00	35.25	33.50	1.75	68.75	28.00	29.50	-1.50	57.50	30.50	31.50	-1.00	62.00	61.56	18
7	1	27.00	26.50	0.50	53.50	43.25	34.00	9.25	77.25	26.25	24.25	2.00	50.50	29.75	29.25	0.50	59.00	60.06	44
7	2	29.75	26.00	3.75	55.75	35.75	32.75	3.00	68.50	24.25	26.00	-1.75	50.25	29.50	31.50	-2.00	61.00	58.87	31
7	3	28.50	30.00	-1.50	58.50	33.25	*	*	*	26.50	26.00	0.50	52.50	31.00	28.75	2.25	59.75	*	*
7	4	28.50	29.00	-0.50	57.50	33.00	31.50	1.50	64.50	27.25	26.00	1.25	53.25	30.00	31.00	-1.00	61.00	59.06	19
7	5	27.00	29.00	-2.00	56.00	34.00	35.00	-1.00	69.00	27.00	24.00	3.00	51.00	31.00	30.50	0.50	61.50	59.37	30
7	6	29.50	28.25	1.25	57.75	34.25	30.75	3.50	65.00	24.00	26.75	-2.75	50.75	29.75	29.00	0.75	58.75	58.06	24
7	7	27.00	30.00	-3.00	57.00	34.25	34.50	-0.25	68.75	26.75	31.00	-4.25	57.75	31.75	31.00	0.75	62.75	61.56	19
7	8	27.25	30.00	-2.75	57.25	32.00	30.00	2.00	62.00	27.75	26.50	1.25	54.25	28.50	34.00	-5.50	62.50	59.00	13
7	9	24.00	*	*	*	34.25	31.25	3.00	65.50	26.75	26.50	0.25	53.25	30.50	31.00	-0.50	61.50	*	*
7	10	27.00	26.25	0.75	53.25	31.50	30.00	1.50	61.50	27.50	24.25	3.25	51.75	34.00	28.50	5.50	62.50	57.25	18
7	11	*	25.00	*	*	33.50	28.25	5.25	61.75	26.50	24.50	2.00	51.00	26.75	27.00	-0.25	53.75	*	*
7	12	26.25	27.00	-0.75	53.25	32.25	27.00	5.25	59.25	29.00	25.50	3.50	54.50	27.75	28.00	-0.25	55.75	55.68	10
7	13	29.50	24.75	4.75	54.25	36.50	29.50	7.00	66.00	28.50	29.50	-1.00	58.00	30.00	27.50	2.50	57.50	58.93	19
7	14	27.00	27.00	0.00	54.00	32.25	30.75	1.50	63.00	26.50	26.25	0.25	52.75	31.75	34.00	-2.25	65.75	58.87	22
7	15	26.25	25.50	0.75	51.75	38.00	32.00	6.00	70.00	26.50	26.00	0.50	52.50	30.00	27.00	3.00	57.00	57.81	31
7	16	19.50	28.50	-9.00	48.00	30.75	28.50	2.25	59.25	*	26.00	*	*	29.00	29.50	-0.50	58.50	*	*
7	17	25.25	32.50	-7.25	57.75	34.00	35.00	-1.00	69.00	30.50	25.00	5.50	55.50	29.50	34.00	-4.50	63.50	61.43	21
7	18	30.00	27.00	3.00	57.00	35.50	35.00	0.50	70.50	31.50	28.00	3.50	59.50	29.25	35.00	-5.75	64.25	62.81	21
7	19	24.75	30.00	-5.25	54.75	28.00	38.00	%-10.00	66.00	27.25	31.00	-3.75	58.25	28.00	37.00	-9.00	65.00	61.00	18
7	20	32.50	24.00	8.50	56.50	33.50	33.00	0.50	66.50	25.00	25.00	0.00	50.00	30.00	27.00	3.00	57.00	57.50	28
7	21	26.50	26.00	0.50	52.50	34.00	33.00	1.00	67.00	29.50	29.00	0.50	58.50	31.50	35.50	-4.00	67.00	61.25	23
7	22	34.00	29.00	5.00	63.00	43.50	32.00	11.50	75.50	31.50	34.50	-3.00	66.00	27.50	35.50	-8.00	63.00	66.87	18
7	23	29.75	26.00	3.75	55.75	37.50	34.00	3.50	71.50	25.50	32.00	-6.50	57.50	23.75	26.00	-2.25	49.75	58.62	37
7	24	25.00	24.50	0.50	49.50	36.00	24.75	11.25	60.75	29.00	28.50	0.50	57.50	23.00	28.00	-5.00	51.00	54.68	20
7	25	34.50	30.00	4.50	64.50	34.50	32.50	2.00	67.00	28.75	31.00	-2.25	59.75	25.25	34.00	-8.75	59.25	62.62	12
7	26	25.00	25.50	-0.50	50.50	34.50	30.50	4.00	65.00	22.25	29.00	-6.75	51.25	27.50	33.50	-6.00	61.00	56.93	25
7	27	28.75	26.00	2.75	54.75	29.75	32.00	-2.25	61.75	28.75	28.50	0.25	57.25	33.00	25.00	8.00	58.00	57.93	12
7	28	27.00	26.00	1.00	53.00	27.50	32.00	-4.50	59.50	24.50	28.00	-3.50	52.50	28.50	28.75	-0.25	57.25	55.56	12
7	29	19.25	34.00	%-14.75	53.25	29.00	27.25	1.75	56.25	31.00	21.00	10.00	52.00	28.00	28.25	-0.25	56.25	54.43	7
7	30	25.00	26.25	-1.25	51.25	30.75	29.50	1.25	60.25	25.00	26.75	-1.75	51.75	21.00	26.75	-5.75	47.75	52.75	23
7	31	24.50	23.50	1.00	48.00	31.00	17.50	13.50	48.50	24.50	21.75	2.75	46.25	26.00	26.00	0.00	52.00	48.68	11
8	1	26.00	26.00	0.00	52.00	33.50	22.50	11.00	56.00	27.50	25.25	2.25	52.75	23.00	26.00	-3.00	49.00	52.43	13
8	2	23.50	24.00	-0.50	47.50	28.00	30.00	-2.00	58.00	23.50	26.00	-2.50	49.50	24.75	27.00	-2.25	51.75	51.68	20
8	3	28.00	24.00	4.00	52.00	30.50	28.50	2.00	59.00	27.00	25.00	2.00	52.00	25.50	24.00	1.50	49.50	53.12	17
8	4	25.00	24.50	0.50	49.50	32.50	25.00	7.50	57.50	26.25	25.50	0.75	51.75	28.25	25.00	3.25	53.25	53.00	15
8	5	22.75	21.25	1.50	44.00	26.50	26.00	0.50	52.50	27.00	21.50	5.50	48.50	29.50	25.00	4.50	54.50	49.87	21
8	6	26.00	22.50	3.50	48.50	33.00	24.00	9.00	57.00	25.25	19.00	6.25	44.25	22.25	18.50	3.75	40.75	47.62	34
8	7	21.75	24.25	-2.50	46.00	26.50	27.00	-0.50	53.50	24.50	22.00	2.50	46.50	18.50	27.00	-8.50	45.50	47.87	16

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 2WTD IF	04 4WTT OT	02 2AM WT	02 2PM WT	02 2WTD IF	02 2WTT OT	02 2AM WT	02 2PM WT	02 2WTD IF	02 2WTT OT	02 5AM WT	02 5PM WT	02 5WTD IF	02 5WTT OT	HERD AVG	RNG/AVG
8	8	25.75	27.00	-1.25	52.75	36.50	29.00	7.50	65.50	23.00	30.00	-7.00	53.00	28.00	26.00	2.00	54.00	56.31	22
8	9	29.25	25.00	4.25	54.25	34.00	34.50	-0.50	68.50	28.50	26.00	2.50	54.50	29.25	33.50	-4.25	62.75	60.00	23
8	10	36.00	24.00	12.00	60.00	31.25	30.50	0.75	61.75	31.75	27.00	4.75	58.75	29.50	32.50	-3.00	62.00	60.62	5
8	11	24.00	26.50	-2.50	50.50	7.00	46.00	%-39.00	53.00	25.50	24.50	1.00	50.00	26.75	32.00	-5.25	58.75	53.06	16
8	12	32.00	23.00	9.00	55.00	31.50	20.00	11.50	51.50	27.75	23.00	4.75	50.75	32.50	28.50	4.00	61.00	54.56	18
8	13	32.50	26.00	6.50	58.50	26.75	34.00	-7.25	60.75	25.50	23.00	2.50	48.50	31.25	31.00	0.25	62.25	57.50	23
8	14	27.00	31.50	-4.50	58.50	25.50	26.00	-0.50	51.50	30.50	27.00	3.50	57.50	28.75	30.00	-1.25	58.75	56.56	12
8	15	24.00	31.00	-7.00	55.00	26.50	34.00	-7.50	60.50	22.50	25.50	-3.00	48.00	27.25	28.00	-0.75	55.25	54.68	22
8	16	35.00	28.25	6.75	63.25	26.50	30.00	-3.50	56.50	30.00	22.00	8.00	52.00	33.50	30.00	3.50	63.50	58.81	19
8	17	32.25	30.00	2.25	62.25	22.50	22.00	0.50	44.50	28.00	27.00	1.00	55.00	25.00	34.00	-9.00	59.00	55.18	32
8	18	31.75	25.00	6.75	56.75	22.50	16.00	6.50	38.50	28.00	25.00	3.00	53.00	28.50	32.50	-4.00	61.00	52.31	43
8	19	32.00	29.75	2.25	61.75	24.00	15.00	9.00	39.00	27.50	25.00	2.50	52.50	21.00	34.50	%-13.50	55.50	52.18	43
8	20	29.00	23.00	6.00	52.00	22.50	27.00	-4.50	49.50	22.00	15.00	7.00	37.00	26.00	33.00	-7.00	59.00	49.37	44
8	21	35.25	25.50	9.75	60.75	30.50	23.75	6.75	54.25	27.75	23.00	4.75	50.75	31.00	34.00	-3.00	65.00	57.68	24
8	22	25.50	27.00	-1.50	52.50	27.25	28.00	-0.75	55.25	28.00	17.00	11.00	45.00	25.00	31.00	-6.00	56.00	52.18	21
8	23	25.50	23.00	2.50	48.50	33.50	31.50	2.00	65.00	14.25	20.75	-6.50	35.00	26.00	30.50	-4.50	56.50	51.25	58
8	24	27.00	24.00	3.00	51.00	34.50	30.00	4.50	64.50	22.50	15.00	7.50	37.50	32.50	30.00	2.50	62.50	53.87	50
8	25	25.25	27.00	-1.75	52.25	30.50	34.00	-3.50	64.50	18.00	26.00	-8.00	44.00	25.50	27.00	-1.50	52.50	53.31	38
8	26	24.50	25.50	-1.00	50.00	34.00	32.50	1.50	66.50	23.25	19.50	3.75	42.75	29.50	30.50	-1.00	60.00	54.81	43
8	27	31.00	31.00	0.00	62.00	35.75	24.50	11.25	60.25	25.75	24.50	1.25	50.25	25.50	33.50	-8.00	59.00	57.87	20
8	28	26.00	25.50	0.50	51.50	32.00	33.00	-1.00	65.00	19.00	24.00	-5.00	43.00	30.50	34.00	-3.50	64.50	56.00	39
8	29	31.00	23.50	7.50	54.50	33.75	*	*	*	24.00	19.25	4.75	43.25	26.25	30.00	-3.75	56.25	*	*
8	30	31.75	25.50	6.25	57.25	30.75	28.50	2.25	59.25	24.25	24.50	-0.25	48.75	34.25	35.00	-0.75	69.25	58.62	34
8	31	27.50	24.50	3.00	52.00	29.50	27.50	2.00	57.00	19.50	25.00	-5.50	44.50	30.75	27.00	3.75	57.75	52.81	25
9	1	26.25	25.00	1.25	51.25	34.00	28.50	5.50	62.50	24.50	25.00	-0.50	49.50	24.75	30.00	-5.25	54.75	54.50	23
9	2	26.50	25.00	1.50	51.50	31.50	32.50	-1.00	64.00	19.50	25.00	-5.50	44.50	30.00	31.00	-1.00	61.00	55.25	35
9	3	27.50	35.00	-7.50	62.50	*	32.50	*	*	25.50	23.50	2.00	49.00	31.50	29.00	2.50	60.50	*	*
9	4	24.00	30.00	-6.00	54.00	26.50	34.00	-7.50	60.50	25.50	22.00	3.50	47.50	24.50	25.50	-1.00	50.00	53.00	24
9	6	25.55	28.50	-2.96	54.05	26.00	28.00	-2.00	54.00	18.75	18.00	0.75	36.75	23.50	29.00	-5.50	52.50	49.32	35
9	7	23.50	25.00	-1.50	48.50	29.00	33.00	-4.00	62.00	18.50	19.50	-1.00	38.00	26.00	23.50	2.50	49.50	49.50	48
9	8	22.00	22.50	-0.50	44.50	26.00	29.50	-3.50	55.50	16.75	18.50	-1.75	35.25	26.00	27.50	-1.50	53.50	47.18	42
9	9	20.00	20.00	0.00	40.00	37.00	22.25	14.75	59.25	16.50	16.50	0.00	33.00	25.50	27.50	-2.00	53.00	46.31	56
9	10	20.00	19.00	1.00	39.00	31.75	23.50	8.25	55.25	13.00	23.00	%-10.00	36.00	25.50	31.00	-5.50	56.50	46.68	43
9	11	20.75	22.00	-1.25	42.75	25.00	22.00	3.00	47.00	15.75	15.50	0.25	31.25	25.50	24.50	1.00	50.00	42.75	43
9	12	22.00	20.00	2.00	42.00	25.00	22.00	3.00	47.00	15.50	16.00	-0.50	31.50	24.00	24.00	0.00	48.00	42.12	39
9	13	22.50	22.00	0.50	44.50	21.50	26.00	-4.50	47.50	14.75	17.00	-2.25	31.75	21.25	24.50	-3.25	45.75	42.37	37
9	14	22.50	22.75	-0.25	45.25	26.00	26.50	-0.50	52.50	17.00	16.50	0.50	33.50	26.00	24.50	1.50	50.50	45.43	41
9	15	22.00	23.50	-1.50	45.50	22.50	30.00	-7.50	52.50	16.25	20.50	-4.25	36.75	23.75	25.00	-1.25	48.75	45.87	34
9	16	24.00	23.50	0.50	47.50	26.00	27.75	-1.75	53.75	16.75	17.25	-0.50	34.00	24.50	22.50	2.00	47.00	45.56	43
9	17	22.00	24.50	-2.50	46.50	24.50	25.50	-1.00	50.00	17.00	17.50	-0.50	34.50	22.50	24.00	-1.50	46.50	44.37	34
9	18	22.00	21.00	1.00	43.00	26.75	25.00	1.75	51.75	17.00	18.50	-1.50	35.50	23.25	24.00	-0.75	47.25	44.37	36
9	19	23.00	18.00	5.00	41.00	27.00	34.00	-7.00	61.00	18.50	16.00	2.50	34.50	*	22.50	*	*	*	*
9	20	19.50	21.50	-2.00	41.00	26.25	25.50	0.75	51.75	23.50	22.50	1.00	46.00	22.00	23.50	-1.50	45.50	46.06	23

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM W	04 2PM W	04 2WT DIF	04 2WT TOT	02 2AM W	02 2PM W	02 2WT DIF	02 2WT TOT	02 2AM W	02 2PM W	02 2WT DIF	02 2WT TOT	02 5AM W	02 5PM W	02 5WT DIF	02 5WT TOT	HERD AVG	RNG/AVG
9	21	22.50	20.25	2.25	42.75	25.00	22.25	2.75	47.25	17.50	15.75	1.75	33.25	23.00	23.50	-0.50	46.50	42.43	32
9	22	20.00	23.00	-3.00	43.00	26.50	25.50	1.00	52.00	13.50	15.00	-1.50	28.50	22.00	24.50	-2.50	46.50	42.50	55
9	23	21.00	21.00	0.00	42.00	35.50	25.30	10.20	60.80	17.50	15.00	2.50	32.50	19.50	23.50	-4.00	43.00	44.57	63
9	24	20.80	20.50	0.29	41.30	22.80	26.50	-3.71	49.30	9.50	23.00	%-13.50	32.50	20.00	22.50	-2.50	42.50	41.40	40
9	25	20.00	19.50	0.50	39.50	22.00	22.25	-0.25	44.25	13.00	14.00	-1.00	27.00	19.50	20.50	-1.00	40.00	37.68	45
9	26	19.75	19.75	0.00	39.50	26.25	20.50	5.75	46.75	14.25	15.00	-0.75	29.25	20.50	19.00	1.50	39.50	38.75	45
9	27	20.50	20.00	0.50	40.50	23.50	24.50	-1.00	48.00	15.25	16.00	-0.75	31.25	20.75	20.00	0.75	40.75	40.12	41
9	28	23.00	20.00	3.00	43.00	25.00	22.50	2.50	47.50	18.00	15.50	2.50	33.50	21.25	19.50	1.75	40.75	41.18	33
9	29	19.50	21.50	-2.00	41.00	32.00	21.75	10.25	53.75	13.00	14.50	-1.50	27.50	19.25	23.00	-3.75	42.25	41.12	63
9	30	21.50	21.00	0.50	42.50	22.50	23.00	-0.50	45.50	14.50	16.00	-1.50	30.50	21.00	21.00	0.00	42.00	40.12	37
10	1	17.25	19.50	-2.25	36.75	27.00	21.50	5.50	48.50	21.00	15.50	5.50	36.50	21.00	22.50	-1.50	43.50	41.31	29
10	2	20.00	19.00	1.00	39.00	23.50	22.00	1.50	45.50	8.00	17.00	-9.00	25.00	21.00	18.50	2.50	39.50	37.25	55
10	3	18.50	17.50	1.00	36.00	22.00	20.50	1.50	42.50	11.50	11.00	0.50	22.50	19.50	22.00	-2.50	41.50	35.62	56
10	4	*	18.00	*	*	20.50	18.00	2.50	38.50	10.75	10.75	0.00	21.50	19.00	17.50	1.50	36.50	*	*
10	5	18.00	17.50	0.50	35.50	22.50	19.50	3.00	42.00	12.25	11.50	0.75	23.75	15.75	17.00	-1.25	32.75	33.50	54
10	6	17.50	17.00	0.50	34.50	19.50	19.50	0.00	39.00	11.25	11.00	0.25	22.25	15.00	15.00	0.00	30.00	31.43	53
10	7	17.00	17.50	-0.50	34.50	17.25	20.50	-3.25	37.75	12.00	12.50	-0.50	24.50	15.50	16.50	-1.00	32.00	32.18	41
10	8	17.00	17.50	-0.50	34.50	18.25	21.00	-2.75	39.25	11.25	14.00	-2.75	25.25	*	*	*	*	*	*
10	9	17.00	17.00	0.00	34.00	18.50	20.00	-1.50	38.50	*	13.50	*	*	*	*	*	*	*	*
10	10	17.25	17.50	-0.25	34.75	19.75	19.00	0.75	38.75	10.50	14.00	-3.50	24.50	*	*	*	*	*	*
10	11	15.50	19.50	-4.00	35.00	17.00	19.50	-2.50	36.50	12.00	10.00	2.00	22.00	*	*	*	*	*	*
10	12	20.50	18.50	2.00	39.00	18.50	20.00	-1.50	38.50	13.25	11.50	1.75	24.75	*	*	*	*	*	*
10	13	16.50	20.50	-4.00	37.00	18.75	19.00	-0.25	37.75	11.00	12.00	-1.00	23.00	*	*	*	*	*	*
10	14	18.50	19.00	-0.50	37.50	18.50	*	*	*	17.50	10.50	7.00	28.00	*	*	*	*	*	*
10	15	18.75	19.00	-0.25	37.75	18.25	20.00	-1.75	38.25	11.75	12.50	-0.75	24.25	*	*	*	*	*	*
10	16	19.00	18.50	0.50	37.50	18.00	18.50	-0.50	36.50	8.00	12.50	-4.50	20.50	*	*	*	*	*	*
10	17	19.00	19.00	0.00	38.00	20.00	18.50	1.50	38.50	9.25	11.50	-2.25	20.75	*	*	*	*	*	*
10	18	18.50	18.00	0.50	36.50	20.00	18.00	2.00	38.00	11.50	11.00	0.50	22.50	*	*	*	*	*	*
10	19	17.00	19.00	-2.00	36.00	18.00	19.00	-1.00	37.00	11.50	12.00	-0.50	23.50	*	*	*	*	*	*
10	20	17.75	18.00	-0.25	35.75	18.00	18.50	-0.50	36.50	12.50	12.00	0.50	24.50	*	*	*	*	*	*
10	21	17.50	16.50	1.00	34.00	19.00	17.25	1.75	36.25	10.50	9.50	1.00	20.00	*	*	*	*	*	*
10	22	15.75	14.50	1.25	30.25	17.50	17.00	0.50	34.50	11.25	11.00	0.25	22.25	*	*	*	*	*	*
10	23	16.00	16.00	0.00	32.00	15.80	17.50	-1.70	33.30	8.30	12.00	-3.70	20.29	*	*	*	*	*	*
10	24	15.50	16.00	-0.50	31.50	18.00	16.00	2.00	34.00	10.00	8.50	1.50	18.50	*	*	*	*	*	*
10	25	15.50	17.00	-1.50	32.50	18.00	17.50	0.50	35.50	10.75	9.50	1.25	20.25	*	*	*	*	*	*
10	26	14.50	15.00	-0.50	29.50	17.00	17.00	0.00	34.00	11.25	10.00	1.25	21.25	*	*	*	*	*	*
10	27	14.75	16.00	-1.25	30.75	17.00	17.00	0.00	34.00	9.50	10.00	-0.50	19.50	*	*	*	*	*	*
10	28	12.50	15.50	-3.00	28.00	16.75	14.50	2.25	31.25	8.50	8.00	0.50	16.50	*	*	*	*	*	*
10	29	16.25	15.50	0.75	31.75	24.00	18.00	6.00	42.00	10.00	11.50	-1.50	21.50	*	*	*	*	*	*
10	30	14.00	15.00	-1.00	29.00	15.00	17.00	-2.00	32.00	8.50	8.50	0.00	17.00	*	*	*	*	*	*
10	31	13.50	15.50	-2.00	29.00	18.00	15.00	3.00	33.00	9.00	9.25	-0.25	18.25	*	*	*	*	*	*
11	1	12.00	13.50	-1.50	25.50	16.00	16.00	0.00	32.00	6.00	9.00	-3.00	15.00	*	*	*	*	*	*
11	2	12.50	14.00	-1.50	26.50	16.50	17.00	-0.50	33.50	8.75	9.00	-0.25	17.75	*	*	*	*	*	*

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 WTDIF	04 WTOT	22 0AM WT	22 0PM WT	22 WTDIF	22 WTOT	22 2AM WT	22 2PM WT	22 WTDIF	22 WTOT	22 5AM WT	22 5PM WT	22 WTDIF	22 WTOT	HERD AVG	RNG/AVG
11	3	12.00	13.00	-1.00	25.00	16.00	15.00	1.00	31.00	8.00	8.00	0.00	16.00	*	*	*	*	*	*
11	4	14.00	14.50	-0.50	28.50	15.75	15.00	0.75	30.75	8.25	8.25	0.00	16.50	*	*	*	*	*	*
11	5	12.25	12.75	-0.50	25.00	12.50	14.25	-1.75	26.75	8.25	7.75	0.50	16.00	*	*	*	*	*	*
11	6	14.75	13.25	1.50	28.00	14.00	13.25	0.75	27.25	7.25	8.25	-1.00	15.50	*	*	*	*	*	*
11	7	14.50	14.50	0.00	29.00	17.00	18.00	-1.00	35.00	7.75	*	*	*	*	*	*	*	*	*
11	8	13.00	15.50	-2.50	28.50	13.00	15.00	-2.00	28.00	7.75	8.00	-0.25	15.75	*	*	*	*	*	*
11	9	14.25	14.50	-0.25	28.75	13.75	13.50	0.25	27.25	7.25	8.00	-0.75	15.25	*	*	*	*	*	*
11	10	14.00	8.75	5.25	22.75	12.50	11.75	0.75	24.25	7.25	8.00	-0.75	15.25	*	*	*	*	*	*
11	11	14.00	12.50	1.50	26.50	14.00	13.25	0.75	27.25	5.50	7.50	-2.00	13.00	*	*	*	*	*	*
11	12	11.25	11.25	0.00	22.50	13.00	*	*	*	7.75	6.50	1.25	14.25	*	*	*	*	*	*
11	13	10.75	13.50	-2.75	24.25	*	*	*	*	6.75	*	*	*	*	*	*	*	*	*
11	14	12.50	13.50	-1.00	26.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	15	11.50	12.00	-0.50	23.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	16	12.00	10.00	2.00	22.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	17	11.50	11.00	0.50	22.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	18	10.50	11.50	-1.00	22.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	19	11.75	12.75	-1.00	24.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	20	11.75	12.25	-0.50	24.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	21	13.25	12.00	1.25	25.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	22	12.75	13.00	-0.25	25.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	23	13.75	13.00	0.75	26.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	24	12.80	12.50	0.30	25.30	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	25	17.00	13.00	4.00	30.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	26	12.50	12.00	0.50	24.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	27	12.75	12.50	0.25	25.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	28	12.25	12.00	0.25	24.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	29	11.75	12.00	-0.25	23.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
11	30	12.25	12.75	-0.50	25.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	1	11.50	12.75	-1.25	24.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	2	12.50	12.25	0.25	24.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	3	11.75	12.00	-0.25	23.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	4	13.25	10.50	2.75	23.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	5	12.50	11.00	1.50	23.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	6	11.25	11.00	0.25	22.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	7	12.50	11.50	1.00	24.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	8	11.00	12.00	-1.00	23.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	9	12.50	10.50	2.00	23.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	10	13.00	12.00	1.00	25.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	11	11.00	10.75	0.25	21.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	12	12.00	10.50	1.50	22.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	13	11.00	10.50	0.50	21.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	14	10.50	11.00	-0.50	21.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	15	10.50	11.00	-0.50	21.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*

1987 KENNING MILK PRODUCTION RECORD FOR 4 COWS.

MONTH	DAY	04 2AM WT	04 2PM WT	04 WT DIF	04 WT OT	202 AM WT	202 PM WT	202 WT DIF	202 WT OT	220 AM WT	220 PM WT	220 WT DIF	220 WT OT	225 AM WT	225 PM WT	225 WT DIF	225 WT OT	HERD AVG	RNG/AVG
12	16	9.75	10.75	-1.00	20.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	17	11.75	10.50	1.25	22.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	18	10.75	10.50	0.25	21.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	19	12.00	10.00	2.00	22.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	20	10.75	10.50	0.25	21.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	21	9.50	9.50	0.00	19.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	22	9.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	23	9.75	10.00	-0.25	19.75	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	24	10.50	9.50	1.00	20.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	25	9.50	11.00	-1.50	20.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	26	10.00	10.00	0.00	20.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	27	9.75	10.50	-0.75	20.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	28	10.00	10.25	-0.25	20.25	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	29	11.00	9.50	1.50	20.50	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	30	11.00	11.00	0.00	22.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*
12	31	10.50	9.50	1.00	20.00	*	*	*	*	*	*	*	*	*	*	*	*	*	*

----------Multiple Regression----------

Data Base Name C:\EMD\MILK

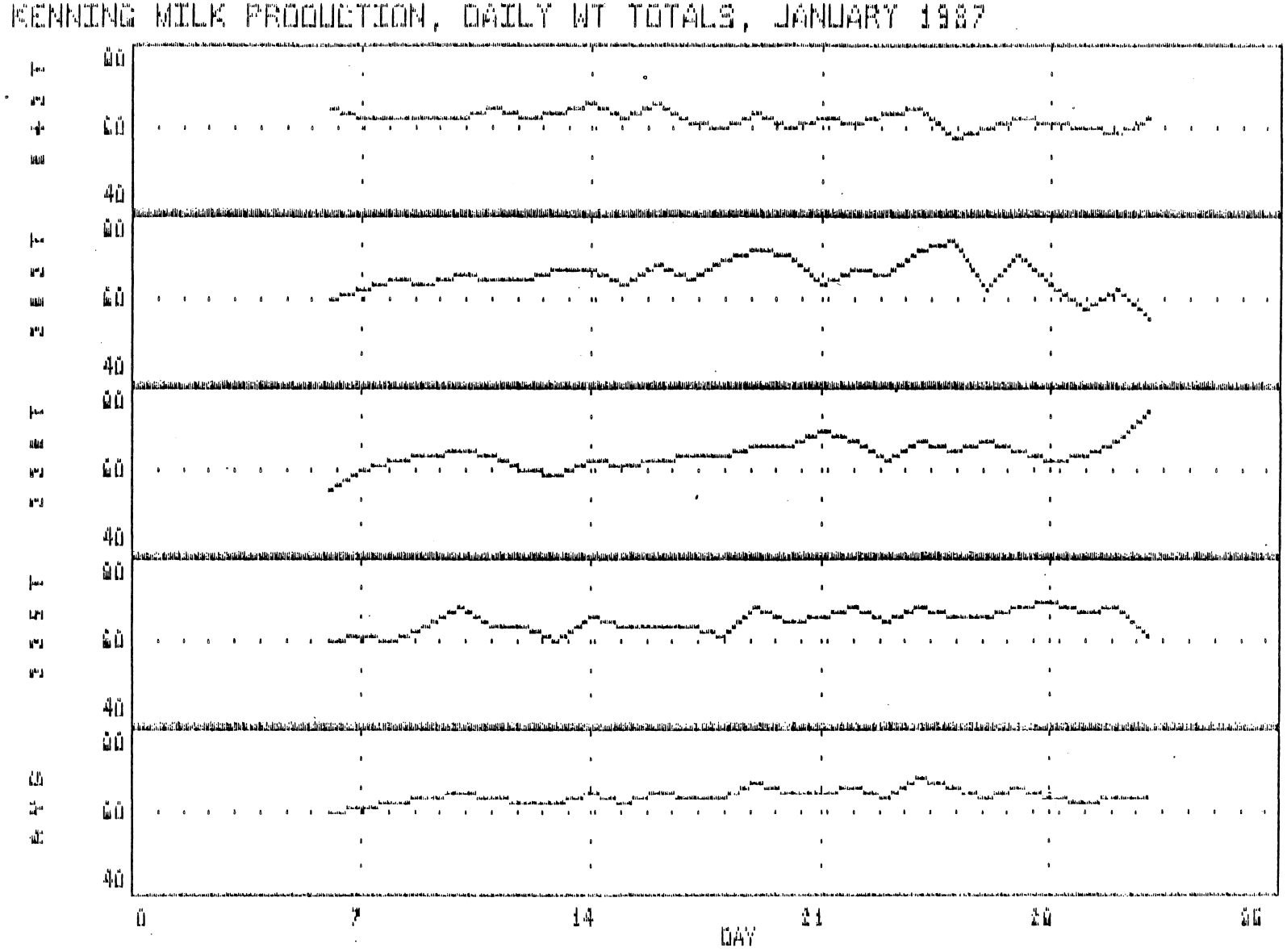
Correlations

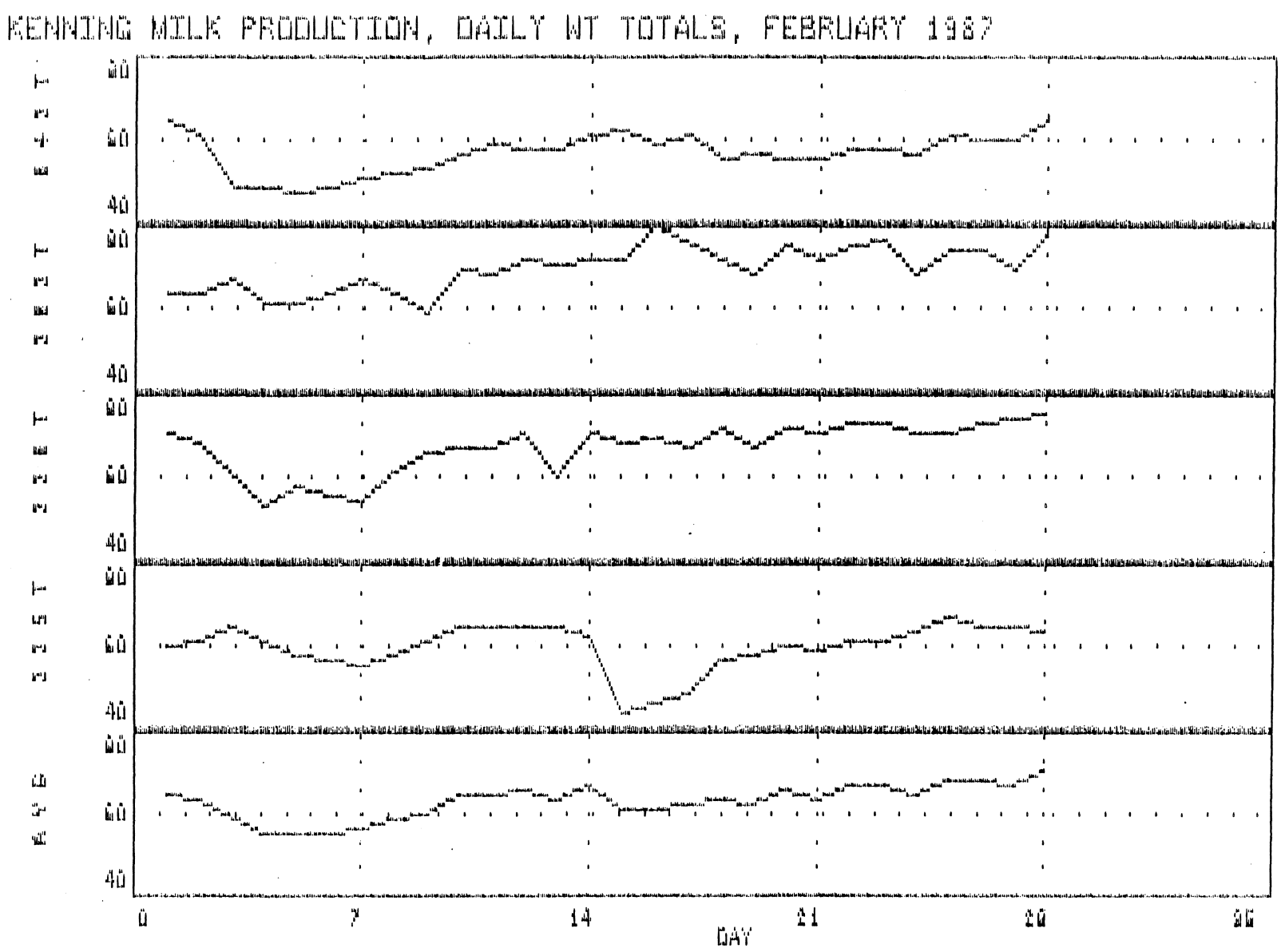
	042A	042P	042D	042T	202A	202P
042A	1.0000	0.6404	0.4594	0.9093	0.4244	0.3257
042P	0.6404	1.0000	-0.3881	0.9019	0.4370	0.5180
042D	0.4594	-0.3881	1.0000	0.0480	0.0039	-0.2083
042T	0.9093	0.9019	0.0480	1.0000	0.4754	0.4639
202A	0.4244	0.4370	0.0039	0.4754	1.0000	0.4934
202P	0.3257	0.5180	-0.2083	0.4639	0.4934	1.0000
202D	0.1033	-0.0739	0.2094	0.0180	0.5136	-0.4929
202T	0.4344	0.5523	-0.1174	0.5435	0.8662	0.8621
220A	0.5841	0.6546	-0.0562	0.6832	0.6498	0.6109
220P	0.5237	0.6359	-0.1069	0.6391	0.6558	0.6889
220D	0.1672	0.0992	0.0860	0.1478	0.0541	-0.0797
220T	0.5759	0.6701	-0.0839	0.6869	0.6776	0.6735
225A	0.5259	0.5268	0.0218	0.5811	0.5350	0.5507
225P	0.5068	0.5641	-0.0443	0.5906	0.4257	0.5229
225D	0.0747	0.0092	0.0790	0.0470	0.1805	0.0872
225T	0.5666	0.5973	-0.0108	0.6422	0.5292	0.5893
RNG/AVG	-0.5467	-0.6402	0.0844	-0.6543	-0.2096	-0.3095
AVG	0.6858	0.7618	-0.0581	0.7984	0.7413	0.7511

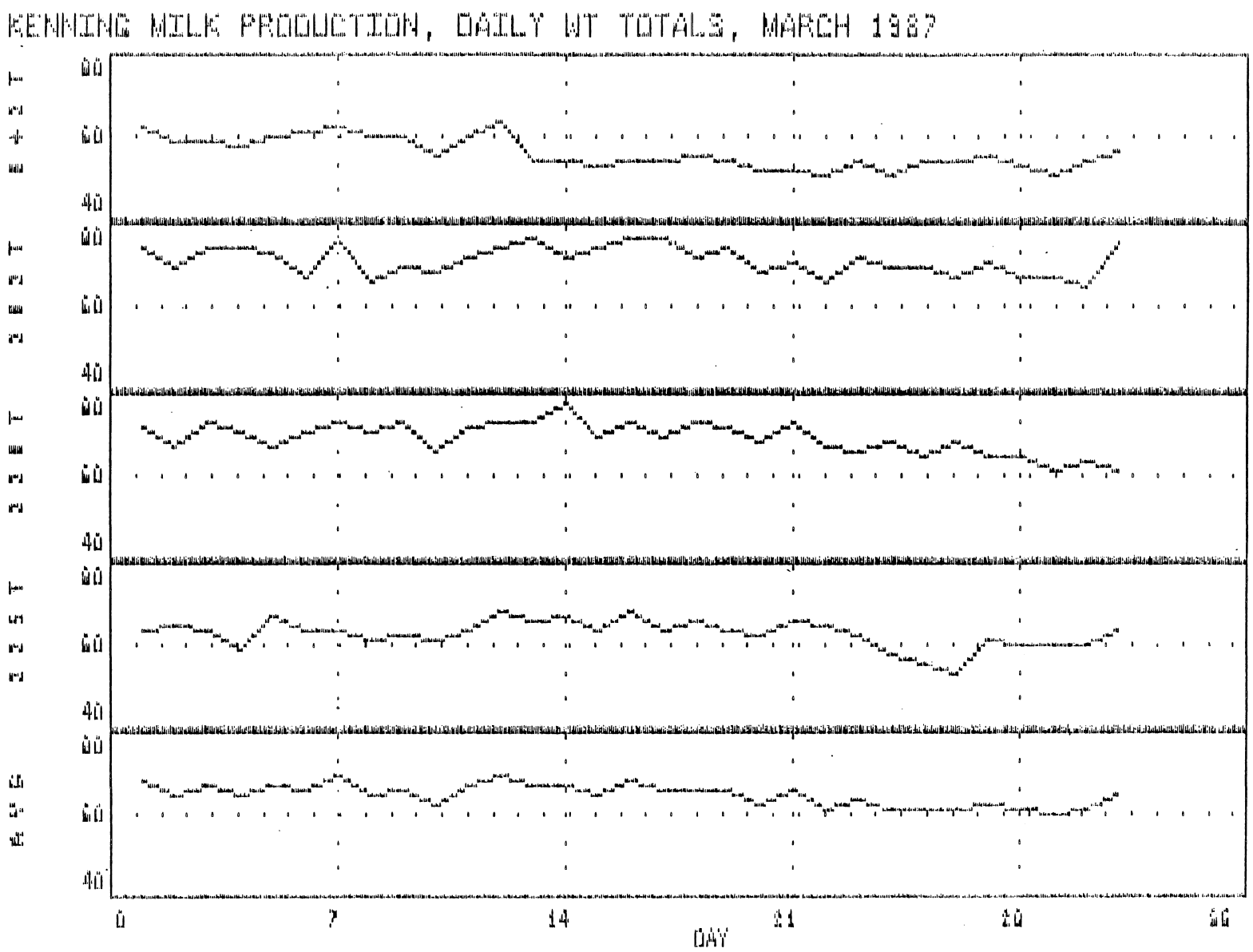
	202D	202T	220A	220P	220D	220T
042A	0.1033	0.4344	0.5841	0.5237	0.1672	0.5759
042P	-0.0739	0.5523	0.6546	0.6359	0.0992	0.6701
042D	0.2094	-0.1174	-0.0562	-0.1069	0.0860	-0.0839
042T	0.0180	0.5435	0.6832	0.6391	0.1478	0.6869
202A	0.5136	0.8662	0.6498	0.6558	0.0541	0.6776
202P	-0.4929	0.8621	0.6109	0.6889	-0.0797	0.6735
202D	1.0000	0.0160	0.0474	-0.0236	0.1328	0.0134
202T	0.0160	1.0000	0.7296	0.7780	-0.0143	0.7818
220A	0.0474	0.7296	1.0000	0.8559	0.3599	0.9653
220P	-0.0236	0.7780	0.8559	1.0000	-0.1745	0.9613
220D	0.1328	-0.0143	0.3599	-0.1745	1.0000	0.1037
220T	0.0134	0.7818	0.9653	0.9613	0.1037	1.0000
225A	-0.0081	0.6282	0.7026	0.6796	0.1117	0.7177
225P	-0.0901	0.5485	0.5744	0.6109	-0.0084	0.6147
225D	0.0945	0.1553	0.2191	0.1477	0.1507	0.1913
225T	-0.0520	0.6469	0.7031	0.7091	0.0594	0.7329
RNG/AVG	0.0957	-0.3000	-0.5691	-0.5233	-0.1395	-0.5676
AVG	0.0006	0.8634	0.9089	0.9124	0.0845	0.9453

Correlations

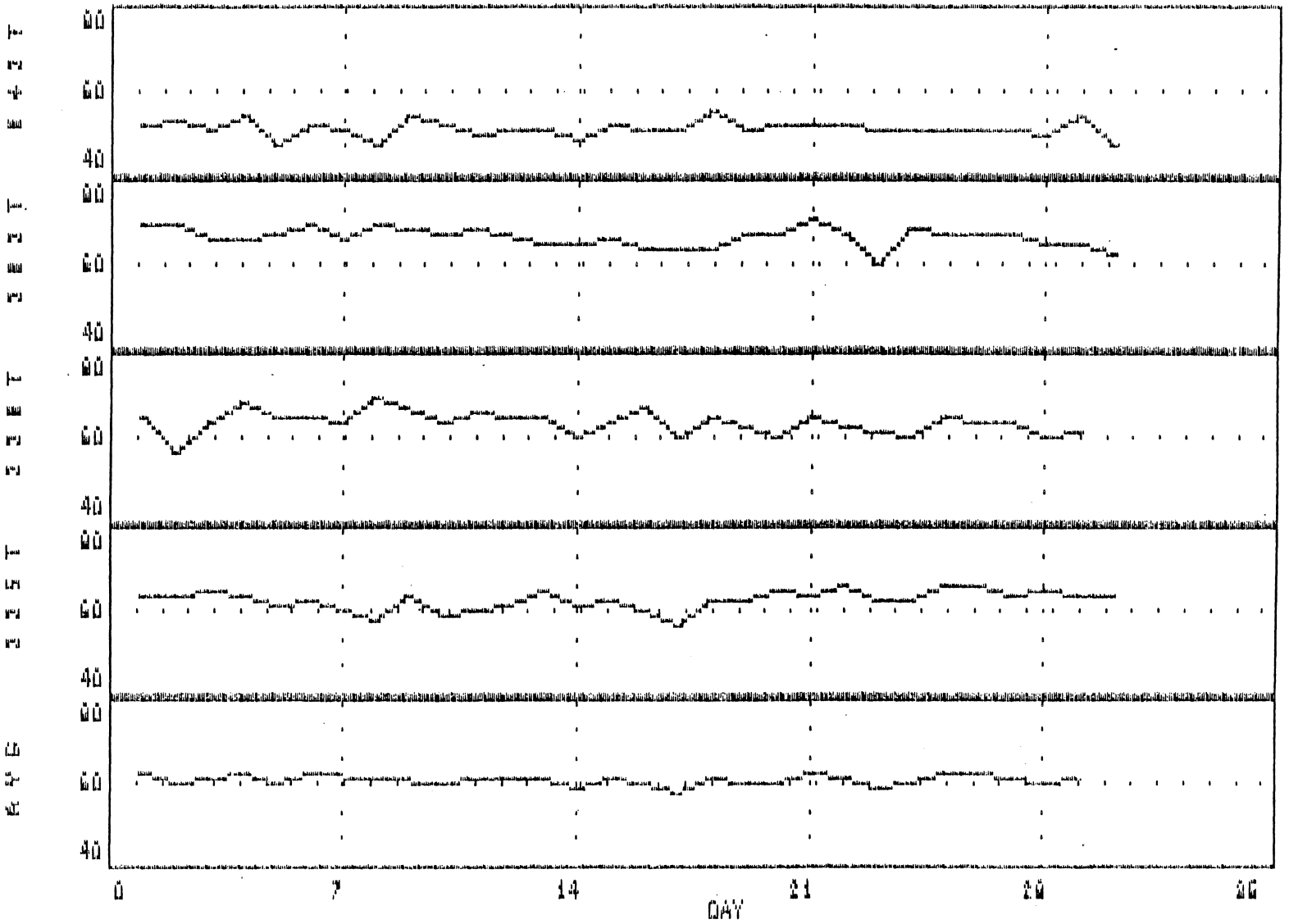
	225A	225P	225D	225T	RNG/AVG	AVG
042A	0.5259	0.5068	0.0747	0.5666	-0.5467	0.6858
042P	0.5268	0.5641	0.0092	0.5973	-0.6402	0.7618
042D	0.0218	-0.0443	0.0790	-0.0108	0.0844	-0.0581
042T	0.5811	0.5906	0.0470	0.6422	-0.6543	0.7984
202A	0.5350	0.4257	0.1805	0.5292	-0.2096	0.7413
202P	0.5507	0.5229	0.0872	0.5893	-0.3095	0.7511
202D	-0.0081	-0.0901	0.0945	-0.0520	0.0957	0.0006
202T	0.6282	0.5485	0.1553	0.6469	-0.3000	0.8634
220A	0.7026	0.5744	0.2191	0.7031	-0.5691	0.9089
220P	0.6796	0.6109	0.1477	0.7091	-0.5233	0.9124
220D	0.1117	-0.0084	0.1507	0.0594	-0.1395	0.0845
220T	0.7177	0.6147	0.1913	0.7329	-0.5676	0.9453
225A	1.0000	0.6626	0.4920	0.9192	-0.5367	0.8133
225P	0.6626	1.0000	-0.3261	0.9040	-0.5024	0.7483
225D	0.4920	-0.3261	1.0000	0.1094	-0.0934	0.1567
225T	0.9192	0.9040	0.1094	1.0000	-0.5705	0.8577
RNG/AVG	-0.5367	-0.5024	-0.0934	-0.5705	1.0000	-0.5928
AVG	0.8133	0.7483	0.1567	0.8577	-0.5928	1.0000


KENNING MILK PRODUCTION, DAILY WT TOTALS, JANUARY 1987
80
60
40
0
7
14
21
28
35
DAY

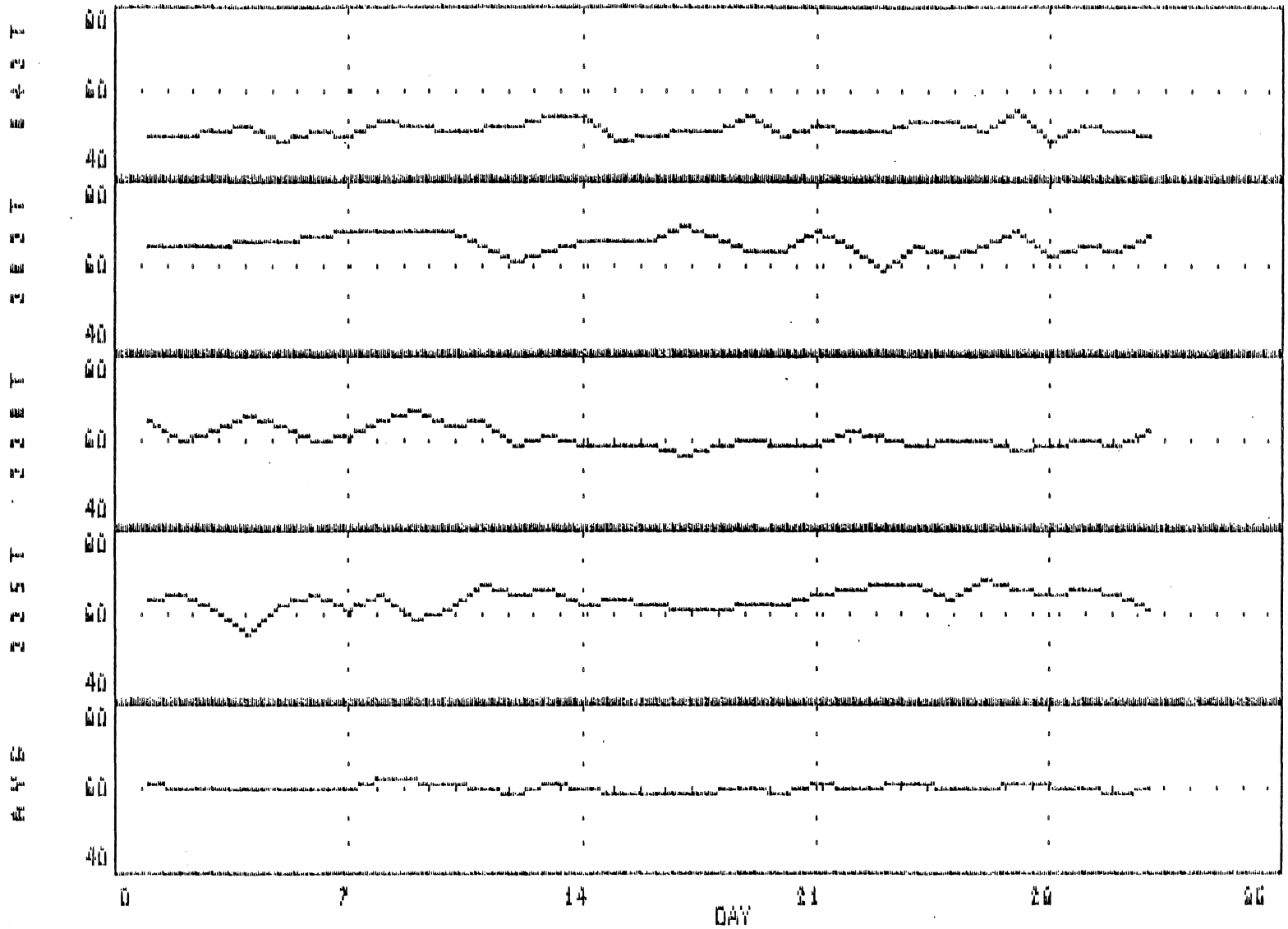

KENNING MILK PRODUCTION, DAILY WT TOTALS, FEBRUARY 1987
80
60
40
0
7
14
21
28
DAY

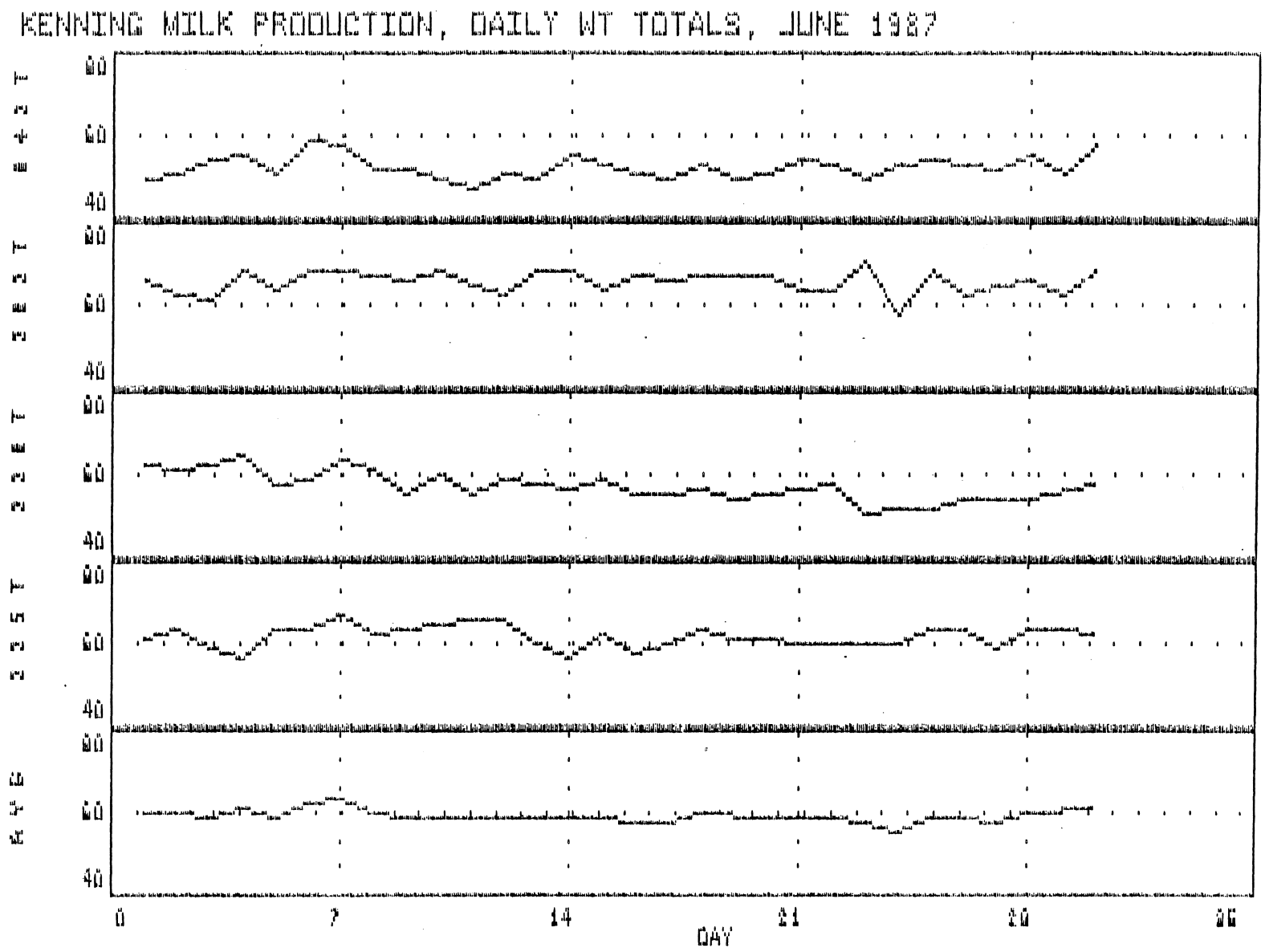

KENNING MILK PRODUCTION, DAILY WT TOTALS, MARCH 1987
60
40
0
7
14
21
28
DAY

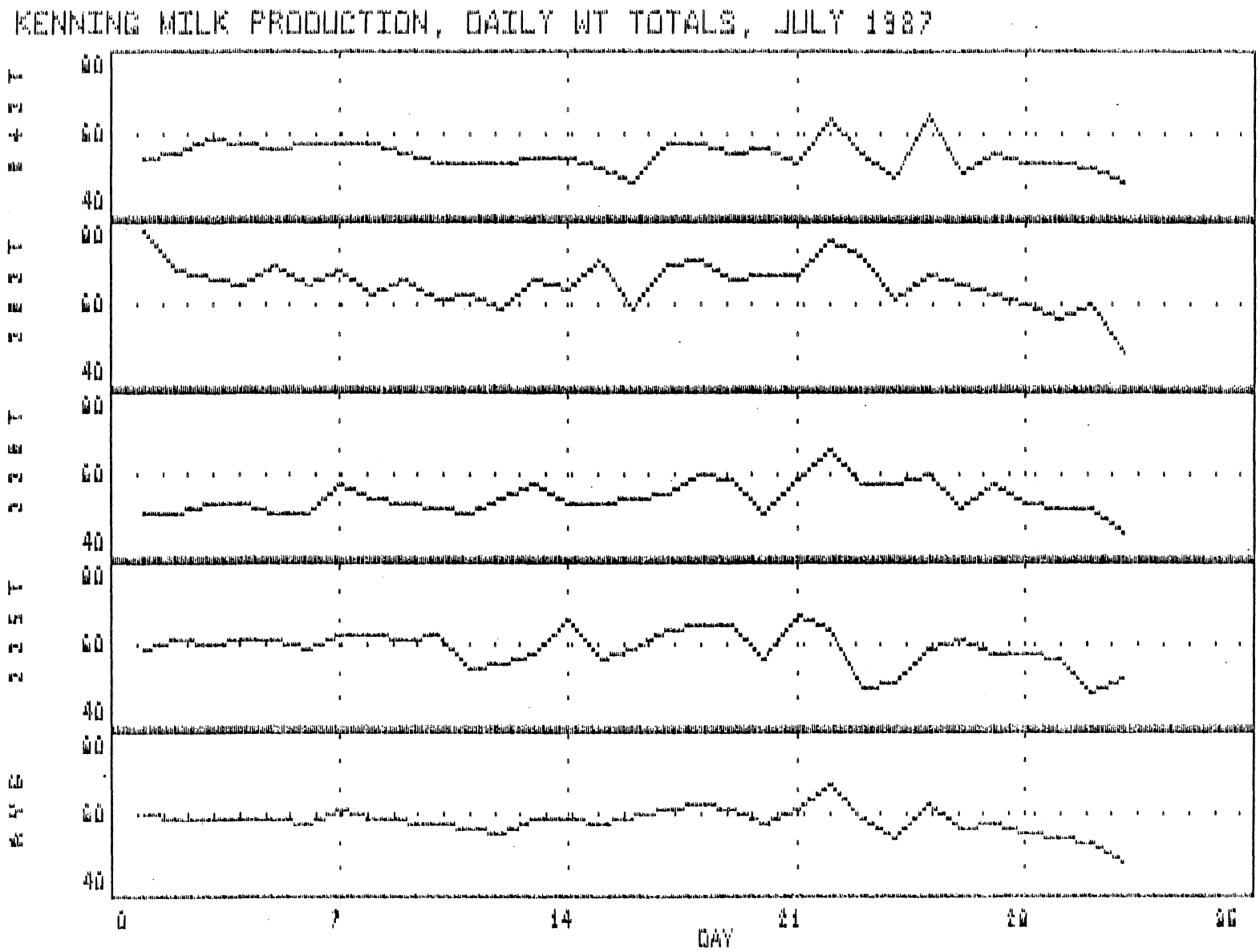
KENNING MILK PRODUCTION, DAILY WT TOTALS, APR 1987



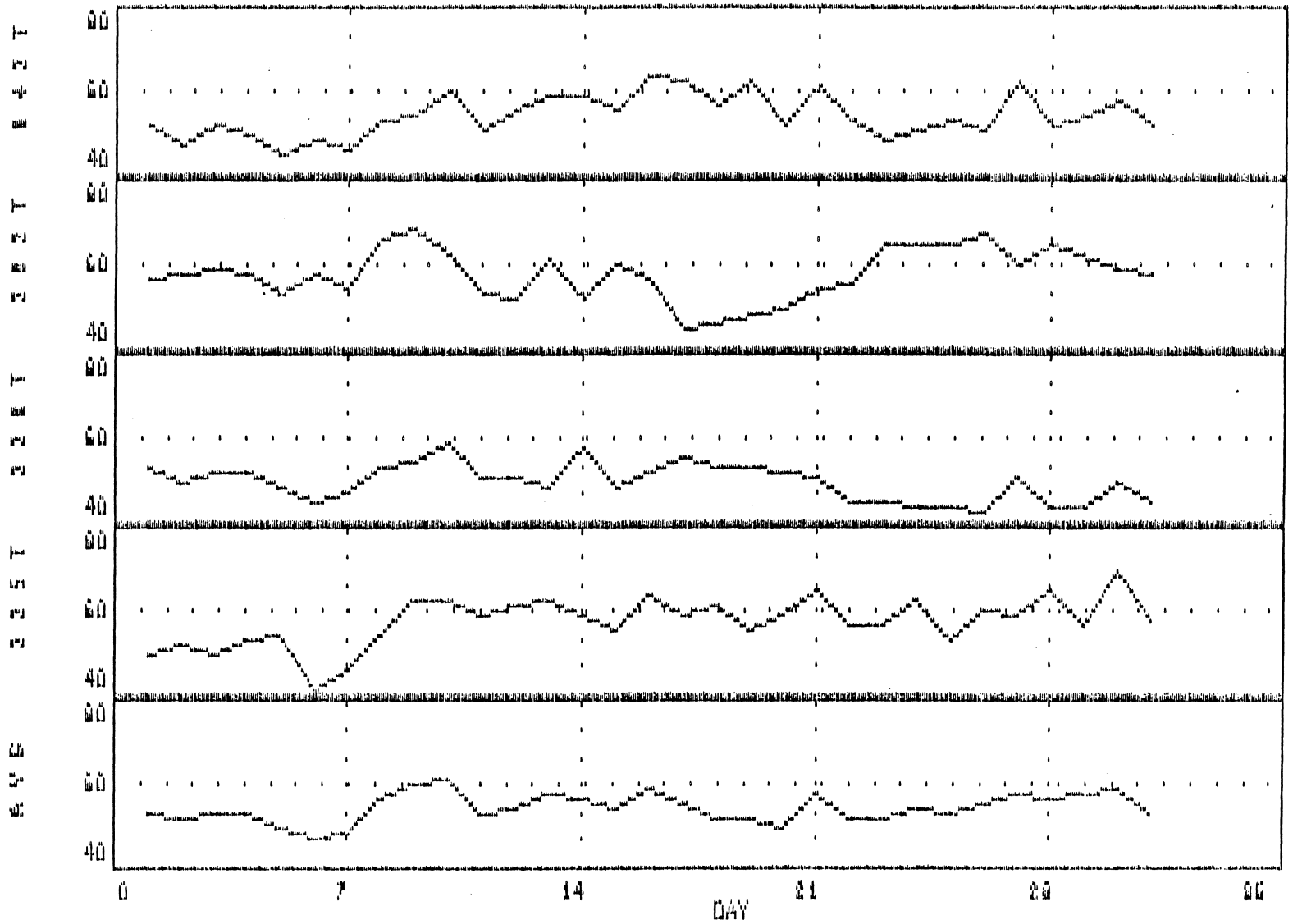
KENNING MILK PRODUCTION, DAILY WT TOTALS, MAY 1987

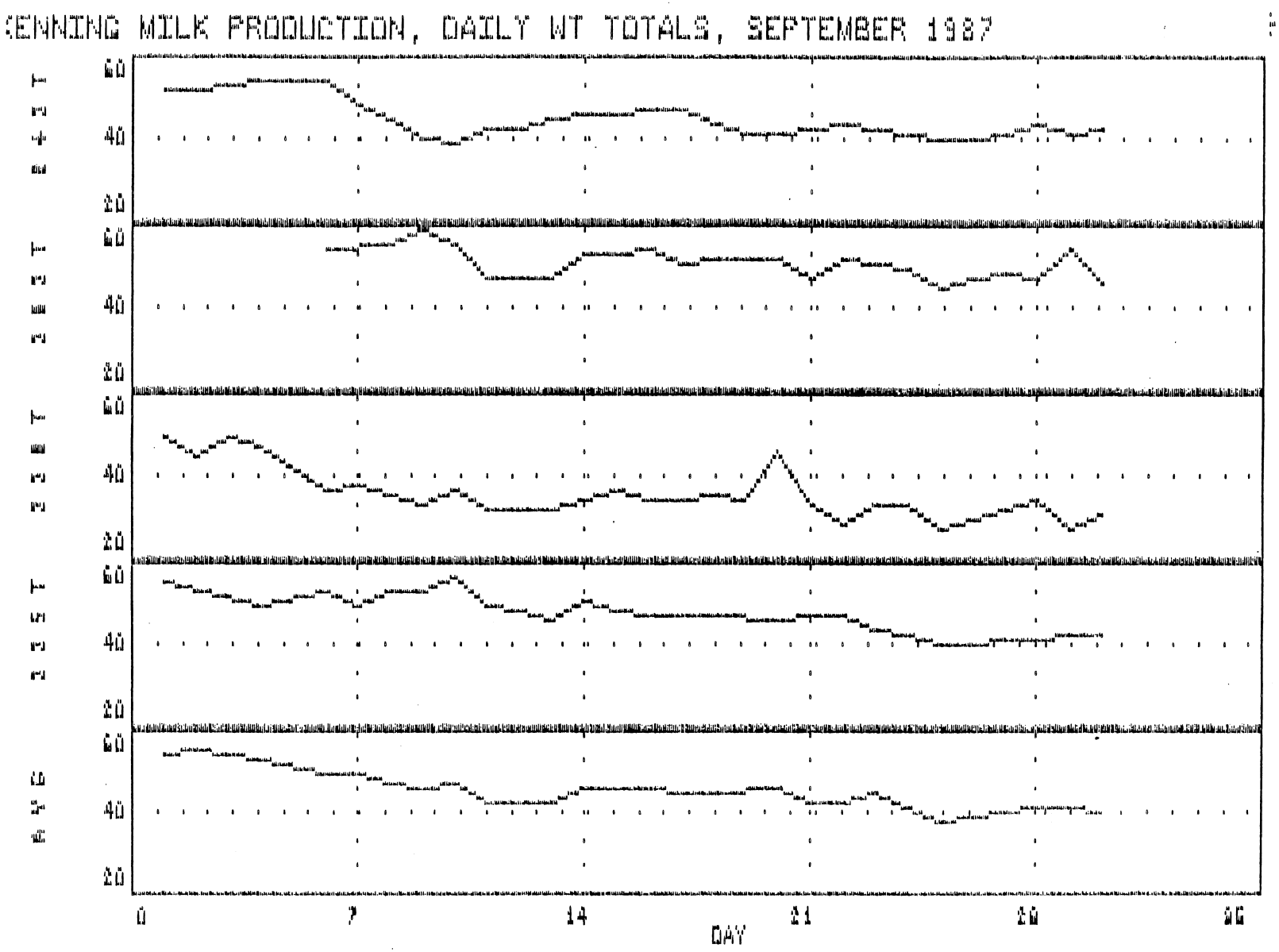


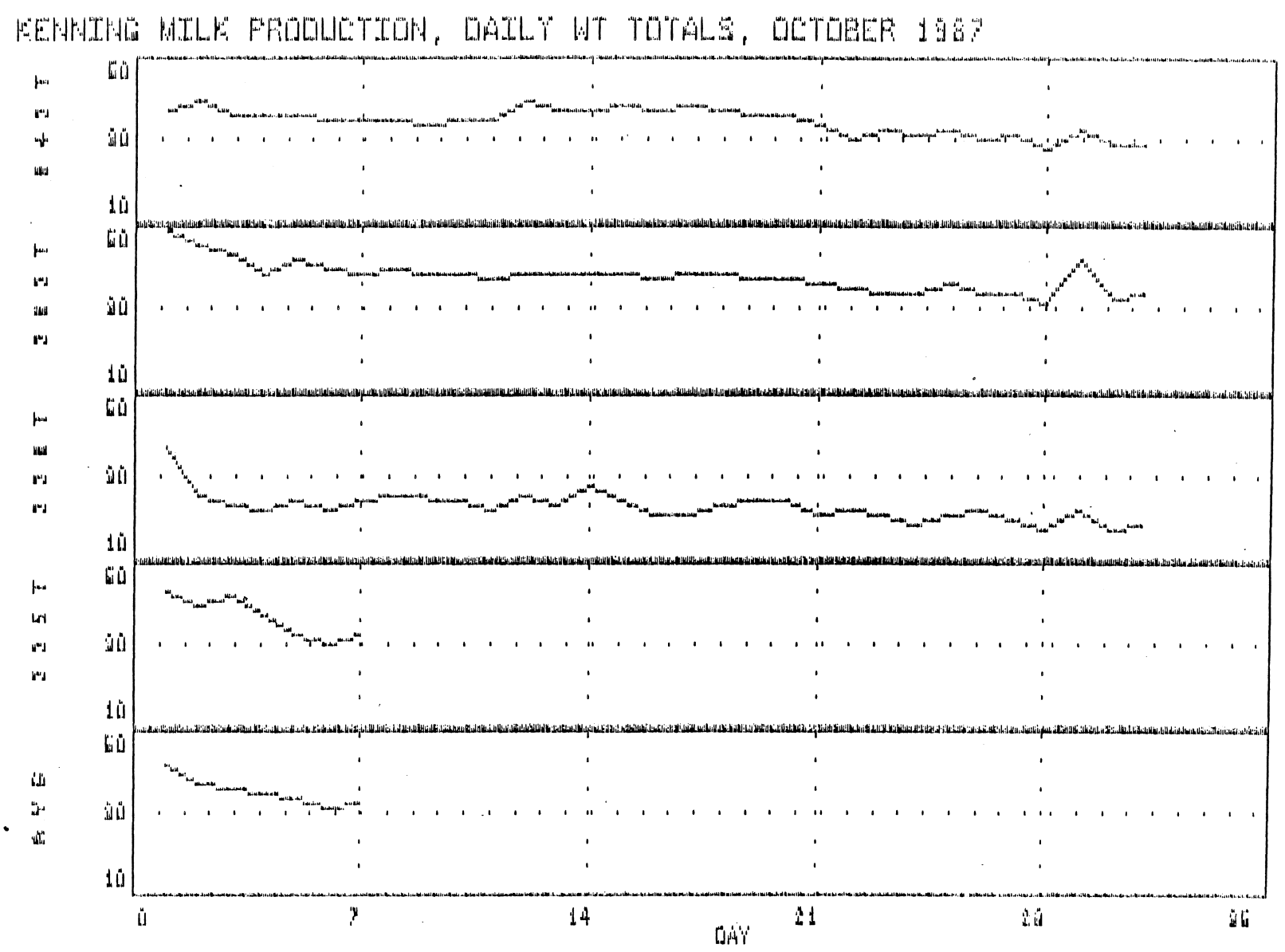

KENNING MILK PRODUCTION, DAILY WT TOTALS, JUNE 1987
80
60
40
0
7
14
21
28
35
DAY


KENNING MILK PRODUCTION, DAILY WT TOTALS, JULY 1987
80
60
40
0
7
14
21
28
35
DAY

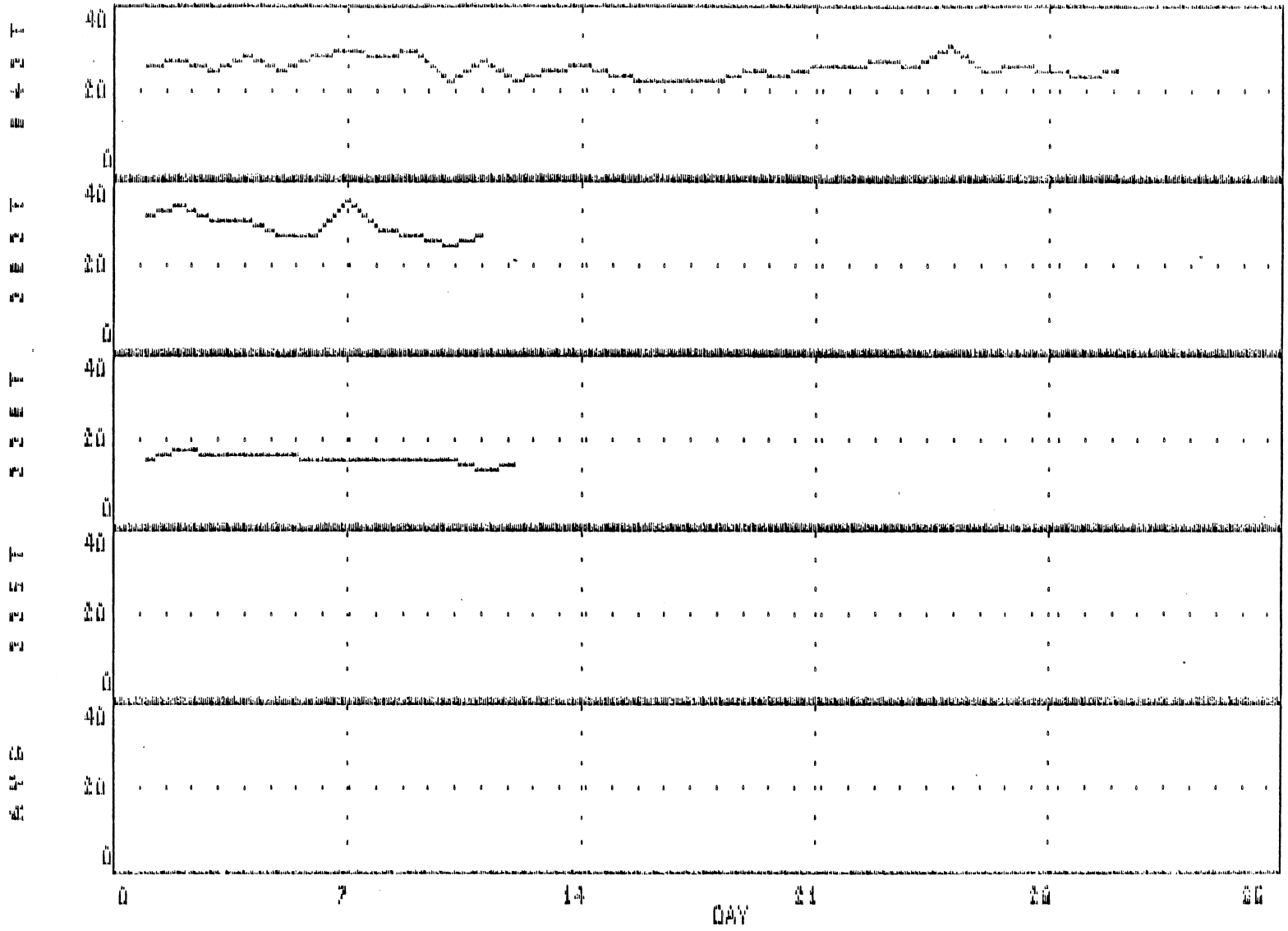
KENNING MILK PRODUCTION, DAILY WT TOTALS, AUGUST 1987



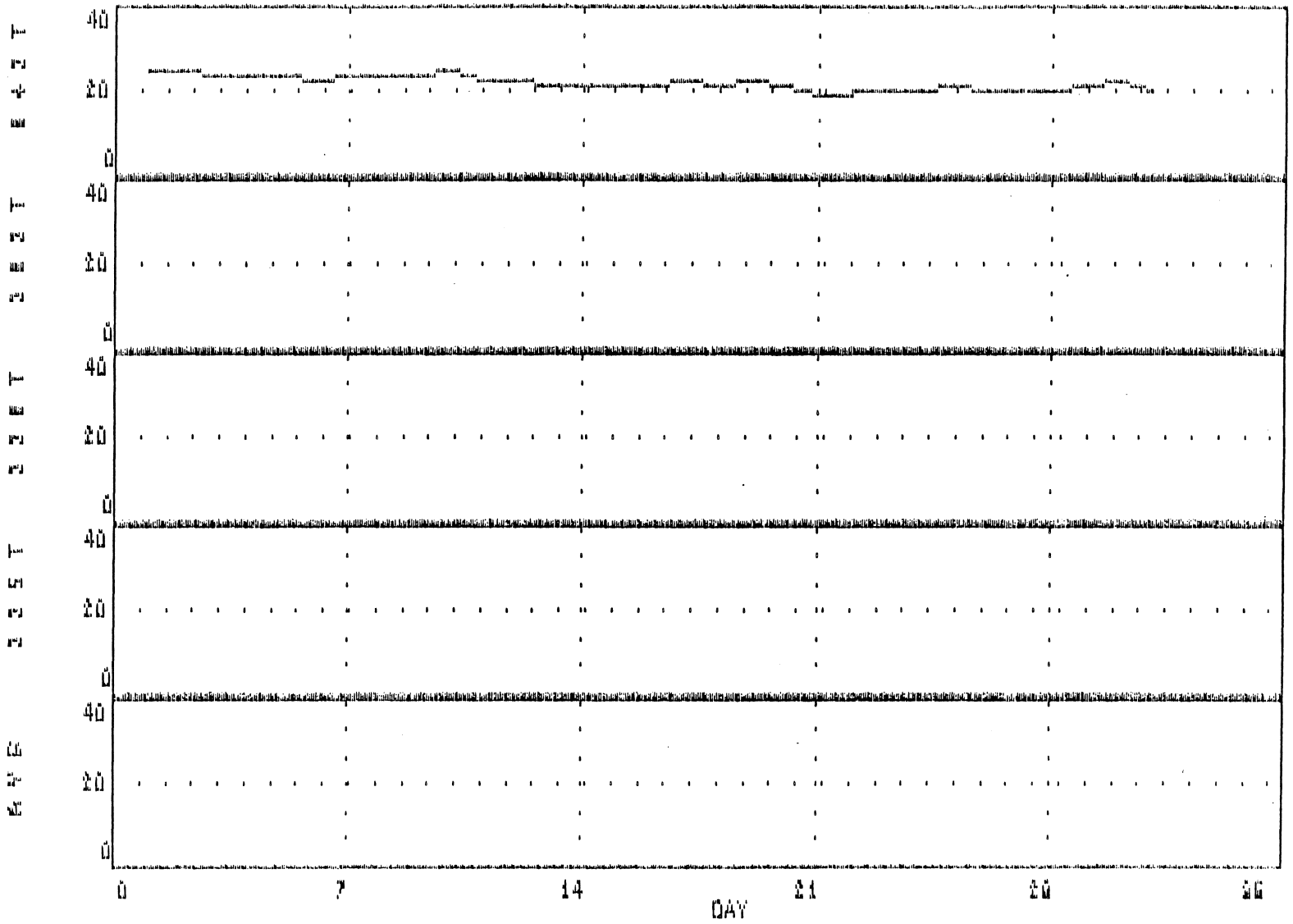

JENNING MILK PRODUCTION, DAILY WT TOTALS, SEPTEMBER 1987
60
40
20
0
7
14
21
28
DAY


KENNING MILK PRODUCTION, DAILY WT TOTALS, OCTOBER 1987
60
30
10
0
7
14
21
28
DAY

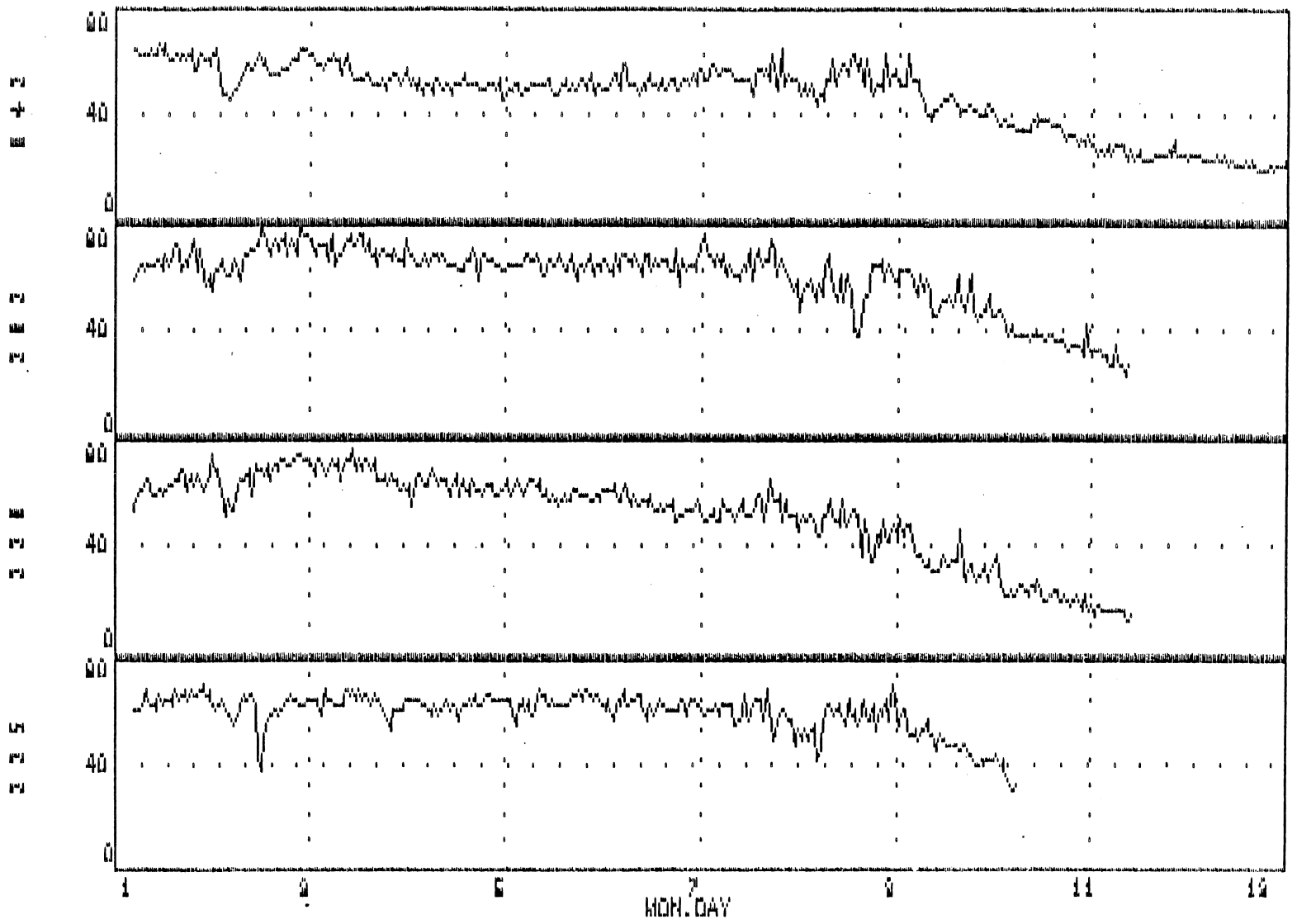
KENNING MILK PRODUCTION, DAILY WT TOTALS, NOVEMBER 1987

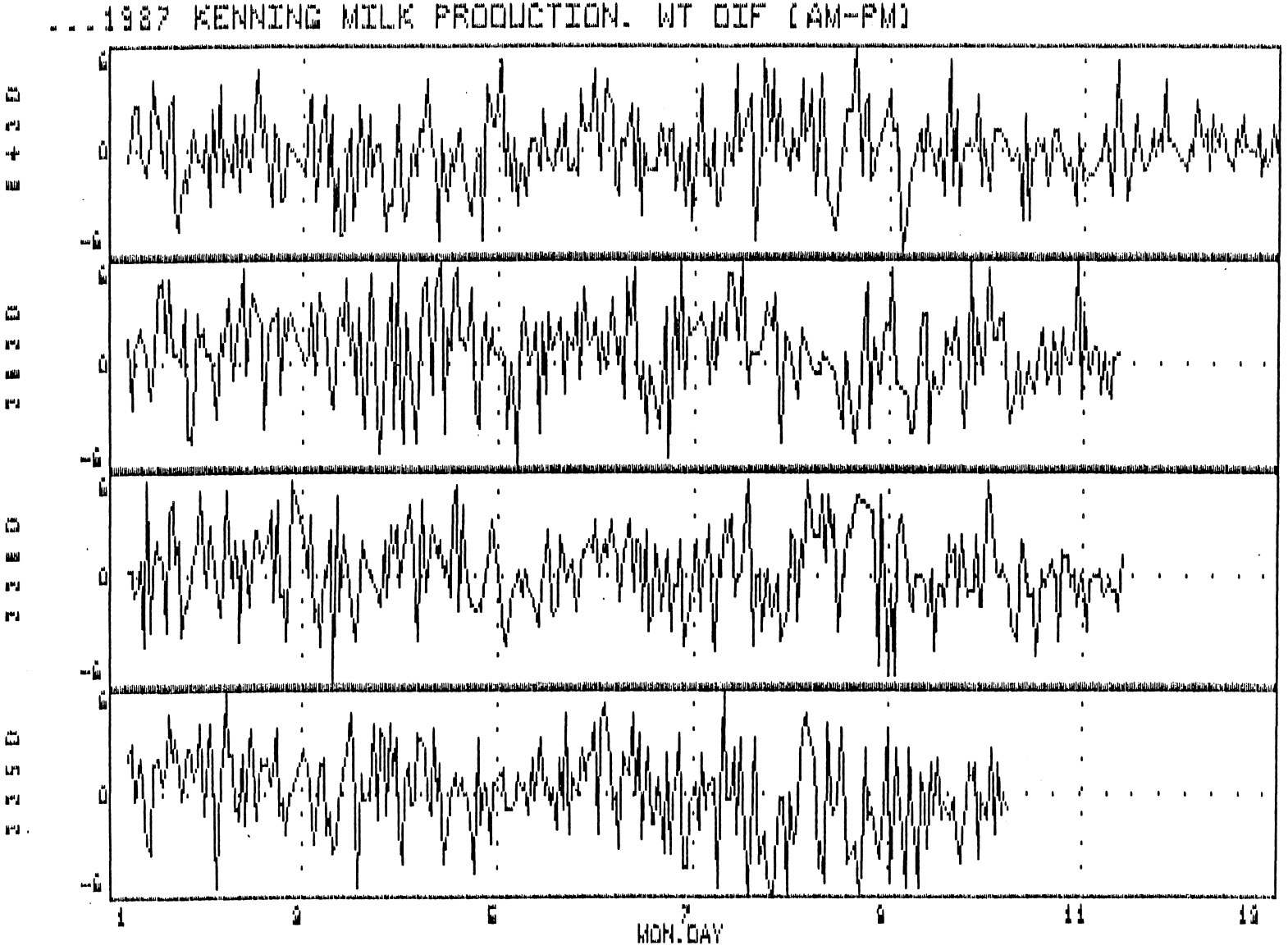


KENNING MILK PRODUCTION, DAILY WT TOTALS, DECEMBER 1987



1987 KENNING MILK PRODUCTION. INDIVIDUAL DAILY WT TOTALS




...1987 KENNING MILK PRODUCTION. WT DIF (AM-PM)
1 2 3 4 5 6 7 8 9 10 11 12
MONTH
1 2 3 4 5 6 7 8 9 10 11 12
MONTH
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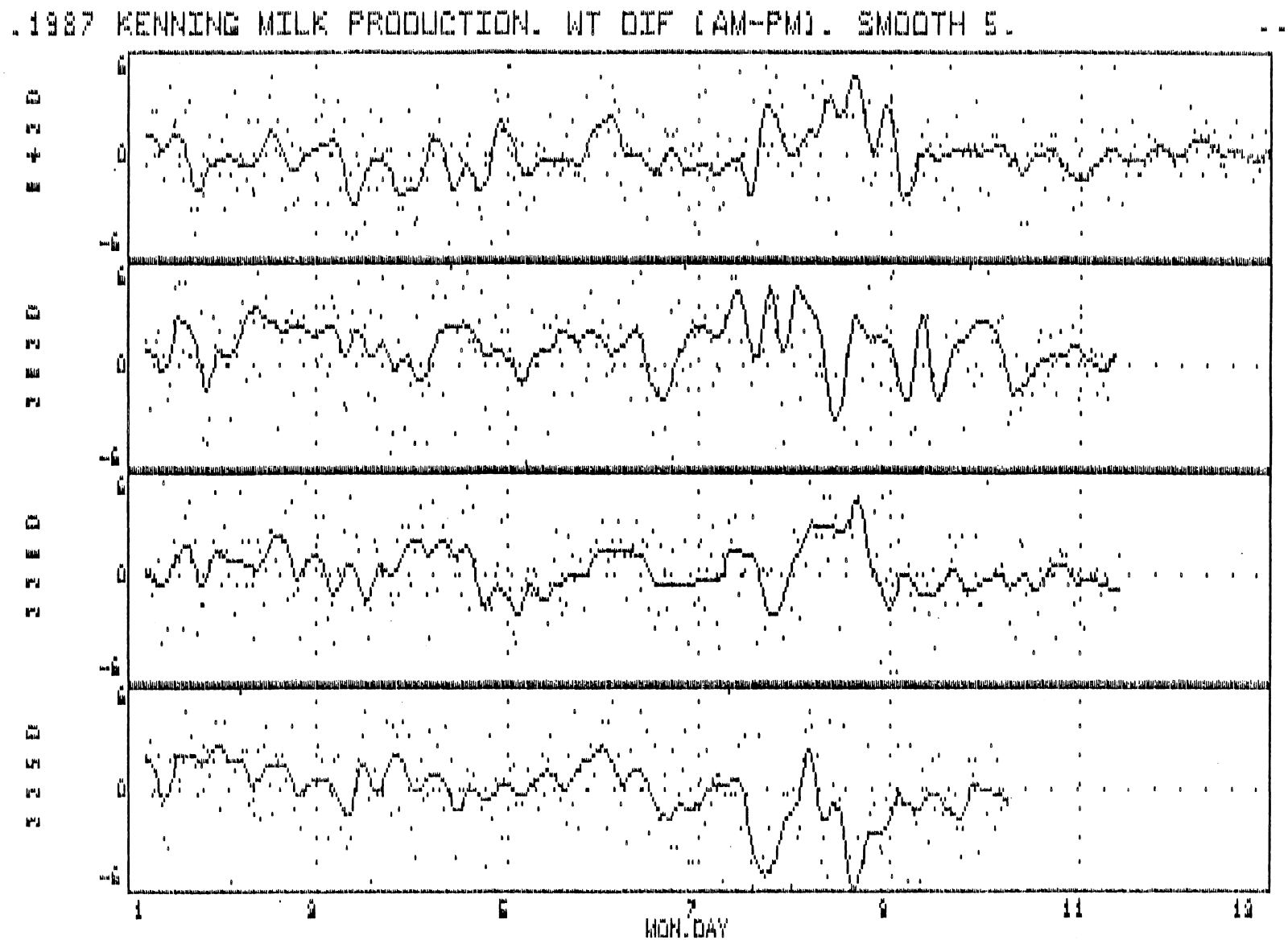
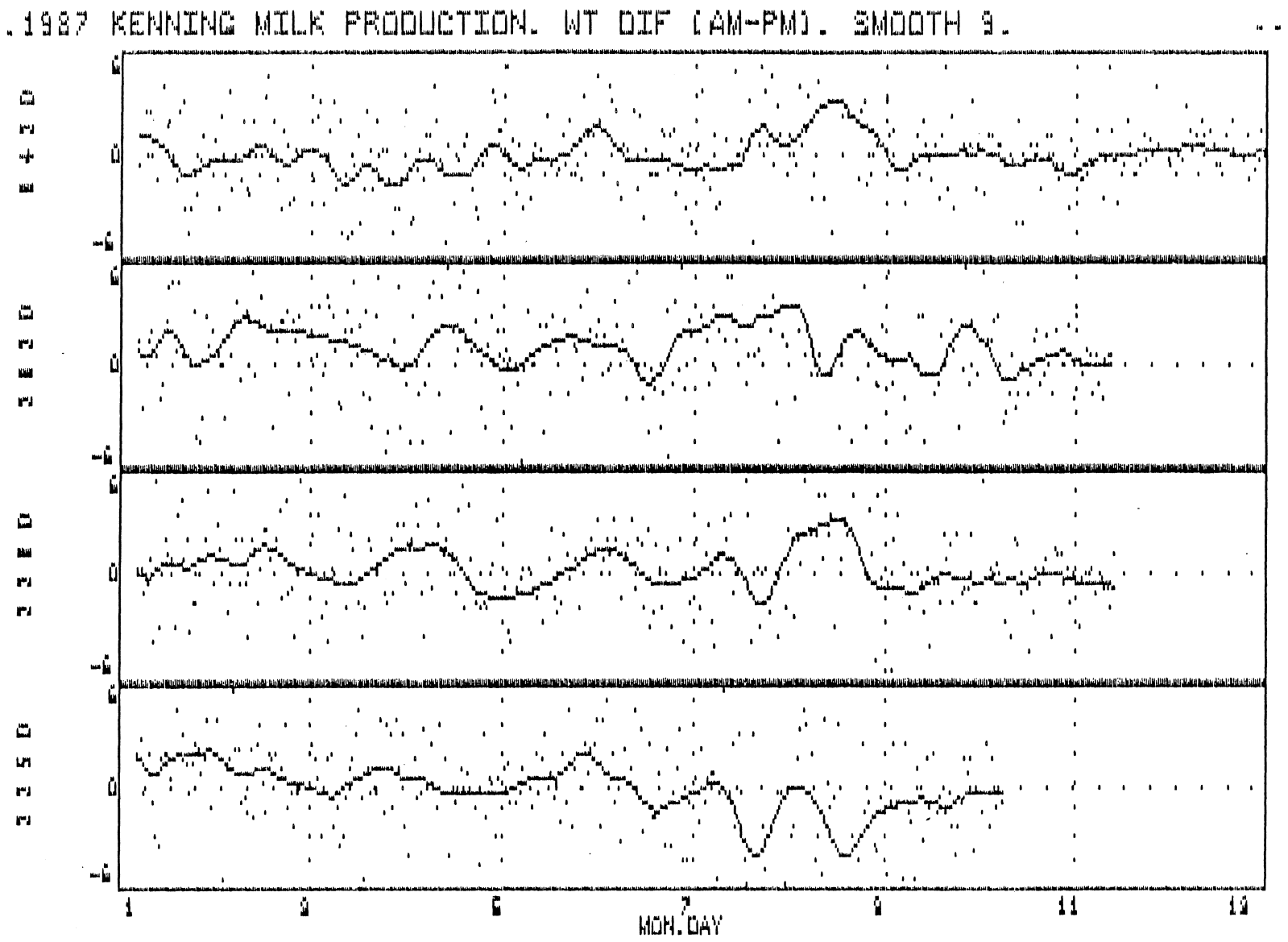
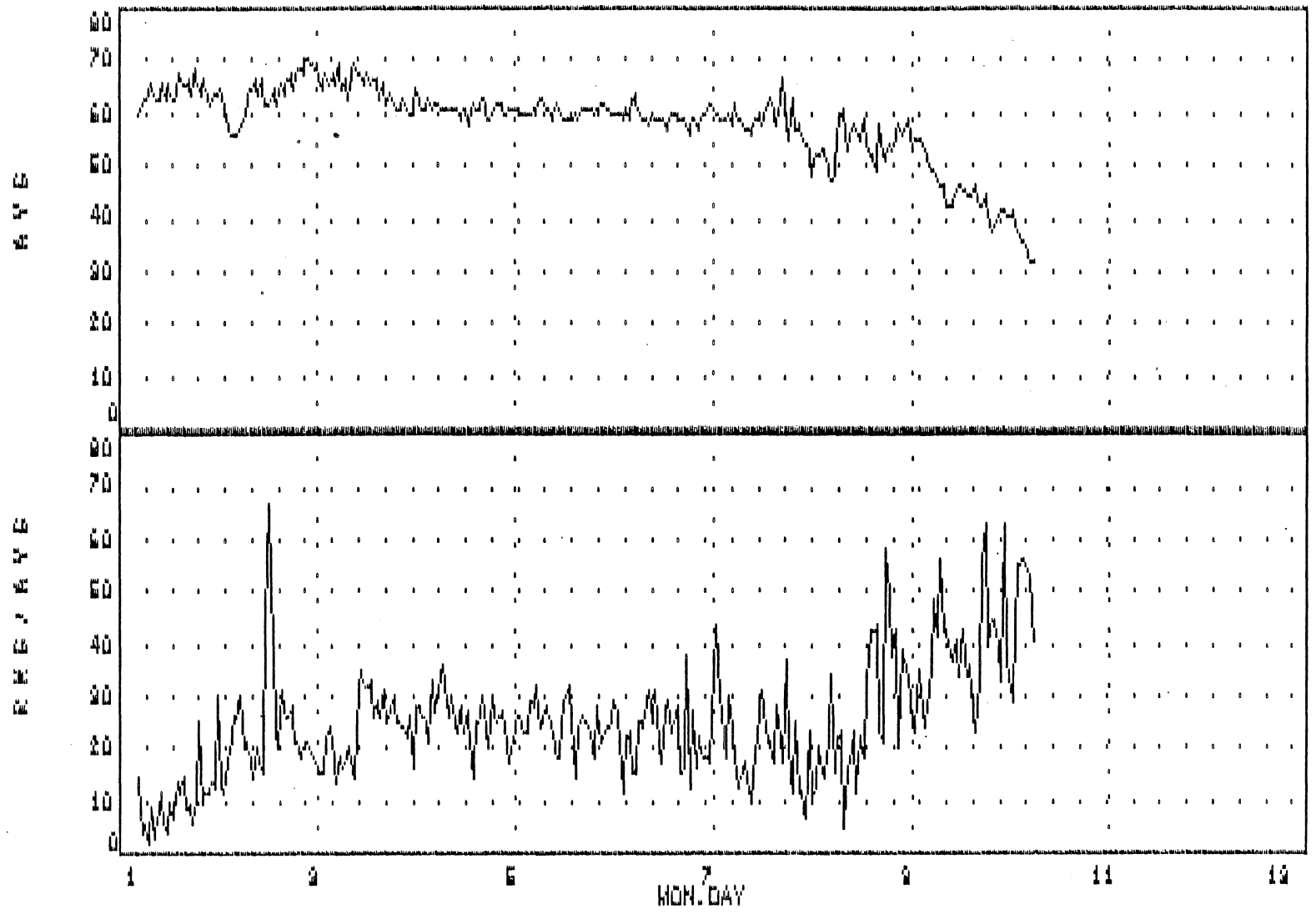
MONTH
1 2 3 4 5 6 7 8 9 10 11 12
MONTH
1 2 3 4 5 6 7 8 9 10 11 12
MON.DAY


.1987 KENNING MILK PRODUCTION. WT DIF (AM-PM). SMOOTH 5.
E 4 2 3 0
E 3 2 3 0
E 2 2 3 0
E 1 2 3 0
5
0
-5
1
3
5
7
9
11
13
MON.DAY


.1987 KENNING MILK PRODUCTION. WT DIF (AM-PM). SMOOTH 9.
E 4 2 0
E 3 2 0
E 2 2 0
E 1 2 0
1
3
5
7
9
11
13
MON.DAY

1987 KENNING MILK PRODUCTION. AVG (4 COWS) AND RANGE/AVG %



8. CONCLUSION

The first listing of generic findings and the coincident limitations of this research were delivered to the Low Livestock Productivity Advisory Board on December 16, 1988 (Progress Report). A draft of this report was presented to the Board on March 14, 1989, and Dataright, Inc. was then asked to develop a set of conclusions, though it was mutually acknowledged that the current analysis was incomplete. That listing of conclusions was delivered to the Board on March 31, 1989 (Appendix F). As a result of these considerations, a significant point of misunderstanding developed regarding a perception that this work was critical of traditional stray voltage investigations. This was not our intent as we recognize the assessment of stray voltage as essential, given the pervasiveness of the problem, to activities of the dairy enterprise. It is our intent and the purpose of this report to broaden the scope of electrical environment considerations on those farms where traditional approaches have failed to resolve the problem. All of the family farms evaluated here have a five to ten year history of persistent problems which they believe to be electrical in nature. Furthermore, all of these farms have made investments ranging from a few thousand to several tens of thousands of dollars in efforts to modify electrical characteristics of their dairy facilities.

The proposal approved for this research did not include a responsibility to offer either recommendations or conclusions regarding this work. Rather, the objective was to report the findings of the investigation to the Low Livestock Productivity Advisory Board. Because of the diversified nature of this research, the Board has since requested that this section be added. It is written following the review of the draft report and references comments received per that review (Appendix F).

It is clear, based on comments received, that no one is satisfied with this information as it currently stands, including the personnel responsible for the research. Though we believe both the database that has been established and the preliminary analysis of that information are of unprecedented quality and quantity in this field of study, we recognize the inadequacies of both the analysis and limitations of the variables described. As a result, what is offered here is opinion based on experience rather than statistically indexed findings.

The funding for this study ($46,000.00) should have been adequate to identify a key factor acutely and adversely affecting production if it occurred consistently between the study farms and was included in those evaluated. Though resources were inadequate to support a complete analysis of this data, we now doubt that any major variable capable of causing a direct and acute loss of milk production is included in the database or even is likely to be subsequently identified. We expect that future success in improving dairy productivity problems will depend on the identification of a causal domain of variables that act

synergistically to depress profitability. While these concerns were also apparent in the proposal approved for this work, we now have a new understanding of both the nature of the question to be asked and the breadth of factors to be considered in future studies.

In the progress report submitted by Dataright, Inc. on December 16, 1988, the following general findings of this project were noted:

"GENERAL FINDINGS:

1. Non transient contact potentials to which animals were exposed were in the magnitude of a few hundred millivolts across all farms studied and typically did not represent what would be considered a "shock" condition.

2. All farms where electrical problems were suspected had previously taken corrective actions and installed devices to mitigate neutral to earth voltages though some were not in current use.

3. The soil characteristics of the farms studied differ markedly.

4. The soil fertility of the farms studied was generally good to excellent in several cases indicating that no further application of fertilizer was needed to support a 100 bu/a next year corn crop.

5. Herd management practices vary substantially between study farms but there is a remarkable similarity associated with animal symptoms reported by farm operators.

6. Differences in animal behavior and production may prove to be physiologically indexable on some farms.

7. AC magnetic field strengths vary substantially between and within study farms.

8. The local electric power distribution systems and on-farm electrical services differ markedly between study farms.

9. Neutral to earth voltages recorded under various reference conditions vary substantially between study farms.

10. Earth conductivity appears to be remarkably different between study farms indicating that the concept of a zero ground potential may be inappropriate."

The same report acknowledged the following limitations:

"PROJECT LIMITATIONS:

It is now apparent that a number of potentially important

research considerations were beyond the scope of this project. At the same time, it is difficult to perceive a method of inquiry which would have defined this understanding independent of the work completed within this project. Important understanding may be gained through further consideration of the following issues:

1. Source and strength of ac magnetic fields in the barn and farm yard areas.

2. Determination of nmr conditions due to static and dynamic field interaction.

3. Measurement of low level differential body potentials to index animal stress.

4. Consideration of power frequency harmonics and biological effects windows.

5. Symptoms survey to determine the extent of the syndrome on problem and non-problem farms.

6. Determination of earth conductivities at multiple locations in Minnesota, (this information is likely to be already available from local electric cooperatives specific to the depth and extent of ground design for specific substations.)

7. Additional monitoring of farm electrical service loading coincident with animal exposure.

8. Spectral analysis of the electrical environment to which the animal is continuously exposed.

9. Mapping the occurrence of fast, high magnitude transients to which the animal may subsequently respond as influenced by both the magnitude, duration, and density of the transients.

10. Construct real time computer based simulations of the local distribution system to determine the extent and direction of earth currents as a function of system loading.

11. Deploy experimental animals with established performance records on problem farms to index production losses and symptom expression.

12. Examine the existing database for daily and weekly periodicity related to energy use."

There is a keen need to establish a priority to such a listing to benefit the economy of future investigations and improve the likelihood of resolving chronic problems on affected farms. We also believe there is a certain need to redefine the question. Our work indicates that the consequence of concern is not the production of the dairy operation but the profitability of that operation. Major losses may be found to be associated with conception failures, herd health maintenance costs, failure to

achieve premium quality milk, operator time commitments that pre-empt other farm activities, and decreased milk production.

Certain objections to the work we have reported here are included in the reviewer comments (Appendix F). Several comments reference the need for continued attention to management practices and the need to not neglect traditional stray voltage considerations. We agree and in this report have included those concerns as a part of the same period record contrastable with considerations of the extended electrical environment.

Human health studies completed during the last decade impose a need to include considerations of the magnetic field and other characteristics of the electrical environment in biological effects research (25, 30, 52, 53). Most of the literature that we have reviewed would indicate that this is one of the first studies of dairy production problems to do so (1, 4, 5, 6, 7, 8, 9, 11, 12, 15, 16, 17, 18, 19, 20, 22, 33, 40, 41, 45, 56).

It is our intent that this report and the considerations listed here should broaden the scope of consideration of the electrical environment in future studies of production/profitability problems on dairy farms. Furthermore, we believe that records of the occurrence of electrical environment variables should be recorded numerically in a time-defined database as was done in this study so that statistical analyses are possible. To our knowledge, the database included here is the first demonstration of such a record.

One of the major faults of this record is that it includes only a very brief consideration of ground currents and that data was not analyzed due to funding limitations. Yet several contested legal settlements have been recently awarded in Michigan and Wisconsin focused on this issue. For this reason, we would recommend future research activities include such considerations. Also of concern are the occurrence of fast, high potential transient spikes that occur on the power distribution systems. These events are well known as hazards in the computer industry and substantial progress has been made in their identification and suppression. Methods are available to pursue the quantification of animal stress and Dataright, Inc. is developing expertise in this area. Just as a decline in animal performance would lag exposure to a period of stress , the ability to define that stress period would benefit the disclosure of causal stress factors. Success with elevated housing structures on the Joe Kenning farm would indicate a need for controlled experiments related to his observations.

To progress scientifically toward understanding cause and effect relationships, there is a need to improve understanding of the index variable of concern whether it be production or profitability. This is not a simple task as it requires that assessment of the anticipated causal factors be defined over the same period of time as the effects are represented. The database described here is averaged to yield one-minute observations for

eight to twelve variables over a period of about two weeks per farm. This results in approximately 800,000 discrete data points per farm. Though we feel this constitutes an original contribution to the science of this subject, one reviewer criticized the study because the "data sweep" of the electrical environment was not fast enough (inclusive of enough discrete data points) to represent changes in the electrical environment. We note that part of the available record is on a one-second time base but that this rate of collection fills a 360 kB diskette in 20 minutes. The contrasting production variable is collected twice daily and is typically represented as the bulk behavior of the entire dairy herd while the principal performance index of profitability is usually only known on a monthly basis.

We foresee no simple solutions to these problems as the foregoing concerns would indicate. We also make the general observation that our extended experience with dairy farmers and dairy production seminars and surveys would indicate that some ten to twenty five percent of the dairy farms may be experiencing production problems which appear to exceed their management initiatives and may be related to characteristics of the electrical environment.

Recent advancements in assessment technology coupled with an understanding of electrical field theory may well yield solutions of benefit to the dairy industry in the State. But the questions asked need to be better fitted to the scale of available resources. In this research Dataright, Inc. defined a very broad initiative that exceeded both the scope of the Request for Proposals and the funding attached to that request. It is now estimated that the total investment in this project in donated professional services, materials, equipment and debt-financed activities exceeds the original appropriation by a factor of two. While this approach has represented a valued investment in future activities, such contributions exhaust personnel resources and cannot be expected to occur routinely.

It is recommended that future research plans require a multidisciplinary approach including, at least, joint expertise in biological and physical science and the garnished experience as learned by the affected farmers. During the winter of 1989 the Minnesota Department of Agriculture reported a loss exceeding 100 dairy farms per week in Minnesota. This represents a direct loss to the original wealth and resource economy of this State. Additionally, each of the family farms studied in this project claim annual losses which approach or exceed the total appropriation for this project. There is now an apparent need to integrate these diversified public and private losses into a cooperative plan of action leading to their resolution and prevention.

APPENDICES

A. Photographic Record

B. Regional Topology, Geology and Hydrologic Maps

C. Local Electrical Distribution Maps

D. Farm Operators' Logs

E. ac Field Evaluations

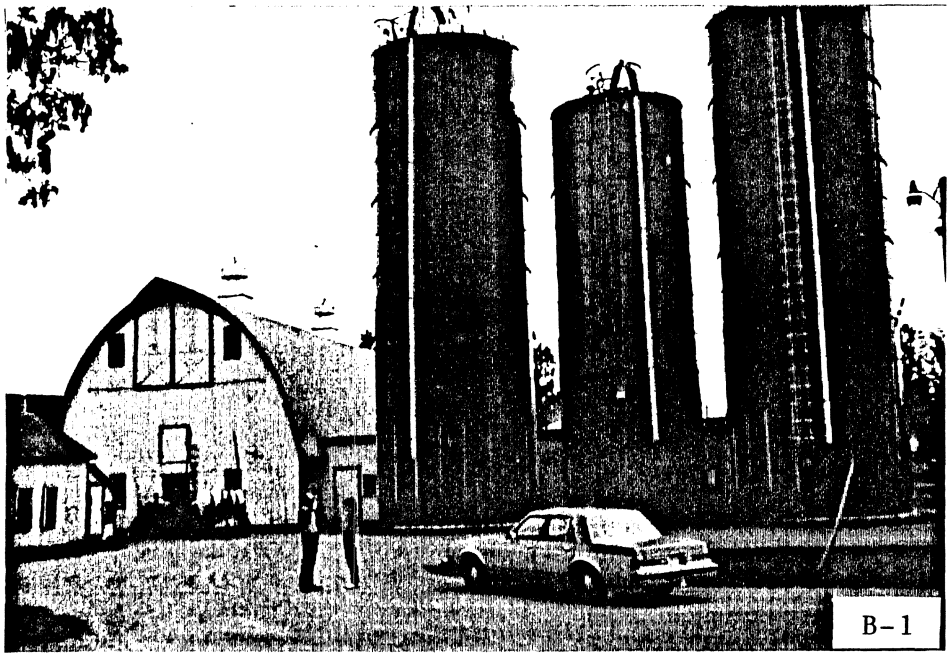
F. Project Documentation and Reviewer Comments

G. References

PHOTO RECORD

Photo #	Description
B-1	Art Borgerding farm, Freeport, Minnesota
B-2	primary neutral-remote ground normal loading
B-3	B-2 + milker on
B-4	B-3 + barn cleaner on
B-5	B-4 + silo uloader on
B-6	B-5 + manure pump on
B-7	B-6 + pump start load
B-8	B-2 repeated
J-1	Harold Johnson farm, Swanville, MN
J-2	underground to overhead distribution Johnson
J-3	Blackburn system - Johnson
J-4	terminal box - shielded cable - Johnson Johnson - cow
J-5	Johnson - cow
J-6	Johnson - cow
J-7	contact blocks - Johnson
M-1	dairy barn - Morris
M-2	interior barn - Morris
M-3	SE stall as monitored - Morris
M-4	Truetest milk meter as used in study
M-5	Morris - cow
M-6	Morris - cow
K-1	Kenning monitoring facility and remote reference rod installation
K-2	Kenning - milking parlor
K-3	calf with birth defect

G-1	distribution near Upsala
G-2	3 phase underground service - Johnson
G-3	underground cable repair - Morris
G-4	stillbirth - Borgerding
G-5	cow - abcess?
G-6	cow - excess hoof growth
G-7	field mill in operation - Johnson
G-8	blood sampling - Johnson
G-9	surgical repair twisted stomach
G-10	soil sampling - Johnson
G-11	soil sampling - Morris
G-12	soil conductivity - Kenning
G-13	AC magnetic field grid - Morris
G-14	continuous B field monitoring - Morris



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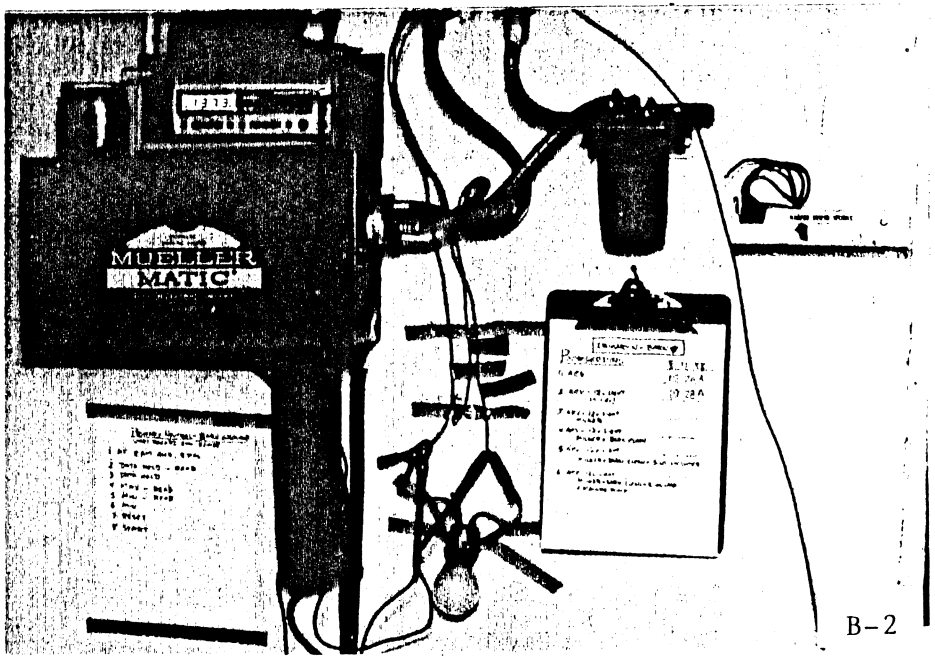

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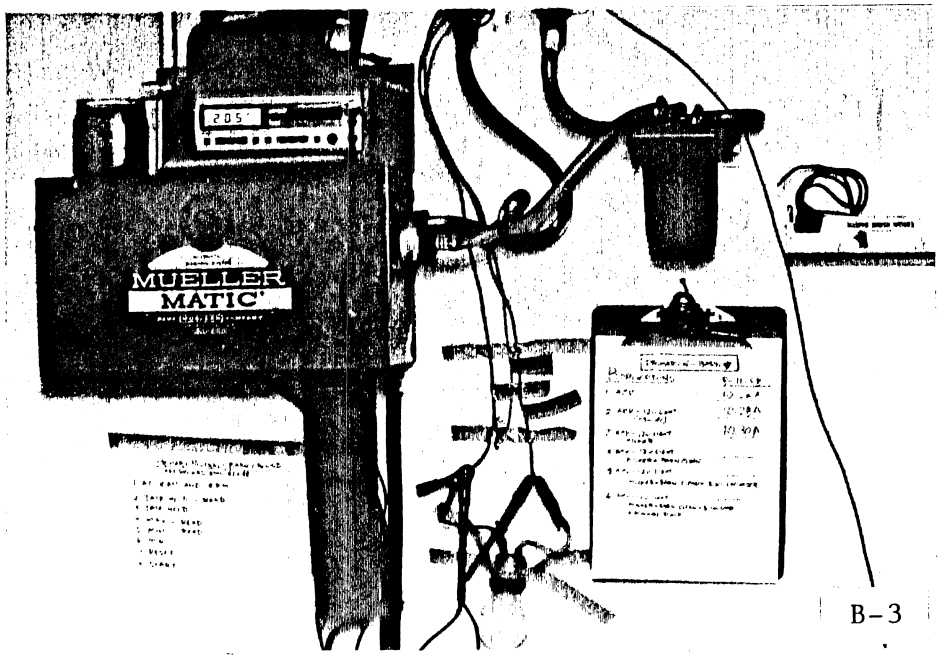

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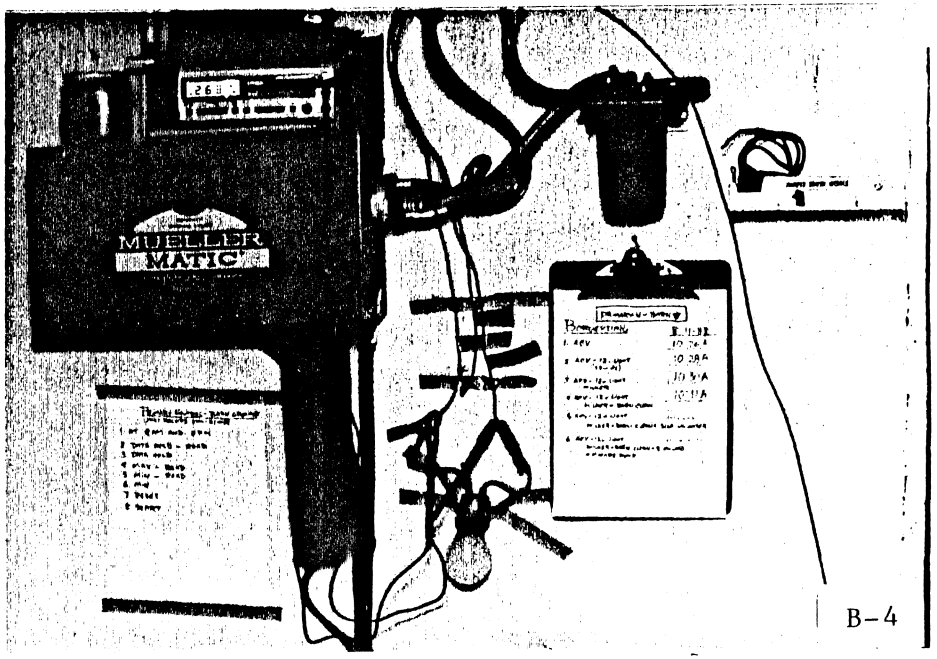

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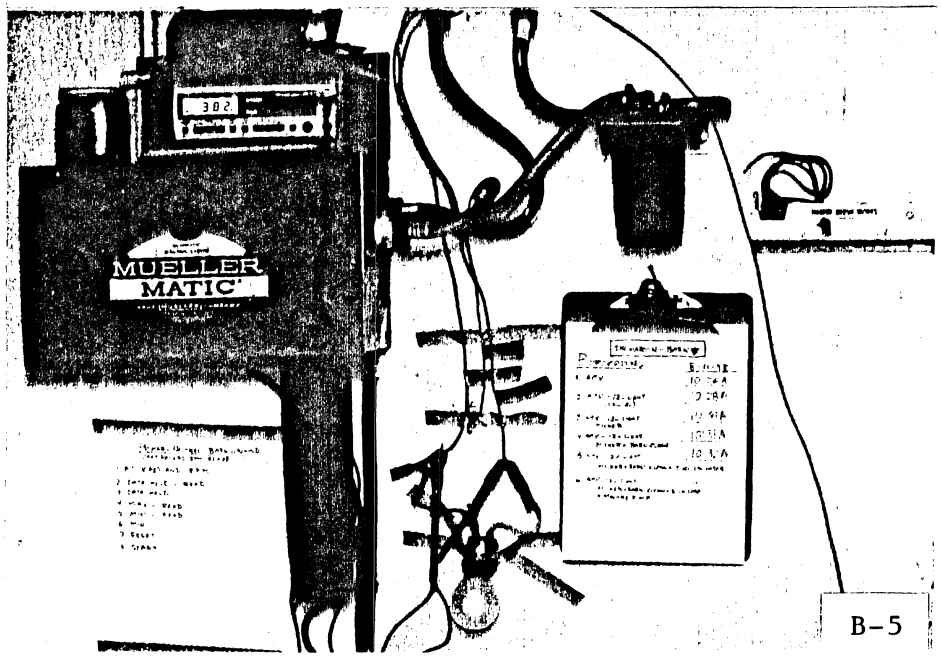

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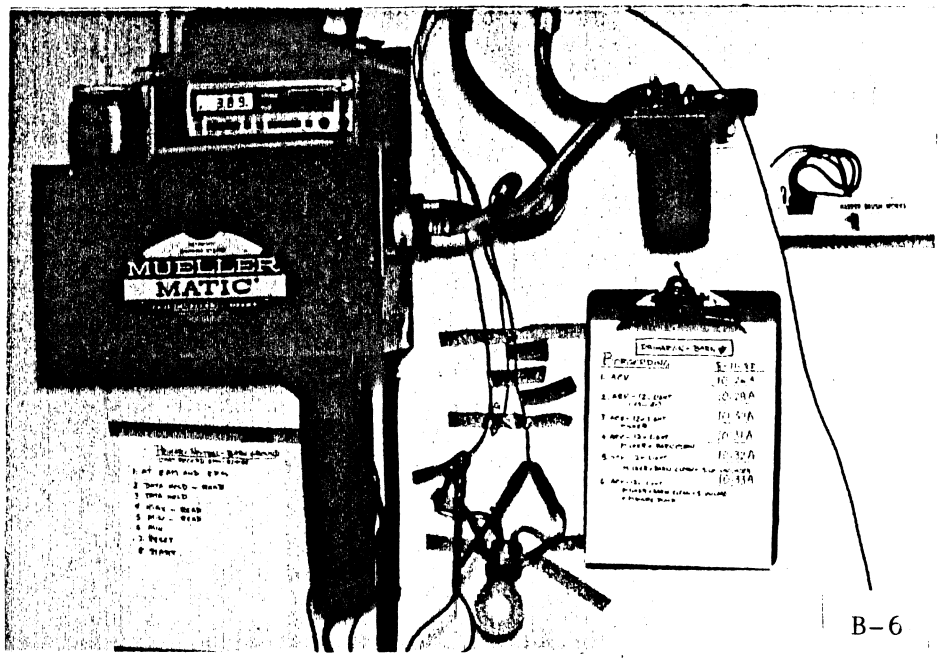

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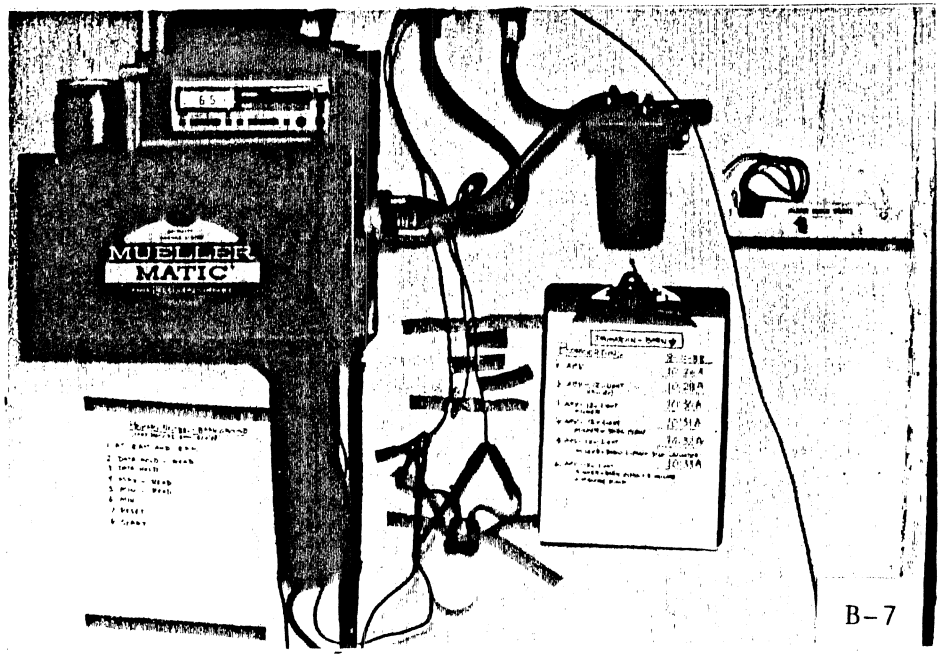

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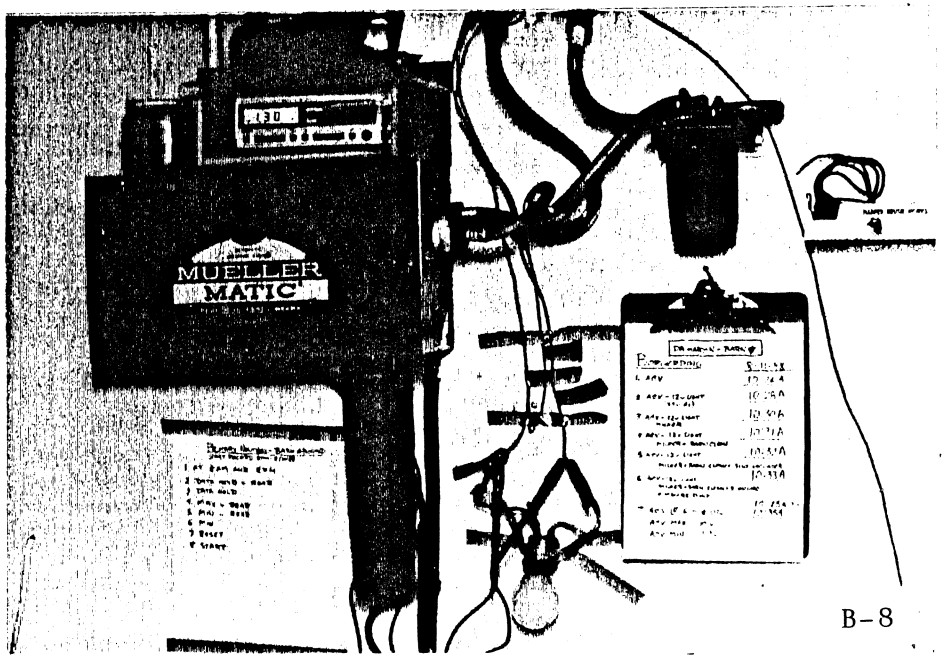

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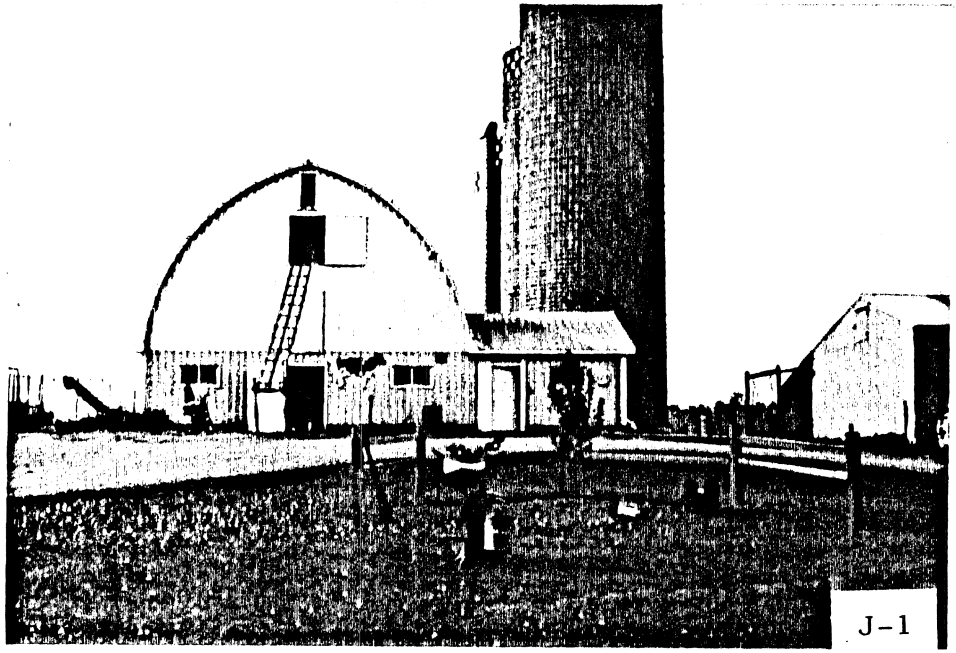

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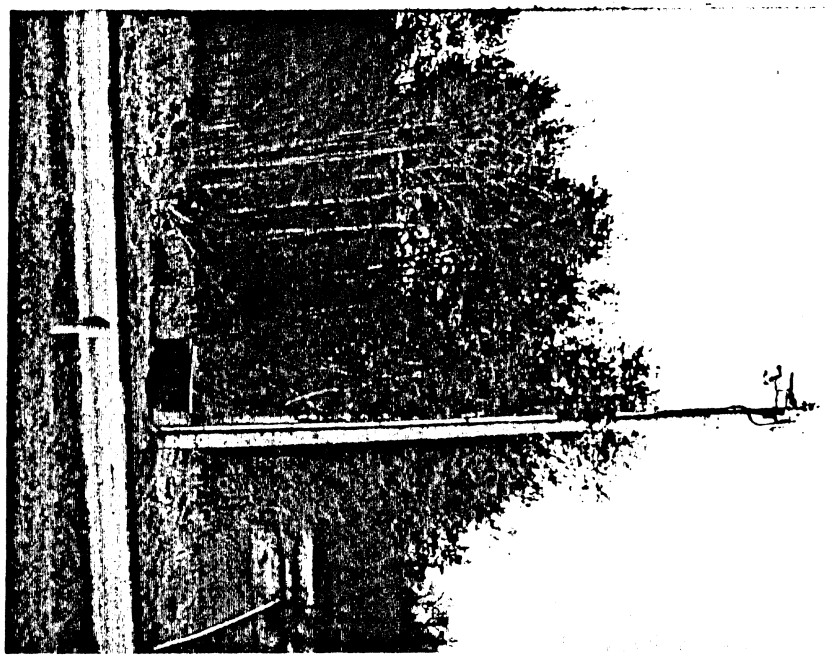

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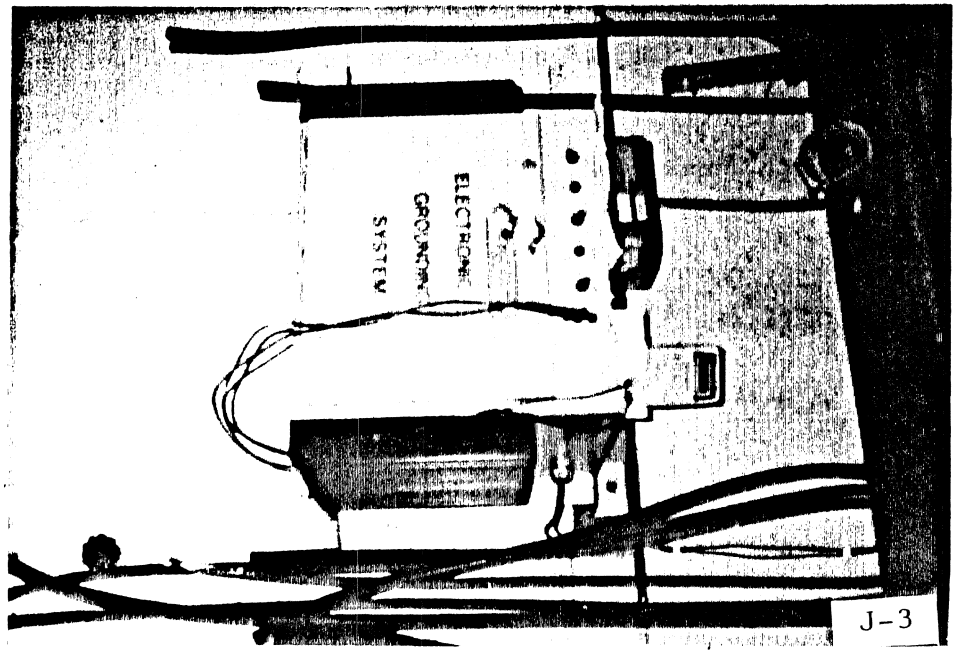

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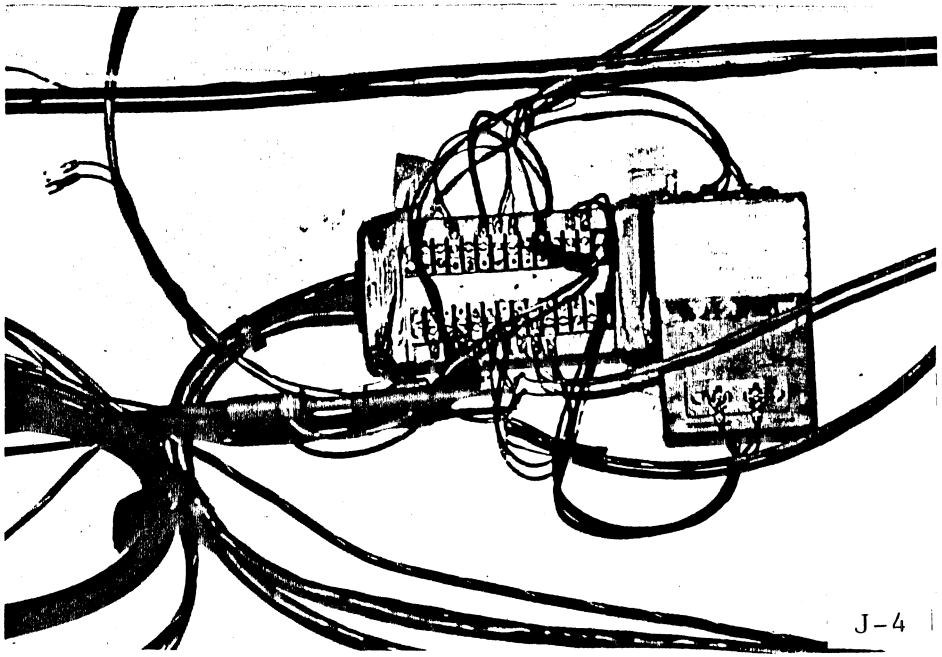

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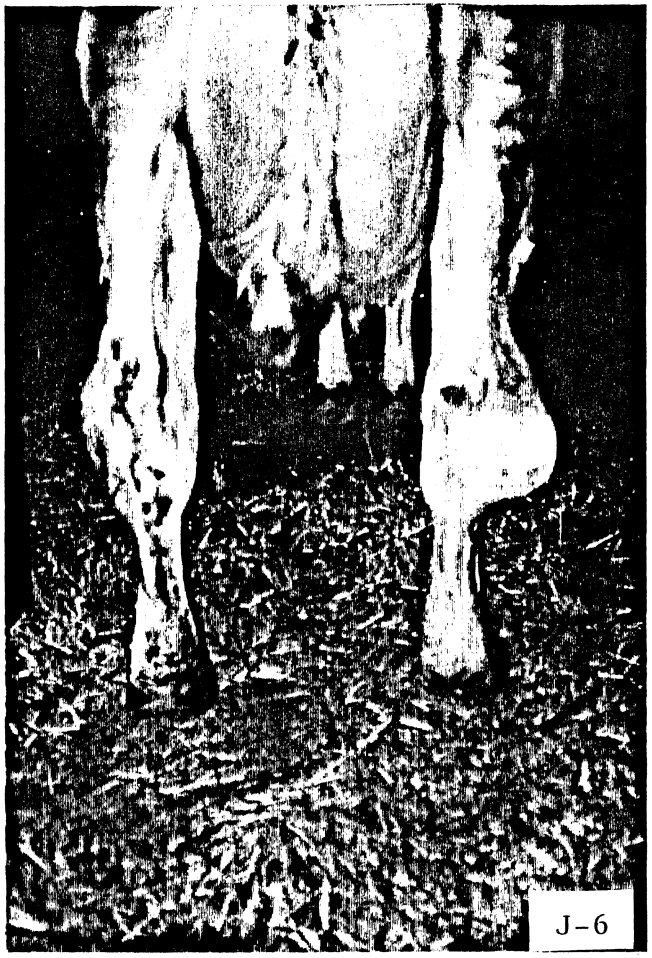

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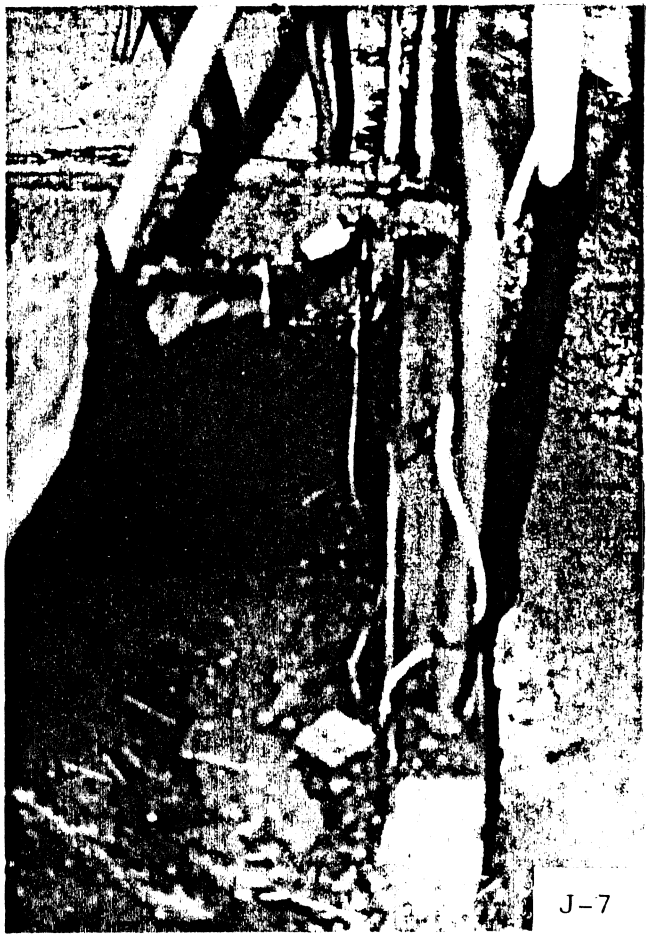

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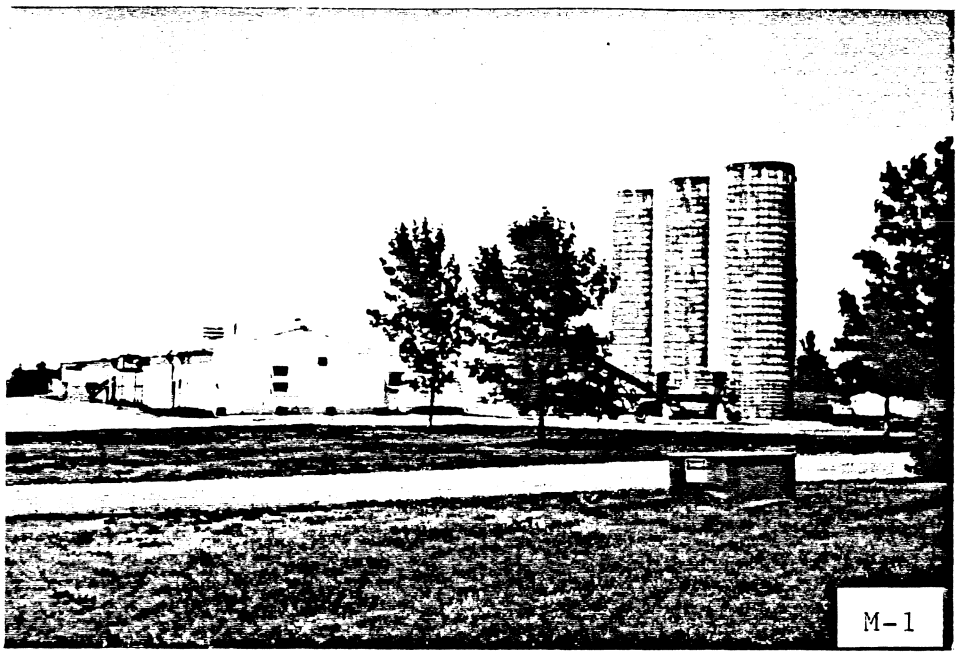

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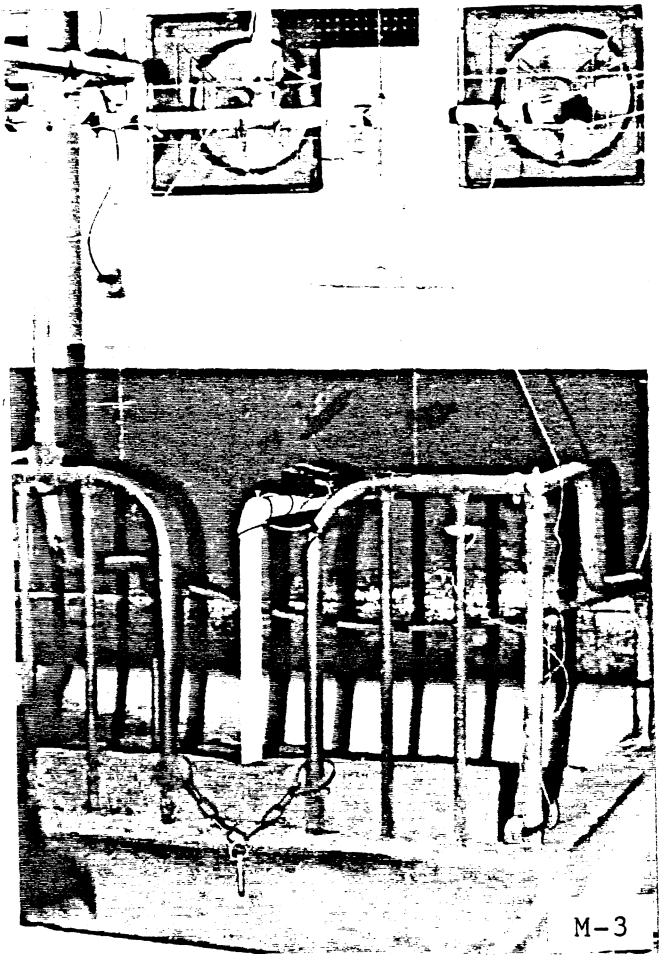

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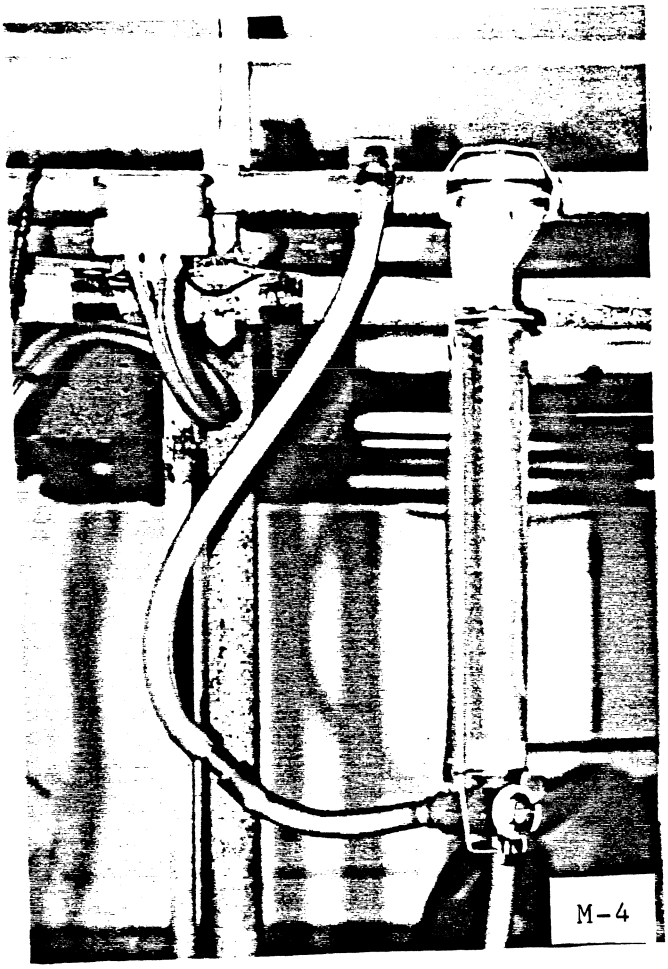

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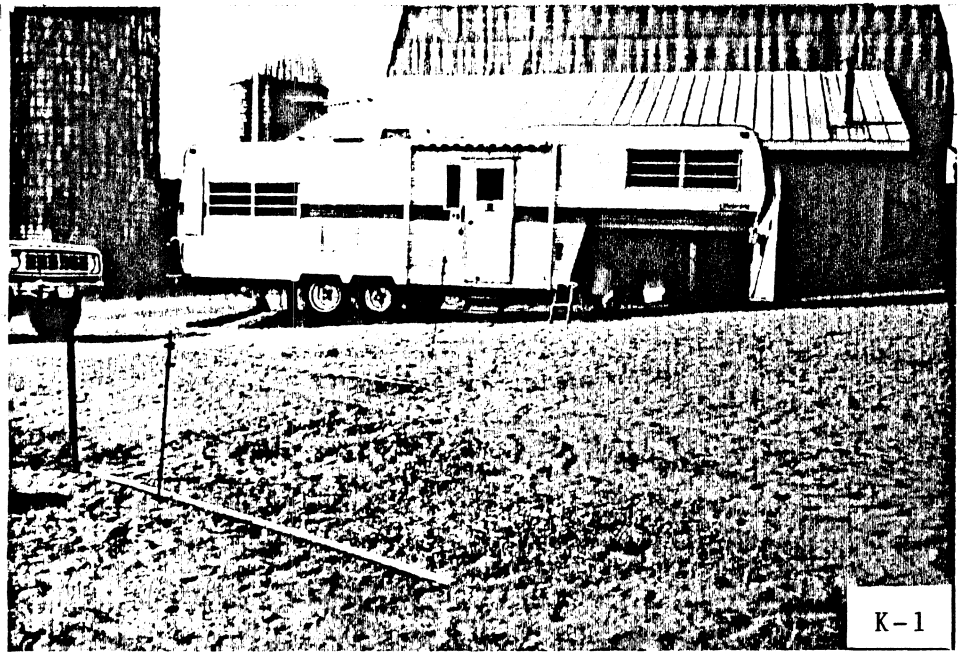

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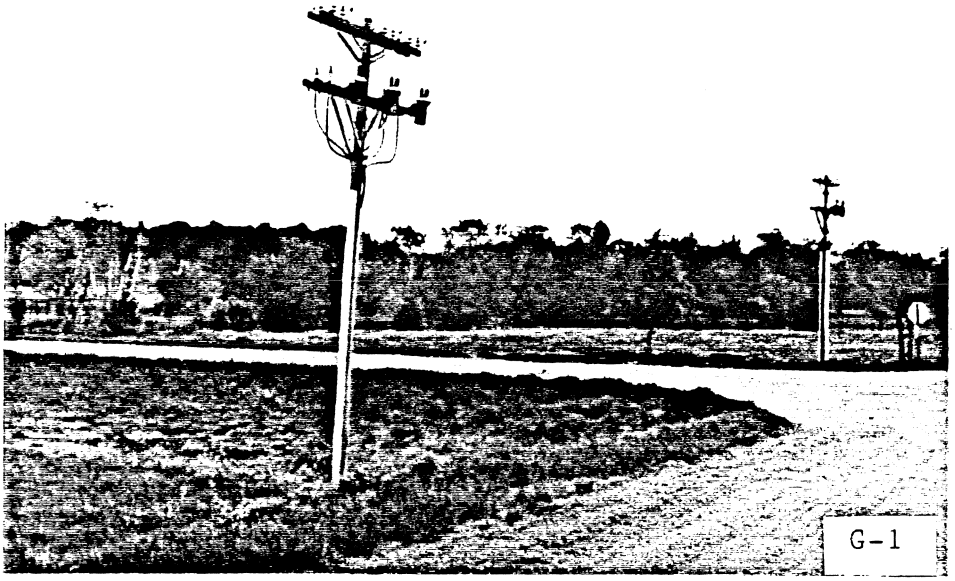

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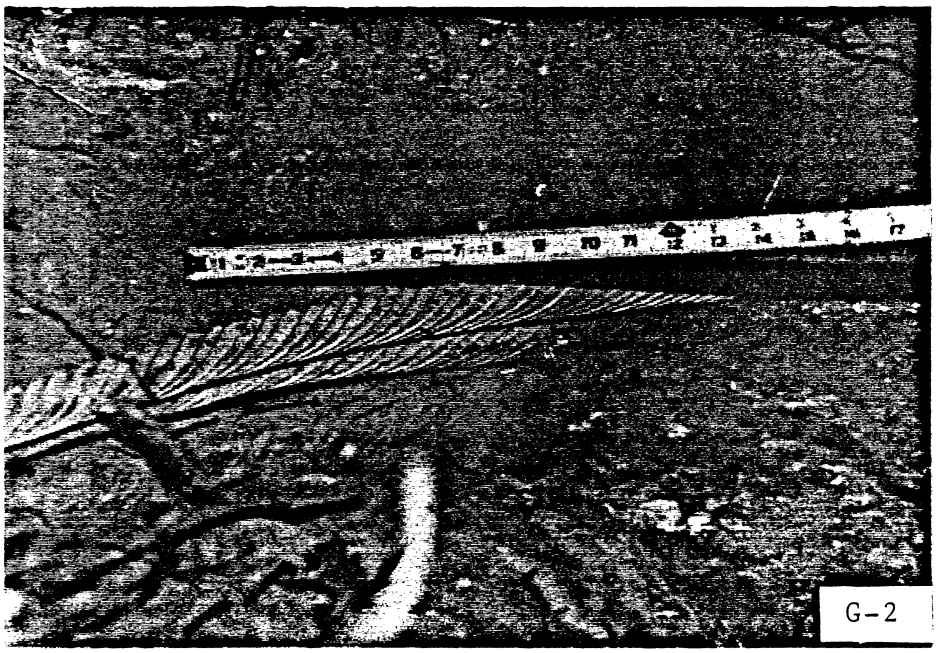

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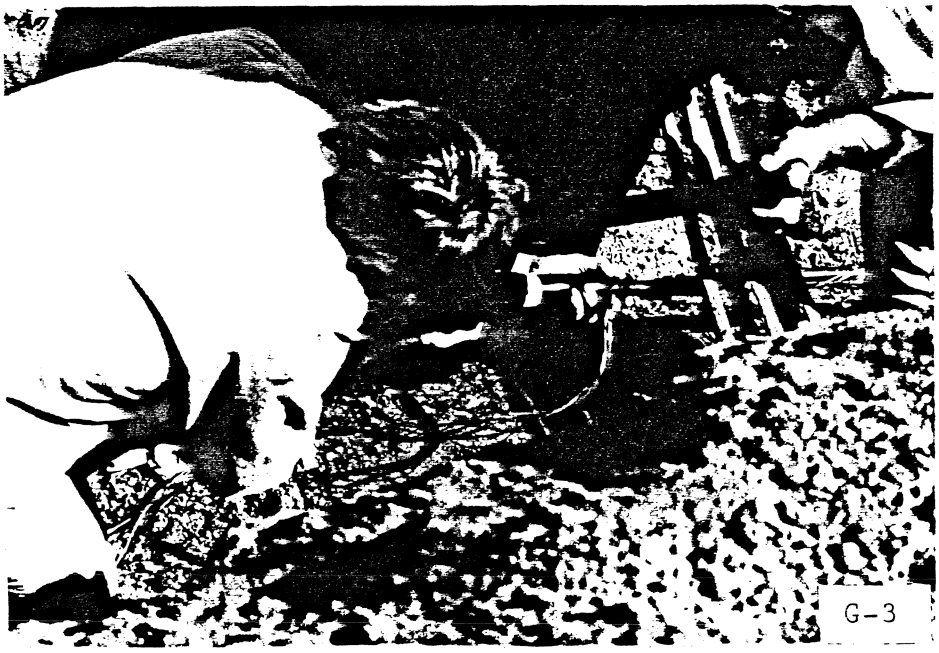

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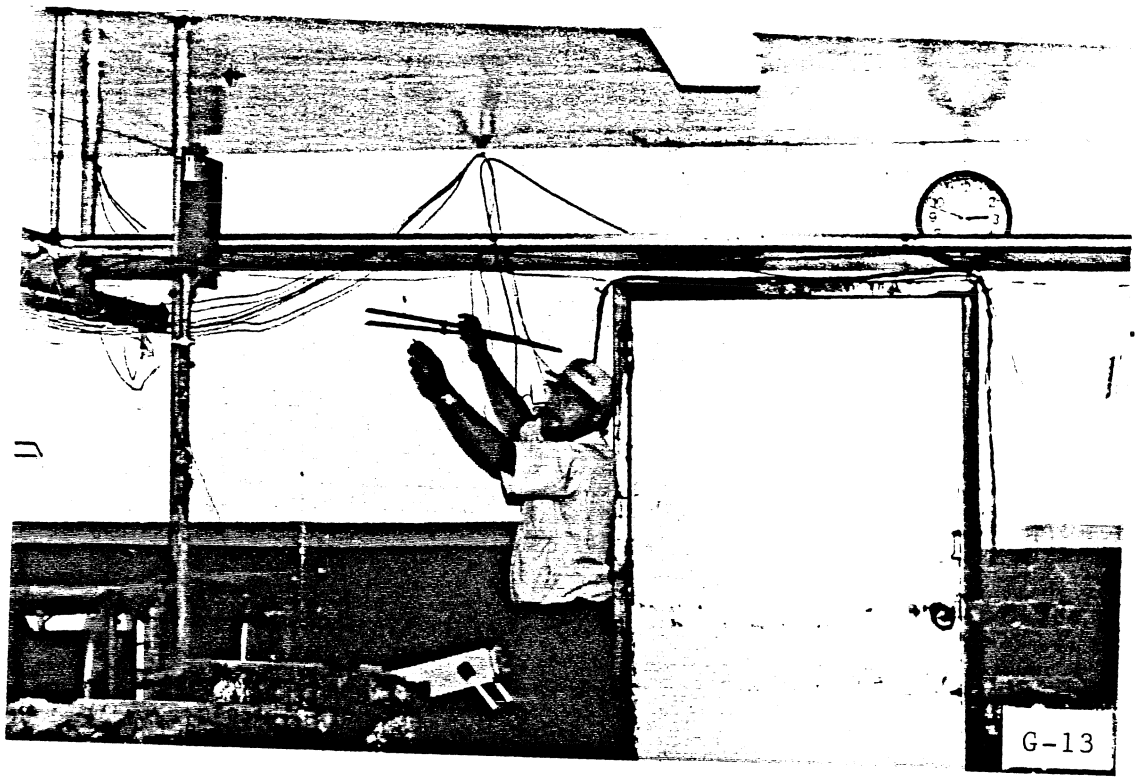

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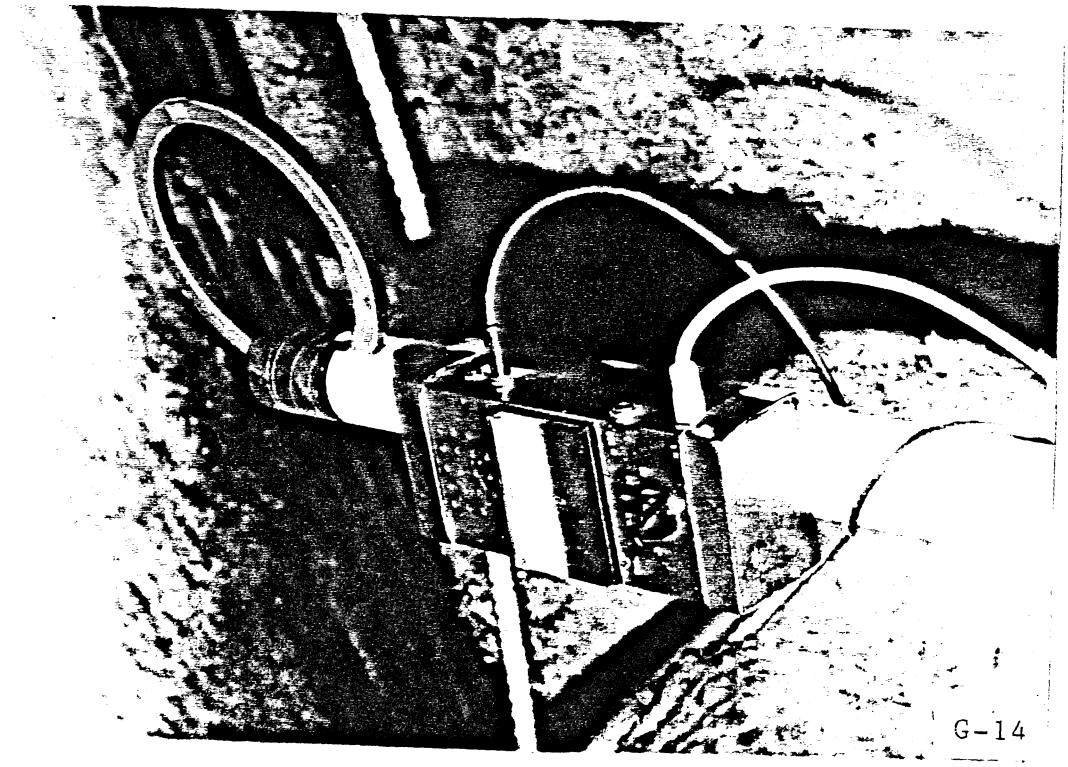

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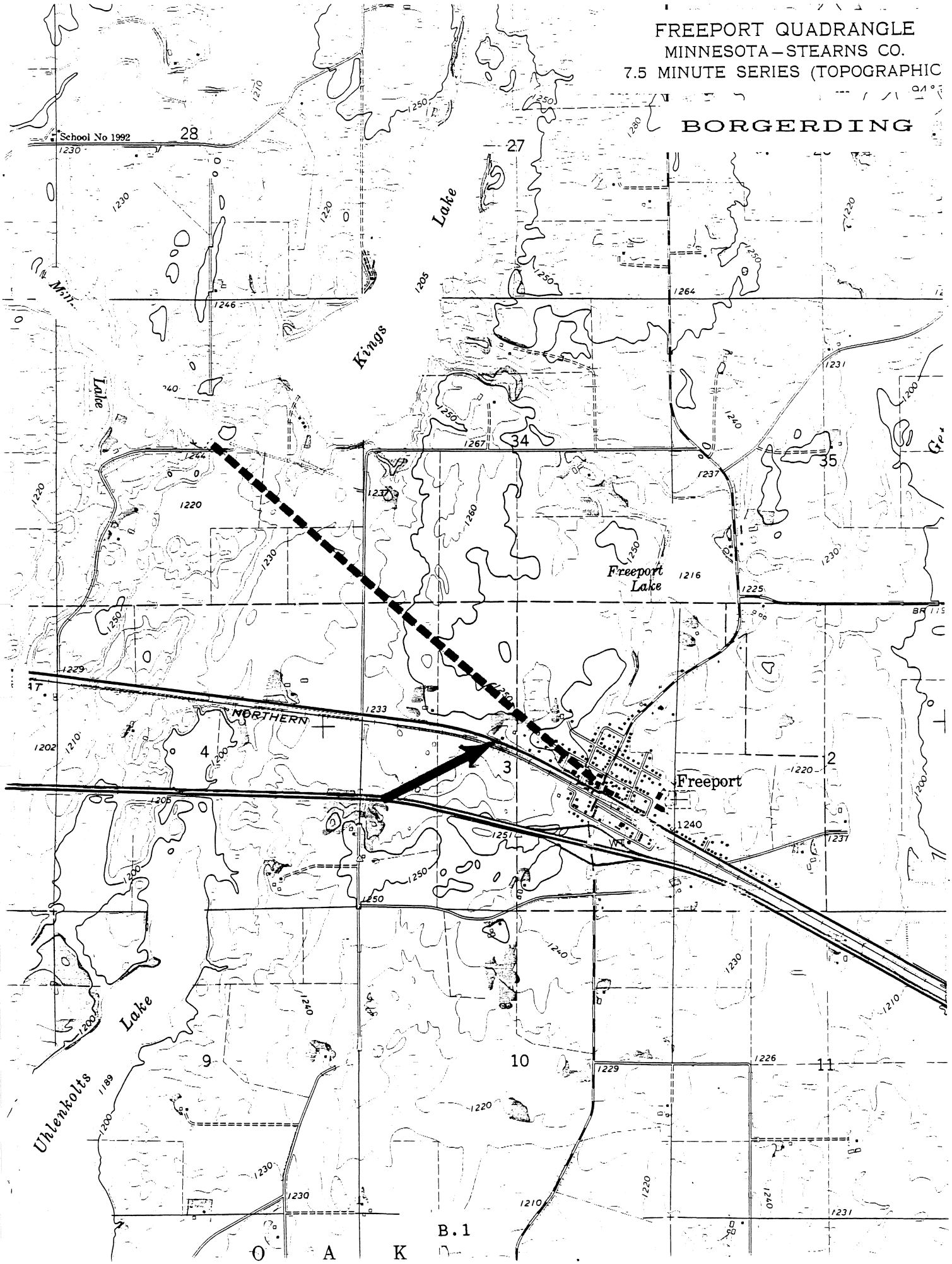
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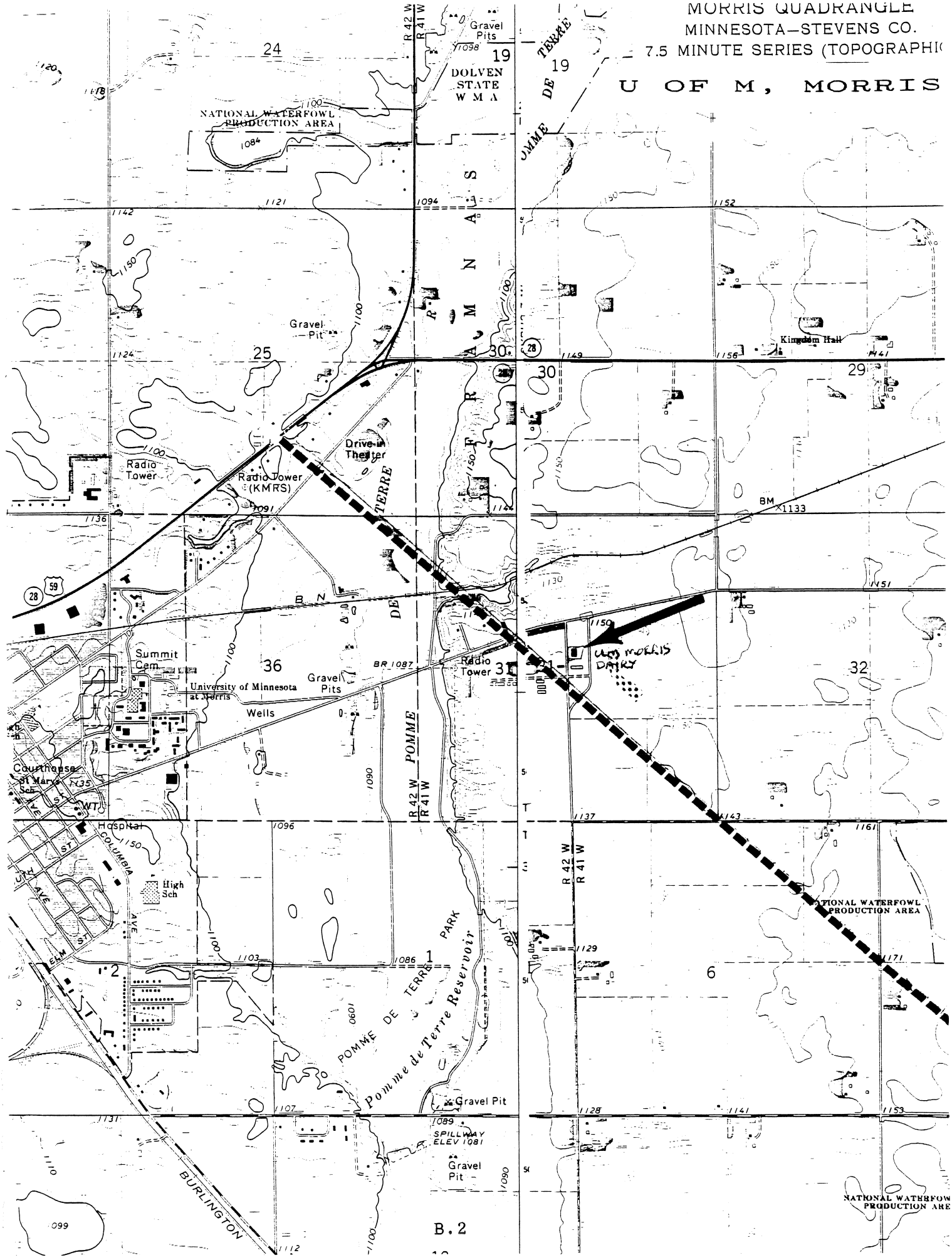
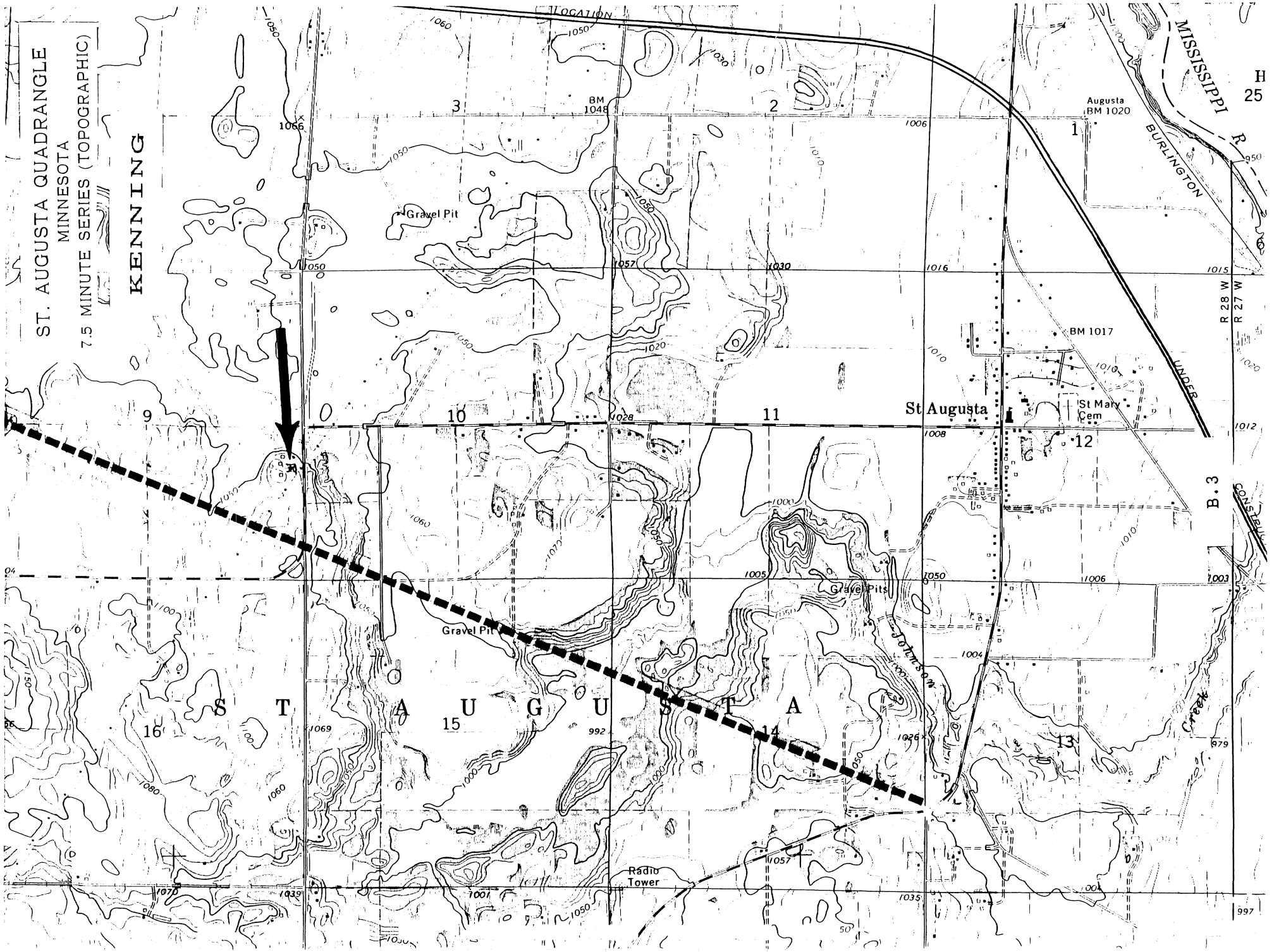
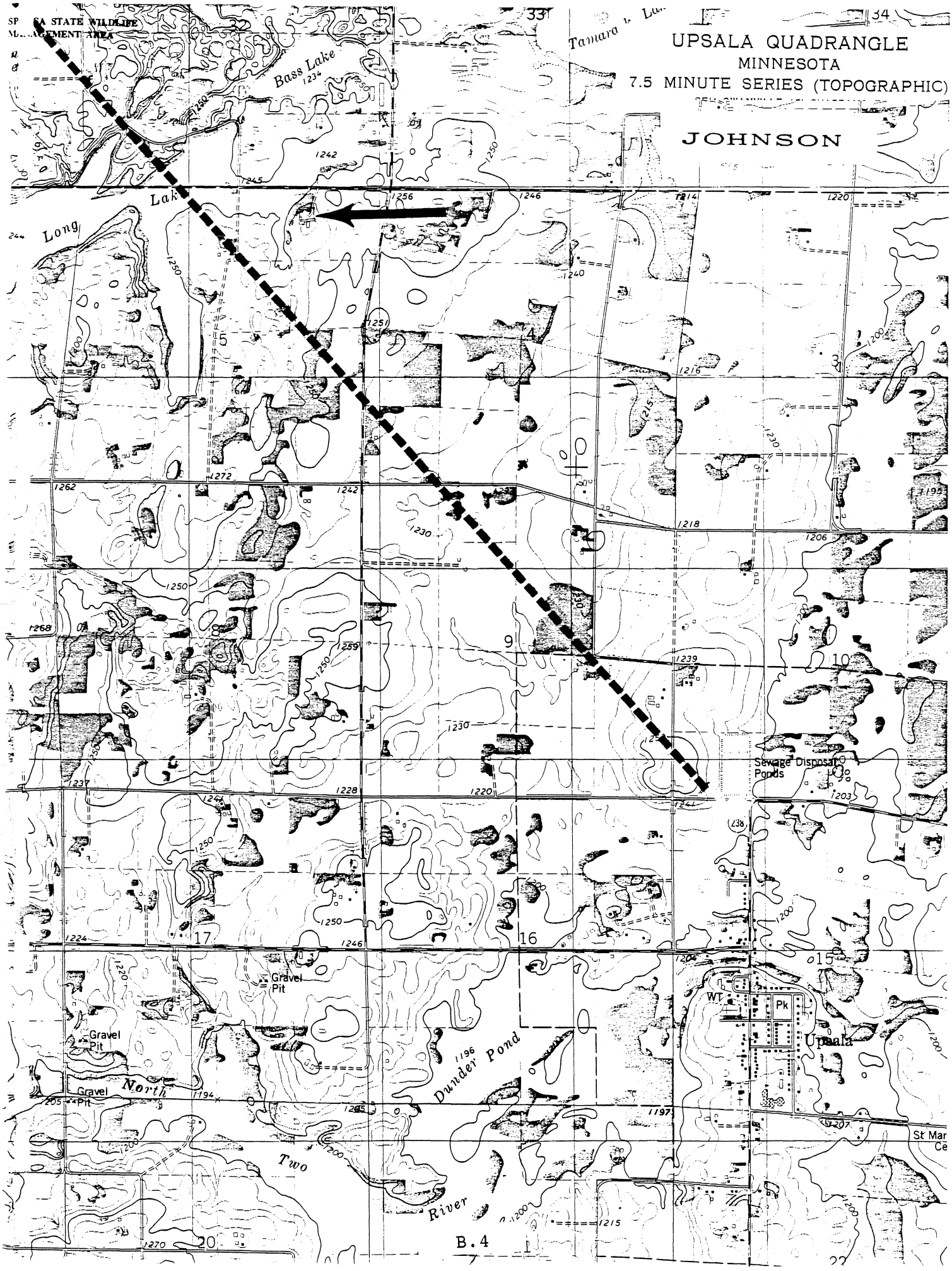
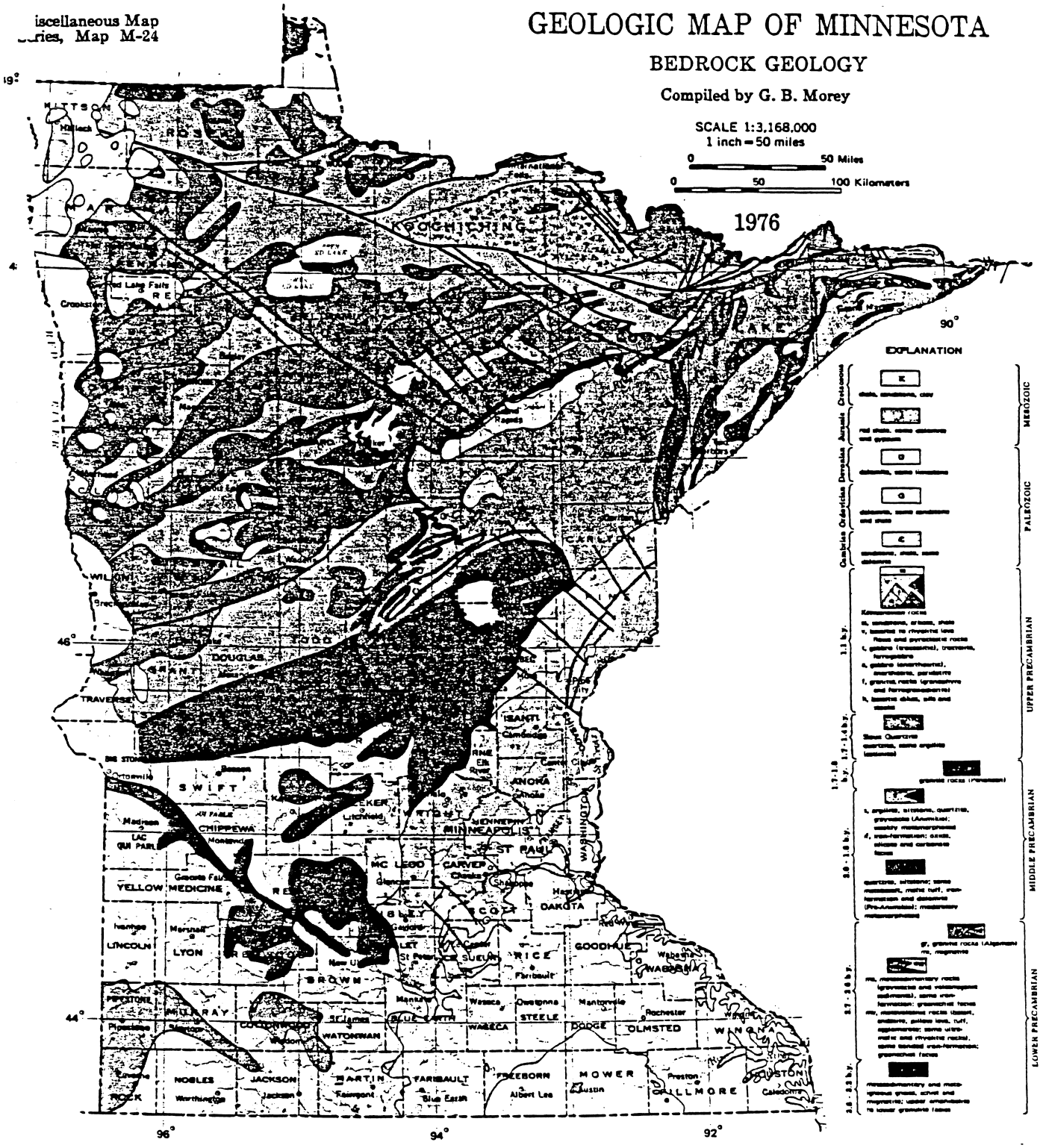
O A K


MORRIS QUADRANGLE
MINNESOTA—STEVENS CO.
7.5 MINUTE SERIES (TOPOGRAPHIC
U OF M, MORRIS
DOLVEN STATE W M A
NATIONAL WATERFOWL PRODUCTION AREA
Gravel Pits
Gravel Pit
Drive-in Theater
Radio Tower
Radio Tower (KMRS)
Kingdom Hall
BM 1133
Summit Cem
University of Minnesota at Morris
Wells
Courthouse
St Marys Sch
Hospital
High Sch
Radio Tower
Gravel Pits
BR 1087
POMME DE TERRE
Pomme de Terre Reservoir
SPILLWAY ELEV 1081
BURLINGTON
R 42 W
R 41 W
T 123 N
24
25
30
29
36
31
32
1
6
12
19


ST. AUGUSTA QUADRANGLE
MINNESOTA
7.5 MINUTE SERIES (TOPOGRAPHIC)
KENNING
LOCATION
MISSISSIPPI R.
BURLINGTON
UNDER
Augusta
BM 1020
BM 1048
BM 1017
Gravel Pit
Gravel Pits
St Augusta
St Mary Cem
Radio Tower
Johnson Creek
R 28 W
R 27 W
B.3
H
25
S T A U G U S T A
1
2
3
9
10
11
12
13
14
15
16


UPSALA QUADRANGLE
MINNESOTA
7.5 MINUTE SERIES (TOPOGRAPHIC)
JOHNSON
Bass Lake
Long Lake
Tamara Lake
Sewage Disposal Ponds
Gravel Pit
Gravel Pit
Gravel Pit
North Two River
Dunder Pond
Upsala
WT
Pk
St Mar
Ce
33
34
32
5
4
3
8
9
10
17
16
15
20
22

iscellaneous Map
..ries, Map M-24

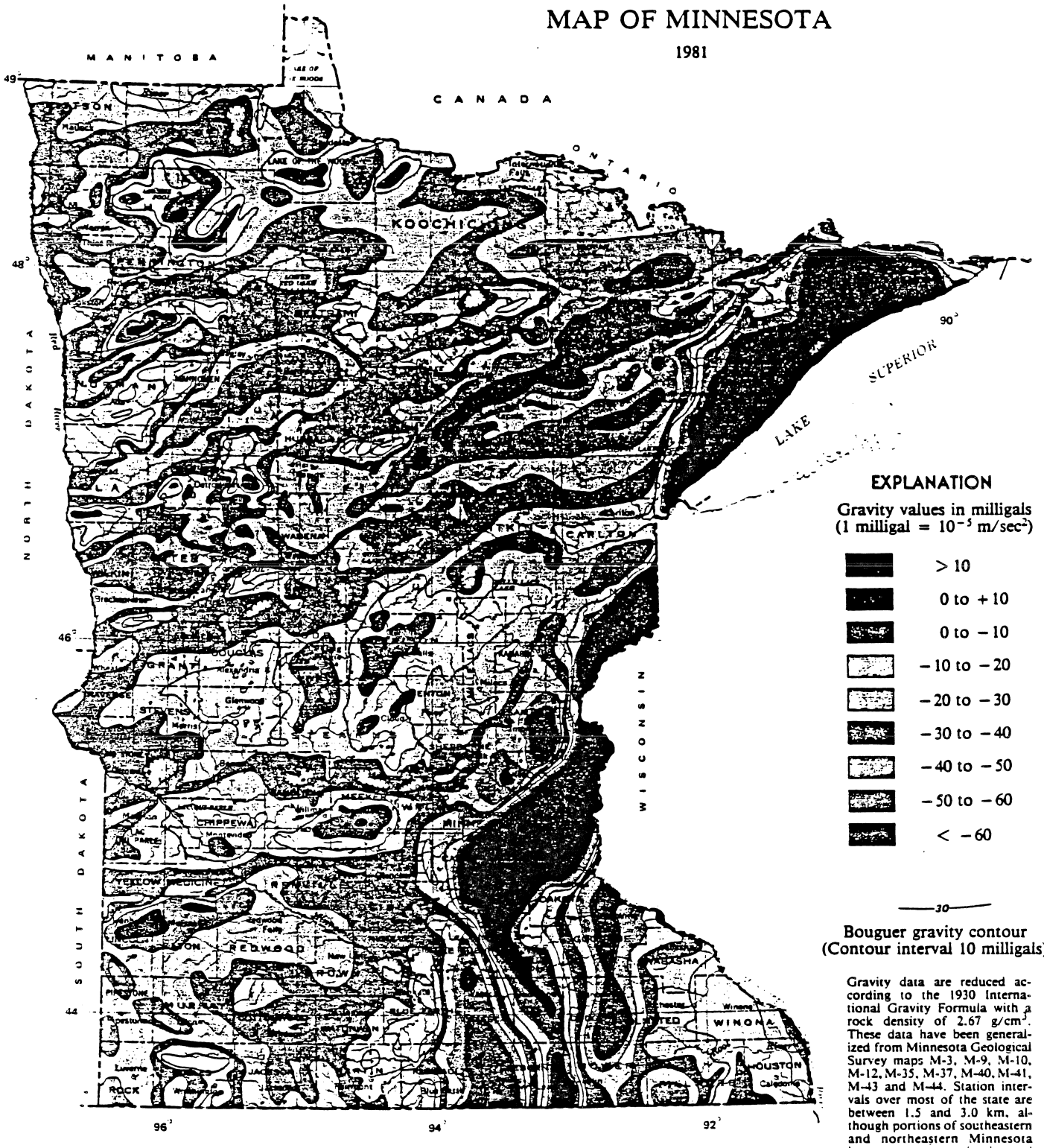


MINNESOTA GEOLOGICAL SURVEY- THE UNIVERSITY OF MINNESOTA

M t Walton, Director

SIMPLE BOUGUER GRAVITY ANOMALY MAP OF MINNESOTA

1981



EXPLANATION

Gravity values in milligals
(1 milligal = 10^{-5} m/sec^2)

	> 10
	0 to +10
	0 to −10
	−10 to −20
	−20 to −30
	−30 to −40
	−40 to −50
	−50 to −60
	< −60

—30—

Bouguer gravity contour
(Contour interval 10 milligals)

Gravity data are reduced according to the 1930 International Gravity Formula with a rock density of 2.67 g/cm^3. These data have been generalized from Minnesota Geological Survey maps M-3, M-9, M-10, M-12, M-35, M-37, M-40, M-41, M-43 and M-44. Station intervals over most of the state are between 1.5 and 3.0 km, although portions of southeastern and northeastern Minnesota have an average station interval of 5.0 to 10.0 km. Data were gathered under the supervision of V.W. Chandler, C. Craddock, C.P. Ervin, R.J. Ikola, L.D. McGinnis.

SCALE 1:3,168,000
1 inch = 50 miles

0 50 Miles

0 50 100 Kilometers

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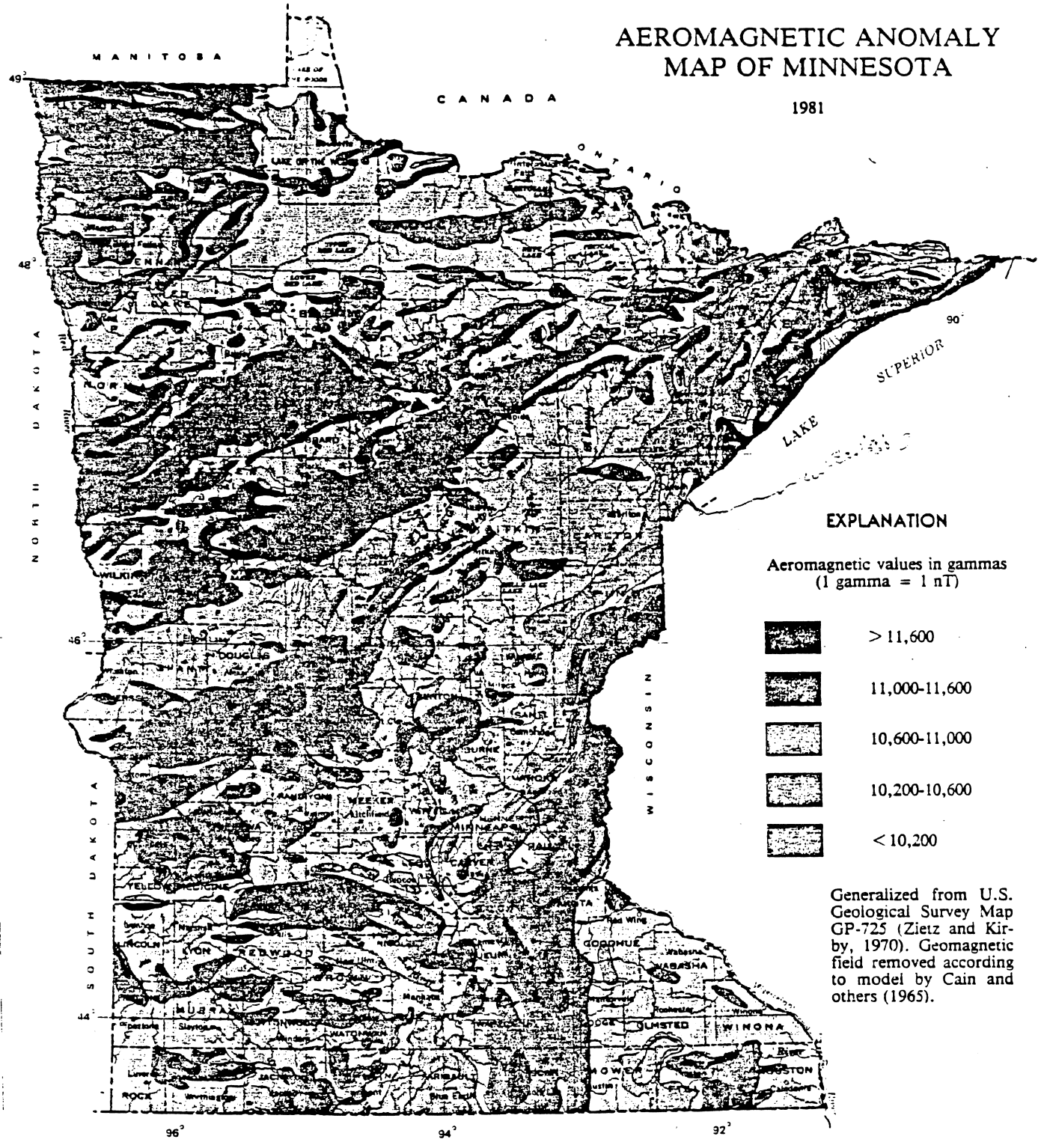
N inesota Geological Survey
Jniversity of Minnesota
Matt Walton, Director

AEROMAGNETIC ANOMALY MAP OF MINNESOTA

1981



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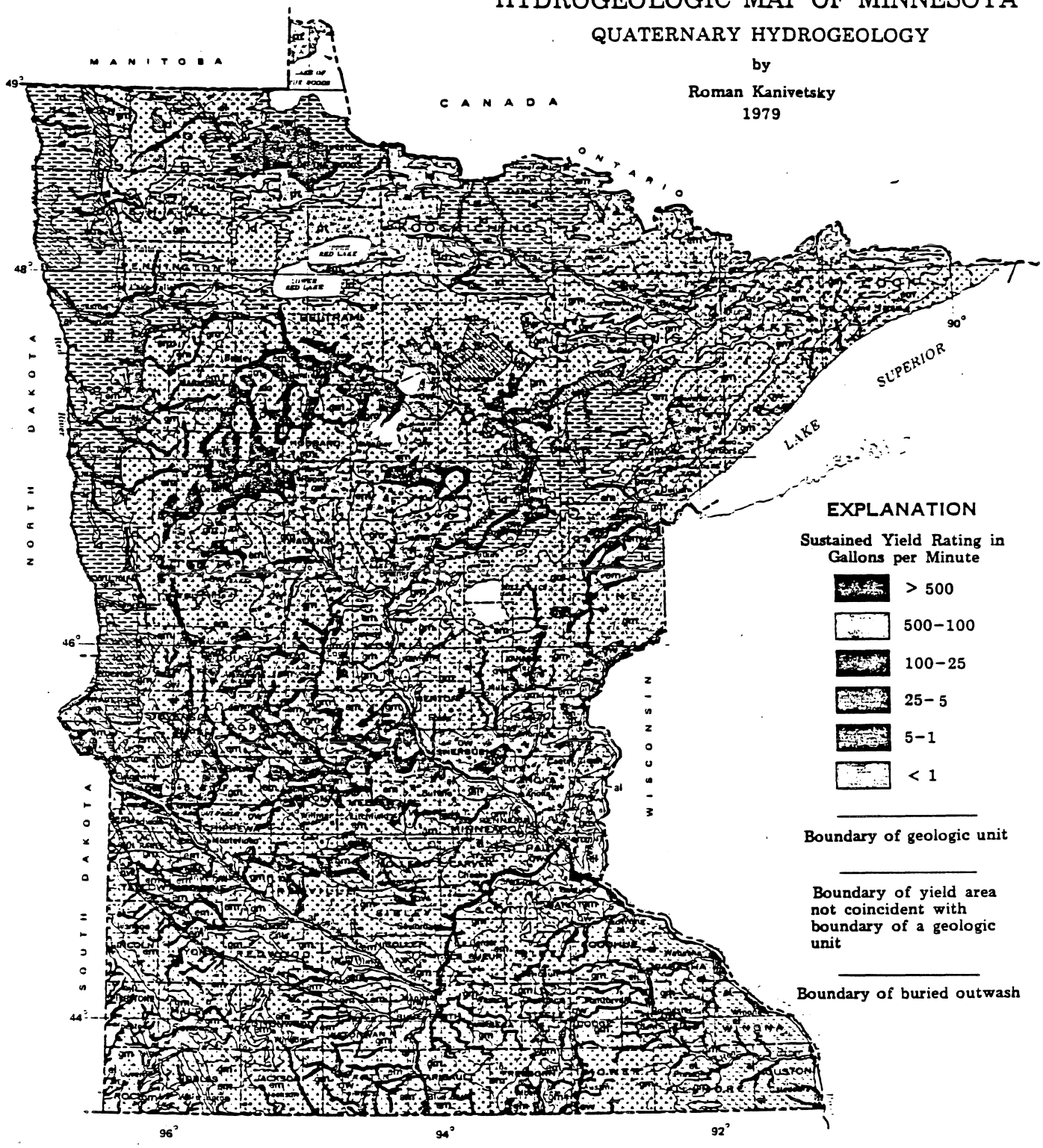
HYDROGEOLOGIC MAP OF MINNESOTA

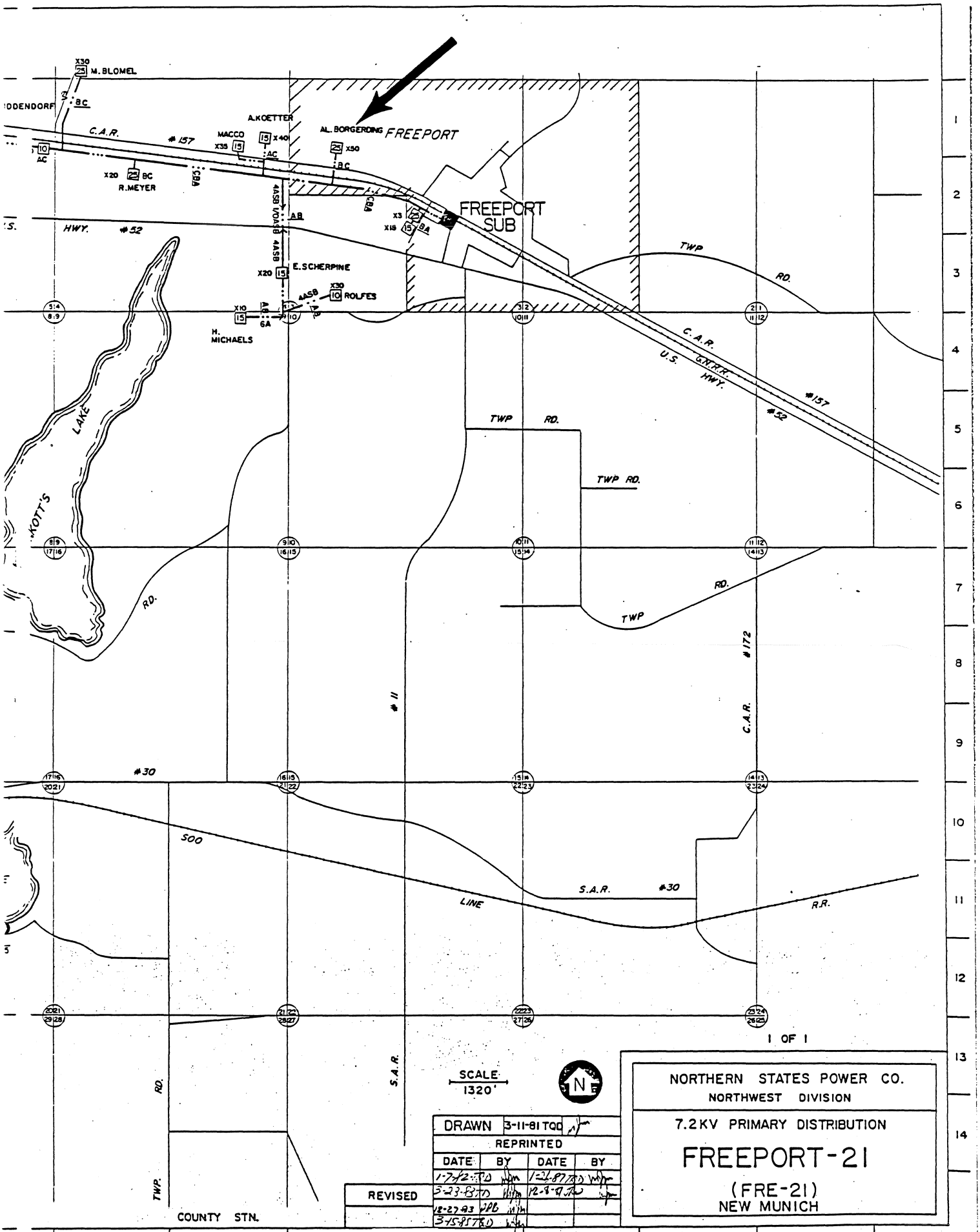
QUATERNARY HYDROGEOLOGY

by

Roman Kanivetsky
1979



Published with the support of the Legislative Commission on Minnesota Resources



1 OF 1

SCALE 1320'

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NORTHWEST DIVISION

7.2KV PRIMARY DISTRIBUTION

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(FRE-21)
NEW MUNICH

DRAWN	3-11-81 TQD	
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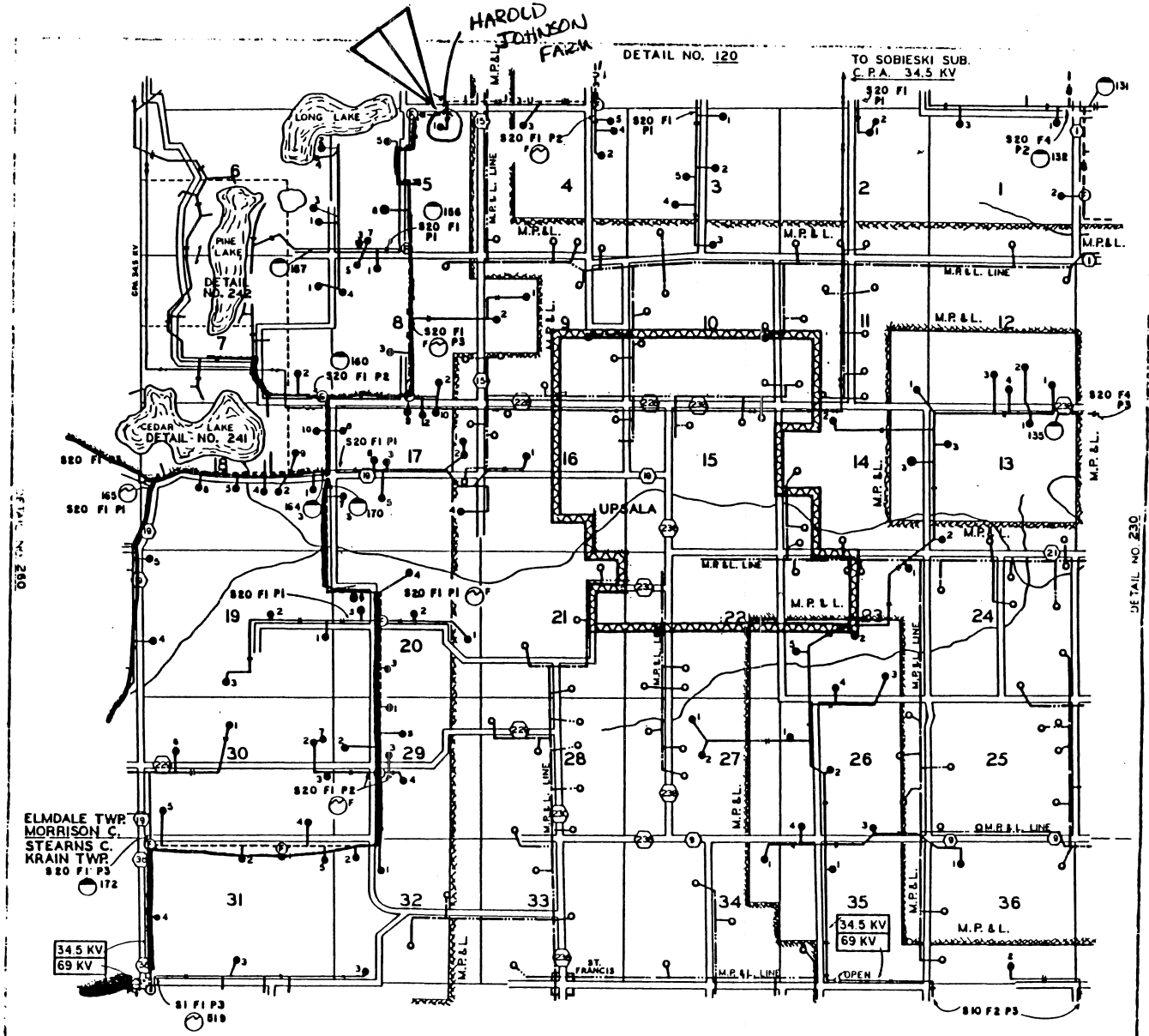
3-15-95 TQD			

REVISED



6-16-71 DETAIL CEDAR LAKE
2-1-72 ADD M.P. & L. LINES
7-31-74 REDRAW ORIGINAL
2-15-80ADD URD-SEC. 4&5

STEARNS COOPERATIVE ELECTRIC ASSOCIATION
MELROSE MINNESOTA
MINNESOTA 34 STEARNS

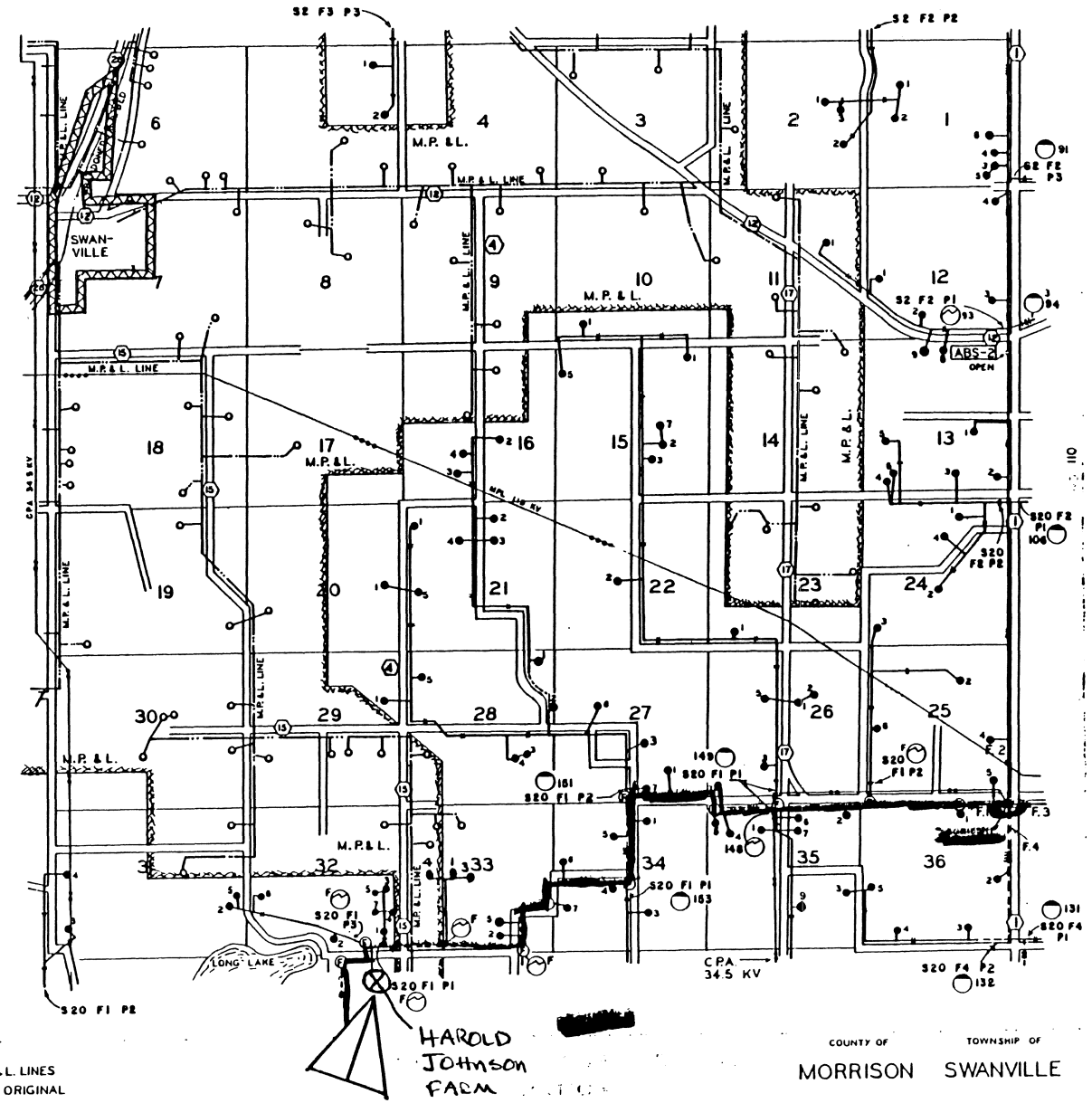
A.M.B. 7-31-74

COUNTY OF MORRISON & STEARNS
TOWNSHIP OF ELMDALE & KRAIN
MINN. 127 N. 31 W.

C.2

C.3

DETAIL NO. 45



2-1-72 ADD M.P.& L. LINES
11-21-74 REDRAW ORIGINAL
9-22-75 ADD SUB. NO. 20
2-15-80 ADD URD. FEEDER 1
3-15-83 ADD FEEDER 4

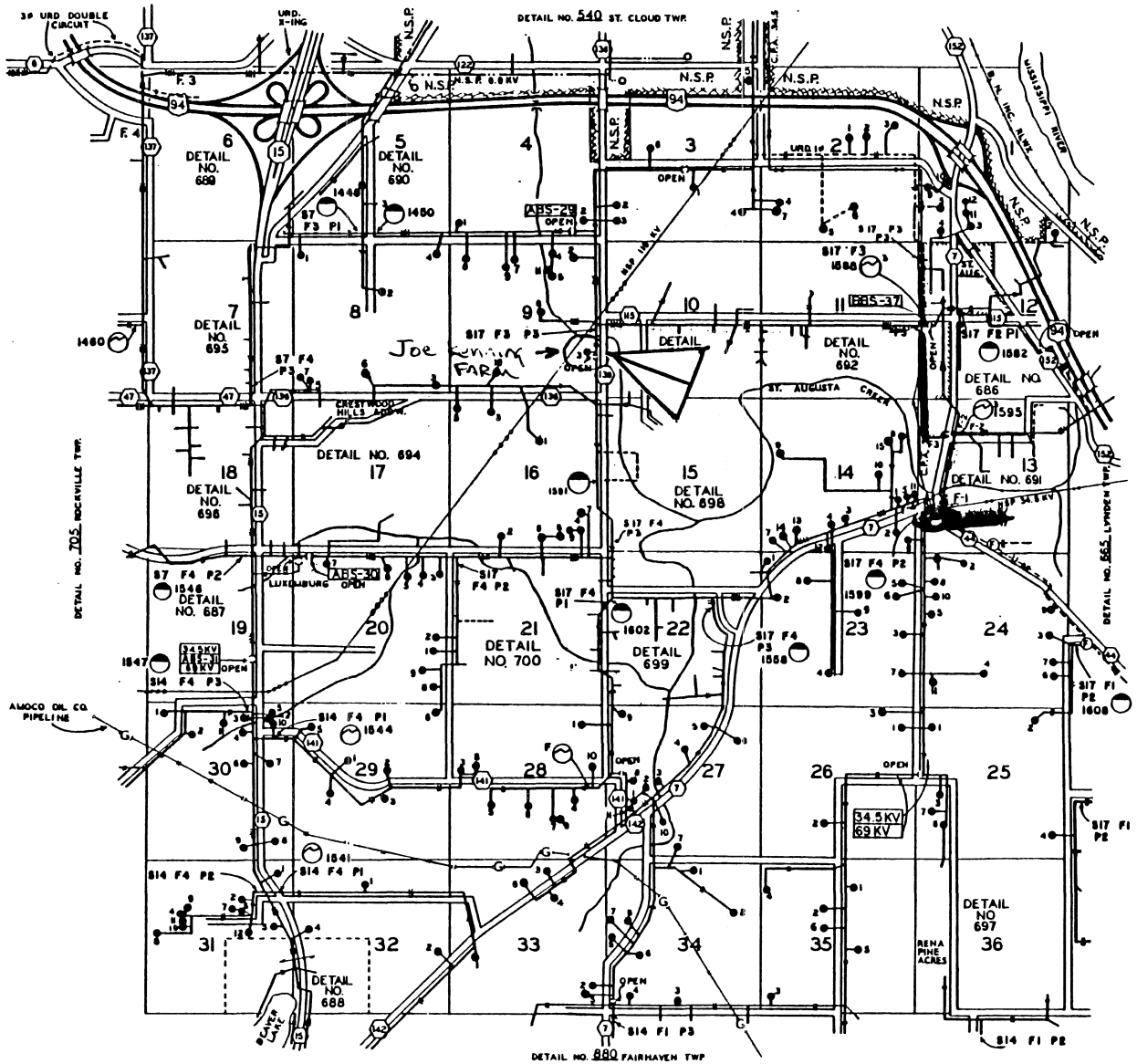
A.M.B. J.B.B.

COUNTY OF MORRISON

TOWNSHIP OF SWANVILLE

1 128 31 120

C.3



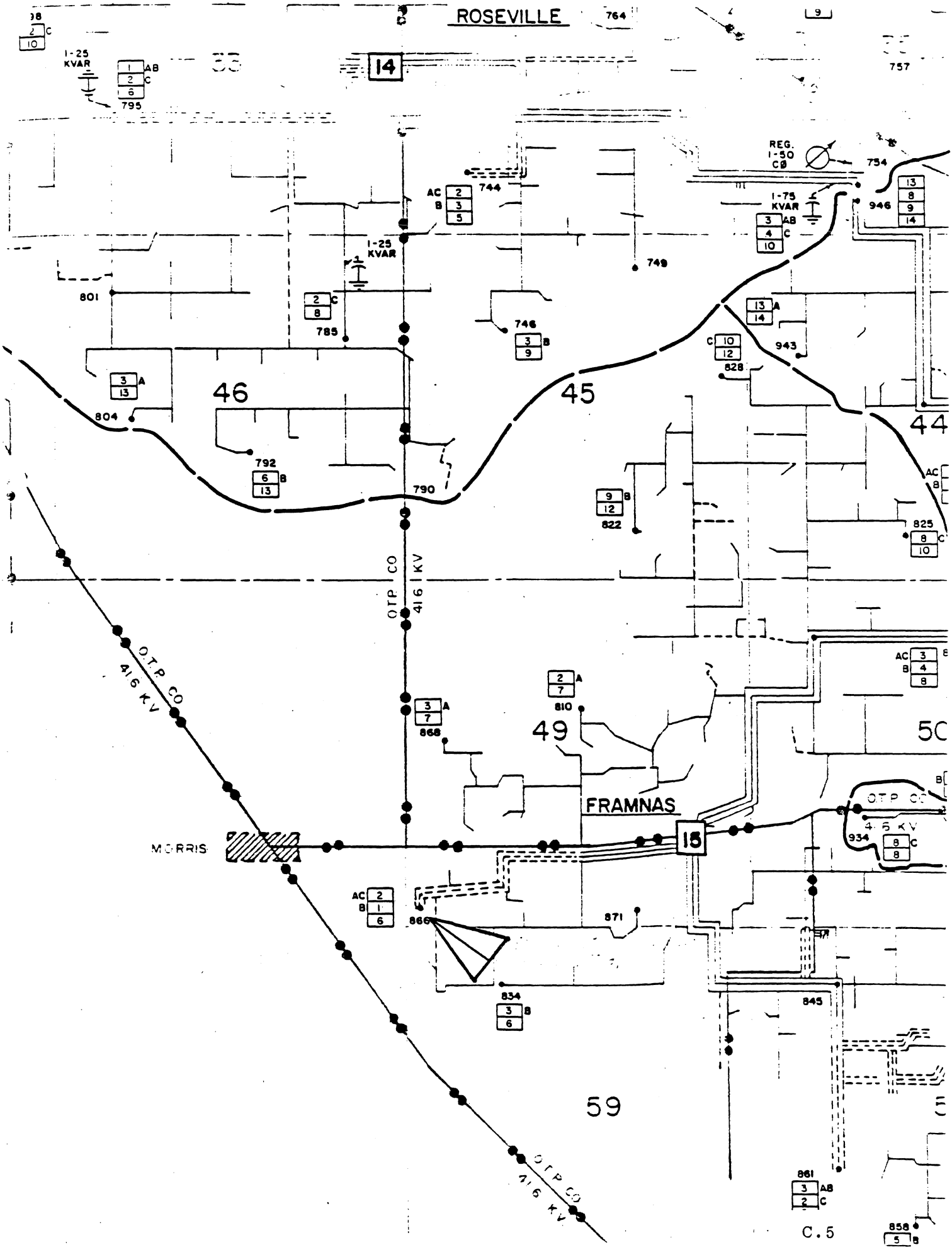
4-20-71 ADD N.S.P. LINES
7-14-71 DRAW-DETAIL SEC. 11
7-14-71 DRAW-DETAIL SEC. 10
9-71 10 URD.-SEC. 2 & 1
10-20-72 DRAW-DETAIL SEC. 17
11-20-72 ADD NEW SUB #17
3-27-74 ADD I-94
3-27-74 REDRAW DETAIL
1-3-78 DRAW DET. SEC. 7&18
4-26-79 DRAW DET. SEC. 36
8 85 DRAW DET. SEC. 13, 22

A.M.B. J.B.B. 3-26-74

STEARNS ST. AUGUSTA

123N. 28W. 685

C.4


ROSEVILLE
764
757
14
795
1-25 KVAR
744
754
REG. 1-50 CØ
946
1-75 KVAR
749
801
785
1-25 KVAR
746
943
828
46
45
44
804
792
790
822
825
OTP CO 416 KV
OTP CO 416 KV
810
49
868
FRAMNAS
15
MORRIS
866
871
834
845
934
861
858
59
C.5

INSTRUCTIONS - DAIRY LOG

1. Print your name on the top of the form.

2. Enter the date of the first morning milking.

3. START: Enter the time (hour and minute) that you put the milker on the first cow.

4. END: Enter the time (hour and minute) that you took the milker off the last cow.

5. #MILK: Read the milk level in your bulk tank.

6. EMETER-B: Read the electric meter for your barn/farm.

7. #COWS: Enter the number of cows you milked.

8. OPERATOR CODE: Rate the behavior of your cows and the way you and any others assisting you feel on a scale from 1 (lowest) to 10 (highest). For example: C-5 = cows were average, J-6 = John felt a little better than average, S-1 = someone has called for medical assistance for Sue.

9. GENERAL:

   Make all readings that are not specific to milk time at about the same time after each milking for each day. For example: 8:30 am and 8:30 pm.

   Read the electric meter for your house if separate.

   Enter other readings of interest on your farm. For example, neutral-to-earth voltage.

   Enter any comments you feel are appropriate.

   Sign and date each record sheet when complete.

   Try to make your first records inclusive of the period from August 19, 1988, through September 23, 1988. Return completed forms to:

   DATARIGHT, INC.
   ROUTE 4, BOX 241
   MILACA, MINNESOTA 56353

THANK YOU!

OPERATOR LOG: ART BORGERDING

DATE	START	END	TIME	# MILK	# COWS	OPERATOR RATINGS COWS	ART	RANDY	
7/30/88	6:10	8:00	110	946	52	5	3	6	Bad P.M.
7/30/88	6:00	8:00	120	921	52	4	4	5	
7/31/88	6:05	7:55	120	982	52	4	4	5	Calf abor
7/31/88	6:00	7:50	110	998	52	6	7	6	A. better
8/1/88	6:00	7:55	115	977	52	4	4	4	
8/1/88	6:00	7:45	105	918	52	6	7	7	Vet trt.
8/2/88	6:10	8:10	120	992	52	4	4	7	1" rain,
8/2/88	6:00	8:00	120	900	52	5	5	7	A little
8/3/88	6:15	8:15	120	970	52	4	4	4	Cloudy ho
8/3/88	6:00	7:55	115	902	52	4	5		Tail swin
8/4/88	6:15	8:20	125	1026	52	4	4		Glen milk
8/4/88	6:00	8:00	120	939	52	4	4		Tail swin
8/5/88	6:05	8:10	125	994	52	4	4	6	Gen.<35mi
8/5/88	6:00	7:25	85	933	52	4	5		Generator
8/6/88	6:05	7:35	90	1037	52	4	5		Generator
8/6/88	6:25	8:00	95	944	52		5		
8/7/88	6:05	7:50	105	1021	52	4	4		
8/7/88	6:05	7:30	85	984	52	4	4		Generator
8/8/88	6:10	7:30	80	1031	52	6	6		Gen., coo
8/8/88	6:15	8:00	105	931	52	5	4	4	Generator
8/9/88	6:15	7:45	90	960	52	6	6		
8/9/88	6:00	7:40	100	942	52	4	4	3	
8/10/88	6:00	7:52	112	1026	52	4	4		
8/10/88	6:00	7:55	115	953	52	3	3	6	
8/11/88	6:05	8:00	115	1038	52	3	3		
8/11/88	6:00	7:55	115	930	52	3	3		MOV in AC
8/12/88	6:00	8:00	120	987	52	3	3		
8/12/88	6:00	7:55	115	944	52	3	3		
8/13/88	6:00	8:00	120	934	52	3	3	5	
8/13/88	6:00	7:50	110	917	52	4	4		
8/14/88	6:00	7:50	110	993	52	3	4		
8/14/88	6:10	7:50	100	944	52	4	4		
8/15/88	6:00	7:50	110	968	52	4	4		
8/15/88	6:00	7:50	110	960	52	5	6		
8/16/88	6:00	7:50	110	976	52	4	5		
8/16/88	6:05	7:55	110	944	52	5	5		
8/17/88	6:10	7:55	105	994	52	4	4		
8/17/88	6:00	7:50	110	895	52	4	5		
8/18/88	6:05	7:55	110	926	52	4	4		
8/18/88	6:00	7:50	110	891	52	4	4		

OPERATOR LOG: HAROLD JOHNSON

DATE	START	END	TIME	# MILK	# COWS	OPERATOR RATINGS COWS	HAROLD	BRUCE	COMMENTS
8/11/88	6:00	7:20	1.33	5948	50		5		
8/11/88	6:05	7:26	1.33				4		
8/12/88	6:00	7:18	1.3	2830	50		5		
8/12/88	6:03	7:25	1.36				4		Some rest
8/13/88	6:00	7:21	1.35	5630	50		6		
8/13/88	6:05	7:28	1.38				5		Uneven mi
8/14/88	5:58	7:21	1.38	2815	50	5	5		
8/14/88	6:05	7:28	1.38			5	5		
8/15/88	6:02	7:23	1.35	5595	50	5	6		
8/15/88	6:06	7:28	1.4			5	3		My feet w
8/16/88	6:03	7:22	1.31	2666	49	5	6		
8/16/88	6:01	7:26	1.41			4	4		A lot of
8/17/88	6:00	7:22	1.36	5213	50	5	5		
8/17/88	5:58	7:25	1.45			4	5		Research
8/18/88	5:58	7:15	1.28		50	5	5		
8/18/88	6:05	7:26	1.35			4	4		Uneven mi
8/19/88	5:58	7:15	1.28	5039	50	6	6		
8/19/88	6:02	7:23	1.35			6	6		Milkout f
8/20/88	6:04	7:30	1.43	2607	49	4	5		
8/20/88	6:10	7:31	1.35			4	4		Using mil
8/21/88	6:05	7:27	1.36	5300	49	5	5		
8/21/88	5:58	7:14	1.26			6	4		Generator
8/22/88	6:03	7:17	1.23	2695	49	6	6		
8/22/88	6:22	7:38	1.2			6	6		Generator
8/23/88	6:00	7:21	1.35	5387	49	5	5		
8/23/88	6:05	7:28	1.21			6	5		Some let
8/24/88	6:03	7:19	1.26	2731	49	6	6		
8/24/88	6:09	7:28	1.32			5	6		Cooler we
8/25/88	6:03	7:26	1.38	5395	49	6	6		
8/25/88	6:09	7:29	1.33			5	5		Cooler
8/26/88	6:04	7:25	1.35	2739	50	6	6		
8/26/88	6:07	7:26	1.32			5	5		Switching
8/27/88	6:03	7:26	1.38	5508	50	6	6		
8/27/88	6:18	7:37	1.32			5	5		My feet h
8/28/88	6:03	7:24	1.35	2695	48	5	5		
8/28/88									
8/29/88				5474	50				
8/29/88									
8/30/88				2906	53				
8/30/88									
8/31/88				5894	53	4		4	
8/31/88						4		4	
9/1/88				3010	53				
9/1/88									
9/2/88				6020	53				
9/2/88									
9/3/88				3018	53				
9/3/88									

DAIRY LOG 8/19/88 TO 9/22/88

DATE	STARTING TIME	ENDING TIME	MILK /COW	TANK READING	#COWS	EXTRA COWS	OPERATOR CODE 1-10
8/19/88 AM	6:20	7:48	1373		64	2	C-6 J-5 P-4
8/19/88 PM	5:53	7:29	1377		64	2	C-6 J-5 P-4
8/20/88 AM	6:16	7:49	1461		64	2	C-6 J-5 P-4
8/20/88 PM	5:40	7:35	1361	1361	64	2	C-5 J-5 D-2
8/21/88 AM	5:55	7:16	1418	2779	66		C-5 J-5 P-5
8/21/88 PM	5:06	6:48	1428	4207	66		C-5 J-5 P-4
8/22/88 AM	6:23	8:07	1517	5724	66		C-5 J-5 M-4
8/22/88 PM	5:52	7:35	1373	1373	66		C-5 J-5 M-4
8/23/88 AM	6:23	7:53	1440	2813	66	1	C-5 J-5 P-4
8/23/88 PM	6:00	7:36	1439	4252	66	1	C-5 J-5 P-5
8/24/88 AM	6:24	7:51	1441	5693	66	1	C-5.5 J-5 P-5
8/24/88 PM	5:51	7:29	1390	1390	66	1	C-6 J-5.5 P-5
8/25/88 AM	6:14	7:48	1444	2834	66	1	C-6 J-5.5 P-5
8/25/88 PM	6:02	7:38	1433	4267	67		C-5 J-5 P-5
8/26/88 AM	6:21	7:54	1511	5778	67		C-5 J-5 P-5
8/26/88 PM	5:52	7:40	1453	1453	67		C-4.5 J-5 P-4
8/27/88 AM	6:23	7:02	1485	2938	67		C-5 J-5 P-3
8/27/88 PM	6:04	7:49	1462	4400	67		C-5 J-5
8/28/88 AM	5:21	7:04	1409	5809	67		C-6 J-5 P-4
8/28/88 PM	6:02	7:20	1558	1558	66		C-5.5 J-5 P-5
8/29/88 AM	6:24	8:02	1498	3056	66		C-6 J-5.5 P-6
8/29/88 PM	5:49	7:44	1359	4415	66		C-5 J-5 P-5 D-
8/30/88 AM	6:13	7:44	1471	5886	66		C-5 J-5
8/30/88 PM	5:39	7:18	1465	1465	66		C-6 J-5
8/31/88 AM	6:22	7:56	1570	3035	66		C-5 P-5 F-5
8/31/88 PM	5:34	7:29	1410	4445	65		C-5 P-4
9/01/88 AM	6:38	8:28	1537	6018	65		C-5 P-5
9/01/88 PM	6:03	7:51	1453	1453	65		C-4.5 J-5 P-6
9/02/88 AM	6:14	8:02	1485	2938	65		C-5.5 J-5 P-5
9/02/88 PM	6:08	7:40	1477	4415	65		C-4.5 J-5 P-5
9/03/88 AM	6:20	7:59	1525	5940	65		C-4.5 J-5 P-5
9/03/88 PM	5:57	7:39	1465	1465	65		C-5.5 J-5 P-5
9/04/88 AM	5:37	7:11	1431	2896	65		C-6 J-5 P-5
9/04/88 PM	5:34	7:10	1534	4430	65		C-5 J-5 P-5
9/05/88 AM	6:07	7:45	1557	5987	65		C-5 J-5 P-5
9/05/88 PM	6:04	7:47	1465	1465	65		C-5 J-5 P-5
9/06/88 AM	6:21	7:59	1480	2945	65		C-5 J-5 P-5
9/06/88 PM	6:04	7:47	1411	4356	64		C-4.5 J-5 P-5
9/07/88 AM	5:09	6:55	1345	5701	64	1	C-5 J-5
9/07/88 PM	5:48	7:36	1546	1546	61	1	C-4.5 J-5 P-5
9/08/88 AM	6:04	7:42	1406	2952	61	1	C-5 J-5
9/08/88 PM	6:05	8:10	1485	4437	61	1	C-4 J-4.5 P-4
9/09/88 AM	6:14	8:03	1410	5847	62	1	C-4.5 J-5
9/09/88 PM	5:42	7:36	1453	1453	62	1	C-4.5 P-5 D-5
9/10/88 AM	6:22	8:07	1540	2993	62	1	C-5 J-5 P-5
9/10/88 PM	6:02	7:53	1452	4445	62	1	C-4.5 P-5 D-4.
9/11/88 AM	5:41	7:12	1402	5847	62	1	C-6 J-6
9/11/88 PM	5:03	6:52	----	----	62	1	C-4.5 J-5 P-5
9/12/88 AM	6:14	8:04	----	3027	62	1	C-5 J-5
9/12/88 PM	6:08	7:48	1449	4526	62	1	C-5 J-5
9/13/88 AM	6:11	8:01	1468	5994	62	1	C-5 J-5
9/13/88 PM	5:53	7:48	----	----	62	1	C-4.5 P-5 D-5
9/14/88 AM	6:23	8:10	----	2931	62	1	C-5 J-5
9/14/88 PM	5:48	7:47	1425	4356	62	1	C-5.5 P-5

DAIRY LOG 8/19/88 TO 9/22/88

9/15/88	AM 8:05	7:55	1476	5832	62	1 C-5 J-5
9/15/88	PM 6:23	8:07	----	----	62	1
9/16/88	AM 6:11	8:07	----	2938	63	C-4.5 J-
9/16/88	PM 5:47	7:38	1395	4333	63	C-4 P-4.5 D-4.
9/17/88	AM 6:21	8:11	1553	5886	63	C-5 J-5
9/17/88	PM 5:48	7:39	1402	1402	63	C-5 J-5
9/18/88	AM 5:45	7:16	1439	2841	63	C-6 J-6 P-6
9/18/88	PM 5:38	7:24	1485	4326	63	1 C-5 J-5
9/19/88	AM 6:15	8:14	1490	5816	63	1 C-4.5 J-5
9/19/88	PM 5:45	7:27	1396	1396	63	2 C-5 J-5
9/20/88	AM 6:17	8:05	1500	2896	63	2 C-5 J-5
9/20/88	PM 5:59	8:10	1437	4333	63	2 C-3.5 P-4 D-4
9/21/88	AM 6:04	7:56	1437	5770	64	1 C-5 J-5
9/21/88	PM 5:34	7:36	1459	1459	64	1 C-5 J-5
9/22/88	AM 6:11	8:06	1562	3021	65	1 C-5 J-5
9/22/88	PM 6:06	8:04	1498	4519	65	2 C-3.5 P-5

Thursday, Oct 28, 1988

60 HZ ELECTRIC FIELD MEASUREMENTS

Measurements of 60 Hz electric fields at the barn floor and at the ground surface outside the barn were made at four locations including the North Central Agricultural Experiment Research Center, Harold Johnson Farm, Art Borgerding Farm and the Joe Kenning Farm.

The system used for measurement consisted of two parallel plates connected to a preamp and a Keithley multimeter. Calibration provides a reading in volts/meter.

NORTH CENTRAL AGRICULTURAL EXPERIMENT RESEARCH CENTER

The 60 Hz fields at the floor surface in the barn ranged from 1 to 20 V/M. The field decreased rapidly with distance from the floor reaching zero at about 10 cm above the floor. North of the walkway on the East side of the barn the lowest values of field were recorded. The entire East side had the greatest difference between location of front and back feet. The West side and the South end had the greatest fields. Two cows were in the barn during measurements. the cow on the West side was very nervous and did not like the equipment near. The fields were higher in that stall than in stalls on either side. The cow in the East side did not appear as nervous but did not appear well.

During the measurements the florescent lights were on as well as the manure handling system. The turning off of the manure handling system made no change in measured fields. Turning off the florescent lights, however caused a decrease in a factor of two in measured field. When the trainer was turned on the measured field increased by a factor of ten. The reasons for these changes was two fold. One, the meter was affected by induced currents and second, the currents changed in the floor. The presence of rubber mats on the floor did not appear to have any effect on the measured fields. Proximity to florecsent lights did, however.

HAROLD JOHNSON FARM

Measured values of 60 Hz fields closely paralleled those of August 17. With lights off and only a few fans operating in the barn, fields at the barn floor ranged from 2 to 20 V/M. The field variations seemed random varying from the highest to the lowest in the space of one stall width. Some exceptions included higher values at the North end and in the middle area. In the barn the zero field was at approximately 10 cm from the floor. In the regions between buildings on the farm the 60 Hz fields were extremely high ranging between 200 and 1000 V/M. The highest values were found above buried electrical and telephone cables. The highest values were also found above buried water lines and in other places where there was nothing known to be buried. The results of these measurements imply a very significant 60 Hz ground current on this farm. On August 17 the measurements repeated with the Blackburn Grounding system off showed no significant decrease. The implication of this result is that the origin of these ground currents is somewhere other than the farm. Substations and large users of electrical energy should be located in order to assess this issue. In addition the nature of the earth materials in the region of this farm should be investigated in order to determine the potential for rectification and

ion migration. My profession judgement is that these ground currents are unacceptable.

ART BORGERDING FARM

Values of 60 Hz fields around the farm yard ranged from 2-4 V/M. Around grounds the fields increased. Inside the barn the 60 Hz fields at the floor ranged from 2 to 30 V/M. The highest values were at the East end of the barn and in the region of a buried electrical cable. Measurements were made with all electrical equipment off in the barn. Observations of the field at a specific location revealed it to be continuously varying. One cause was the electric fencer which was feeding electricity into the earth in the pasture area. Electrical equipment was turned on and off in the barn in order to determine their effects on ground cuurents. No changes were observed as motors were turned on and off. Some increase in variability was observed when the trainers were turned on. The turning on of incandescent lights in the barn increased the field from 10 to 30 V/M. Art has a wire in the barn which is connected to a ground some distance from the barn. Significant 60 Hz potentials between that wire and the barn ground occur at times, sufficient to light a low potential light bulb. When that wire was connected to the barn ground there was approximately a 30% drop in the observed field (at the floor of the barn). Ground currents in this barn are clearly affected by both the type of electrical use and the grounding procedure. It appears evident that the ground currents in the barn are affected by electrical use in off-farm areas. Measurements should be continued on this farm to determine what variations of electric fields at the floor surface that the cows experience especially during milking. In addition the magnitude of DC cathodic protection on underground and surface pipes, cables and tracks should be investigated. Because of all the DC sources, this barn could have abnormal DC fields at the ground surface as well as significant DC in the ground.

JOE KENNING FARM

Over the areas measured in the farm yard and the milking parlor the 60 Hz field was in the range of 2 V/M. The fact that the field varied so little spatially is probably due to Joe's ungrounded neutral electrical system on the farm. The measured field, therefore, was the result of currents introduced off-farm. Larger values of field were measured on the floor of the shop. 60 Hz fields did vary in time at locations measured.

CONCLUSIONS

Measurements of 60 Hz AC field provide information relative to the presence of the 60 Hz currents in the ground.

The measured values of 60 Hz fields may be weakly correlated or associated with the effects in livestock.

Other electromagnetic parameter or parameters appear to be involved in the effects. An understanding and measurement of such parameter or parameters would aid in understanding the observed correlations to 60 Hz fields.

60 Hz ground currents need to be investigated. They appear to be associated with the effects observed

APPENDIX F

PROJECT DOCUMENTATION

AND

REVIEWER COMMENTS

Dataright inc.
INFORMATION REVIEW AND DEVELOPMENT SERVICES

March 31, 1989

TO: Members of the Low Livestock Productivity Advisory Board, State of Minnesota.
RE: Request for conclusions and recommendations per meeting of March 14, 1989.

At the report review meeting of March 14, 1989 there was a general request made to Dataright, Inc. that conclusions and recommendations be submitted to the Board regarding study findings and future research needs. We offer the following:

CONCLUSIONS:
1. We see limited value in continuing traditional "stray voltage" investigations except as a matter of routine inquiry.
2. There is no apparent association between a number of well known production variables and the loss of profitability of the study farms. While all of the farms could have done some things better, there was no consistency of any particular thing done "wrong".
3. It is inappropriate to focus future studies on "production" as the objective. Profitability of the operation should be made the objective of successful outcome. Several of the farms studied have, through remarkable personal efforts, managed to maintain or even increase production but the economic costs of doing so have substantially decreased the profitability of their operations to the point of economic failure in some cases.
4. Previous studies have been too narrowly focused to be useful in a consideration of electrical environment effects. At least, the same level of comprehensiveness and methodology that we have made an effort to represent should be expected in all future studies.
5. We believe that the profitability problems encountered on the farms studied are in certain and significant aspect beyond the realm of control of the farm operator and that much more comprehensive investigations are immediately called for to protect the value of this economy as it contributes to the wealth of the State.
6. General project findings (page 3) and recommendations for future study (project limitations, page 4) are as indicated in the progress report submitted to the Board on December 16, 1988 (attached).

LOW LIVESTOCK PRODUCTIVITY ADVISORY BOARD MEETING
March 31, 1989, St. Cloud, MN

Members Present:
K. Folger
R. Millot
R. Goodrich
D. Lusty
D. South

Also Present:
D. Lang
W. Coleman

The meeting was called to order by Bill Coleman in the absence of the chairman at 1:00 p.m.

The purpose of the meeting was to review the draft of the Dataright report which was presented to the Board at the March 14th meeting.

It was decided that following Dr. Lang's discussion of his conclusions and recommendations (attached), that each member would offer their comments.

Goodrich:

1. Conclusion #2 does not state the same as discussed on the top of page 1-3.

2. Raw data in the report is not clearly explained and should be made easier to interpret.

3. Literature review is only listed, not explained or referenced.

4. Report of University of Minnesota referred to on the Borgerding Farm should be included as part of the appendix. Borgerding agreed to release the letter to Dataright.

5. Many units of measure are missing from the data.

6. Statement on lack of foresight by early researchers of stray voltage is not accurate.

7. The document needs an interpretative statement on perceived results at the conclusion of the analysis of each farm.

8. Documentation is needed to support the statement concerning electrical problems made on page 5-3.

9. Clarification of water being a problem on page 5-4, these appear to be a subjective opinion.

10. Need better documentation of measured values on page E-2, it appears to be only a subjective statement.

D. South:

1. Lacking in analysis. It was difficult to understand what was done or what the charts and graphs were about.

R. Millot:

1. Explanation and/or summary statement to accompany each graph or chart.

2. Restate the goals and objectives or include the original proposal that the board accepted for this project.

3. The background or vita for each researcher involved in this project should be included in the document.

K. Folger:

1. The original proposal called for the inclusion of measurements related to traditional stray voltage. These are not included in the document.

2. Question on the validity of conclusion #1 in the March 31, 1989 letter from Dataright which states that continuing to investigate traditional stray voltage is only of limited value.

D. Lusty:

1. A summary of this large document is necessary to supply interested persons, particularly Legislators.

2. More corrilation of Kenney data.

3. Need to include comments from farmers concerning reports on their farms as contained in the document.

4. Need to see a clear indication of data on the Kenney farm as to which are barn and which are trailer measurements.

5. Don't rule out getting a better understanding of stray voltage.

6. More electrical measurements need to be made to find out where the problems are.

No other responses were received from absent Board members for presentation at this time.

The Board decided that Dr. Lang should take under consideration the responses from members and prepare a paper to be included with the draft document and that both be circulated for comment. There was a concern raised about going to the legislature with only this draft document to request more funding. No decision was made. Legislators could review the draft as could any interested party and if they chose to take action aside from the Board, that would be up to them. It was pointed out that the Board's charge at this point is to present a final report to the Commissioner for delivery to the Legislature by July 1, 1989.

The draft document along with Dataright's additional comments should be ready for distribution by the Department of Agriculture on April 14, 1989. All responses should be sent back to Bill Coleman at the MN Dept. of Agriculture no later than May 15, 1989. The Board will then meet to discuss these responses and work with Dr. Lang of Dataright in preparation of the Final Report to be available to the Commissioner of Agriculture by June 16, 1989.

The meeting adjourned and the next meeting will be held during the week of May 15, 1989.

Submitted By

William W. Coleman

Corrected letter

Dataright inc.

March 31, 1989

TO: Members of the Low Livestock Productivity Advisory Board, State of Minnesota.

RE: Request for conclusions and recommendations per meeting of March 14, 1989.

At the report review meeting of March 14, 1989 there was a general request made to Dataright, Inc. that conclusions and recommendations be submitted to the Board regarding study findings and future research needs. We offer the following:

CONCLUSIONS (revised per comments by Board review on 3/31/89):

1. We see limited value in continuing traditional "stray voltage" investigations except as an appropriate initiative of general management practice.

2. There is no apparent association between a number of well known production variables and the loss of profitability of the study farms. While all of the farms could have done some things better, there was no consistency of any particular thing done "wrong".

3. It is inappropriate to focus future studies on "production" as the objective. Profitability of the operation should be made the objective of successful outcome. Several of the farms studied have, through remarkable personal efforts, managed to maintain or even increase production but the economic costs of doing so have substantially decreased the profitability of their operations to the point of economic failure in some cases.

4. Previous studies have been too narrowly focused to be useful in a consideration of electrical environment effects. At least, the same level of comprehensiveness and methodology that we have made an effort to represent should be expected in all future studies.

5. A complete analysis of the data representing the electrical environment is beyond the scope of present funding and obviously deficient per project recommendations/limitations (page 4). However, no immediately apparent association between electrical and production data was observed.

6. We believe that the profitability problems encountered on the farms studied are in certain and significant aspect beyond the realm of control of the farm operator and that much more comprehensive investigations are immediately called for to protect the value of this economy as it contributes to the wealth of the State.

7. General project findings (page 3) and recommendations for future study (project limitations, page 4) are as indicated in the progress report submitted to the Board on December 16, 1988 (attached).

5/15/89

William W. Coleman
Minnesota Department of Agriculture
90 West Plato Boulevard
St. Paul, MN 55107

Dear Mr. Coleman,

Thank you for sending me a copy of the draft report prepared by Dataright, Inc. It is quite a voluminous report with a lot of electrical data, but very little analysis and discussion of the data.

In my opinion the basic electrical conclusions arrived at by the people involved in this study appear in three sections of the report:

1) The Project Overview from pages 1.1 to 1.4.
2) The section titled "Animal Health and Physiological Survey on Livestock Productivities" authored by Dr. Hartsell.
3) The section titled "60 HZ Electrical Field Measurements" authored by Dr. Dahlberg.

I will try to give you my impressions of the conclusions as I see them. The conclusion drawn in the Project Overview is stated on top of page 1.3, "None of the variables examined appear to be directly associated with the productivity problems encountered on the study farms." I can not understand the meaning of the sentence following this conclusion on the top of page 1.3. Also, if they do not appear to be directly related, is there something to indicate they are indirectly related to the productivity problems? Then they draw the conclusion that "Based on our work to date, it is apparent that deeper questions need to be asked". They then discuss the return current flowing in the earth on a multi-grounded distribution system and imply that this is one of the "deeper questions" that needs to be asked.

The "electrical conclusions" implyed in Dr. Hartsell's discussion are related to the Art Borgerding farm and the Joe Kenning farm. Relative to the Borgerding farm, he says "It is interesting to note that in the past Borgerding was able to temporarily clear up these problems by cutting the ground cables along the power distribution line to his farm". Relative to the Kenning farm, he suggests that Kenning "has a unique way of measuring ground current" and that Kenning "can show that an increase in his SCC is most always preceded by an increase in ground currents". In my opinion, these conclusions are based on opinions and not on the electrical data presented in this report.

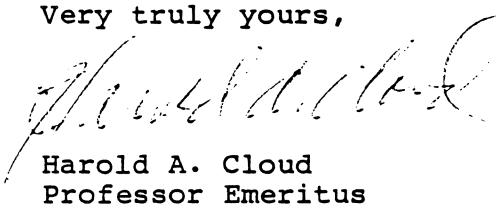
In Dr. Dahlberg's section he discusses "ground currents" relative to all three farms. Relative to the Harold Johnson farm, he concludes "these measurements imply a very significant 60 Hz ground current on this farm" and "that the origin of these ground currents is somewhere other than the farm". Relative to the Art Borgerding farm he concludes "It appears evident that the ground currents in the barn are affected by electrical use in off-farm areas". Relative to the Kenning farm he states "The measured field, therefore, was the result of currents introduced off-farm". In my opinion, these conclusions are highly speculative.

Dr. Dahlberg also discusses "signifcant 60 Hz potentials" between a wire connected to a "ground some distance from the barn" and "the barn ground". At times the potential was "sufficient to light a low potential light bulb". I am familiar with this situation and it is my opinion that Dr. Dahlberg should more carefully describe the "ground some distance from the barn" so the reader can understand the situation.

In my opinion, the impetus for this study was the theory that earth currents originating from electrical distribution and transmission systems were causing the low productivity problems on these dairy farms. The discussions on "ground currents" in this report give the reader the impression that this can now be concluded and that further studies need to be undertaken to prove they are the reason for low livestock productivity. In my opinion, the electrical data presented in this report does not support this implied conclusion.

I am enclosing copies of two letters relating to the Art Borgerding farm. I call your attention to 4th and 5th paragraphs of my letter to Senator Davis and Representative Wenzel. I do not believe the Dataright report provides an answer to Mr. Borgerding's problems. I believe a scientific study of the Borgerding situation, as outlined in this letter, should now be undertaken.

Very truly yours,



Harold A. Cloud
Professor Emeritus

877 Arbogast St.
St. Paul, MN 55126
(612) 484 9225

THE ELECTROMAGNETICS RESEARCH FOUNDATION Inc.

To: The Low Electrical Productivity Advisory Board

From: Duane A. Dahlberg, Ph.D. for The Electromagnetics Research Foundation

Subject: Report on Analysis of Variables Associated with the Occurrence of Electric and Magnetic Fields Which May Contribute to Low Productivity of Dairy Animals.

1. This is certainly the most complete set of electromagnetic data and associated information ever compiled for the dairy barn. Dataright must be commended for assembling this impressive system and collecting these data and information.

2. There is no doubt that there is significantly more information in the electromagnetic data than the authors have presented. It would be important why the variations for some measurements seemed to follow either energy use or time of milking and why the electromagnetic parameters measured were so different from one farm to the next.

3. A primary interest to me in such a study would be searching for correlations especially between physiological and production effect and electromagnetic parameters. Unfortunately very few of these results were provided. Dataright informed me and I am in agreement that neither the amount of money allocated nor the time allotted from collection, signing and due date was sufficient to completely analyze the massive quantity of information and data. Dataright had to choose which aspect of this project required which priority. It would be extremely valuable to provide the funding for a complete analysis of the data assembled for this report.

4. The research is a significant step in assessing the known problem of electromagnetic effects in dairy cattle.

5. The conclusions presented by Dataright are consistant with the results of my research. It should be emphasized that stray voltage historically associated with the shock effect may be a misunderstanding of the problem. In other words the neutral to earth voltages measured to supposedly relate to the potential for shock may not correlate with the level of animal effect nor relate directly to the electromagnetic parameters that may be affecting the cattle but simply be some type of an indicator which may relate to the probability of effect. One would expect that reduction of any and all inadvertant electromagnetic energies from the region of the barn would be beneficial in the dairy operation. Therefore correcting any electrical problems on the farm or off the farm (doing traditional stray voltage trouble shooting) should reduce problems. We are still faced with the question, "specifically what causes the effects?"

6. The recommendations provided by Dataright indicate the need to investigate more completely the cause and effect issue. I would suggest adding to additional recommendations: a) Measurements of AC and DC currents in the ground and in the floor of the barn. b) Measurements of AC and DC electric fields and field gradients especially near the floor or ground surface.

MAY 8. 1989

WILLIAM W. COLEMAN. DIRECTOR
DAIRY AND LIVESTOCK DIVISION
90 W. PLATO BLVD.
ST. PAUL. MN. 55107

DEAR MR. COLEMAN:

AFTER WORKING WITH AND REVIEWING THE WORK THAT DATARIGHT INC. HAS DONE WE FEEL THEY HAVE DONE AN EXCELLENT JOB FOR THE MONEY.

BUT THERE IS MUCH WORK NEEDED TO BE DONE YET AND WE SHOULD ALL WORK TO CONTINUE TO SOLVE THIS SERIOUS PROBLEM.

WE HAVE WORKED ON THIS PROBLEM FOR MANY YEARS AND HAVE FOUND MANY CORRECTIVE MEASURES TO INCREASE OUR PRODUCTION AND EASE OUR PROBLEMS. SOME OF THESE INCLUDE: HAVING A TRANSMISSION LINE MOVED, PUTTING IN AN ISOLATION TRANSFORMER AND PUTTING IN A BALANCED 110 VOLT SYSTEM NON NEUTRAL TO EARTH. WHICH HAVE ALL HELPED US OUT TREMENDOUSLY! BUT WE HAVE ALSO FOUND THAT ELEVATING AND ISOLATING LIVESTOCK FROM THE ELECTRICAL MAGNETIC FIELDS IN THE GROUND HAVE HELPED US INCREASE MILK PRODUCTION BY ABOUT 1/3, LOWER SOMATIC CELL COUNTS, LESS MEDICATION USE AND GENERALLY BETTER HEALTH OF LIVESTOCK. THIS WAS ALSO SUPPORTED BY DATARIGHTS WORK.

IN CONCLUSION WE FEEL THERE HAS TO BE MORE WORK DONE TO SHOW PEOPLE THE DAMAGE THESE ELECTRICAL MAGNETIC FIELDS CAUSE SO WE CAN CONVINCE THEM OF THE CORRECTIVE MEASURES THAT HAVE TO BE TAKEN.

SINCERELY,

Gee Kenning

April 11, 1989

TO: Members of the Low Livestock Productivity Advisory Board

RE: Response to comments received per Board meeting 3/31/89 (***response indicated by ***)

GOODRICH (University of Minnesota):

1. Conclusion #2 does not state the same as discussed on the top of page 1-3.
***Conclusion #5 has been added. However, it is our clear intent to focus future studies on characteristics of the electrical environment as a result of this inquiry.

2. Raw data in the report is not clearly explained and should be made easier to interpret.
***Very little "raw data" is included in the report. The data which is included represents an estimated 800,000 data points as one minute averages of 60 one second observations. This information has been further reduced to a graphical/visual format to benefit understanding and supported with descriptive statistics. We will welcome specific suggestions which will benefit interpretation.

3. Literature review is only listed, not explained or referenced.
Essentially all of the information included in the report is original. It was an early recommendation by Board members that a literature review not be a significant component of this work. References are included as a result of a recent search of several national data bases to benefit additional interests of readers.

4. Report of University of Minnesota referred to on the Borgerding Farm should be included as part of the appendix. Borgerding agreed to release the letter to Dataright.
This information has been received and will be included.

5. Many units of measure are missing from the data.
We have made an attempt to indicate units both in the text and in the accompanying graphs. Efforts will be made to correct any omissions brought to our attention.

6. Statement on lack of foresight by early researchers of stray voltage is not accurate.
Our concern is not lack of "foresight" but what we feel is excessive attention to a narrow aspect of the electrical environment. Please provide reference to specific text.

7. The document needs an interpretive statement on perceived results at the conclusion of the analysis of each farm.
Because our analysis of this information is minimal we have avoided specific opinions which may bias reader understanding. General observations, however, are included in the descriptions of the study farms.

8. Documentation is needed to support the statement concerning electrical problems made on page 5-3.
Statement is a personal opinion based on the experience of this consultant and will be referred for his review.

9. Clarification of water being a problem on page 5-4, these appear to be a subjective opinion.
Same as above.

10. Need better documentation of measured values on page E-2, it appears to be only a subjective statement.
Referred to consultant for comment.

SOUTH (Farmer/representative):

1. Lacking in analysis. It was difficult to understand what was done or what the charts and graphs were about.
Most of the information contained in this report in terms of format, quantity and continuity is, to our knowledge, presented here for the first time as an original contribution. Funding limitations to analysis are acknowledged in the text. We welcome specific comments that will benefit understanding.

Millot (Agralite Electric Cooperative):

1. Explanation and/or summary statement to accompany each graph or chart.
Most of the graphs in this report are of the same general format and described in the text preceding that section. For example, more than 150 graphs representing animal exposure are of the same kind and we felt it would be redundant to reproduce this information. Efforts will be made to address specific concerns.

2. Restate the goals and objectives or include the original proposal that the Board accepted for this project.
***The goals and objectives as described in the proposal are restated as understood on page one of the report. The report now

represents some 530 pages of information which we believe is important to understanding the nature of this problem and additional information as previously provided to the Board was not included in the interest of economic efficiency.

3. The background or vita for each researcher involved in this project should be included in the document.
Personnel data will be added to the appendix.

FOLGER (Ottertail Power Co.)

1. The original proposal called for the inclusion of measurements related to traditional stray voltage. These are not included in the document.
The original proposal called for investigations "other than traditional stray voltage". All of the farms selected for study have dealt comprehensively with "traditional stray voltage" previous to our investigations. We respect the initial need for this work. Additionally, all animal contact potentials were examined using traditional means to protect the sensitivity of the computer based data acquisition system prior to putting the system "on line". Numerous "true RMS channels" are also represented as components of this data base and represent, at least, "traditional stray voltage" assessments. Finally, we have found that sensitive contact potentials as typically represented in this research, readily describe electrical anomalies such as would be associated with ungrounded motors and other unbalanced ac potentials to ground in devices or unbalanced circuits typically associated with "stray voltage".

2. Question on the validity of conclusion #1 in the March 31, 1989 letter from Dataright which states that continuing traditional stray voltage is only of limited value.
We have modified this conclusion accordingly. It is clear that investigators such as those representing Ottertail Power Company of Fergus Falls, Minnesota provide a very important service. It is, however, our fundamental concern that electrical environment considerations not be preempted by the failure of a "stray voltage" inquiry to resolve the profitability problems the farmer has encountered.

LUSTY (Farmer/representative):

1. A summary of this large document is necessary to supply interested persons, particularly, Legislators.
We agree but feel it is beyond the scope of the current project to consolidate this information to a point that exceeds the project limitations detailed 12/16/88 and the conclusions provided as requested 3/31/89.

2. More correlation of Kenning data.
***The electrical data and production data are not, as yet, of

the same time base. For that reason, a correlation analysis was not done. Forcing this analysis requires averaging the electrical data base and the risk of masking important information. Because funding was inadequate to support this analysis, the data is presented in graphical format and as such suggests that a more instructive analysis may involve a consideration of the correlation of increased variability of these variables over time rather than an association of absolute values per time.

3. Need to include comments from farmers concerning reports on their farms as contained in the document.
All related comments will be included in the appendix.

4. Need to see a clear indication of data on the Kenning Farm as to which are barn and which are trailer measurements.
Final report will be revised accordingly.

5. Don't rule out getting a better understanding of stray voltage.
We respect existing expertise in this area and welcome additional understanding.

6. More electrical measurements need to made to find out where the problems are.
We agree

Fergus Falls
April 14, 1989

SUBJECT: REPORT OF DATARIGHT - SUBMITTED ON MARCH 31, 1989
ANALYSIS OF VARIABLES ASSOCIATED WITH THE OCCURRENCE OF ELECTRIC AND MAGNETIC FIELDS WHICH MAY CONTRIBUTE TO LOW PRODUCTIVITY IN DAIRY ANIMALS

SUBMITTED TO: THE LOW LIVESTOCK PRODUCTIVITY ADVISORY BOARD
STATE OF MINNESOTA

A letter submitted by DataRight, dated March 31, 1989, states in conclusion that it is assumed that no value is placed on traditional stray voltage investigations except as a routine inquiry. This statement and many others made without the data or test results to back them up seriously affect the credibility of this study.

The request for proposal stated that stray voltage studies were to be included as part of the overall evaluation of each farm that was studied. However, we do not find anywhere in the final report any documentation that this work was ever completed. This is one area that may be very important in developing a well-rounded study before final conclusions are made.

As one reads the report, reference is made in the project overview:

> "This research was initiated in response to a request for proposal issued by the Low Livestock Productivity Board as administered by the Minnesota Department of Agriculture. The objective of this work, as outlined in the request for proposal, was to '...establish the causes which continue to bring on low livestock productivity and poor animal health which may be related to other than traditional stray voltage.'"

Wasn't it submitted in the original request for proposal that the following tests be made?

> "II. On-farm measurements for this study.
>
> A. Measurements made must be accomplished through recognized standards acceptable to the scientific community. These should include but are not limited to the following:
>
> 1. AC electric and magnetic fields
> 2. DC electric fields
> 3. Geomagnetic fields
> 4. Earth conductivity
> 5. Electrical currents to include traditional stray voltage."

Throughout the report stray voltage is mentioned in varying degrees, such as page 1.2:

> "Many of the on-farm investigations have simply stated that the problem is limited to contact potentials or 'stray voltage,' and is insignificant unless these potentials exceed 300 to 500 millivolts;" (Where is the test data to support this?)

or,

> "This adversarial contest has resulted in a spiral of declining profitability for problem farms. The farmer confronts a production problem that will not respond to his previous (and in all cases reviewed here, successful) management experiences. The investigators work to mitigate a 'stray voltage' condition. The on-farm production experience typically improves, then declines." (Where is the test data to support this?)

or (page 1.3),

> "None of our data indicated that the problems reported on the farms studied are attached to an acute causality that will yield to a simple solution. However, many farms experiencing the more obvious 'stray voltage' condition would." (Where is the test data to support this?)

In particular on the Borgerding farm, reference in the farm description report, page 2.2, stated we have no information related to the balance of the components of this three-phase load. Stray voltage results would have considered this.

The Johnson farm, (page 2.2) would indicate that much work has been done in the past. Why wasn't this included in the study?

The University of Minnesota barn personnel say they don't have a stray voltage problem or electrical problem associated with production of the herd. Where are the results?

The Kenning farm refers to an electrical environment problem. What is this?

I have the following comments on the report from DataRight called "Reporting on request for conclusions" which were in their March 31, 1989, letter.

Conclusion #1: Stray voltage is still a very real issue and needs to be addressed. There is nothing routine about this.

Conclusion #2: The report is very vague about what could have been done better or what things were done wrong.

Conclusion #3: Why are studies on 'production' inappropriate? Doesn't production and profitability go hand in hand? Where are some numbers?

Conclusion #4: Where is the data? Apparently there have been previous studies so a comparison shouldn't be to difficult to produce.

Conclusion #6: Project Findings:

1. What would be considered a shock condition? Disregarding any publications, and with DataRight's background, what do they feel is that level?

2. What were the electrical problems 'very vague'? What were the corrective actions? What types of devices were installed? Why are some of these devices not being used?

Conclusions #7 and #8: This could be expected.

Conclusion #9: There are no two farms alike electrically or any other way so conditions will vary between them.

Conclusion #10: Very true.

In the area of herd management, production levels reported were 16,000 pounds, 18,000 pounds, 17,000 pounds, and 13,500 pounds with SSC varying 100,000 through 600,000. Attached to this report is a DHI yardstick for 1989. It is interesting to see the number of herds tested and also the herd averages compared to the percentage of cows tested positive. As the SSC is lowered, notice how production increases. Production levels on the test farms were from 13 to 18,000 and the 1988 Minnesota average was 16,716 pounds.

The East Otter Tail County DHIA Association and the West Otter Tail County DHIA progress chart which is attached shows some very interesting comparisons with respect to herds tested and production levels. The official herd average for 1988 was 17,051 pounds for West Otter Tail County, and for East Otter Tail County it was 16,563 pounds. Production averages do vary considerably between dairies tested, but what do the results look like over a five-year or greater period.

In conclusion, the report as submitted doesn't really identify or address the basic question and that was to identify the type of electricity that causes low livestock productivity and/or poor animal health. In addition most of the conclusions that were drawn are not based on tests run or data collected.

I feel this report is not only incomplete but also misleading due to all the unfounded statements.

Keith Folger

Keith Folger
Board Member

bjl

HOW ARE WE DOING?

This chart shows average cow and herd production comparisons in the East Otter Tail County Association.

Year	Herds On Test	Cows On Test	Milk	Fat	Value Of Product	Feed Cost	Income Over Feed Cost
1988	235	11,985	16,563	610	$1,935	$721	$1,214
1983	233	11,283	15,060	568	$1,964	$750	$1,214
1978	181	7,883	14,223	523	$1,393	$530	$ 863
1968	90	2,572	12,239	472	$ 574	$198	$ 376

TYPES OF DHI TESTS AVAILABLE

Official DHI: Supervisor weighs and samples all milkings in a 24 hour period. Lactation records are used in Sire Summaries. Herd records may be used for advertising and sale of cattle. Herd owner agrees to provide visible identification on all calls.

Official DHIR: Same as Official DHI, except all lactation records for Registered cows are sent to the breed association for publicity. Herd owners must apply to the breed association involved.

Official DHI AM-PM: A monitoring device, provided by the supervisor, is attached to the herd owner's milking system at least 36 hours prior to the sampled milking. Herd owner must provide for a monitor hook up. Supervisor weighs and samples milk alternately at AM and PM milkings in consecutive test periods. Records are used for Sire Summaries and sale of cattle. Visible identification required. Cost is eighty-five percent of the official test, plus 2 cents per cow per month for use of the monitoring system.

Owner-Sampler: Herd owner takes milk samples and weighs milk, thus reducing cost. Supervisor drops off sample containers and picks up from herd owner each month. Two milkings are sampled. Records are unofficial, not used in Sire Summaries or advertising. Visible identification not required.

Owner-Sampler Supervised: Supervisor takes milk samples and weighs milk at one milking per month, preferably alternating morning and evening milkings each month. Monitor is not used. Records are unofficial. Cost is about 2/3 of the official test.

1988 W.O.T. DHI Official Herd Averages:

Cows Per Herd: = 50

Milk: = 17051 lbs.

Fat: = 616 lbs.

% Fat: = 3.6

Protein: = 539 lbs.

Value of Product: = $1973

WEST OTTER TAIL DHIA PROGRESS CHART

This chart shows average cow comparisons in W.O.T. County Association for production, value of product and feed costs.

YEAR	HERDS ON TEST	COWS ON TEST	MILK LBS	FAT LBS	VALUE OF PRODUCT	FEED COST	INCOME OVER FEED COST
1988	126	6300	17051	616	$1973	$738	$1235
1987	129	6321	16344	590	1978	670	1308
1980	102	4488	14771	538	1822	558	1264
1974	96	3840	12808	487	994	382	612

State Ave 1988
16,716 lbs

DHI YARDSTICK FOR 1989

Holstein Rolling Herd Averages, August 1988 (by thousand lbs milk)

	13-14	16-17	19-20	>22
No. of herds	328	1004	471	39
Cows per herd	51	55	58	56
% Cows in milk	86	86	87	88
Milk lbs	13563	16508	19458	22928
% Fat	3.7	3.6	3.6	3.5
Fat lbs	504	602	703	810
MLM lbs	45	53	62	72
All Feeds 100% DM				
* Grain lbs	5209	5940	6575	7310
Total DM/cwt BW	3.0	3.2	3.3	3.5
Forage DM/cwt BW	1.9	1.9	1.9	1.9
Energy index	114	112	108	104
Protein index	132	126	121	116
Milk/lb grain DM	2.6	2.8	3.0	3.1
Value of product $	1555	1902	2247	2630
Total feed cost $	621	695	762	840
Income over feed cost $	934	1207	1485	1790
Feed cost/cwt milk $	4.58	4.21	3.92	3.66
Milk price/cwt $	11.47	11.52	11.55	11.47
* % SCC positive	37	28	'22	19
Average Sire PD				
* Avg. PD$, service sire	116	122	127	134
Avg. PD$, 1st lactation	44	55	67	79
Avg. PD$, other cows	17	26	39	50
1st Lactation vs Other Cows				
% Of herd, 1st lactation	33	33	35	35
Avg. production index, 1st lactation	102	102	101	101
Avg. production index, other cows	103	103	104	104
Avg. age, 1st lactation	28	28	27	27
Avg. age, other cows	60	59	57	57
* % Sire ID, 1st lactation	54	77	91	92
* % Sire ID, other cows	46	68	88	93
* Avg. peak lbs, 1st lact. (Holsteins)	52	60	68	77
* Avg. peak lbs, other cows (Holsteins)	67	78	90	100
Peak ratio, 1st ÷ 2nd+ lact.	0.78	0.77	0.76	0.77
* % Leaving herd, 1st lactation	10	10	12	16
* % Leaving herd, other cows	28	28	29	30
Days Dry Before Calving				
Avg. days dry	66	63	60	58
* % Dry less than 40 days	17	10	9	12
* % Dry more than 70 days	31	25	20	16
Pregnant Cows				
* Min. calving months interval	13.8	13.3	13.1	13.0
Avg. days to 1st breeding	86	84	84	84
Avg. days open	142	125	121	116
Conception rate	58	56	56	55
* Heat detection index	41	47	52	56

* Note: Highlighted variables are related to production level. Individual herds may deviate drastically from averages on any variable indicating management differences.

UNIVERSITY OF MINNESOTA
TWIN CITIES

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1988 Fitch Avenue
St. Paul, Minnesota 55108
(612) 625-8781

May 9, 1988

Mr. Art Borgerding
28034 Co. Rd. 157
Freeport, MN 56331

Dear Art,

Enclosed find my tabulation of the reproductive performance of the cows in your herd as of my last visit on April 20. This record lists each cow in calving order and then lists subsequent breedings and results (rebred, open or pregnant). I like this system as it quickly shows which cows are falling behind their herdmates and are becoming problems. It is also easy to make a list of cows needing veterinary examination. I am enclosing a couple of blank pages so you can continue this system if you wish. Pregnancy exam results from my visits to your farm on March 23 and April 20 are recorded on this record.

On April 20, I was able to determine the pregnancy results of 18 inseminations which occurred between February 19 and March 19. Eight of these (44%) resulted in pregnancy. The professional AI technician (Schmidt) had 5 pregnancies from 11 inseminations and you had 3 pregnancies from 7 inseminations. We caught 3 bred heifers and found all of them to be pregnant but did not examine the remainder. Twelve new inseminations had occurred since March 23 which was too soon to evaluate pregnancy results, 2 cows had been culled and replaced with 2 newly freshened heifers. No evidence of ovarian cysts or uterine infections were found.

Evaluation of your herd's conception rate results (% of individual inseminations resulting in pregnancy) was calculated as follows:

Month		Inseminations	Pregnancies	%
August, 1987		6	0	0
September		11	1	9
October		12	1	8
November		15	0	0
December		24	1	4
January 1988		23	1	4
February				
	by Schmidt	3	3	
	by Art	28	7	
	TOTAL	31	10	32%
March	by Schmidt	8	2	
	by Art	7	2	
	TOTAL	15	4	27%

March & April: 13 unknown results on April 20.

Obviously these results are far below expectations. Even the improved results for February and March at about 30% are far below industry expectations of 45-55% of all inseminations producing pregnancies. I cannot find evidence of abnormalities in the cows, i.e. cysts, infections, etc., to explain these results. In most herds, low conception rates are caused by inaccurate heat detection, improper timing of AI, and/or poor AI technique. With results as poor as you have had last fall and winter (4 pregnancies from 91 services), I'd suspect that your semen supply may have been damaged or that some other major change in your herd's management occurred in February of this year. Is that possible? As you know, this recent hint of improvement will have to continue for several months for your herd to get back on tract. I believe that is now possible.

For the future, I recommend you continue to use recommended procedures for successful AI and use some form of veterinary reproductive examination of your cows to know which cows are pregnant and to allow you to know if insemination results are increasing or decreasing. If results drop to near zero again, I suggest a quicker request for help to improve our chances of finding the cause. I remain willing to help you, within my area of expertise, in any way that I can. Contact me if you have questions or need further assistance.

Sincerely,

Brad Seguin

Brad Seguin, DVM, PhD
Professor, Theriogenology
(612) 625-6769

Enclosures

cc: Dr. Bill Olson, Department of Large Animal Clinical Sciences
Dr. Harold Cloud, 313 Ag Engineering
Dr. Dave Tomsche, 309 5th Ave. SE, Melrose, MN 56352

Concordia College
901 South Eighth Street
Moorhead, MN 56560

Physics Department
(218) 299-4611

May 17, 1989

David S. Lang, Ph.D., President
Dataright, Inc
Route 4 Box 241
Milaca, Mn 56353-9357

Dear Dave:

In response to the Board's request to change my conclusions: The conclusions would have been expressed more strongly and additional ones provided if they reflected the sum of my research. I believe it would be inappropriate for me to make any changes in my conclusions.

Sincerely,

Duane A. Dahlberg

an equal opportunity employer

PROFILE

DAVID S. LANG

David S. Lang is a science consultant and president of Dataright, Inc. at Milaca, Minnesota. He is also owner-operator of a small farm in central Mille Lacs County. He graduated from the University of Minnesota in 1978 with a Ph.D. in plant pathology with collateral study in biochemistry, ecology and statistics. He held a faculty appointment as a research fellow in the Department of Plant Pathology until 1979 completing post doctoral studies initiated under contact to the U. S. Environmental Protection Agency. From 1979 to 1984 he was employed as senior environmental scientist to the Minnesota Environmental Quality Board. His responsibilities in that position included the management of research projects examining the pollution of air, land and water resources, and participation in studies dealing with the health and safety of powerlines. He is co-author of a review examining a possible method for cancer induction related to the nuclear magnetic resonance of biologically important ions. In 1982 he developed and managed a cooperative research project with the University of Minnesota, the National Park Service , the U. S. Forest Service and several Minnesota State agencies. Its purpose was to develop a biological method to directly measure the effects of pollution on agricultural and forest species that are economically important to Minnesota. That project is continuing and is now in its fourth year of a proposed ten year study to measure the long term effects of atmospheric pollution. Ten monitoring sites are now operated throughout Minnesota and an extensive computer searchable data base has been assembled at the University of Minnesota. Working cooperatively with the University in 1980, he managed a State sponsored project on crop loss assessment supporting the participation of a multidisciplinary team of international authorities to address the topic.

Dr. Lang has worked as research scientist (Effects of Submicron Acid Aerosols on Vegetation, 1978) and author (National Criteria Document for Ozone, Biomonitoring Section, 1984) for the Environmental Protection Agency. He now works as an agricultural and environmental consultant with individual and public clients in education and government. His current interests are focused on the assessment of effects associated with long term exposures to environmental contaminants and on sustainable agricultural production practices that emphasize on-farm profit rather than the maximization of production.

PROFILE

RILEY C. HENDRICKSON

Riley C. Hendrickson is a senior associate in physical science with Dataright, Inc. of Milaca, Minnesota. He provides scientific support for environmental research and monitoring activities, specializing in the description and analysis of atmospheric phenomena including air pollution, electromagnetic fields and space charge distributions. He held a faculty appointment at the Department of Plant Pathology, University of Minnesota from 1976 to 1980. As a research specialist in electronics, he directed the assembly of an extensive database representing a continuous record of the occurrence of oxidants in the rural atmosphere at ten sites over a period of four years. Concurrently he provided support for a comprehensive survey of air pollution emissions from a coal gasification plant under contract to the Department of Energy. He was responsible for an instrumentation system for dispensing and monitoring of air pollutants in open-top growth chambers. From 1980 to 1986, he was a project director and senior technical analyst for the Minnesota Environmental Quality Board. As principal investigator, he was responsible for studies of the electrical environment near high voltage transmission lines. He expertise was focused on monitoring the electric field and space charge distributions outside the right of way of dc and ac lines and he was the first to demonstrate the magnitude and extent of significant concentrations of space charge downwind of a high voltage dc transmission line.

Hendrickson is a graduate of the University of Minnesota at Minneapolis. He studied physics, mathematics and computer science and earned a Bachelor of Physics degree in 1973 followed by a Master of Science degree in 1975. As a teaching associate he taught undergraduate physics and astronomy laboratory courses for two years and is a Vietnam-era veteran of the US Navy.

His current professional interests include systems development for environmental studies and processes affecting global atmospheric degradation.

1. Albright, J.L., Dillon, W.M., Sigler, M.R., Wisker, J.E., Arnholt, D.J. 1988. Dairy farm analysis of stray voltage problems in Indiana. Journal of dairy science. Purdue Univ., West Lafayette, IN 47907.

2. Algers, N., Hennichs, K. 1984. Effects of electromagnetic fields on fertility in cattle. Sveriges Lantbruksuniversitet, 532 00 Skara, Sweden. Svensk Veterinartidning. 36 (6): 289-292.

3. American Institute of Biological Sciences. 1985. Assessments and viewpoints on the biological and human health effects of extremely low frequency (ELF) electromagnetic fields. Compilation of commissioned papers for the ELF literature review project.

4. Aneshansley, D.J., Gorewit, R.C., Pellerin, R.A., Ludington, D., Price, L.R. 1987. AC voltages on milking unit: effects on behavior and production. Cornell Univ., Ithaca, NY 14850. Journal of Dairy Science. 70 (Suppl. 1):214.

5. Aneshansley, D.J., Gorewit, R.C., Ludington, D.C., Pellerin, R.A., Xin, Z. (Zhao, X.). 1987. Effects of neutral-to-earth voltage on behavior, production and water intake in dairy cattle. Dept. Ag. Engineering, Cornell Univ., Ithaca, NY 14853. Paper, American Society of Ag. Engineers. 87-3034:24.

6. Appleman, R.D., Gustafson, R.J., Brennan, T.M. 1987. Production record analysis of dairy herd response to neutral isolation. Dept. Animal Science, Univ. Minnesota, St. Paul, MN 55108. Paper, American Society of Ag. Engineers. 87-3039:12.

7. Appleman, R.D. 1987. Dairy farm diagnostics. AG-BU-2892.

8. Appleman, R.D., Gustafson, R.J. 1985. Source of stray voltage and effect on cow health and performance. Dept. of Animal Science, Univ. of Minnesota, St. Paul, MN 55108. Journal of Dairy Science. 68 (6): 1554-1567.

9. Buschermohle, M.J., Bunn, J.M., Spray, R.A. 1984. Extraneous voltage levels on South Carolina dairy farms. Ag. Eng. Dept., Clemson Univ., Clemson, SC. St. Joseph, MI 49085. Paper, American Society of Ag. Engineers. 84-3501:17.

10. Linn, J.G., Hutjens, M.F., Howard, W.T., Kilmer, L.H., Otterby, D.E. 1988. Feeding the dairy herd. MN-AG-BU-0469.

11. Cloud, H.A., Appleman, R.D., Gustafson, R.J. 1987. Stray voltage problems with dairy cows. N. Central Regional Extension Publication 125, Minnesota Extension Service, University of Minnesota. AG-BU-1359.

12. Currence, H.D., Steevens, B.J., Winter, D.F., Dick, W.K., Krause, G.F. 1987. Dairy cow and human sensitivity to 60 hertz currents. Dept. Ag. Engineering, Univ. Missouri, Columbia, MO 65211. Paper, American Society of Ag. Engineers. 87-3036:11.

13. Dahlberg, D.A. 1985. Study of electro-magnetic effects on the health and production of dairy cows. Minnesota Department of Agriculture, St. Paul, MN.

14. Dairyland Electrical Industries, Inc. 1988. Neutral isolator for primary/secondary neutral isolation. Oregon, WI.

15. Drenkard, D.V.H., Gorewit, R.C., Scott, N.R., Sagi, R. 1985. Milk production, health, behavior, and endocrine responses of cows exposed to electrical current during milking. Dept. of Ag. Engineering, Cornell Univ., Ithaca, NY 14853. Journal of Dairy Science. 68 (10): 2694-2702.

16. Gorewit, R.C., Zhao, X., Aneshansley, D.J., Ludington, D.C., Pellerin, R.A. (Xin, Z.). 1987. Effects of neutral-to-earth voltage on animal health and reproduction in cattle. Dept. Animal Science, Cornell Univ., Ithaca, NY 14853. Paper, American Society of Ag. Engineers. 87-3035:15.

17. Gorewit, R.C., Scott, N.R. 1986. Cardiovascular responses of cows given electrical current during milking. Dept. Animal Science, Cornell Univ., Ithaca, NY 14853. Journal of Dairy Science. 69 (4):1122-1127.

18. Gorewit, R.C., Scott, N.R., Czarniecki, C.S. 1985. Responses of dairy cows to alternating electrical current administered semirandomly in a nonavoidance environment. Dept. of Animal Science, Cornell Univ., Ithaca, NY 14853. Journal of Dairy Science. 68 (3): 718-725.

19. Gorewit, R.C., Drenkard, D.V.H., Scott, N.R. 1985. Physiological effects of electrical current on dairy cows. Dept. of Animal Science, Cornell Univ., Ithaca, NY 14850. ASAE Publication 3-85:1-19.

20. Gorewit, R.C., Scott, N.R., Drenkard, D.V.H. 1984. Effects of electrical current on milk production and animal health. Cornell Univ., Ithaca, NY 14853. ASAE paper, American Society of Ag. Engineers. 84-3502:19.

21. Gorewit, R.C., Bristol, D.G., Aronmando, M., Thomas, G.G. 1984. Mammary blood flow of cows measured by ultrasonic and electromagnetic flow meters. Cornell Univ., Ithaca, NY 14850. Journal of Dairy Science. 67 (1):159.

22. Gustafson, R.J., Brennan, T.M., Appleman, R.D. 1985. Behavioral studies of dairy cow sensitivity to AC and DC electric currents. Ag. Engineering Dept., Univ. Minnesota, St. Paul, MN. Transactions of the ASAE. 28 (5): 1680-1685. 84-3504.

23. Gustafson, R.J., Folen, D.A. 1984. Transition designs for equipotential planes. Ag. Engineering Dept., Univ. of Minnesota, St. Paul, MN 55108. Publication, American Society of Ag. Engineers. 3-85:153-165.

24. Gõnen, Turan. 1986. Electric Power Distribution System Engineering. McGraw-Hill Book Company.

25. Hendrickson, R.C. 1986. Space charge drift from a +/-400kV direct current transmission line. Minnesota Environmental Quality Board, Power Plant Siting Program, St. Paul, MN. Bioelectromagnetics 7:369-379.

26. Hertz, C.M., Hall, J.P., Winsett, I.L. 1984. Using saturating reactors to mitigate stray voltage problems. Ronk Electrical Industries, Inc. Nokomis, IL 62075. Paper, American Society of Ag. Engineers. 84-3505:6.

27. Kammel, D.W., Jones, B. 1987. Analysis of equipotential plane installations. Dept. Ag. Engineering, Univ. Wisconsin, Madison, WI 53706. Paper, American Society of Ag. Engineers. 87-3037:11.

28. Kavet, R., Black, R. 1985. Electrical and magnetic fields: health research. Health Effects Inst., Cambridge, MA. Agricultural Engineering. 66 (1): 21-24.

29. Kirk, J.H. 1984. Possible causes of stray voltage-like signs in dairy cows. Dept. of large animal clinical science, College of Vet. Medicine, Michigan State Univ., East Lansing, MI 48824. Publication, American Society of Ag. Engineers. 3-85:62-64.

30. Lang, D.S., Hendrickson, R.C. 1988. Carcinogenesis and nonionizing radiation. International perspectives in public health. Vol. 4:24-25.

31. Lanzerotti, Louis J., Giovanni P. Gregori. Telluric Currents: The Natural Environment and Interactions with Man-made Systems. In (), 232-250.

32. Lefcourt, A.M., Kahl, S., Akers, R.M. 1986. Correlation of indices of stress with intensity of electrical shock for cows. USDA milk secretion lab., Beltsville, MD 20705. Journal of Dairy Science. 69 (3): 833-842.

33. Lefcourt, A.M., Akers, R.M., Miller, R.H., Weinland, B. 1985. Effects of intermittent electrical shock on responses related to milk ejection. Milk Secretion & Mastitis Lab., Animal Science Inst., USDA, Beltsville, MD 20705. Journal of Dairy Science. 68 (2):391-401.

34. Leskinen, P., Taponen, J., Saloniemi, H. 1988. Stray voltage, a problem on dairy farms. Suomen Elainlaakarilehti. 94 (7-8): 336-340. Helsinki, Finland.

35. Ludington, D.C., Pellerin, R.A., Aneshansley, D.J., Gorewit, R.C. 1987. Transmission of neutral/earth current in dairy barns. Dept. Ag. Engineering, Cornell Univ., Ithaca, NY 14853. Paper, American Society of Ag. Engineers. 87-3032:19.

36. Lyubimov, V.E., Sinel'shchikov, A.I. 1985. Electrophysiological indicators during application of a field in milking of cows. Moskovskaya Vet. Akad., Moscow, USSR.

37. Lyubimov, V.E. 1985. Adaptive reactions of the udder to stimulation by UHF electromagnetic fields. Moskovskaya Vet. Akad., Moscow, USSR.

38. McCurdy, J.A., Anderson, P.M., Fairchild, J.W. Bonding and grounding electrical equipment. The Pennsylvania State University, College of Agriculture, Cooperative Extension Service, agricultural engineering sheet.

39. Minnesota Department of Agriculture. 1986. Stray voltage survey. St. Paul, MN.

40. Norell, R.J. 1984. Dairy cattle sensitivity to electrical shocks as determined with behavioral indices. University of Minnesota, St. Paul, MN 55108. Dissertation Abstracts International, B. 44 (11): 3251.

41. Norell, R.J., Gustafson, R.J., Appleman, R.D., Overmier, J.B. 1983. Behavioural studies of dairy cattle sensitivity to electrical currents. Animal Science Dept., Idaho Univ., Idaho Falls, ID. Transactions of the ASAE. 26 (5): 1506-1511.

42. Reese, N.D., Surbrook, T.C. 1985. Voltage gradient control in animal areas. Ag. Engineering Dept., Michigan State Univ., East Lansing, MI 48824. Publication, American Society of Ag. Engineers. 3-85:147-152.

43. Roble, Raymond G., Israel Tzur. The Global Atmospheric-Electrical Circuit. In (), 206-231.

44. Roy, W.R., Lee, J.M. 1984. Transmission line impacts on agriculture: issues and research. American Elec. Power, North Liberty, IN. Paper, American Society of Ag. Engineers. 84-3033:14.

45. Scott, N.R., Gorewit, R.C., Drenkard, D.V.H. 1984. Effects of electrical current on milking behavior. Ag. Ext. Sta., Cornell Univ., Ithaca, NY 14853. Publication, American Society of Ag. Engineers. 3-85:20-34.

46. Southwick, L.H., Pellerin, R.A., Guest, R.W. 1987. The prevalence of neutral to earth voltage on New York dairy farms. Cornell Univ., Ithaca, NY 14850. Journal of Dairy Science. 70 (Suppl. 1): 137.

47. Street, W.L., Summers, J.W. 1983. Animal protective apparatus and method for protecting the animal from electrical power. United States Patent 1983. (US 4 401 055 A).

48. Surbrook, T.C., Reese, N.D. 1984. Importance of source elimination and adherence to the National Electrical Code. Ag. Engineering Dept., Michigan State Univ., East Lansing, MI 48824. Publication, American Society of Ag. Engineers. 3-85:129-139.

49. Surbrook, T.C., Reese, N.D. 1984. Theory, installation and experiences with isolation devices. Ag. Engineering Dept., Michigan State Univ., East Lansing, MI 48824. Publication, American Society of Ag. Engineers. 3-85:166-175.

50. Surbrook, T.C., Reese, N.D., Gustafson, R.J., Cloud, H.A. 1983. Deisgning facilities to prevent stray voltage problems. Dairy Housing II. Proceedings of second national dairy housing conference, Madison, WI. ASE SP 4-83. Ag. Engineering Dept., Michigan State Univ., East Lansing, MI. St. Joseph, MI. American Society of Ag. Engineers. 29-35.

51. U.S. Dept. of the Interior, Bureau of Mines, Guide for the Construction of Driven-Rod Ground Beds, Information Circular 8767.

52. U.S. Department of Energy, Contractors Review, Project Resumes. 1988. Biological effects from electric and magnetic fields, air ions and ion currents associated with high voltage transmission lines. Hyatt Regency Hotel, Phoenix, AZ.

53. Voigt, D. 1987. Effects of electromagnetic fields on biological systems. Magnets, Meeting of the minds, Oct. 1987 lecture.

54. Winter, D.F., Dick, W.K. 1984. Field experience with the electronic grounding system for stray voltage reduction. ITT Blackburn Co., St. Louis, MO 63114. Paper, American Society of Ag. Engineers. 84-3503:12.

55. Winter, D.F., Dick, W.K. 1983. A method for compensating neutral-to-earth potentials in dairy facilities. Agricultural electronics - 1983 and beyond. Volume II: Controlled environments, livestock production systems, materials handling and processing. Proceedings of National Conference, Dec. 11-13, 1983. Chicago. ITT Blackburn Co., St. Louis, MI. St. Joseph, MI. American Society of Ag. Engineers. 492-500.

56. Wisconsin Department of Agriculture, Trade and Consumer Protection. 1987. SVAT nine farm study.