OPERATING MANUAL FOR THE U.S. GEOLOGICAL SURVEY'S DATA-COLLECTION SYSTEM WITH THE GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE

Edited by Joanne C. Jones, Debra C. Tracey, and Frances W. Sorensen

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CONVERSION FACTORS

Multiply	By	To obtain
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second (m/s)
inch (in)	25.40	millimeter (mm)
pound (lb)	0.4536	kilogram (kg)

ACRONYMS AND ABBREVIATIONS

A	ASCII
A/D	Analog-to-digital
ac	Alternating-current
ADAPS	Automated Data Processing System
ADC	Analog-to-digital Converter
ADR	Analog-to-digital recorder
Ah	Ampere-hour
AIMS	Automated Instrument Monitoring System
AMLC	Asynchronous Multi-line Controller
ANSI	American National Standards Institute
APRM	Abnormal Platform Response Message
ASCII	American Standard Code for Information Interchange
AWG	American Wire Gage
B	Binary
BASIC	Beginner's All-Purpose Symbolic Instructional Code
BCD	Binary Coded Decimal
BKSP	Backspace
BLK	Black
BLU	Blue
BRN	Brown
CD	Configuration Description
CDCP	Convertible Data Collection Platform
CF	Configuration Formats
CFOP	Current format operation
CFP	Current format
CMOS	Complimentary Metal-Oxide Semiconductor
CN	Change name
COMO	Command output file
CP	Current data character
CPS	Characters Per Second
CR	Carriage Return
CS	Configuration Sensors
CTRL	Control
D	Data field descriptions
dB	Decibel
dBm	Decibel referred to 1 milliwatt
DC	Device Configuration
dc	Direct-current
DCF	Device Configuration Files

DCP	Data-Collection Platform
DCS	Data-collection system
DD	Data Descriptor
DECODES	Device Conversion and Delivery System
DEL	Delete
DIM	Dimension
DIS	Distributed Information System
DMM	Digital Multimeter
DO	Dissolved oxygen
DRGS	Direct read-out ground station
DV	Device
EC	End of Configuration
EDIM	End Device Interface Module
EDL	Electronic Data Logger
EPROM	Electrically programmable read-only memory
EST	Eastern Standard Time
EUMSG	Engineering Units Message Formats
F	Fixed interval
F&P	Fischer and Porter
FIPS	Federal Information Processing Standards
FTR	File Transfer Request
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GOES DCS	GOES Data-Collection System
GRN	Green
h	Hour
HIF	Hydrologic Instrumentation Facility
Hz	Hertz
I/O	Input-output
ID	Identification
INC	Increment
IRAC	Interior Radio Advisory Committee
kV	Kilovolt
L	Labarge Pseudo ASCII
L&S	Leupold and Stevens
LED	Light-emitting diode
mA	Milliampere
MAN	Manual
MCM	Master Control Module
mg/L	Milligrams per Liter
MHz	Megahertz
mL	Milliliter
mm	Millimeter
MOV	Metal-oxide varistors
N/A	Not Applicable
NAWDEX	National Water Data Exchange
NEMA	National Electrical Manufacturers Association
NESDIS	National Environmental Satellite Data and Information Service
NWS	National Weather Service
PAR	Parameter Command
PASS	Platform Assignment Scheduling Subsystem
PC	Personal Computer

PDF	Platform data file
PFC	Personal field computer
PIC	Precision Industrial Components
PP	Print Processor
PROCOMM	Program connecting PC to Prime
PUR	Purple
QMSBSL	Node Name--Headquarters Unit, Mississippi, Bay St. Louis
QU	Dissemination Queue
QVARSB	Node Name--Headquarters Unit, Virginia, Reston, B-System
RAM	Random-access memory
RAMDSK	RAM disk
RD	Random channels
RF	Radio Frequency or reflective
ROM	Read-only memory
RR	Random Reporting
RS-232C	The Electronics Industry Association's (EIA) recommended standard, defining the electrical characteristics and physical specifications for serial transmission.
s	Seconds
S	Siemens
S	Sensor field descriptions
SATIN	Satellite and Telemetry Input System
SATLOC	Satellite Locator Program
SD	Site Device
SDF	Site Device File
SF	Script Files
SI	Site Information
SPOTS	Standard Programming of Telemetry Sytems
SPOTSB	Version of SPOTS for the Tandy by Traveling Softwares, Inc.
SPOTSR	Version of SPOTS for the Tandy by NODEINE
SS	Site Sensor Parameters
SST	Solid State Timer
ST	Self-Timed
ST	Standard
T	Time field descriptions
TEL	Telemetry
TI	Time interval
TNC	Time of Next Collection
TT	Transmission Time
UHF	Ultra high frequency
UNIX	Computer operating system
UTC	Universal Time, Coordinated
v	volt
V	Variable interval
VHF	Very high frequency
Vp	Velocity of propagation
WATSTORE	National Water Data Storage and Retrieval System
WHT	White
WRD	Water Resources Division
YEL	Yellow

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ABSTRACT

The Geostationary Operational Environmental Satellite (GOES) data-collection system allows data transmission from locations on Earth to a geostationary satellite, which retransmits the data to a direct read-out ground station. Two satellites, each with 266 channels, are located over the equator at an altitude of approximately 23,500 miles. A remote data-collection platform telemeters data to the direct read-out ground station through GOES. A data-collection platform collects data from sensors, converts these data to engineering units, stores the data, and transmits data at predetermined intervals. The direct read-out ground stations receive, format, and transfer data to the collecting offices through the U.S. Geological Survey's Distributed Information System. Computer programs assist the Survey's Data Relay Office in assigning and scheduling data-collection platform use and help the user in setting up data-collection platforms, formatting data from direct read-out ground stations, and automatic monitoring of the system.

INTRODUCTION

The Geostationary Operational Environmental Satellite data-collection system (DCS) allows data transmission from locations on Earth to a geostationary satellite, which retransmits the data to a direct read-out ground station (DRGS). Two GOES satellites, each with 266 channels, are located over the equator at an altitude of approximately 23,500 miles. The eastern satellite uses only odd-numbered channels, and the western satellite uses only even-numbered channels. Each satellite contains two channel types: self-timed and random.

Self-timed channels require data collection and storage in a data-collection platform (DCP). Data are transmitted at an assigned time. The interval between transmissions usually is 4 hours; however, some stations transmit at 1-, 2-, 3-, and 6-hour intervals. The available time to make each transmission is 1 minute at a data-transmission rate of 100 bits per second.

Random channels allow transmissions at some random interval after each data-acquisition cycle (data collected from the sensor). The time period in which the random transmission is made is usually the same length as the data-acquisition cycle.

All models of DCP's covered in this report, except the LaBarge Convertible Data Collection Platform (CDCP), use both types of channels. The U.S. Geological Survey (USGS) uses self-timed channels to relay routine data and the random channels to relay alert data (data that are above or below threshold limits programmed into the DCP by the user); however, the random channels can receive routine data. Operators may program DCP's to make the more frequent random transmissions when the DCP detects a preprogrammed parameter threshold or rate of change; this allows more frequent data acquisition when streams are flooding. The operator may program DCP's to extend messages to include previously transmitted data, thus preventing loss of data due to loss of a single transmission.

Data transmissions from GOES are received by a direct-readout ground station (DRGS) and subsequently transferred to U.S. Geological Survey offices for processing. Several programs used in these offices to assimilate the collected data into usable form are described in this report. Steps in data gathering and some of the programs used in processing the data are illustrated in figure 1.

The Platform Assignment Scheduling Subsystem (PASS) program is used to schedule data collection platform (DCP) transmissions and to schedule message reception by each DRGS. This program can also be used to modify existing transmission schedules.

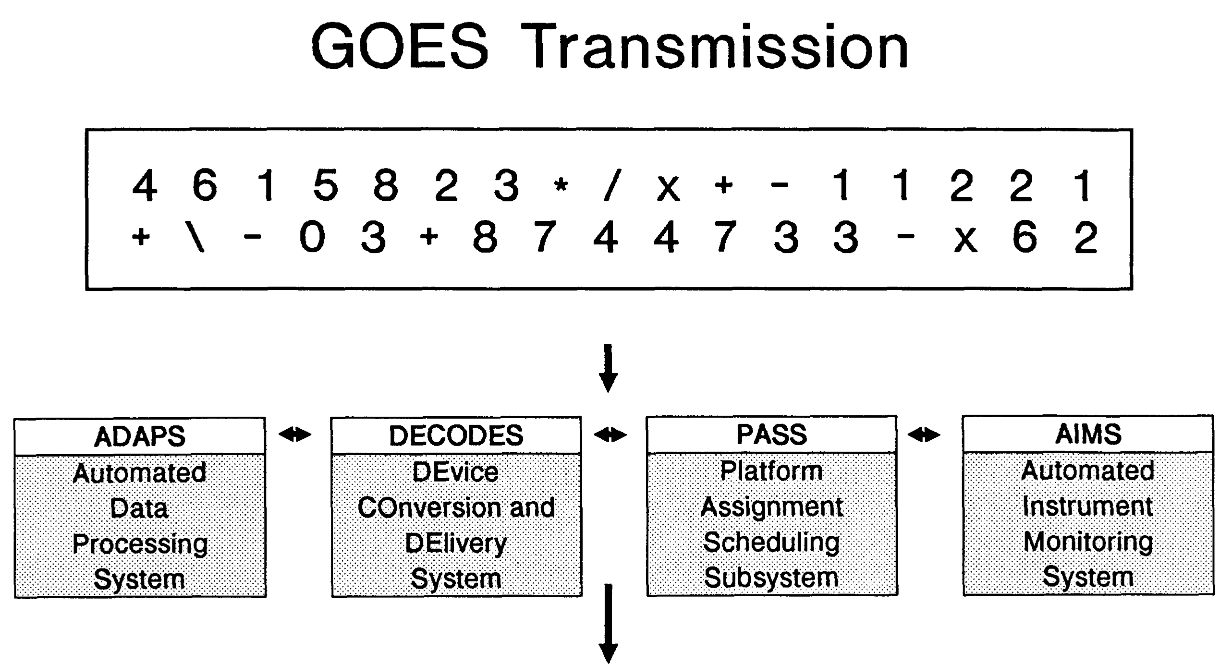
The U.S. Geological Survey-operated DRGS's receive, check, and distribute satellite-telemetered data. The Distributed Information System (DIS) is used to transfer data received by a DRGS to the appropriate user district. Data received on the host district's PRIME computer are loaded into the Automated Data Processing System (ADAPS) unit-value data base.

Data, from several types of recording devices, are converted through the Device Conversion and Delivery System (DECODES) to a standard data format for ADAPS entry.

This operating manual replaces U.S. Geological Survey Open-File Report 86-479, *GOES data-collection system instrumentation, installation and maintenance manual*, by John W. H. Blee, H. E. Herlong, C. D. Kauffman, Jr., J. Hardee, M. L. Field, and R. F. Middelburg, Jr. Two new chapters in this report are Standard Programming of Telemetry System and Satellite Locator Program. Standard programming of telemetry systems reduces the amount of equipment the field person requires to service multiple makes of DCP's. The satellite locator program provides bearing and elevation information to assist in aiming the DCP antenna.

Purpose and Scope

This manual assists the user in the installation, operation, and maintenance of the Survey's GOES data-collection system. The manual supplements the manufacturers' manuals for the DCP's and other components of the system. No recommendations are made as to the best instrument system for any given application. The information provided assists managers and users in the selection and operation of equipment that best meets the requirements of a particular site.



DISCHARGE, IN CUBIC FEET PER SECOND
WATER YEAR OCTOBER 1987 TO SEPTEMBER 1988
MEAN VALUES

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	246	276	290	246	276	290	246	276	290	246	276	290
2	243	253	270	243	253	270	243	253	270	243	253	270
3	240	243	311	240	243	311	240	243	311	240	243	311
4	249	249	1000	249	249	1000	249	249	1000	249	249	1000
5	278	250	1890	278	250	1890	278	250	1890	278	250	1890
6	246	276	290	246	276	290	246	276	290	246	276	290
7	243	253	270	243	253	270	243	253	270	243	253	270
8	240	243	311	240	243	311	240	243	311	240	243	311
9	249	249	1000	249	249	1000	249	249	1000	249	249	1000
10	278	250	1890	278	250	1890	278	250	1890	278	250	1890

Figure 1.--Data gathering and processing in the Survey's data-collection system.

Acknowledgment

The HIF wishes to acknowledge the work of the late John W. H. Blee, a U.S. Geological Survey engineering technician, for his work with the GOES data-collection system and his many hours and much effort expended in producing the original version of this operating manual.

INITIAL START-UP

The procedures listed guide the user through the beginning steps of using a DCP with GOES.

1. Contact the U.S. Geological Survey's Data-Relay Office, Branch of Instrumentation, Reston, Virginia, for user registration, which includes documentation of user identification, password, and station assignment, and for the latest instructions on the use of a DCP with GOES.

2. Acquire technical information and price lists for the DCP, solar-panels, batteries, and sensor specifications, or consider the HIF (Hydrologic Instrumentation Facility) DCP rental program. Appendix A is a list of GOES-related equipment manufacturers.

3. Design the system.

   a. For Survey stations in which equipment is to be installed, consider:

      - shelter dimensions
      - shelter construction material
      - station type (manometer or float)
      - shading (if solar panels are used)
      - equipment already installed
      - potential for vandalism and protection needed
      - accessibility
      - whether station is in line of sight of the satellite

   b. Learn how to program your particular unit by referring to manufacturer's manuals and appropriate sections of this manual.

   c. Test equipment in the office before placing it in the field. Test each item separately and then together as a unit. After testing, keep equipment together as a unit and install it as such. Equipment to be tested should include the following:

      - DCP
      - sensor(s)
      - input-output (I/O) cable
      - radio-frequency coaxial cables
      - power system
      - antenna

4. Become familiar with Platform Assignment and Scheduling Subsystems (PASS) described later in this manual in the chapter "Data-collection platform information management system."

5. Read the chapter "User instructions for receiving data-collection platform data from a direct read-out ground station" found later in this manual.

6. Study explanations and instructions given throughout this manual.

DATA-COLLECTION PLATFORMS

The three basic functions of a DCP are

- sensor interfacing,
- control of the frequencies of sensor sampling and transmissions, and
- transmission of data to the satellite.

All DCP's perform these basic functions, and some DCP's perform additional functions depending on the model and make.

Many of the Survey's first DCP's, built by LaBarge Electronics in the mid-1970's, are in operation today. Additional manufacturers have entered the DCP market. New microprocessor advancements have increased the DCP's ability to perform more complex functions. Newer DCP's can transmit on two different channels; time-tag, manipulate, and convert data; self-test; execute multiple algorithms; and communicate with computer terminals through an RS-232 interface. The following paragraphs describe the features of the DCP's currently (1991) used by the Survey.

Handar Model 524

The Handar Model 524 (fig. 2), widely used by the Survey, performs the basic DCP functions. This model makes alert random transmissions on a secondary channel. All 266 transmission channels are selectable. The Handar Model 524 does not convert data to engineering units or have different sampling intervals for different parameters. Its only data manipulation capability is averaging an input parameter over the period of the transmission interval. Manufacturer's specifications are listed in appendix B.

The Model 524 DCP's most advanced capabilities are realized only through use of its most recent firmware version. Several versions of this firmware--an electronically programmable read-only memory (EPROM) chip--exist. Contact Handar to determine if the firmware in the platform to be used is the most recent. A charge is made to exchange old firmware for the new version. The Handar Model 526 programming set was designed to program the Model 524 DCP (figs. 2 and 3). The Model 524 DCP does not have RS-232 communication capabilities; therefore, if the Model 526 programming set is not used, a special interface, developed and built by NOHOU Corp., is required. This NOHOU Model CGD256 Programming Interface Adaptor is used with an ASCII data terminal or a laptop computer equipped with the Survey's Personal Field Computer (PFC) software to program this model DCP.

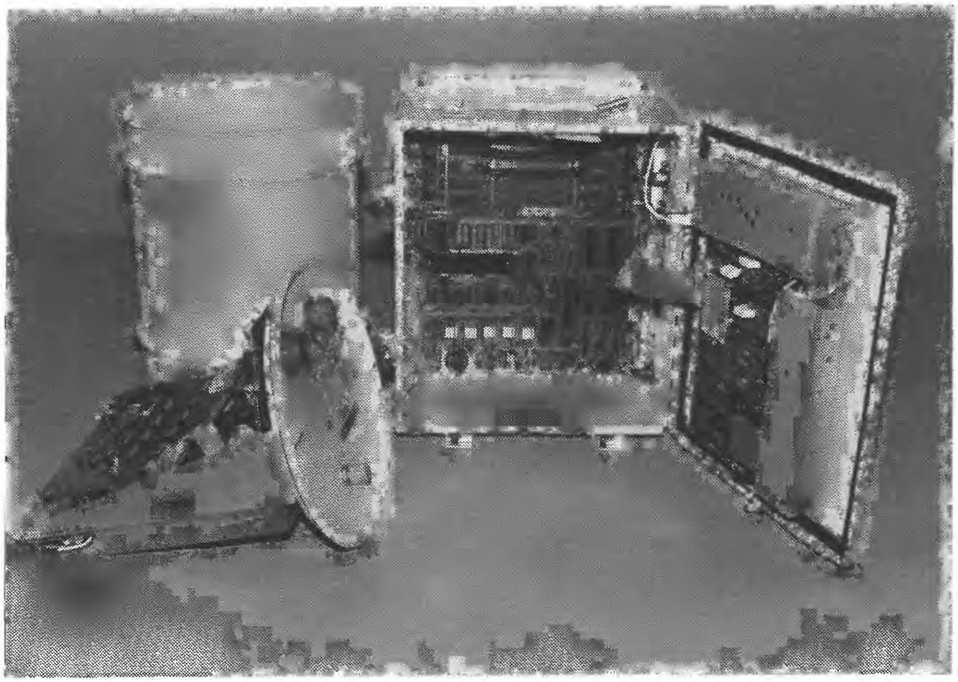


Figure 2.--Handar data-collection platforms. Left: Handar Model 524. Right: Handar Model 560.

Figure 3.--Handar programming sets. Left: Handar Model 526 for use with Model 524 data-collection platforms. Right: Handar 545A for use with Models 540 and 560 data-collection platforms.

Handar Model 540A-1

The Handar 540A-1 Data-Collection Platform is designed for collecting hydrologic and meteorologic data in severe outdoor environments where commercial power is not available. All cable connections are mated to military-type connectors and can operate over temperature ranges from -40 °C to +60 °C while exposed to weather elements. The Model 540A-1 is a microprocessor-based device that uses stored programs for an easy menu-driven setup. This DCP can be programmed with the Handar Model 545B Programming Set, an ASCII data terminal, or a laptop computer with the Survey's Personal Field Computer (PFC) software.

The Model 540A-1 DCP can be interfaced to most analog or digital hydrometeorological sensors, using a variety of plug-in interface cards. Data retrieval options include satellite, telephone, UHF/VHF radio and Random Access Memory (RAM). Any sensor used has to be interfaced to the Model 540A-1 with an optional sensor interface card. Six interface card slots are available.

Handar Model 560

The Handar Model 560, (fig. 2) a hydrologic DCP, replaced the Model 524. The Model 560, a single unit housed in a NEMA 4[1] environmental enclosure with airtight I/O connectors, can scale input data, convert raw data to engineering units, and execute several data-manipulation algorithms. Manufacturer's specifications are in appendix B.

The basic unit has an up-down counter and an interface for an incremental encoder, an event counter for a tipping-bucket rain gage, and a voltage monitoring system for the power-supply battery. An additional ADR-analog card will be needed to use analog-to-digital recorders (ADR's) or analog inputs. The ADR-analog card handles two ADR's and four analog inputs. More cards can be added for additional inputs.

The operator may program the Model 560 with a Handar 545A programming set or with an ASCII data terminal or with a laptop computer equipped with the Survey's PFC software. An optional method of programming the Model 560 is with a Tandy TRS-80 Model 100 or 102 portable computer.

Handar Model 570A

The Handar Model 570A is an integrated Expandable Data-Aquisition System, which can provide data retrieval by satellite, telephone, UHF/VHF radio, or RAM options. The Model 570, which includes a microprocessor-controller with an 8-bit analog-to-digital converter (ADC), is housed in a

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[1] National Electrical Manufacturers Association type 4 environmental enclosures are intended for indoor or outdoor use primarily as a measure of protection against water, hose-directed water, wind-blown dust and rain, splashing water, and ice.

NEMA 4 weatherproof enclosure. The Model 570A can be programmed with the Handar Model 545B programming set, an ASCII data terminal, or a laptop computer with the Survey's PFC software.

The basic 570A, with no optional interface boards, is capable of interfacing with a Handar Model 436A Incremental Shaft Encoder and a tipping-bucket rain gage. The Model 570A includes a light-emitting diode (LED) display and three switches for calibrating and monitoring the status of the incremental shaft encoder without the need of a programming set or data terminal. With this display, the last stored data can be monitored for all of the programmed channels. The user may add up to six optional cards to provide interfaces to analog sensors, Analog-to-Digital (ADR) recorders, absolute shaft encoders and additional incremental encoders, and wind-speed and wind-direction sensors. Other boards for specific sensors are available from Handar. Manufacturer's specifications are in appendix B.

Sutron Model 8004 Series

The Sutron Model 8004 is packaged in an environmentally sealed aluminum casting (fig. 4). The DCP accommodates 16 sensors and two dedicated switch-closure (tipping-bucket) inputs. The user may arrange the sensors in any mixture of analog and (or) digital inputs. The microprocessor firmware controls the data acquisition by operating sensors, collecting data, and detecting failure. The user may program the Sutron DCP with an ASCII data terminal or a laptop computer with the Survey's PFC software. The DCP transmits on any of the GOES channels in either binary or ASCII format. The Model 8004 has both self-timed and adaptive random transmission modes. Manufacturer's specifications are in appendix B.

Sutron Model 8200 Series

The Sutron Model 8200 data collection system is packaged in an environmentally protected aluminum container (fig. 5). The series consists of four versions that differ only in their capability as follows:

- A basic data logger
- A logger with telephone modem and optional speech
- A logger with GOES satellite transmitter
- A logger with external line-of-sight radio transmitter

The 8200 is specifically designed for hydrologic and meteorologic sensors. The 8200 has a range of inputs designed to support the most common data collection needs:

- Water level
- Rainfall
- Temperature/pressure
- Relative humidity
- Wind speed and direction

These measurements are supported through two shaft encoder inputs, four analog-to-digital (12-bit) inputs, one SDI-12 port, one RS-232 port, and one up-counter (tipping-bucket rain gage).

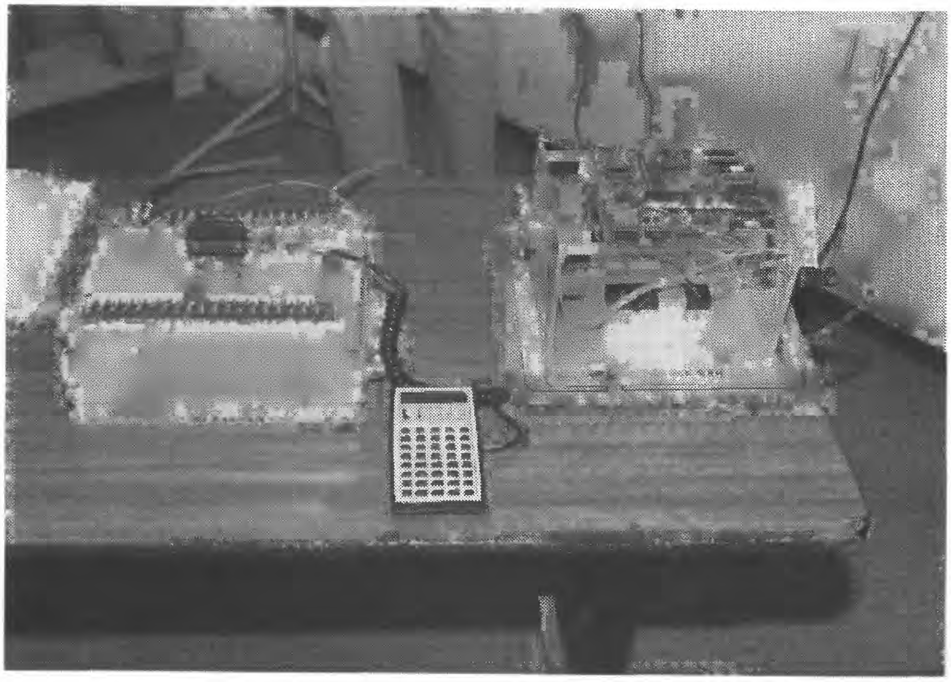


Figure 4.--Sutron 8004 data-collection platform (left), programming terminal (center), and Sutron incremental shaft encoder (right).

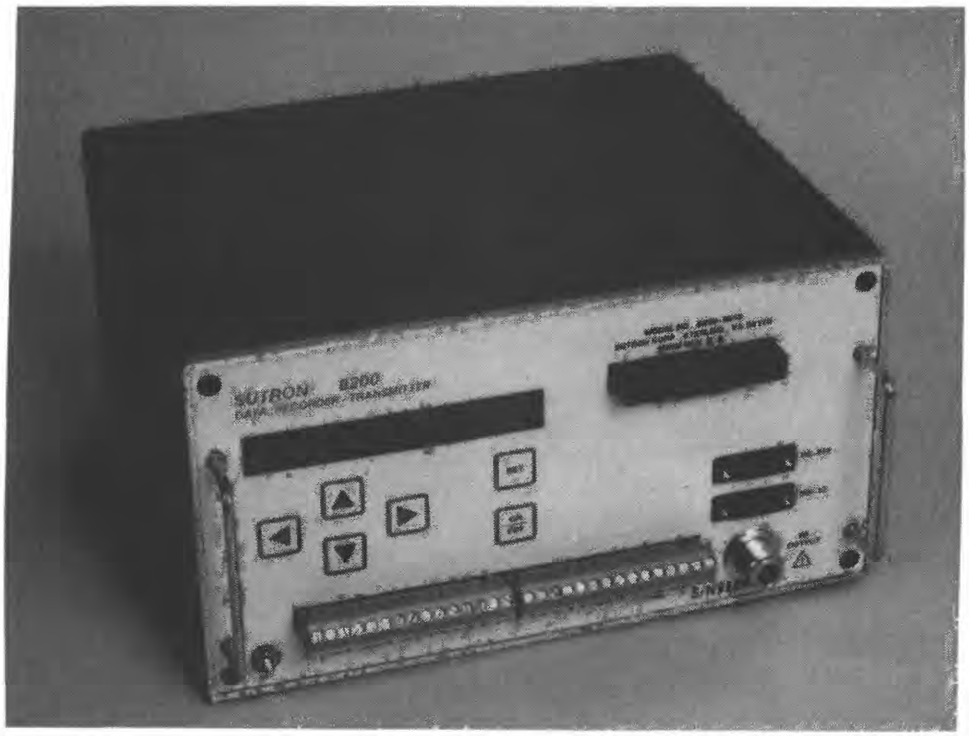


Figure 5.--Sutron Model 8200 data collection system.

Configured as a data logger, the 8200 can be fitted with up to 128K bytes of data storage (64000 data values) memory in 32K increments. Units with telemetry capability can be purchased with limited memory (32K). The memory is battery backed-up RAM for data storage, 128K of EPROM for the operating system and up to 2K of EPROM for setup information and security. The memory system uses lithium batteries for a shelf life of at least 2 years.

The 8200 is programmed by means of a sealed, touch-sensitive keypad on the front panel or, as is required for modem-equipped versions, through the serial port. The user is assisted through a setup sequence with menus displayed on the front panel. See figure 6. The 8200 can store data or setups on small RAM pack cartridges. Each cartridge holds up to 64K bytes of data or setup information. RAM packs are inserted into the RAM-pack socket, in the upper right corner of the front panel, in order to transfer data from the internal RAM to the RAM pack. The 8200 can also be programmed by a portable laptop computer through the RS-232 port.

At the time of this publication, there is no support for programming the Sutron Model 8200 with the PFC or SPOTS software on the Tandy Model 100 or 102. Communications software is available from Sutron for use with external computers. This software called TS8200 must be obtained from Sutron; the request must specify either 3.5-inch or 5.25-inch floppy disks and required density. The TS8200 provides full screen displays of all of the sub-menus and greatly simplifies setup and data viewing.

Synergetics Model 3400 Series

The Synergetics Model 3400 series DCP is the only modularized DCP of those used by the Survey (fig. 7). The basic Model 3400 has three modules--the Master Control Module (MCM), which controls the collection, processing and transmission of data; the End Device Interface Module (EDIM), a hydrologic-sensor interface module, which interfaces sensors to the control module; and the communications module, which contains the GOES transmitter. Manufacturer's specifications are in appendix B.

The basic Model 3400 is not contained in an environmental enclosure; however, an environmental enclosure is available if needed.

The operator uses a handheld terminal or an Epson HX-20 portable computer with Up/Down Loader Software from Synergetics to program the Model 3400; however, any terminal with RS-232C output or a laptop computer with the Survey's PFC software can be used. The Epson portable computer allows platform programs to be written in the DCP, then copied on magnetic tape and later downloaded to other DCP's.

The Model 3400 does not contain firmware algorithms for data manipulation; the user defines and enters algorithms. This makes this model more complicated to put into operation but gives greater versatility in data sampling and manipulation. The basic model has one "up" counter, one "up-and-down" counter, four 16-bit digital inputs, and eight analog inputs. The basic model uses an 8-bit analog-to-digital conversion but has an optional 12-bit analog-to-digital converter.

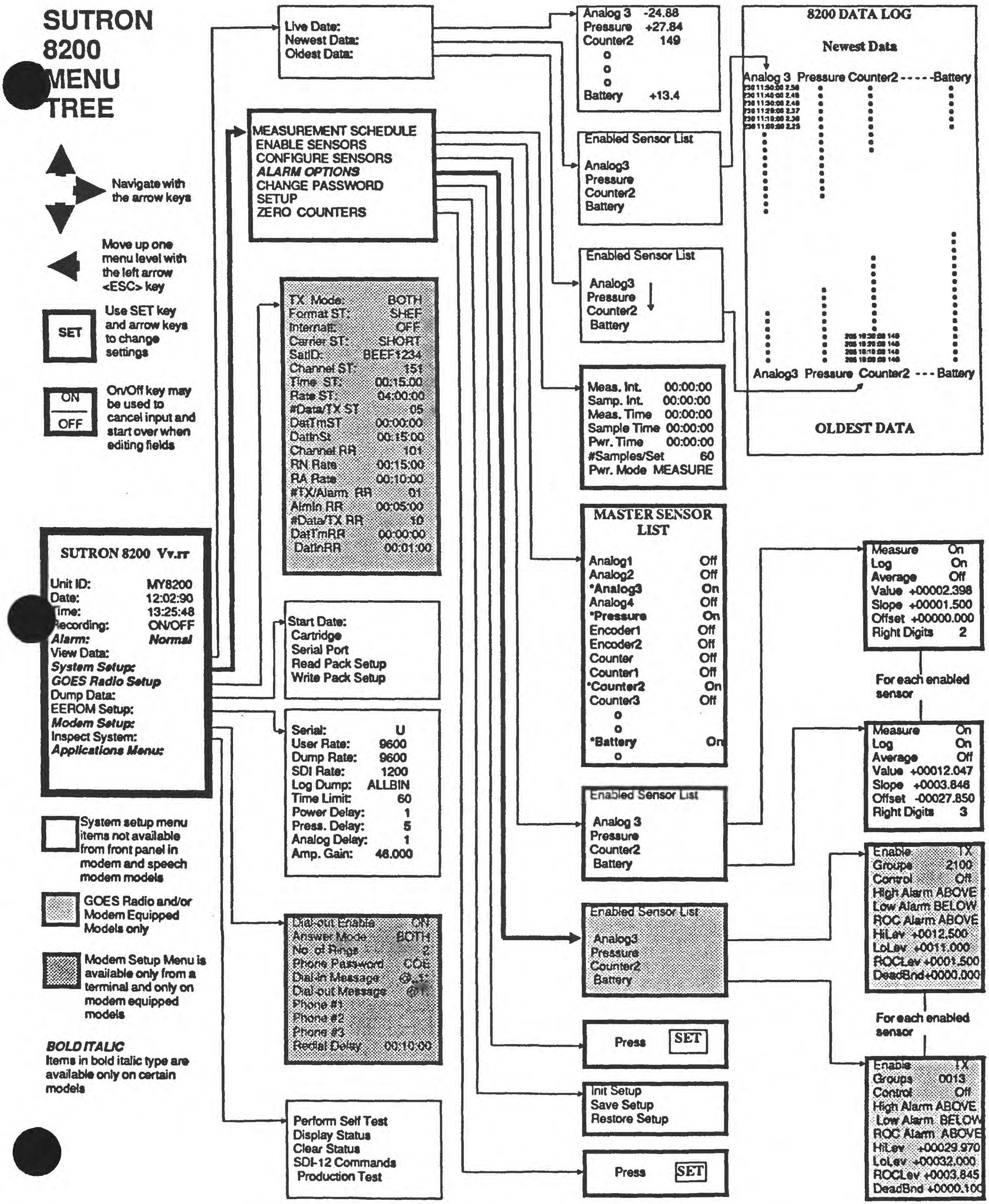


Figure 6.--Sutron 8200 menu tree. [From Sutron, 1991, p.3-5.]

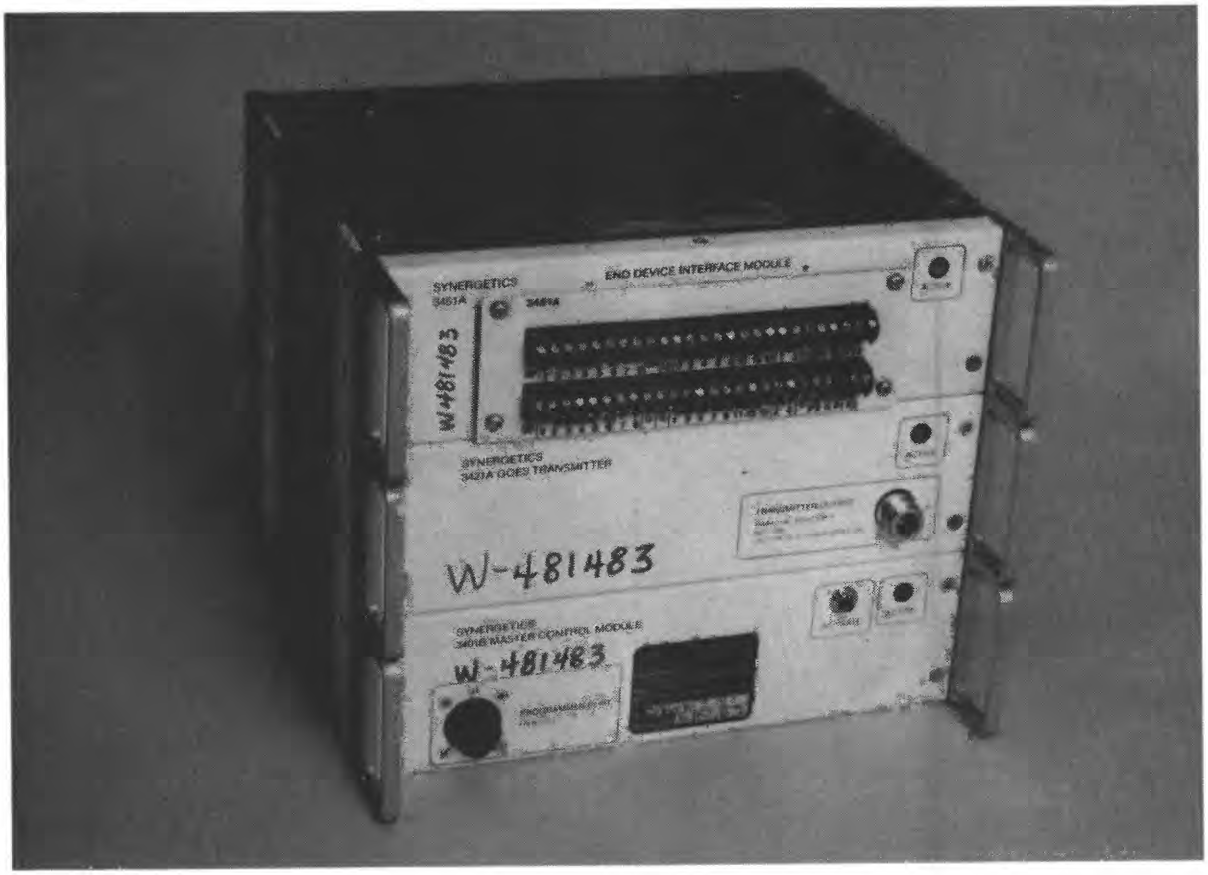


Figure 7.--Synergetics 3400 series data-collection platform.

POWER-SUPPLY SYSTEM

By Truth E. Olive

Introduction

A major element of any DCP installation is the electrical energy source necessary to power the platform and associated equipment. Much of the data gathered by the Survey are obtained during hydrologic events, often accompanied by power failures. Even when alternating current (ac) line power is available, batteries are used because of their reliability during these adverse weather conditions.

The 12-volt sealed, gelled-electrolyte, lead-acid battery is the power supply recommended for GOES DCP installations by the HIF. This battery is the backbone of the power-supply system for the instruments in the gage house. Calculating the energy requirements of the instruments in the gage house is important in guaranteeing that a constant reliable power supply will be available to the instruments. When the energy requirements are known, the battery with the ampere-hour capacity to meet these requirements can be selected and the size of the solar panel needed to keep the battery properly charged can be calculated. Alternating-current (ac) line power and solar panel are the two methods for recharging the battery. The battery can be recharged using ac line power at the gage house or at the office when the battery is used in cyclic operation. A solar panel can be used for recharging the battery at the gage house if adequate sunlight is available. Use of a proper charging system is important to ensure long, reliable service from the battery. A lightning-protection system helps ensure uninterrupted data collection and helps minimize expensive repairs due to lightning damage. The ac power line, telephone line, sensor lines, and DCP antenna cable need lightning-protection devices. A low-resistance earth ground is the foundation of the lightning-protection system. Routine maintenance and troubleshooting techniques are essential to reliable data collection.

Batteries

Sealed, Gelled-Electrolyte, Lead-Acid Batteries

Rechargeable sealed, gelled-electrolyte, lead-acid batteries are recommended by the HIF as the power supply for USGS gage-house instruments. (Kirk V. Sharp, Wayne B. Higgins, William P. Bartlett, Jr., U.S. Geological Survey, written commun., 1983). Presently (1991), the USGS through the HIF has a battery contract with Power-Sonic; this contract will be in force until March of 1992. HIF plans are to maintain a contract for rechargeable sealed, gelled-electrolyte, lead-acid batteries. Although several manufacturers produce this type of battery, the characteristics of these batteries are very similar regardless of the manufacturer. Three sizes of sealed, gelled-electrolyte, lead-acid batteries are on this contract: the 8-ampere-hour, the 26-ampere-hour, and the 60-ampere-hour batteries (see fig. 8). Contact the HIF if there are questions about the battery contract or technical questions about batteries.

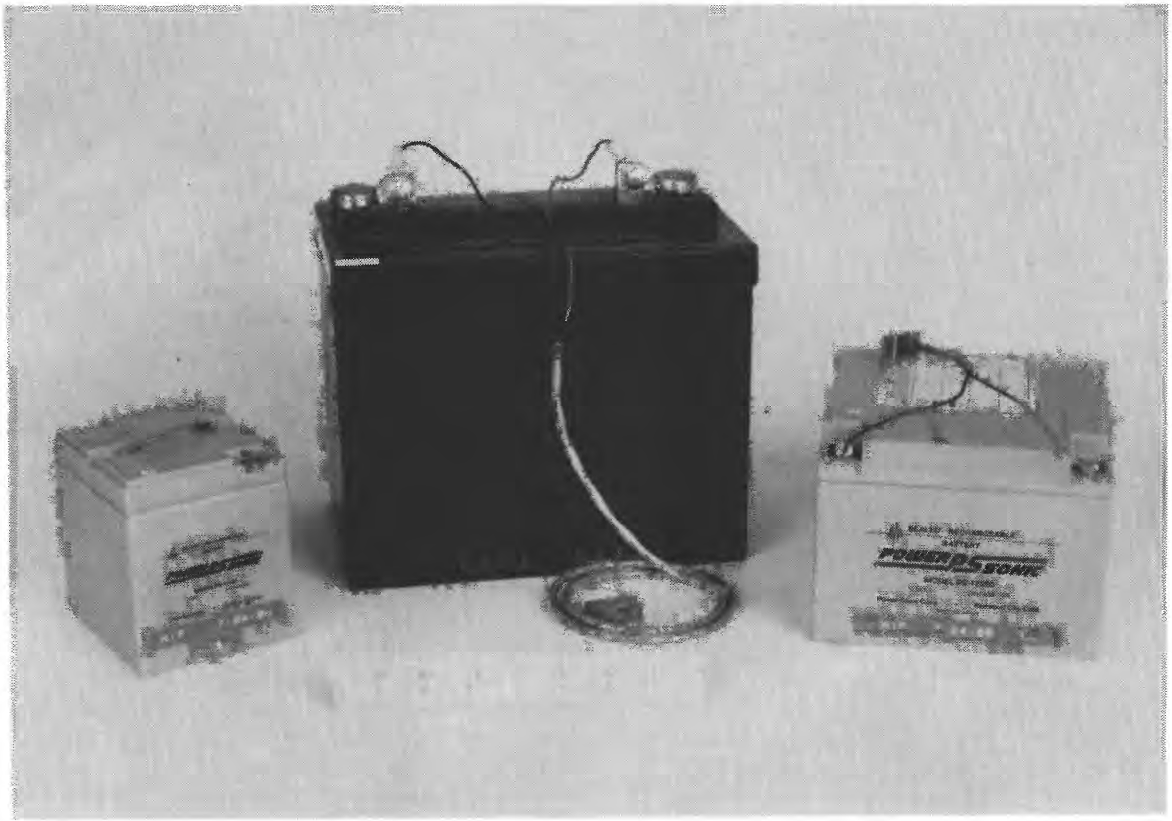


Figure 8.--Power Sonic rechargeable sealed, gelled-electrolyte, lead-acid batteries with battery wiring harness. Left to right: 8-, 60-, and 26-ampere-hour batteries with battery label on the top of the 26 ampere-hour battery.

Automobile and Motorcycle Batteries

The disadvantages of using automobile and motorcycle batteries at the DCP site are corrosion due to the emission of hydrogen and oxygen gas at the battery terminals; boiling off of the liquid electrolyte exposing the lead plates; high self-discharge rate; gas pockets collecting on the battery plates; and freezing of the electrolyte in extremely cold weather if the battery reaches a low state of charge. The automobile battery is rated in cold cranking amperes not in ampere-hour capacity as is the gelled-electrolyte battery; thus, it is difficult to compare the battery capacities. The automobile battery is designed to deliver about 300 amperes for a few seconds. It is not designed for delivering small current draws as is typical of a DCP system.

The HIF does not recommend the use of automobile batteries in gage houses for safety reasons and system reliability. The vented automobile battery is the least desirable for the application and should be avoided. The advantages of rechargeable sealed, gelled-electrolyte, lead-acid batteries outweigh the advantages of automobile and motorcycle batteries.

Advantages of Rechargeable Sealed, Gelled-Electrolyte, Lead-Acid Batteries

The rechargeable sealed, gelled-electrolyte, lead-acid battery has many advantages over other types of batteries. There is no need to add an electrolyte or water. The sealed construction prevents the generation of gases at the terminal during proper charging of the battery. These batteries, when properly cared for, are easier to handle, more economical, and have longer life than other types of batteries. The self-discharge rate is lower than for other types of batteries. The batteries will provide energy over the entire temperature range that most USGS gage houses experience. These batteries provide reliable performance for gage-house instruments. The energy requirements are low average-current demands with occasional high-current demands of the DCP transmitter, ADR, and manometer. This battery type also works well with solar panels. Having three battery sizes from which to choose affords the opportunity to use a lighter, smaller battery when a large one is not needed.

Factors Affecting the Life of a Lead-Acid Battery

Several important factors affect the life of all lead-acid batteries. These are temperature, charging, rate of discharge, depth of discharge, and self-discharge rate (also known as shelf life). The specifics listed below are related to the manner in which they affect rechargeable sealed, gelled-electrolyte, lead-acid batteries.

The ideal temperature for storage and operation of sealed, gelled-electrolyte, lead-acid batteries is 20 °C (68 °F). At this temperature, the expected life of these batteries is 4 years and their rated capacity is 100 percent. In northern latitudes with proper charging and discharging, these batteries will last 4 to 5 years. In the desert, these batteries will last from 3 to 4 years due to the life-shortening effect of temperatures of 60 °C (140 °F) or higher. Battery life is cut in half for each 10 °C (18 °F) above 20 °C (68 °F). Batteries in temperatures above 20 °C (68 °F) have greater capacity but shorter life. The opposite is also true. At -40 °C (-40 °F), the battery's available capacity is 50 percent of its rated capacity. An 8-ampere-hour battery has an available capacity of about 4 ampere-hours at -40 °C (-40 °F), and at -20 °C (-4 °F) it has about a 5.4-ampere-hour available capacity. At -40 °C (-40 °F), the battery electrolyte freezes when the indicated voltage of the battery gets to about 12.00 volts. Refer to table 3 and figure 10 in the section "Influence of temperature on available battery capacity."

Both overcharging and undercharging a battery will shorten its life. The best way to charge a battery properly is to use a temperature-compensated, dual-rate, constant-voltage charger designed for the ampere-hour capacity of the battery. The USGS charger/regulator will charge an 8-to-20-ampere-hour battery. Refer to section "USGS regulators for solar panel and alternating current charging systems for data collection platforms" for more information. Multiple chargers are commercially available, but the user has to be careful that these meet the charging requirements of the particular battery that is being used. For site charging, a solar panel or ac charger needs a temperature-compensated regulator to charge the battery properly.

A low-current, pulsed rate of discharge, such as in most USGS applications, prolongs the life of the battery. Limiting depth of discharge to 12.15 volts, which is 50 percent of capacity, prolongs the battery life. The self-discharge rate of this battery is such that it should not be stored unused for more than 6 months without recharging.

Power Requirement of Equipment

The power supply for a DCP installation needs to be designed carefully. The design has to ensure that the system has the capacity to remain operational between routine field visits. A number of elements have to be considered--amount of power used by the equipment, ambient temperatures, available sunlight if solar panels are used, cost, potential for vandalism, and time between routine visits to the site.

Power is calculated as voltage multiplied by current. Voltage (electromotive force) is the potential needed to drive the electrical current through the circuit (wiring). The current is the energy needed to operate the instruments. The relation between voltage and current can be compared to a water faucet and hose, except that the electrical circuit has to form a closed loop. The voltage is like the water pressure and the current is like the water in the hose. When the faucet is opened, the water flows; likewise, when voltage is applied, the current flows through the closed circuit.

To provide dependable, trouble-free electrical power to the DCP instrument system, the ampere-hour-per-day energy requirements of the load, the ampere-hour capacity reserve of the battery, and ampere-hour-per-day energy provided by the battery charging system must be calculated.

Calculating Energy Requirements

Power requirements for an instrument system can be expressed in terms of the system's energy requirements in ampere-hours per day. An instrument's energy requirement can be determined by the amount of electrical current an instrument needs and the length of time that the instrument is operating. Defining instrument energy requirements in ampere-hours per day makes it easy to match the total current requirements with average daily charging currents available from a solar panel or ac power line charger for on-site charging systems. When the total energy requirements are known, the battery with the ampere-hour capacity and the solar panel or ac power line charger with the charging capabilities to meet these requirements can be selected.

The total energy requirement per day that the DCP instrument system needs is the sum of the energy needed by different DCP components. In the following example, these components are the transmitter, the interface boards, the master controller, sensors, and recording devices that are connected to the battery. The electrical current needed by the instrument multiplied by the length of time that the instrument is on equals the energy requirement of the instrument. This product multiplied by 24 hours per day gives the ampere-hour per day energy requirement of the instrument.

The following is an example of the calculation of the energy needed per day for a Synergetics Series 3400 DCP consisting of master control module (MCM), end device interface module (EDIM), and GOES transmitter. In this example, the DCP takes a reading every 15 minutes from a tipping-bucket rain gage and shaft encoder, which is recording stage from a Leupold and Stevens (L&S) Model 7000 with Module A Analog-to-Digital Recorder (ADR) with a USGS Solid-State Timer (SST) Model III.

The length of time that the instrument is on in a 24-hour period is a ratio of how long it is on in a time interval divided by the length of the time interval. The "time on" divided by "interval" is a ratio; thus, both need to be expressed in the same units of time. For example, if a DCP transmitter takes 40 seconds to transmit data and transmits every 4 hours, the "time on" is 40 seconds and the "interval" is 4 hours. There are 3,600 seconds per hour. To express "time on" and "interval" as a ratio in the same units of time, multiply the 4 hours by 3,600 seconds. The ratio of "time on" per "interval" is 1 for an instrument that is on continuously. Using equation 1, compute the energy requirement of each component as follows:

$$(\text{Current in amperes}) \left(\frac{\text{time on in seconds}}{\text{interval in seconds}}\right) \left(24\ \frac{\text{hours}}{\text{day}}\right) = \frac{\text{ampere-hours}}{\text{day}} \tag{1}$$

The L&S ADR requires 0.420 amperes for 13 to 15 seconds.

- Energy for the L&S ADR Model 7000 with module A

$$(0.420\ \text{amperes}) \left(\frac{15\ \text{seconds}}{15\ \text{minutes}}\right) \left(\frac{1\ \text{minute}}{60\ \text{seconds}}\right) \left(24\ \frac{\text{hours}}{\text{day}}\right) = 0.168\ \frac{\text{ampere-hours}}{\text{day}} \tag{2}$$

The SST-III requires 0.3 milliamperes (0.0003 amperes) and is on continuously.

- Energy for the SST-III timer

$$(0.0003\ \text{amperes})(1) \left(24\ \frac{\text{hours}}{\text{day}}\right) = 0.0072\ \frac{\text{ampere-hours}}{\text{day}} \tag{3}$$

The shaft encoder is on continuously and requires less than 0.5 milliamperes (0.0005 amperes).

- Energy for the shaft encoder

$$(0.0005\ \text{amperes})(1) \left(24\ \frac{\text{hours}}{\text{day}}\right) = 0.012\ \frac{\text{ampere-hours}}{\text{day}} \tag{4}$$

The tipping-bucket rain gage requires 0.1 milliamperes (0.0001 amperes)and is on continuously.

- Energy for tipping-bucket rain gage

$$(0.0001)\ (1)\ \left(\frac{24 \text{ hours}}{\text{day}}\right) = 0.0024\ \frac{\text{ampere-hours}}{\text{day}} \tag{5}$$

The master control module (MCM) quiescent (sleep) current is 9 milliamperes (0.009 amperes).

- Quiescent energy for the MCM is

$$(0.009 \text{ amperes})\left(\frac{14 \text{ min } 57 \text{ sec}}{15 \text{ minutes}}\right)\left(\frac{1 \text{ minute}}{60 \text{ seconds}}\right)\left(\frac{24 \text{ hours}}{\text{day}}\right) = 0.2153\ \frac{\text{ampere-hours}}{\text{day}}$$

$$(\underline{.009 \text{ amperes}})\ \left(\frac{897 \text{ sec}}{900 \text{ sec}}\right)\left(\frac{24 \text{ hours}}{\text{day}}\right) = 0.2153\ \frac{\text{ampere-hour}}{\text{day}} \tag{6}$$

When active, the MCM plus EDIM requires 270 milliamperes (0.270 amperes). It takes less than 3 seconds every 15 minutes for the DCP to collect data from the tipping-bucket rain gage and shaft encoder.

- Awake energy for EDIM and MCM is

$$(0.270 \text{ amperes})\left(\frac{3 \text{ seconds}}{15 \text{ minutes}}\right)\left(\frac{1 \text{ minute}}{60 \text{ seconds}}\right)\left(\frac{24 \text{ hours}}{\text{day}}\right) = 0.0216\ \frac{\text{ampere-hours}}{\text{day}} \tag{7}$$

The transmitter requires less than 3 amperes. The transmitter is on for less than 40 seconds. The transmission interval is every 4 hours.

- Energy for transmitter is

$$(3 \text{ amperes})\ \left(\frac{40 \text{ seconds}}{4 \text{ hours}}\right)\left(\frac{1 \text{ hour}}{3600 \text{ seconds}}\right)\left(\frac{24 \text{ hours}}{\text{day}}\right) = 0.200\ \frac{\text{ampere-hours}}{\text{day}} \tag{8}$$

The sum of all these energy requirements is the energy that the example DCP system needs per day as follows:

$$0.168 + 0.0072 + 0.012 + 0.0024 + 0.2153 + 0.0216 + 0.200 = 0.6265\ \frac{\text{ampere-hours}}{\text{day}}\ ($$

The total energy requirement is 0.6265 ampere-hours per day for a 15-minute recording interval and a 4-hour DCP transmission interval. The total energy requirement for a 30-minute recording interval and a 4-hour DCP transmission interval is 0.424 ampere-hours per day. Comparing the total energy requirement for a 15-minute recording interval of 0.6265 ampere-hours per day with the total energy requirement for a 30-minute recording interval of 0.424 ampere-hours per day shows that the energy requirement for the 30-minute recording interval is NOT half the energy requirement for a 15-minute recording interval.

This procedure can be used to calculate the energy requirement of any combination of DCP instrument components. Consult the manufacturer's manual for the particular DCP and instruments being used to find the current requirement and on-time for each instrument. Instrument current requirements and on-times are presented in table 1.

Table 1.--*Instrument current requirements and on-times*

Instrument	Current (amperes)	On-time per interval (seconds)
Manometer Miniservo Control[1]	0.0003	continuous
Solid State Timer III	0.0003	continuous
L&S ADR Model 7000 with Module A	0.420	13 to 15
F&P ADR Model 1542 with telemetry kit	0.060	13 to 15
USGS Minimonitor quiescent (standby)	0.000250	continuous
L&S Input-Output Recorder	1.300	0.75
Signal conditioner		
temperature and specific conductance	0.100	20
temperature, specific conductance, and pH	0.110	20

[1] Refer to HIF operating manual "Rechargeable 12-volt power system: Implementation guide" for detailed instruction on calculating power requirements for sites with manometers. (Sharp and others, 1983, p. 24-27, 2-4.)

The minimonitor energy consumption is less than 1 ampere-hour per month at a 1-hour recording interval with temperature and specific conductance. See revised minimonitor operating manuals--Open-File Report 88-491, "Operating manual for the USGS minimonitor, 1988 revised edition, punched-paper-tape model" (Ficken and Scott, 1988, p. 4) and Open-File Report 89-403, "Operating manual for the USGS minimonitor, 1988 revised edition, analog-voltage model" (Ficken and Scott, 1988, p. 4).

Battery Capacity

The capacity, or size, of a battery is measured in ampere-hours. Capacity is the amount of electrical energy available from a fully charged battery. For example, an 8-ampere-hour battery will supply a steady 400 milliamperes for 20 hours. This is the battery capacity at the 20-hour rate. The ampere-hour capacity of the battery diminishes with time and is determined by the discharge rate, which is dependent upon current load and the battery temperature.

Relation between battery open-circuit voltage and remaining capacity

The open-circuit voltage of rechargeable sealed, gelled-electrolyte, lead-acid batteries varies with surrounding temperature and remaining capacity (state of charge). The battery open-circuit voltage is measured across the battery terminals when only the voltmeter is connected to the battery. It is possible to determine the approximate remaining capacity of the battery from the open-circuit voltage. The open-circuit voltage of a Power Sonic battery is approximately 12.9 volts when fully charged and approximately 11.5 volts when completely discharged. The following graph depicts this general relation (fig. 9). The shaded area depicts the range of open circuit terminal voltage. Table 2 gives the approximate percentage of remaining capacity in relation to battery open-circuit voltage as represented by the bottom line of the shaded area in figure 9. (See section on measuring voltage and measuring current.)

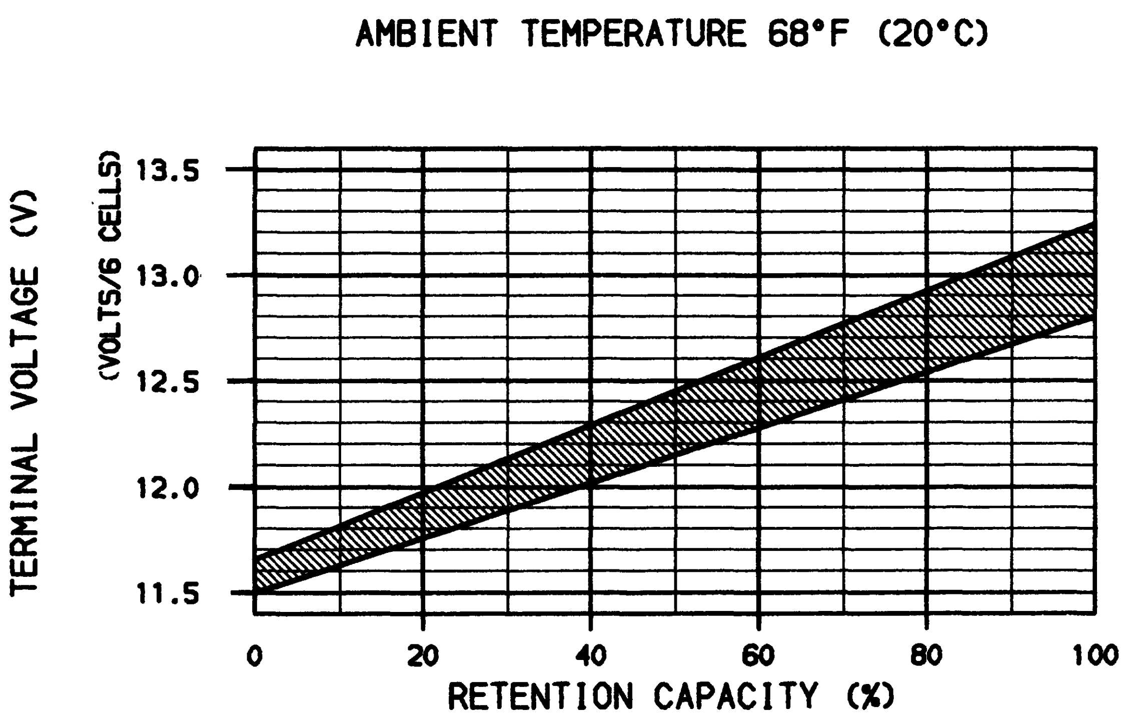


Figure 9.--Relation between battery open-circuit voltage and remaining capacity for Power Sonic batteries.

Table 2.--*Estimate of open-circuit voltage as a function of remaining capacity*

Voltage (open-circuit)	Remaining capacity (percent)
12.80	100
12.60	90
12.55	80
12.40	70
12.30	60
12.15	50
12.00	40
11.90	30
11.75	20
11.60	10

Influence of temperature on available battery capacity

When the ampere-hour-per-day load requirement and the location of the DCP site are known, the size of the battery and solar panel can be determined. Temperature affects the available capacity of the battery. Cold winter temperatures reduce the available capacity of the battery. At -40 degrees Fahrenheit (^{0}F) the available capacity is about 50 percent. Extending the graph in figure 10 to -40 ^{0}F also shows this relation and the 0.05 X C AMPS current usage curve best represents the energy requirements of the typical gage house. See table 3 for approximate available capacity corresponding to temperature. This table indicates approximate capacity percentages taken from figure 10.

Table 3.--*Estimate of available battery capacity with temperature change*

Temperature, in Degrees Celsius	Temperature, in Degrees Fahrenheit	Percent capacity
40	104	105
30	86	102
20	68	100
10	50	92
0	32	85
-10	14	75
-20	-4	68
-30	-22	60
-40	-40	50

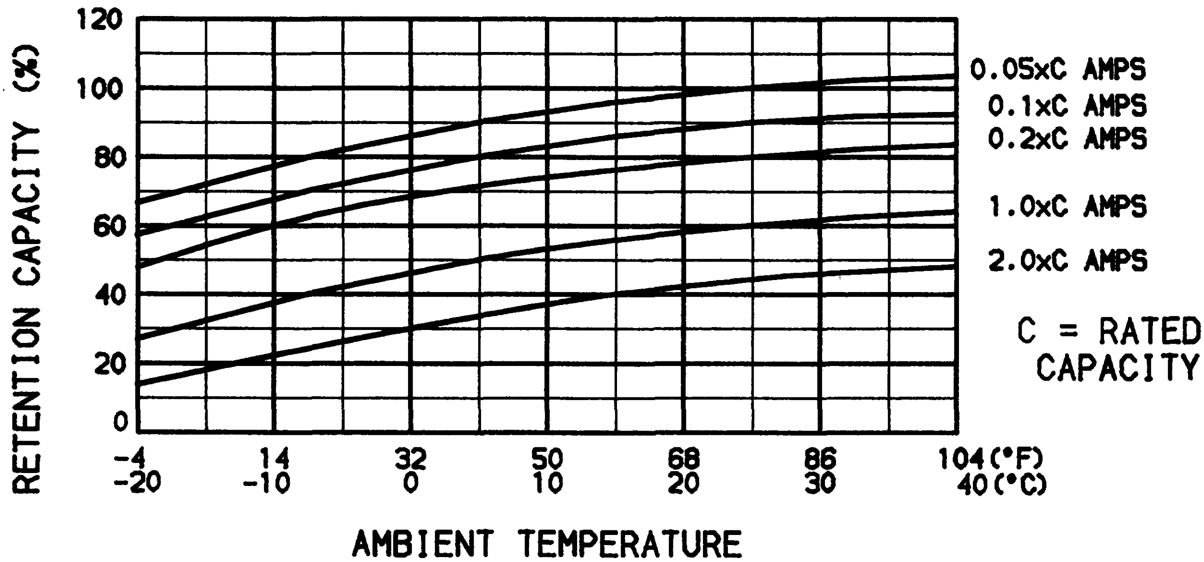


Figure 10.--The effects of temperature on available battery capacity for Power Sonic batteries.

Battery-Charging Systems and Required Capacities

A battery charging system may be divided into three elements: battery, charging power source, and regulator. The battery's state of charge may be maintained on-site by using a solar panel or ac line power as the source of charging power, or the battery may be taken off-site and charged at another location, using ac power. Removing the battery from the site and charging it at another location is referred to as cyclic charging. On-site charging is more convenient but is not always practical or possible. Figure 11 shows on-site charging using a solar panel. When cyclic charging is used, the battery is replaced as the open circuit voltage of the battery reaches 12.15 volts. Refer to the maintenance and troubleshooting section for further information.

On-site battery charging reduces the number of batteries that need to be carried back and forth from the gage houses. It eliminates the need at the office or shop for a charging system large enough to handle all of these batteries. It also simplifies keeping track of where, when, and how the batteries were used.

Cyclic Charging

In cyclic charging, the battery is exchanged periodically because the station has no ac power or solar panel to recharge the battery. The battery is taken back to the office or shop and recharged there. The ampere-hour-per-day energy requirement of the DCP and sensors, the number of days between station visits, and the lowest air temperature are the data needed to determine the ampere-hour capacity of the battery. Using only 50 percent of the battery capacity before recharging prolongs its life. Fifty percent

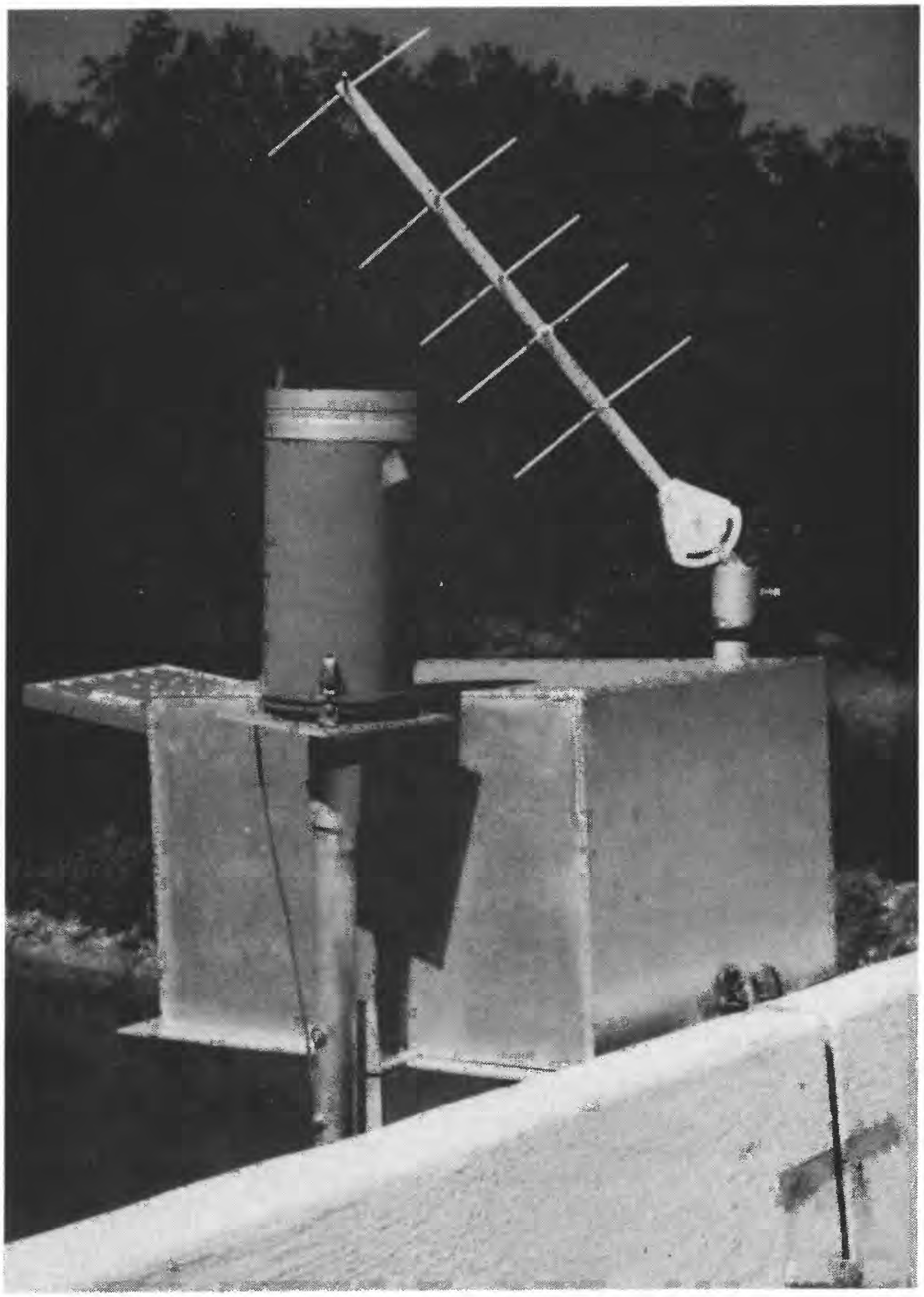


Figure 11.--Bridge-mounted gage house with solar panel, data-collection platform antenna, and tipping-bucket rain gage.

of capacity of a rechargeable sealed, gelled-electrolyte, lead-acid battery has been reached when the open-circuit voltage is approximately 12.15 volts. The battery ampere-hour capacity needed is determined by twice the total system energy requirements in ampere-hours per day multiplied by the number of days between visits divided by percent capacity available due to temperature. See table 3. The calculation is made as follows:

$$\frac{2\begin{bmatrix}\text{total system}\\ \text{energy requirement,}\\ \text{ampere-hours per day}\end{bmatrix}\begin{bmatrix}\text{number of days}\\ \text{between visits}\end{bmatrix}}{\begin{bmatrix}\text{percent capacity}\\ \text{available due to}\\ \text{temperature}\end{bmatrix}} \qquad (10)$$

Example:

Determine the ampere-hour capacity of the battery needed for a DCP instrument system during winter conditions. For this example, the energy requirement is 0.125 ampere-hours per day with 42 days (6 weeks) between visits. Because the lowest winter temperature will be -30 ^{o}C, (-22 ^{o}F), only 60 percent (0.60) of the battery capacity is available. (See table 3 and fig. 10.)

$$\frac{2\left[0.125\ \frac{\text{ampere-hour}}{\text{day}}\right](42\ \text{days})}{(0.60)} = 17.5 \text{ ampere-hour battery} \qquad (11)$$

For this example, a standard 26 ampere-hour battery would safely provide the required energy for 6 weeks.

Charging the Battery at the DCP Field Site

Calculating the capacity of the battery when using the gaging-station charging system, either ac or solar panel, is the same as calculating the battery capacity needed in cyclic charging explained in the previous section. The only difference is the number of days of reserve energy required from the battery. For an on-site charging system, a 14-day reserve is usually adequate. To calculate the capacity, replace the "number of days between visits" with 14 days in equation 10.

Solar Panels and Regulators

The HIF has a temperature-compensated regulator (fig. 12) available through the catalog--stock No. 5305007. The regulator can be used with a 5-watt solar panel. At sites that have 120-volt ac power, this regulator can be used with the ac-to-dc transformer that can also be obtained from the HIF. The advantage of this regulator is that it is repairable by the HIF. The USGS regulator operating manual 7-84-04 can also be ordered from the

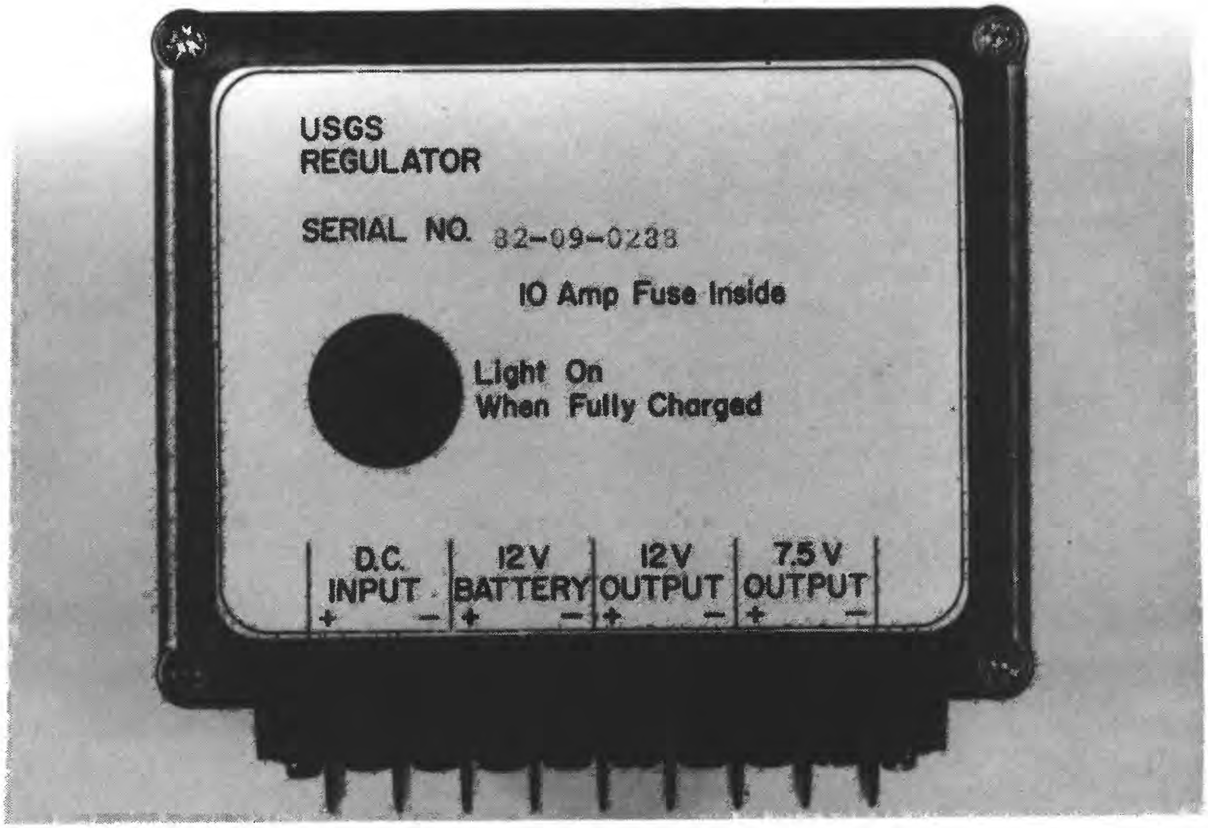


Figure 12.--USGS regulator.

HIF. This manual gives a full description of the regulator and describes installation, calibration, and test procedures.

The USGS regulator has an automatic temperature compensation that is preset at the HIF before shipment. Input voltage can be either 120-volt ac through the USGS ac charger or up to 25-volt dc from a solar panel.

Maximum current input to the USGS regulator is 0.50 amperes. Solar panels ranging from 0.5 to 5 watts can be used with this regulator. A larger solar panel will have more current output than this regulator can handle. With a larger solar panel and the battery less than fully charged, the regulator fuse will blow and the regulator circuitry may also be damaged. The newer model USGS regulator, as shown in figure 12, has diode protection so that the solar panel will not drain the battery at night. The battery supplies the energy needed during transmission and during the night. The regulator has terminal connections for a 12-volt, 5-to-20-ampere-hour, rechargeable sealed, gelled-electrolyte, lead-acid battery. Its output is 12-volts dc to load through an internal 10-ampere fuse. It will supply an average load capacity of 100-milliamperes with the USGS 120-volt ac charger. The regulator has a standby current draw of 1.1 milliamperes. The battery, solar panel, and USGS regulator can supply a short-term current draw of as much as 10 amperes, as long as the average is 100 milliamperes. This is equal to an instrument energy requirement of 2.4 ampere-hours per day or 72 ampere-hours per month.

Calculating Size of Solar Panel

Typical solar-panel currents to the load at peak power are listed for common sizes of solar panels.

Watts	Amperes
5	0.26 to 0.30
7.5	0.47 to 0.50
10	0.57 to 0.60
20	1.12 to 1.20

The load energy requirement, calculated as described in the section titled "Introduction to calculating battery capacity needed," in ampere-hours per day, divided by winter peak sun hours, estimated from figure 13, equals the solar panel peak amperes. The total daily sunlight energy converted to an equivalent number of hours of peak sunlight is shown in figure 13. After obtaining the solar panel peak amperes from the chart above, the size of the solar panel needed for a location can be determined. For example, assuming that the load requirement is 0.5 ampere-hour per day and that the site location is Denver, Colorado, for which figure 13 indicates an estimate of winter peak sun hours to be 4.5,

$$\frac{\left(0.5 \text{ ampere } \frac{\text{hours}}{\text{day}}\right)}{\left(4.5 \text{ peak sun } \frac{\text{hours}}{\text{day}}\right)} = 0.11 \text{ ampere solar panel peak current.} \qquad (12)$$

The table listing solar panel size and corresponding current to load at peak power, indicates that a 5-watt solar panel supplies between 0.26 and 0.30 ampere. Therefore a 5-watt solar panel will supply the recharging energy needed.

NOTE: USGS regulator should not be used with a solar panel larger than 5 watts.

Some DCP site locations may require more than a 14-day battery reserve. Local weather records can provide this information. Solar panel manufacturers will help determine the size of battery and solar panel needed for any DCP site location when the load energy requirement is known.

Solar-Panel Regulators

The solar-panel battery system needs a temperature-compensated regulator/controller to ensure that the battery is properly charged and is prevented from overcharging. The battery capacity should be adequate to supply

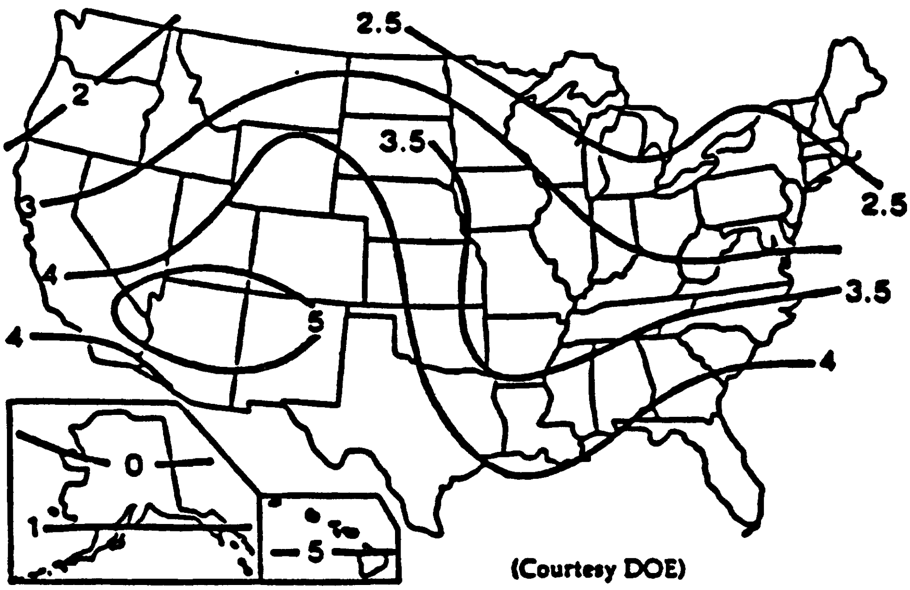


Figure 13.--Peak sun hours per day--four-week average (December 7 through January 4).

the reserve power needed when the solar panel is not at maximum efficiency during periods of cloudiness and during the long winter nights. The solar panel should be large enough that it will maintain the battery at full charge most of the time and be able to charge the battery fully after it has been used as reserve power. Features needed in a solar panel regulator are diode protection, temperature-compensated charging, and dual-rate constant-voltage-potential charging for the rechargeable sealed, gelled-electrolyte, lead-acid batteries. Refer to the section entitled "Proper charging of rechargeable sealed, gelled-electrolyte, lead-acid Power Sonic batteries" for description of dual-rate constant-voltage-potential charging.

Solar-Panel Charging Regulator Types

To protect the battery from overcharging when a solar panel is the charging source, a charging regulator is needed. There are two types of commercial solar-panel regulators. One is similar to the USGS regulator, which is a dual-rate, constant-potential, temperature-compensated regulator, and the other is a switching-shunt voltage regulator with no temperature compensation. A temperature-compensated regulator is preferred because it ensures proper charging of the battery in gage houses where the temperature is not a constant 68 °F.

A switching-shunt voltage regulator allows the current from the solar panel to flow into the battery through a blocking diode, usually lighting a "charging" indicator light. The battery voltage will slowly rise until a charge termination voltage of about 14.3 volts is reached. The voltage regulator stops charging the battery by blocking solar panel current from the battery. The regulator allows battery charging to resume when the battery voltage goes down to about 13.2 volts.

Charging of Rechargeable Sealed, Gelled-Electrolyte, Lead-Acid Power Sonic Batteries

The preferred charging method for a sealed, gelled-electrolyte, lead-acid battery is dual-rate constant-potential charging with temperature compensation. Because a battery in cyclic operation is charged in the relatively constant temperature of an air-conditioned environment instead of the wide range of temperatures of the DCP field site, battery chargers from manufacturers such as Power Sonic typically are only temperature compensated for 20 ^{o}C (68 ^{o}F). The dual-rate, constant-potential charger at room temperature provides a constant voltage between 14.50 and 14.70 volts dc with the current limited at the appropriate level for each size battery until the battery voltage reaches 14.70 volts. The charger will hold this voltage level until the current that the battery will accept drops to its float current. Then the charger automatically drops to a float charging voltage of 13.50 to 13.80 volts. At this voltage the battery will seek its own current level and maintain itself in a fully charged condition. Leaving a battery connected to the charger at this float level will not damage it. In fact, it will ensure that all of the capacity is restored to the battery. Normally, a battery is fully charged in about 16 hours. Leaving the battery on the charger for 24 hours will help ensure full capacity.

Power-System Installation

Proper power system installation requires consideration of connecting cables, solar panels, lightning protection, and grounding. System reliability and personnel safety procedures are covered in this section.

Parallel Connection of Batteries

If more capacity is needed, it is best to get a larger capacity battery. Two 12-volt batteries of the same ampere-hour capacity connected in parallel will provide 12-volts and double the capacity of one battery. Batteries connected in parallel have their positive terminals connected together and their negative terminals connected together; that is, the batteries are connected to each other by two wires. The instrument positive is connected to the first battery positive; the instrument negative is connected to the first battery negative. Refer to figure 14.

Two brand new fully charged batteries of the same ampere-hour capacity need to be used when setting up either a series or parallel battery connection. If the two batteries are not identical, the one that has the lower capacity will determine when the capacity to the system is depleted. If one of the batteries has very low capacity and the other has an acceptable amount of capacity, the low capacity of the one can cause a battery or battery cell to reverse polarity or to short. DO NOT use two batteries of different capacities, of different ages, of different charging histories, or of different use histories.

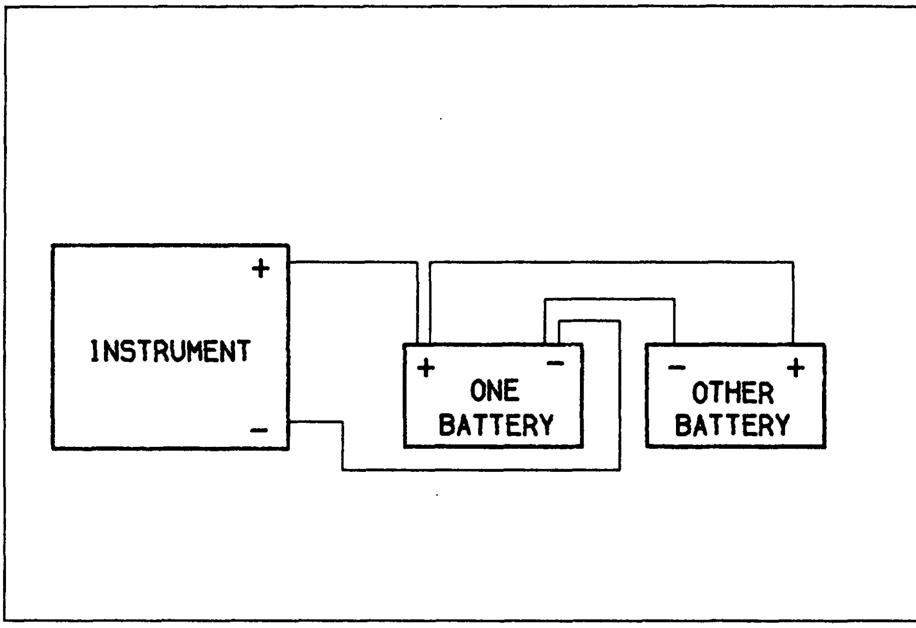


Figure 14.--Batteries connected in parallel with an instrument double the ampere-hour capacity to the instrument.

Series Connection of Batteries

Two 12-volt batteries of the same ampere-hour capacity connected in series will provide 24 volts and the ampere-hour capacity of one battery. Batteries connected in series are connected to each other by only one wire. The positive terminal of one battery is connected to the negative terminal of the other battery. The instrument negative is connected to the negative of one battery. The instrument positive is connected to the positive of the other battery. In a series connection, only one wire connects any of the terminals. Refer to figure 15.

Two brand new fully charged batteries of the same ampere-hour capacity need to be used when setting up either a series or parallel battery connection. If the two batteries are not identical, the one that has the lower capacity will determine when the capacity to the system is depleted. If one of the batteries has very low capacity and the other has an acceptable amount of capacity, the low capacity of the one can cause a battery or battery cell to reverse polarity or to short. DO NOT use two batteries of different capacities, of different ages, of different charging histories, or of different use histories.

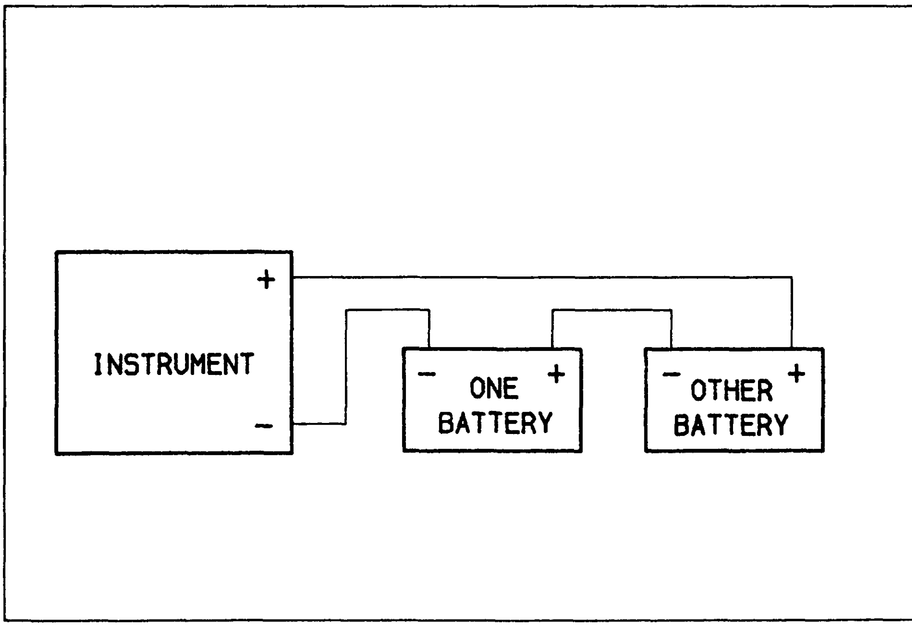


Figure 15.--Batteries connected in series with an instrument double the voltage to the instrument.

Solar Panels

The components of a solar power system are the solar panel, charging regulator, blocking diode, fuse, wiring, battery, mounting platform, and lightning-protection equipment. Most 12-volt solar panels require the external blocking diode to prevent current drain from the battery at night.

The optimal angle of the solar panel is the degrees of latitude of the site plus 15 degrees. A good rule of thumb for the United States is to mount the solar panel facing south at a 45-degree angle. Instructions for installing the solar panel are covered in the chapter entitled "Antennas." Figure 11 shows a bridge-mounted gage house with solar panel.

The amount of shade and vandalism influence the sizing and positioning of the solar panel. Although the solar panel is less visible to vandals if mounted flat on the roof, it is more efficient if mounted at an angle to catch the maximum sun rays. The solar panel is most efficient when it is clean; positioned to get full, direct sunlight; and cool. Ventilation across the back of the panel helps to cool it. If, to avoid shade, wiring needs to be run a long distance, the voltage drop across this length of wire needs to be considered.

Lightning Protection

A transient is a temporary change in the normal voltage and (or) current to the equipment. A lightning transient can be conducted directly to the equipment on the ac power line, telephone line, sensor line, or DCP antenna cable. A lightning transient can also be induced into the equipment by a nearby lightning strike as the lightning current travels through the soil.

The goal of lightning protection is to divert lightning's destructive energy from the gage-house electronic equipment. This is done by providing lightning the shortest, straightest, least resistant path to earth ground. Total protection from lightning is impossible. Low-power electronics, such as DCP's, data loggers, and sensors need more protection than rugged mechanical devices. Without an effective low-resistance grounding system, the ac-power-line, telephone-line, and coaxial-cable protection devices will not work. An effective low-resistance grounding system is provided by using the common-point ground connected to the copper-clad steel earth-grounding rod.

A lightning-protection system helps ensure uninterrupted data collection and minimizes expensive repairs necessitated by lightning damage. The best and most effective lightning protection for instruments such as DCP's, electronic data loggers, sensors, phone modems, computers, and other microprocessor-based instrument systems is protection that is designed for and built into the instrument circuitry. Built-in protection can more closely match the protection needs of the circuitry than can protection that is added to the instrument after it is manufactured. When lightning protection is inadequate, supplemental protection needs to be provided. The devices described in the following section provide this supplemental protection.

Alternating-current power-line and phone-line protectors

An ac-power-line and telephone surge-suppressor protection device needs to have low clamping voltage (between 190 and 210 volts), fast response time (in picoseconds), and large energy-handling capacity (in the range of 300 to 450 joules). A joule is a unit of energy equal to a watt-second. A watt is equal to 1 ampere flowing across a potential difference of 1 volt. The Sutton ZX1NT and the Panamax TeleMAX are suppression-protection devices that have three levels of protection in addition to an external fuse. The three levels of protection are silicon avalanche diodes for fast clamping response in picoseconds; metal-oxide varistors (MOV) for energy dissipation; and a spark gap for shunting the largest portion of the surge current to earth ground. Both models have an indicator light that when lit indicates the circuitry is protecting the system (see fig. 16).

Phone-line-only protectors

For gage houses with telephone lines but no ac power, the Tripp Lite Model TSB Telespike Blok has three-stage protection for the telephone or phone modem. The Telespike Blok uses gas discharge tubes, avalanche diodes, and surge-limiting resistors to limit voltage spikes on the phone line to a safe 200-volt level. Its response is fast, less than 5 nanoseconds, and it can suppress voltages as high as 12kv. It has automatic reset. Several companies make phone-line protectors.

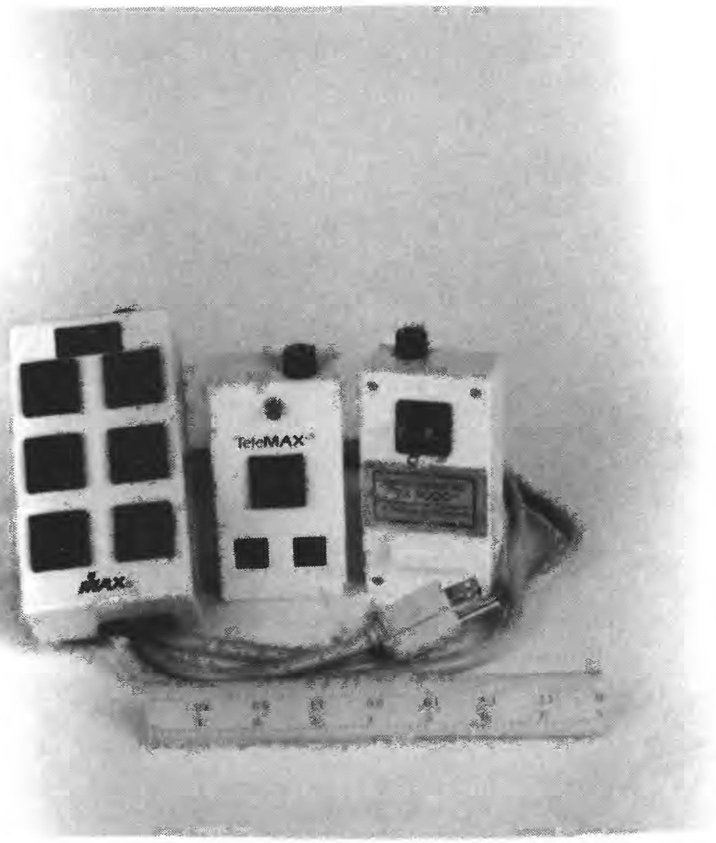


Figure 16.--Alternating-current power line and phone modem lightning-protection devices manufactured by Panamax and Sutton.

Antenna cable protectors

The antenna coaxial cable needs a transient protector device to protect the DCP transmitter radio frequency port not only from lightning but also from the voltage difference in an electrostatic discharge. At DCP sites where lightning may not be a great threat, electrostatic discharge voltages can be a threat. Electrostatic discharges created by the intermittent on and off of the DCP transmitter can disrupt or scramble the programs in the DCP memory. Antenna-cable transient protection connected to a good earth grounding system will protect the DCP programs from the electrostatic discharge voltages.

The coaxial-cable protector needs to provide protection for a 10-watt, 402-MHz transmitter. The coaxial-cable protector needs to limit the lightning energy to the transmitter to 200 micro joules. The device needs coaxial N-connectors to connect to the N-connectors of the antenna cable. The device needs to be connected to the antenna cable outside the DCP housing. The coaxial protector needs to be connected to the earth grounding system. If the DCP is put inside another environmental enclosure, such as a metal Hoffman box, the protector needs to be outside this enclosure. Polyphaser Corp IS-B50LN is a device that meets these requirements. See figure 17.

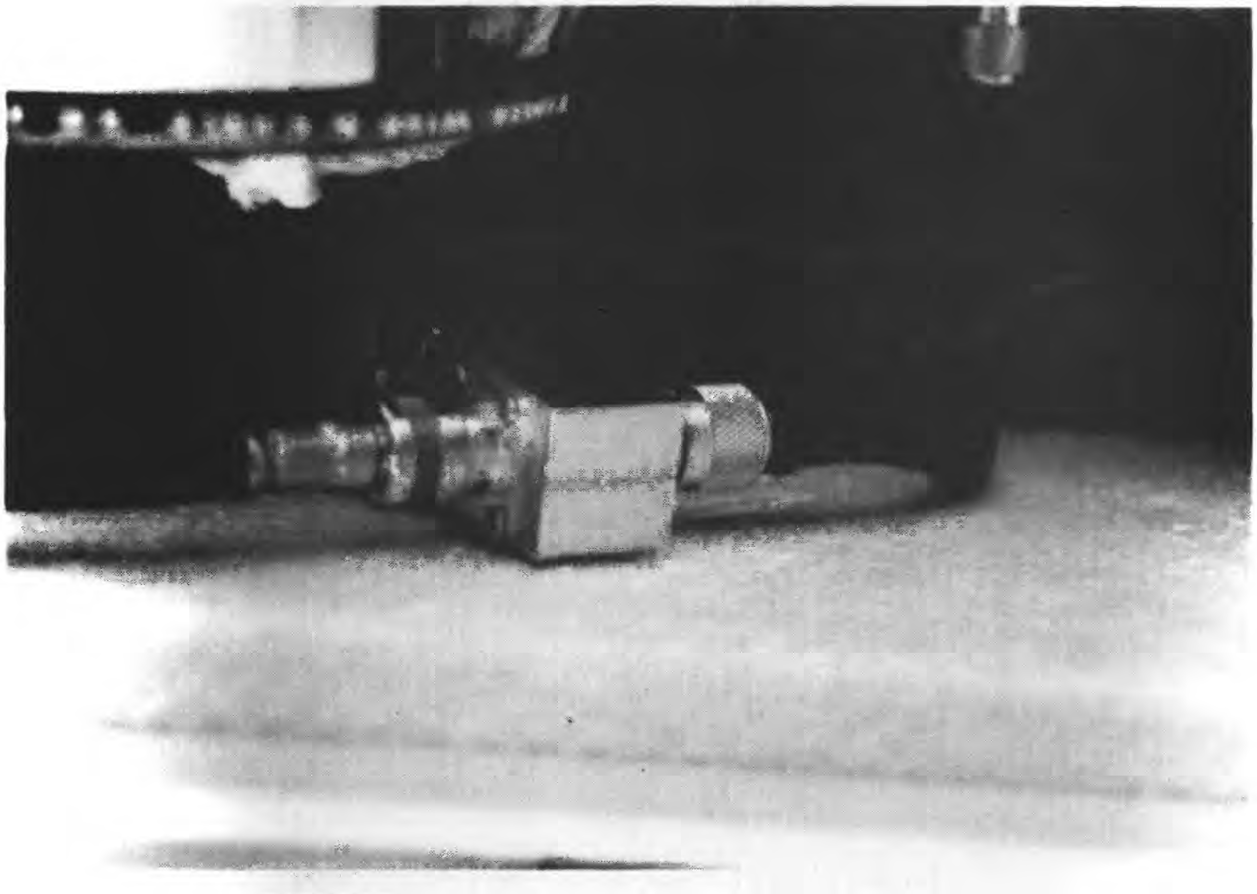


Figure 17.--In-line, gas-charged, lightning arrester for DCP antenna coaxial cable manufactured by Polyphaser Corp.

Sensor-line protectors

Twisted-pair shielded cables should always be used for connecting sensors to the DCP or a data logger to reduce the induced lightning transient. This also helps to eliminate the additional problem of current loops on sensor lines. The cable shielding should be connected to the grounding system as close to where it enters the gage house as possible. The negative lead of the sensor cable can be connected to a terminal strip that has a gas discharge tube, such as the Clare CL90L, of the proper characteristics to protect it from lightning transients. If this is not sufficient protection for the sensor line, a guard wire the length of the sensor cable can be buried in the ground 6 to 12 inches above the sensor line. This guard wire is connected to the grounding system, and it carries the transient energy. A plastic connector between the float and the steel tape helps prevent the steel tape from conducting lightning currents from the water. The HIF has designed and supplies a pulley with a plastic hub that electrically isolates the metal pulley from the metal shaft on the Basic Data Recorder encoders.

CAUTION: Ground only one end of the cable shielding.

Grounding

Common-point grounding

The purpose of a common-point ground is to keep the system components within the gage house at the same voltage potential relative to one another anytime the system becomes part of the lightning discharge circuit; thus, the lightning current is prevented from flowing in the interconnections. All interconnections need to be as short and straight as possible, avoiding sharp bends in the wire. The importance of clean, well-made connections at all points cannot be over emphasized. Refer to the manufacturer's DCP manual for the proper procedures for connecting the DCP to the common-point ground.

All components of the system--the DCP, the ADR, electronic shaft encoder, the negative terminal of the battery, the ground terminals of the surge-protection devices, and the metal parts of the gage house--must be connected to a common point of a 1.5-inch-wide copper strap (made from 0.050-inch or heavier copper sheet or copper braid) that runs directly from the DCP to the water-level recorder. In addition, No. 10 AWG (minimum size) solid copper wire must run from this same common-ground point to an earth ground; however, a No. 4 AWG solid copper wire provides better protection. The copper ground strap needs to be as short as possible.

Earth grounding

The grounding rod-to-earth resistance needs to be as close to 5 ohms as possible. Earth's resistance varies with the type of soil, soil temperature, and moisture content. Sandy soil has more resistance than more organic, loamy soil. Cold and frozen soils greatly increase the resistance of the grounding system. Moisture in the soil provides a lower resistance than does dry soil. A grounding rod buried below the soil frost line provides a uniform low-resistance ground the year round.

The earth resistivity and the resistance of ground-rod connection to earth can be measured by using the Biddle Megger Null-Balance Earth Tester. The earth resistivity can be measured before a new gage house site is picked so that the lowest resistance in the immediate area can be found. For an existing gage-house grounding system, the resistance of the grounding rod can be measured using the Biddle Megger Direct-Reading Ground-Resistance Tester. The two Biddle meters can be rented from the HIF.

The grounding rod needs to be at least 8 feet long and 5/8 inch in diameter and must be made of copper-clad steel. The thickness of the copper jacket cannot be less than 0.012 inches. It is very important that the contact between the down conductor wire and the grounding rod be a clean tight one. Over time, corrosion develops and greatly increases the resistance of the connection. The best contact is an exothermic weld (for example, a Cadwell), but, if this is not possible, the two surfaces need to be free of any oxidation, dirt, and corrosion before they are tightly clamped together and sprayed with a polyurethane spray that prevents corrosion. Special clamps are made for clamping grounding rods to conductors such as the J-2 used with 1 1/2- to 2 1/4-inch pipe. The bends of the conductors connected to the grounding rod should not have angles of less than 90 degrees or a radius of bend of less than 8 inches.

If one grounding rod does not provide the 5 ohms of resistance, a second grounding rod can lower the resistance by about half. The two rods need to be connected by No. 2 AWG bare copper wire. If two rods do not provide the 5 ohms resistance, three or more rods can be used. Eight-foot-long grounding rods, driven vertically into the soil, need to be placed about 15 feet from each other. Wide, strong metal clamps need to be used to attach the connecting wire to the grounding rod. The wire and grounding rod must be free of dirt and corrosion before they are clamped together. After the grounding rod and connecting wire are clamped together, a polyurethane spray coating will protect them from moisture and corrosion.

A grounding wire alone run to the river may not be a low-resistance path to earth. Low-conductivity water has very high resistance. For example, water with specific conductance of 100 microsiemens has a resistance of 10,000 ohms. A No. 2 AWG bare copper wire clamped to 8-foot grounding rods at 15-foot spacings and run to the river will provide a much better grounding system than will a wire run to the river.

Stilling wells can offer a low-resistance earth ground. If the measured resistance to earth of the stilling well is close to 5 ohms, the well can be used in place of a grounding rod, but good mechanical connections that remain corrosion free are required.

When bedrock is near the surface, vertical grounding rods are impractical. Buried horizontal conductors, which may be horizontal strips of metal, solid wires, or stranded cables buried 18 to 36 inches deep, may be used effectively. Burying an 8-foot, 5/8-inch, copper-clad steel grounding rod may provide the required low-earth resistance. Two-to-several grounding rods laid out in a star pattern connected by No. 2 AWG bare copper wire can be used. The number of rods needed is determined by the number required to achieve the 5-ohm or lower resistance.

All the metal in the soil around the gage house needs to be tied together using No. 2 AWG bare copper wire. The ac-power-line grounding rod, the telephone grounding rod, the metal superstructure of the gage house, and any metal pipes and conduits need to be tied together electrically. The connections of the metal and wire need to be clean, tight, securely fastened, and protected from dirt and corrosion. With all the metal in the area tied together, when a lightning strike occurs, all the equipment within the gage house is kept at the same voltage potential. Keeping all of the equipment at the same voltage potential prevents destructive lightning currents from flowing in the wiring.

Lightning-protection devices to be used with satellite DCP's may be purchased from Synergetics and Handar or may be constructed from the materials from local electrical parts suppliers. The mast grounding attachment is shown in figure 18. The wires are bare copper No. 4 AWG.

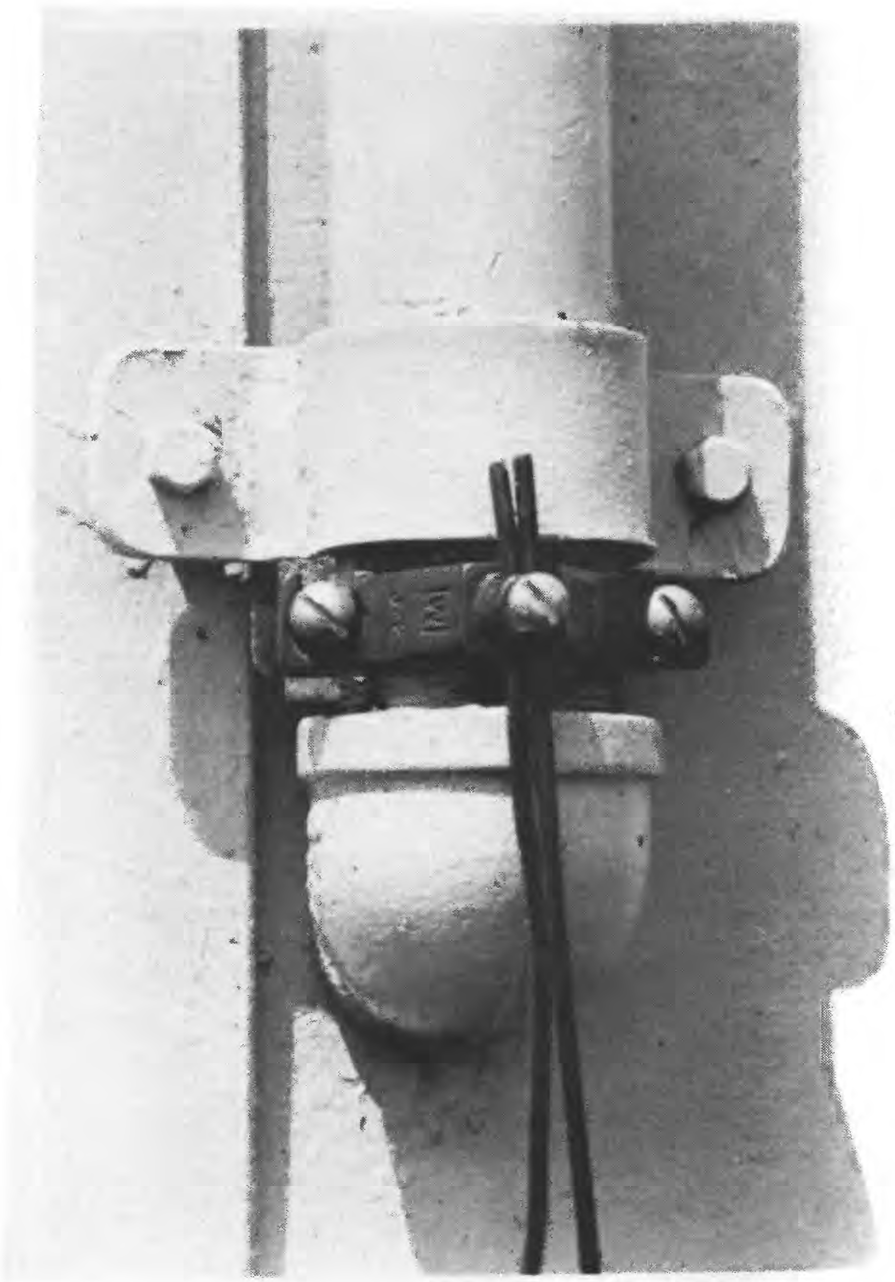


Figure 18.--Ground cable attached to antenna mast.

Maintenance and Troubleshooting

Low Battery Voltage

A battery should not be used if its open-circuit voltage ever measures less than 12.15 volts. At the 12.15-volt level, 50 percent of the battery capacity has been used. The on-site charging system should maintain battery voltage above this level. A battery with a voltage of less than 12.15 volts needs to be tagged or marked for replacement. Although the battery may take a charge, the battery is not reliable. If it is in cyclic operation, the battery needs to be recycled before it reaches 12.15 volts.

If the current draw of an instrument is measured and found to be within tolerance but the battery voltage under load is 0.5 volt less than the measured battery open-circuit voltage, the battery has reduced capacity and should not be used. For example, if the open-circuit voltage of the battery is 12.8 volts and the voltage under load is 12.3 volts, the battery should be discarded and should not be connected to an ac charger or solar-panel charging system.

Overcharging a Sealed, Gelled-Electrolyte, Lead-Acid Battery

Overcharging the battery, which greatly shortens its life, should be prevented. This can be accomplished by using a battery adequate for the power required, by using a voltage regulator, and by periodically checking the battery voltage.

A charging voltage of 15.00 volts will overcharge a sealed, gelled-electrolyte, lead-acid battery and greatly reduce its life. Even though these batteries are sealed against spillage and outgassing during normal charging, overcharging can create hydrogen and oxygen that is generated at the terminals and vented to the atmosphere through the pressure relief valve. These gases are corrosive to metals and equipment and can be explosive. Batteries should not be placed in airtight instrument boxes. Proper charger-regulators should be used with the batteries to prevent overcharging.

Immediate Cyclic Charging of Batteries

Batteries need to be recharged immediately when brought in from the field. Letting a discharged battery sit shortens its life and reduces its useful capacity as does letting a fully charged battery sit on a shelf for more than 6 months without recharging.

Battery Voltage after Cyclic Charging

For batteries in cyclic operation, record the battery voltage before putting it on the charger. After removing the battery from the charger, read the voltage again. The voltage after charging should be at least 13.00 volts. If the voltmeter leads are held on the terminals for a couple of minutes, a rapid voltage decrease can be seen. The voltage will stabilize about 8 hours after the battery is removed from the charger. The stabilized voltage on a properly charged battery will be between 12.70 and 12.79 volts. At this voltage, a rechargeable sealed, gelled-electrolyte, lead-acid battery has been restored to 100 percent capacity.

Checking New Batteries

When new batteries are received from the manufacturer, the open-circuit voltage should be measured. The open-circuit voltage needs to be at least 12.60 volts or higher. If not, contact the manufacturer and make arrangements for the batteries to be returned. A new fully charged battery with an open-circuit voltage of 12.90 volts is close to 100 percent of rated capacity. This voltage needs to be measured 8 to 24 hours after the battery has been taken off the charger.

Battery Wiring Harnesses and Terminals

Battery wiring harnesses help prevent accidental polarity reversal of batteries and short-circuiting of equipment. It also provides for quick and easy connecting and disconnecting of the battery to the instrument. Battery wiring harnesses are available from HIF or can be made in the office using Methode connectors (fig. 8). Protect the battery terminal connection from corrosion by using a silicone rubber compound or polyurethane spray sealant.

Record Keeping and Battery Labels

Good record keeping helps ensure a battery's long, reliable life. The HIF Operating Manual "Rechargeable 12-volt Power System implementation guide (7-83-01)" shows sample battery record-keeping formats.

Each battery should have a unique identification. Incorporating the year of purchase in this number will help keep track of the battery's age. The HIF has designed battery labels that can be attached permanently to the side of the battery. Battery labels can be ordered from HIF-CSS (Computerized Support System). The stock number is 7105001. Dates installed, removed, and charged can be recorded on these labels (fig. 19).

Monitoring Battery Voltage

It is important to monitor the battery voltage. A decline in battery voltage over time indicates problems with the battery or the charging system. When a solar panel is being used, a normal decline in battery voltage may be observed when there are several days of cloudiness but battery voltage should recover when full sunshine returns. If it does not recover but continues to decline, the solar panel and battery will cease supplying the energy that the DCP system needs when the battery's reserve has been used. The battery voltage can be recorded using the DCP battery monitoring option. If the battery voltage is measured each day at the same hour, a comparison of the most recent and previous readings will give a good indication of the state of charge of the battery. Daily readings are best taken each day at 5:00 a.m. (just before sunrise) because the solar panel would

HYDROLOGIC INSTRUMENTATION FACILITY

Date Received ____________

Voltage ____________

	Date	Volts	Date	Volts
Charged				
Installed				
Removed				
Charged				
Installed				
Removed				
Charged				
Installed				
Removed				
Charged				
Installed				
Removed				
Charged				
Installed				
Removed				
Charged				
Installed				
Removed				
Charged				
Installed				
Removed				

Designed by Fred A. Hubbard

Figure 19.--Battery label for all three sizes of Power Sonic batteries.

not be charging the battery at that hour nor would it have been during the preceding night hours.

Measuring Voltage

The open-circuit voltage of the battery is measured when only the digital multimeter (DMM) is connected to the battery. Refer to figure 20, which shows DMM leads connected in parallel to the battery for measuring open-circuit voltage. Connect the meter leads to the meter for measuring voltage. With the DMM set to measure dc voltage, the open-circuit voltage of the battery is measured by placing the negative lead of the DMM on the negative terminal of the battery and the positive lead of the DMM on the positive terminal of the battery. Polarity is important when measuring voltage using an analog meter. The polarity is not critical when using a digital meter to measure the voltage of a battery. If the leads are reversed, the digital meter will display a negative sign in front of the voltage reading.

The voltage under load measurement means that the battery is connected to an instrument that is drawing current. This may be an ADR or other device. Refer to figure 21, which shows a DMM connected in parallel to the battery and instrument for measuring voltage under load. Connect the meter leads to the meter for measuring voltage. With the DMM set to measure dc voltage, the battery voltage under load is measured by placing the positive

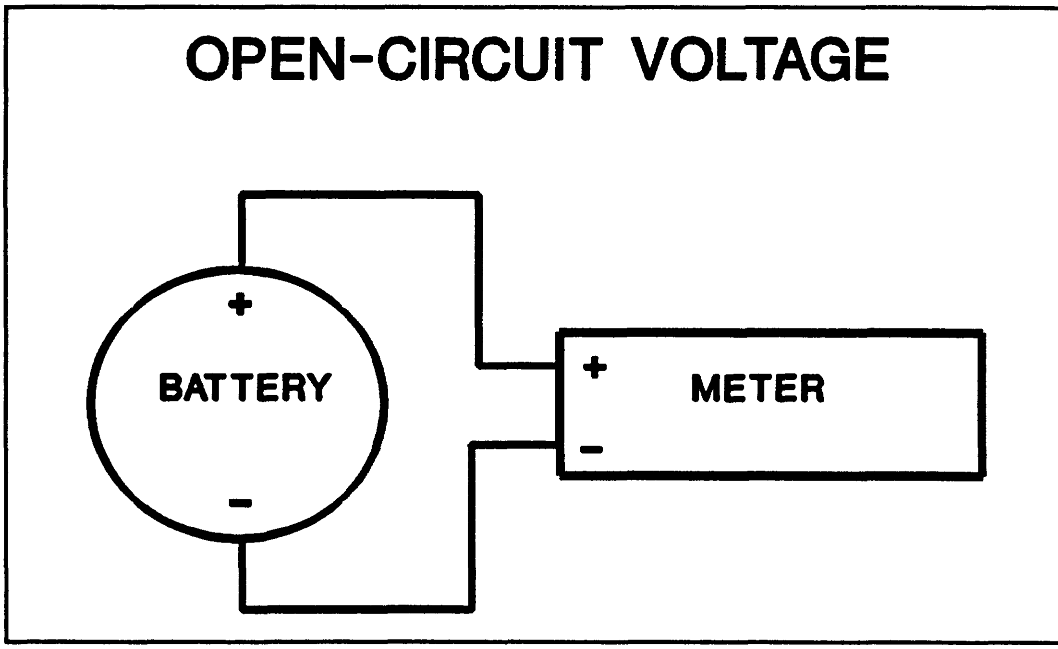


Figure 20.--Digital multimeter leads connected, in parallel, to the battery and instrument for measuring open-circuit voltage.

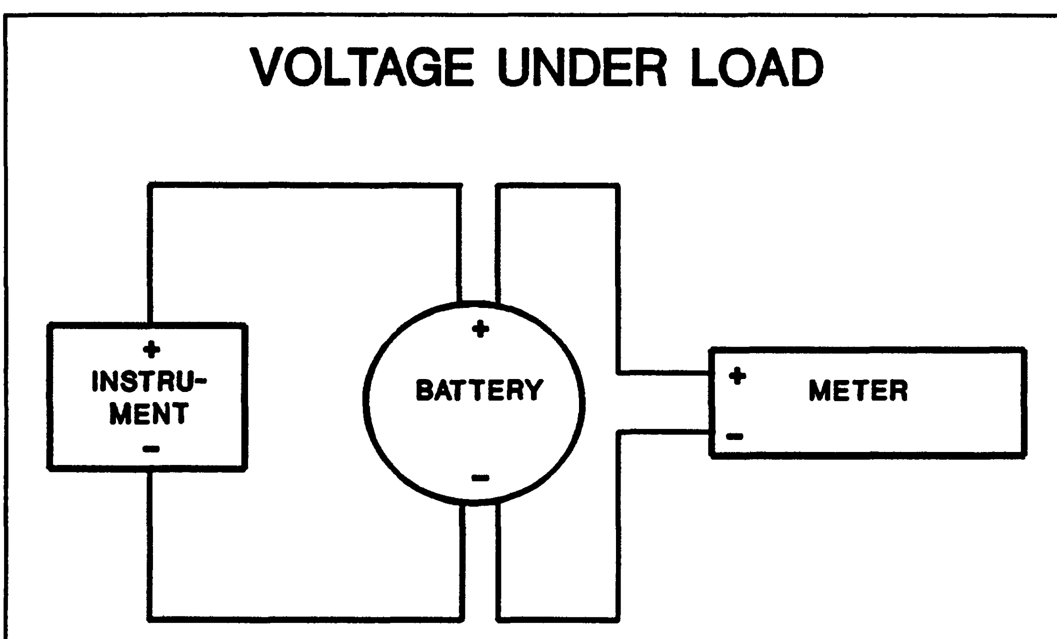


Figure 21.--Digital multimeter leads connected, in parallel, to the battery and instrument for measuring voltage under load.

lead of the DMM on the positive terminal of the battery and the negative lead of the DMM on the negative terminal of the battery when the instrument is connected to the battery and operating.

Measuring Current

Measuring the current in the circuit is done differently from measuring voltage. Refer to figure 22. The DMM is connected in series to the battery and instrument for measuring current. Set the DMM for measuring current. Connect the meter leads to the meter for measuring current. To measure the current draw of an instrument, the meter is connected in series with the instrument and the battery. **To do this, remove the terminal connector from one of the battery terminals. Place one of the leads of the DMM on this battery terminal. Connect the other lead of the DMM to the connector that was removed from the battery.**

CAUTION: Set the meter current-measuring range to the highest range possible. Decrease the DMM current-measuring range to correspond with the current being measured. When using an analog ammeter that does not have a scale for displaying negative values, connect the negative lead of the analog ammeter to the positive terminal of the battery. The circuit will be the battery, the meter, and the instrument.

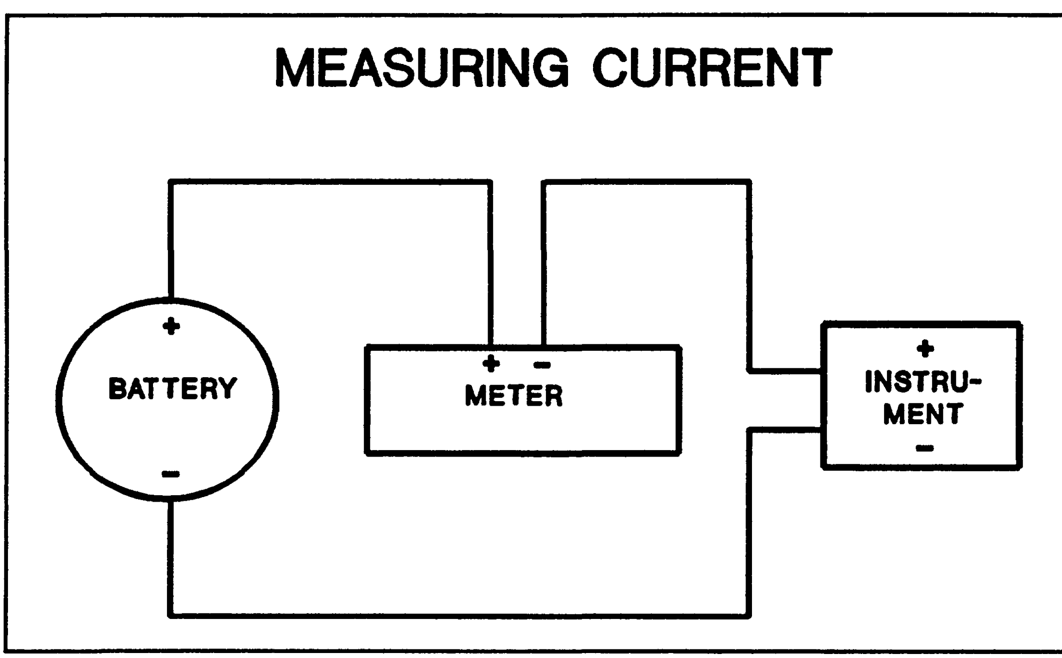


Figure 22.--Digital multimeter leads connected, in series, to the battery and instrument for measuring current.

If the current draw of an instrument is measured and found to be within tolerance but the battery voltage under load is 0.5 volt less than the measured battery open-circuit voltage, the battery has reduced capacity and should not be used. For example, if the open-circuit voltage of the battery is 12.8 volts and the voltage under load is 12.3 volts, the battery should be discarded and should not be connected to an ac charger or solar-panel charging system.

CAUTION: Do not try to measure voltage when the meter is set for measuring current or the meter leads are connected for measuring current. Do not try to measure current when the meter is set for measuring voltage or the meter leads are connected for measuring voltage. It is easy to forget to change the meter settings and the lead connections. Incorrect meter settings on lead connections may result in a blown fuse in the DMM. If the DMM gives no reading when attempting to measure current, consult the DMM manual, remove the fuse, and test it for continuity. A blown (bad) fuse measures as an open circuit that has a very high resistance value usually in the megohm range.

Consult instrument operations manuals for the normal current draw for each instrument. An instrument that draws more current than it should will drain a battery. If the system is on a solar-panel charging system, the charging system may not be able to supply the increased current demand. An instrument that is drawing more current than expected may not be working properly. Many times what seems to be a battery failure problem is really a malfunctioning instrument problem.

ANTENNAS

By Joseph G. Gorman & Truth E. Olive

The most common GOES antenna in use is the crossed Yagi, although some helix types are in use. The crossed Yagi antenna is smaller and lighter than the helix but is more fragile and more easily damaged by ice loading or vandalism. The two antennas have similar transmission characteristics. The transmission frequency of the antenna must be 402 MHz $\pm$ 5 MHz. The antenna impedance should be 50 ohms to match impedance of the DCP transmitter and antenna extension cable.

The crossed Yagi antennas are shipped with the elements removed. The user should assemble the antenna on site rather than transport it already assembled because the elements can be broken easily. Care must be taken to assemble the elements in proper order and to attach each set of four elements at points specified in the instructions that accompany each antenna. Pliers or vise grips should not be used to tighten the antenna elements.

Antenna Extension Cable

An antenna extension cable is needed to connect the antenna to the DCP transmitter because the antenna comes with a short 6- to 12-inch coaxial cable attached. An extension cable 15-feet long is adequate for most DCP installations. If longer lengths are needed, the power loss due to the total length of the cable should be considered. If the transmitter power is 10 watts, a 3 decibel loss means that 5 watts of power are lost. Extension cable lengths of 50 feet or more may require that the transmitter power be increased. Suggested coaxial cable for use with GOES DCP's is RG-8/U with 11 AWG center conductor, cellular polyethylene dielectric, bare copper braid shield, PVC outer jacket, nominal attenuation of 4.2 decibels at 400 MHz per 100 feet, and 50 ohm impedance. For sites needing an extension cable more than 50 feet in length, where increasing the DCP transmitter power is undesirable or not possible, an extremely low loss cable is available. It is produced by Cableware Systems, part no. HCC-12-50J-975, and has a nominal attenuation of 0.7 decibel per 100 feet. This cable is higher in cost then standard cable and more difficult to install but offers an alternative to increasing DCP transmitter power.

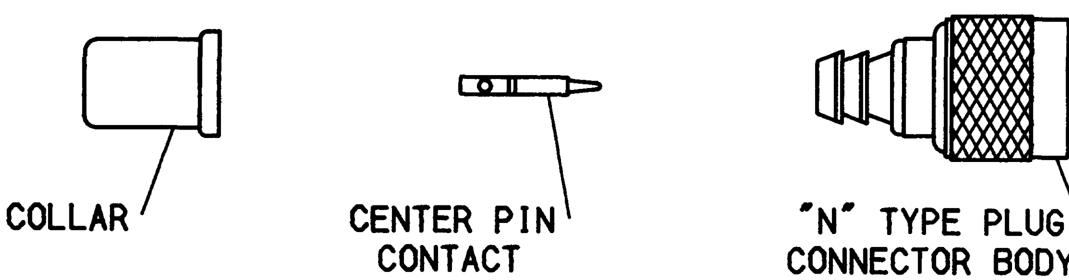
If coaxial cables are purchased from the platform manufacturer, the user has no control over the type of coaxial cable provided; however, most manufacturers supply RG-8/U coaxial cable in a variety of standard lengths. It is good practice to purchase and have available 100 feet of coaxial cable and the appropriate connectors. Keep them in reserve for installations where longer lengths are needed or where damaged cables need to be replaced. Some cable manufacturers produce cable jackets that are immune to chemical damage and have self-healing properties in the event of small cuts or rodent chews. Decibel Products VB-8 and Times Wire and Cable Co. Imprevon cable jackets are two such products.

N-Type Connectors and Cable-Making Procedure

The weakest link in any electronic equipment setup is the interconnecting cables and connectors. An intermittent open circuit can be difficult to find, yet can create problems in obtaining consistent and reliable data. Properly constructed cables and properly fitting connectors are essential for a trouble-free DCP system. Take care when cutting the cable jacket not to cut into the cable braid. A few strands may have to be cut off the center conductor to allow for proper fit of the center pin contact. Lightly tin (solder) the center conductor before installing the center pin contact. The connector needs to be closely matched to the coaxial cable. These are important considerations for making a reliable, trouble-free cable.

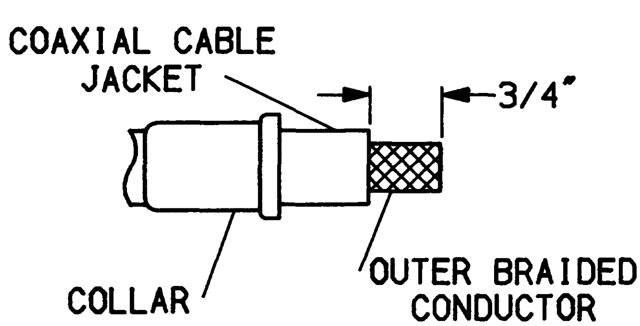
Coaxial N-type connectors are identified as plug (male) and receptacle (female). U.S. coaxial connector manufacturers designate the plug by the solid center pin contact, which is soldered to the center conductor of the coaxial cable. The receptacle (female connector) is designated by the center receptacle that is soldered to the center conductor of the coaxial cable.

The connector used for antenna extension cables and test cables is an N-type plug connector. Two types are available: crimp-on and compression. Both types of connectors are acceptable. The crimp-on connector requires a special crimping tool. The compression-type connector provides a more secure connection and does not require a crimping tool. Assembly instructions for crimp-on and compression N-connectors are shown in figures 23 and 24, respectively.

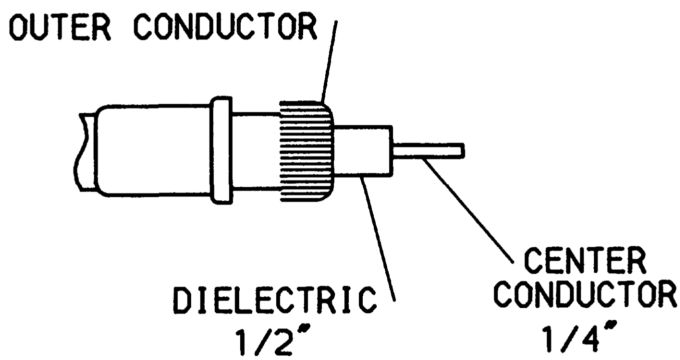


COAXIAL N-TYPE CRIMP-ON CONNECTOR

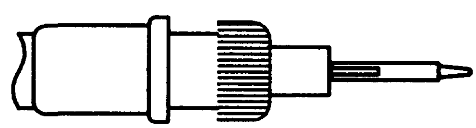
1. Cut off three-fourths of an inch of the cable jacket (insulation). Be careful not to cut into the copper braid. Slip the crimp collar onto the cable with the flared portion of the collar toward the end of the cable.



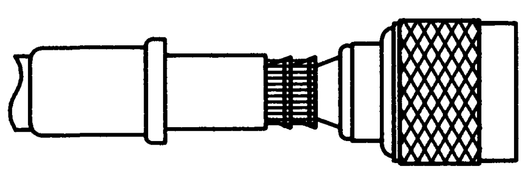
2. Peel back the braid to expose dielectric (nonconductor) and cut off dielectric, exposing one-fourth of an inch of the center conductor. Tin the center conductor.



3. Solder male pin to center conductor. Use proper soldering techniques. Do not create cold solder joints. Avoid melting cable dielectric.



4. Slide N-connector body onto dielectric and apply light pressure to seat. Trim exposed braid to a length of three-eighths of an inch.



5. Position braid around flanged stem of N-connector body. Slide crimp collar over braid and push snugly against the base of the N-connector body. Use crimping tool to crimp collar onto the braid and N-connector.

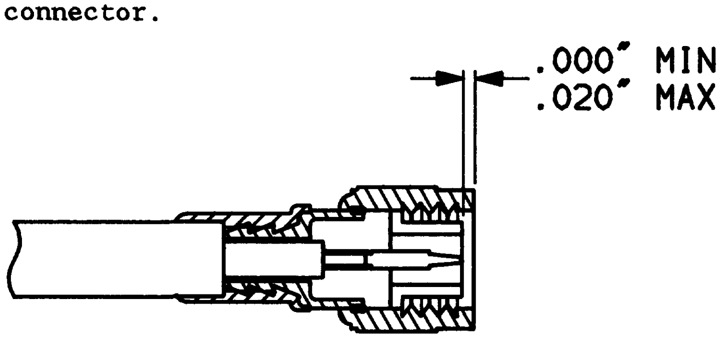
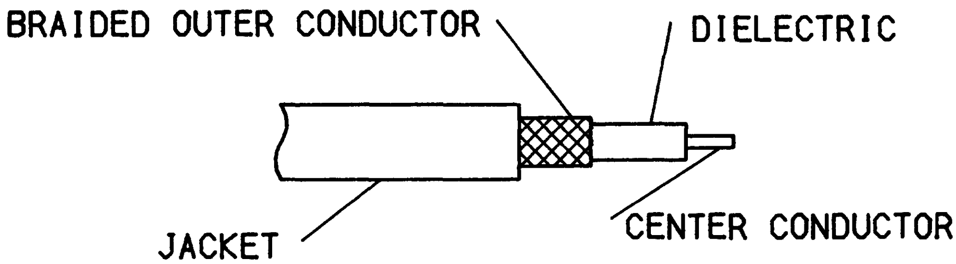
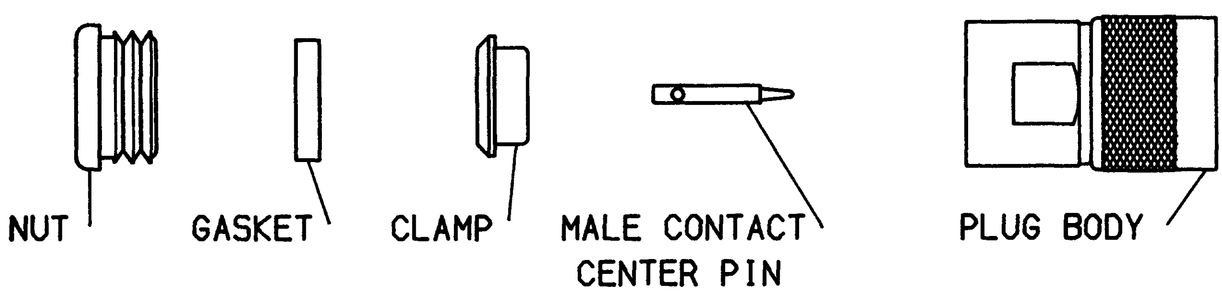


Figure 23.--Coaxial N-type crimp-on connector.

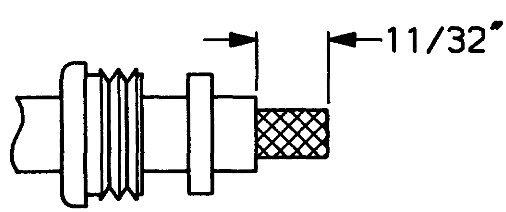


COAXIAL CABLE

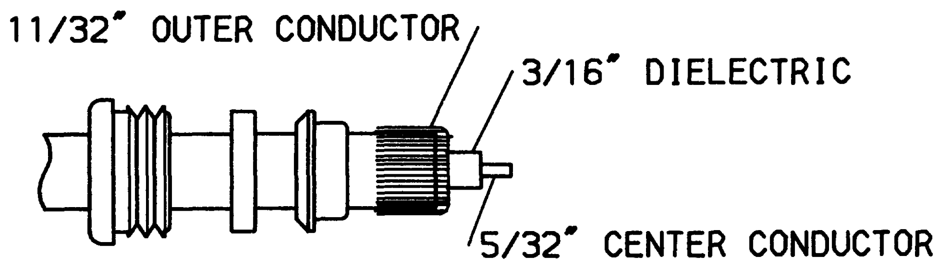


COAXIAL N-TYPE COMPRESSION CONNECTOR

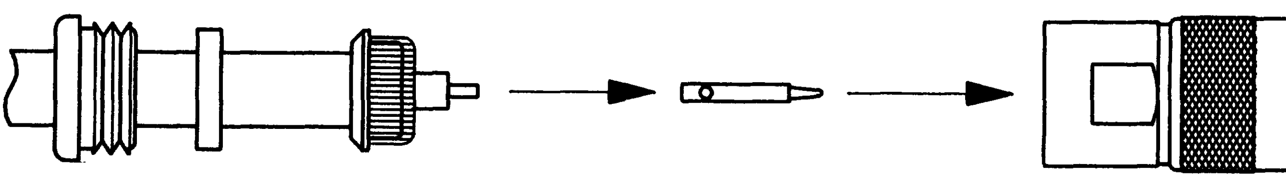
1. Cut the cable evenly. Remove eleven thirty-seconds of an inch of vinyl jacket. Comb out copper braid. Cut off dielectric five thirty-seconds of an inch from end.



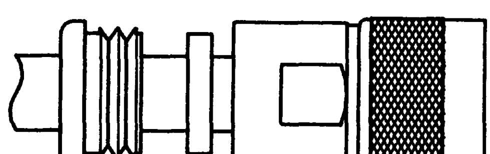
2. Slide nut and gasket clamp over vinyl jacket. Slide clamp over braid with internal shoulder of clamp flush against end of vinyl jacket.



3. Smooth braid back over clamp and trim. Soft-solder contact to center conductor. Avoid use of excessive heat and solder. See that end of dielectric is clean. Contact has to be flush against dielectric. Outside of contact has to be free of solder. Male contact is shown; procedure is similar for female contact.



4. Slide body into place carefully so that contact enters hole in insulator (male contact shown). Face of dielectric has to be flush against insulator. Slide completed assembly into body by pushing nut.



5. When nut is in place, tighten with wrenches.

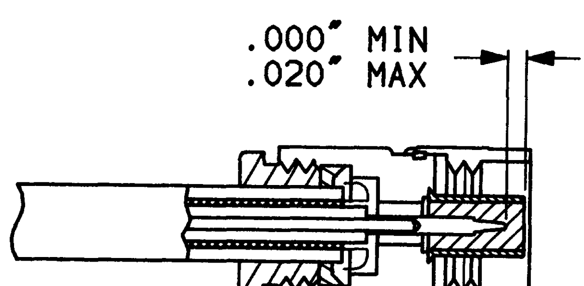


Figure 24.--Coaxial N-type compression connector.

Antenna Masts

Most GOES antennas fit onto 2 1/2-inch outside-diameter masts. The most popular mast material is 2-inch diameter water pipe or 2-inch diameter, thick-walled conduit (both actually 2.3765-inch outside diameter). Both are widely available and are strong enough to stand 15 or more feet high without requiring guy-wire support. The mast must be high enough for the transmission pattern to clear surrounding objects, and the antenna should be positioned out of easy reach of people. A mast length of 10 to 13 feet generally satisfies both requirements.

Antenna and Mast Installation

Because of the large variety of designs and construction materials used for gaging stations throughout the country, the authors cannot prescribe any specific method to install antenna masts. Antenna masts can be mounted on the ground, attached to the side of the gage house, or attached on the gage house roof. Some general methods, however, can be applied to most situations. One of the simplest and least expensive methods for attaching the mast to the gage shelter is by using U-bolts or metal brackets as shown in figure 25. The elbow at the bottom of the mast allows the coaxial and solar-panel cables to be brought down through the inside of the mast and into the gage shelter to prevent the cables from being vandalized. If the elbow or roof overhang does not allow the mast to mount flush with the wall, the mast needs to be shimmed out as shown in figure 26. If moisture in the antenna mast is a problem, drilling a hole in the bottom of the mast will allow drainage.

If the gage shelter is made of concrete or concrete block, the user may mount the mast with crest-stage gage mounting brackets as shown in figure 27. The mounting method must be strong enough to hold heavy 2-inch pipe. In cases where gage shelters are made of wood, the mast may have to be brought to ground level or to some other stabilizing point because of the leverage that can be applied from an unguyed, 10- to 15-foot mast.

A 6-inch pipe nipple threaded into the elbow at the bottom of the mast, long enough to extend through the gage house wall into the interior of the gage house, is advised. Although this adds some difficulty to the installation, especially for concrete or block gage houses, it is worth the effort because the weight of the mast rests upon the pipe nipple and the possibility of the mast slipping down and cutting the antenna extension cable or solar panel wiring is eliminated.

Placing the coaxial, solar-panel, and mast-mounted sensor cables inside the mast protects them from vandalism and excessive weathering. It is beneficial to do this at all DCP stations. Three methods of placing the cables into the mast are

- by cutting, with an acetylene torch or electric drill, a 3/4-inch hole about 6 inches below the top of the mast;

- by cutting a 3/4- by 4-inch notch down from the top of the mast; and

Figure 25.--Yagi antenna, antenna mast, solar panel, and rain-gage collector attached to 5- by 5-foot metal gage house.

Figure 26.--Yagi antenna, antenna mast, solar panel, and rain-gage collector attached to 5- by 5-foot block gage house.

ANTENNA MOUNTING
DETACHED POLE

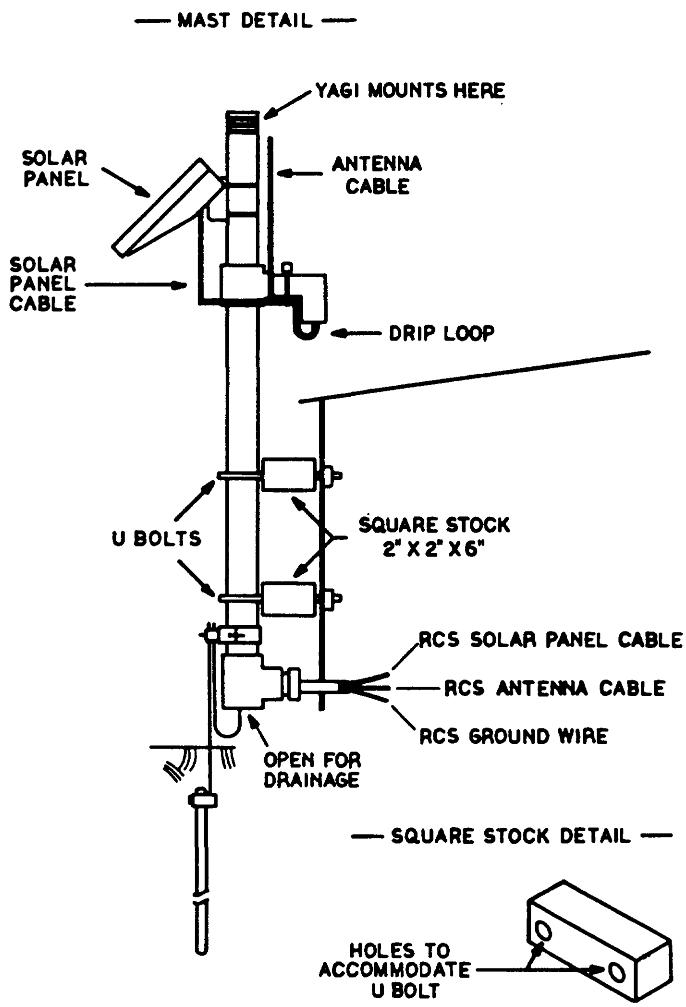


Figure 27.--Antenna and antenna mast attached to side of gage house.

- by placing a 2-inch pipe tee on top of the mast, with a 4- to 6-inch-long pipe nipple extending upward for mounting the antenna.

The cables can then be inserted into the hole, notch, or the remaining opening in the pipe tee and down through the inside mast. When the notch method is used, it is possible to place the antenna cable connection inside the mast where it is protected from the elements.

The antenna, solar panel, antenna extension cable, and wiring can be installed into the mast. The mast is then attached to the gage house as one unit. The procedure follows:

1. Attach the solar panel to the mast.

2. Insert the antenna extension cable and solar panel wiring through the hole, notch, or pipe tee down through the elbow and pipe nipple located on the bottom of the mast.

3. Attach antenna mount assembly to the top of the mast. Connect antenna extension cable to antenna lead and cover the coaxial connector with rubber tape, silicon seal, or other product, which will prevent water from entering the connection and yet can be easily removed. If a mast with a notch is used, the antenna extension cable is connected to the antenna lead before the antenna and mount are set on the mast. When the connection is made, the coaxial connectors are placed inside the mast with the antenna lead inserted into the mast through the notch. The antenna and mount are then set on the mast and secured.

4. Insert the antenna extension cable, solar panel wiring and pipe nipple at the lower end of the mast into the access hole cut in the gage house wall. Raise and plumb the mast and temporarily secure it by use of U-bolts, brackets, anchors, or other methods.

5. Position solar panel toward the south and tighten all mast-mounting bolts, brackets, or anchors.

NOTE: Ensure that the antenna mast and antenna extension cable are properly grounded. Refer to the sections entitled "Antenna cable protectors" and "Grounding" in the previous chapter.

Aiming the Antenna

Once the mast is secured, the azimuth and elevation of the antenna can be set. First, determine the azimuth and elevation of a DCP antenna by using the map and overlay in appendix F, the Survey's platform assignment and scheduling subsystems, or the SATLOC program (described in a separate chapter of this manual) in the PFC software. To determine the azimuth and elevation from the map and overlay in appendix F, place the center of the overlay over the position of the satellite to be used. The normal position of the two operational satellites is on the equator at longitude 75°W for the east satellite and longitude 135°W for the west satellite. Read azimuth and elevation from the overlay of the DCP's location. The azimuth on the overlay represents true north; therefore, be sure that the proper magnetic declination is applied to the area of study.

NOTE: The locations of GOES east and west satellites may differ from the positions listed in this manual. Consult your DRGS site operator for the current position of the satellites before determining antenna azimuth and elevation.

An example of antenna aiming follows:

1. Assume a DCP site location of 40° north latitude and 100° west longitude and a satellite location of 140° west longitude.

2. Position overlay center on map at satellite longitude of 140° west.

3. Locate latitude 40° north and longitude 100° west on map beneath overlay.

4. Read overlay azimuth and elevation at this point. (Azimuth equals 234° and elevation equals 26°.)

Determine magnetic declination. If the declination is eastern, the value is subtracted from the antenna azimuth. Western declinations are added to the antenna azimuth. For the above example, the magnetic declination is a western declination of ≈ 8°. Set the antenna azimuth to 234° + 8° = 242° magnetic.

When the azimuth and elevation for a site have been determined, the antenna can be set accordingly. Some methods to set antenna azimuth follow:

- Use a compass to locate a prominent feature on a line with the azimuth for the site and the antenna mast. Be sure to apply the magnetic declination for the area. Avoid being too close to metal bridges, gage houses, vehicles, or other metal objects because they can distort the compass reading. When a prominent feature is found in line with the proper azimuth, point the antenna at the feature and tighten antenna mounting bracket.

- Locate on a topographic map the gaging station where a DCP is to be installed, and determine the proper azimuth line to set the antenna. Look for landmarks or physical features, which are identifiable at the site, on this line. Point the antenna on this line and tighten antenna mounting bracket. This method is very simple and accurate; it eliminates the problem of distorted compass readings due to magnetic pull.

To set antenna elevation, use an inclinometer or a carpenter's level and protractor.

Protection from Vandalism

If vandalism is a problem in an area or at a particular site, the installer may need to redesign the setup to safeguard equipment. In severe cases, it may be necessary to relocate the station.

Several solutions are available to prevent vandalism. The solar panel may be mounted flat on the gage house roof so it is out of sight. Covering the solar panel with a thick piece of Plexiglas can prevent damage from rocks and small-caliber rifles. Solar-panels are available that can absorb some damage without adversely affecting the panel's output. The mast can be extended 8 to 10 feet above the gage house to make access to the antenna and solar panel by vandals very difficult.

An antenna and solar panel protector can also be fabricated at minimal cost and, when added to the mast, not only protects exposed equipment but can be used as a work platform when servicing the antenna or solar panel. A materials list and instructions needed to fabricate the antenna and solar-panel protector are as listed in figure 28. A photograph of the antenna with solar-panel protector is shown in figure 29.

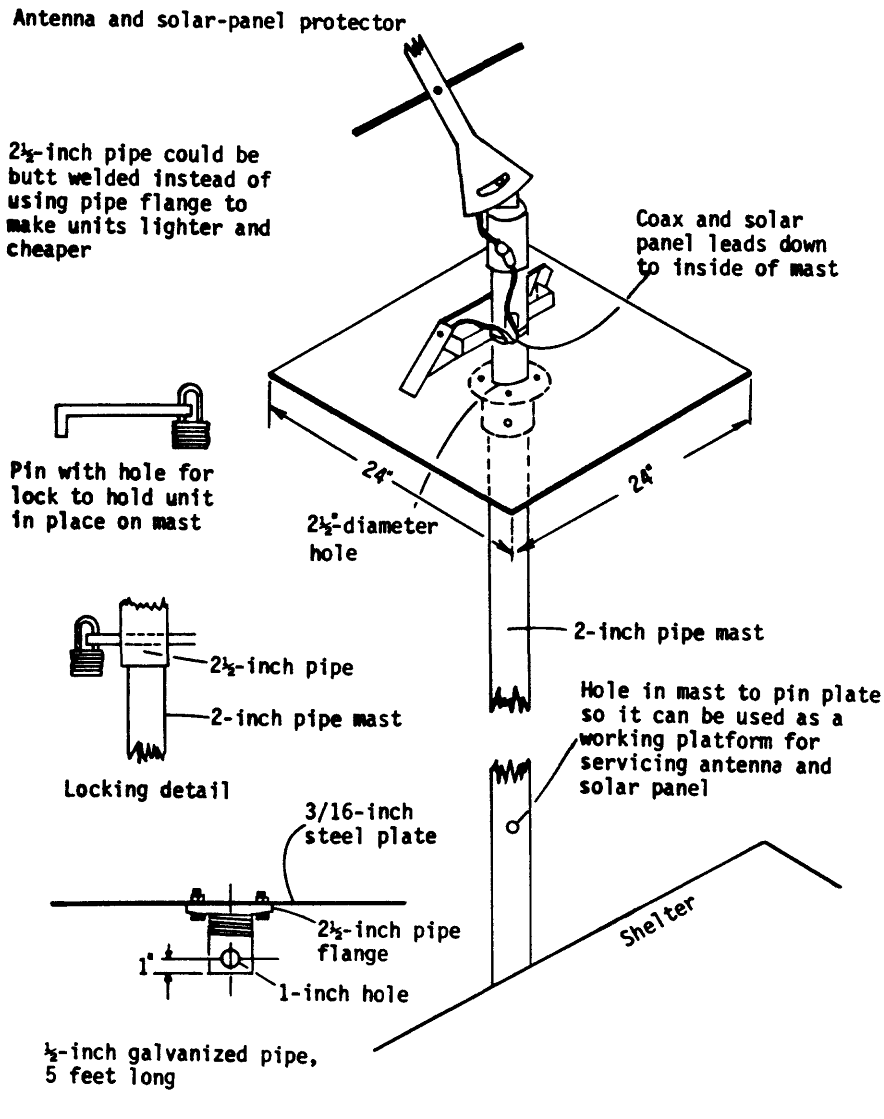


Figure 28.--Yagi antenna using solar-panel theft-protection plate.

Figure 29.--Yagi antenna, solar panel, and theft-protection plate.

Troubleshooting Radio Frequency Problems

To ensure proper maintenance of a network of DCP's, test the quality of the transmissions at the site and the performance of the antenna, antenna extension cable, and coaxial connections. A wattmeter, such as a Bird Thruline[R] Model 43, is used to perform these tests.

The wattmeter measures forward power and reflected power. The forward power is the signal strength from the DCP transmitter. The reflected power is the power loss caused by electrical resistance (impedance) in the coaxial cable, connectors, and the antenna.

For most sites with an antenna extension cable length of 15 to 20 feet, the DCP transmitter needs to generate 8 to 10 watts of forward power. If antenna extension cable length reaches or exceeds 50 feet, the DCP forward power may need to be increased to match the power loss in the longer antenna extension cable. If this is the case, consult the operator's manual for the proper procedure to increase forward power for the type of DCP being operated.

If the direction of the wattmeter element is reversed before or during a transmission, the reflected power in the antenna, antenna extension cable, and coaxial connectors can be measured. The reflected power normally measures 0.5 to 2.0 watts of power. A system that has a reflected power greater than 1.5 watts needs to be monitored closely, and the antenna and (or) antenna extension cable will need to be replaced if the reflected power degrades to 2.0 watts or more.

When to Test Radio Frequency Power

The DCP radio frequency (RF) power, both forward power and reflected power, should be tested when a DCP system is initially installed. The forward power and reflected power also should be measured when a DCP antenna or antenna extension cable is replaced or when the user is troubleshooting a system or performing routine maintenance.

The equipment needed to test the DCP RF power, both forward and reflected power, is as follows:

- A terminal or PFC to communicate with the DCP.
- An RF directional wattmeter, such as the Bird Thruline[R] Model 43, with a 25-watt, 400 to 1,000-MHz element.
- A 50-ohm, 25-watt attenuator (dummy load).
- A 4-foot and a 15-foot length of coaxial cable with an N-plug connector on both ends, used as test leads.
- A good quality voltmeter.

This equipment should be carried by all field crews responsible for DCP installation and maintenance.

How to Use a Wattmeter

To use the Bird Thruline[R] Model 43 RF directional wattmeter to test DCP RF power, the user first has to understand the Model 43 wattmeter. The Model 43 wattmeter is a sturdy instrument with a microammeter that can be read on 3 scales: 0 to 25, 0 to 50, and 0 to 100. See figure 30. Because most DCP's transmit in a range of 8 to 10 watts, the 0- to-25 scale of the microammeter is read. At this scale, each increment of the microammeter scale represents 0.5 watt. The Model 43 has two threaded receptacles: one protruding from the left side of the meter and one protruding from the right side of the meter (left and right as looking at the front of the wattmeter). The connector on the left side of the meter is the input connector and the connector on the right side is the output connector. On the front of the meter, below the microammeter, is a socket in which the measuring element is placed. The proper measuring element to use is a 25-watt element in the 400- to 1000-MHz frequency range. The wattage, frequency, and a directional arrow are on the face of each element. The element rotates 180 degrees in its socket and measures forward power when the arrow points toward the output connector and reflected power when the arrow points toward the input connector. When transporting or storing the wattmeter, position the element so the arrow points toward the microammeter; this dampens the microammeter needle movement and shunts the meter circuit. Holes in the left and right sides of the meter body are used to store extra measuring elements. It is a good idea to carry extra elements.

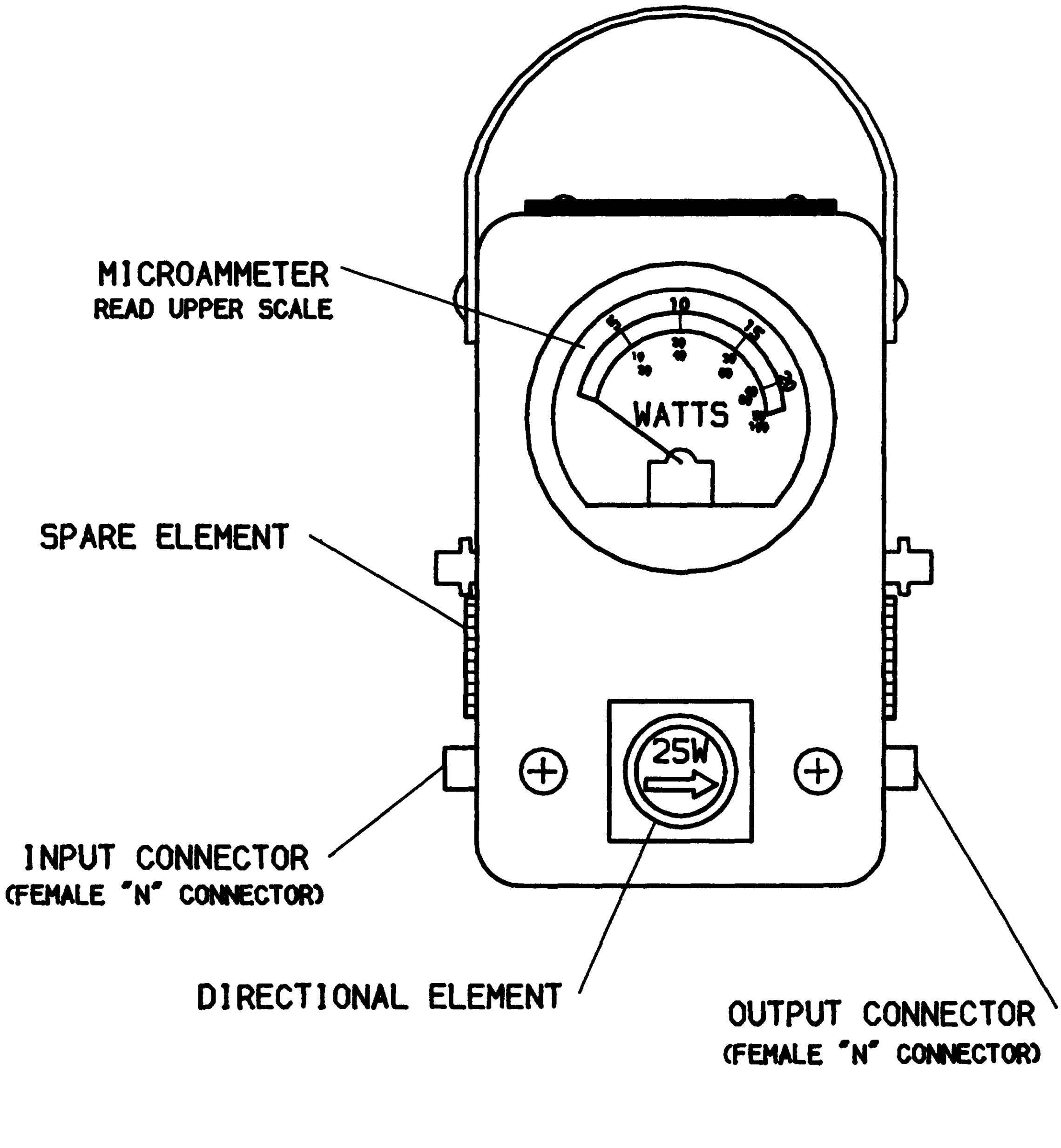


Figure 30.--Bird Thruline radio frequency directional wattmeter Model 43.

Radio Frequency Power Test

To test the forward power of a DCP (fig. 31) self-timed or random channel, remove the antenna extension cable from the DCP radio frequency port and attach one end of a 4-foot test cable to this port and the other end to the wattmeter input connector. Attach a 50-ohm, 25-watt attenuator (dummy-load) to the wattmeter output connector and rotate the wattmeter element until the element arrow points toward the dummy load. (The dummy load is used to absorb and dissipate the transmission power and signal generated by the DCP). Activate the DCP transmission channel being tested using the appropriate command for the type of DCP used. The wattmeter microammeter needle should jump to 8 to 10 watts and hold steady throughout the transmission. If no forward power is indicated by the wattmeter, check the following:

- DCP programing--Make sure the DCP program is entered properly.
- DCP fail-safe--The fail-safe is a device that shuts off the transmitter if a DCP transmission exceeds 90 seconds or begins within 90 seconds of a previous transmission (as with Sutron DCP's). If the fail-safe is tripped, the DCP does not transmit and may have to be sent back to the factory to be reset.
- Low power--Replace battery.
- Defective DCP--Replace DCP.
- Faulty wattmeter or test cable--If the wattmeter is suspect, attach a voltmeter lead to one of the antenna cross elements and the other lead to the tubular body of the antenna. Activate the random channel and observe the voltmeter. When the DCP is transmitting, a slight voltage reading should register on the voltmeter. This method does not indicate signal strength or quality but is a means of confirming that test equipment is operating.

If the wattmeter indicates forward power but the reading is low or fluctuates, check for the following:

- Weak battery--If the battery is suspect, load-test the battery with a 3-amp load tester or attach a voltmeter to the battery and observe the battery voltage during a transmission. If the battery is charged, a slight voltage drop ($\approx$ 0.5 volt) will occur; if the battery is weak, the voltage will drop rapidly (2 to 4 volts) once the transmission begins.
- Bad power leads from battery to DCP--Poor leads or loose connections may not allow adequate power flow from battery to DCP during transmissions.
- Weak or defective DCP--Replace DCP.

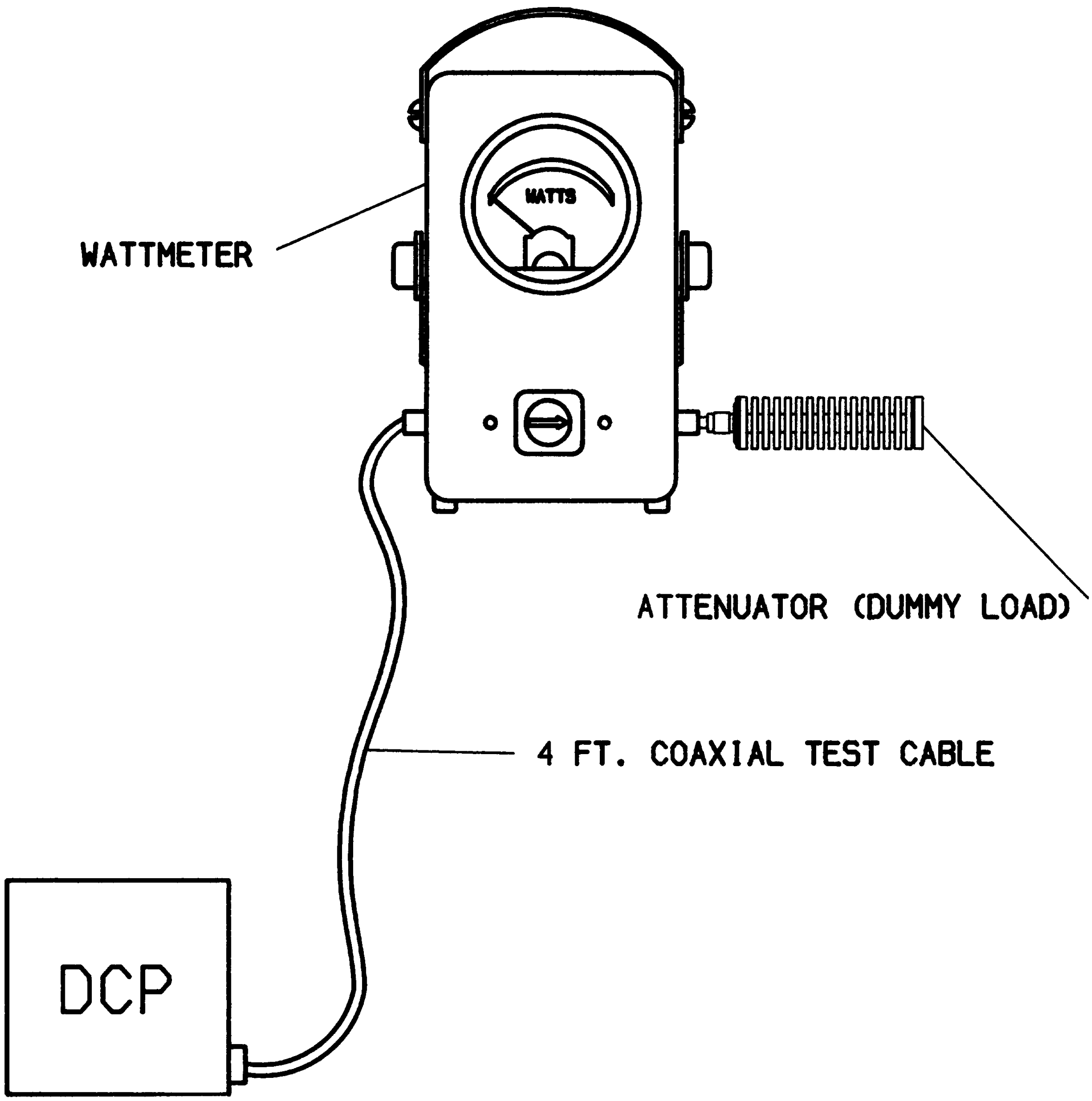


Figure 31.--Wattmeter, dummyload, and test cable setup to test forward power of self-timed channel or random channel.

NOTE: The self-timed channel test must always be made through a dummy load (unless made during assigned transmission time). Making the test transmission through a dummy load absorbs and dissipates the signal and power generated by the DCP so that transmissions from other DCP's will not be blocked. The dummy load protects the DCP transmitter from damage that can occur if transmissions are sent through an open line. During testing of the random channel, transmissions can be sent through the antenna without fear of disturbing other transmissions.

To test the reflected power of a DCP (fig. 32) antenna, antenna extension cable, and coaxial connectors, attach one end of a 4-foot test cable to the DCP radio frequency port and the other end to the wattmeter input connector. Attach the antenna extension cable to the wattmeter output connector and to the antenna. Turn the wattmeter element so the arrow points toward the wattmeter input connector. Activate the random channel and observe the microammeter. The reflected power should read 0.5 to 2.0 watts. If the reading is greater than 2.0 watts, a problem exists within the antenna, antenna extension cable, or coaxial connectors. To isolate the defective equipment, substitute a 15-foot test cable in place of the antenna extension cable. Reactivate the random channel. If the reflected power is less than 2.0 watts, then the antenna extension cable is bad; if the reflected power is greater than 2.0 watts, replace the antenna and retest.

When performing a test of the reflected power, always use the random channel. If a transmission is sent on the self-timed channel at other than the assigned times, interference with other DCP's is possible.

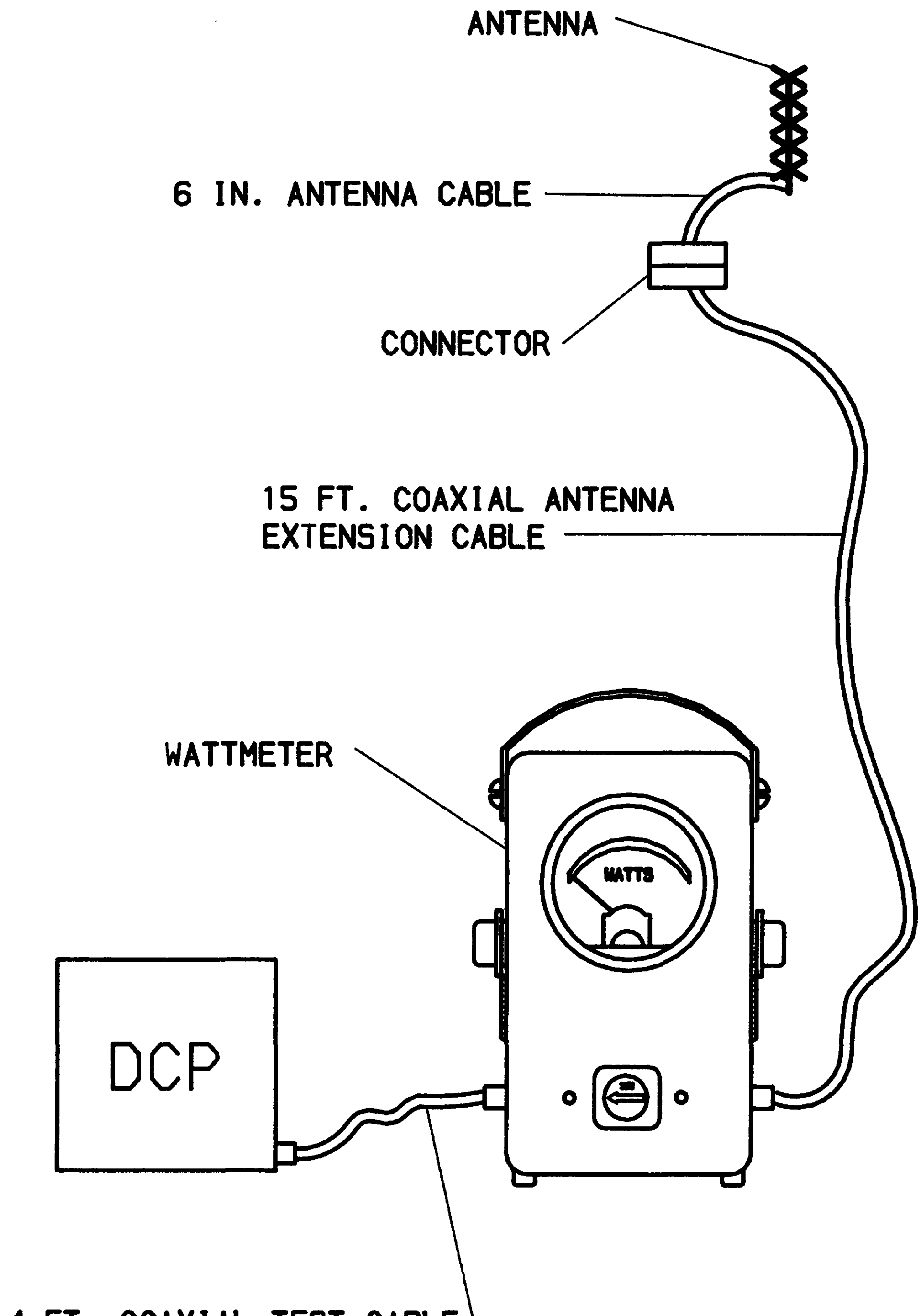


Figure 32.--Wattmeter and test cable setup to test reflected power for use only with random channel.

DIGITAL DEVICES

By Jack Hardee

Two types of digital devices are commonly used in Survey field installations: 1) up counters (tipping-bucket rain gages or anemometers) and 2) up-down counters (incremental shaft encoders).

Data from mechanical analog sensors such as floats, manometers, and deflection vanes have to be digitized before they can be input to a DCP. Some type of encoder is used to code the data into a form that the DCP can read. In the Survey, this code typically is binary coded decimal (BCD).

The two most commonly used devices for encoding mechanical analog data (such as stage) to the DCP are

- a digital, 16-channel punched-paper-tape recorder with an encoding attachment, such as the Module A encoder for the Leupold and Stevens (L&S) 7000 recorder or the telemetry kit for the Fischer-Porter Model 1542 recorder and

- incremental shaft encoders, which are made by most DCP manufacturers.

Analog-to-digital Recorder with Encoder Attachment

The only encoder attachment for ADR's purchased and made available on the rental program by HIF is the L&S Module A. The L&S ADR with Module A is an electromechanical device (fig. 33). During an update, the recorder drives 18 latch bars to the recorder code drum. Each latch bar has a small reed switch attached to it. If a latch bar strikes a ridge on the code drum (1 logic), the bar is forced down and positions the reed switch near a magnet, which closes the switch. If the latch bar is opposite a valley on the code drum (0 logic), the reed switch is left open. Upon scanning, the DCP reads, in parallel, the momentary closure of the reed switches. When the recorder is near the end of its cycle, the recorder sets all reed switches to an open position, where they remain until the next update.

Testing the Analog-to-digital Recorder with Encoder Attachment

Test the ADR with Module A thoroughly before placing it in the field. Measure the cycle time and cycling current, and test the operation of Module A as described below:

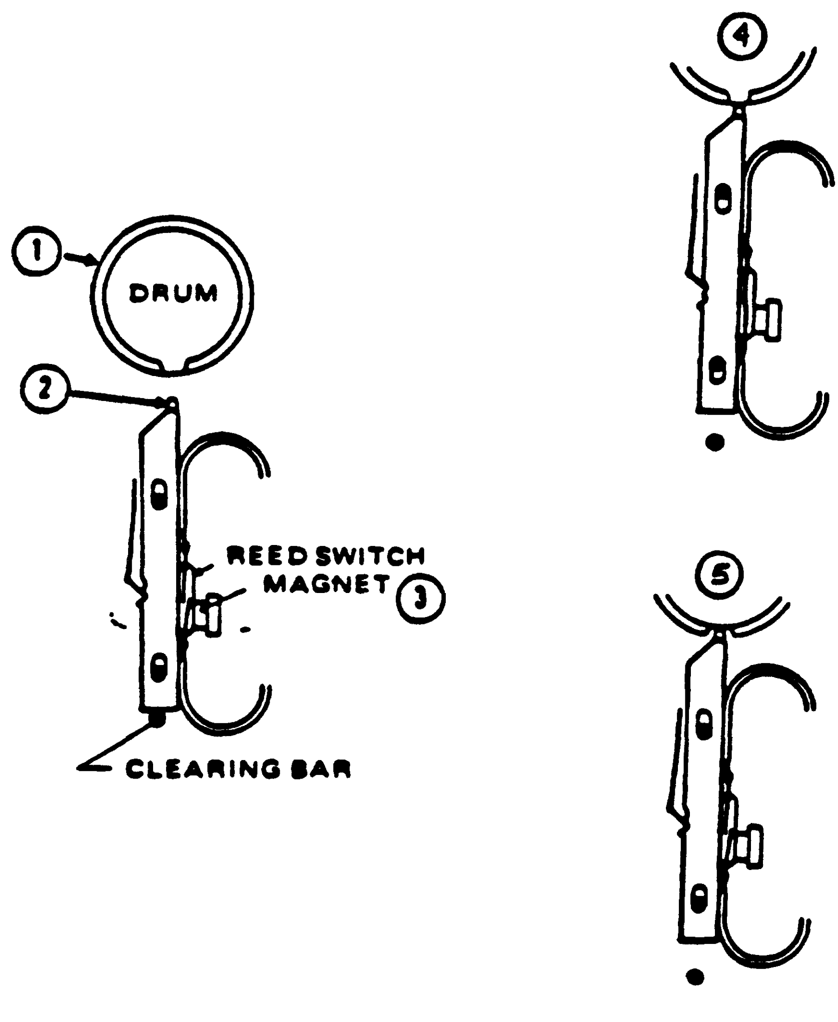
1. Cycle time--The recorder should complete cycle in 8 to 15 seconds.

2. Cycling current--The recorder should draw no more than 400 milliamperes (mA) when operating correctly.

3. Module A--Connect recorder to a DCP, set recorder to all zero's, scan, and read the encoded value from the programming set connected to DCP. Repeat this process by setting recorder to all

one's, all two's, and so on through all nine's or setting recorder to 1248, 2481, 4812, 7777, and 8124. If erroneous values appear on the programming set, scan the recorder again and observe latch bars while recorder is cycling to determine that only the latches necessary to encode the value are driven down.

If the ADR and Module A do not pass the above tests, return the unit to the HIF with a clear and detailed description of the problems that were encountered.



1 - Recorder Code Bar
2 - Latch Bar
3 - Reed Switch (open) and Magnet
4 - Latch Bar on ridge (1 logic)
5 - Latch Bar in valley (0 logic)

Figure 33.--Operation of Leupold and Stevens Module A encoder.

Troubleshooting the Leupold and Stevens ADR Equipped with a Module A

Failures of an L&S ADR equipped with a Module A can often be diagnosed by a characteristic symptom. This section discusses two symptoms and possible causes for the failures.

SYMPTOM: Encoded data contains intermittent gage-height values of 00.00.

POSSIBLE CAUSES FOR FAILURE:

Failure of the ADR to cycle can cause 00.00 to be encoded to the DCP if the digital tape is running slowly. Common reasons for the failure of the ADR are:

- The platform fails to strobe or deliver power to the ADR. Test the ADR 7.5-volt power supply with a voltmeter during a scan to check the 7.5-volt strobe. Refer to the manufacturer's operations manual for pin location. If the platform does not deliver the 7.5-volt strobed voltage, the problem is with the platform.

- The ADR microswitch is faulty or out of adjustment. Poor adjustment of the microswitch often causes the coding of alternating good data and zeros.

- The ADR cycles too slowly or too quickly. With this problem, the momentary closures of the Module A reed switches are outside of the specific time window in which the DCP reads the encoder. Time the ADR cycle, to determine if this type of malfunction is occurring. Check the cycle time before the ADR is placed in the field to help avoid this problem.

SYMPTOM: Encoded gage-height values on the paper tape are valid binary coded decimal (BCD) characters, but values in the DCP are incorrect as in example 1 or gage-height values are invalid BCD characters (HEX A, B, C, D, E, F) as in example 2.

POSSIBLE CAUSES FOR FAILURE:

- The latch bars have too much side play or lateral movement. If the latch bars have too much lateral movement, the friction of one dragging against another can cause adjacent bars to be drawn down or the bar can move under an adjacent code disk on the coding drum and can read a one instead of the desired zero. Check for this problem by moving the latch bars through their full lateral movement when conducting the ADR bench test.

- Friction from foreign material between the bars causes the latch bars to draw down adjacent bars. Dirt, fine sand, or even ice between latch bars can cause this problem.

EXAMPLE 1:

Erroneous value		Correct value	
Binary	Platform output	Binary	Platform output
0001 0101 0111 1000	15.78	0000 0101 0111 1000	05.78

In example 1, the erroneous value does not have any invalid BCD characters. The 10 bit is encoded in error. A large error of this type is fairly easy to detect. An error that occurs in the tenth's or hundredth's place is difficult to identify.

EXAMPLE 2:

Erroneous value		Correct value	
Binary	Platform output	Binary	Platform output
0000 0110 1101 0111	06.D7	0000 0110 1001 0111	06.97
		or	
		0000 0110 0101 0111	06.57

In example 2, the 0.8-bit or the 0.4-bit reed switch has closed instead of remaining open. The operator usually can determine the bit that is in error by observing correctly encoded values adjacent to the erroneous ones. In any case, the tenth's place has an invalid BCD character.

Incremental Shaft Encoders

The incremental shaft encoder digitizes the position of a rotating shaft. The encoder causes two switches to close and open as the shaft rotates. The closing and opening arrangement of the switches allows each switch to output a square wave form that is 90 degrees out of phase with the other (fig. 34). An accumulating up-and-down counter reads each side of the square wave form that is pulsed by the switches. As long as the shaft rotates in one direction, the counter adds or subtracts one count (depending on the direction of rotation) for each pulse made by the switches. As the shaft rotates in any given direction, the pulses alternate between switches. If the direction of rotation changes, the same switch outputs two consecutive pulses. When this occurs, a logic circuit detects the condition and the counter begins to accumulate counts in the opposite direction.

The switches may be mechanical or solid-state devices and usually output 100 pulses for each revolution. Therefore, if the encoder shaft rotates once for each 1-foot change in stage, each pulse or count equals 0.01 foot. This arrangement allows the use of ADR float wheels, sprockets, and chain for driving the incremental shaft encoder.

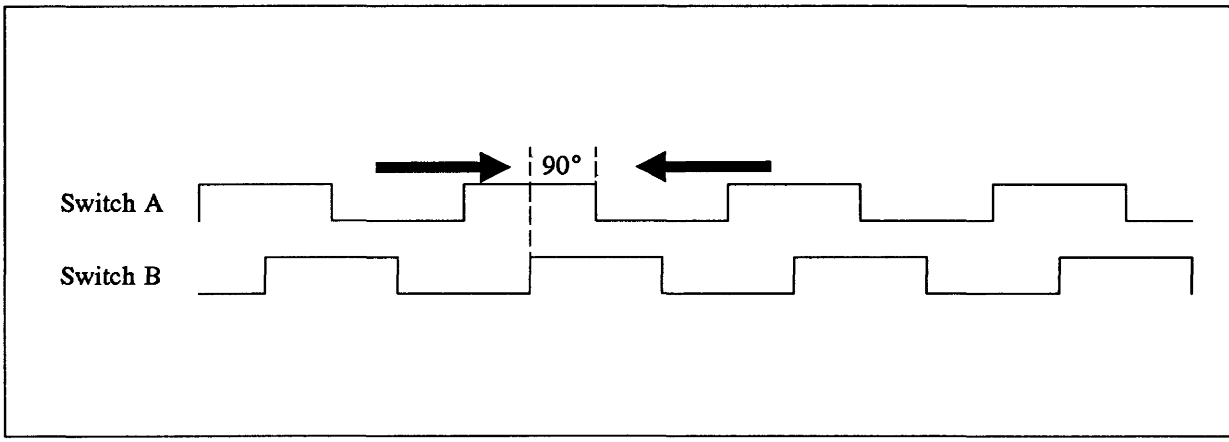


Figure 34.--Output from incremental shaft encoder.

Handar Model 565A Electronic Stream Gage

The Handar Model 565A (fig. 35) is designed to be an electronic replacement for the L&S Model 7000 with Module A or the Fischer-Porter Model 1542 with telemetry. The system emulates either of the electromechanical ADR's and provides an interface for most DCP's. The Handar Model 436A encoder senses the pulley-angle position and sends the information to the data encoder, which stores the data in low-power complementary metal-oxide semiconductor (CMOS) circuits. Upon command from the DCP, the Handar Model 565A transfers the data to the DCP with the same timing as a slow-cycle ADR. This model uses a lithium battery as a backup power source to maintain the operation of the encoder system if the external power is interrupted. The data encoder contains four LED displays for observing the current gage height. Depressing the READ button activates the display. Four switches, which can be set to the current gage reading, calibrate the data encoder.

The plastic insulators should be removed from the lithium-battery holder when the unit is placed into service. The lithium batteries provide power to the unit for short intervals during servicing of the DCP system. The insulators should be replaced or the batteries removed when the Handar Model 565A is taken out of service.

The shaft on the Handar Model 436A is compatible with a Standard ADR float shaft so that most pulleys and clamps install easily. The encoder normally operates so that clockwise rotation of the pulley corresponds to increasing readings. The direction of the responses to pulley rotation can be changed by reversing the connection of the red and yellow wires in the Handar Model 565A.

The user calibrates the data encoder by setting the internal switches to the measured gage reading and pressing the LOAD switch. Depressing the READ switch displays the current reading of the encoder. The user may read the Handar Model 524 DCP encoder value by placing the programming unit in the program mode and monitoring digital channel 01. When the equipment is operating correctly, this reading and the reading observed on the internal LED display are the same, assuming that the ADR cable is wired to provide the strobe on channel 01.

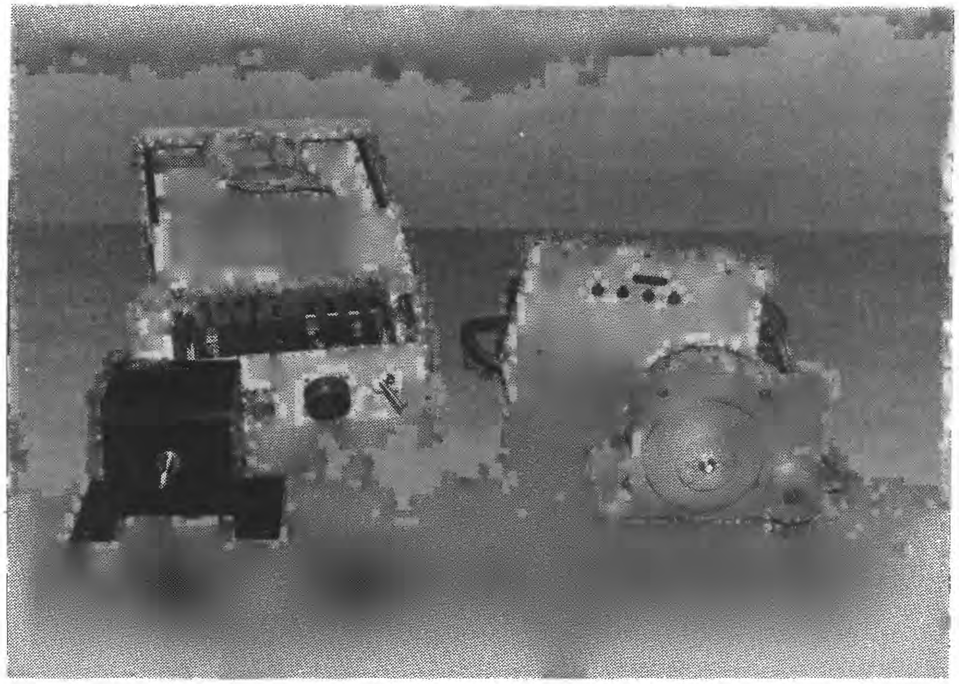


Figure 35.--Handar 436A incremental shaft encoder and 565A interface (left) and HIF incremental shaft encoder and interface (right).

The internal lithium batteries have a service (not shelf) life of about 288 hours and, under normal operation, do not require replacement for the life of the Handar Model 565A. The current drain on these batteries is about 0.7 mA anytime the Model 565A is not connected to an operating Model 524 or equivalent platform supplying 7.5 volts of continuous power to the Model 565A.

U.S. Geological Survey Shaft Encoder/Interface for Handar Model 524, LaBarge Convertible, and Sutron Data-Collection Platforms

The interface instrument consists of a shaft encoder unit and a microprocessor-controlled interface box. The shaft encoder is an incremental type that uses optics and a slotted code wheel to detect changes in the encoder's shaft position. By monitoring the changes in the shaft position, a microprocessor in the interface box tracks the encoder's reading. In addition to the encoder, the interface box also has an input for a tipping-bucket rain gage, a standby battery connector, and an analog jack. The pins in the analog jack are connected directly to the pins in the DCP. When strobed by the DCP, the interface sends the encoder and rainfall data to the digital port of the DCP. Using the interface box, the user reads water stage and rainfall from a six-digit display and sets initial values with four pushbutton switches. The encoder has a shaft input identical to those used by the L&S and Fischer-Porter digital recorders, thus ensuring compatibility with existing wheel and (or) sprocket assemblies. For further information, order the HIF Operating Manual 85-01 USGS Shaft Encoder/ Interface Stock Number 0000802.

To install the encoder, anchor it using the mounting holes and level the encoder with the leveling adjuster. The encoder can be chain or float driven. Connect the encoder to the interface with the four-pin connector. If the cable is not long enough, cut it and splice in a section of cable no more than 400 feet long. Connect the interface's large cable connector to the Handar, LaBarge, or Sutron DCP. The interface equipped for the Sutron platform has spade lugs on its output cable in place of the plug. Refer to the table in the Sutron manual (ADR connection) for their proper connection. Connect the battery cable from the back of the platform connector to a 12-volt power source. This power source powers the platform and the encoder interface units.

Press the down button to observe the stage reading on the display. If the encoder shaft is turned, the reading changes. To display rainfall, press the up button and hold until the left-most digit indicates channel 1. Manually tip the bucket on the rain gage, and the reading on the display increases by 1. The rain-gage switch has to be open for a second or two before it counts a closure. Thus, operating the switch rapidly in succession causes no counts. This design is to prevent switch bounces from being counted.

Setting Initial Values of Stage and Rainfall

Channels 2 through 7 are used in conjunction with switches A and B to set initial values. Channels 2, 3, and 4 set stage, and channels 5, 6, and 7 set rainfall. An interlock prevents accidental change of the readings. To advance past this interlock to the set channels, press the up and down buttons at the same time. Use each channel in conjunction with buttons A and B to perform tasks as indicated on the cover. For example, moving to channel 2 and then pressing A reduces the stage reading by 0.01 foot (pressing B would increase the stage reading by 0.01 foot). Thus, the user can use channel 2 to set the 0.01 digit. In a similar way, use channel 3 to set the 0.1 and 1 digits and channel 4 to set the 10 digit. Set rainfall in the same way as stage except use channels 5, 6, and 7.

After the values are set, the platform programming set can be used to read the data from the interface. Follow the instructions provided with the platform. The platform reads the interface in the same way it reads a stage recorder equipped with a Fischer-Porter telemetry kit or an L&S Module A.

Analog-to-Digital Recorder Channel Selection

The interface units are shipped with stage data set to transmit to DCP output digital channel 1 (ADR 1) and rainfall to output to digital channel 2 (ADR 2). Jumpers on the interface circuit card determine these channel selections. The user can designate that stage or rainfall be output on channel 1, 2, 3, or 4, but should not select the same channel for both. Table 4 shows the jumper's position for the various channels. To change channels, remove the jumper and install it in the proper row.

Table 4.--*Channel positions for jumpers on the interface circuit card*

	COLUMN E		COLUMN F		COLUMN J		COLUMN A
Row 1	0	CH 1	0	Row 1	0	CH 1	0
Row 2	0	CH 2	0	Row 2	0	CH 2	0
Row 3	0	CH 3	0	Row 3	0	CH 3	0
Row 4	0	CH 4	0	Row 4	0	CH 4	0

Standby Battery

When the power is disconnected, the interface loses the stage and rainfall readings. If the display is off and the battery is changed within 10 seconds, the readings are not lost. If the loss of data with power is a problem, connect the standby-battery lead to a 12-volt standby battery. The interface draws its power from the higher voltage battery. Replace or recharge the standby battery when the platform battery is serviced. An alternative is to use a General Electric or Gates 2.5- or 5-Ah rechargeable 8-volt lead-acid battery. If this alternative is used, the interface trickle charges the standby battery from the main battery eliminating standby-battery maintenance (fig. 36). Tie back or tape the standby-battery leads when they are not in use, to prevent shorting to other power devices.

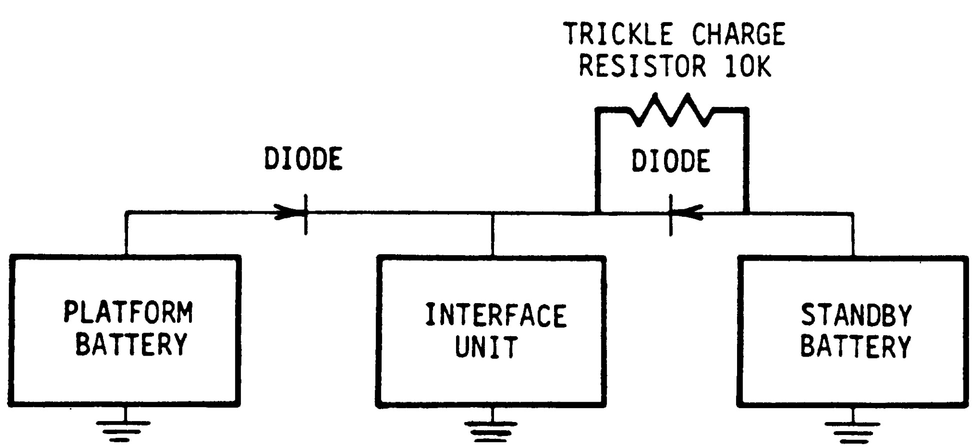


Figure 36.--Battery circuit for HIF shaft encoder interface.

Analog Connections

An analog plug provides for connection of analog signals to the DCP. The pins in this plug connect directly to the pins in the DCP as indicated in table 5.

Because of wiring differences, the LaBarge and the Handar platforms are grounded differently. Before using the analog on the interface, determine if the ground wires are connected properly for the platform being used. For the LaBarge DCP, the WHT-RED-BLK wire connects to pin 1 of the analog jack and the WHT-PUR is open. Insulate the open wire to prevent it from shorting to the circuit card. For the Handar Model 524 platforms, connect the WHT-RED-BLK and the WHT-PUR to pin 1 of the analog plug.

Table 5.--*Pin positions for analog connector*

Interface pin	Interface color	Use	Platform pin
A	WHT-YEL	ANL1	(j)
B	WHT-BLU	ANL2	(z)
C	WHT-BLK-BRN	ANL3	(m)
D	RED-YEL	ANL4	N
E	WHT-BLK-BLK	ANL5	AA
F	WHT-BLK-GRN	ANL6	T
G	WHT-BLK-PUR	ANL7	U
H	WHT-BLK-RED	ANL8	(n)
I	WHT-RED-BLK	GRD	E,F,DD
I*	WHT-PUR	ANL GD	(r)
J	WHT-BLK-GRAY	12V SWITCHED	A

*Note: (r) must be left open for use on the LaBarge platform.

Sutron Incremental Shaft Encoder

The Sutron Model 8201 incremental shaft encoder (fig. 37) is a stand-alone instrument for measuring stage. The encoder includes a 1-foot-circumference float wheel, a low-power optical sensor, an LED display, and initializing buttons. The average power consumption is 1.5 mA from an external 12-volt supply; an internal rechargeable battery provides 7 days of standby power.

The shaft encoder interfaces to the Sutron DCP using a ±12-volt ground and a single-parameter connection (B1-B16) for control and data. The encoder can be located more than 5,000 feet from the DCP and has a range of 0 to 655.25 feet.

The user can read the encoder at any time by pressing the READ button. Use other buttons--UP and DOWN--to preset or alter the current encoder value; however, the UP and DOWN button operates only if the READ button is also pressed. The encoder has an internal switch for clockwise or counter-clockwise operation.

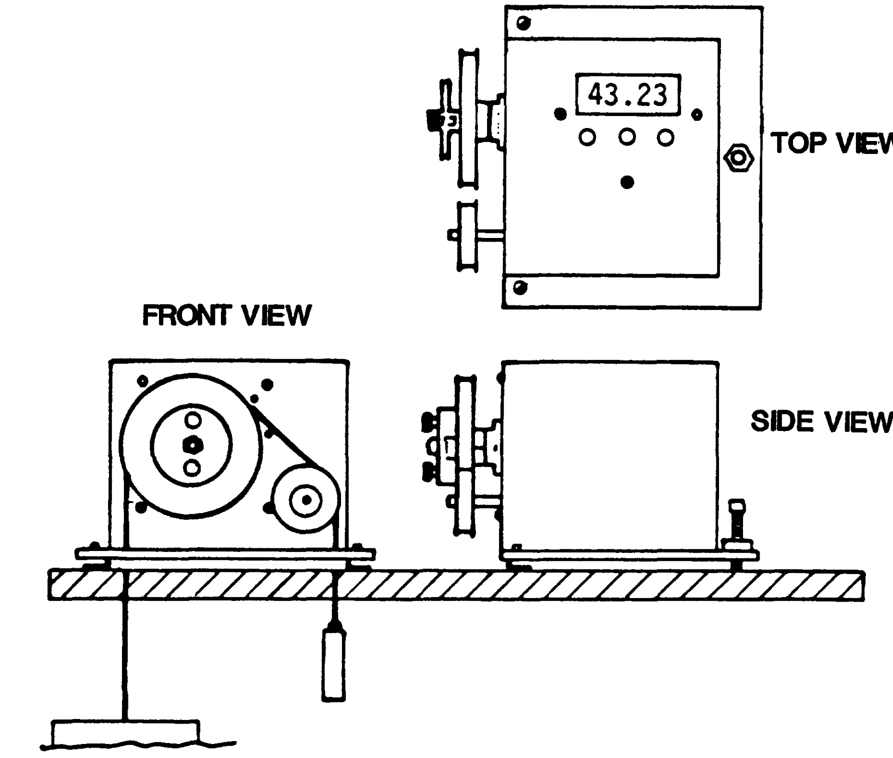


Figure 37.--Sutron Model 8201 incremental shaft encoder.

Internal Battery Connections

The internal battery of the Sutron encoder is a rechargeable 6-volt gell-cell battery. When the battery is connected to the encoder circuitry, the circuitry activates and draws 1.5 mA even if no other power is connected. Connect the battery only if the unit is to be tested or installed. To connect the battery, attach the black cable to the negative (-) terminal and the red cable to the positive (+) terminal. The circuitry is reverse voltage protected so the circuitry cannot be damaged by reverse hookups.

Clockwise-Counterclockwise Operation

The operator may set the Sutron encoder reading to increase with clockwise or counterclockwise shaft rotation. The jumper pins on the solder side of the encoder circuitry allow this selection. With the pins shorted together (by use of the blue jumper provided), the unit is configured for counterclockwise operation; with the pins disconnected (no jumper installed), the encoder operates clockwise. The blue jumper normally is taped to the cover for future use when not installed.

Data-Collection Platform Connections and Setup

The Sutron Model 8201 encoder interfaces directly to the Sutron 8004B or the LaBarge CDCP. The Model 8201 encoder interface can be used with the Sutron 8004A DCP at an increased cost; however, the maximum value sent to the DCP is 9999. The operator may replace the standard 10-foot length of 3-wire cable with a longer cable. The cable (fig. 38) connects to ground (GND), +12 volts, and any parameter (1 to 16 on the DCP). Built-in encoder GND and +12-volt line protection prevent reverse connection damage.

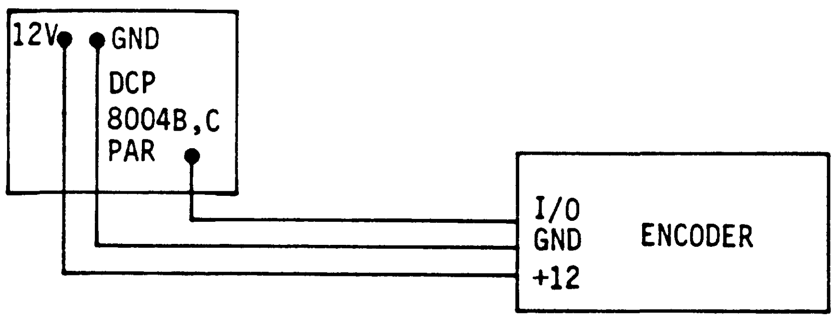


Figure 38.--Sutron data-collection platform encoder connections.

Activating the Display

Press READ to activate the display. The display remains lighted for 30 seconds after the operator releases READ. If the display shows an incorrect value or an E indicating an error condition, use the procedures in the following sections to set a proper value or clear the error indicator.

Increasing and Decreasing the Encoder Value

Two methods increase the encoder value:

- Rotate the shaft with the drive chain or float wheel.

- Use the buttons marked READ and UP. With READ pressed, momentarily press UP--the value will increase by 1 (0.01 if decimal point included). Press UP and READ simultaneously to obtain large increases needed to arrive at the proper value. After 4 seconds, the value changes by 50 (0.50 if the decimal point is included) every quarter of a second. Release UP and READ when the value is approached and then use momentary pressure to advance the reading to the exact value. The encoder value does not rise indefinitely. The maximum value is 65525 after which the value rolls over to 0.

Three methods decrease the encoder value:

- Rotate the shaft with the drive chain or float wheel.

- Reset the display as described in the next section.

- Use the buttons marked READ and DOWN. With READ pressed, momentarily press DOWN--the value will decrease by 1 (0.01 if a decimal is included). Unlike holding the UP button, holding DOWN does not cause a quick decrease in the value. Any decrease of the value below 0 rolls the number over to the maximum value--65525.

Clearing the Error Indicator and Resetting Encoder to Zero

When the encoder is powered up, the encoder value is set to 0 and any error conditions are cleared. To reset the indicator and value, remove all power to the encoder and then reapply it. The buttons, if pressed correctly, also reset the encoder. Request the reset by holding down the UP-and-DOWN buttons and momentarily press READ. If the error indicator E appears on the display, the reset clears the indicator but leaves the value intact. Clear the value by performing the same reset sequence (hold down UP or DOWN buttons, momentarily press READ) when no error conditions are indicated.

Error Indicator

The program displays the encoder value when the operator presses READ. An E to the left of the data warns of an error. When an E is present, the data displayed may be in error. Like many encoders, the Model 8201 samples the code wheel to detect changes in the wheel position. If the wheel rotates faster than half the sample rate (300 hertz (Hz)), the detected changes are unreliable. The encoder can detect these conditions and set the error indicator. The maximum rate sensed by the encoder is 10 feet (10 turns) for each second. If the level sensed by the encoder changes faster than this, the error indicator should be set.

Installation of Incremental Shaft Encoder

Incremental shaft encoders manufactured by Handar and the HIF have a 5/16-inch shaft with 24 threads per inch. These sizes are the same as those for the float wheel shafts on Fischer-Porter and L&S ADR's. The Synergetics and Sutron shaft encoders have a 1/4-inch, nonthreaded shaft; therefore, other provisions need to be made for driving these encoders.

Figures 39 and 40 show a Handar Model 436A incremental shaft encoder installation. A 1.5-foot-circumference (1:6) L&S Model A-35 float wheel, using Precision Industrial Components (PIC) "No Slip" geared pulleys and drive belt, drives the Handar encoder (figs. 41 and 42). The PIC belts, made of molded polyurethane with multiple strands of Dacron or stainless steel core, have an allowable static pull strength of 20 pounds for the Dacron core and 100 pounds for the steel core. The Winfred M. Berg Co. (Appendix A) manufactures a similar type of belt and geared pulley that is interchangeable with the PIC system. The geared pulleys, which are made of anodized aluminum and need to be tapped to fit the recorder and encoder

Figure 39.--Gaging station data-collection platform installation with Handar 560 platform and Handar 436A incremental shaft encoder.

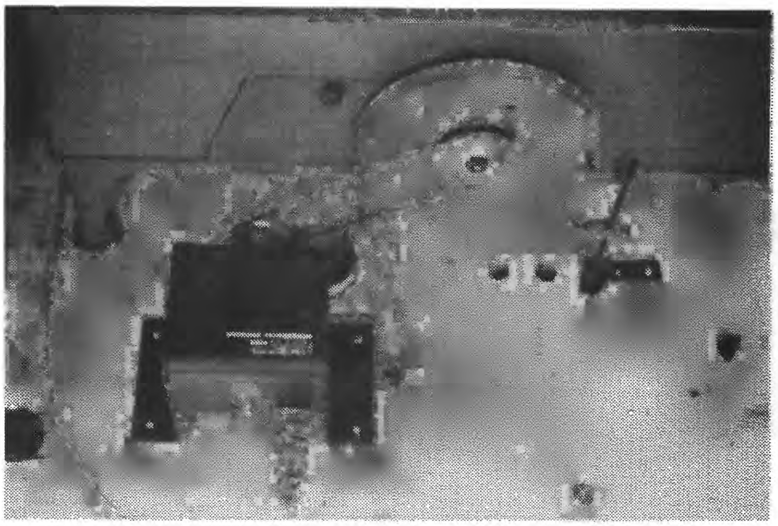


Figure 40.--Handar 436A incremental shaft encoder driven by a Leupold and Stevens A-35 recorder using a Precision Industrial Component geared-belt system.

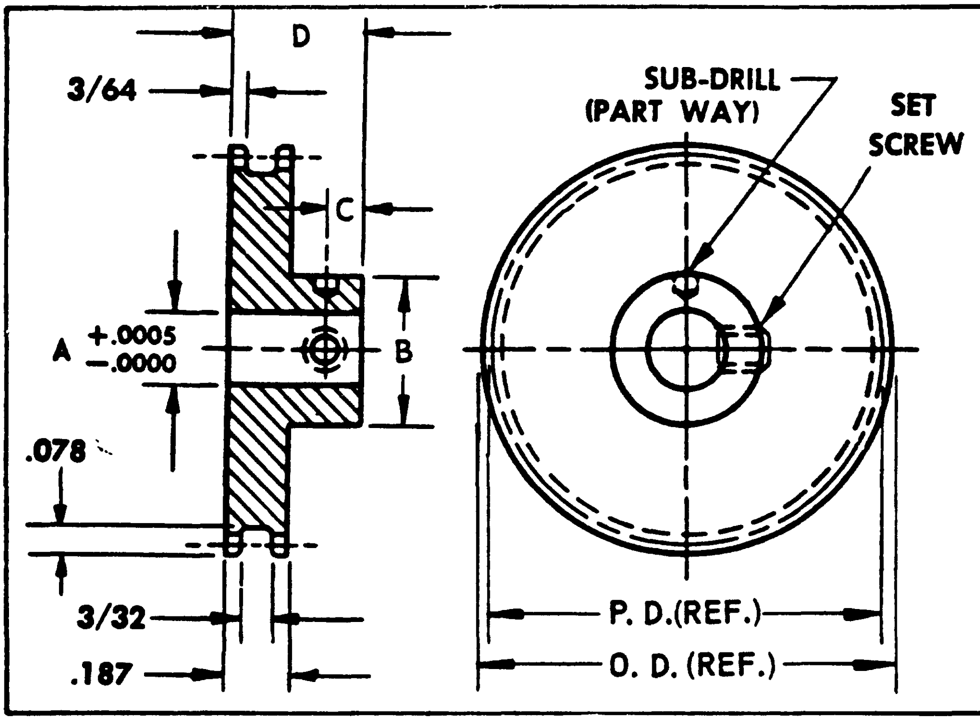


Figure 41.--Precision Industrial Component "No Slip" geared pulley.

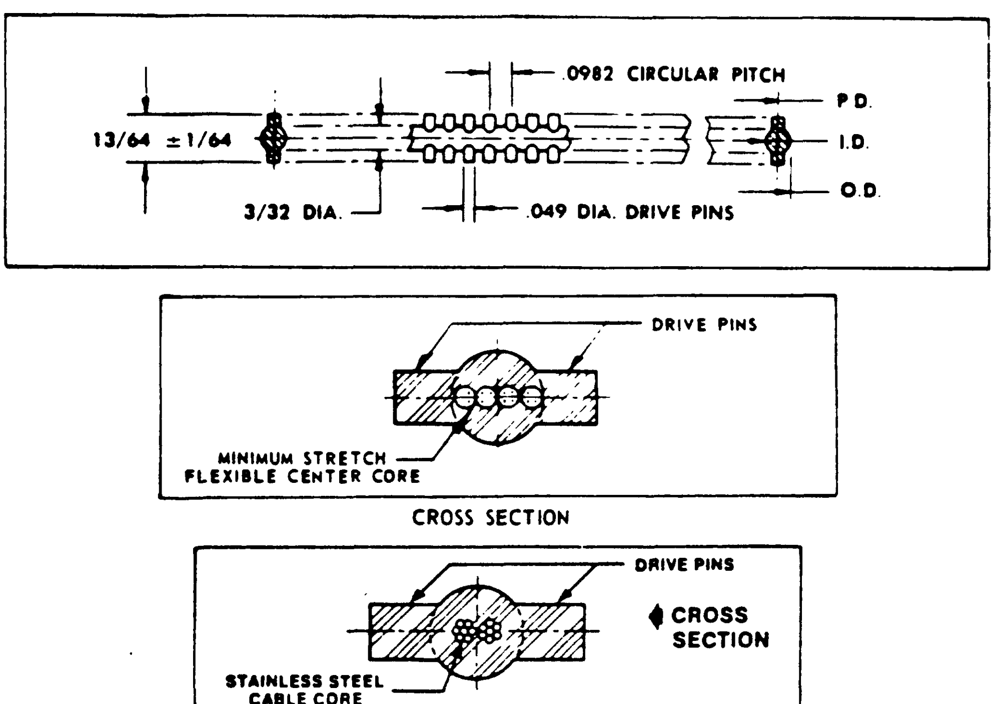


Figure 42.--Precision Industrial Component "No Slip" drive belt.

shaft threads, have a drive ratio of 1.5:1. The geared pulley on the recorder has 72 teeth, and the encoder pulley has 48 teeth. If the float wheel of an ADR drives the encoder, use a 1:1 drive ratio.

Set belt tension with the A-35 recorder's level adjustment on the legs. If an ADR drives the encoder, make some other provision for adjusting belt tension. Slotted fastening holes on the encoder or a base with slotted fastening holes can be used to facilitate this adjustment.

Standard copper ladder chain and sprockets can drive an encoder from an ADR by using two 20-tooth or two 10-tooth sprockets (HIF Catalog No. 5305001 or No. 5305002). A standard sprocket combination is not available to drive an encoder from an A-35 recorder when using the recorder's float wheel. If the user operates an incremental encoder with a manometer, many different combinations from manometer to encoder may be used. Figure 43 shows the various copper-ladder-chain sprocket sizes used for different combinations of recorders and encoder.

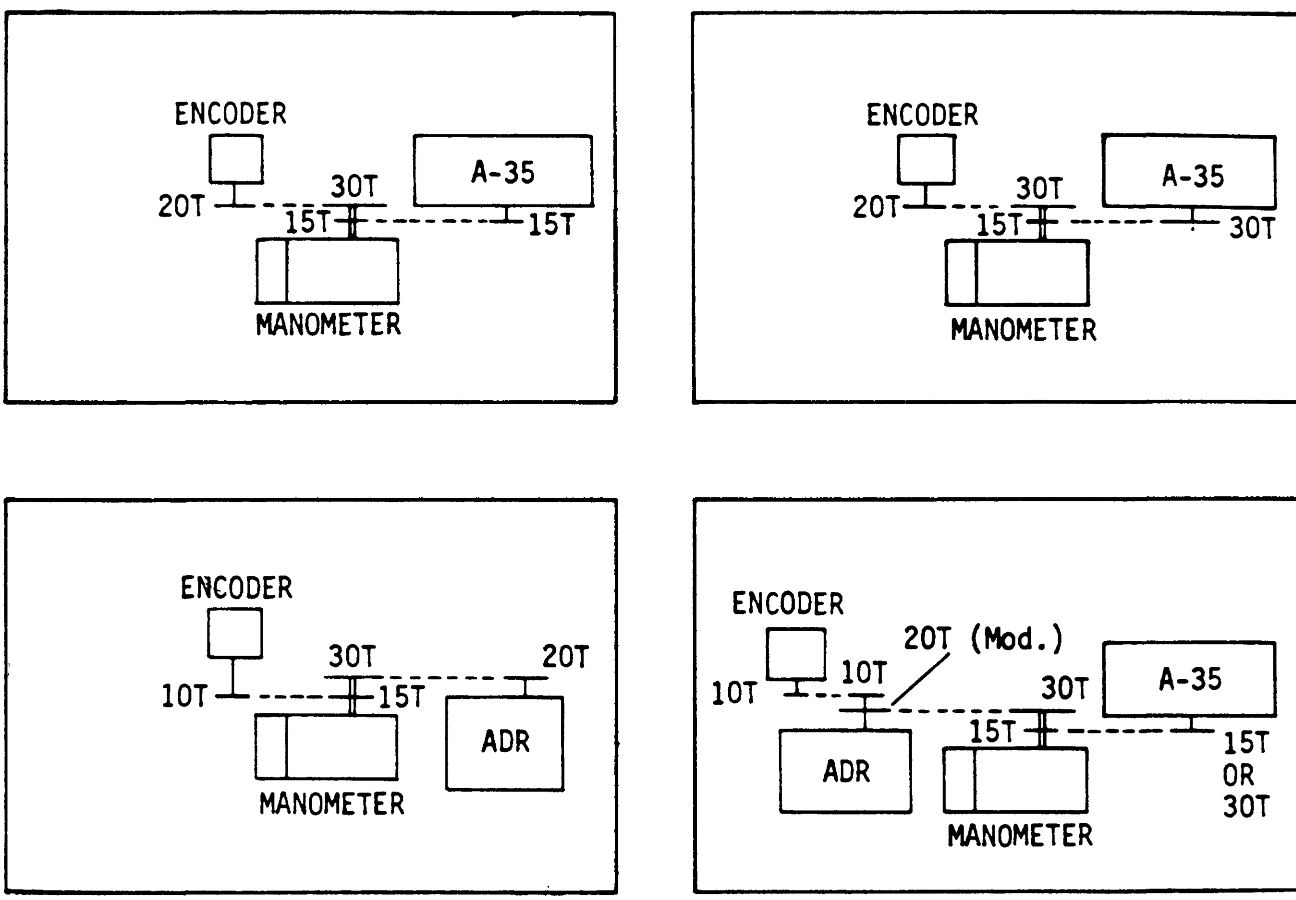


Figure 43.--Combinations of copper ladder chain hookups between manometer, recorders, and incremental shaft encoder.

The HIF warehouse also stocks hubs with 1/2-inch shoulders that can be pressed into the ladder chain sprockets and ADR float wheels. Hubs are available for 1/4-inch shafts (HIF stock number 5304016) and 5/16-inch shafts (HIF stock number 5304020). Encoders connected to sprockets and tape wheels with the above hubs do not require mechanical adjustment. The operator may set the precise reading, using the software in the DCP.

If the PIC geared-belt or similar systems are used, only two geared-pulley sizes are needed to drive the encoder regardless of station (manometer or float) or recorder type. This system requires that the encoder always be driven by the recorder. The only exception is a 3.0-foot-circumference (1:12) L&S Model A-35 or A-71 float wheel, which cannot be used because the float wheel protrudes into the plane of the drive belt. If a 1:12 gage-height scale is needed in a float-operated station, a scale-reducing attachment (L&S gage-scale standard with clamp assembly for ratio 1:12, part No. 31140) can be added to the recorder. This attachment produces a 1:12 chart scale using a 1.5-foot-circumference (1:6) float wheel. Table 6 shows various PIC geared-pulley sizes for different encoder-recorder combinations.

An advantage of an incremental shaft encoder is that the operator can locate it some distance from the DCP. This is particularly useful if an auxiliary gage is needed or two gages are close enough so that one DCP can be used to transmit data from both gages. The maximum distance between the encoder and the DCP locations depends upon whether the encoder switches or the up-and-down counter transmits as pulses.

The Sutron Model 8201 incremental shaft encoder is a stand-alone unit that contains the pulsing switches and the up-and-down counter. The counter serially transmits the output data to the DCP by a three-conductor cable. This arrangement allows the encoder to be located as far as 5,000 feet from the DCP.

Table 6.--*Various Precision Industrial Components geared-pulley sizes for different encoder-recorder combinations*

Combination	Recorder geared pulley	Encoder geared pulley
ADR to encoder[1]	72 tooth, tapped for 5/16-inch; 24 threads per inch	72 tooth, tapped for 5/16-inch; 24 threads per inch
A-35 or A-71 with 1.5-foot float wheel (1:6) to encoder[2]	72 tooth, tapped for 1/4-inch; 32 threads per inch	48 tooth, tapped for 5/16-inch; 24 threads per inch

[1]If ADR is driven by manometer, use a 20-tooth, modified, copper ladder-chain sprocket (HIF No. 5305000) for manometer linkage.

[2]If 1:12 chart scale is needed, use scale-reducing attachment.

Handar Model 436A, Synergetics, and HIF incremental shaft encoders contain only the pulsing mechanism; this limits the distance between encoder and DCP to about 400 feet. The DCP or an interface unit, depending on the type and model of DCP, contains the counter portion. The operator uses a four-conductor cable to connect the encoder to the DCP or interface unit. If the encoder is to be located more than 10 feet from the DCP, the connecting cable needs to be shielded and the shielding properly grounded. If the cable does not have grounded shielding, external interference can cause spurious counts, which produce an accumulative error in gage height.

Tipping-Bucket Rain Gage

The tipping-bucket rain gage is a true digital sensor and is one of the easiest to interface with a DCP. An electronic counter within or external to the DCP accumulates the count of switch closures activated by each bucket tip--each tip being equivalent to some increment of precipitation. The earlier DCP's, such as the LaBarge CDCP and Handar 524, required that tipping-bucket counters be added as an optional item. Data-collection platforms presently being manufactured include tipping-bucket counters as a standard feature.

Three types of switches activate tipping buckets: mercury switches, microswitches, and magnetically actuated proximity switches. The microswitch, which is found on some models of the Survey type 0.10-inch tipping-bucket rain gage (fig. 44), is of marginal reliability when used with electronic counters. The user can obtain better results by replacing the microswitch with a proximity switch, such as the Hamlin proximity switch No. 5801, or a mercury switch. To make the switch change, replace the microswitch actuator cam with an actuator arm to which the magnet is attached.

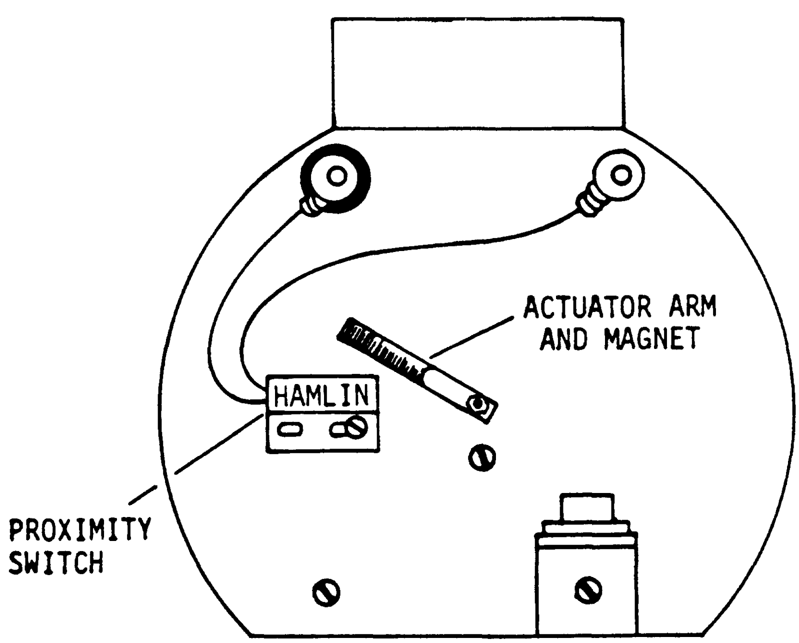


Figure 44.--USGS 0.1-inch tipping-bucket rain gage with switch modification.

Secure the magnet to the actuator arm with shrink tubing. Mount the switch by drilling and tapping an additional mounting hole as shown in figure 44. The actuator arm needs to be made of sheet aluminum or brass, 1-3/8-inch long by 1/4-inch wide by 1/16-inch high.

Accurate measurements depend upon accurate leveling of tipping-bucket rain gages at installation. Test a tipping-bucket rain gage after installation to determine its proper functioning and the accuracy of its measurements. Slowly pour a quantity of water equivalent to the volume of the basket into the rain gage to ensure that the bucket tips. Perform this test four or five times, observing the tip count each time to ensure that each tip is registering. If the bucket tips before all the water is poured in or does not tip, the rain gage is out of level or the bucket is out of adjustment. The quantity of water required to produce one tip using various types of rain gages is shown in table 7.

Table 7.--*Quantity of water for various types of rain gages*

Type	Amount of water equivalent to one tip (milliliters)
8-inch ID orifice, 0.1-inch for each tip	82.37
8-inch ID orifice, 0.01-inch for each tip	8.24
12-inch ID orifice, 1 mm for each tip	72.97

Perform this test periodically to ensure continuing proper calibration of the rain gage and correct functioning of all elements.

Other Uses of Electronic Counter

The operator also may use the electronic counter as an event counter for the following applications:

- count the number of samples taken by a water-quality or sediment sampler,
- count output from totalizing anemometers, and
- count the cycles of an auxiliary ADR to monitor its operation.

ANALOG DEVICES

By Henry E. Herlong and Clayton D. Kauffman, Jr.

Analog sensors used with DCP's are analog-voltage devices. The voltage (0 to 5 volts) output to the platform is directly proportional to the parameter value. A generalized block diagram of an analog-voltage sensor is shown in figure 45. The sensor is a potentiometric device, which means that the electrical resistance of the sensor changes in proportion to the change of the parameter being measured. The sensors include thermistors, pressure transducers, and multiturn potentiometers.

Because the DCP requires a voltage representation of the parameter being measured by the sensor, change in the electrical resistance of the sensor has to be translated to a voltage that is proportionately scaled between 0 and 5 volts. The signal conditioner, which supplies a regulated voltage to the sensor and outputs the voltage change across the resistive element, performs this function. Most signal conditioners perform a ranging and scaling function. These signal conditioners have zero adjustments and span (gain) adjustments to correct the zero and parameter range of the 0- to 5-volt output. First and second generation DCP's, such as the LaBarge CDCP and the Handar 524, did not have signal conditioners included within the platform. Signal conditioning was done outside the platform with the 0- to 5-volt analog signal being supplied to the appropriate analog channel at the DCP Input-Output (I/O). Many later model DCP's include signal conditioner cards within the DCP so that the sensor can be connected directly. Most of these signal conditioners, however, are designed for sensors of a particular type and manufacturer.

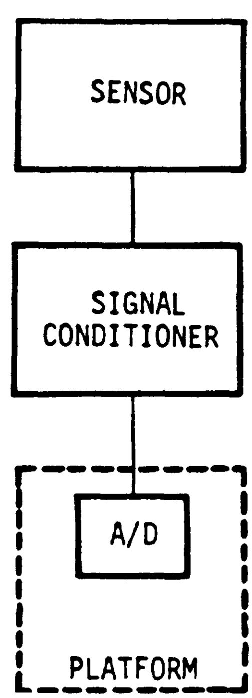


Figure 45.--Analog-voltage sensor.

Because all data have to be in a digital form for storage and transmission, the 0- to 5-volt analog input has to be digitized. An 8- to 12-bit analog-to-digital converter (ADC) performs this function. This means that the 0- to 5-volt analog voltage is converted to an 8- to 12-bit binary number, which, in base 10, would have a range from 0-to-255 or 0-to-4,095 counts, respectively. The LaBarge CDCP, Handar 524, and Handar 560 DCP's have 8-bit ADC's. The Handar 540 meteorological platform and Sutron 8004 have 12-bit ADC's. The Synergetics 3400 series DCP has a standard 8-bit ADC but offers a 12-bit ADC as an option.

Resolution

The analog-sensor output from the DCP is no more accurate than the element with the least amount of resolution or accuracy. The elements are the sensor, signal conditioner, and the ADC. For example, if a DCP contains an 8-bit ADC, the best resolution obtainable is 1 part in 256 ± 1 bit no matter how accurate the sensor.

If a temperature sensor with the 0- to 5-volt output representing 0 to 50 °C with an accuracy of ± 0.10 °C are input to an 8-bit ADC, the best resolution obtainable is 50 degrees divided by 255 or +0.20 °C; if the temperature range is -50 to 50 °C, the best resolution is 100 degrees divided by 255 or ±0.39 °C. Therefore, the limiting factors on resolution in this example are the 8-bit ADC and the range of temperature covered by the sensor.

If a 12-bit ADC is used in the previous example, the ADC resclution is 50 degrees divided by 4,095 or ±0.012 °C and 100 degrees divided by 4,095 or ±0.024°C, respectively. The limiting factor on resolution in this case is the sensor or signal conditioner.

As seen from the examples, the user needs to consider all elements of an analog system before purchasing the system. Do not use an expensive, high-resolution analog sensor and signal conditioner with a DCP that contains an 8-bit ADC.

Calibration

If the signal conditioner has zeroing and spanning (gain) adjustments, the user can calibrate it to cover the portion of the sensor range that is needed. As pointed out earlier in this chapter, the smaller the range is, the better the absolute resolution.

The user may calibrate a signal conditioner in two ways:

- Submit the sensors to known parameter values near each end of the range to be covered, as when a thermistor is calibrated in a water bath.

- Substitute a precision resistor for the sensor, which is equivalent to sensor resistance at different parameter values.

Continue to calibrate the signal conditioner and sensor in the following manner:

1. Connect a good digital voltmeter (0.5 percent or less error accuracy) to the 0- to 5-volt output on the signal conditioner.

2. Apply a known parameter value to the sensor input that is near the low end of the output range (0 to 5 volts) and allow it to stabilize.

3. Turn zero adjustment so that the

$$\text{Output voltage} = \frac{5}{U-L}\ P,$$

   where
   U is the value for the upper end of parameter range,
   L is the value for the lower end of parameter range, and
   P is the parameter value being input.

   EXAMPLE: Thermistor input is calibrated for a range of 0 to 25 °C (0 °C = 0 volts, 25 °C = 5 volts). Place thermistor in ice water, which is 0.4 °C as measured by a laboratory thermometer. Zero adjustment is turned until the

$$\text{Output voltage} = \frac{5}{25-0} \times 0.4 = 0.080 \text{ volts.}$$

4. Apply a known parameter value that is near the upper end of the output range to the sensor input and allow it to stabilize.

5. Turn span (gain) adjustment until the

$$\text{Output voltage} = \frac{5}{U-L}\ P.$$

   EXAMPLE: Thermistor is removed from ice water and placed in water, which is 22.3 °C as measured by a laboratory thermometer. Span adjustment is turned until the

$$\text{Output voltage} = \frac{5}{25-0} \times 22.3 = 4.460 \text{ volts.}$$

6. Repeat steps 2, 3, 4, and 5 until correct output voltage is achieved without having to make any adjustment. Check linearity by applying a parameter value near the mid-range of calibration and comparing the actual voltage output with expected voltage using the equation in step 3.

7. Remove voltmeter and connect DCP. Repeat steps 2 through 5 and read output through DCP using the programming set. Make sure sensor values read by the DCP are the same as the sensor input values plus or minus the resolution of the ADC. If values do not read the same, make zero and span adjustments until they do.

The calibration procedures outlined above apply to most voltage analog systems in use.

An analog instrument that has widespread use in the Survey is the minimonitor. Data-collection platforms can be interfaced easily with minimonitors and are probably used with more Survey DCP's than any other analog device.

Use of the Minimonitor with Individual Data-Collection Platforms

The user may wish to refer to U.S. Geological Survey Open-File Report 88-491, Operating Manual for the U.S. Geological Survey Minimonitor, 1988 Revised Edition, Punched-Paper-Tape Model. The sections "Servicing internal components of the Minimonitor," "Connecting the Minimonitor for Operation," and "Operation of the Minimonitor with the LaBarge GOES Data-Collection Platform" are included in appendix E for the readers' convenience.

Handar Model 524 Data-Collection Platform

The Handar Model 524 uses the same I/O cable (55-pin connector to DCP) as the LaBarge CDCP except that the analog pin positions are slightly different. The Model 524 uses analog 1 (55-pin connection J) to monitor the power-supply voltage; therefore, the first parameter from the minimonitor is connected to analog channel 2 (pin z) on the 55-pin platform connector. The 10-pin analog telemetry jack connects to the Handar 524 as shown in table 8. Be sure that the minimonitor telemetry connector is wired as shown in the table. Set minimonitor switches as described in appendix E. If three or four digital channels are used, set switch 25A to 64 seconds and 24A to 128 seconds (delay times). Connect minimonitor and Model 524 power cables to a single power supply or to two separate power supplies; either arrangement will work. Program the platform as described in the Handar 524/525A operating and service manual. Remember that A1 (Analog No. 1) is used by the platform to monitor battery voltage; therefore, program one analog channel in addition to the number of analog parameters from the minimonitor. When using the monitor key on the 526A programming set to read the minimonitor analog outputs, set the minimonitor to manual mode. The analog reading from the platform is not in engineering units but is the decimal equivalent of the A/D 8-bit binary reading. This number ranges between 0 and 255, where 0 = 0 volts and 255 = 5 volts. To convert the analog output to engineering units, use the equation:

$$\text{Parameter value} = \frac{U-L}{255} R,$$

where

U is the value for the upper end of parameter range,
L is the value for the lower end of the parameter range, and
R is the analog reading from the platform.

Although the minimonitor recording interval switches (26A) are set for a 1-hour sampling interval, the platform scan interval may be set to 1 hour or less. Because the platform is controlling the recording interval, the minimonitor's clock resets to zero each time the platform scans. After the platform is programmed and running, ensure that the minimonitor is set to AUTO and the clock is set to zero.

Table 8.--*Minimonitor pin connections for the Handar 524 data-collection platform*

Minimonitor pin	Function	Platform pin
A	CH 2 input (0 to 5 volts)	z
B	CH 3 input (0 to 5 volts)	m
C	CH 4 input (0 to 5 volts)	N
D	CH 5 input (0 to 5 volts)	AA
E	CH 6 input (0 to 5 volts)	T
F	CH 7 input (0 to 5 volts)	U
G	CH 8 input (0 to 5 volts)	n
H	N/A	
I	Analog ground	
J	12-volt switched from platform	A

Handar Model 560 Data-Collection Platform

Using a minimonitor with the Handar Model 560 DCP requires an additional card not supplied with the basic platform. The card needed is an 8-channel analog and incremental encoder interface assembly, Handar Part No. 560-7007. The 560-7007 is an 8-bit ADC card and contains eight analog inputs, an additional incremental encoder input, and an additional tipping-bucket precipitation counter. The 26-pin Handar 560-7007 interface card input/output description is presented in table 9.

To put the minimonitor and Handar Model 560 into operation, set the minimonitor timing switches as described earlier and connect the 10-pin minimonitor cable to the 560 26-pin connector as described in table 9. Program the platform as described in the Handar Model 560 operating and service manual using sensor type 10 for each minimonitor parameter. Program the input address and power address as given in table 8. To make a fast scan (FSCAN), place the minimonitor in manual mode.

Handar Model 540A-1 Data-Collection Platform

The user may program and operate the Handar Model 540A-1 DCP in the same manner as the Handar Model 560. The 540A-1 interface panel is supplied with individual military-type, 6-pin connectors for all sensors. The 12-bit analog card for the 540A-1 includes an incremental shaft-encoder input.

Table 9.--*Description of 26-pin connector with the Handar 560-7007 interface card*

Minimonitor 10-pin connector	Handar 560 26-pin connector	436A Incre-mental encoder	Function	Input address	Power address
A	T	-	Analog 1	2	0
B	R	-	Analog 2	7	0
C	S	-	Analog 3	5	0
D	M	-	Analog 4	4	0
E	B	-	Analog 5	0	0
F	W	-	Analog 6	1	0
G	U	-	Analog 7	3	0
H	K	-	Analog 8	6	0
I	N or L	-	Analog ground	-	-
J	c or b	-	12-volts switched	-	-
-	a	E	Encoder signal (01)	-	-
-	Z	D	Encoder signal (02)	-	-
-	Y	C	Encoder 5-volt switched	-	-
-	X	F	Encoder ground	-	-
-	F	-	Tipping-bucket input	-	-
-	E	-	Tipping-bucket input	-	-
-	J	-	5-volts switched	-	-
-	H	-	5-volts switched	-	-
-	D	-	5 volts	-	-
-	G	-	5 volts	-	-

Handar Model 570A Data Collection Platform

The user may program and operate the Handar Model 570A DCP in the same manner as the Handar Model 560. The 570A is supplied with a terminal-strip sensor interface. The analog card for the 570A may be either 8- or 12-bit ADC; the 8-bit card includes an additional incremental shaft-encoder input.

Sutron Model 8004 Data-Collection Platform

The U.S. Geological Survey Minimonitor, although designed to interface with the LaBarge DCP, also interfaces with the Sutron DCP. For operation with the Sutron platform, the user must set switches 26A6, 26A7, 25A3, 25A4, 24A5, and 24A4 to the closed position on the minimonitor programmer card. All other switches on 24A, 25A, and 26A need to be open. These switch settings cause the minimonitor to come on once an hour, wait 48 seconds, turn on the signal conditioners, wait 48 seconds more, and record data.

The 10-pin analog telemetry jack connects to the Sutron DCP as described in table 10. After setting the minimonitor for proper delays and hooking up the telemetry jack, program the Sutron DCP as follows:

Sutron DCP-to-Minimonitor Interface Sample Program

```
OM - 1
ID1 - 12345678
ID2 - 12345678
TT - 000:00:00:00
TI - 180
GMT - 000:00:00:00
STD - 0
FMT - 1
NS - 24
TNC - 000:00:00:00
UI - 15
WT - 65
INC - 1
PAR 1 through 4
PT - 1
GA - 2
CO - 4
MV - 0
```

This program collects data from all parameters on a 15-minute acquisition cycle, stores 24 values for each parameter, and transmits on a 3-hour interval.

At the data-collection time, the Sutron DCP turns on the switched 12-volt terminal and resets the minimonitor clock to 00. The switched 12-volt terminal turns off 65 seconds later and the DCP inputs the analog data from each sensor; 96 seconds after the clock resets, the scan-and-record cycle begins. This sequence will repeat every 15 minutes. To put the system in operation, proceed as follows:

1. Set the platform to the correct time and set the platform data-acquisition time and the minimonitor recording interval to the same desired length.

2. Advance the minimonitor through all the channels and back to zero.

3. Set minimonitor clock to 00.

The minimonitor is triggered by the next data-collection cycle of the platform. This keeps the minimonitor clock synchronized with the platform's clock.

Table 10.--*Minimonitor pin connections for the Sutron 8004 data-collection platform*

Minimonitor pin	Function	Platform
A	CH 1 out	Par 1
B	CH 2 out	Par 2
C	CH 3 out	Par 3
D	CH 4 out	Par 4
E	--------	-----
F	--------	-----
G	--------	-----
H	--------	-----
I	Analog ground	Ground
J	12-volt from platform	Switched 12 volts

Synergetics Model 3400 Series Data-Collection Platform

The U.S. Geological Survey Minimonitor interfaces with the Synergetics DCP. The Synergetics DCP needs to be equipped with the 12-bit ADC converter option (3451-001) for better resolution. Several software versions for the Synergetics DCP are available. The processing equations listed in this manual usually work on all the Synergetics DCP's with Scada I software. Scada II software is a later version and is not covered in this manual. For purposes discussed herein however, Scada I and Scada II are essentially the same except that equations designated as "T" equations in Scada I have been replaced by "A" equations in Scada II.

For operation with the Synergetics platform, the user needs to reset the minimonitor programmer card switches for the type of data being collected. For the most part, this depends on whether or not dissolved oxygen (DO) is being monitored. If DO is monitored, the user needs to set the time delays on switches 25A and 24A at 40 and 48 seconds, respectively, as referenced in Open-File Report 88-491 (Ficken and Scott, 1988 p. 34). If DO is not monitored, set NO DELAY on 25A and not less than 4 seconds on 24A.

The DCP normally is programmed to strobe the minimonitor and scan for data at each minimonitor recording interval. The same delay set in the minimonitor has to be programmed into the DCP to ensure that the DCP scans for data while power is connected to the SIGNAL CONDITIONER card. Each time the DCP strobes the minimonitor, the minimonitor clock is reset and the two clocks are synchronized.

The 10-pin analog telemetry jack located on the minimonitor connects to the Synergetics 3451A End Device Interface Module (EDIM) as presented in table 11. After setting the minimonitor for proper delays and hooking up the telemetry jack, the user needs to program the DCP. Each change in the number of inputs or data-acquisition frequency requires a change in the program.

The following program collects data from four minimonitor channels (including DO) every 15 minutes. This program stores 32 values for each minimonitor parameter and gives one full transmit cycle of backup data for each minimonitor parameter when using a 4-hour transmit interval.

```
S(n) SCAN.INT = 0 0 15 0
SCAN.TIM = 0 0 0
T(n)   <- 64 ON 4 0 64 OUTPUT 10 DELAY 0 0 64 OUTPUT;
T(n+1) <- 480 DELAY 1 64 INPUT 500 4095 */ 32 DIM ;  ---(50.0 Degrees = 500)
T(n+2) <- 2 64 INPUT 1000 4095 */ 32 DIM ;  ---------(1000 micromhos = 1000)
T(n+3) <- 3 64 INPUT 1000 4095 */ 32 DIM ;  ----------(10.0 pH units = 1000)
T(n+4) <- 4 64 INPUT 1000 4095 */ 32 DIM 64 OFF ;---------(10.0 mg/L = 1000)
```

Elements of the T(n) equation do the following:

64 ON: turns the EDIM address 64 on.
4 0 64 OUTPUT: sets the output strobe #3 on "HI"
10 DELAY: sets a one second delay
0 0 64 OUTPUT: sets the output strobe on "LO"

Table 11.--*Minimonitor pin connections for the Synergetics 3400 Series data-collection platforms*

Minimonitor Pin	Function	Data-collection platforms Terminal Strip	Pin
A	CH 1 out	1 ANALOG HI	49
B	CH 2 out	2 ANALOG HI	47
C	CH 3 out	3 ANALOG HI	45
D	CH 4 out	4 ANALOG HI	43
E	CH 5 out	5 ANALOG HI	41
F	CH 6 out	6 ANALOG HI	39
G	CH 7 out	7 ANALOG HI	37
H	CH 8 out	8 ANALOG HI	35
I	ANALOG GROUND	ANY ANALOG LO[1]	50
J	7.5 VDC SWITCHED (strobe from DCP)	3 OUT	11

[1] Analog low should be bridged to the battery ground of the EDIM.

Elements of the T(n+1) equation do the following:

480 DELAY: sets 48-second delay
1 64 INPUT: retrieves data from analog input No. 1
500 4095 */: multiplies the input by 500 and divides by 4095
32 DIM: stores 32 data updates

The T(n+2-4) equations do the same as the T(n+1) equation except they retrieve data from analog inputs 2 through 4 and multiply these inputs by 1000, and T(n+4) turns the EDIM off. In the T(n+3) equation, input is multiplied by 1000 (instead of 10) so that final pH units can be recorded to two decimal places. For example, an input reading of 3500 times 10 and then divided by 4095 would equal 8 instead of the desired value of 8.54. The DCP processor would truncate at the decimal.

NOTE: Channel 0 on address 64 controls the strobe outputs. Four outputs, labeled 1, 2, 3, and 4, are set "HI" (on) or "LO" (off) as if represented by a 4-bit binary number. If the user programs (1 0 64 OUTPUT), the 1 is represented by the 4-bit binary number 0001; in this case, the number 1 output is activated. If the user programs (15 0 64 OUTPUT), the 15 is represented by the binary number 1111; in this case all four outputs are activated. Program a 4 (0100) and the number 3 output is activated. Program a 5 (0101) and the number 3 and 1 outputs are activated. In the above programs, output 3 has been used because output 1 is used with an ADR and outputs 1 and 2 are used with a Series 500 Interface.

The following program collects data from two minimonitor channels every hour and stores eight values for each parameter; for a 4-hour transmit interval, this gives one full transmit cycle of back-up data for each minimonitor parameter.

```
S(n) SCAN.INT = 0 1 0 0
S(n) SCAN.TIM = 0 0 0
```

```
T(n)   <- 64 ON 4 0 64 OUTPUT 10 DELAY 0 0 64 OUTPUT ;
T(n+1) <- 40 DELAY 1 64 INPUT 500 4095 */ 8 DIM ;  -----(50.0, DEGREES = 500)
T(n+2) <- 2 64 INPUT 10000 4095 */ 8 DIM 64 OFF ; --(10,000 micromhos = 10000)
```

T(n) is the same as the first program.
T(n+1) is the same as the first program except the delay is for 4 seconds and stores eight updates.
T(n+2) is the same as the first program except it stores eight updates and monitors conductance values from 0 to 10,000 micromhos.

Using either of the above programs, the user may collect and store (DIM)[1] time along with the water-quality parameters. The time of data collection is helpful if room exists in the transmission time slot.

The following T equations collect and store time as a data parameter and may be used with either of the above programs.

```
T(n)   <- 11 0 INPUT 60 / SAVE ;
T(n+1) <- 10 0 INPUT 100 * T(n) + SAVE ;
T(n+2) <- T(n+1) 32 DIM ;
```

Elements of the T(n) equation do the following:

11 0 INPUT: reads the input from channel 11 address 0
60 / SAVE: divides the input by 60 and saves the value

Elements of the T(n+1) equation do the following:

10 0 INPUT: reads the input from channel 10 address 0
100 * T(n) + SAVE: multiplies the input by 100, adds the value of T(n), and saves the answer

The T(n+2) equation stores 32 values of the answer produced by T(n+1).

NOTE: Address 0 is 3401A Master Control Module (MCM), channel 11 is current seconds into hour and channel 10 is current hour.

In the above program for four minimonitor inputs plus stage and time, the length of each 4-hour transmission is about 54.1 seconds (with binary format and long preamble). The transmission time can be shortened by reducing the DIM to 16 with no redundant data or by changing the data recording interval to a longer period.

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1. A SCADA-SOFT word for "dimension." When DIM is used in a processing equation, the DCP will store the number of values indicated by the number immediately preceeding the word, "DIM."

STANDARD PROGRAMMING OF TELEMETRY SYSTEMS

By Jack Hardee

Introduction

Standard Programming of Telemetry Systems (SPOTS), developed to reduce the amount of equipment the field person needs to service more than one make of DCP, features capabilities for

- writing and storing complete station programs (scripts) in the text files of the computer,
- downloading station scripts to the DCP automatically with date and time, and
- storing in the computer up to ninety station scripts for different types of DCP's.

After the development of SPOTS, the HIF assumed responsibility for its distribution and support. The HIF developed hardware requirements and software for personal field computers (PFC). A section of the PFC software is DCP support. The HIF will continue to make SPOTS available on the Prime computer but will make upgrades or enhancements of DCP support in the PFC software.

Tandy Portable Computer

The Tandy portable computer, which is used in many field applications because it is economical, has a full keyboard, and can be purchased or serviced at most locations throughout the country, has two models on which SPOTS software can be used: Models 100 and 102. The Tandy Model 100 is the earlier version of the Tandy portable computer and has the same capabilities as the Model 102. The only difference is in the configuration of the function keys on the keyboard. The user may increase the standard 24K memory to 32K with the purchase and installation of one 8K memory chip.

The HIF has three versions of SPOTS available for the Tandy, all of which require expanded memory:

- SPOTS, which is for the Tandy with 32K internal memory only.
- SPOTSB, which is for the Tandy with the Booster Pak memory enhancement by Traveling Software, Inc.
- SPOTSR, which is for the Tandy with a DATAPAC memory enhancement by Node, Inc.

Portable Computer Memory Expansion

To store enough station scripts for a complete field trip, the Tandy portable computer needs memory in addition to the 32K internal memory. Many computer companies supply memory enhancement modules for both models of the Tandy portable computer.

Booster Pak Memory Enhancement Package

The Booster Pak is a memory enhancement package that provides additional memory for the Tandy Models 100 and 102. Two connector cables attach the package to the bottom of the Tandy computer. The narrower cable attaches to the open ROM (Read-only memory) socket inside the ROM module expansion compartment of the computer; the wider cable connects to the system bus on the back of the computer. The Tandy portable computer with the Booster Pak can be loaded with the SPOTSB software for DCP support and the Booster Pak is the only memory module that can use the PFC software.

The Booster Pak (Traveling Software part no. HW1-BP2) basic unit has 136K memory, including 96K available for files. The unit has eleven sockets free for installing additional RAM (random-access memory) chips (Traveling Software part No. HW1-BP3) to increase memory to 256K. The Booster Pak's memory may be expanded to 2MB with the purchase and installation of a RAM expansion board and RAM expansion modules.

DATAPAC Memory Enhancement Module

The DATAPAC is a memory enhancement module that provides additional memory to the Tandy Models 100 and 102. The DATAPAC attaches to the bottom of the Tandy but does not cover the entire bottom as does the Booster Pak. The DATAPAC is not expandable and cannot be loaded with the PFC software because of the memory limitations. It can be used for DCP support when loaded with the SPOTSR software package.

SPOTS

Loading SPOTS from HIF Prime To Local Prime

These instructions are for loading SPOTS software into the Tandy Model 100 or 102 **without** the Booster Pak or the DATAPAC memory enhancements.

Follow the command given below **to load SPOTS from the HIF Prime to the user's FTS_Depot on the local Prime minicomputer**.

FTR SPOTS>SPOTS.DO FTS_DEPOT> — -SS QMSBSL <CR>

Loading SPOTS from Local Prime to Tandy

Follow the directions given in this section **to load SPOTS from the user's local Prime minicomputer to the user's Tandy portable computer**.

NOTE: The communications line from the Prime has to be set to 1200 baud. Proper transfer **will not** occur at faster speeds. Consult the local Prime System Operator or Administrator.

1. Connect the communications line from the Prime to the Tandy Model 100 or 102 RS-232 port. Set up communications on Tandy using TELCOM as follows:

   a. Enter TELCOM. Press F3 (Stat).

   b. Type 57I1E and press ENTER.
   c. Press F4 (Term).

2. Log onto Prime. Check the line speed setting if login is unsuccessful. Check Tandy settings and retry login. Attach to the directory that contains the SPOTS.DO file. Do the following:

   a. Type SLIST SPOTS.DO **BUT DO NOT PRESS ENTER!**
   b. On Tandy, press F2 (Down).
   c. After prompt **FILE TO DOWNLOAD?** type SPOTS.DO and press ENTER.
   d. Press ENTER again.

   File transfer begins and takes about 4 1/2 minutes.

3. Do the following after completion of the file transfer:

   a. Press F2 (Down).
   b. Press F8 (Bye).
   c. Type Y (for YES) and press ENTER.
   d. Press F8 (Menu) to return to normal mode.

4. Log off Prime. Remember to reset the line speed if the setting differs from the setting before the connection to Tandy.

Converting SPOTS Download File into BASIC

The SPOTS software is on the Tandy portable computer as an ASCII file and must be converted to a BASIC file before it can be run. Enter SPOTS and follow the steps listed below to delete the extra carriage return (designated by a left-facing arrowhead) at the beginning of the file and the extra line after the last numbered line in the program that contains the Prime system ready prompt (Next? or OK,).

1. Place the cursor block over the < and press the SHIFT and DEL-BKSP keys.

2. Press the CTRL and down-arrow keys and release (to go to bottom of program).

3. Use the DEL-BKSP key to remove this line and any extra carriage returns at the end of the file.

4. Press F8 (Menu) to refile.

Convert SPOTS.DO (ASCII) file to SPOTS.BA (BASIC) by performing the following steps:

1. Place cursor block over BASIC and press ENTER.

2. Type LOAD "SPOTS.DO" and press ENTER.

   NOTE: Loading takes about 3 minutes. Loading is complete when the OK prompt appears on screen.

3. Type SAVE "SPOTS" and press ENTER.

4. Press F8 (Menu).

5. Place cursor block over BASIC and press ENTER.

6. Type KILL "SPOTS.DO", this deletes SPOTS.DO, which uses up memory space.

7. Type NEW and press ENTER.

8. Type CLEAR 512,MAXRAM and press ENTER. This clears memory for running SPOTS.BA.

9. Press F8 (Menu) to return to normal mode.

Setting Greenwich Mean Time in Tandy

Enter time by typing TIME$="hh/mm/ss" and press ENTER. Use Greenwich Mean Time (GMT) for proper synchronization of DCP transmission times.

Running SPOTS Program

Before the SPOTS program can run, at least one station script has to be created and stored in SPOTS. (See writing and storing station scripts section.) Place the cursor block over SPOTS.BA and press ENTER. Follow the program prompts.

Loading SPOTS from Personal Computer to Tandy

Follow the directions given in this section **to load SPOTS from the user's personal computer to the Tandy portable computer.**

1. Connect the communications port of the user's personal computer (PC) to the communications port of the Tandy portable computer, using a cable with pins 2 and 3 swapped at one connector.

2. Set up communications on Tandy, using X-TEL, as follows:

    a. Place cursor block over X-TEL.BA and press ENTER.
    b. Press F3 (Stat).
    c. Type 88N1E and press ENTER.
    d. Press F4 (Term).

3. Set up communications on the PC, using PROCOMM, as follows:

    a. Enter PROCOMM.
    b. Check line settings. They need to be 9600 baud, no parity, 8 bits, 1 stop bit, and x-on/x-off activated.

Transferring SPOTS File

After communications have been established, transfer the SPOTS file as described below:

1. On the user's PC, enter file upload mode, select ASCII communications, and type path\SPOTS.DO (C:\SPOTS.DO if the file is in directory C of the PC), but **DO NOT PRESS ENTER!**

2. On the Tandy, press F2 (Down). After prompt **FILE TO DOWNLOAD?**, type SPOTS.DO and press ENTER.

   NOTE: Although the XModem transfer F6 (X-Dn) is faster and more efficient, it does not work properly.

3. Press ENTER on the user's PC. File transfer begins and takes about 4 1/2 minutes. When transfer is complete, do the following:

   a. Press F2 (Down).
   b. Press F8 (Bye), type Y, and press ENTER.
   c. Press F8 (Menu) to return to normal mode.

Converting SPOTS Download File into BASIC

Follow directions given earlier in this section to convert SPOTS download file into BASIC, set GMT in the Tandy portable computer, and run the SPOTS program.

SPOTSB

Loading SPOTSB from HIF Prime to Local Prime

These instructions are for loading SPOTSB software into the Tandy portable computer **with** the Booster Pak memory enhancement module.

The same procedure is used for loading SPOTSB from the HIF Prime to the local Prime as for loading SPOTS except for the file names. Follow the command given below **to load SPOTSB from the HIF Prime to the user's FTS_Depot on the local Prime minicomputer.**

FTR SPOTS>SPOTSB.DO FTS_DEPOT> — -SS QMSBSL <CR>

Loading SPOTSB from local Prime to Tandy

Follow the directions given in this section **to load SPOTSB from the user's local Prime minicomputer to the user's Tandy portable computer.**

NOTE: The communications line from the Prime needs to be set to 1200 baud. Proper transfer does not occur at faster speeds. Consult the local Prime System Operator or Administrator.

1. Connect the communications line from the Prime to the Tandy RS-232 port. Set up communications on Tandy, using X-TEL, as follows:

   a. Place cursor block over X-TEL.BA and press ENTER.
   b. Press F3 (Stat).
   c. Type 57I1E and press ENTER.
   d. Press F4 (Term).

2. Log onto Prime. Check the line speed setting if login is unsuccessful. Check Tandy settings and retry login. Attach to the directory that contains the SPOTSB.DO file. Do the following:

   a. Type SLIST SPOTSB.DO but **DO NOT PRESS ENTER!**
   b. On Tandy, press F2 (Down).
   c. After prompt **FILE TO DOWNLOAD?**, type SPOTSB.DO and press ENTER.
   d. Press ENTER again.

   File transfer begins and takes about 4 1/2 minutes.

3. After completion of file transfer, do the following:

   a. Press F2 (Down).
   b. Press F8 (Bye).
   c. Type Y (for YES) and press ENTER.
   d. Press F8 (Menu) to return to normal mode.

4. Log off Prime. Remember to reset the line speed if the setting differs from the setting before the connection to Tandy.

Converting SPOTSB Download File into BASIC

The SPOTSB software is on the Tandy portable computer. To convert the SPOTSB download file into BASIC, press F4 (Work), place cursor block over SPOTSB.DO, and press ENTER.

To delete the extra carriage return (designated by a left-facing arrowhead) at the beginning of the file and the extra line after the last numbered line in the program that contains the Prime system ready prompt (Next? or OK,), do the following:

1. Place the cursor block over the < and press the SHIFT and DEL-BKSP keys.

2. Press F1 (Find). The prompt **STRING?** appears.

3. Type 3300 and press ENTER. An extra line appears after the line that starts with **3300** and contains the user's Prime system ready prompt (**NEXT?** or **OK,**). An extra carriage return appears also.

4. Use the DEL-BKSP key to remove this line and any extra carriage returns at the end of the file.

5. Press F8 (Menu) to refile.

6. Place the cursor block over SPOTSB.DO and press F1 (Copy).

7. Press F1 (RAM). At the prompt **NEW NAME:** type R:SPOTSB.DO and press ENTER.

8. Press F2 (Kill) and type Y. (This deletes SPOTSB.DO, which is no longer needed and takes up memory.)

9. Press F4 (RAM). Place cursor block over BASIC and press ENTER.

Setting Greenwich Mean Time in Tandy

Enter time by typing TIME$="hh/mm/ss" and press ENTER. Use Greenwich Mean Time (GMT) for proper synchronization of DCP transmission times.

Running SPOTSB Program

Before the SPOTSB program can run, a station script has to reside in the Tandy. The Booster Pak, when initialized, created the ROOT directory. The station script has to be in the STA NA <> subdirectory created under the ROOT directory.

Begin in the RAM Disk Menu and activate the MkDr function key (F8). In response to the prompt **DIRECTORY NAME:** type STA NA and press ENTER. As soon as the user enters a directory name, the RAM Disk Menu changes to reveal the menu for that directory. Place the cursor block over TEXT and press ENTER. After typing a name for the file (station script) to be created, use the TEXT editor to write the script needed to program the DCP. (See Writing and Storing Station Scripts section.)

To run SPOTSB, place the cursor block over SPOTSB.BA and press ENTER. Follow the program prompts.

Loading SPOTSB from Personal Computer to Tandy

Follow the directions given in this section **to load SPOTSB from the user's personal computer to the Tandy portable computer.**

1. Connect the PC communications port to the Tandy communications port, using a cable with pins 2 and 3 swapped at one connector.

   a. Place cursor block over X-TEL.BA and press ENTER.
   b. Press F3 (Stat).
   c. Type 88N1E and press ENTER.
   d. Press F4 (Term).

2. Set up communications on the user's PC, using PROCOMM:

   a. Enter PROCOMM.
   b. Check that line settings are 9600 baud, no parity, 8 bits, 1 stop bit, and x-on/x-off activated.

Transferring SPOTSB File

After communications have been established, transfer the SPOTSB file as described below:

1. On the user's PC, enter file upload mode, select ASCII communications, and type path\SPOTSB.DO (C:\SPOTSB.DO if the file is in directory C of the PC), but **DO NOT PRESS ENTER!**

2. On Tandy, press F2 (Down). After the prompt **FILE TO DOWNLOAD?** appears, type SPOTSB.DO and press ENTER.

   NOTE: Although the XModem transfer F6 (X-Dn) is faster and more efficient, it does not work properly.

3. Press ENTER on the user's PC. File transfer begins and takes about 4 1/2 minutes.

4. Do the following after completion of the transfer:

   a. Press F2 (Down).
   b. Press F8 (Bye), type Y, and press ENTER.
   c. Press F8 (Menu) to return to normal mode.

Converting SPOTSB download file into BASIC

Follow directions given earlier to convert SPOTSB download file into BASIC, set GMT in Tandy, and run SPOTSB program.

SPOTSR

Loading SPOTSR from HIF Prime to Local Prime

These instructions are for loading SPOTSR software into the Tandy **with** the DATAPAC memory enhancement module.

The operator uses the same procedures for loading SPOTSR from HIF Prime to local Prime as for loading SPOTS except for the file names.

Follow the command given below **to load SPOTSR from the HIF Prime to the user's FTS_Depot on the local Prime minicomputer.**

FTR SPOTS>SPOTSR.DO FTS_DEPOT> — -SS QMSBSL <CR>

Loading SPOTSR from Local Prime to Tandy

Software for loading SPOTSR from local Prime to Tandy and from local Prime to the user's PC and for converting the SPOTSR download file to BASIC is the same as for loading and converting SPOTS except for the names.

Follow the directions given in this section **to load SPOTSR from the user's local Prime minicomputer to the user's Tandy portable computer.**

NOTE: The communications line from the Prime has to be set to 1200 baud. Proper transfer **does not** occur at faster speeds. Consult the local Prime System Operator or Administrator.

1. Connect the communications line from the Prime to the Tandy Model 100 or 102 RS-232 port. Set up communications on Tandy using TELCOM as follows:

   a. Enter TELCOM. Press F3 (Stat).
   b. Type 57I1E and press ENTER.
   c. Press F4 (Term).

2. Log onto Prime. Check the line speed setting if login is unsuccessful. Check Tandy settings and retry login. Attach to the directory that contains the SPOTSR.DO file. Do the following:

   a. Type SLIST SPOTSR.DO but **DO NOT PRESS ENTER!**
   b. On Tandy, press F2 (Down).
   c. After prompt **FILE TO DOWNLOAD?**, type SPOTSR.DO and press ENTER.
   d. Press ENTER again.

   File transfer begins and takes about 4 1/2 minutes.

3. Do the following after completion of the file transfer:

   a. Press F2 (Down).
   b. Press F8 (Bye).
   c. Type Y (for YES) and press ENTER.
   d. Press F8 (Menu) to return to normal mode.

4. Log off Prime. Remember to reset the line speed if the setting differs from the setting before the connection to Tandy.

Converting SPOTSR Download File into BASIC

The SPOTSR software is on the Tandy portable computer. Enter SPOTSR and follow the steps listed below to delete the extra carriage return (designated by a left-facing arrowhead) at the beginning of the file and the extra line after the last numbered line in the program that contains the Prime system ready prompt (Next? or OK,).

1. Place the cursor block over the < and press the SHIFT and DEL-BKSP keys.

2. Press the CTRL and down-arrow keys and release (to go to bottom of program).

3. Use the DEL-BKSP key to remove this line and any extra carriage returns at the end of the file.

4. Press F8 (Menu) to refile.

Convert SPOTSR.DO (ASCII) file to SPOTSR.BA (BASIC) by performing the following steps:

1. Place cursor block over BASIC and press ENTER.

2. Type LOAD "SPOTSR.DO" and press ENTER. **NOTE:** Loading takes about 3 minutes. Loading is complete when the OK prompt appears on screen.

3. Type SAVE "SPOTSR" and press ENTER.

4. Press F8 (Menu).

5. Place cursor block over SPOTSR.DO, press F2 (Kill), type Y (for YES). This deletes SPOTSR.DO, which uses up memory space.

6. Place cursor block over BASIC and press ENTER.

7. Type NEW and press ENTER.

8. Type CLEAR 512,MAXRAM and press ENTER. This clears memory for running SPOTSR.BA.

9. Press F8 (Menu) to return to normal mode.

Loading SPOTSR from Personal Computer to Tandy

Follow the directions given in this section **to load SPOTSR from the user's personal computer to the Tandy portable computer.**

1. Connect the communications port of the user's personal computer (PC) to the communications port of the Tandy portable computer, using a cable with pins 2 and 3 swapped at one connector.

2. Set up communications on Tandy, using X-TEL, as follows:

   a. Place cursor block over X-TEL.BA and press ENTER.
   b. Press F3 (Stat).
   c. Type 88N1E and press ENTER.
   d. Press F4 (Term).

3. Set up communications on the PC, using PROCOMM, as follows:

   a. Enter PROCOMM.
   b. Check line settings. They need to be 9600 baud, no parity, 8 bits, 1 stop bit, and x-on/x-off activated.

Transferring SPOTSR File

After communications have been established, transfer the SPOTSR file as described below:

1. On the user's PC, enter file upload mode, select ASCII communications, and type path\SPOTSR.DO (C:\SPOTSR.DO if the file is in directory C of the PC), but **DO NOT PRESS ENTER!**

2. On the Tandy portable computer, press F2 (Down). After the prompt **FILE TO DOWNLOAD?** appears, type SPOTSR.DO and press ENTER. **NOTE:** Although the XModem transfer F6 (X-Dn) is faster and more efficient, it does not work properly.

3. Press ENTER on the user's PC. File transfer begins and takes about 4 1/2 minutes.

4. Do the following after completion of the file transfer:

   a. Press F2 (Down).
   b. Press F8 (Bye), type Y, and Press ENTER.
   c. Press F8 (Menu) to return to normal mode.

Converting SPOTSR Download File into BASIC

Follow directions given earlier in this section to convert the SPOTSR download file into BASIC, set GMT in the Tandy portable computer, and run the SPOTSR program.

Copying SPOTSR.BA from MAIN RAM to BANKED RAM

After converting the SPOTSR.DO to SPOTSR.BA, copy the SPOTSR.BA file from MAIN RAM to BANKED RAM. To do so, follow the steps listed:

1. In the Tandy MAIN RAM directory, place the bar cursor over RAMDSK and press ENTER.

2. Press F4 (COPY). The MAIN RAM directory appears.

3. Place bar cursor over SPOTSR.BA. Press ENTER.

4. Type in the same name (SPOTSR.BA). Press ENTER.

5. Press F1 (EXIT).

6. Place the bar cursor over BASIC. Press ENTER.

7. Type KILL "SPOTSR.BA and press ENTER.

8. Type KILL "SPOTSR.DO and press ENTER.

9. Press F8 (Menu) to return to the MAIN RAM directory.

10. Place bar cursor over RAMDSK and press ENTER to get into the BANKED RAM.

Setting Greenwich Mean Time in Tandy

Enter time by typing TIME$="hh/mm/ss" and press ENTER. Use Greenwich Mean Time (GMT) for proper synchronization of DCP transmission times.

Running SPOTSR Program

Before the SPOTSR program can run, at least one station script has to be created to be operated by SPOTSR. (See writing and storing station scripts section.) Place the cursor block over SPOTSR.BA and press ENTER. Follow the program prompts.

Writing and Storing Station Scripts

The system generates station scripts (programs that are ASCII text files) to be uploaded by SPOTS, SPOTSR, and SPOTSB to the DCP's. The operator writes the station scripts in the Tandy, using the TEXT EDITOR, in a format that answers the programming questions asked by the DCP. If the TEXT-generated station script gives a wrong answer to the DCP, the DCP shows an error and asks the question again. When this happens, the Tandy replies with the next answer, which is incorrect and gives errors all the way through the programming function. A station script has to be monitored for errors the first time it is uploaded to a DCP. If an error occurs, the station script has to be corrected in the Tandy and the upload function restarted from the beginning.

In Tandy without Memory Enhancement

With no additional memory, the Tandy displays all added files and programs in the main menu with the five program files that come with the Tandy. The station scripts, SPOTS.BA, and SATLOC.BA are in the same directory. Before a DCP can be uploaded automatically, the user needs to copy station scripts into the directory or create them in the TEXT file. The user may use the function keys and edit functions to change or copy a station script that is created by use of TEXT. However, this station script can be deleted only in BASIC with the use of the KILL "filename" command.

In Tandy with DATAPAC Memory Enhancement

When the DATAPAC is installed in the Tandy, the RAMDSK directory is created and appears in the Tandy directory (MAIN RAM). Place the bar cursor over RAMDSK and press enter to get into the DATAPAC memory area (BANKED RAM). The BANKED RAM directory appears with the program TEXT, the file RAMDSK.DO, and the function key list with BANKED RAM free bytes on the lowest line of the display. Copy station scripts into this directory or use the TEXT file to create station scripts before autoloading a DCP if possible. The user may edit, copy, or kill station scripts in the BANKED RAM directory.

In Tandy with Booster Pak Memory Enhancement

The user has to create a directory named STA NA before any station scripts can be written and uploaded automatically to the DCP. To do so, follow the directions listed below:

1. Turn the Tandy on while in the ROOT <> Directory.

2. Press "F8" for MkDr (make directory).

3. When the display asks for **DIRECTORY NAME:** type STA NA and press ENTER. A new display appears showing the STA NA.<> Directory with only four programs. These programs were copied to the new STA NA.<> Directory automatically.

4. Place the cursor block over TEXT and press ENTER.

5. Type in the station name (up to six characters) and press ENTER.

6. Type a station script for the station using examples provided in this manual for each type of DCP.

7. When the file is completed, press F8 to save the file under the name entered at the beginning.

8. Repeat this procedure for each station script.

9. Monitor a station script for errors the first time it is uploaded to a DCP. If an error occurs, the script has to be corrected in the Tandy.

When an error is discovered, go to the STA NA <> Directory, place the cursor block over the station script with the error, and press ENTER. Make corrections using the TEXT EDITOR.

1. Press F8, this returns the user to the STA NA.<> Directory.

2. Place the cursor block over ROOT .<> and press ENTER. The program returns the user to the ROOT .<> Directory.

3. Restart the uploading from the beginning with a cold start on the DCP.

The files contain special characters (tokens) to invoke certain functions in the DCP programming such as setting clock time, date, scan time, transmission time, and so forth. These characters may be followed by the information required or may stop the loading of the program and require operator input such as an offset value for stage encoders.

The list below gives these special characters with explanations. Station scripts, which may be used as examples to generate station files, follow the list.

* Set DCP clock time (uses time from Tandy clock)

/ Set date in Synergetics DCP (M/D/Y) or the year for Handar 560-570 DCP

& Set the day of year (Julian) in Handar 560-570 DCP

@ Set the next transmission time in all DCP's. Enter in the text file in the format @, MMM, HHmm, where MMM equals the transmission interval in minutes and HHmm equals the first transmission time of the day (HH - hours, mm - minutes).

Set the next scan time in all DCP's; Enter in the text file in the format #, MMM, HHmm.

[Used to replace the encoder setting. For the Synergetics DCP, it replaces the "T1" equation, and, for the Handar DCP, it replaces the "current value." This character is not used for Sutron DCP's.

< Used anywhere in the text file where uploading needs to be stopped and a direct entry needs to be entered from the Tandy keyboard. Any informational prompt up to 255 characters may be added behind the character.

> Used to display information on the Tandy screen during the station file upload without a keyboard entry, except ENTER, to continue with the upload.

Samples of Station Scripts in Personal Field Computer

Handar Model 524 Data-Collection Platforms

NOTE: A NOHAU Model CGD256 Interface Adaptor must be used with the PFC to program the Handar Model 524 or 530 DCP.

The following station script programs the DCP to drive a digital recorder (with MOD KIT) and store stage and battery voltage at 15-minute intervals. The DCP transmits the 15-minute stage readings and an average battery voltage to the satellite every 4 hours. A pencil switch inside the HANDAR Model 524 DCP has to be set to allow the platform to transmit redundant data to the satellite.

SPOTS VALUE	EXPLANATION
?	Place 524 in program mode
I	I - identification
162127B0	Assigned NESDIS identification
K	K - XMIT
0400	Transmission interval in hours
L	L - Transmission type
1	1 - Normal transmission, 2 - threshold
N	N - Number of analog and digital channels
A1D1	A - Number of analog D - Number of digital NOTE: A1 is battery voltage
M	M - Select channel number
A1	Select channel A1; A1 is always battery voltage
Q	Q - Set limit of channel

255A	Set limits for A1; A indicates average of all scans
M	M = Select channel number
D1	D = Select channel D1; maximum = 8
Q	Q = Set limit of channel
FFFF	Value for threshold transmissions; FFFF = maximum (no randoms)
O	O = Select scan interval
0015	Scan interval in minutes; 0015 = 15 min, xc0100 = 1 h
S	S = Select scan delay
#,15,0000,#	15 = Scan interval in minutes, 60 = 1 hour, 0000 = offset
T	T = Select transmission delay
@,240,0037,@	240 = Transmission interval in minutes, 0037 = first transmission time of day (GMT).

The PFC and NOHAU pause for a minute or two after computing the transmission delay to initialize the DCP clock correctly. Wait for the PFC to return to the terminal mode before disconnecting from the DCP.

Handar Models 540A-1, 560, and 570A Data-Collection Platforms

The following station script programs a Handar Model 560 to transmit hourly values of temperature, specific conductance, pH, and dissolved oxygen (DO) from a U.S. Geological Survey Minimonitor (minimonitor) to the satellite on a 4-hour transmission interval. One battery voltage is sent on each transmission. One random transmission is sent to the satellite each day as a status check. This file expects the analog card to be in card slot 1 of the DCP.

SPOTS VALUE	EXPLANATION
I1655C4D4	I = identification; 1655C4D4 = assigned
NESDIS identification	
K52	K = XMIT 52 = channel ordered, redundant, short preamble
V@,240,0034	240 = Transmission interval in min, 0034 = first transmission time in GMT
V0400	4-hour transmission interval
V25	Random adaptive reporting
V00	Sensor header information; always use 00
V001	One random transmission a day as a health check, 2 = 2, 3 = 3 and so forth
V0	Number of randoms a day at alert rate; user selectable
V0	Number of randoms a day at warning rate; user selectable
V01.00	Unit load, 1.00 = 120 s each day; randoms take 2 to 4 s
J*	J = Time * = Set time token; **clock in PFC needs to be correct GMT.**

V/	/ - Set year token
V&	& - Set Julian day token
M01	Channel number 1
N10	N - Sensor type, 10 - analog; DCP needs to have analog card
V10	10 - Sensor name tag
V01	Indicates slot number in DCP of analog card
V2	Sensor input address on analog card
V0	Sensor power address
V000125	000125 - 1 min and 25 s; delay between power up and scan
V50.0	5 V from sensor sends 50.0 to satellite
V00.0	0 V from sensor sends 0.00 to satellite
V01	01 - 1 h scan interval; 0015 - 15 min, 0030 - 30 min
2	2 - Do not change scan interval for all channels
V#,60,0000	# - Set scan time token; 60 - scan interval, 0000 - offset
2	2 - Do not change start of measurement of all channels
V1	Measurement type, 1 - logs data
V3	Transmits data in three bytes
M2	(Channel number 2)
N10	
V10	
V01	
V7	(Input address on analog card)
V0	
V000125	
V1000	(5 V from sensor sends 1000 to satellite)
V0000	(0 V from sensor sends 0000 to satellite)
V01	
V#,60,0000	
V1	
13	
M3	(Channel number 3)
N10	
V10	
V1	
V5	(Input address on analog card)
V0	
V000125	
V10.0	(5 V from sensor sends 10.0 to satellite)
V00.0	(0 V from sensor sends 00.0 to satellite)
V01	
V#,60,0000	
V1	
V3	
M4	(Channel number 4)
N10	
V10	
V1	

V4	(Input address on analog card)
V0	
V000125	
V10.0	(5 V from sensor sends 10.0 to satellite)
V00.0	(0 V from sensor sends 00.0 to satellite)
V01	
V#,60,0000	
V1	
V3	
M5	(Channel number 5)
N12	(N - Sensor type, 12 - battery voltage)
V12	(Sensor name tag for battery voltage)
V04	(4-hour scan interval)
V#,240,0	(# - Set scan time token; 240 - scan interval, 0 - offset)
V1	
V3	
Y	

The following station script programs a Handar Model 560 to transmit hourly values of temperature, specific conductance, pH, and DO from a mini-monitor to the satellite on a 4-hour transmission interval. One battery voltage is sent on each transmission.

SPOTS VALUE	EXPLANATION
I1628C21E	Identification
K52	Transmission type
V@,240,0123	Scroll down,@,240 - transmission interval in minutes; 0123 - first transmission time in GMT.
V0400	4-hour transmission interval
V21	Secondary transmission type
V00	Sensor header information; always use 00
V01	Number of alert transmissions
V0015	Random transmission interval
J*	J - time, * - set time token
V/	/ - set year token
V&	& - set day of year
M01	M - channel number, 01 - channel 1 (NOTE: Channel 1 reserved for stage encoder.)
N11	N - sensor type, 11 - shaft encoder
V11	11 - sensor name tag
V08	08 - card slot
V01	01 - encoder direction, 0 - clockwise, 1 - counterclockwise
V00.01	
V[	[- encoder set token
V0015	
2	Change all channels? 2 - no
V#,15,0013	# - set scan time, 15 - scan interval, 0013 - first time of day

V2	2 - level 1 measurement
V000001	
V120	
V1	
V03	
V03.00	
M2	M - channel number, 2 - channel 2
N12	
V04	
V#,240,0000	# - set scan time, 240 - scan interval, 0000 - first time of day
V1	
Y	Run mode

Synergetics Data-Collection Platforms

The following station script programs a Synergetics DCP with SCADA-SOFT Version 1.0.x/x software to measure water level every 15 minutes with an incremental encoder, store 32 values (8 hours of data), and transmit these values every 4 hours with Self-Timed (ST) GOES transmission.

SPOTS VALUE	EXPLANATION
/	Set date
*	Set clock
1	DCP mode, 1 - ST (Self-timed)
S1	DCP scan number
0 0 15 0	S1 scan interval, - 15 min
#,15,0000	Set scan interval and time
[	Encoder set token
T2 <- 10 64 INPUT T1 + 32 DIM ;	Read encoder, add offset (T1) and save 32 values
DONE	No more equations for S1
DONE	No more scans
0	ST transmission preamble, 0 - short
64	ST GOES channel number
1	Confirm GOES channel
12345678	ST GOES station identification (ID) no.
1	Confirm station ID
0 4 0 0	ST transmission interval
@,240,0232	Set transmission interval and time
0	Transmission output mode; 0 - ASCII
H0 T2	Transmission output list
DONE No more output equations	
ABCD Master password	
EFGH	Limited password
START	Start DCP

The following station script programs a Synergetics DCP with SCADA-SOFT Version 1.0.x/x software to measure the water level every 5 minutes with an incremental encoder. The program compares the water level to three designated threshold values and shortens the Random Reporting (RR) Interval to 5, 15, or 30 minutes. If the water level is not greater than any of these values, the RR interval is left at 24 hours. The program stores 32 water level values, measured at 15-minute intervals (8 hours of data), and transmit these values every 4 hours with Self-Timed (ST) GOES transmission.

SPOTS <u>VALUE</u>	<u>EXPLANATION</u>
/	Set date
*	Set clock
3	DCP mode, 3 = dual
S0	DCP scan number
DONE No S0 equations	
S1	DCP scan number
0 0 5 0	S1 scan interval = 5 min
0 0 0	S1 scan time = even 5 min interval
[	Encoder set token
T2 <- 10 64 INPUT T1 + SAVE ;	Read encoder, add offset (T1) and save
T3 <- 400 SAVE ;	T3 = threshold value of 4 ft
T4 <- 800 SAVE ;	T4 = threshold value of 8 ft
T5 <- 1200 SAVE ;	T5 = threshold value of 12 ft
T6 <- T2 T5 > IF 300. ELSE T2 T4 > IF 900. ELSE T2 T3 > IF 1800. ELSE 86400. ENDIF ENDIF ENDIF S0 !INT ;	Compare water level to 12, 8, and 4 ft, and change S0 Scan Interval to 5, 15, or 30 min if true, or back to 24 hrs. if false
DONE No more equations for S1	
S2	DCP Scans
0 0 15 0	S2 scan interval = 15 min
0 0 0	S2 scan time = even 15 min interval
T7 <- T2 32 DIM ;	Save 32 stage values
DONE No more equations	
DONE No more scans	
0	ST transmission preamble, 0 = short
64	ST GOES channel number
1	Confirm channel number
12345678	ST GOES station identification (ID)
1	Confirm station ID
0 4 0 0	ST transmission interval
2 32 10	ST transmission time (1st Xmit of day)
0	Transmission output mode, 0 = ASCII
H0 T7	ST transmission output list
DONE No more output equations	
118	Random reporting (RR) GOES channel no.
1	Confirms RR channel
12345678	RR GOES ID
1	Confirms RR ID
1 0 0 0	RR transmission interval
2	RR momentum
H0 T2	RR transmission output list

DONE No more RR output equations	
JJJJ Master password	
HHHH Limited password	
START	Start DCP

The following station script programs a Synergetics DCP with SCADA-SOFT Version 2.X.x/x software to measure water level every 15 minutes with an incremental encoder, store 32 values (8 hours of data), and transmit these values every 4 hours with Self-Timed (ST) GOES transmission.

> **NOTE:** The "[" (encoder set token) cannot be used, because there is no T1 equation. The "@" (set next transmission time) and the "#" (set next scan time) may be used but are not needed. All versions of SCADA-SOFT 2 will compute the next transmit or scan time when you enter the first scan or transmit time of the day.

SPOTS VALUE	EXPLANATION
N	Use stored program
/	Set date
*	Set time
Y	Communications C1? (YES)
31	GOES XMTR
Y	ADDR 31
1	Self-timed (ST)
0	Short preamble
64	ST GOES channel no.
Y	ST channel no. is correct
12345678	ST GOES station identification (ID) no.
Y	Confirm station ID
Y	C2? (no)
0	DONE (with communications)
Y	A1? action (YES)
0 SAVE ;	A1 action (W.L. value for encoder)
Y	A2? action (YES)
10 64 INPUT A1 + SAVE ;	A2 action (read encoder add A1)
Y	A3? action (YES)
A2 32 DIM ;	A3 action (save 32 values of stage)
C1 IF ASCII PRINT A3 END-PRINT ENDIF END-COMM ;	A4 action (transmit in ASCII A3 for C1)
N	A5? (NO)
0	DONE (with actions)
Y	E1? EVENT (YES)
1	A1 action to be under this event
1	Add no. 1
2	A2 action to be under this event
1	Add no. 2
3	A3 action to be under this event
1	Add no. 3
0	DONE (with actions)

1	Self-timed
1	Normal
0 0 15 0	E1 interval = 15 min
0 0 0	E1 time = even 15 min
Y	E2? (YES)
4	A4 action to be under this event
1	Add A4
0	DONE (with actions under E2)
1	Self-timed
0	ST GOES type event
0 4 0 0	E2 interval = 4 h (ST GOES XMIT)
2 32 10	First XMTR time is 0232
N	E5? (NO)
0	DONE (with events)
START	Start DCP

The following station script programs a Synergetics DCP with SCADA-SOFT Version 2.X.x/x software to measure the water level every 5 minutes with an incremental encoder. The program compares the water level to three designated threshold values and shortens the Random Reporting (RR) Interval to 5, 15, or 30 minutes. If the water level is not greater than any of these values, the RR interval is left at 24 hours. The program stores 32 water-level values, measured at 15-minute intervals (8 hours of data), and transmits these values every 4 hours with Self-Timed (ST) GOES transmission.

SPOTS VALUE	EXPLANATION
N	Use stored program
/	Set date
*	Set time
Y	Communications C1? (YES)
31	GOES XMTR
Y	ADDR 31
1	Self timed (ST)
0	Short preamble
64	ST channel no.
Y	ST channel no. is correct
12345678	ST GOES station identification (ID) no.
Y	ST GOES ID is correct
Y	Communications C2? (YES)
31	GOES XMTR
Y	ADDR 31
0	Random Reporting (RR)
121	RR channel no.
Y	Confirm RR channel
12345678	RR ID no.
Y	RR ID is correct
N	Communications C3? (NO)
0	Done with communications)
Y	A1? action (YES)

```
0 SAVE ;                                 A1 action (W.L. value for encoder)
Y                                        A2? (YES)
10 64 INPUT A1 + SAVE ;                  A2 action (read encoder add A1)
Y                                        A3? (YES)
A2 32 DIM ;                              A3 action (save 32 values of stage)
                                         A4? (YES)
15 0 INPUT SAVE ;                        A4 action (read status word and save)
Y                                        A5? (YES)
C1 IF ASCII PRINT A3 CR A4 END-PRINT     A5 action (transmit in ASCII A3
  ENDIF END-COMM ;                         carriage return A4 for C1)
Y                                        A6? (YES)
400 SAVE ;                               A6 action (store 4.00-foot threshold)
Y                                        A7? (YES)
800 SAVE ;                               A7 action (store 8.00-foot threshold)
Y                                        A8? (YES)
1200 SAVE ;                              A8 action (store 12.00-foot threshold)
Y                                        A9? (YES)
A2 A8 > IF 300. ELSE A2 A7 > IF          A9 action (compare stage to 12.00,
  900. ELSE A2 A6 > IF 1800. ELSE          8.00 & 4.00 ft, then change E4
  86400. ENDIF ENDIF ENDIF E4 !INT ;       interval to 5, 15, 30 min or leave
                                           at 24 h).
Y                                        A10? (YES)
C2 IF NESS-BINARY A2 EXECUTE             A10 action (transmit in NESS-BINARY
  ENDIF END-COMM ;                         A2 for C2)
N                                        A11? (NO)
0                                        DONE (with actions)
Y                                        E1? EVENT (YES)
1                                        A1 action to be under this event
1                                        Add no. 1
2                                        A2 action to be under this event
1                                        Add no. 2
5                                        A5 action to be under this event
1                                        Add no. 5
6                                        A6 action to be under this event
1                                        Add no. 6
7                                        A7 action to be under this event
1                                        Add no. 7
8                                        A8 action to be under this event
1                                        Add no. 8
0                                        DONE (with actions)
1                                        Self timed
1                                        NORMAL type event
0 0 5 0                                  E1 interval (DAY HR MIN SEC - 5 min)
0 0 0                                    E1 time (HR MIN SEC - even 5 min)
Y                                        E2? EVENT (YES)
1                                        A1 action to be under this event
1                                        Add A1
2                                        A2 action to be under this event
1                                        Add A2
3                                        A3 action to be under this event
1                                        Add A3
0                                        DONE (with actions under E2)
1                                        Self timed
```

1	Normal type event
0 0 15 0	E2 interval (DAY HR MIN SEC - 15 min)
0 0 0	E2 (HR MIN SEC - even 15 min)
Y	E3? (YES)
5	A5 action to be under this event
1	Add A5
0	DONE (with actions under E3)
1	Self timed
1	ST GOES type event
0 4 0 0	E3 interval (4-hour GOES XMIT)
2 32 0	First XMTR time is 0232
Y	E4? (YES)
9	A10 action to be under this event
1	Add A10
0	DONE (with actions under E4)
0	RR type event
0	GOES type event
1 0 0 0	E4 interval (DAY HR MIN SEC - 1 day)
N	E5? (NO)
0	DONE (with events)
START	Start DCP

Sutron Data-Collection Platforms

SPOTS <u>VALUE</u>	<u>EXPLANATION</u>
<CR>	
Password	Enter password if using a DCP with phone modem
CM	Clear memory (NOTE: Always clear memory before entering new program.)
OM - 1	Operating mode: 0 - random only 1 - self-timed only 2 - random and self-timed
ID1 - 1628C21E	Self-timed station identification
@,240,014310	Self-timed transmission time (in place of TT command)
TI - 240	Transmission interval in minutes
*	Set clock (in place of GMT command)
FMT - 1	Data format; 0 - binary, 1 - engineering
GRP - 1	Index for group commands; GRP is set to 1 at power up or when memory is cleared
NS - 16	Number of stored values for each parameter in the group
#,15,0000	Set time of next collection; takes place of TNC command
UI - 1	Update interval for each parameter in the group
WT - 0	Sensor warm-up time
INC - 1	Increment used in formatting a self-timed message; INC - 1 sends all stored data for each group
PAR - 1	PAR is index for parameter commands; PAR is set to 1 at power up or when memory is cleared; 16 parameters available
PT - 4	Parameter type; instructs DCP of type of input
GA - 1	Group assignment; indicates which GRP the parameter belongs

CO = 0	Conversion option; used to control how DCP processes acquired data
C2 = 0	Minimum value; used as starting point for counter
PAR = 2	Parameter 2
PT = 8	Parameter type
GA = 1	Group assignment
CO = 1	Conversion option
C2 = 0	Minimum value
SYN	Command to start channel entry sequence for D and E Model 8004 DCP's
A,52	Channel type; A = self-timed
Y	Answers DCP question; 'Y' indicates entry of proper channel number

Uploading Station Scripts to Data-Collection Platforms

Each DCP has a format for communicating with a programming set or terminal; the Tandy emulates one of these devices to communicate with the DCP. The user may upload the station scripts stored in the Tandy to the DCP in the AUTO mode after establishing communications between the Tandy and the DCP.

Handar Models 524 and 530

To program a Handar Model 524 or 530 DCP with the Tandy, use a programming interface adaptor designed and built by the NOHAU Corp. If a digital recorder is to be used, disconnect the 26-pin plug at the rear of the digital recorder before programming begins. Follow the steps listed below:

1. Attach the RS-232 cable between the Tandy and the NOHAU and attach the other cable on the NOHAU to the Handar DCP.

2. Turn on the Tandy power and connect the battery to the DCP.

3. Go to the ROOT DIRECTORY, place the cursor block over SPOTS, SPOTSR, or SPOTSB, and press ENTER.

4. When the display asks the user **TYPE OF DCP TO BE PROGRAMMED**, press "4" for Handar 524 or 530 and ENTER.

5. The display then asks if the user wants to "(1)PROGRAM A DCP through RS-232" or (2)PROGRAM A DCP through MODEM." Press "1" for RS-232 and ENTER.

6. The display now reads **** TERMINAL IN MANUAL MODE ****. Press F1 for AUTO.

7. The display reads **** TERMINAL IN AUTO MODE **** and offers four options. Press F1 to load a program.

8. The display lists all the station scripts in the STA NA<> directory and asks the user to **ENTER STATION NAME (F6 to quit)?** Type the station script (without the ".DO") to be uploaded to the DCP and press ENTER.

The DCP requests programming commands and the Tandy answers with the commands from the station script file. The program pauses for one or two minutes when the display reads **XMIT DELAY** so please be patient. After the programming is completed, the display reads **** TERMINAL IN MANUAL MODE **** and the NOHAU can be unplugged from the DCP. Remember to attach the digital recorder to the DCP before leaving the site.

Handar Models 540A-1, 560, 570A

Attach the RS-232 cable between the Tandy and the DCP, turn the Tandy power on, and connect the battery to the DCP. If for any reason the programming fails, disconnect and reconnect the battery to the DCP before trying to reprogram the platform. (Be sure a solar panel or charger does not still supply power when the battery is disconnected.)

1. At the ROOT DIRECTORY, place the cursor block over SPOTS, SPOTSR, or SPOTSB, and press ENTER.

2. When the display asks the user **TYPE OF DCP TO BE PROGRAMMED**, press "3" for Handar 540, 560, or 570, and ENTER.

3. The display then asks if the user wants to program a DCP through an RS-232 or MODEM. Press "1" for RS-232 and ENTER.

4. The display responds with **** TERMINAL IN MANUAL MODE ****. Press F1 to set the Tandy in AUTO mode.

5. The display responds with the following options: F1 to load a program, F2 to read and reset the encoder, F3 to reset DCP clock, and F6 to return to manual mode. Press F1.

6. The display lists all the station scripts from the STA NA <> directory and asks the user to **ENTER STATION NAME (F6 TO QUIT)?** Type the station script (without the ".DO") to be uploaded to the DCP and press ENTER.

The DCP requests programming commands and the Tandy responds with the user-written commands from the station script. If the operator uses the "[" token for an incremental encoder, the programming stops and ask for the gage height. Type in the gage height with the exact format shown on the Tandy display. (Include all leading zeros and the decimal point.) If the user gives an incorrect format, the Tandy and the DCP are out of proper sequence and the user needs to type a "Ctrl C" to stop the SPOTS program. The user has to disconnect the power to the DCP and start at the beginning. When a successful upload occurs, the Tandy displays **** TERMINAL IN MANUAL MODE ****. The user may unplug the Tandy from the DCP or may type any command that the DCP can accept while in the run mode. The user may disconnect the Tandy at any time while the DCP is in the run mode without damaging the program uploaded by SPOTS.

Synergetics Data-Collection Platforms

Attach the RS-232 cable between the Tandy and the DCP, turn on the Tandy power, and connect the battery to the DCP. (A Synergetics DCP can have a program uploaded to it only from a cold start.)

1. Go to the ROOT DIRECTORY, place the cursor block over SPOTS, SPOTSR, or SPOTSB, and press ENTER.

2. When the display asks the user **TYPE OF DCP TO BE PROGRAMMED**, press "1" for Synergetics and ENTER.

3. The display asks if the user wants to **(1)PROGRAM A DCP via RS-232** or **(2)PROGRAM A DCP via MODEM**. Press "1" for RS-232 and ENTER.

4. The display reads **PRESS ACTIVATE BUTTON ON DCP AND ENTER**. If the red light on the master control module is not on, press the activate button and press ENTER (the same as with the Epson up/down loader). If the display does not read **-MEMORY LOST-**, **-PRESS ESCAPE-** within about 3 seconds, press the ENTER key a few times in rapid succession.

5. Press the ESC key. The display gives the SCADA-SOFT VER 1.0.x/x and asks for the DCP.CLOCK, MON DAY YR?. Press F1 for AUTO.

6. The display reads *** * TERMINAL IN AUTO MODE * *** and offers four options. Press F1 to load a program, F2 to read or reset the encoder, F3 to reset the DCP clock, or F4 to return to the manual mode. Press F1.

7. The display lists all the station scripts in the STA NA <> directory and asks the user to **ENTER STATION NAME (F6 TO QUIT)?** Type the station script (without the ".DO") to be uploaded to the DCP and press ENTER.

The DCP requests programming commands and the Tandy answers with the user-written commands from the station script. If the operator uses the "[" token for an incremental encoder, the programming stops and asks for the gage height. Type the correct gage height with no decimals and using all four spaces (example 0567). Press ENTER. The DCP questions and the station script answers will be displayed on the screen as they are asked and accepted by the DCP.

Sutron Data-Collection Platforms

Attach the RS-232 adapter to the Sutron DCP terminals A6, A7, A8, A9, and A10 (the A terminal strip is located on the top side of the DCP) so that the adapter coupler extends below the A terminal strip and the blue jumper on the adapter faces away from the DCP. Attach the RS-232 cable between the Tandy and the adapter on the DCP. To complete the communications connection, follow the directions given below.

1. Place the the cursor block over SPOTS, SPOTSB, or SPOTSR in the Tandy and press ENTER. The display asks **TYPE OF DCP TO BE PROGRAMMED**.

2. Press "2" for Sutron and press ENTER. The display asks if the user wants to program a DCP through RS-232 or a Modem.

3. Press "1" for RS-232 and ENTER. The display reads * * **TERMINAL IN MANUAL MODE** * *.

4. Connect power to the DCP.

The communications connection is complete and the Tandy is in MANUAL TERMINAL MODE. A WELCOME message stating software version appears. If no welcome is received, disconnect the DCP and then reconnect it. When the welcome message is received, the DCP is ready to communicate with the Tandy.

5. Press F1 for AUTO. The display reads * * **TERMINAL IN AUTO MODE** * * and offers four options.

6. Press F1 to load a program, F2 to read or reset the encoder, F3 to reset the DCP clock, or F4 to return to the manual mode.

7. PRESS F1 to upload a station script to the DCP.

The Tandy display lists all the station scripts in the STA NA <> directory and asks the user to **ENTER STATION NAME (F6 TO QUIT)?** Type the station script (without the ".DO") to be uploaded to the DCP and press ENTER.

The DCP asks for the programing commands and the Tandy answers with the commands written in the station script. If the operator uses the "[" token for an incremental encoder, the programming stops and asks for the gage height. Type the correct gage height with no decimals and using all four spaces (example 0567). Press ENTER.

Backup of Software and Station Scripts

Backup of operating software and station scripts is very important. The user is advised to make, test, and file for safekeeping more than one copy of the latest version of the operating software and a copy of the station scripts. The user may find it beneficial to keep a copy of the operating software and station scripts in some form of memory that can be carried to the field.

Prime

Using TERM.BA Program to Upload from Tandy to Prime

Follow the directions given below to upload from Tandy to Prime using the TERM.BA program:

1. All files to be uploaded have to be in the ASCII form (.DO after the filename). If Basic (.BA) files are to be uploaded, the operator has

to convert them to ASCII (.DO) files before transferring them to the Prime. To convert files or programs from Basic to ASCII perform the steps listed below.

a. Go to BASIC in the Tandy, type NEW, and press ENTER.
b. Type LOAD "R:filename" and press ENTER.
c. Type SAVE "R:filename.DO", then press ENTER.

2. All files to be uploaded have to be in the Directory with TERM.BA. If more than one or two files are to be uploaded, copy TERM.BA to the directory in which the files are located.

a. Place the bar cursor over TERM.BA and press ENTER.
b. Press 1 for direct connection.
c. Press ENTER when connected to Prime.
d. Press 1 for terminal mode.
e. Toggle F6 to Full. (Check the label line on the bottom of the screen to determine status.)
f. Toggle F7 to 9600 (baud rate).
g. Toggle F8 to PRIM (Prime COMPUTER).

3. Log onto Prime and enter user password. Change the Prime AMLC line for 1200 baud communication. (The Site Administrator can help.) Before going further, toggle F7 to 1200 baud to match the new baud rate on the Prime line.

a. Type ED to get into EDITOR (**NOTE:** The user is in the INPUT mode.)
b. Press ENTER to get into EDIT mode.
c. Type MODE NOSEMI. This keeps the ";" from ending a line in the file.
d. Press ENTER and go to INPUT.
e. Press F4 (UP for upload) and type the filename to be uploaded from the Tandy to the Prime. The Tandy screen displays the file line numbers as the program transfers the file and scrolls the file on the screen. In the EDIT mode, type FILE filename.

The user, for each file that is transferred, has to return to the point where EDIT is entered and continue to the point where FILE filename is typed. To go back to the Tandy, press the SHIFT and PAUSE keys at the same time and type MENU. The Tandy returns to the directory in which work was started. If continued communication with the Prime is needed, the user probably is still logged in. Go into TERM.BA, press ENTER three times, toggle F6, F7, and F8 to the proper settings. Type WHERE to check if the user still is logged into Prime. Remember, the Prime AMLC line is set for 1200 baud and does not communicate with the regular terminal if the baud rate is different.

Using TERM.BA Program to Download from Prime to Tandy

Follow the directions given below to download from Prime to Tandy using the TERM.BA program:

1. Set up a communication link between the Tandy and the Prime as described in the previous section on upload. Log onto the Prime and perform the steps listed below.

   a. Type ED (to go into EDITOR).
   b. Press ENTER (to go to EDIT mode).
   c. Type MODE NOSEMI and press ENTER.
   d. Press F5 (DN download). The query **FILE?** is displayed on the screen.
   e. Type filename and press ENTER.
   f. Two arrows on either side of DN indicate that download is active.
   g. Type LOAD filename and the print appears at top of screen over the previous screen.
   h. Type T,pxx (These are EDIT commands where T goes to top of file and pxx scrolls the pointer down through xx number of lines in the file. Enter the number of lines or a number greater than the number of lines in the file in place of xx.)
   i. The file scrolls on the Tandy screen until it reads BOTTOM, which indicates the end of the file.
   j. Press F5 to get out of the download mode.
   k. Press Q to get out of EDIT. The screen displays FILE MODIFIED, OK TO QUIT?
   l. Press Y for yes.

2. To return to the Tandy directory, do the following:

   a. Press the SHIFT and PAUSE keys at the same time.
   b. Type MENU, to return to the Tandy directory.
   c. Place the bar cursor over TERM.BA and repeat the previous instructions to download another file.

Remember, the Prime AMLC line is set for 1200 baud and will not communicate with the regular terminal if the baud rate is different.

Using TELCOM on Tandy to Upload to Prime

Follow the directions given below to use TELCOM on Tandy to upload files to the Prime:

1. Make sure the Baud rate on the AMLC line to the Prime is set for 1200.

2. Turn on the Tandy and attach to the directory location of the files that are to be transferred to the Prime.

3. Copy files to be uploaded to the Prime from the Tandy directory to the Tandy workspace.

a. Connect the Prime line to the Tandy, place the bar cursor over TELCOM, and press ENTER. The screen displays the XON and XOFF handshaking protocol (57I1E,10 pps). Under this message, Telcom is displayed.
b. If screen described in step 3a does not appear, type STAT 57I1E and press ENTER.
c. When the proper handshake protocol is displayed, press F4 (Term) and log onto the Prime.

The information scrolled across the screen is slow (1200 baud) and is not aligned properly because of the 40 character line length on the Tandy screen. After completion of this process, the Tandy is a terminal to the Prime.

4. Continue with the uploading.

a. Type ED and press ENTER. (The screen display is INPUT).
b. Press F3 (UP upload) and the screen display is **File to Upload?**
c. Type filename.DO and press ENTER. The screen display is **Width:**.
d. Type 80 and press ENTER.
e. The file scrolls across the screen and, when completed, returns the user to the EDIT mode.
f. Type "FILE filename" and press ENTER.
g. Type Q to quit EDITOR. Type SLIST and press ENTER to determine if the file is in the user's Prime Directory.

5. Return to the Tandy directory to place another file in the workspace.

a. Press F8 (Bye) and the screen display is **disconnect?** Press Y for yes.
b. The screen displays **57I1E,10 pps** and one line down shows **TELCOM:**.
c. Press F8 (Menu) to return to the Tandy directory.
d. Press F4 (Work). The bar cursor is positioned over the file just copied to the Prime.
e. Press F2 (Kill). The screen displays **SURE?** Press Y to erase the file.
f. Press F4 (RAM) to return to the original directory. Use the procedure described previously to place a new file in the workspace and copy it into the Prime.

Remember, the Prime AMLC line is set for 1200 baud and does not communicate with the regular terminal if the baud rate is different.

Using TELCOM on Tandy to Download from Prime to Tandy

Use the procedure described in the previous section to set up a communication link between the Tandy and the Prime. Follow the directions listed below to use TELCOM on Tandy to download files from the Prime to the Tandy:

1. Log onto Prime and type ED to get into EDITOR.

2. Press ENTER (now in the EDIT mode).

3. Type LOAD filename and press ENTER.

4. Press F2 (Down for download) and the screen displays **FILE TO DOWNLOAD?**

5. Type the filename. Use the EDIT commands and then type T,pxx (T goes to the top of the file and pxx moves the pointer from the top down xx lines.) The xx has to be a number that is equal to or greater than the number of lines in the file being copied.

6. Exit TELCOM and return to the Tandy directory in the same manner as described in the previous chapter for uploading.

Remember, the Prime AMLC line is set for 1200 baud and does not communicate with the regular terminal if the baud rate is different.

Portable Disk Drive

The Tandy Portable Disk Drive 2 is a very good backup device and is designed for field use. The Disk Drive 2 uses the single-sided, 3 1/2-inch microfloppy diskette and is powered by four AA batteries. The operator may use Disk Drive 2 with an ac adapter where line power is available. Tandy supplies Disk Drive 2 with a cable for connection to the computer; it works very well with the Tandy Model 100 or 102 computers with Booster Pak. The operator may store programs and station scripts that are long and require large amounts of memory space on Disk Drive 2. These files may be transferred, in a very short amount of time, to the Tandy. The Portable Disk Drive 2 reduces the amount of free memory required in the Tandy computer.

Tandy Portable Disk Drive 2 with Enhanced Tandy Booster Pak

Follow the directions listed below to use the Tandy Portable Disk Drive 2 with Tandy Model 100 or 102 computer with Booster Pak:

1. Connect the computer to the Disk Drive 2 with the cable supplied with the Portable Disk Drive 2.

2. Switch on the computer and the Disk Drive 2.

3. Enter the Tandy directory from which files are to be copied, insert a new diskette into the Disk Drive 2, and look at the bottom of the Tandy display to determine which function key to press.

4. Press F5 (Disk). A red light on the front of the disk drive flickers on and off if the system is operational.

5. Read the computer display line just above the label line, which shows NOT FORMATTED, and follow directions for formatting the disk. Every disk has to be formatted before it can be used.

    a. Press F6 (Frmt), and follow instructions given.

b. Press Y and the bottom line displays **Formatting....** and the red light flickers on and off.
c. Formatting is complete when the light stops flickering and the line above the label line displays **Free:202240.** Various disks may display different numbers. The number indicates the amount of free memory remaining on the disk.

Two banks (separate areas on which files or data can be stored) are on each disk. The program formatted both banks, and the user starts on bank 0, indicated on the top line of the display. No files are on the disk as indicated by the display.

6. Return to the computer directory to copy files from the computer to the disk drive.

   a. Press F4 (RAM, all Tandy memory) to return to the computer directory.
   b. Place the bar cursor over the file to be transferred to the disk and press F1 (Copy).
   c. The label line has changed. Press F3 (Disk). The bottom line of the display asks for the new filename (New Name:).
   d. Type in a new filename or press ENTER to use the old name (same as in the computer directory).
   e. The light on the disk drive flickers until the file transfer is completed.
   f. Press F5 (Disk) to check if the file is in the disk. The file name is shown in the upper left corner of the display.

The operator uses the computer's function keys (F1, F2, F3, F4, F5, F6, F7, and F8) to transfer files between the computer and the disk drive. The program displays available options on the bottom line of the computer screen. The options change for different operations. Only four options exist for the Copy Function: **RAM** for computer memory, **Work** for computer work area, **Disk** for the Portable Disk Drive 2, and **Quit** to return to the directory.

Tandy Portable Disk Drive 2 with Datapac-Enhanced Tandy or Tandy with no Memory Enhancement

The Tandy Models 100 and 102 are not supplied with a disk file-management system. The disk file-management system is on the utility diskette supplied with the Portable Disk Drive 2 and has to be copied into the Tandy. Complete instructions for copying the disk file-management system into the Tandy are given in the Portable Disk Drive 2 Operating Manual (Cat. No. 26-3814).

The following abbreviated instructions, included here with the manufacturer's permission, are for copying the disk file-management system in the Tandy Portable Computer.

Use the cable supplied with the Portable Disk Drive 2 to connect the computer to the Disk Drive 2. Insert the utility diskette into the Disk Drive 2 and turn the Disk Drive 2 OFF. Turn the computer ON.

1. In the main menu of the computer, place the cursor block over BASIC press ENTER.

2. Type 10 RUN"COM:98N1ENN" and press ENTER.

3. Type SAVE "IPL" and press ENTER.

4. Turn the disk drive on. The following message will be displayed:

```
---INITIAL PROGRAM LOADER II---
    WAIT A MINUTE!
now loading file-manager
```

- If this message does not appear, press the Shift and Break keys. When the OK prompt appears, repeat the procedure from step 1. If **?OM ERROR** appears, the computer does not have enough free memory to run the IPL program. If the low battery light on the disk drive flickers, begin again at step 1. After the IPL operation, the terminal settings for TELCOM need to be changed back to the normal settings.

NOTE: When the message **SYSTEM EXISTS** appears on the display, IPL cannot be run because of another program residing in high memory. The user may erase the old program and load File Manager in BASIC by typing CLEAR 256, MAXRAM and pressing ENTER. Try the IPL operation again from step 1.

5. After about 20 seconds, the menu returns automatically to the display. Find "FLOPPY" in the menu.

NOTE: "FLOPPY" is the file name of the management program. If "FLOPPY" does not appear in the main menu, reload the program.

To copy files from the computer to disk drive return to the computer directory and proceed as follows:

1. Insert a formatted disk into the disk drive and turn on the disk drive.

2. Select FLOPPY and press ENTER.

3. Press F3 (Save). A list of files in the Tandy appears on the screen. The words **SELECT FILE:** (with blinking cursor) are at the bottom of the screen.

4. Type the file name to be transferred to the disk drive and press ENTER.

5. Below the **SELECT FILE:** (filename), the message **SAVE AS** ________: (with blinking cursor) appears. Type the new filename or press ENTER, and the file is transferred to the disk drive with the same name.

6. Press F1 (File) view the file in the disk drive directory.

To copy files from the disk drive to the computer, return to the computer directory, select FLOPPY, and press ENTER.

1. Press F2 (Load). A list of files in the disk drive appears on the screen. The words **SELECT FILE:** (with blinking cursor) are at the bottom of the screen.

2. Type the filename to be transferred to the Tandy's RAM and press ENTER.

3. Below **SELECT FILE:** (filename), the message **FILE NAME IN RAM:** (with blinking cursor) appears. Type the filename to be transferred, or press ENTER to use the same filename in the Tandy.

The disk drive functions are listed on the bottom of the screen above the function keys (F1, F2, F3, F4, F5, F6, F7, F8) on the computer.

F1 "File" to view the file on the diskette for the bank being accessed.
F2 "Load" to copy a file from the disk drive to the Tandy.
F3 "Save" to copy a file from the Tandy to the disk drive.
F4 "Bank" to change from one bank to the other.
F5 "Kill" to delete a file in the disk drive.
F6 "Name" to change the name of a file in the disk drive.
F7 "Fmt" to format a diskette.
F8 "Menu" to return to the Tandy directory.

Hardware and Software Support

Hardware

The HIF stocks and sells through the warehouse the Booster Pak memory enhancement module with 256K of memory and the Softskin keyboard cover. The HIF also stocks and sells cables for connecting the Tandy to the Synergetics, Sutron, and Handar DCP's. The HIF does not stock the Tandy computer or the carrying case. The soft carrying case supplied by Tandy is not recommended for field use. Suitable hard cases with foam padding manufactured by Platt are available from Specialized Products Company.

Software

The HIF has copies of SPOTS, SPOTSB, SPOTSR, and SATLOC (discussed in following chapter) in the Prime. These programs can be transferred to a local Prime or sent to the user on 3 1/2- or 5 1/4-inch diskettes. The HIF does not make any changes or updates to these programs. Data-Collection Platform support, included in the Personal Field Computer (PFC) software, takes the place of SPOTS. Improvements or additional support for DCP's will be done through the PFC software.

SATELLITE LOCATOR PROGRAM

By Jack Hardee

Introduction

The Satellite Locator Program (SATLOC) provides bearing and elevation information to assist in aiming the DCP antenna. The menu-driven program requires the user to know the approximate location of the antenna in relation to a state map.

Loading SATLOC

Loading SATLOC from HIF Prime to Local Prime

The following command loads SATLOC software from the HIF Prime into FTS_DEPOT on the local Prime minicomputer.

FTR SPOTS>SATLOC.DO FTS_DEPOT> — -SS QMSBSL

Loading SATLOC from Local Prime to Tandy

The following instructions are for loading SATLOC software into the Tandy Model 100 or 102 **without** the Booster Pak or the DATAPAC memory enhancements. **NOTE:** The communications line from the Prime has to be set to 1200 baud. Proper transfer does not occur at faster speeds. Consult the local Prime System Operator or Administrator for assistance.

1. Connect the communications line from the Prime to the Tandy Model 100 or 102 RS-232 port. Set up communications on Tandy, using TELCOM, as follows:

   a. Enter TELCOM. Press F3 (Stat).
   b. Type 57I1E and press ENTER.
   c. Press F4 (Term).

2. Log onto Prime. Check line speed setting if unsuccessful. Note the original line speed setting if it is changed. Check Tandy settings and log on. Attach to the directory that contains the SATLOC.DO file.

   a. Type SLIST SATLOC.DO **but DO NOT PRESS ENTER!**
   b. On Tandy, press F2 (Down).
   c. After the prompt **File to download?**, type SATLOC.DO and press ENTER.
   d. Press ENTER again.

   File transfer begins and takes about 4 1/2 minutes.

3. Do the following after completion of the file transfer:

   a. Press F2 (Down).
   b. Press F8 (Bye).
   c. Type Y (for YES) and press ENTER.
   d. Press F8 (Menu) to return to normal mode.

4. Log off Prime. Remember to reset the line speed if the setting differs from the setting before the connection to Tandy.

Converting SATLOC Download File into BASIC

The SATLOC software is on the Tandy portable computer as an ASCII file and must be converted to a BASIC file before it can run. Enter SATLOC and follow the steps below to delete the extra carriage return (designated by a left-facing arrowhead) at the beginning of the file and the extra line after the last numbered line in the program that contains the Prime system ready prompt (Next? or OK,).

1. Place the cursor block over the < and press the SHIFT and DEL-BKSP keys.

2. Press the CTRL and down-arrow keys and release (to go to bottom of program).

3. Use the DEL-BKSP key to remove this line and any extra carriage returns at the end of the file.

4. Press F8 (Menu) to refile.

To convert SATLOC.DO (ASCII) file to SATLOC.BA (BASIC), do the following:

1. Place cursor block over BASIC and press ENTER.

2. Type LOAD "SATLOC.DO" and press ENTER.

   NOTE: Loading will take about 3 minutes. Loading is complete when OK prompt appears on screen.

3. Type SAVE "SATLOC" and press ENTER.

4. Press F8 (Menu).

5. Place cursor block over BASIC and press ENTER.

6. Type KILL SATLOC.DO.

7. Type NEW and press ENTER.

8. Type CLEAR 512,MAXRAM and press ENTER. (This clears memory for running SATLOC.BA).

9. Press F8 (Menu) to return to normal mode.

Running SATLOC Program

To run SATLOC program, do the following:

1. Place the cursor block over SATLOC.BA and press ENTER.

2. Follow the program prompts. The program displays a map of the United States with a blinking dot (at Kansas) located in the center of the map.

3. Move the dot with the cursor arrows to the operator's approximate location and press "L" on the keyboard.

4. Type the appropriate number to respond to the program's request for the longitude of the satellite at which to aim the antenna and press ENTER. The program redraws the U.S. map with 5-degree magnetic declination lines.

   NOTE: For east declinations, subtract the magnetic declination from the true azimuth and for the west declinations, add the magnetic declination to the true azimuth. This may be incorrect in some of the earlier versions of SATLOC!

5. Interpolate the operator's magnetic declination, press the corresponding number on the keyboard, and press ENTER. The Tandy displays the platform location, the antenna elevation, and the true and magnetic bearings of the satellite.

Loading SATLOC from Personal Computer to Tandy

The instructions for loading SATLOC software from a personal computer (PC) into the Tandy Model 100 or 102 **without** the Booster Pak or the DATAPAC memory enhancements, follow.

1. Connect the PC communications port to the Tandy communications port, using a cable with pins 2 and 3 swapped at one connector.

2. Set up communications on Tandy using X-TEL as follows:

   a. Place cursor over X-TEL.BA and press ENTER.
   b. Press F3 (Stat).
   c. Type 88N1E and press ENTER.
   d. Press F4 (Term).

3. Set up communications on the PC, using PROCOMM, as follows:

   a. Enter PROCOMM.
   b. Check line settings. They need to be 9600 baud, no parity, 8 bits, 1 stop bit, and x-on/x-off activated.

After communications have been established, transfer the SATLOC file as described below:

1. On the PC, enter file upload mode, select ASCII communications, and type path\SATLOC.DO (C:\SATLOC.DO if the file is in directory C of the PC), but **DO NOT PRESS ENTER!**

2. On the Tandy, press F2 (Down). After prompt **File to download?**, type SATLOC.DO and press ENTER.

   NOTE: Although the XModem transfer F6 (X-Dn) is faster and more efficient, it does not work properly.

3. Press ENTER on the PC. File transfer begins and takes about 4 1/2 minutes. When transfer is complete, do the following:

   a. Press F2 (Down).
   b. Press F8 (Bye), type Y, and press ENTER.
   c. Press F8 (Menu) to return to normal mode.

<u>Converting SATLOC Download File into BASIC</u>

Follow instructions given earlier in this section to convert SATLOC download file into BASIC and run SATLOC program.

Loading SATLOC from Local Prime to Tandy with Booster Pak

The instructions for loading SATLOC software from a local Prime to the Tandy Model 100 or 102 **with** the Booster Pak memory enhancement module follow.

1. Connect the communications line from the Prime to the Tandy RS-232 port. Set up communications on Tandy, using X-TEL, as follows:

   a. Place cursor block over X-TEL.BA and press ENTER.
   b. Press F3 (Stat).
   c. Type 57I1E and press ENTER.
   d. Press F4 (Term).

2. Log onto Prime. Check line speed setting if login is unsuccessful. Check Tandy settings and retry login. Attach to the directory that contains the SATLOC.DO file. Do the following:

   a. Type SLIST SATLOC.DO but **DO NOT PRESS ENTER!**
   b. On Tandy, press F2 (Down).
   c. After prompt **File to download?**, type SATLOC.DO and press ENTER.
   d. Press ENTER again.

   File transfer begins and takes about 4 1/2 minutes.

3. After completion of transfer, do the following:

   a. Press F2 (Down).
   b. Press F8 (Bye).
   c. Type Y (for YES) and press ENTER.
   d. Press F8 (Menu) to return to normal mode.

4. Log off Prime. Remember to reset the line speed if the setting differs from the setting before the connection to Tandy.

<u>Converting SATLOC Download File into BASIC</u>

Instructions for converting the SATLOC download file into BASIC are as follows:

1. Press F4 (Work).

2. Place cursor block over SATLOC.DO and press ENTER.

Delete the extra carriage return (designated by a left-facing arrowhead) at the beginning of the file and the extra line after the last numbered line that contains the Prime system ready prompt (Next? or OK,).

1. Place the cursor block over the < and press the SHIFT and DEL-BKSP keys.

2. Press CTRL and the down arrow to move to the bottom of the program. An extra line appears after the last numbered line and contains the user's Prime system ready prompt (**Next?** or **OK,**). An extra carriage return may also appear.

3. Use the DEL-BKSP key to remove this line and any extra carriage returns at the end of the file.

4. Press F8 (Menu) to refile.

5. Place the cursor over SATLOC.DO and press F1 (Copy).

6. Press F1 (RAM). At the prompt **New Name:** type R:SATLOC.DO and press ENTER.

7. Press F2 (Kill) and type Y. (This deletes SATLOC.DO, which is no longer needed and takes up memory.)

8. Press F4 (RAM). Place cursor block over BASIC and press ENTER.

Loading SATLOC from Personal Computer to Tandy with Booster Pak

The instructions for loading SATLOC software from a PC into the Tandy Model 100 or 102 **with** the Booster Pak memory enhancement module follow.

NOTE: The communication line from the Prime has to be set to 1200 baud. Proper transfer does not occur at faster speeds. Consult the local Prime System Operator or Administrator.

1. Connect the PC communication port to the Tandy communication port, using a cable with pins 2 and 3 swapped at one connector.

    a. Place cursor block over X-TEL.BA and press ENTER.
    b. Press F3 (Stat).
    c. Type 88N1E and press ENTER.
    d. Press F4 (Term).

2. Set up communications on the PC, using PROCOMM as follows:

    a. Enter PROCOMM.
    b. Check that the line settings are 9600 baud, no parity, 8 bits, 1 stop bit, and x-on/x-off activated.

After communications have been established, transfer the SATLOC file as described below:

1. On the user's PC, enter file upload mode, and select ASCII communications, and type path\SATLOC.DO (C:\SATLOC.DO if the file is in directory C of the PC), but **DO NOT PRESS ENTER!**

2. On the Tandy, press F2 (Down). After the prompt **File to download?** appears, type SATLOC.DO and press ENTER.

   NOTE: Although the XModem transfer F6 (X-Dn) is faster and more efficient, it does not work properly.

3. Press ENTER on the PC. File transfer begins and takes about 4 1/2 minutes.

4. When transfer is complete, do the following:

   a. Press F2 (Down).
   b. Press F8 (Bye), type Y, and press ENTER.
   c. Press F8 (Menu) to return to normal mode.

Converting SATLOC download file into BASIC

Follow the instructions given earlier to convert SATLOC download file into BASIC and run the SATLOC program.

Loading SATLOC into Tandy with Datapac Memory Enhancement Module

Software for loading SATLOC from the local Prime to Tandy with DATAPAC, from PC to Tandy, and converting SATLOC download file to BASIC are the same as for the Tandy with no memory enhancement.

DATA-COLLECTION PLATFORM INFORMATION MANAGEMENT SYSTEM

By Michael L. Field

The Platform Assignment Scheduling Subsystem (PASS) permits registration of users of the GOES data-collection system. The PASS supports the scheduling of DCP transmissions and allows users to request a new DCP assignment or modify existing assignments.

The PASS employs user-input information to select a GOES DCP identification code (ID) on the proper channel for the site location, to assign the DCP to a Survey direct read-out ground station (DRGS), and to calculate antenna azimuth and elevation. This program allows for modification of most of the information and has features for listing and transferring the assignment records to another Prime computer. The program checks extensively to prevent such problems as duplicate station and device numbers. In addition to processing DCP assignments, PASS automatically creates and transmits a preliminary DCP maintenance form to the appropriate DRGS operator.

The system uses Fortran 77 format for the main menu and for information needed for calculations. The remaining screens and input use the Prime INFO programs.

Authorizations

To use the GOES satellite for data transmission, the user needs two authorizations: one for use of the GOES satellite and the other to emit radio transmissions of any type. When the user enters a new station or changes a primary operating parameter, PASS will automatically generate the proper forms for the Data Relay Project to submit to the Department of Interior. The authorization for new DCP stations has to be generated 30 days before the DCP is activated. The authorization forms for the Data Relay Project, should be submitted to National Environmental Satellite Data and Information Service (NESDIS) 2 weeks prior to DCP activation. To meet this NESDIS imposed schedule, users have to request that PASS print the authorization no sooner than 30 days and no later than 21 days before activation of the DCP. Users need to contact the appropriate Survey DRGS operator 24 hours before actual activation.

INFO Conventions

The conventions presented below are to be followed during data entry or update through the PASS computer screen input forms. The following controls are used by INFO. Use only the keys enclosed in < >. TYPE ONLY IN UPPER CASE LETTERS.

<space> <return>	This command leaves a blank value for the input.
<-> <return> or <tab> <return>	During update, this command retains the current value and the cursor will move to the next entry.

<backslash> <return>	This command returns the cursor to the previous entry.

For all other information, enter the value followed by <return>.

Keywords In The Platform Assignment Scheduling Subsystem

The following is a description of all the items needed for PASS. An asterisk (*) after the term means the information is **mandatory**. Two asterisks (**) after the term means the information is supplied by PASS and cannot be directly updated by the user.

Office Information

PERSON ID*	Prime personal ID; limited to 22 characters.
NODE*	Prime node in the Prime Distributed Information System (DIS) network; limited to 6 characters. For example: QVARSB or DAZTCN.
NAME*	Person responsible for the site; person who can be contacted in case of problems or who desires to receive the transmitted data. First name is limited to 12 characters, initial to 1 character, and last name to 22 characters.
ADDRESS*	Mailing address of the NAME person; limited to 22 characters.
AGENCY	National Water Data Exchange (NAWDEX) agency code of the contact; limited to 5 characters. For example: USGS or USCOE.
PHONE*	FTS and (or) commercial number for contacting the NAME person. (xxx-xxx-xxxx)
PRIME DIRECTORY*	Full pathname to Prime directory to which data are to be transferred through the Prime DIS network; limited to 30 characters.

Station Information

STATION NAME*	Standard U.S. Geological Survey station name; limited to 48 characters.
STATION NUMBER*	USGS downstream station number or latitude-longitude sequence number; limited to 15 characters. For example: 01234567.
NEAREST CITY*	Name of nearest city to the station that is shown on a USGS topographic map; limited to 16 characters.

LATITUDE*	Latitude of station as DDMMSSD; include (N)orth or (S)outh. For example: 352515N.
LONGITUDE*	Longitude of station as DDDDMMSSD; include (E)ast or (W)est. For example: 0835343W or 1211917W.
STATE CODE*	FIPS numeric state code for the state in which the station is located; limited to 2 characters. For example: 42.
OWNER AGENCY*	NAWDEX agency code of the agency that owns the DCP located at the station; limited to 5 characters. For example: USGS or USCOE.
SITE ELEVATION*	Elevation, in feet above sea level, for the station; limited to 5 digits, including sign and no decimal. For example: -4244.

Data-Collection Platform Information

TRANSMIT INTERVAL**	For self-timed DCP's, the time interval (hh), in hours, between regularly scheduled transmissions. For example: 04.
PLATFORM MANUF*	Name of the DCP manufacturer; use (H)andar, (L)aBarge, (SU)tron, (SY)nergetics, or (other); limited to 2 characters.
MODEL*	Model number of the DCP; limited to 6 characters. For example: 3400.
TRANSMIT TYPE*	Type of transmission from DCP; use (S)elf-timed, (R)andom, (A)lert, (I)nterrogated; limited to 1 or 2 characters, but 2 modes, such as (SA) self-timed with alerts, can be used.
NUMBER OF DEVICES*	The number of different devices to be transmitted from the DCP, including any internal devices such as battery voltage or DCP status. The number has to correspond to the number of DEVICES described in the next section of the form. This number can range from 1 to 20.
ANTENNA HEIGHT*	The height, in feet, that the antenna is located above the land surface; limited to 2 characters. For example: 10.
DEPLOY DATE*	The approximate date of deployment to the field. This date is used to generate the NESDIS platform data file (PDF) at the proper time. The date is limited to 8 characters, including the slash (/). For example: 01/12/86. This data allows the Data

Relay Project to send the DCP information to NESDIS at least 2 weeks in advance of the DCP deployment.

NESDIS NOTIFIED** — Dáte indicating when the NESDIS PDF was sent.

NESDIS QUEUE** — NESDIS login ID in the event that data retrieval from NESDIS is necessary.

DEMOD SCHEDULE** — DEMOD assigned by PASS; used by the USGS DRGS operator.

INVENTORY CNTL NO. — An 8-character data field for use in identifying the instrument used. This field is used in the DCP information section to identify the DCP and in the device section to identify the individual devices.

DATE ASSIGNED** — Date the station information was entered into PASS.

Device Information

PASS requests information for <n> devices, where <n> equals the user entry made for NUMBER OF DEVICES. This is filled out for each DEVICE NUMBER in the order transmitted.

DEVICE NUMBER** — Device identifier supplied by PASS.

PARAMETER CODE* — The National Water Data Storage and Retrieval System (WATSTORE) (STORET) parameter code, limited to 5 digits, that designates the location in which the information is to be stored in the PRIME INTRIM-WATSTORE files. For example: 00065 or 65.

PARAMETER DESC — Abbreviated character name, such as temp or cond; limited to 6 characters. For example: stage.

PARAMETER UNITS — Units assigned to the data; limited to 6 characters. For example: feet or meters.

DEV UPD INT* — The time (hhmm), in hours and minutes, between successive data values. If the DCP reads stage every 15 minutes, the recording interval is 0015. If the DCP measures battery voltage once for each transmission, the recording interval is the same as the TRANSMIT INTERVAL. For example: 0400.

Operation of the Platform Assignment Scheduling Subsystem (PASS)

PASS is in the QVARSB PRIME and the user has to netlink to QVARSB to access it. To obtain the PERSON ID and password, please contact Mike Field

(MLFIELD) at QVARSB or by telephone (FTS 959-5362). Because of the different types of terminals in use with the Primes, INFO has to be set up so that the screen controls work for the terminal being used. Use the following procedure to do this:

- If a TAB, GraphOn, or VT-100 terminal is used, the screen clears before the first question listed in the example appears.

  Answer with a Y and continue.

- If the screen does not clear, make a selection from the list printed by the computer. If the terminal type is not included in the list, find a selection that is compatible with the terminal being used. For example, SuperBrain terminals use type AREG and VT-100 type terminals use type ANSI.

An example of the procedure for clearing the screen follows:

```
IF YOUR SCREEN DID NOT CLEAR BEFORE
THIS MESSAGE, YOU WILL HAVE TO CHANGE
YOUR TERMINAL TYPE.  DID YOUR SCREEN
CLEAR?  (Y OR N)?   N

ACT-I     VACT5A     ADDS       ADML1
AREG      BEEH       CONCEPT    CYBERNEX
HONW      HP2621     I304       IBM1
OWL       PST100     SOROC      TVI924
ADM3      ANSI       ANSIW      DGRX
DMED      HARD       LYNW       NEWB
NONE      VCRG       VT52       SEIK
```

```
PLEASE TYPE IN THE TERMINAL TYPE
SELECTED.  ANSI

DID YOUR SCREEN CLEAR (Y OR N)? Y
```

The process started is completed using menus. The main menu as viewed on the computer screen is shown below. All the options return to this point. Explanations and helps for the options follow.

```
 1   ADD NEW STATION
 2   ADD NEW STATION FOR NON-USGS DCP
 3   MODIFY EXISTING STATION INFORMATION
 4   DELETE STATION
 5   MODIFY FIELD OFFICE INFORMATION
 6   MODIFY DEVICE INFORMATION
 7   SUBMIT NESDIS PLATFORM DATA FILE
 8   LIST STATION INFORMATION
 9   TRANSFER STATION INFORMATION
10   LIST STATION SUMMARY BY STATE OR PERSON ID
11   TRANSFER STATION INFO BY STATE OR PERSON ID
12   CALCULATE ANTENNA AZIMUTH AND ELEVATION
14   QUIT
```

Option 1 Add New Station

This option selects a DCP ID and the corresponding channel, assigns the proper supporting DRGS, and calculates the antenna azimuth and elevation. This calculation is absolute, using no magnetic variations. Some of the data displayed on the screen is calculated (azimuth and elevation) or is assigned data (DCP ID, channel, DRGS, and transmission times) and cannot be changed.

The following information is requested when option 1 is selected.

```
INPUT OPTION NUMBER - 1
PERSON ID -
STATION NUMBER -
2 DIGIT STATE CODE -
6 DIGIT LATITUDE + (N OR S) -
7 DIGIT LONGITUDE + (E OR W) -
NEAREST CITY OR TOWN -

IS THE ABOVE INFORMATION CORRECT (Y OR N)?

CHECKING STATION NUMBER.
CHECKING PERSON ID.
CHECKING STATE CODE.
CHECKING FOR AVAILABLE DCP ID.
CHECKING FOR AVAILABLE DEMOD SPACE.
```

The **office information screen** shown below is displayed only if the PERSON ID is new to the data base. An asterisk (*) indicates a mandatory item; the cursor does not move until an entry is made. Two asterisks (**) indicate entry is made by PASS, which completes the screen entry if

- data have been supplied previously, such as station number or PERSON ID,
- an assignment is made, such as DCP ID or DRGS, or
- a calculation is made, such as antenna azimuth or antenna elevation.

```
PERSON ID:**                   NODE:*
NAME:*          MID INIT.:    LAST NAME:*
ADDRESS:*
ADDRESS:
CITY:*                       STATE:**    ZIP:*
AGENCY:
FTS PHONE:                  NON-FTS PHONE:
PRIME DIRECTORY:*
```

Option 1 Add New Station (continued)

The **station information screen** shown below appears next.

```
 ______________________________________________________________________
|STATION NUMBER:**                  NEAREST CITY:**                    |
|STATION NAME:*                                                        |
|LATITUDE:**                        LONGITUDE:**                       |
|STATE CODE:**                      OWNER AGENCY:                      |
|SITE ELEVATION:*                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|______________________________________________________________________|
```

The **DCP information screen** shown below appears next.

```
 ______________________________________________________________________
|DCP ID:**                           DRGS:**                           |
|ASSIGNED TIME:**                    TRANSMIT INT:**                   |
|PRIMARY CHANNEL:**                  SECONDARY CHANNEL:**              |
|ANTENNA AZIMUTH:**                  ANTENNA ELEVATION:**              |
|PLATFORM MANUF (L,H,SY,SU):*        PLATFORM MODEL:*                  |
|TRANSMIT TYPE (S,R,A,SA,RA):*       NUMBER OF DEVICES:*               |
|ANTENNA HEIGHT ABOVE SITE:*         INVENTORY CNTL NO.:               |
|DEPLOY DATE (MM/DD/YY):*  /  /      NESDIS NOTIFIED:**  /  /          |
|NESDIS QUEUE:**                     DEMOD SCHEDULE:**                 |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|______________________________________________________________________|
```

Option 1 Add New Station (continued)

The **device information screen** shown below appears once for each device specified.

```
|DEVICE
|  NUMBER:**
|PARAMETER
|  CODE   :*
|  DESC   :
|  UNITS  :
|DEV UPD INT (HHMM):*
|INVENTORY CNTL NO.:
|  DONE WITH STATION INPUT.
|  DOING FORMS.  PLEASE WAIT.
|  IRAC FORM DONE. ·
|  NESDIS PDF WILL BE SENT AT THE PROPER TIME.
|YOU WILL BE NOTIFIED OF THE TIME OF TRANSMITTAL.
```

The Interior Radio Advisory Committee IRAC FORM is used by the Data Relay Project to request authorization to emit radio transmissions. The NESDIS GOES assignments and DRGS DCP maintenance forms are automatically printed.

Option 2 Add New Station for Non-USGS Data Collection Platform

This option allows the entry of a new DCP, for which assignments have **not** been coordinated by the USGS, into the data base. This procedure requires the user to enter the cooperator-assigned DCP ID, channel, assigned time, and transmit interval. Once the DCP ID is entered, the software follows the same procedures as described in option 1. Because all authorizations have been coordinated by another agency, this option does not create the authorization forms.

```
|INPUT OPTION NUMBER - 2
|PERSON ID -
|STATION NUMBER -
|DCP ID (CCCCCCCC) -
|CHANNEL (CCC) -
|ASSIGNED TIME (HHMM) -
|TRANSMIT INTERVAL (HH) -
|2 DIGIT STATE CODE -
|6 DIGIT LATITUDE + (N OR S) -
|7 DIGIT LONGITUDE + (E OR W) -
|IS THE ABOVE INFORMATION CORRECT (Y OR N)?
```

Option 3 Modify Existing Station Information

This option allows the station information, such as station number and the number of devices, to be modified. Any new authorization forms that may be necessary are automatically created. Neither this option nor any other allows the change of DCP ID. To do so, the station has to be deleted (option 4) and input as a new station (option 1).

The following is requested for preliminary calculations:

```
INPUT OPTION NUMBER - 3
PERSON ID -
STATION NUMBER -
DO YOU WANT TO CHANGE LAT OR LONG (Y OR N)?
DO YOU WANT TO CHANGE THE NEAREST CITY (Y OR N)?
IS THE ABOVE INFORMATION CORRECT (Y OR N)?
```

The PASS fills screen entries from the data available in the computer files. All entries may be updated except those marked with two asterisks (**). Entries marked with one asterisk (*) cannot be replaced with a null or blank entry.

The **station information screen** shown below appears.

```
STATION NUMBER:*                     NEAREST CITY:*
STATION NAME:*
LATITUDE:*                           LONGITUDE:*
STATE CODE:*                         OWNER AGENCY:
SITE ELEVATION:*                     PERSON ID:*
```

Option 3 Modify Existing Station Information (continued)

The **DCP information screen** shown below appears.

```
|DCP ID:**                          DRGS:**                          |
|ASSIGNED TIME:**                   TRANSMIT INT:**                  |
|PRIMARY CHANNEL:**                 SECONDARY CHANNEL:**             |
|ANTENNA AZIMUTH:**                 ANTENNA ELEVATION:**             |
|PLATFORM MANUF (L,H,SY,SU):*       PLATFORM MODEL:*                 |
|TRANSMIT TYPE (S,R,A,SA,RA):*      NUMBER OF DEVICES:*              |
|ANTENNA HEIGHT ABOVE SITE:*        INVENTORY CNTL NO.:              |
|DEPLOY DATE (MM/DD/YY):  /  /      NESDIS NOTIFIED:**          /  / |
|NESDIS QUEUE:**                    DEMOD SCHEDULE:**                |
|____________________________________________________________________|
```

If the NUMBER OF DEVICES is not changed, the following screen appears:

```
|LIST STATION DONE.                                                  |
|IRAC FORM DONE.                                                     |
|____________________________________________________________________|
```

Option 3 Modify Existing Station Information (continued)

If the NUMBER OF DEVICES is increased, such as from 2 to 4, the following screen appears:

```
DEVICE - 1                 PARM CODE -                PARM DESC -
DEVICE - 2                 PARM CODE -                PARM DESC -

NEW DEVICE NUMBER -
```

The **device information screen** shown below appears.

```
DEVICE NUMBER:**
PARAMETER CODE:*
PARAMETER DESC:
PARAMETER UNITS:
DEV UPD INT (HHMM):*
INVENTORY CNTL NO.:
  LIST STATION DONE.
  IRAC FORM DONE.
```

Option 3 Modify Existing Station Information (continued)

The device information input fields appear twice. This allows the user to enter data for NEW DEVICE NUMBER = 3 and NEW DEVICE NUMBER = 4, providing the user is adding to the end of the list. If the DCP reporting order requires that a new device be placed at the front of the list (inserted), the user specifies NEW DEVICE NUMBER = 1, and PASS increments by one the DEVICE NUMBERS for all other devices.

If the NUMBER OF DEVICES is decreased, such as from 2 to 1, the following screen appears:

```
DEVICE = 1                 PARM CODE =               PARM DESC =
DEVICE = 2                 PARM CODE =               PARM DESC =

DEVICE NUMBER TO DELETE =

LIST STATION DONE.
IRAC FORM DONE
```

If DEVICE NUMBER 2 is deleted, the station is left with DEVICE 1. If DEVICE NUMBER 1 is deleted, all entries for DEVICE 2 are assigned to DEVICE 1 by PASS, and the station is left with one device. If a device other than the highest number is deleted, PASS automatically consolidates the device information, reusing the number(s) of the deleted device(s).

Option 4 Delete Station

This option applies when DCP operations at a station are to be permanently discontinued. It deletes all the station information and unassigns the DCP ID. The ID is then available for reassignment. If the DCP ID is a non-USGS ID, the software deletes the ID from the data base.

```
INPUT OPTION NUMBER - 4
PERSON ID -

STATION NUMBER -

IS THE ABOVE INFORMATION CORRECT (Y OR N)?
IRAC FORM DONE.
STATION INFORMATION DELETED FOR STATION
DEVICE INFORMATION DELETED FOR STATION
DCP ID            IS NO LONGER ASSIGNED
```

Option 5 Modify Field Office Information

This option permits the change of any field office information for an existing PERSON ID. It requests new field office information when a **new** PERSON ID is entered under options 1, 2, or 3. PERSON ID's are added or changed under options 1, 2, or 3. Field office information is automatically deleted (options 3 and 4) for a person who no longer has any stations assigned.

```
INPUT OPTION NUMBER - 5

PERSON ID -
```

Option 5 Modify Field Office Information (continued)

The **office information screen** shown below appears.

```
|PERSON ID:**                          NODE:*                          |
|NAME:*               MID INIT.:       LAST NAME:*                     |
|ADDRESS:*                             ADDRESS:                        |
|CITY:*                     STATE:*                         ZIP:*      |
|AGENCY:                                                               |
|FTS PHONE:                 NON-FTS PHONE:                             |
|PRIME DIRECTORY:*                                                     |
|                                                                      |
|______________________________________________________________________|
```

One set of office information exists for each PERSON ID in PASS. This option allows the user to change the information previously stored for a PERSON ID.

Option 6 Modify Device Information

This option allows all of the device information for a station except the device number to be changed. Devices are identified and modified by device number. Use option 3 to add or delete devices.

```
|INPUT OPTION NUMBER - 6                                               |
|PERSON ID -                                                           |
|STATION NUMBER -                                                      |
|                                                                      |
|IS THE ABOVE INFORMATION CORRECT (Y OR N)?                            |
|                                                                      |
|DEVICE NUMBER -                                                       |
|                                                                      |
|______________________________________________________________________|
```

Option 6 Modify Device Information (continued)

The **device information screen** is shown below.

```
DEVICE
  NUMBER:**
PARAMETER
  CODE   :*
  DESC   :
  UNITS  :
DEV UPD INT (HHMM):*
INVENTORY CNTL NO.:
```

The device number entered by the user determines the device to be updated. Use option 3 to add or delete devices.

Option 7 Submit National Environmental Satellite Data and Information Service Platform Data File

This option allows the user to reschedule the generation of the NESDIS PLATFORM DATA FILE. Data Relay Project personnel use this file for authorization request to use the GOES DCP's for the assigned DCP ID and channel. Update the DEPLOY DATE under this option if necessary. This update has to be made no later than 21 days before the DCP is activated.

```
INPUT OPTION NUMBER - 7
PERSON ID -
STATION NUMBER -

CURRENT USER ASSIGNED DEPLOYMENT DATE -
NEW DEPLOYMENT DATE (MM/DD/YY) -

IS THE ABOVE INFORMATION CORRECT (Y OR N)?

NESDIS PDF WILL BE SENT AT THE PROPER TIME.
   YOU WILL BE NOTIFIED OF THE TIME OF TRANSMITTAL.
```

Option 8 List Station Information

This option displays all the station information on the screen. Copies can be made from terminals with attached printers.

```
INPUT OPTION NUMBER = 8
STATION NUMBER = 12040700
```

Screens appear as follows:

```
             FIELD OFFICE INFORMATION FOR STATION 12040700
PERSON ID:  LFTUNNELL                    NODE:           DWATCM
NAME:  LEONARD F. TUNNELL
ADDRESS:  1201 PACIFIC AVE.
ADDRESS:
CITY:                TACOMA              STATE:   WASHINGTON
ZIP:                  98402              AGENCY:  USGS
FTS PHONE:  FTS-390-6510                 NON-FTS PHONE: 206-593-6520
PRIME DIRECTORY:

                STATION INFORMATION FOR STATION 12040700
    STATION NAME:  HOH RIVER BELOW MT TOM CREEK NEAR FORKS  WA.
    NEAREST CITY:  FORKS
    LATITUDE:               475207N      LONGITUDE:        1235302W
    STATE CODE:                53        OWNER AGENCY:         USGS
    SITE ELEVATION:           650

                          ENTER Q TO QUIT
                                OR
                      KEY RETURN TO CONTINUE
```

Option 8 List Station Information (continued)

```
|                    DCP INFORMATION FOR STATION 12040700                    |
|DCP ID:             1635D590             DRGS:                      DWATCM |
|ASSIGNED TIME:  0048                      TRANSMIT INTERVAL:            04 |
|PRIMARY                                  SECONDARY                         |
|  CHANNEL:                      34         CHANNEL:                   118 |
|  IRAC SERIAL NUMBER:                      IRAC SERIAL NUMBER:             |
|  IRAC DATE ASSIGNED:  /  /                IRAC DATE ASSIGNED:  /  /      |
|ANTENNA AZIMUTH:               194       ANTENNA ELEVATION:             33 |
|PLATFORM MANUF:                  H       PLATFORM MODEL:               524 |
|TRANSMIT TYPE:                  SA       NUMBER OF DEVICES:              2 |
|ANTENNA HEIGHT ABOVE SITE:   20          INVENTORY CNTL NO.:               |
|DEPLOY DATE (MM/DD/YY):  /  /            NESDIS NOTIFIED:**  /  /          |
|NESDIS QUEUE:**            USGS12        DEMOD SCHEDULE:**                 |
|DATE ASSIGNED:**  /  /                                                     |
|                                                                           |
|                             ENTER Q TO QUIT                               |
|                                   OR                                      |
|                          KEY RETURN TO CONTINUE                           |
|                                                                           |
|___________________________________________________________________________|
```

```
|                  DEVICE INFORMATION FOR STATION 12040700                   |
|DEVICE NUMBER:                 1             2                              |
|PARAMETER                                                                  |
|  CODE    :                   65         70969                             |
|  DESC    :                STAGE        BATVLT                             |
|  UNITS   :                 FEET         VOLTS                             |
|DEV UPD INT (HHMM):           15           400                             |
|INVENTORY CNTL NO.:                                                        |
|                                                                           |
|                          KEY RETURN TO CONTINUE                           |
|                                                                           |
|___________________________________________________________________________|
```

Option 9 Transfer Station Information

This option sends the station information report, through electronic mail, to the person and node specified.

```
INPUT OPTION NUMBER = 9
INPUT PERSON ID OF PERSON TO RECEIVE LIST
VIA E-MAIL                                PERSON ID =
INPUT STATION NUMBER =

STATION 123456    PLACED IN MAILBOX FOR MLFIELD
```

Option 10 List Station Summary by State or Person Identification Code

This option provides the user with a short summary of the group of stations that are retrieved by the identification code (ID) of the responsible person or by state code. The information listed on the terminal screen is station number, station name, DCP ID, channel, and assigned time.

Option 10 List Station Summary by State or Person Identification Code (continued)

One of the following two procedures is used to select the station group. The first example shows a selection by state code and the second demonstrates selection by person ID. All output is to the user's terminal.

Procedure one:

```
INPUT P FOR SELECTION BY PERSON ID
           OR
   INPUT 2 DIGIT STATE CODE
SELECTION = 01

STATION NUMBER   STATION NAME                  DCP ID    CH  TIME
02371500         CONECUH RIVER AT              16CAE48C   3  0057
                   BRANTLEY, AL
02423380         CAHABA RIVER NEAR             16CC92D2   3  0151
                   MOUNTAIN BROOK, AL
02423390         CAHABA RIVER AT BWWB          16CC8F76   3  0150
                   PUMP STATION NR B'HAM
02423410         L. CAHABA RIVER BL LK         16CC9C00   3  0152
                   PURDY NR CAHABA HEIGH
02424000         CAHABA RIVER AT               16CAD116   3  0055
                   CENTREVILLE, AL

PRESS RETURN TO CONTINUE
```

Procedure two:

```
INPUT P FOR SELECTION BY PERSON ID
             OR
    INPUT 2 DIGIT STATE CODE
SELECTION = P
INPUT PERSON ID = CDFARRAR
STATION NUMBER      STATION NAME     DCP ID     CH      TIME
10265150         HOT CREEK FLUME     1634D9B8    6      0255
11242400        NF WILLOW CREEK NR.  16C1AAFC   77      0111
                 SUGAR PINE, CA
373745118554003
           SHERWIN CREEK WELL, NR.   1632CA00    6      0139
               MAMMOTH LAKES, CA
373759118474101 CORE HOLE 5, NR.     1632BC90    6      0137
                MAMMOTH LAKES, CA
373930118491602
              HOT CREEK DRILL HOLE   1632C4D2    6      0138
             NO. 2, NR. MAMMOTH, CA
374045118491001  CORE HOLE 1 NR.     1632B242    6      0136
                   MAMMOTH, CA
PRESS RETURN TO CONTINUE
```

Option 11 Transfer Station List by State or Person Identification Code

This option sends the user the short summary for a group of stations retrieved by PERSON ID or state code. The output is transferred to the mailbox for the person and node selected.

The first part of this option is the same for both retrieval options. All output is to the user's mailbox.

```
INPUT PERSON ID OF PERSON TO RECEIVE LIST
VIA E-MAIL.                              PERSON ID - MLFIELD
```

Procedure one:

```
INPUT P FOR SELECTION BY PERSON ID
          OR
  INPUT 2 DIGIT STATE CODE
SELECTION - P
INPUT PERSON ID - MLFIELD
LIST STATION DONE.
```

Option 11 Transfer Station List by State or Person Identification Code (continued)

Procedure two:

```
INPUT P FOR SELECTION BY PERSON ID
         OR
  INPUT 2 DIGIT STATE CODE
SELECTION = 01
LIST STATION DONE.
```

An example of the station list that is transferred is found in option 10.

Option 12 Calculate Antenna Azimuth and Elevation

This option provides the DRGS operator and the DCP user with the correct antenna-aiming angles for the site location. The use of this option requires the current satellite longitude, the latitude and longitude of the site and the magnetic deviation for the site. Pay close attention to the number of characters the program requests for input. The following information is requested when option 12 is selected:

```
ENTER SATELLITE LONGITUDE (DDDMM):  07500

ENTER STATION LATITUDE (DDMM):  3600
ENTER STATION LONGITUDE (DDDMM):  10500

MAGNETIC DEVIATION TO LEFT OF NORTH IS CONSIDERED TO BE MINUS
MAGNETIC DEVIATION TO RIGHT OF NORTH IS CONSIDERED TO BE PLUS

ENTER MAGNETIC DEVIATION (+/-DDMM):  -0000

ANTENNA AZM = 136
ANTENNA ELV =  37

                       PRESS ANY KEY TO CONTINUE
```

USER INSTRUCTIONS FOR RECEIVING DATA-COLLECTION PLATFORM DATA FROM A DIRECT READ-OUT GROUND STATION

By Robert F. Middelburg, Jr.

Each U.S. Geological Survey district office receives its GOES telemetered data from one of six USGS-operated Direct Read-Out Ground Station's (DRGS's) located in Tacoma, Washington; Denver, Colorado; San Juan, Puerto Rico; Ft. Worth, Texas; Harrisburg, Pennsylvania; and Columbia, South Carolina. The Tacoma and Denver DRGS's receive data transmitted through the west satellite, and the Harrisburg, San Juan, and Columbia DRGS's receive data transmitted through the east satellite. The Ft. Worth DRGS receives data transmitted through the east and the west satellites. Each district may receive data from an assigned DRGS. Figure 46 shows locations of DRGS's and areas these stations serve.

Data received by the DRGS's are transferred to the appropriate user district by the Distributed Information System (DIS). Data received on each district's Prime are loaded into the Automated Data Processing System (ADAPS) unit-value data base.

Access to a USGS-operated DRGS is available to qualified users who wish to check and read satellite-telemetered data. To obtain permission and the required access instructions, interested persons should contact the DRGS operator for the DRGS receiving the DCP information for that location. A list of USGS DRGS stations and operators follows:

DRGS location	Operator	FTS phone number
Texas	Dennis Myers	334-5551
Pennsylvania	Clayton Kauffman	590-3797
South Carolina	Henry Herlong	677-3692
Washington	Scott Knowles	390-6520
Colorado	Jennie Steinheimer	776-9404
Puerto Rico	George Arroyo	498-4346

Depending on the particular setup for the user's host DRGS, access is made by direct telephone connect through a computer modem to the DRGS or by a computer link from the host Prime computer. These instructions refer to both methods where applicable. In these instructions, commands to be entered are in CAPITAL LETTERS. Lower-case letters are used for comments.

When reading DCP-transmitted information on the DRGS, the user needs to know the type of DCP for each station read. Data-collection platform manufacturers format and transmit the data differently. Some transmit the most current information first and others transmit the most current information last.

DCP manufacturer	Order of reporting
Handar	Most current information listed last
LaBarge	Most current information listed last
Sutron	Most current information listed first
Synergetics	Most current information listed first

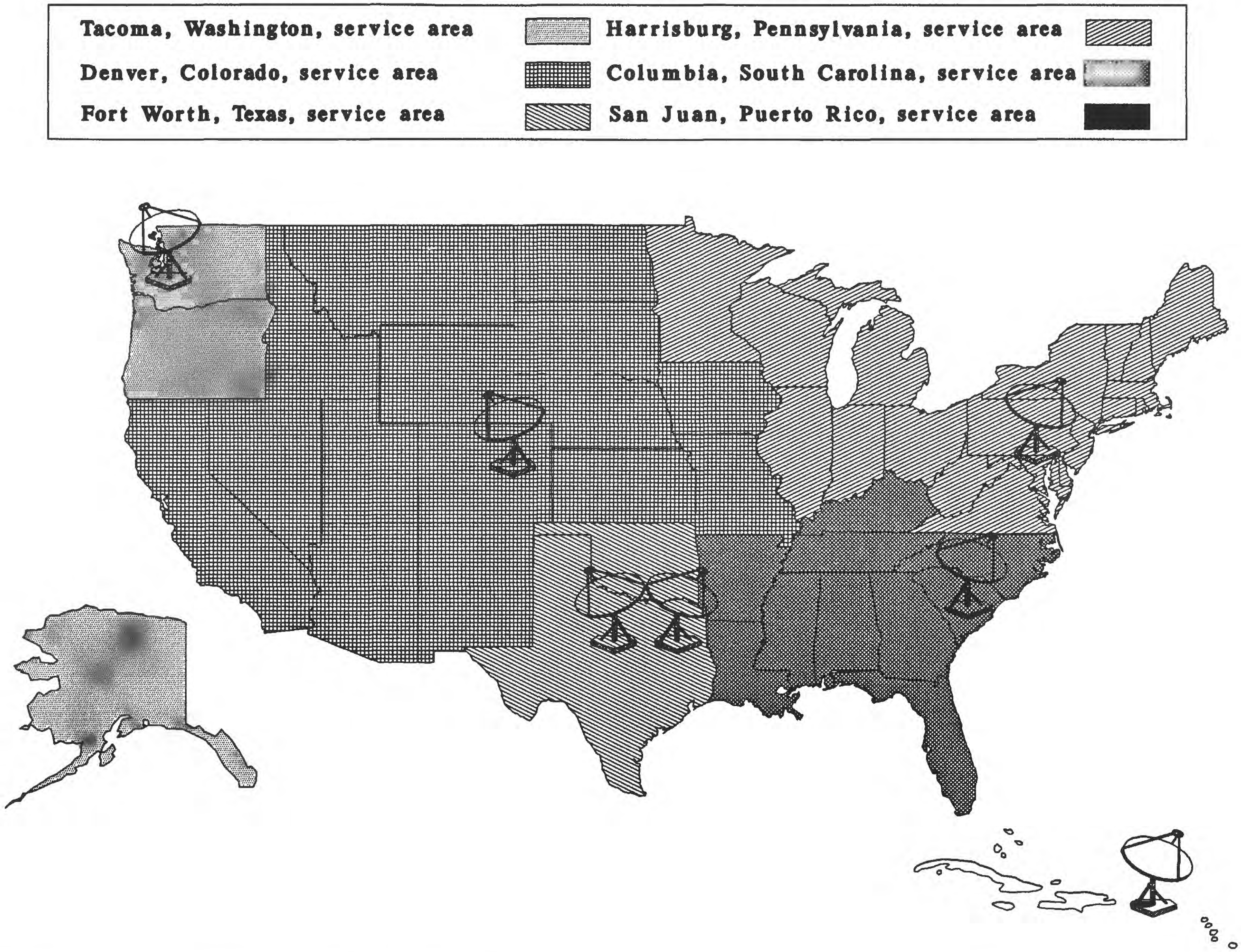

Figure 46.--Locations of direct read-out ground stations and areas the stations serve.

Accessing the Direct Read-Out Ground Station Computer

Access Using Host Prime Computer

For access through DRGS host Prime Computer, log on to the host Prime by using your local user ID and password. Because security on different Prime and DRGS computers must be maintained, no access information is published here. Shown below are system queries for pertinent information, which is supplied by the DRGS host operator or Prime System Administrator.

USER ID:______________________ ON PRIME COMPUTER NODE:________________

PRIME PASSWORD:__________________________

After introductory information is completed, attach to the Ground Station Data General computer by issuing the proper command supplied by the host operator.

ACCESS COMMAND TO DRGS USING PRIME COMPUTER:_____________________________

If the line is available, a message is received that the linkage is established. Respond to the message with a carriage return (CR). When asked for the Data General computer password, enter the proper password. If the line is not available, follow the disconnect procedures supplied by the DRGS host operator.

LINE BUSY DISCONNECT PROCEDURES:_________________________________

When communicating with the Data General computer, all characters must be in upper case (CAPITALS). If a mistake is made, simply enter a CARRIAGE RETURN (CR) or backslash (\) and retype the command. Operations on the DRGS, such as LIST, can be terminated or aborted with the command <CTRL SPACE>, where space is the space bar.

Access Using Telephone Modem

If access to the DRGS is by direct dial to the DRGS modem, perform the following steps:

1. Set the dial-out modem and terminal to the correct configuration. The Synergetics DRGS Model 10C supports the following protocol:

    Data bits = 7
    Parity = EVEN
    Stop bits = 1
    Baud rate = 300 or 1200 (Others available upon special request. Consult the DRGS host operator.)

2. Dial the DRGS number supplied by the DRGS host operator.

3. When modem connect is established, enter a CARRIAGE RETURN (CR).

4. Enter the proper password. Only three attempts are allowed. After the third unsuccessful attempt, the connection is automatically dropped and the user has to redial to make further attempts.
   DRGS PASSWORD:_______________(Supplied by DRGS host operator)

Reading Data-Collection-Platform Data

Accessing the Data Files

The user is connected to the DRGS Data General computer and ready to access data files. Two different files are available for reading the DCP data. The first--DISMSG--contains the actual transmission as received by the DRGS. Normally, only one to two days of data are stored in DISMSG. The second--EUMSG--stores DCP data in engineering units, with parameter names and time attached to the data. Data stored in EUMSG may cover several weeks. Data from newly installed DCP's appear only in the DISMSG file until the DRGS operator enters the DCP decode data necessary to convert the data to engineering units for storage in EUMSG. When this is complete, data are transferred automatically to EUMSG following each DCP transmission. The following commands allow the user to read the data.

PASSWORD?	Asks the user to enter the password. Computer responds with RETRV:
CRT	Tells the Data General computer the user is operating from a CRT-type terminal and sets the correction characters for CRT.
DISMSG	Attaches the user to the raw data-file access program. The computer responds with DISMSG:
EUMSG	Attaches the user to the engineering units data base. The computer responds with EUMSG:
EXIT	Exits the DISMSG or EUMSG retrieval program and takes the user to RETRV. EXIT has to be used before moving from one data base to another.
TIME	Displays Julian day and Greenwich Mean Time (GMT). TIME can be used only when in DISMSG or EUMSG.

Setting the Time Block

After selecting the desired file, DISMSG or EUMSG, the user sets the time block for the period to be viewed. All times are GMT time. The time block stays in effect until the user redefines it or exits to RETRV.

TIMBLK bbb hh:mm eee hh:mm

where
bbb- beginning Julian day
hh:mm- hour : minute (in GMT time)
eee- ending Julian day
hh:mm- hour : minute (in GMT time)

(Note the use of spaces and colons.)

On some DRGS's, the time block can be set automatically by use of one of the following commands in place of TIMBLK. Check with your local DRGS operator to see if these commands are available for use.

THREEHOUR	Sets the time block for the 3 hours preceding the current time.
FOURHOUR	Sets the time block for the last 4 hours.
ONEDAY	Sets the time block for the last 24 hours.
THREEDAY	Sets the time block for the last 72 hours or 3 days.

Listing the Data

To retrieve the desired DCP data, use the LIST command as shown below:

LIST (DCP ID) (pp) — Lists the NESDIS DCP ID or the character name if known. If the ID is not given, the retrieval lists data for all DCP's received during the time selected. After the ID is listed, a print processor (pp) must be given. The four commonly used print processors are

- HD — Lists only the header information for the DCP retrieved. HD can be used in DISMSG or EUMSG data files.
- AL — Lists the header information and the data. AL can be used only in the DISMSG data file.
- DT — Lists the header information and data in engineering units. DT can be used only in the EUMSG data file.

- MSMSG — Checks the DCP transmissions for the time period selected and summarizes the number of messages received and missing. MSMSG can be used only in the EUMSG data file and is best used with ONEDAY or THREEDAY time blocks.

Disconnecting From the Direct Read-Out Ground Station

After retrieving all data desired, exit DISMSG or EUMSG data files by use of the EXIT command. To log off the DRGS, issue the command BYE. When the password prompt appears, hang up the telephone if the DRGS was accessed through the modem, or enter a BREAK if the DRGS was accessed through the Prime computer. The BREAK key is on some terminals; others require a CTRL-P combination.

EXIT	Exits from DISMSG or EUMSG to RETRV.
BYE	Logs out the user from RETRV. After about 4 seconds, the password prompt appears. The DRGS is ready for the next user. If entry to the DRGS was through the direct access modem, hang up the phone at this time; otherwise use <BREAK>.
<BREAK>	Press the BREAK key on the terminal. If the terminal does not have a BREAK key, press CRTL-P. After the computer response, enter a Q.
Q	Disconnects linkage from the host Prime to the DRGS and returns user to the host Prime. The user may then log off.

Help Command

The help command (HELP) lists the available commands and their functions. This command can be issued from any of the programs in the Data General computer.

Sample Direct Read-Out Ground Station Retrievals

Shown below are commands and actions associated with them. Examples of output are provided in figures 47-49. An underscore indicates user input followed by a carriage return.

PASSWORD?	Enter proper password
RETRV: CRT	Select CRT correction characters
RETRV: DISMSG	Access the raw DISMSG DCP data files
DISMSG: TIME	Show current Julian date and GMT
85 298 18:45:22 USING NBS TIME	(Year 1985, Julian day 298, 18:45:22 GMT) (or USING INTERNAL TIME with the colons in the time replaced with ?)
DISMSG: ONEDAY	(Set TIMBLK to previous 24 hours)
DISMSG: LIST 16329A7C HD	(List only header information for each DCP transmission using HD print processor)
DISMSG: THREEHOUR	(Set TIMBLK for previous 3 hours)
DISMSG: LIST ANRDC AL	(List transmitted data using AL print processor. ANRDC is an alternate abbreviated name for the NESDIS ID)

```
02.74  02.74  02.74  02.74  02.74  02.74  02.74  02.74  02.73  02.73 02.73
  02.73
33.60  33.60  33.60  33.60  33.60  33.60  33.60  33.60  33.60  33.60 33.60
  33.60
12.4  12.5  13.1
```

Figure 47.--Raw data listing from DISMSG file.

DISMSG:
EXIT (Exit DISMSG to RETRV)

RETRV:
EUMSG (Attach to EUMSG to read converted data)

EUMSG:
THREEHOUR

EUMSG:
LIST ANRDC DT (List converted and reformatted data using DT print processor)

DATA	START TIME	SAMPLE INTERVAL	DATA VALUES					
STAGE	16:30	0:15	2.74	2.74	2.74	2.74	2.74	2.74
			2.74	2.74	2.73	2.73	2.73	2.73
PREC	16:30	0:15	33.60	33.60	33.60	33.60	33.60	33.60
			33.60	33.60	33.60	33.60	33.60	33.60
BTVT	16:30	1:00	12.4	12.5	13.1			

Figure 48.--Engineering units data listing from EUMSG file.

EUMSG:
ONEDAY

EUMSG:
LIST LCCNDC MSMSG (Check for missing transmissions using MSMSG print processor)

```
MISSING MESSAGE REPORT FOR 51452762
OVER THE TIME BLOCK OF 297 18:28 298 18:28

51452762 297 21:19
51452762 298  5:19
51452762 298  9:19
51452762 298 17:19

#MSSGS FOUND= 2        #MSSGS MISSING= 4
```

Figure 49.--Missing message report.

EUMSG:
<u>EXIT</u>

RETRV:
<u>BYE</u> (Stops the program)

PASSWORD (Enter BREAK or CTRL P)
ENTER COMMAND CODE (Q,R,E,S,A) * <u>Q</u>
(Disconnects from the DRGS)

<u>Interpreting Information Transmitted by a Data-Collection Platform</u>

The information displayed for a DCP contains much information that can tell the user how well the DCP is operating. An example of the DCP header information and the explanations about the various parameters are given below:

STATION — Eight-digit NESDIS identification number unique to the DCP. An abbreviation name may precede the number. Both are valid identifiers for retrieving information from the DCP. The abbreviation name is not transmitted by the DCP. It is assigned to the DCP by the DRGS operator and is used only in the DRGS.

JULIAN DAY — The last two digits of the year and the julian day of the transmission. The julian day is the number of days from the beginning of the calendar year.

TIME — The time of the transmission in GMT. The hour figure GMT changes according to the frequency of transmission such as 3 hours or 4 hours. Minute readings are all the same. The seconds readings are the same but may vary by 1 to 2 seconds. A continuous change, sometimes observed over days, indicates a possible drift in the DCP clock. This problem may require servicing by the manufacturer. An alert transmission received for the DCP, is listed along with the self-timed transmissions, but the time values may not correspond.

DEMOD /CHAN — The DRGS demodulator unit and assigned channel number on which the DCP information was received. Values do not change.

CHAR — Number of data characters transmitted by the DCP. Values do not change unless the DCP has been reprogrammed. The DCP transmits approximately 12.5 characters per second (cps). Alert transmissions will have fewer characters than self-timed transmissions, but all alert transmissions will have the same number of characters.

#-BAD CHAR — Number of invalid characters received in the transmitted message. This message may indicate a faulty DCP transmitter, damaged antenna, or interference from another DCP transmitting at the same time.

EIRP (DBM) — Effective isotropic radiated power. This is an estimation of the DCP transmitted power. Normal transmission levels are 43 to 50 dBm. Variations may be due in part to inherent system noise, satellite wobble in orbit, satellite load at time of transmission, DCP transmitter degradation, DCP antenna alignment, or local site conditions inhibiting the signal transmission.

MOD — Modulation index. This is the measurement of the carrier (DB) suppression during modulation. The standard value is -6 dB, but it may vary from -4 to -8 dB. The preferred range is from -5 to -7 dB. Values outside this range indicate possible DCP transmitter problems.

FREQ (HZ) — Data-collection platform frequency offset. It needs to be within 400 Hz of channel center frequency. Transmitter drift outside this range may not be received by the DRGS. Frequency offset is generally within 200 Hz from message to message. Data-collection platform temperature changes can cause fluctuations.

(S+N)/N (DB) — Signal plus noise over noise ratio. This gives an estimate of DCP transmitted power (EIRP) relative to the Pilot signal transmitted power. Normal range is from 10 to 20 dB, but signals can be received as low as 4 dB. Fluctuations are caused by movement of the satellite, changes in satellite loads, and weather. Consistent low values may be the result of a poor transmitter, bad antenna connections, a misaligned antenna, or adverse site conditions.

ER # — Error number can be listed to indicate different types of errors encountered during the transmission. The value needs to be 0. Other listed values may be deciphered by typing the command XMTERR n where n is the error number shown. The XMTERR command is used in DISMSG or EUMSG. Messages indicating a loss of the end of message can indicate a DCP transmit time insufficient for the data being transmitted or weak batteries, which cause the DCP to stop transmitting partway through the transmission.

AUTOMATED INSTRUMENT MONITORING SYSTEM

By Janet C. Ciegler

The Automated Instrument Monitoring System (AIMS) can help a DCP operator or DCP data manager by flagging possible problems with DCP's or with data. This system runs on the Prime computer and interfaces with the Automatic Data Processing System (ADAPS). All data in the AIMS reports are read from the ADAPS unit values file.

This chapter discusses two types of AIMS-generated reports; the Exception Report and the Summary Report. The AIMS Exception Report (fig. 50) lists only those sites with potential problems. The user may generate this report automatically each morning or may request this report interactively at any time. The AIMS Summary Report (fig. 51) presents statistics on data delivery by the satellite data relay system. These statistics are expressed in the number of days of missing or incomplete data.

The AIMS Exception Report can also be customized. The user may set DCP performance thresholds, which are stored in an AIMS MIDASPLUS file and compared to DCP performance data during preparation of the DCP Performance Measurements portion of the Exception Report.

The user may access AIMS programs through the ADAPS menu, option SA (START/STOP PROCESSING/TRANSFER OF SATELLITE DATA) and option 2 (DCP Performance Reports--AIMS). The main menu for AIMS is shown below:

```
 ______________________________________________________________________
|                         MENU--AIMS PROGRAMS                          |
|1--Execute AIMS Exception Report                                      |
|2--Display/Modify DCP Performance Thresholds                          |
|3--Update DCP Information from DECODES                                |
|4--Execute AIMS SUMMARY Report/Build Ctrl File                        |
|        QU--Exit to Previous Menu     EX--Exit to PRIMOS              |
|                                                                      |
|                                                                      |
|                                                                      |
|                                                                      |
|______________________________________________________________________|
```

EXCEPTION REPORT FOR ALL-DCPS FROM 08 16 1989 TO 08 18 1989

DATA SUMMARY REPORT

DCP ID	STATION	PARAMETER	NUMBER OF MINUTES MISSING DATA	NUMBER OF MINUTES SAME DATA	NUMBER OF DATA POINTS VERY HIGH	NUMBER OF DATA POINTS HIGH	NUMBER OF DATA POINTS LOW	NUMBER OF DATA POINTS VERY LOW	VERY RAPID INC	RAPID INC	RAPID DEC	VERY RAPID DEC
165E248E	02156500	00400	0	0	0	0	3*	0	0	0	0	0
165E248E	02156500	00065	0	0	0	0	0	12*	0	0	0	0
165E4168	02160700	00095	0	0	0	14*	0	0	0	0	0	0
165E6784	02160991	00400	0	0	0	23*	0	0	0	0	0	0
165E74F2	02161000	00065	0	0	0	0	7*	0	0	0	0	0
165436AA	02169000	00300	1640*	0	0	0	0	0	0	0	0	0
16505676	021696721	80107	15*	0	0	0	0	0	0	0	0	0
1638009E	02169810	00065	60*	0	0	0	0	0	0	0	0	0
165F13EE	02197000	00065	0	0	0	0	0	34*	0	0	0	0
16365A58	322133081101300	00045	1640*	0	0	0	0	0	0	0	0	0
1636548A	325711081321400	00045	180*	0	0	0	0	0	0	0	0	0
165F3502	334718081553800	00045	0	0	0	0	0	0	0	0	0	1*

DCP PERFORMANCE MEASUREMENTS FOR 08 18 1989

DCP ID	STATION	EIRP (DBM) MIN (+41)	EIRP (DBM) AVG (41-50)	S+N/N (dB) MIN (10)	S+N/N (dB) AVG (10-20)	MOD INDEX (DB) MIN (-8)	MOD INDEX (DB) AVG (-6)	FREQ OFFSET (HZ) MIN (-400)	FREQ OFFSET (HZ) MAX (+400)	BATTERY VOLTS (VOLTS) MIN (11.5)	BATTERY VOLTS (VOLTS) MAX (13.7)	BATTERY VOLTS DIF (0.2)	TIME DRIFT (SECONDS) MIN (6)	TIME DRIFT (SECONDS) MAX (30)	NO OF BAD CHRS (1)	NO OF MISS
1650A6F2	02110730	+44	+46	0*	13	- 6	- 5	- 94	- 50				0*	3	0	0
16DAA018	02110755	+32*	+36*	0*	4*	- 6	- 4	-130	-100				6	6	32*	0
16DAB36E	02110770	+43	+45	13	14	- 6	- 5	+ 6	+ 94				3*	3	4*	0
165E9700	02148000	+38*	+40*	7*	9*	- 7	- 6	-134	-108	12.2	12.7	0.5	6	9	3*	0
167526C8	02163500	+43	+54*	11	13	- 6	- 5	-434*	-382				0*	0	0	0
16541046	02167000	+44	+45	11	12	- 7	- 6	-104	- 88	12.0	12.1	0.1	24	24	28*	0
1638009E	02169810	+31*	+32*	2*	2*	-53*	-53*	-172	-130	11.7	12.0	0.3	21	21	43*	1*
167526C8	02171690															7*
16751352	02171700	+44	+44	11	12	- 6	- 5	+ 86	+ 86				12	12	0	6*
16CB0584	02172001															9*
16381D3A	02172019	+40*	+45	0*	12	- 7	- 7	+ 36	+200	12.1	12.4	0.3	18	21	0	0
1650709A	02172020	+37*	+47	0*	14	- 7	- 6	- 82	+ 26	12.0	12.6	0.6	15	18	12*	0
1650801E	02172040	+46	+48	12	16	- 9*	- 6	-182	-126	12.5	13.1	0.6	18	18	3*	0
1650F68E	02189004	+42	+51*	9	10	- 7	- 6	-144	- 44	13.6	15.6*	2.0	30	30	0	0
16365A58	322133081101300															7*
1636548A	325711081321400	+43	+44	12	13	-53*	-14*	- 66	+ 38	12.2	12.8	0.6	0*	0	22*	7*

* outside acceptable range

Figure 50.--An AIMS exception report, page 1.

```
                              LEGEND FOR DCP PERFORMANCE PARAMETERS
                                                                                   Normal Values
                   Measurement                                            Minimum   Maximum   Average

        EIRP      ( Effective Isotropic Radiated Power, units = DBM )       +41       +50       +45
        (S+N)/N   ( Signal + Noise / Noise, units = dB )                     10        20        15
        MOD IND   ( Modulation index, units = DB )                           -8        -4        -6
        FREQ OFFSET  ( DCP Frequency Shift, units = HZ )                   -400      +400         -
        BAT VOLTS    ( Battery voltage, units = volts )                    11.5      13.7         -
        TIME DRIFT   ( Difference between assigned time and actual
                       time of data transmission, units = seconds )           6        42        12
        NO OF BAD CHRS    ( Number of bad characters in a transmission )      0         1         -
        NO OF MISS TRANS  ( Number of missing transmissions )
        NO OF RANDM TRANS  ( Number of random transmissions )


==================================================================================================
                                  SUPPORT FILE ERROR REPORT FOR 08 18 1989
==================================================================================================

   STATION                PROBLEM

021973527       No record found in AM.DATA
343555083013300 No DD performance record for DD  13
343555083013300 No DD performance record for DD  14
343555083013300 No DD performance record for DD  15
92110770        DEVICE NUMBER 1 ** DECODES UPDATE ERROR: *****INVALID SITE-ID OR AGENCY

NOTE: These errors may be caused by missing, incorrect or duplicate data in the AIMS file or ADAPS "DATA DESCRIPTOR" file.
Please request your local ADAPS Data Base Administrator to check and correct these files using the ADAPS SUPPORT (SU) SUB-ME
   Options 1 and 2, the AIMS SUB-MENU Option 4, or DECODES (DEvice COnversion and DElivery System).

IMPORTANT:  IF SUPPORT FILES ARE NOT CORRECT, HYDROLOGIC DATA MAY NOT BE STORED ACCURATELY.


==================================================================================================
                                    DATA DELIVERY REPORT FOR 08 20 1989
==================================================================================================

WARNING:  MORE THAN 10 % OF MESSAGES WERE RECEIVED MORE THAN  30  MINUTES AFTER BEING RECORDED.

                       TOTAL          DELIVERY  TIME  IN  MINUTES              DELIVERY  TIME  STATISTICS
                      MESSAGES     00-15     15-30     30-45      >45        MIN       MAX      MEAN     STD DEV

FROM PRIMARY SITE        992        743       109       135         5          1        71        14        9.3
FROM BACKUP SITE          19          7         0         2        10          1        94        41       32.1
TOTAL                   1011        750       109       137        15          1        94        16       34.0
```

Figure 50.--An AIMS exception report, page 2.

```
================================================================================================
                              ALERT MESSAGES FOR 08 16 1989 TO 08 18 1989
================================================================================================

STATION           DATE   TIME           ALERT MESSAGE

02110715         890816 115504 AN ALERT WAS ISSUED AND THE BEEPER WAS CALLED -- DD=  3
02110715         890816 132325 AN ALERT WAS ISSUED AND THE BEEPER WAS CALLED -- DD=  3
02110715         890816 162209 AN ALERT WAS ISSUED AND THE BEEPER WAS CALLED -- DD=  3
02110715         890816 180238 AN ALERT WAS ISSUED AND THE BEEPER WAS CALLED -- DD=  3


================================================================================================
                    ABNORMAL PLATFORM RESPONSE MESSAGES FOR 08 16 1989 TO 08 18 1989
================================================================================================

                                           GENERAL MESSAGES

                        890817 01:21 DCS OUTAGE REPORT FOR 16AUG89 JD228. NO OUTAGES THIS DAY.

                        890817 08:10 DCS OUTAGE REPORT FOR 17AUG89 JD229//, 0000-0800. NO OUTAGES YET.
                                 RMF

                        890817 16:06 DCS OUTAGE REP. DAY 229 8/17/89 EAST AND WEATST OUTAGE DUE TO
                                 COMPUTER A AND B FAILURE AT CDA ..........

                        890817 18:15 PLAT  16E85318  ACTIVATED

                        890818 00:02 DCS OUTAGE REPORT FOR 17AUG89 JD229//. BOTH PRIME AND SECONDARY SYSTEM
                                 AT WALLOPS FAILED FROM 120000-122150. EAST AND WEST DATA LOST.
================================================================================================

                                          SITE-SPECIFIC MESSAGES

 STATION           DCP ID    DATE  UTC TIME             APRM MESSAGE

02173500          1653D76C  890816  20:03  S.T. NOT POSTED.   MSG IN PROGRESS: 1653C41A
02147000          16540330  890816  20:06  S.T. NOT POSTED.   MSG IN PROGRESS: 16000000
02168504          1636B778  890816  20:21  S.T. NOT POSTED.   MSG IN PROGRESS: 1636AADC
322133081101300   16365A58  890816  20:11  EXPECTED MESSAGE NOT RECEIVED.
322133081101300   16365A58  890817  00:11  EXPECTED MESSAGE NOT RECEIVED.
02171700          16751352  890817  01:44  EXPECTED MESSAGE NOT RECEIVED.
322133081101300   16365A58  890817  04:11  EXPECTED MESSAGE NOT RECEIVED.
02171700          16751352  890817  05:44  EXPECTED MESSAGE NOT RECEIVED.
```

Figure 50.--An AIMS exception report, page 3.

AIMS Summary Report from 01/01/88 to 06/07/88

TOTALS FOR ALL SITES

	Totals	Percent of Total
Number of stations	10	100
Number of station-days of possible operation	1513	100
Number of station-days DCP's transmitted all data	1463	97
Number of station-days partial data transmitted	1	0
Number of station-days DCP's transmitted no data	49	3
Total number of missing gaps	6	
Number of 0-1 day gaps	1	17
Number of 2-3 day gaps	1	17
Number of 4-7 day gaps	2	33
Number of 8-14 day gaps	0	0
Number of 14-21 day gaps	2	33
Number of 22-28 day gaps	0	0
Number greater than 28 days	0	0

SOUTH CAROLINA DISTRICT

			Number of Missing Record Gaps for the Specified Gap Lengths in Number of Days						
Station ID	Operating Days	Missing Days	0-1	2-3	4-7	8-14	15-21	22-28	28+
02110500	159	0	0	0	0	0	0	0	0
02110730	155	0	0	0	0	0	0	0	0
02110755	159	1	1	0	0	0	0	0	0
02110770	159	6	0	1	1	0	0	0	0
02168500	86	0	0	0	0	0	0	0	0
TOTAL:	718	7	1	1	1	0	0	0	0

Corps of Engineers

			Number of Missing Record Gaps for the Specified Gap Lengths in Number of Days						
Station ID	Operating Days	Missing Days	0-1	2-3	4-7	8-14	15-21	22-28	28+
343610082260000	159	19	0	0	0	0	1	0	0
343610082260000	155	19	0	0	0	0	1	0	0
344031082484900	159	0	0	0	0	0	0	0	0
344031082484900	159	0	0	0	0	0	0	0	0
344043083202700	159	4	0	0	1	0	0	0	0
TOTAL:	795	42	0	0	1	0	2	0	0

Figure 51.--An AIMS summary report.

AIMS Exception Report

Defining Groups for AIMS

The AIMS Exception Report requires ADAPS groups of stations. Each person or phantom that will be running AIMS has to have at least one group defined with that login ID as part of the group name. After groups have been prepared, they are immediately available for use and can be used indefinitely.

The user may define and modify ADAPS groups by use of the ADAPS menu or any editor (ED, WORDMARC, EMACS). To use the ADAPS menu, do the following:

1. Select the DI routine for displaying unit values.

2. Enter ST to select a new station.

3. Enter GROUP to build or manipulate a group of stations.

4. Select BD to build a group.

5. Enter a name with no more than 13 characters (no periods).

6. Enter a description.

7. Select SINGLE STATION SELECTION.

8. List all the station ID's desired, ending with END.

9. Select KE to save the group.

10. Select PARAMETER SELECTION OPTION: NO DD RECORDS, SELECT INDIVIDUALLY, or FROM INSTRUMENTS.

ADAPS automatically appends the login ID of the person building the group onto the name entered for the group. All groups are stored in WATSTORE>ADAPS>REV85.1>AUXDATA>GROUPS>DATABASEn (where n = database number, usually "1").

To build a group using an editor, first spool an existing group to study the format. Column alignment is critical. An existing list of DCP stations may be used to build a group. No DD numbers are required in the fourth column for AIMS. Only one entry for each station is needed because AIMS automatically finds all DCP parameter codes for each station; duplicate stations with separate DD's are also acceptable.

The Primos COPY command can be used to copy groups. This is the easiest way to get groups for SATIN or JOB_TIMER. The user may use the Primos CN (change name) command to change group names.

Automatic Daily AIMS Report

Daily automatic preparation of an AIMS Exception Report requires the following:

- One or more groups named with the name of the ADAPS phantom.
- The file AIMS.DAILY.CPL placed in the SCHEDULE for the JOB_TIMER (See Prime Administrator).

The AIMS Exception Report will run automatically for all groups named with the ADAPS phantom's name.

The program prepares a separate report for each group and sends electronic mail each morning to the data managers defined in the ADAPS Node Configuration file. This mail notifies the data manager of the existence of an AIMS Exception Report.

Automatic DAILY AIMS Exception Reports, stored in the directory WATSTORE>ADAPS>REV85.1>SYSTAT and named AIMS.groupname.date.time, are automatically deleted after 7 days. These reports may be spooled, copied, edited, or mailed electronically as any other file. Spool reports using the spool option -FTN.

Interactive AIMS Report

Any ADAPS user may generate AIMS Exception Reports at any time. Begin by preparing one or more groups with the user's login ID as part of the group name.

To produce a report, enter the ADAPS menu, submenu SA, select AIMS (2), and then AIMS EXCEPTION REPORT (1). Change the USER display for PA (FILE PATH), OT (OUTPUT TO), DB (DATA BASE), and DT (DATES) as desired. Note that instrument-monitoring data (bad characters, battery voltage, and so forth) are deleted from the unit values file after a predetermined time period, usually 60 days (see ADAPS Administrator).

Answer the query as to whether a Data Delivery Report is desired; answer N unless that report is needed. See sample Data Delivery Report on Aims Exception Report (fig. 50). Host DRGS sites do not have the option to request a Data Delivery Report.

Select groups for the report either by choosing ALL with the user's login ID or by selecting one or more by number and ending with 999. After a short wait, the report is ready and the user may view it on the terminal, print it on the desired printer, or send it to a file as previously specified in the USER display. The report may be sent, without recalculation, to additional output devices by again modifying the USER display.

Interpreting an AIMS Exception Report

Exception Reports may have up to six parts, depending on many factors. They are Data Summary Report, DCP Performance Measurements, Support File Error Report, Data Delivery Report, Alert Report, and Abnormal Platform Response Messages. If no parts are generated and AIMS runs automatically, the ADAPS data managers receive electronic mail stating that no AIMS Exception Report has been prepared.

All information in the AIMS reports comes from the ADAPS unit values file in the local Prime computer and reflect the same data as shown in a UV-TABLE. The AIMS report uses stored computed unit values, when available; otherwise, edited unit values are used. If edited values are used, no data appear in the last eight columns of the Data Summary Report.

The exact time covered in the report differs for interactive and automatic execution. Because the DAILY jobs usually are run early in the morning, the report covers the entire previous day and the last transmission of the preceding day. The report includes data from the current day up to the time of execution, ignoring missing data for the current day. The entire period specified by the user to the current time, with the exception of one transmission interval of MISSING data on the current day, is the time covered in a user-generated report.

All hydrologic and instrument-monitoring data for DCP instruments are automatically included (unless the instrument-monitoring data have been deleted).

Data Summary Report

The first portion of the AIMS Exception Report is the Data Summary Report (fig. 50). It lists only those stations and parameter codes that have data values indicating a potential problem. On each line of the report, an asterisk (*) indicates the value(s) that caused the line to be printed. If no stations are out of tolerance, this portion is not printed. The items shown below are included in this portion:

DCP ID	For identification
STATION	For identification
PARAMETER	For identification
MISSING DATA	Entire day missing - 1440 minutes. Previous day missing (DAILY) - 200 minutes. Current day missing (DAILY) is ignored. Otherwise missing data totaled as found, up to current time less one transmission.
SAME DATA	Not working
VERY HIGH	Number of values exceeding VHIGH threshold
HIGH	Number of values exceeding HIGH threshold

LOW	Number of values exceeding LOW threshold
VERY LOW	Number of values exceeding VLOW threshold
VERY RAPID INCREASE	Number of values exceeding VRI threshold
RAPID INCREASE	Number of values exceeding RINCR threshold
RAPID DECREASE	Number of values exceeding RDEC threshold
VERY RAPID DECREASE	Number of values exceeding VRD threshold

The user may use the ADAPS SU (Support) menu to modify the INSTRUMENT or DD file to set the above thresholds for each station and parameter code.

DCP Performance Measurements

The program generates the DCP Performance Measurements portion of the AIMS Exception Report only if values in the instrument-monitoring data indicate a potential problem. On each exception line, an asterisk (*) indicates the value(s) that caused the line to be printed. The default range of values is indicated in the column headings and repeated in the legend at the bottom of the report.

The elements shown below appear in this portion:

DCP ID	For identification		
STATION	For identification		
EIRP	MIN	AVG	
SIGNAL+NOISE/NOISE RATIO	MIN	AVG	
MODULATION INDEX	MIN	AVG	
FREQUENCY OFFSET	MIN	MAX	
BATTERY VOLTS	MIN	MAX	DIF
TIME DRIFT	MIN	MAX	
NUMBER OF BAD CHARACTERS			
NUMBER OF MISSING TRANSMISSIONS			
NUMBER OF RANDOM TRANSMISSIONS			

The user may use the AIMS menu option 2 (Display/Modify DCP Performance Thresholds) to set station-specific DCP performance thresholds.

For DCP's described in the performance thresholds as being powered by a solar charger, the difference between maximum and minimum voltage is flagged if this difference is less than 0.2 volts. Otherwise, the difference is reported but not flagged.

Support-File Error Report

The Support File Error Report portion of the AIMS Exception Report is included only if records in the ADAPS DD or PROCESSOR data files or the AIMS data file are missing or incorrect. Any stations listed here are not included in the other portions of the AIMS report. Errors in the DD or PROCESSOR files may cause incoming DCP data not to be stored, and, therefore, need to be resolved promptly. Including an incorrect or deleted station ID in the group causes that station to be listed in the Error Report. Errors in updating AIMS from DECODES are also listed.

Data Delivery Report

The Data Delivery portion of the AIMS Exception Report is present only if requested by an interactive user or, on Sunday, by DAILY automatic execution. Do not request the Data Delivery Report unless it is specifically desired because it takes longer to generate than the other portions. This report is available only to remote (nonhost) sites.

The Data Delivery Report lists statistics on the length of time between receipt of a transmission by the host node Prime and the time that data are stored in the ADAPS unit values file at the remote site. That time includes processing time by the host node, time for transmission by File Transfer Request (FTR), and processing time at the remote node. Statistics include the total number of transmissions delivered from the primary host and from the backup host (in case the regular host was out of service), and the percentage of each of these delivered within various time periods.

Alert Report

The Alert portion of the AIMS Exception Report includes a listing of all ALERT messages generated by a site-specific alert program incorporated into ADAPS.

Skeleton programs intended for local revision named ALERT02.F77 through ALERT25.F77 are in the directory WATSTORE>ADAPS>REV85.1>ADRSRC>ALERT_LIB. To include ALERT messages in the AIMS Exception Report, a local programmer needs to revise an ALERTnn.F77 program to call the subroutine ALERT_AIMS.F77 with appropriate arguments. In the same directory, edit LIST.OF.SUBROUTINES and add a line for ALERT_AIMS in any position. Install these revisions by reinstalling ADAPS (see local ADAPS Administrator or Prime Administrator).

Store screening thresholds, which are selected to trigger an Alert, and the number "nn" of the ALERTnn program in ADAPS, using the ADAPS/SU/1 menu. After entering the station ID, choose ED, then CH, select the DD, enter "1" (Display/update DCP channel information), next AL (respond 'Y' to the query), and finally PG (Alert program number).

When a station so flagged has data that exceed the programmed threshold(s), ADAPS calls the ALERTnn program, which writes the user-written message to a file SATIN>MISC>ALERT.date.time. Automated Instrument Monitoring System then copies those messages to the Exception Report and deletes the files after 5 days.

Abnormal Platform Response Messages Report

The Abnormal Platform Response Messages (APRM) section of the Exception Report is generated only if the host site receives APRM messages. General messages (concerning GOES satellite outages, eclipses, and so forth) appear on each AIMS report. Messages specific to a station appear on the report only if that station is in the group.

APRM messages are stored as

SATIN>MISC>APRM.node.date.time

and are automatically deleted by AIMS after 5 days.

Fine-Tuning the AIMS Exception Report

To be of greatest use, the report needs to list all those sites with potentially important problems and those sites only. Many of the thresholds are user programmable; the following programmable options may be adjusted if too many or too few sites appear on the report.

Adjusting the Data Summary Report

NUMBER OF DATA POINTS: To reduce number of lines on the report, adjust the thresholds using the ADAPS SU menu. If always all zeroes, set the thresholds.

MINUTES OF MISSING DATA: If apparently in error for any station, check the Sampling Rate for that parameter code using DECODES and correct it if needed. Then update AIMS from DECODES (AIMS menu option 3).

Adjusting the DCP Performance Report

All items: Set thresholds for each instrument using option 2 of the AIMS menu. (See section titled "Data-collection platform performance thresholds.")

Adjusting the Support File Error Report

Look for duplicate, missing, or out-of-date records in the AIMS, DECODES, DD, and PROCESSOR records. Check DECODES for invalid transmission rate. Check the groups for incorrect station ID's.

Adjusting Alert Report

To change ALERT messages, see section titled "Alert report."

Data-Collection Platform Performance Thresholds

The user may set DCP performance thresholds at any time for any of the elements (except MISSING TRANSMISSIONS) on the DCP Performance portion of the AIMS Exception Report. Thresholds may be set the same for all instruments or may be set individually for one or more stations.

The program stores DCP threshold data in an AIMS MIDASPLUS file AM.DATA. That file also includes some information formerly in the ADAPS Instrument file but now updated through DECODES, the DEvice COnversion and DElivery System. (See section titled "Updating automated instrumentation monitoring system.")

To manipulate DCP threshold data, enter ADAPS submenu SA (SATIN Information), select option 2 (AIMS), and then select option 2 (Display-Modify DCP Performance Thresholds). The following menu appears:

```
SUBMENU--DCP PERFORMANCE THRESHOLDS OPTIONS

ED - EDIT AN EXISTING DCP THRESHOLD RECORD
AL - EDIT ALL DCP THRESHOLD RECORDS
DI - DISPLAY DCP THRESHOLD RECORD(S)
LI - LIST ALL DCP'S FOR THIS STATION
CH - CHANGE TO DIFFERENT INSTRUMENT
DC - LOCATE DCP INSTRUMENT FROM NESS-ID'S
DE - DELETE DCP THRESHOLD RECORD
US - RE-START PROGRAM, DISPLAY USER INFORMATION
QU - QUIT THIS PROGRAM
EX - EXIT ADAPS SYSTEM
```

Editing Thresholds for One Station

Selection of ED - EDIT AN EXISTING THRESHOLD RECORD produces a complete display of all data in the AIMS file for the station previously selected. The upper portion (device-ID, device number, NESS-ID, transmission time and interval, GMT offset, daylight-savings-time flag, and host node) is displayed only for information and cannot be modified through the AIMS menu. These and sampling rates for each data DD (not displayed) have to be modified through DECODES.

To modify any of the performance threshold parameters in the lower portion, enter the two-letter code from the left column and follow the prompts.

```
 ___________________________________________________________________________
|   AIMS UPDATE:  SITE 02148315    DEVICE-ID SYN    DEVICE NO.1             |
|                 Description:              RAIN - COE                      |
|                                                                           |
|NESS identification:     165E1114                                          |
|DCP type:                SYN              ----------------------           |
|Transmission time:       03:34           |To modify any of these |         |
|Transmission interval:   4               |parameters, use DECODES|         |
|GMT offset:              -5         <----| (DEvice COnversion    |         |
|Daylight saving time:    NO              | and DElivery System)  |         |
|Host node:               DSCCMB           ----------------------           |
|   ------------------------------------------------------------------      |
|             DCP PERFORMANCE            LOW          HIGH OR MEAN         |
|     CODE       PARAMETERS            THRESHOLD       THRESHOLD          |
|       EI - EIRP                        40.50          50.50              |
|       SN - Signal/S+N Ratio             9.50          20.50              |
|       MD - Modulation Index            -8.50          -3.50              |
|       FQ - Frequency Offset          -400.50         400.50              |
|       BV - Battery Voltage             11.45          13.75              |
|       TD - Time Drift                   5.50          30.50              |
|       BC - Bad Characters                     1                          |
|       RA - Random Transmissions               0                          |
|       CH - Type of Charger       0 - OTHER (NOT SOLAR PANEL)             |
|       ID - Instrument Description -                                      |
|Enter code to edit field or [CR] to continue:                            |
|___________________________________________________________________________|
```

Editing Thresholds for All Stations

Menu option AL - EDIT ALL DCP THRESHOLD RECORDS sets thresholds for all stations with a single operation. Default threshold values (not the values previously set) are displayed for reference.

To set any of the performance thresholds for all stations, enter the two-letter code from the left column and follow the prompts. A warning is given that this overwrites any station-specific thresholds previously set for that parameter code. For example, setting the battery voltage minimum to 10 and the maximum to the default of 13.75 causes all battery voltage thresholds in the entire AIMS file to be set to 10 and 13.75 but does not change any other thresholds (bad characters, time drift, and so forth) unless those also are selected.

Deleting an AIMS Record

Select menu option DE - DELETE DCP THRESHOLD RECORD if a DCP instrument has been removed. Failure to delete old records does not cause any problem.

Other Data-Collection Platform Performance Threshold Options

The other options on the DCP Performance Threshold menu are essentially the same as in the present instrument file:

DI - Displays all AIMS data for selected station without any editing option.

LI - Lists all DCP instruments for that station.

CH - Permits change to another instrument for the same station.

US - Returns to USER display for selecting a new station, agency, or output device.

DC - Lists all NESS-ID's and permits selection of new station.

Updating AIMS Data from Device Conversion and Delivery System

The following items are updated only through DECODES:

Device-ID	Device number
NESS-ID	Transmission interval
GMT offset	Transmission time
Host node	Daylight savings time
Sampling rate for each data DD	

To update AIMS data from DECODES, enter DECODES and update information. That produces an update file on Prime for AIMS (SATIN>MISC>DECODES.date.time).

These update files may be applied in two ways. If the user desires an immediate update, enter the ADAPS/AIMS menu and select option 3 (Update DCP Information from DECODES). The update runs quickly, displaying each file processed. If an immediate update is not needed, AIMS.DAILY.CPL processes all DECODES files just before producing the Exception Report. Each update file is deleted immediately after update has been completed. Any errors from failed updates appear in the Support File Error Report.

If information in AM.DATA is not updated, hydrologic data continues to be stored and processed correctly, but the AIMS Exception Report is inaccurate.

AIMS Summary Report

The AIMS Summary Report (fig. 51) is used occasionally to check the performance of the satellite relay system and to garner statistics. It requires a single control file, AIMSUM.CTRL. This file may be generated by any of several methods and will be created in the directory previously specified in the USER display.

Selection of option 4 from the main AIMS menu (Execute AIMS SUMMARY Report/Build Ctrl File) provides this submenu:

```
|                 SUBMENU--AIMS SUMMARY PROGRAMS                     |
|         1.  Build Control File for AIMS SUMMARY Report             |
|         2.  Execute AIMS SUMMARY Report (Submit BATCH job)         |
|        QU--Exit to Previous Menu     EX--Exit to PRIMOS            |
|____________________________________________________________________|
```

Selection of option 1 leads to another submenu:

```
|         Building Control File for AIMS SUMMARY Report              |
|              1.  Automatic Build from SATIN Groups                 |
|              2.  Build from User Groups                            |
|              3.  Enter all Categories and Station-ID's from        |
|                  Terminal                                          |
|        QU--Exit to Previous Menu     EX--Exit to PRIMOS            |
|____________________________________________________________________|
```

Option 1 compiles all groups named with the name of the SATIN phantom into a single AIMSUM.CTRL file. Option 2 permits the user to compile any or all of the user's groups into a control file. Option 3 may be useful for quickly obtaining statistics on one or a few stations. All methods request confirmation before overwriting a previous control file. AIMSUM.CTRL also may be created or modified using any editor, but the user needs to exercise extreme care to preserve the exact format of the file.

When ready to produce the report, the user selects option 4 (Execute AIMS Summary Report) from the submenu and inputs a starting date. This submits a batch job. The resulting report is

WATSTORE>ADAPS>REV85.1>SYSTAT>AIMS_SUMMARY

The user may spool, copy, delete, or mail this report as with any file. The next time the program is executed, AIMS_SUMMARY is overwritten.

The AIMS Summary Report gives statistics from any starting date up to the present, based on records in the ADAPS unit values file. It calculates the percentage of complete days, partial days, and missing days. It also summarizes the lengths of gaps in the data by number of days and presents a table showing the length of gaps (if any) for each station in the control file.

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Ficken, James H. and Scott, Carl T., 1988, *Operating Manual for the U.S. Geological Survey Minimonitor, 1988 Revised Edition, punched-paper-tape model*: U.S. Geological Survey. Open-File Report 88-491, 76 p.

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----- 1986, *Model 3452A General Purpose Interface Module Technical Manual*: Synergetics International, Inc., Boulder, Colorado, p. 1-3, 1-4 (Document No. 03452-94101), 3, 4 (Document No. 03451-94101), and 3-5 (Document No. 03452-94101).

Tandy Corporation, 1986, *Tandy Portable Disk Drive 2 Operation Manual*: Tandy Corporation, Ft. Worth, Texas, p. 8-9.

APPENDIX A--MANUFACTURERS OF DATA-COLLECTION PLATFORMS AND RELATED EQUIPMENT

The following list of manufacturers is included for the convenience of users who require technical information about DCP-support use.

PLATFORM MANUFACTURERS

LaBarge, Inc.
Electronics Division
P.O. Box 926
Tulsa, OK 74101

Handar, Inc.
1380 Borregas Avenue
Sunnyvale, CA 94086
Phone: (408) 734-9640

Sutron Corp.
11150 Main Street
Fairfax, VA 22030
Phone: (703) 471-0810

Synergetics International, Inc.
P.O. Box E, 6565 Odell Place
Boulder, CO 80306
Phone: (303) 530-2020

BATTERY MANUFACTURERS

C & D Batteries
3043 Walton Road
Plymouth Meeting, PA 19462
Phone: (215) 828 9000

Delco Remy
2401 Columbus Avenue
Anderson, IN 46011
Phone: (317) 646-7406

Exide
Philadelphia, PA

Gates
1050 S. Broadway
P.O. Box 5887
Denver, CO 80217
Phone: (303) 744 4806

Power Sonic Corp.
P.O. Box 5242, 3106 Spring Street
Redwood City, CA 94063
Phone: (425) 364-5001

Yuasa Battery (America), Inc.
8108 S. Freestone Avenue
Santa Fe Springs, CA 90670
Phone: (213) 698-2275

SOLAR PANEL MANUFACTURERS

Atlantic Solar Power
6455 Washington Boulevard
Baltimore, MD 21227
Phone: (301) 796-3357

Photowatt International, Inc.
2414 W. 14th Street
Tempe, AZ 85281
Phone: (602) 894-9564

Solarex Corp.
1335 Piccard Drive
Rockville, MD 20850
Phone: (301) 948-0202

Spectrolabs
12484 Gladstone Avenue
Sylmar, CA 91342
Phone: (213) 365-4611

ACCESSORIES MANUFACTURERS

Precision Industrial Components
P.O. Box 335, Benrus Center
Ridgefield, CT 06877
Phone: (203) 431-1500

Bird Electronics
30303 Aurora Road
Cleveland, OH 44139

Winfred M. Berg, Inc.
499 Ocean Avenue
East Rockaway, L.I., NY 11518

Node, Inc.
408 Broad Street
Nevada City, CA 95959
Phone: (916) 265-4668

Traveling Software, Inc.
North Creek Corporate Center
19310 North Creek Parkway
Bothell, WA 98011
Phone: (800) 343-8080

Specialized Products Co.
3131 Premiere Drive
Irving, TX 75063
Phone: (800) 527-5018

APPENDIX B--DATA-COLLECTION PLATFORM SPECIFICATIONS

For the reader's convenience, DCP specifications for Handar Models 524, 540, 560, and 570; Sutron 8004 series; and Synergetics Model 3401 are provided with the manufacturers' permission.

HANDAR

524A/525A TECHNICAL SPECIFICATIONS

FREQUENCY	
(Crystal controlled)	401.700996-401.847905 MHz (NESS CH 1 - 266)
FREQUENCY STABILITY	
Temperature	$\pm 5 \times 10^{-7}$ (-40 to +50°C)
Long Term	$<\pm 1 \times 10^{-6}$ /Year
Phase Noise	<3° RMS (100 Hz BW)
Supply Sensitivity	$<1 \times 10^{-8}$ (11-14V)
MODULATION	
Long Term	<±6°
Medium Term	3° RMS (100 Hz Bandwidth)
RF POWER OUTPUT	
524A	+40 dBm (10 Watts ±1 dB)
525A	+46 dBm (40 Watts ±1 dB)
SPURIOUS OUTPUT	-60 dBc
HARMONIC OUTPUT	-60 dBc
TIMING SEQUENCE	
Transmission Interval	5 min to 63 hours 59 minutes(1)
Synoptic Delay Interval	5 min to 63 hours 59 minutes(1)
TIMING ACCURACY	±30 Sec/Year
DATA STORAGE	1664 Bits
Scan readings	104
DATA FORMAT	
Unmodulated Carrier	5 sec
Bit Synch (101010...)	2.5 sec
MLS Code	15 Bits
BCH Code (User Programmable)	31 Bits
Data ASCII Character Set	8 Bits/Character Odd Parity
EOT	3 EOT (00100000)
DATA COLLECTION SCAN INTERVAL	5 mins to 63 hrs 59 mins(1)
DATA COLLECTION SCAN DELAY	5 mins to 63 hrs 59 mins(1)

(1) Programmable in 1 minute increments

HANDAR

524A/525A TECHNICAL SPECIFICATIONS (Continued)

SENSOR INITIATE	
Scan Time	15 second/Digital Channel
Positive going line 1 minute before Sensor Data Scan	11-14V External Sensor Power 200 mA Max.
Optional user programming in one minute increments	1 min to 31 mins before scan
Channel Selection Strobes	1=7.5V 0=0V
Maximum Current (7.5V)	2A Surge 500 mA Continuous
ANALOG INPUT	8 Channels
Digitizing Time per Channel	0.1 second/Channel
ADC	Dual Slope (8 Bit)
Input Impedance	1 meg.
Input (Full Scale)	0-5V (Differential)
Maximum Input	-20 to +20 (Differential)
Common Mode (Max.) over full I/P range	-2V to +7V
DC Common Mode Rej.	±2 Bits
AC Common Mode Rej.	±2 Bits (0-10 kHz)
Non-Linearity	<1 Bit
Accuracy	.4%(±1 Bit)
Resolution	8 Bits (1/256)
Temperature Coefficient	.02%/°C
DIGITAL INPUT	4 Channels
Number of Bits	16 Bits Parallel Ent.
Logic Levels	Logic 0 = +5V Logic 1 = 0V
ADR Interface	Leupold Stevens or Fischer Porter
Input	524A/525A Inputs Internally Pulled High to +5V
Input Current	Hi (Logic 0) -100μA (Input 4.5V to 5.5V) Lo (Logic 1) -1mA (Input 0.5V to -0.5V)
DC POWER INPUT	
Voltage	12.5V ±1.5V
Current	
Quiescent	< 6 mA @ 12.5V
Peak 524A	< 3.5A @ 12.5V
525A	< 9.0A @ 12.5V

524A/525A TECHNICAL SPECIFICATIONS (Continued)

ENVIRONMENTAL

Operating	-40°C to +50°C
Storage	-65°C to +70°C
Humidity	100%

MECHANICAL HOUSING

Enclosure	Airtight Canister 11" (28 cm) Dia. 13" (33 cm) length
Weight	15 lbs. (6.8 kg)
Data I/O, Power	55 Pin MS3126F-22-55S (Supplied)
Programming I/O	26 Pin MS3126F-16-26S (Supplied)
RF Output	Type N

OPTIONS

001 Guaranteed Cold Temperature Performance to -55°C

002 High Gain Crossed Yagi Antenna

003 Omni Directional Antenna, Quad. Helix 1λ (525A only)

004 15' N/N Coax 142 B/U

005 Precipitation Card

ADR Cables are available in various configurations.
Consult factory for further details.

HANDAR

526A

PROGRAMMING SET SPECIFICATIONS

524A/525A System

Interface	Via Standard Cable (Supplied)
Display	8 Character LCD

DATA TRANSMISSION KEYS	DISPLAY FORMAT
ID (BCH Code)	8 hex Characters
Transmit Delay	Hours-Minutes
Transmit Interval	Hours-Minutes
Transmission Type	0 to 3

DATA COLLECTION KEYS

No. Channels	A1 Analog #	D1 Digital #
Channel Limit	XXXX (Analog)	XXXXX (Digital)
Scan Interval	Hours	Minutes
Scan Delay	Hours	Minutes

DATA MONITOR KEYS

Last Data	CH # - XXX (Analog), XXXX (Digital)
Channel Number	A# or D#
Scan Interval	CH # - XXX (Analog), XXXX (Digital)
Store Location	Location - Hex Value

STATUS KEYS

Monitor
Program

COMMAND KEYS

Sensor Scan
Transmit Initiate

HANDAR

TECHNICAL SPECIFICATIONS (Continued)

SENSOR SIMULATOR

Channel	Voltage	Displayed Output
A1	Battery ÷3	≈200 @ 12.5V
A2	0V	0 ±3 Bits
A3	0.5V	26 "
A4	1.0V	51 "
A5	2.0V	102 "
A6	3.0V	153 "
A7	4.0V	204 "
A8	5.0V	255 +0 Bits -3 Bits

Channel	Code	Display
D1	1111 1111 1111 1010	FFFA
D2	0000 0000 0000 0100	0004
D3	0101 0101 0101 0000	5550
D4	1010 1010 1010 1011	AAAB

ELECTRICAL	Supplied From 524A/525A
Voltage	12.5V ±1.5V
Current	<500 mA
ENVIRONMENTAL	
Operating	-10°C to +50°C
Storage	-55°C to +60°C
Humidity	0-98% Cover On 0-95% Operating @ 40°C
MECHANICAL	
Size	14" x 18" x 6" (36 cm x 46 cm x 15 cm)
Weight	11 lb. (5 kg)

HANDAR

540A-1 Technical Specifications

Sensor Interface Types	
Wind Speed	Tipping Bucket
Wind Direction	Solar Radiation
Temperature	Dew Point
Relative Humidity	Analog Input
Barometric Pressure	Teleradiometer
Weighing Gauge	Snow Pillow
Data Processing	
Precision	16-Bit Signed Binary
Processing Algorithms	
Data Log	
Mean (Average)	Wind Rose
Standard Deviation	Wind Run
Histogram 6 BIN	Histogram 15 BIN with over & underflow
Minimum	Sensor Difference
Maximum	Measurement difference
Analog Input	12-Bit Successive Approximation
Input	0.5 Volt (Differential)
Digitizing Time	1 msec
Resolution	12 Bits
Linearity	±0.05% of F.S. @ 25°C
Accuracy	±0.1% of F.S. @ 25°C ±100 ppm/°C of F.S.
RAM Data Storage	(Internal)
Scan Readings	Up to 900 Data Samples - Depending Upon Sensors and Processing

Data Output

- Satellite Radio/UHF-VHF Radio
- Digital Tape Cassette
- Modem/RS232
- Data Format
  - Measurement Channel Ordered
  - Time Scan Ordered
  - Channel Number, Time Tag, and Scan Interval with Data, WMO

System Clock	
Crystal Controlled	±30 sec/month (±30 sec/year with Option 002)
Data Measurement	
Sensor Sample	1 second to 18 hours
Processing Interval	1 second to 18 hours
Sensor Initiate	0 to 18 hours in 1 sec incr. before scan

Battery Monitor	
Range	0-15 volts
Accuracy	±3%
Resolution	0.1 volts
Power Supply	
Regulator	Series Switching Regulator
Battery	20 AH 12-Volt Gel
Solar Panel	400 mA
Environmental	
Operating	-20°C to +50°C (-40°C to +60°C Optional)
Storage	-65°C to +70°C (less battery)
Humidity	100%
Mechanical	
Enclosure	12" x 16" x 9.5" (30.48 x 40.64 x 24.13 cm)
Weight	55 lbs (25.03 kg)
Type NEMA Type 4	

1.5 560A Technical Specifications

Standard Sensor Inputs	
Precipitation	Tipping Bucket Counter
Incremental Shaft Encoder	HANDAR 436A Shaft Encoder
Data Processing	
Data Log	Precision: 16-Bit Signed Binary
Mean (Average)	Sensor Difference
Standard Deviation	Measurement Difference
Minimum	Maximum
Analog Input	Type: 8-Bit Successive Approximation
Input	0-5 Volt Full Scale
Digitizing Time	1 msec
Resolution	8 Bits
Linearity and Accuracy	±0.4% of Full Scale @ 25°C
Ram Data Storage	Up to 650 Data Samples
System Clock	
Crystal Controlled	±30 sec/no (±30 sec/year with Option 101)
Data Measurement	
Sensor Sample	1 second to 18 hours
Battery Monitor	
Range	0-15 volts
Accuracy	±3%
Resolution	±0.1 volts
DC Power Input	11-14 volts

Environmental	
Operating	$-20^{\circ}C$ to $+50^{\circ}C$ ($-40^{\circ}C$ to $+60^{\circ}C$ Optional)
Storage	$-65^{\circ}C$ to $+70^{\circ}C$
Humidity	100%
Mechanical	NEMA Type 4 Enclosure
Enclosure	12" x 14" x 6" (30.48 x 35.56 x 15.24 cm)
Weight	35 lbs (15.89 kg)

1.6 570A Technical Specifications

Standard Sensor Inputs
Precipitation, Tipping Bucket,
Water Level, 436A Incremental
Shaft Encoder

Connectors
1 Precip/Shaft Encoder/Ext. Power input
1 Programming input/data output
1 RF output (VHF/UHF or GOES radio)
1 Modem (telephone/modem interface)
1 Quick connect terminal strip 108 setscrew input lines

Display: 8 digit, front panel LED for reading sensor values and calibrating reference levels of water level and total precipitation.

Power: External 12 vdc battery input or optional internal 2.6 amp hr Gel Cell rechargeable battery. Power consumption: 2.5 ma standby; 380 ma with display enabled.

Environmental:

Temperature, operating:	$-20^{\circ}C$ to $+50^{\circ}C$
	$-40^{\circ}C$ to $+60^{\circ}C$
Temperature, storage:	$-65^{\circ}C$ to $+70^{\circ}C$
Humidity:	100%

Size: 10"h. x 15 1/2" w. x 13 3/4" d.

Weight: 30 lbs., 33 lbs. with internal battery

SUTRON

Model 8004
SPECIFICATIONS

DATA COLLECTION PLATFORM

MICROPROCESSOR:	Low-power microprocessor; up to 6k bytes RAM and 24k bytes EPROM
OPERATING TEMPERATURE:	-40° to +50°C
TIMING STABILITY:	± 10 sec/6 months over temperature range
SENSOR INTERFACE:	Up to 16 total sensors in any mix of the following:
Analog:	Precision 12-bit A/D converter ±0.05% accuracy; programmable gain amplifier makes full scale 0 to 0.1 v, 0 to 1, 0 to 5 v range
Digital:	Interfaces to parallel switch closure devices such as ADRs
Serial Digital:	Interfaces to Sutron P/SI or other 300 baud 0 to 5 v devices
Burst:	Gated counter for frequency-to-digital conversion (gate time under program control; 1, 2 sec typical) (20 kHz max)
Switch closure:	Two dedicated swich closure counters for tipping bucket and wind speed devices; 10 msec closure, with 10 closures per second max.
AUXILIARY OUTPUTS:	Two outputs to operate recorder punch drives; 5.00 v reference (10 ma) and 12 v switched (2 amp)
DATA STORAGE:	200 characters standard; 1500 characters optional
COMMUNICATIONS OPTIONS:	Satellite or telephone
PACKAGING:	Sealed aluminum castings; 4 1/4 x 13 x 8 1/2 inches; weight: 15 lbs
POWER REQUIREMENTS:	12.5 v ± 2 v; 7 ma quiescent; 30 ma during acquisition and transmission (does not include transmitter power requirements)

SUTRON

Model 8004 (Continued)

GOES TRANSMITTER

CERTIFICATION:	Certified to self-timed and random specifications by NESDIS
OUTPUT FREQUENCY:	401.7010 - 402.0985 MHz, selectable by switch setting; any two NESDIS channels from 1-266; use of either channel is under program control
SPURIOUS OUTPUTS:	-60dBc
FREQUENCY STABILITY:	± 1 ppm over 1 year and -40° to +50°C temperature range
POWER OUTPUT:	Variable with potentiometer setting from 5-15W; permits matching cable losses and NESDIS permissible radiated power
TIMING STABILITY:	± 10 sec/6 months and -40° to +50°C
POWER REQUIREMENTS:	Range: 12.5 ± 2v; Quiescent: 100 uamps Peak (during transmission): 2.5 amp nominal
REPORTING TIME:	Initiate time is set to the second referenced to interval clock. Interval is set in minute increments in a range of 5 minutes to 1440 minutes (24 hours) Full adaptive random algorithm for operation on random channels.
TRANSMISSION FORMATS:	Meets NESDIS-specified formats for self-timed and random channels
OPERATING TEMPERATURE:	-40°C to +50° C
DIAGNOSTIC POINTS:	RF forward, RF reflected voltages lock indicator

SUTRON

SPECIFICATIONS - ALL MODELS OF 8200

Processor	NEC V25	Operates at a clock speed of 5MHz
Memory	RAM	Up to 6(32k by 8) chips - data storage
	EPROM	2(32k or 64k by 8)chips - operating system
	E^2PROM	1(2k by 8) chip - system setup, password
Battery back-up	Lithium Battery for long storage life storage life, 2 years minimum, (actual life will depend upon environment). Backuplife, 1 year minimum.	
Real-time clock	Accuracy, 1 minute per month (Units with GOES have greater precision	
Watch-dog timer	Provides system reset upon microprocessor failure	
Sample Intervals	Portable computer	Data extracted via the serial port
	RAM Pack modules	Retrieval time 15 seconds maximum RAM Pack is connected through terminal on front panel Data may be extracted into any PC through the serial port
Visual Display	16-character LED display	
Serial Sensor	Connection may be made through the RS-232 jack on the front panel Possible to program unit through serial port even when it is used for the sensor input	
SDI-12	The 8200 supports the USGS SDI-12 interface through a second serial port on the front panel	
Communications	GOES Satellite, LOS Radio, and voice-sythesized telephone options available. See separate data sheets for specifications.	
Shaft Encoders(2)	Switch closure with quadrature inputs 3-wire interface.	
Tipping bucket rain gage(1)	Input Levels	Switch closure, 0 to 5 volts

SUTRON

SPECIFICATIONS - ALL MODELS OF 8200 (cont)

Counter Inputs (5 max)	Counter Resolution	16 bits
	Maximum input frequency	1 KHz Typical, over 1 MHzwith 0 to 5V square wave
Analog Inputs	4 Standard	
	Resolution	12 bits
	Accuaacy	+or-0.25% of full scale
	Power consumption of A/D	30 milliwatts active
Pressure transducer(1)	DC Excitation	+/-5 volts interface(1)
	Differential input range	-5 to +100 mv
Power Supply	Internal Battery	6.5 amp hours at 12 volts
	Operation with no charging	90 day at shaft encoder sample rate of once per 15 minutes
	Operating with charging	External AC or solar power input (internally regulated)
	Maxamum Current	300 mA (with full display)
	Quiescent current	500 microA
	Maximum avgerage current	2 mA at shaft encoder sample rate of once per 15 minutes

Specifications

I/O Channel Specifications

* Analog	8 separate channels 8-bit conversion takes place in 3401 MCM 12-bit conversion (optional) takes place in 3451A 0-5 V, differential Common-mode range: -2.5 V to +7.5 V Crosstalk threshold: ± 30 V Min. Input impedence: > 1 Meg Ω
* Up/down counter	Switch-type incrementation Quadrature shaft encoder Accepts other quadrature incrementation shaft encoders Accepts count and up/down output devices Input filters eliminate false counts due to noise and provide > 100 V surge protection.
* Up counter	Debounce circuitry designed for tipping-bucket rain gauge Count rate variable (factory option) Full surge protection: gas tube, resistor, zener CMOS- or TTL-compatible 8-bit counter
* Auxiliary power	12 V: 250 mA continuous, 1 A peak Surge protection: gas tube, series diode

Electrical

* Power Source	VBB and +5C from S-34 Bus® -- all power is from S-34 Bus®
* Input Voltage Range	12.5 V ±2 V and +5.0 V ±.1 V
* S-34 Bus® Power Consumption	Typical room-temperature power consumption:

		Sleep	Wake†	
o +5 V Continuous	+5 V:	20 µA	600 µA	no sensors
o +12 V Battery	+12 V:	150 µA	27 mA	connected

* Instrumentation Interface Inputs

o Inputs	8 analog, 0-5 V DC, differential 16 digital input lines, 0-5 V, TTL-compatible 1 up/down counter channel 1 up counter channel
o Outputs	4 digital output control lines 0-5 V, 0-7.5 V, or 0-12 V 0-7.5 V standard 1 switched auxiliary power output, 12 V @ 250 mA 1 continuous output, 7.5 V @ 250 mA

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†Not required for up counter or Up/Down Counter Readout.

* Lightning Protection

o Auxiliary Power Line	Gas tube, series diode
o Analog Lines	Gas Tube, resistor, Zener
o Up counter	Gas tube, resistor, Zener

Environmental

* Operating Temperature	-40° C to +55° C
* Storage Temperature	-55° C to +85° C
* Relative Humidity	0 - 95% (non-condensing)

Mechanical

* Size	2.62" H x 9.75" W x 9.50" D
* Weight	1 lb.
* Mounting	Case is stackable with all 3400 Series Modules.

Specifications

Electrical

* CPU	8-Bit 6802 with transparent, high-speed wake/sleep mode control	
* Memory (pluggable daughter board)	Up to 61,568 bytes RAM/PROM/ROM/EPROM/ EEPROM as required	
* External I/O	S-34 Bus* Control Port	
Power Available		
VBB	4 Amps	Maximum
+5 C	100 mA	Maximum
Analog Input Channel		
Input Voltage Range (AN+ and AN-)	-2.0 to +7.0 V DC	
Input Conversion Range (Differential)	0 to +5.0 V DC	
Resolution	8 bits	
Absolute Accuracy	±1 LSB	Typical
(Including offset, linearity, temperature)	±1½ LSB	Maximum
Input Impedence	10 MegΩ	Nominal
Digital I/O	Fully S-34-compatible	
Device Addressing	1-254	
Register Addressing (each device)	0-7 Read 0-7 Write	
* Programmer I/O		
Electrical Interface	RS-232C	
Handshake Support	DTR, CTS, RTS	
Wake Control	Positive Transition on DTR	
Baud Rate (Software-Selectable)	110-9600 Baud	Nominal
Mode	Full Duplex	
Terminal Power Available	+5.0 V DC @ 500 mA	Maximum
* Front Panel I/O		
Wake Control	Activate Button	
Display	Active LED	
* Calendar Clock	128 years with leap year settable and readable YR,MO, DAY, HR, MIN, SEC.	
* Alarm Clock	Automatically wakes MCM if in Sleep Mode and activates event(s) at preset YR, MO, DAY, HR, MIN, SEC.	
* Auxiliary Hardware Timer	Interrupts CPU at software-controlled frequency while in Wake Mode.	

- **External Clock Reference Requirements†**

Frequency	3.0 MHz	Nominal
Frequency Stability		
Temperature (-40° C to + 55° C)	$\pm 5 \times 10^{-7}$	Maximum
Long Term (1 year, including temperature)	$\pm 1 \times 10^{-6}$	Maximum
Input Level	0 - 5.0 V	Nominal
Duty Cycle (Square Wave)	50% ±10%	
Input Impedence	74C244 CMOS gate†	

Internal Diagnostic Channels

Channel #	Voltage Measured
0	+5 V_C (internal)
1	+5 C (to S-34 Bus•)
2	VBB
3	+5 V_S
4	+8 V_S
6	-8 V_S
7	Temperature

- **Power Requirements**

Input Voltage	+10.5 to +15.0 V DC	
Input Current (internal to MEM)		
Sleep Mode	+5.0 mA	Typical
Wake Mode (Memory Option Dependent)	200-300 mA	Typical

- **Interface Connectors**

Reference Input	con-hex Jack
Power In	Weidmuller SL-2
S-34 Bus•	3M-3494-1002
RS-232C Port	AMP 206486-1

S-FORTH• Operating System Version 1.0

- High-level language interface to hardware systems.
- S-FORTH• includes a stack-oriented, extensible, high-level language interpreter and compiler.
- S-FORTH• contains an extensive set of 16- and 32-bit integer arithmetic operators.
- S-FORTH• high-level interpreter facilitates interactive debugging of systems.
- Real-time Operating System with three levels of time-critical event timing
  1. 5 msec time-sliced event execution with highest level of priority.
  2. Pseudo-Interrupt-driven event execution with second-order priority.
  3. Chain events with variable priority, executing under the EXECUTIVE routine.
- Tasks can be enabled at each level and execute concurrently.

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† External Clock Reference required only for operation with GOES Data Collection Platorms or other high-stability timing applications; supplied by 3421A GOES Transmitter for GOES applications.

* Programmer Port (RS-232C) I/O executes concurrently with other tasks in the EXECUTIVE routine.
* Transparent software timers with 5 msec resolution; settable, resettable and readable.
* S-34 Bus® Commands
  1. CLEAR
  2. READ (Device Address, Register)
  3. WRITE (Device Address, Register, Data)
* S-34 Bus® Interrupts wake 3401A to initiate or execute an event

Environmental

* Operating Temperature	-40° C to +55° C
* Storage Temperature	-55° C to +85° C
* Relative Humidity	0-95% (non-condensing)
* Altitude	0-20,000 ft.

Mechanical

* Size (Standard 3400 Module)	2.62" H x 9.75" W x 9.50" D including all connectors
* Weight	3.75 lbs.
* Mounting	Case is stackable with all 3400 Series modules.

Specifications

Electrical

* Output Characteristics		
Frequency Range (Synthesizer-controlled)	401.7010-402.0985 MHz	
Channel Spacing	1.500 kHz	
Domestic GOES DCS Channels	1-199	
International GOES DCS Channels	200-266	
Combined Frequency Stability (1 year, -40° C to $+55^\circ$ C)	± 400 Hz	Maximum
Phase Noise ($2 B_L = 20$ Hz)	3° rms	Maximum
Power Output (ALC, Adjustable)	2-13 Watts	Nominal
Power Output Stability (11-15 V DC, -40° C to $+55^\circ$ C)	± 0.5 dB	Nominal
VSWR	1.50	Maximum
Spurious Emissions		
Individual Components		
$f_o \pm 1125$ Hz to $f_o \pm 2250$ Hz	-25 dBc	Maximum
$f_o \pm 2250$ Hz to $f_o \pm 4500$ Hz	-35 dBc	Maximum
$> f_o \pm 4500$ Hz	-60 dBc	Maximum
Combined, $f_o \pm 500$ KHz	-50 dBc	Maximum
Modulation		
Type	PSK	
Index	$\pm 60^\circ$	Nominal
Stability	$\pm 5^\circ$	Maximum
Encoding	Manchester	
Clockrate, phase-locked to internal 3 MHz reference	100 Hz	
Data Asymmetry	.01%	Maximum
Carrier Phase Reference	0°	Nominal
Binary Logic "One"	Negative-to-Positive Phase Transition	
Binary Logic "Zero"	Positive-to-Negative Phase Transition	
* Power Requirements		
Input Voltage Range	+10.5 to +15.0 V DC	
Input Current, Main Power Input		
Quiescent Mode	20 μa	Nominal
Standby Mode	600 ma	Nominal
Transmit Mode (12.5 V DC in)		
Power Output 2 Watts	1.5 amps	Nominal
Power Output 10 Watts	3.1 amps	Nominal
S-34 Power Consumption		
+5 V Continuous	100 μa	Maximum
+12 V Battery	0 μa	Maximum
* Fail-safe Protection	Fuse	
Maximum Transmitter On Time (Jumper-reprogrammable)	240 sec	Minimum
Minimum Transmitter Off Time (Jumper-Reprogrammable)	70 sec	Maximum
* Internal Reference Oscillator Output		
Frequency	3.000 MHz	Nominal
Frequency Stabililty		
Temperature (-40° C to $+55^\circ$ C)	$\pm 5 \times 10^{-7}$	Maximum
Short-Term (1 sec)	$\pm 5 \times 10^{-10}$	Maximum
Long-Term (1 year, including temperature)	1×10^{-6}	Maximum
Waveform	Square wave $\pm 5\%$	
Amplitude	0-5 V, $\pm .25$ V	Nominal
Output Impedance	CMOS Gate	

* Control Interface	S-34 Slave
Device Codes (Switch-Selectable)	10-1F Hex
Device Type	01 Hex (Specifies to MCM that the device is a 3421A UHF transmitter)
Command Set Responses	
Master Clear	Resets all Registers
OFF	Goes to Quiescent State
Standby	Enables all circuitry except PA
Carrier Only	Enables PA
Modulate	Enables 100 bps data stream on carrier
Write Data	Transfers 8-bit bytes of data to the transmit buffer. Double buffering allows up to 150 msec worst-case service response time, 80 msec average.
Write Channel	Transfers channel select word to transmitter
Send Forward Power	Enables Forward Power signal on to S-34 Bus• Analog Channel
Send Reflected Power	Enables Reflected Power signal on to S-34 Bus• Analog Channel
Enable Interrupts	Allows transmitter to cause an S-34 interrupt when data buffer becomes empty.
Disable Interrupts	Prevents S-34 Interrupts
Readable Registers	Current Status Current Channel Selected Device Type
Status Outputs	Current Mode Data Register Empty Data Overrun Error All Loops Phase-Locked Hardware Error
* Auxiliary Outputs	External PA Power (fail-safe protected)
* Interface Connectors	
RF Out	Type N Jack
Reference Out	Con-Hex Jack
Power In/Auxiliary out	SL-4
S-34 Bus•	3M-3494-1002
* Display	LED on when power amplifier enabled

Environmental

* Operating Temperature	-40° C to $+55^{\circ}$ C
* Storage Temperature	-55° C to $+85^{\circ}$ C
* Relative Humidity	0-95% (non-condensing)
* Altitude	0-80,000 ft

Mechanical

* Size (Standard 3400 Module)	2.62" H x 9.75" W x 9.50" D (includes all connections)
* Weight	4 lb
* Mounting	Case is stackable with all 3400 Series Modules

APPENDIX C--SUPPLIES AND EQUIPMENT

Antennas
Batteries (DCP)
Bolt anchors, concrete
Bolts, machine (assortment)
Caulking compound, RTV
Charger/regulator
Coaxial cable
Coaxial connectors
Counter weights
Data-collection platform
Drive chain and sprockets for encoders
Encoder, incremental shaft
Float tape or beaded cable
Floats
Fuses
Grease (for battery terminals)
Ground rods (copper clad)
Grounding clamps (2 inches and 5/8 inches)
Grounding cable (4 gage)
I/O cables
Mast Mounting brackets or "U" bolts
Mast, antenna (2-inch pipe)
Nails (assortment)
Recorder, digital w/mod A
Rope, 50 feet
Screws, sheet-metal (assortment)
Screws, wood (assortment)
Solar panels
Solderless connectors (assortment)
Tape, electricians
Tywraps (assortment)
Wire (assortment)
Desiccant bag in sealed container
Theft-protection plate (antenna mast)

APPENDIX D--TOOLS AND ORDERING INFORMATION

Chisel, cold
Compass (Brunton type)
Crimp N connector, part number -- Aim Electronics - 8005
Crimping Tool, part number -- TYU Spec-4x2131, Hex Crimper
Crimp tool (solderless connectors)
Desoldering tool
Digital multimeter
Digital watch or calculator clock
Drill, cordless (3/8 inch)
Drill, power (3/8 inch)
Drill, Yankee
Drills, masonary
Drills, set
Drivers, screw (set)
Drivers, jewelers (set)
Drivers, Phillips (set)
Drivers, No. 2 Pozidrive
Drivers, nut (set)
Extension cord
Files (set)
Generator (500-1,000W)
Gun, caulking
Hammer, claw (1 lb)
Hammer, double-face (5 lb)
Hemostats
Knife, electricians
Level (8 inch)
Pliers, chain nose
Pliers, curved needle nose
Pliers, water pump
Programming set with manual
Safety belt
Saw, crosscut
Saw, hack
Saw, keyhole
Saw, power jig
Scissors, electrician's
Side cutters
Solder
Soldering iron
Square (12 inch)
Stripper, wire
Tape, measuring
Tin snips (6 inch)
Tool box, pallet type (Jensen or equivalent)
Torch, acetylene, portable with pack frame
Vise grips
WWV receiver (Radio Shack or equivalent)
Watt meter, through line (Bird)
Wrench, pipe
Wrenchs, box rachet (1/4 inch to 3/4 inch)
Wrenchs, Allen (set)
Wrenchs, adjustable end (6, 8, 12 inch)
Wrenchs, socket set

APPENDIX E--MINIMONITOR OPERATING MANUAL SECTIONS RELATED TO GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE: SERVICING INTERNAL COMPONENTS FOR THE MINIMONITOR, By James H. Ficken and Carl T. Scott

There are two models of the USGS Minimonitor available at this time--the old "punched-paper-tape model" and the new "analog-voltage model." The following instructions were written for the punched-paper-tape model. Much of the information given in these instructions is valid for both models. The analog-voltage model and the differences between the two models will be discussed at the end of this section. The HIF is committed to adding SDI-12 communications to the USGS Minimonitor, first to existing analog-voltage models and later to punched-paper-tape models as they are converted to analog-voltage models.

For more detailed instructions about either model of the USGS Minimonitor, please refer to "Operating Manual for the U.S. Geological Survey Minimonitor, 1988 Revised Edition, Punched-Paper-Tape Model," Open File Report 88-491, or "Operating Manual for the U.S. Geological Survey Minimonitor, 1988 Revised Edition, Analog-Voltage Model," Open File Report 89-403. These manuals are available from the HIF Warehouse and can be ordered through the HIF-CSS.

SERVICING INTERNAL COMPONENTS OF THE MINIMONITOR

Occasionally, the inside of the Minimonitor must be opened to change settings on switches, to change fuses on older models, to add or remove circuit boards, and to change the desiccant. The can must be closed carefully to prevent damage to components and to ensure proper operation of the monitor.

Opening the Minimonitor

To prevent moisture from affecting the electronic circuitry, the Minimonitor should be opened only indoors under dry and warm conditions.

The following procedure is used:

1. Disconnect any cables from the top of the Minimonitor. Mark the sensor connectors and cables so they can be reinstalled correctly.

2. Remove the bolt or bolts that secure the locking ring.

3. Remove the locking ring from the top rim of the can.

4. Lift the cover and the electronics assembly from the can.

Figure 2, Minimonitor electronics assembly removed from can, shows the normal positioning of the circuit boards in the electronics assembly. The PROGRAMMER board is in the top slot and the multiplexer (MUX) board is in the bottom slot. SIGNAL CONDITIONER boards are positioned in the intermediate slots. The boards will be referred to as SIGNAL CONDITIONERS in the rest of this report.

The circuit boards are connected to each other, to the ZERO and SPAN potentiometers (called pots or trimpots in the rest of this report), and to the connectors on the Minimonitor cover with both ribbon cables and 16-pin, dual in-line connectors that plug into sockets on the circuit boards.

Internal Settings

Reasons for Internal Settings

Internal switches are used to set the desired

- recording interval;
- number of channels;
- delay times for the power-up, scan, and record cycles;
- specific-conductance range;
- dissolved-oxygen (DO) range; and
- pH range.

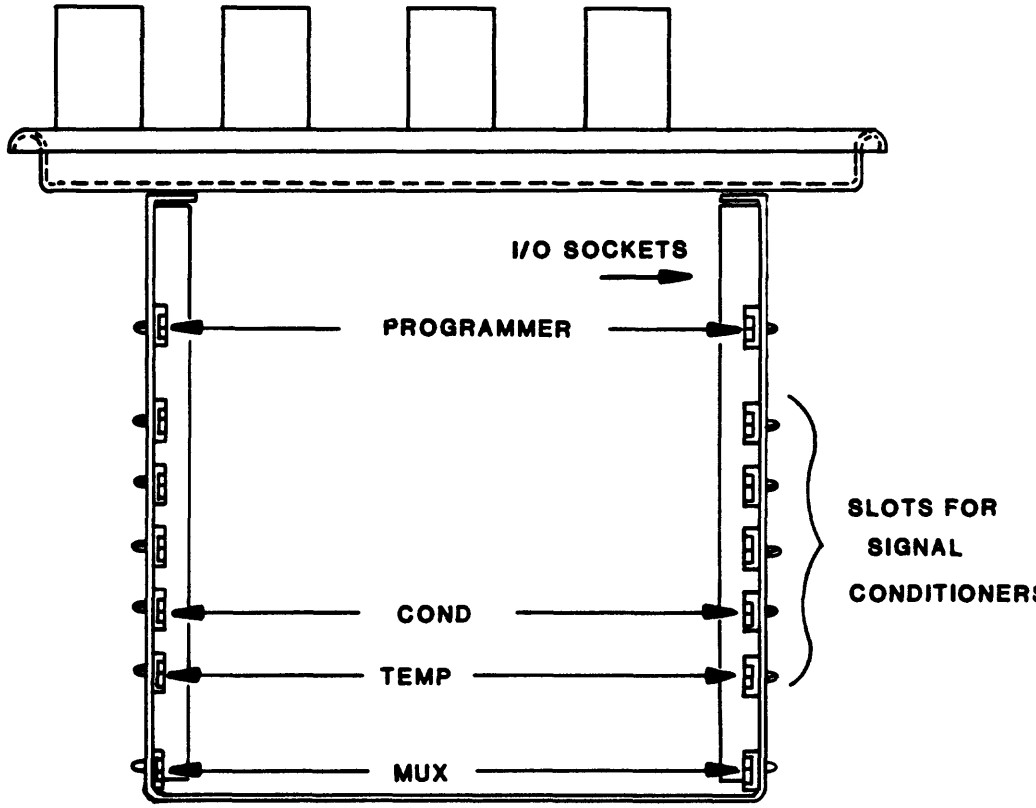


Figure 2.--Minimonitor electronics assembly removed from can.

Before the Minimonitor can be placed in operation, the electronics package must be programmed by internal switches for the number of channels to be recorded, the delay times, the recording interval, and the desired ranges on the SIGNAL CONDITIONERS of the constituents to be measured. These items were set before the monitor was shipped. To change the initial settings, open the Minimonitor as directed in the section entitled "Opening the Minimonitor."

WARNING: The internal wiring and circuits are not designed to withstand rough handling. Changes to internal settings are best made carefully, indoors under dry, warm conditions, and with fresh desiccant added. Internal settings usually are changed in the field.

Internal settings required for operation of the Minimonitor are made on the PROGRAMMER board (fig. 3).

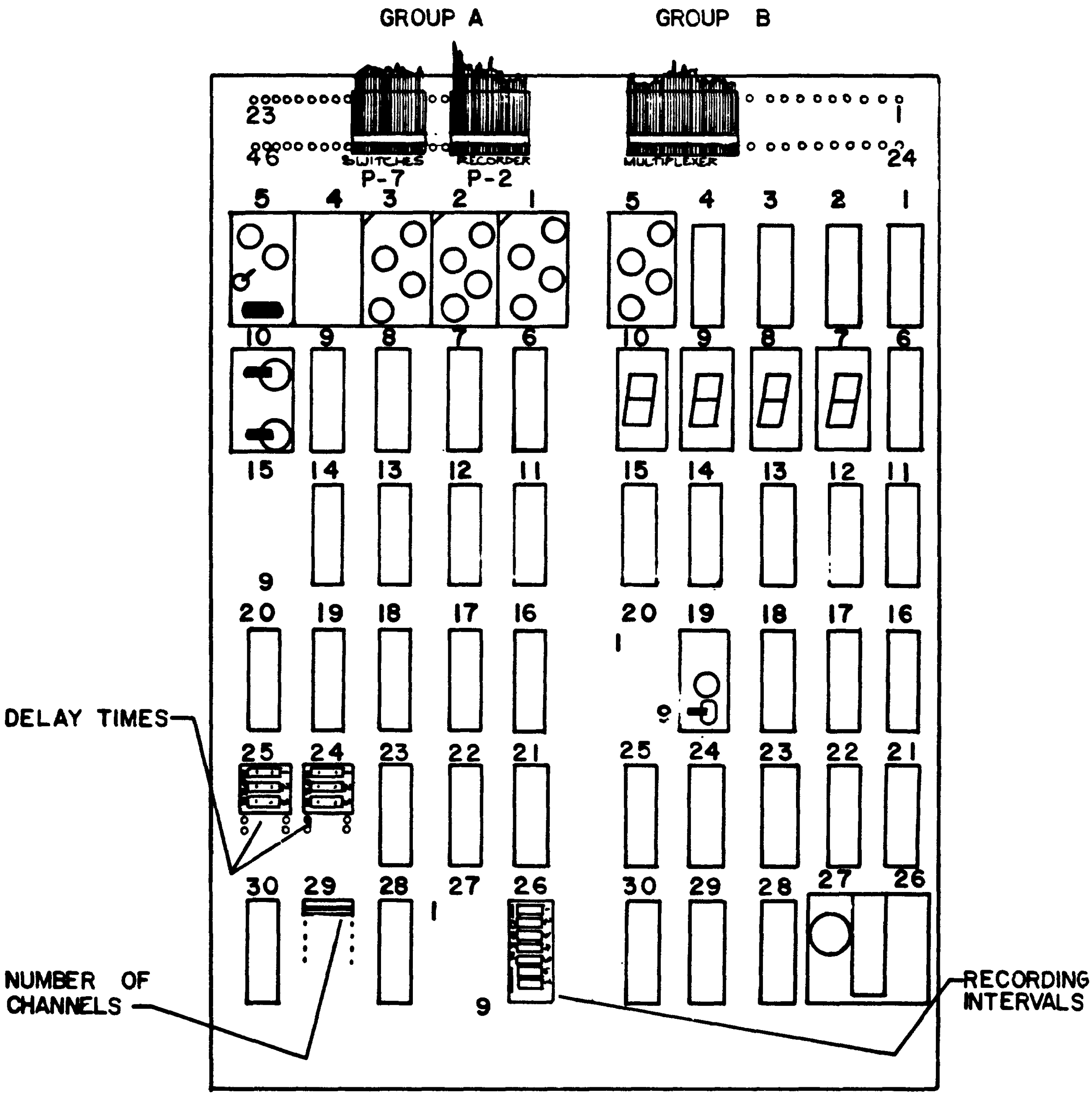


Figure 3.--Programmer board.

Number of Channels

One setting of the internal switch programs the Minimonitor recording for the number of SIGNAL CONDITIONERS in the Minimonitor can. If the Minimonitor is set for the two SIGNAL CONDITIONERS, specific conductance and temperature, they are in slots in the electronics rack and the number of channels is two. Changing the number of SIGNAL CONDITIONERS requires resetting the number of channels.

The number of channels recorded is controlled by a shunt bar in socket 29A on the PROGRAMMER board. Put the shunt in row 1 to record channel 1; in row 2 to record channels 1 and 2; row 3 to record channels 1, 2, and 3; and so forth. To change the number of channels, lift the shunt bar from the card and reinstall the bar in the desired row. See the example in figure 4.

```
Row 1     o  _________  o
    2     o-| SHUNT  |-o
    3     o             o
    4     o             o
    5     o             o
    6     o             o
    7     o             o
    8     o             o
```

Socket 29A

Figure 4.--Minimonitor set to record two channels.

Delay Times

The Minimonitor has two delay times that may be set by the user. A clock pulse initiates the monitor scan-and-record cycle. The DO stir signal is turned on. After a time delay, set by the switches in 25A, SIGNAL CONDITIONER power is turned on. Next, the scan-and-record cycle begins; its starting time is determined by the switch settings in 24A. (See timing diagram, fig. 5.) The delay time of the scan-and-record cycle must be longer than the delay of the SIGNAL CONDITIONER power-on cycle. The delay time in either switch 24A or 25A equals the sum of the value of the closed switches as shown in figure 5. Only three switch closures are allowed in each socket. These three switches can be installed only in adjacent rows. If the desired delay cannot be obtained where the three-switch assembly is located, move the assembly to a different row in the socket.

```
                                                    G               V
                                                    o  Not used     o
                                                   |                |
                   |                              O| o    4 s       o |1
                     __                           P|                |
Clock pulse  |  |_______________________          E| o    8 s       o |2  Move
                                                  N|                |
                    ____________________           | o   16 s       o |3  down
DO stir on   |
                                                     o   32 s       o     for
                   |
SIGNAL CONDITIONER                  ___________      o   64 s       o     longer
Power on     |  Delay 25A      |
                                                     o  128 s       o     delay
Scan and record|
                                       ______        o  256 s       o     times
    Cycle on|  Delay 24A          |
                                                     o  None        o
                   |         Time

        Timing diagram                      Switch values--socket 24A or 25A
```

Figure 5.--Timing diagram and switch values for socket 24A or 25A.

For a system with temperature and specific conductance, use the following delay times (fig. 6):

- A SIGNAL CONDITIONER power delay of 0 seconds set in 25A.

- A record delay of 4 seconds set in 24A.

Put the temperature SIGNAL CONDITIONER in channel 1 because this card stabilizes faster after power-up than the specific-conductance SIGNAL CONDITIONER.

Suggested delay times for other constituents are given in the sections entitled "Dissolved-oxygen range selection, calibration, sensor maintenance, and performance checks"; "pH range selection, calibration, and sensor maintenance"; "Voltage-input specifications, applications, and calibration"; "Ultrasonic Ranger specifications, installation, calibration, and water-stage calculations"; and "Operation of the Minimonitor with the LaBarge GOES data-collection platform."

```
  Time before SIGNAL
  CONDITIONER power                      Time before scan-and-
  is on.                                 record cycle starts.

  G              V                       G              V

  o  Not used    o                       o  Not used    o
 |                |                     |                |
O|o    OPEN      o |1                  O|o   CLOSED     o |1
P|                |                    P|                |
E|o    OPEN      o |2                  E|o    OPEN      o |2
N|                |                    N|                |
 |o    OPEN      o |3                   |o    OPEN      o |3

  o              o                       o              o

  o              o                       o              o

  o              o                       o              o

  o              o                       o              o

  o              o                       o              o

       25A                                    24A
```

NOTE: To close switches, press down on the numbered side opposite the side marked "OPEN."

Figure 6.--Switch settings for timing delays for a system with temperature and specific conductance.

Setting the Recording Interval

The switches on socket 26A of the **PROGRAMMER** board set the recording interval. Each switch on 26A has a value in minutes as shown in figure 7. Close the switches so that the sum of all the closed switches equals the desired time interval. Closing the 8- and 4-minute switches at the same time will result in an illegal number.

Socket 26A

```
  ___________      ___________      ___________      ___________      ___________
 |o 1 min o |1    |o CLOSE o |1    |o CLOSE o |1    |o OPEN   o |1   |o OPEN   o |1
 |          |     |          |     |          |     |          |     |          |
 |o 2 min o |2    |o OPEN   o |2   |o OPEN   o |2   |o OPEN   o |2   |o OPEN   o |2
 |          |     |          |     |          |     |          |     |          |
 |o 4 min o |3    |o CLOSE o |3    |o CLOSE o |3    |o OPEN   o |3   |o OPEN   o |3
O|          |    O|          |    O|          |    O|          |    O|          |
P|o 8 min o |4   P|o OPEN   o |4  P|o OPEN   o |4  P|o OPEN   o |4  P|o OPEN   o |4
E|          |    E|          |    E|          |    E|          |    E|          |
N|o 10 min o|5   N|o OPEN   o |5  N|o CLOSE o |5   N|o CLOSE o |5   N|o OPEN   o |5
 |          |     |          |     |          |     |          |     |          |
 |o 20 min o|6    |o OPEN   o |6   |o OPEN   o |6   |o CLOSE o |6    |o CLOSE o |6
 |          |     |          |     |          |     |          |     |          |
 |o 40 min o|7    |o OPEN   o |7   |o OPEN   o |7   |o OPEN   o |7   |o CLOSE o |7

   o None   o       o None   o       o None   o       o None   o       o None   o

 Switch Values        5 min            15 min           30 min           60 min
```

NOTE: To close switches, press down on the numbered side opposite the side marked "OPEN."

Figure 7.--Recording intervals.

Setting Ranges on Signal Conditioners

When the Minimonitor can is open, the desired ranges may be set on SIGNAL CONDITIONERS. Ranges can be set on SIGNAL CONDITIONERS for measuring specific conductance, DO, pH, and voltage. To set the ranges, refer to the specific sections in the manual associated with range selection of the individual constituents desired.

Changing Fuses

Two 0.5- and 1.5-ampere, AGC-type fuses are used to protect Minimonitor circuitry. When replacing fuses, be sure that the correct replacement sizes are used and are put in the proper place.

Older models have fuses, 0.5 and 1.5 ampere, located on the MUX board (fig. 8). This requires opening the Minimonitor to replace the fuses.

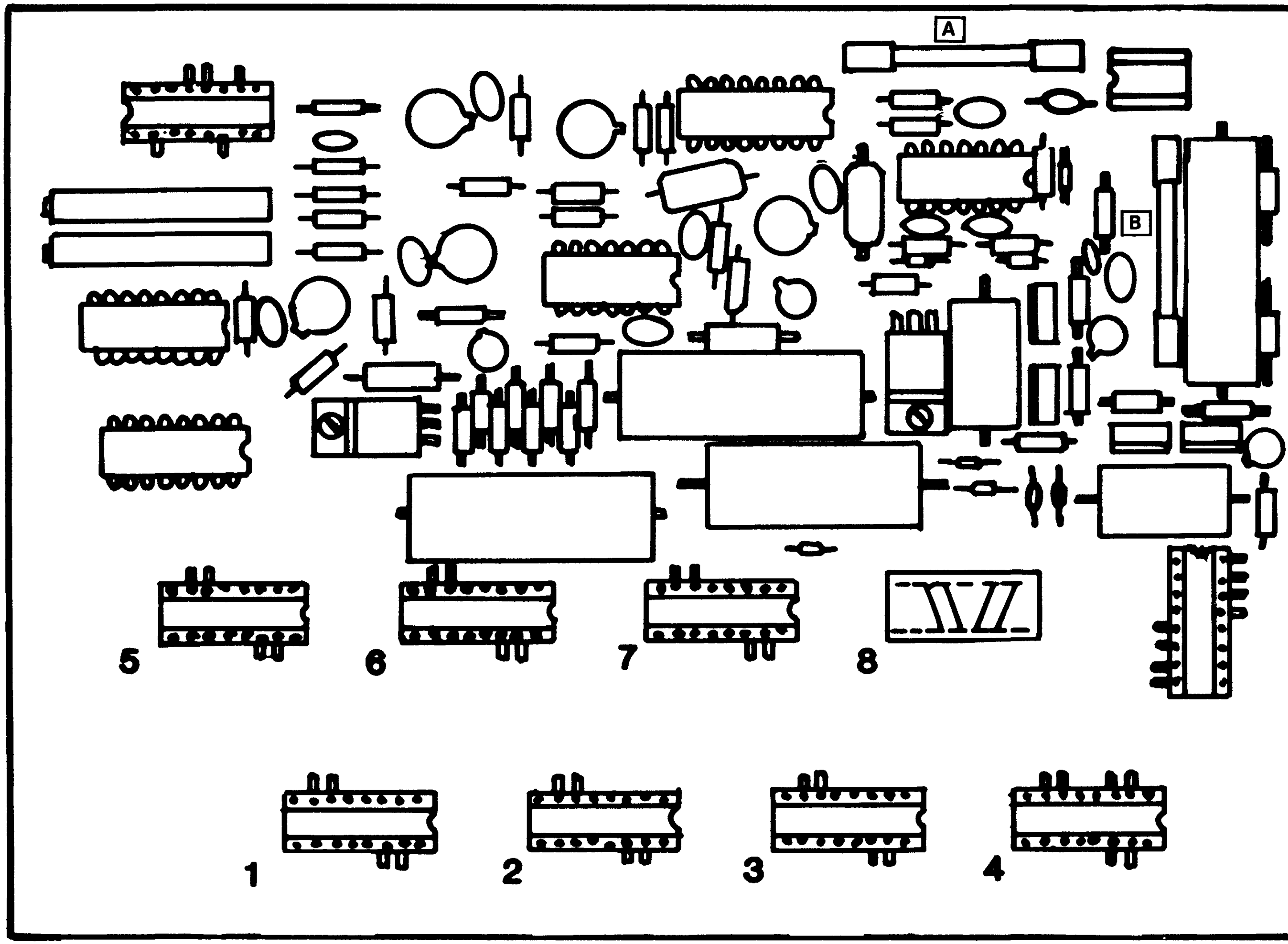


Figure 8.--Multiplexer board.
A.-Fuse--1.5 ampere on older models only
B-Fuse--0.5 ampere on older models only
1 through 8--Signal-conditioner input sockets

Newer models have fuses located in waterproof fuse holders on the lid of the Minimonitor (fig. 9). Fuse holder caps must be unscrewed to replace the fuses. Screw the caps on tightly after replacing the fuses.

Do not substitute fuses of larger values than those indicated because this may result in serious damage to the Minimonitor.

WARNING: TURN OFF POWER WHILE REPLACING FUSES.

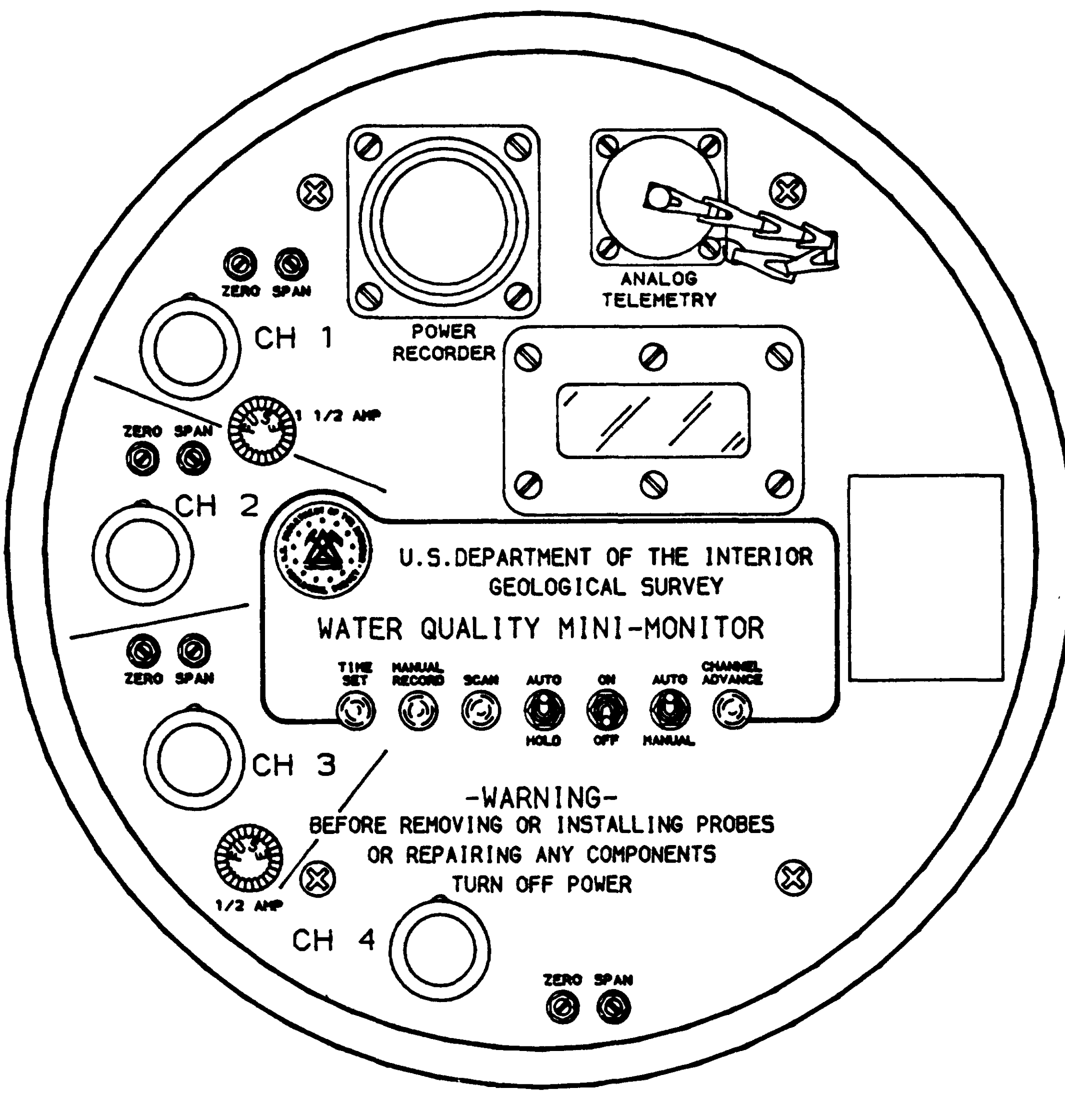


Figure 9.--Minimonitor front panel.

Battery-Check Feature

The battery voltage may be read on the DISPLAY as follows:

1. Turn on the monitor.

2. Set the AUTO-MANUAL switch to the MANUAL position.

3. Use the CHANNEL ADVANCE switch to advance the monitor to the last channel.

4. Now press and hold down the CHANNEL ADVANCE switch.

To determine the battery voltage, add 007 to the DISPLAY value and divide the sum by 10. For example, a reading of 113 indicates 12.0 volts on the battery. A reading on the DISPLAY of less than 093 indicates that the battery voltage is too low and that incorrect data are being read. The battery voltage must not fall below 10.0 volts. The bottom board on the Minimonitor lid assembly is the MUX board (fig. 8). A battery test module normally is plugged into the 16-pin socket marked 8. To record the battery voltage, this battery test module must be removed from the number 8 socket and plugged into the next highest numbered socket after the last one used. For example, if channel 1 and channel 2 are being recorded, plug the module into the number 3 socket. Set the shunt bar in socket 29A on the PROGRAMMER board for an additional channel; in this case, channel 3. Battery voltage will be recorded in the channel 3 position on the paper tape. Calculate the battery voltage from the channel 3 DISPLAY in the same way as described above. In this case, holding the CHANNEL ADVANCE switch down after channel 3 will no longer indicate the battery voltage on the DISPLAY.

Removing or Adding Circuit Boards

NOTE: The HIF will not be responsible for damage caused by improper connection of circuit boards. To ensure proper installation of circuit boards, return the unit to the HIF.

The following steps outline the procedure for adding or removing circuit boards:

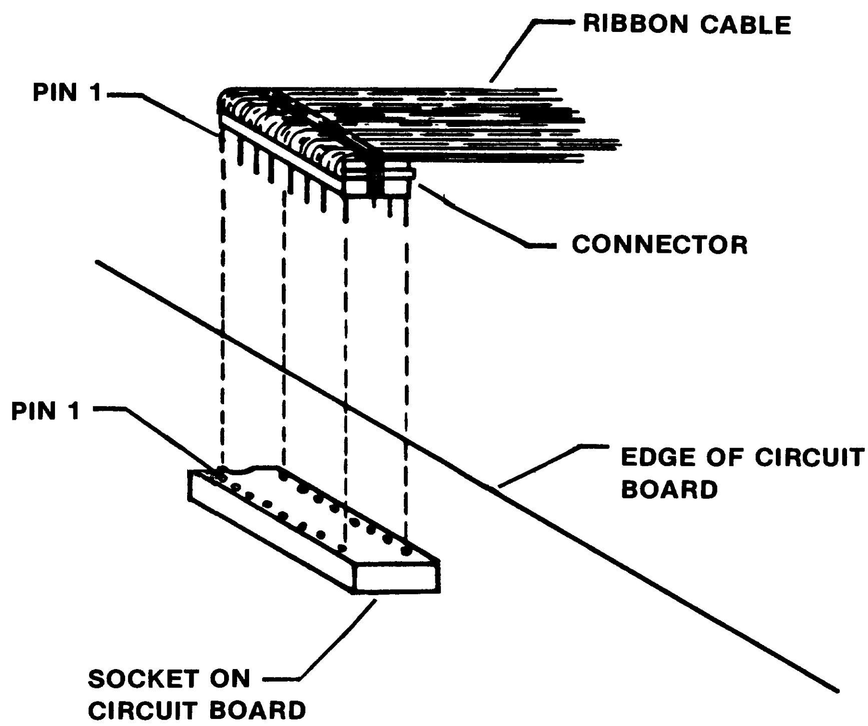
1. Turn off the power. Open the can as directed in the preceding section.

2. If a SIGNAL CONDITIONER is being replaced, disconnect the two connectors that are plugged into it. **Be very careful not to bend the pins on the 16-pin connectors.** Pry the connector loose with a small screwdriver before pulling on the connector. Wedge the screwdriver between the socket and the connector to loosen the connector.

3. Remove the board retainers and slide out the SIGNAL CONDITIONER. On the earlier assemblies, the circuit boards are mounted with screws through angle brackets that have to be removed in order to remove the SIGNAL CONDITIONER.

4. Slide the new SIGNAL CONDITIONER into the desired position. The board retainers may be mounted temporarily from the back side of the mounting screws. This provides a finger grip to aid in installation. First insert the edge of the circuit board with the socket labeled "SENSOR." The opposite edge with the socket labeled "MUX" will then be on the same side as the eight channel sockets on the MUX board. Replace the board retainers. On earlier assemblies, mount the new SIGNAL CONDITIONER by fastening the angle brackets to the mounting frame in the desired location.

5. Connect the socket on the SIGNAL CONDITIONER labeled "MUX" to the desired channel socket on the MUX board. The channel sockets are numbered 1 through 8. Use a ribbon cable assembly with a 16-pin connector on each end. Plug the ribbon cable connector into the socket on the circuit board as shown in figure 10.



WHEN PLUGGING A RIBBON CABLE CONNECTOR INTO A SOCKET ON A CIRCUIT BOARD, ALIGN PIN 1 ON THE CONNECTOR WITH PIN 1 ON THE SOCKET AS SHOWN IN THE ABOVE FIGURE. WHEN PROPERLY INSTALLED THE CABLE EXTENDS AWAY FROM THE CIRCUIT BOARD. BE SURE THAT EACH PIN IS STRAIGHT AND ALIGNED WITH ITS SOCKET HOLE BEFORE APPLYING PRESSURE TO PLUG IN THE CONNECTOR.

NOTE THAT PIN 1 ON THE SOCKET IS INDICATED BY THE NOTCH AT ONE END.

Figure 10.--Connection of ribbon cable.

6. Plug the ribbon cable connector from the sensor connector on the cover into the socket on the SIGNAL CONDITIONER labeled "SENSOR." Plug in the connector as shown in figure 10. Be sure to connect the SIGNAL CONDITIONER to the sensor connector associated with the desired channel.* Mark each sensor connector on the cover to identify the constituent being measured. Earlier assemblies do not have ribbon cables from the sensor connectors. Instead, a bundle of wires from the trimpots and each sensor connector is soldered to a 16-pin connector. Plug in connectors so that the higher numbered pins on the connector are on the side of the socket closest to the edge of the circuit board.

7. Verify that the settings for the number of channels and the delay times on the PROGRAMMER are correct for the SIGNAL CONDITIONERS used.

***CAUTION:** Once the desired delay times and range have been set, prepare the DO sensor and stirrer in accordance with the Yellow Springs Instrument Company (YSI) instructions included in the section "Dissolved-oxygen range selection, calibration, sensor maintenance, and performance checks."

After the sensor and stirrer have been properly prepared, connect the sensor cables to the Minimonitor and calibrate, using the following precautions:

- Ensure that connectors are properly aligned and that the proper channel is being used. (If the SENSOR is connected to a channel having a different SIGNAL CONDITIONER, damage may result.)

- Ensure that adhesive labels to identify channels have been provided.

- Attach the labels to the connectors to help prevent misidentification and possible connection to the wrong channel.

Desiccant

The Minimonitor contains packets of silica gel desiccant material, which prevents moisture buildup in the electronics package. When the monitor is opened for any reason, replace the old desiccant with dry desiccant. The old desiccant can be dried by heating it in an oven at 245 to 260 °F for 12 hours. After drying, store the packets of desiccant in a sealed container to prevent the absorption of moisture from the air.

Closing the Minimonitor

Set the cover assembly back into the can, being careful not to pinch any wires between the cover and the can. Check that the rubber seal in the lid rim is in the proper position. Replace the locking ring and fasten with the bolt or bolts. On models with a single bolt, the locking ring is put on the can by starting on one side and carefully working the ring around the edge of the can.

CONNECTING THE MINIMONITOR FOR OPERATION

Installing the Sensors

Because each site is different, only general suggestions on sensor mounting will be made. Consult U.S. Geological Survey Open-File Report 83-681, "Guidelines for Use of Water Quality Monitors," for more detailed information. Methods of mounting the sensors must be tailored to fit each particular site. Sensors may be protected from silting-in and from damage caused by debris, freezing, vandalism, or other causes. Sensors should be accessible under all river conditions.

The sensors may be held in place by a stainless- or galvanized-steel rod or bracket and anchored to the holding device with hose clamps of the same noncorrosive material. These sensors may be slid down the pipes. Mount the sensors so they can be removed easily for cleaning and calibration during any stream conditions. The cables may be routed to the gage house through a plastic pipe or conduit. The maximum length of cable from the sensors to the monitor is 1,000 feet. In cold weather, the rubber connectors become hard, making them difficult to pull apart.

Sensor Cables and Connectors

Sensor cables and connectors are identical for all parameters, which allows interchangeability of these parts. However, it is possible to plug the wrong sensor into a SIGNAL CONDITIONER, causing damage to the sensor or the electronics. Mark the cables to help prevent improper connections. Many of the Minimonitors have the SENSOR CONNECTORS marked with special tape as follows: TEMP, COND, DO, PH. This marking tape is available upon request from the HIF warehouse. The connectors have an alignment marking on the outside body. When mating the connectors, align these marks and push the connectors together. Figure 11 shows the sensor cable connector.

CAUTION: Forcing the connectors together without aligning the marks can damage the connectors and may electrically harm the SIGNAL CONDITIONER or sensor. After the connector is properly mated, the locking sleeves can be screwed together. **NOTE:** A thin film of electrically nonconductive silicone grease, spread on the connector bodies helps the connectors work easier. Avoid getting grease on the pins.

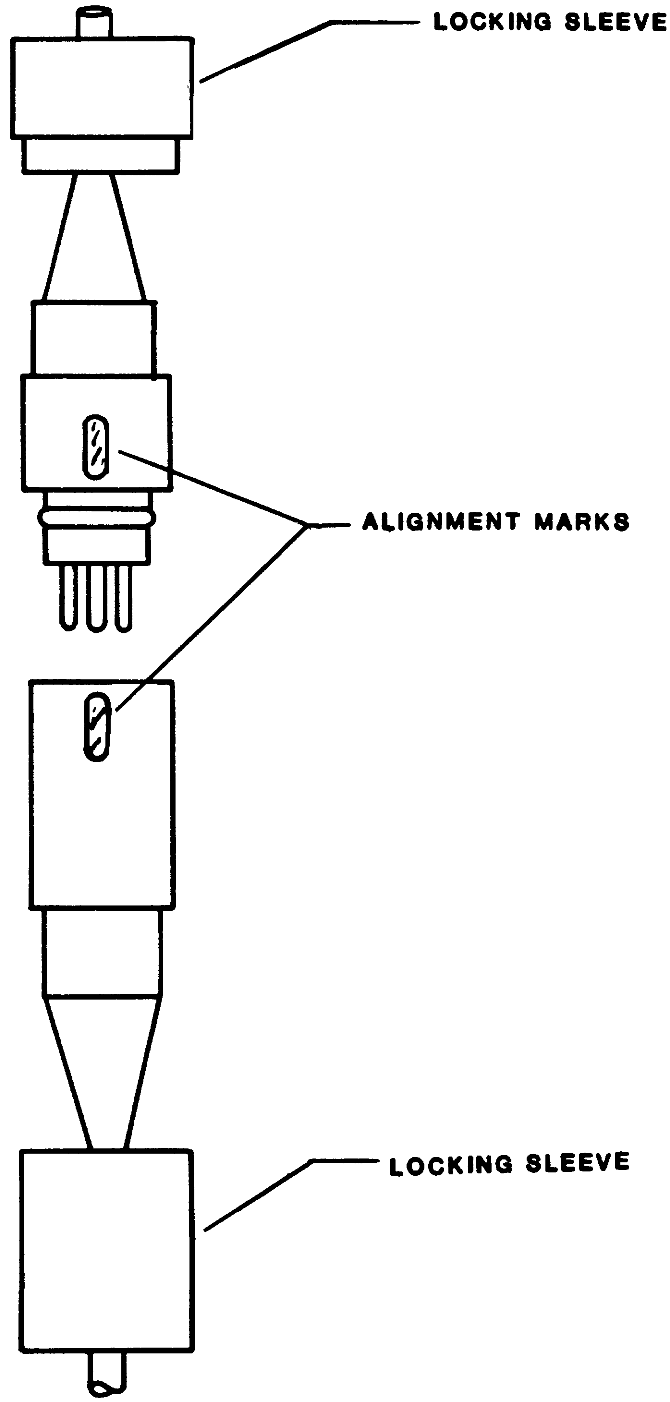


Figure 11.--Sensor cable connector.

Final Connection of Cables

Complete the final connections as follows:

1. Connect the sensor cables to the monitor as described in the section entitled "Sensor Cables and Connectors." Check that the sensors are plugged into the channels that correspond to the matching SIGNAL CONDITIONER. Always turn off or remove power from the unit before installing or removing the sensors or other connectors.

2. Connect the power-and-recorder cable assembly (fig. 12) to the Minimonitor and to a Leupold and Stevens digital input-output recorder.

3. Make sure that the ON-OFF switch is toggled to OFF. Connect the power leads to a 12-volt dc power source. The monitor is now ready for operation.

Power Source

Power the Minimonitor from a 12-volt, dry-cell, lead-acid battery or a dc power supply. The power source must be able to supply a minimum of 2 amperes for the time that the recorder runs. Two 6-volt, dry-cell batteries or rechargeable 12-volt, lead-acid batteries can be used. A solar panel may be used to charge the batteries. Contact the HIF for information.

CAUTION: Never use two 7.5-volt batteries or a 15-volt battery because the actual voltage of these batteries may exceed 15 volts and damage the monitor.

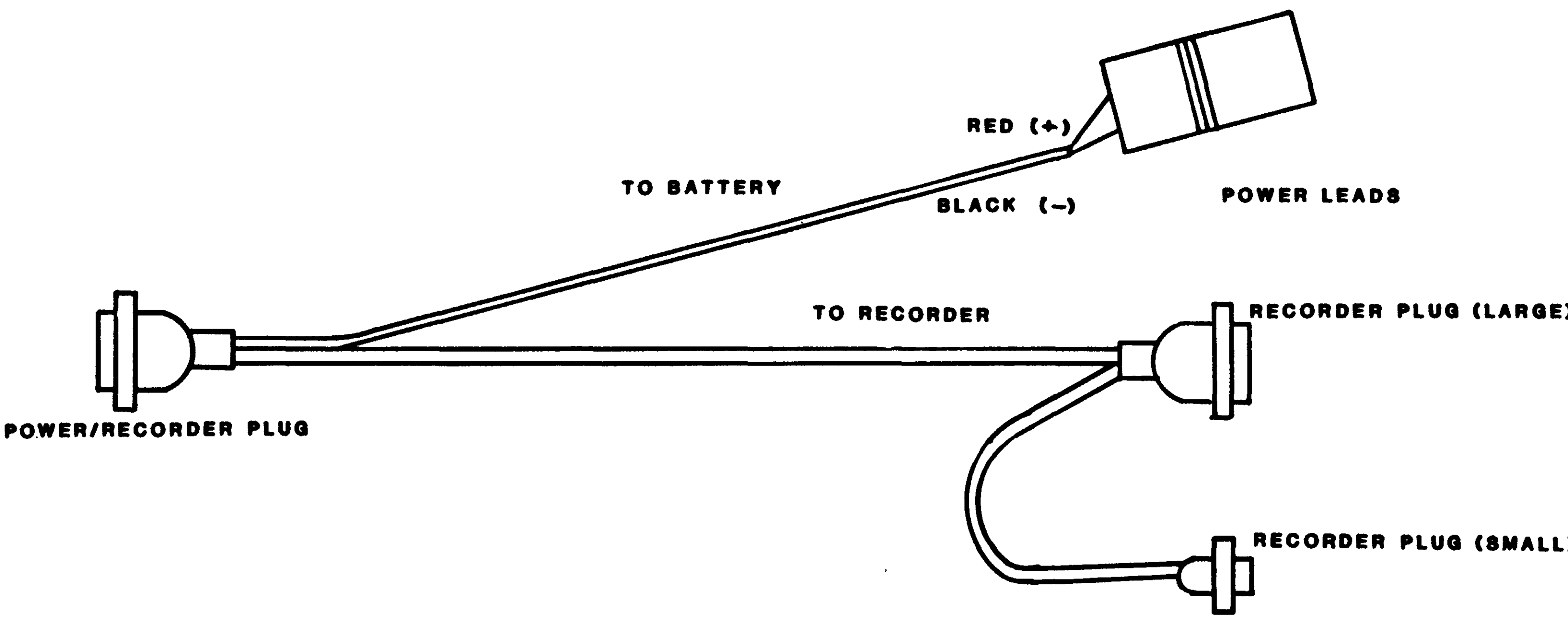


Figure 12.--Power-and-recorder cable assembly.

OPERATION OF THE MINIMONITOR WITH THE LABARGE GOES DATA-COLLECTION PLATFORM

The Minimonitor has been designed to interface with the LaBarge data-collection platform. For operation with the platform, set the following switches to the closed or ON position on the PROGRAMMER card (fig. 3): 26A6, 26A7, 25A3, 25A4, 24A4, and 24A5. All other switches on 24A, 25A, and 26A are open. For more information, see the sections on "Delay Times" and "Setting the Recording Interval." These switch settings will cause the Minimonitor to come on once an hour, wait 48 seconds, turn on the SIGNAL CONDITIONERS, wait 48 seconds more, and record. See the timing diagram, figure 21. Delay times are shown in figure 22.

To connect the Minimonitor to other satellite data-collection platforms, please contact the Electronics unit of the Field Service and Supply Section at the HIF for information.

```
                                                   |
                                                   |______________   Anl. data taken
                                                   |80 s          |________________
GOES 12-V output                             ______| (approximate)
                                                   |
                                                   |______________   Record starts
                                                   |96 s          |________________
Minimonitor scan                             ______|
                                            |         ________
SIGNAL CONDITIONER power              ______|48 s_____|        |____________
```

Figure 21.--Timing.

```
     o        o              o        o            o        o
    __________                ________            __________
 O|_o Open   o_|1         '  o        o  1     '|o  Open   o|1
 P|            |          '  ________          '|           |
 E| o Open   o |2         O|_o Open   o_|2     '|o  Open   o|2
 N|            |          P|            |      '|           |
 '|_o Close o__|3         E| o Open   o |3     O|o  Open   o|3
 '|            |          N|            |      P|           |
 '|_o Close o__|4         '|_o Close  o_|4     E|o  Open   o|4
 '                        '|            |      N|           |
 '   o        o  5        '|_o Close  o_|5     '|o  Open   o|5
 '                        '                    '|           |
 '   o        o  6        '  o        o  6     '|o  Close  o|6
 '                        '                    '|           |
 '   o        o  7        '  o        o  7     '|o_ Close _o|7

     25A                      24A                  26A
```

Figure 22.--Delay Times.

The 10-pin analog telemetry jack connects to the platform as follows:

Minimonitor pin	Function	Platform pin
A	Channel 1 out (0 to 5 volts)	j
B	Channel 2 out (do)	z
C	Channel 3 out (do)	m
D	Channel 4 out (do)	N
E	Channel 5 out (do)	AA
F	Channel 6 out (do)	T
G	Channel 7 out (do)	U
H	Channel 8 out (do)	n
I	Analog ground	P
J	12 volts switched from platform	A

After setting the monitor for the proper delays and hooking up the telemetry, perform the following test to verify that the system is working properly:

1. Set the platform on a 6-minute data-acquisition cycle.

2. Advance the Minimonitor through all of the channels and back to 0.

3. Set the Minimonitor time on the DISPLAY to 01.

4. When the 12 volts on the platform activate, the Minimonitor time will reset to 00. Approximately 80 seconds later, the platform will take in the analog data. Ninety-six seconds after the time resets, the scan-and-record cycle will start.

5. The sequence in step 4 will repeat every 6 minutes. One can verify the analog data by reading the data stored in the platform through the platform-test set.

6. When the test is complete, return the platform to its 1-hour data-acquisition time.

To put the system into operation, proceed according to the steps listed:

1. Set the platform to the correct time and set the platform data-acquisition time and Minimonitor recording interval to the same desired length.

2. Advance the Minimonitor through all of the channels and back to zero using the CHANNEL ADVANCE switch.

3. Set the Minimonitor time to 00 on the DISPLAY.

4. The Minimonitor will be triggered by the next data-acquisition cycle of the platform. This will keep the Minimonitor's clock synchronized with the platform's clock.

Table 7 shows the delay times for the programmer when operating on a LaBarge GOES platform when the Minimonitor has a DO system. This table applies when the Minimonitor is operated on a LaBarge GOES platform.

Table 7.--Delay times for programmer when operating on a LaBarge GOES platform with a dissolved-oxygen system on the Minimonitor

DO Sensor Membrane thickness in mils	Time delays to set in seconds on the PROGRAMMER	
	Switch 25A	Switch 24A
1	64	96
[a]2	160	224

[a] For a 2-mil membrane, set the monitor record interval 2 minutes less than required. Example: For a 60-minute record interval, set the monitor record interval to 58 minutes.

U.S. Geological Survey Minimonitor, Analog-Voltage Model

The analog-voltage model of the U.S. Geological Survey minimonitor is a modification of the punched-paper-tape model. The "mux" and "programmer" cards have been removed (fig. a). The functions of these two boards have been eleminated or included in the new "Analog/Power" card (fig. b). The analog-voltage model cannot be programmed; it is controlled by a data logger/recorder or DCP. The data logger/recorder or DCP must send a control/turn-on signal to the minimonitor and maintain the signal until the data are received from the minimonitor. Delays or warm-up time must be programmed into the data logger/recorder or DCP, depending on the type of sensors being monitored.

The front panel of the analog-voltage model (fig. c) has also been changed. There is no display and only two switches, an ON/OFF switch and an AUTO/MAN switch. With no front-panel display on the monitor, all calibrations and parameter readings must be made using the data logger/recorder, DCP or voltmeter. With the ON/OFF switch in the OFF position, all power is disconnected from the monitor. Toggle this switch OFF when changing sensors or fuses. With the AUTO/MAN switch in the MAN position, the SIGNAL CONDITIONERS are turned ON and remain ON until the switch is toggled to the AUTO position. When leaving the station, the AUTO/MAN switch must be set in the AUTO position, otherwise the SIGNAL CONDITIONERS remain on and the batteries discharge much faster than normal.

There are two connectors on the front panel, a 4-conductor POWER/RECORDER plug and a 10 conductor ANALOG/TELEMETRY socket. The POWER/RECORDER connector is for the 12-volt dc power source (fig. d); later the SDI-12 will be added through this same connector. The analog/telemetry connector provides a 0- to 5-volt analog output for each (up to eight) channel when the SIGNAL CONDITIONER power is ON. The ANALOG/TELEMETRY CONNECTOR also contains the CONTROL/TURN-ON input port. This port must be connected to the data logger/recorder or to the DCP's control output. Socket locations, which correspond to the channels as shown below, are shown in figure e.

Socket	Channel	Function
A	1	Channel 1 out (0 to 5 volts)
B	2	Channel 2 out (do 0
C	3	Channel 3 out (do 0
D	4	Channel 4 out (do 0
E	5	Channel 5 out (do 0
F	6	Channel 6 out (do 0
G	7	Channel 7 out (do 0
H	8	Channel 8 out (do 0
I	Analog ground	Analog Ground
J	Control/turn on	Control/turn on

The only internal settings required with the analog/voltage model are located on the SIGNAL CONDITIONER CARDS. These settings are for selecting the proper ranges on the specific-conductance, dissolved oxygen, and pH cards. Instructions for setting the ranges on the SIGNAL CONDITIONER cards can be found in either of the above manuals.

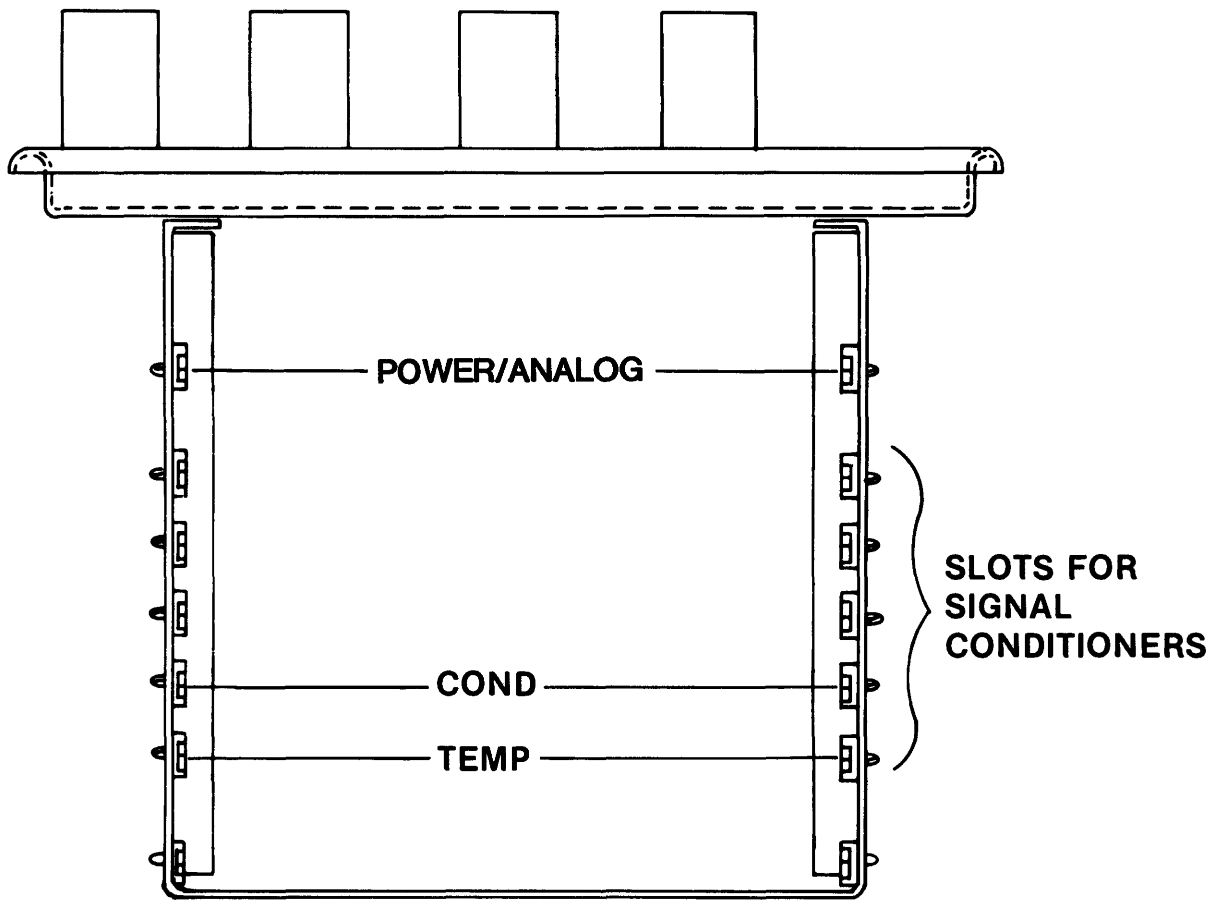


Figure A.--Minimonitor electronics assembly removed from can.

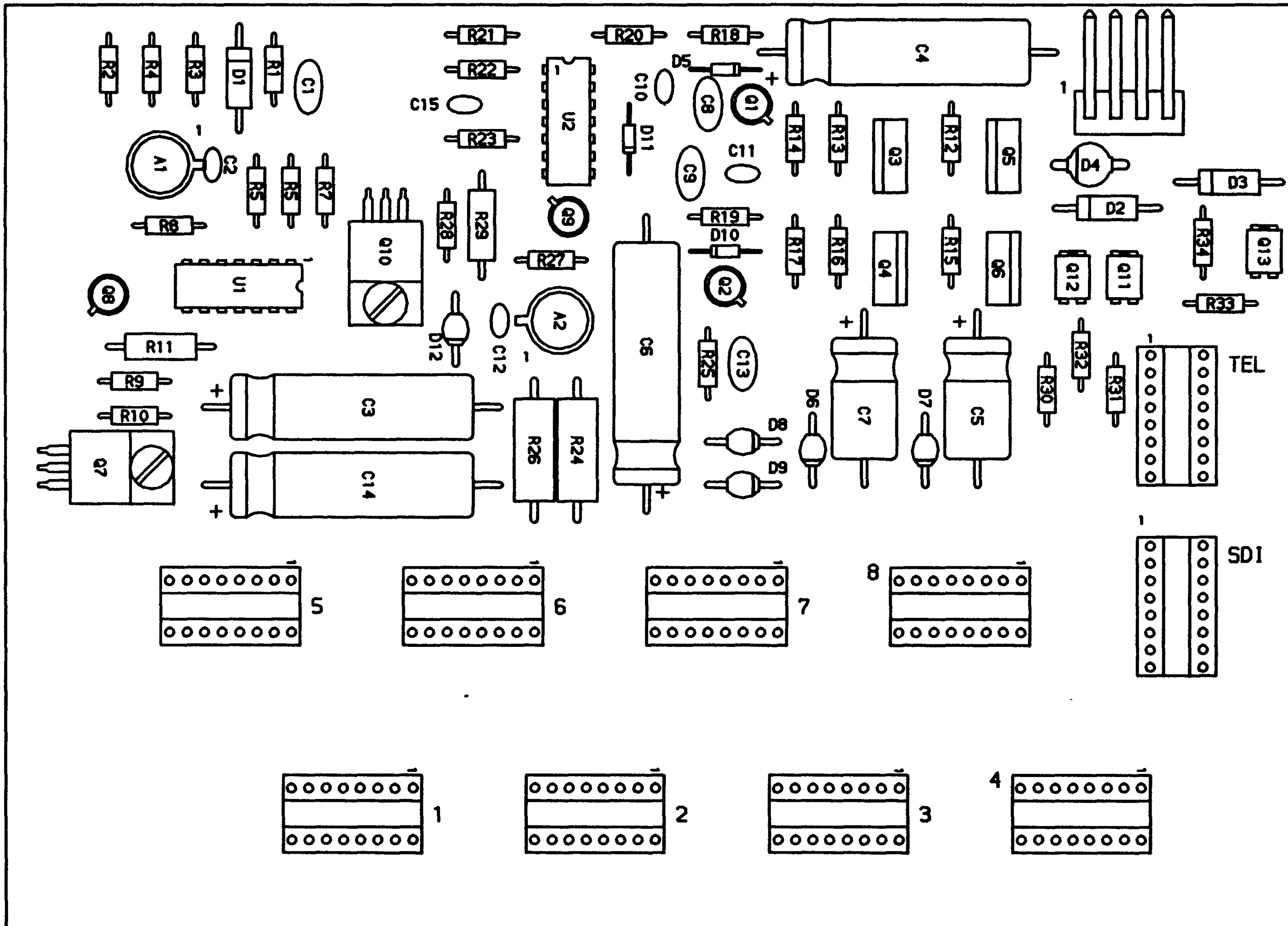


Figure B.--POWER/ANALOG board.
1 through 8--Signal-conditioner input sockets

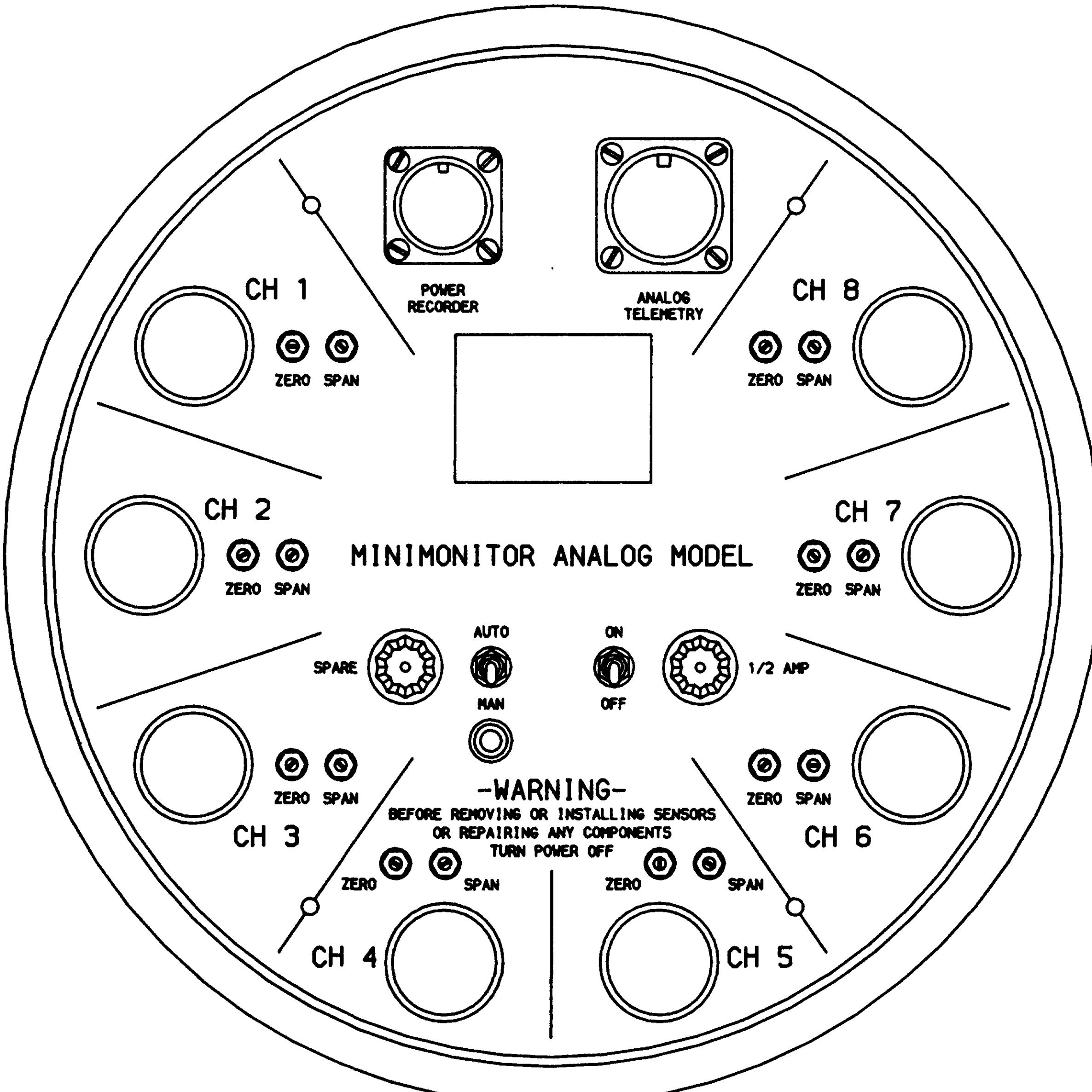


Figure C.--Minimonitor front panel.

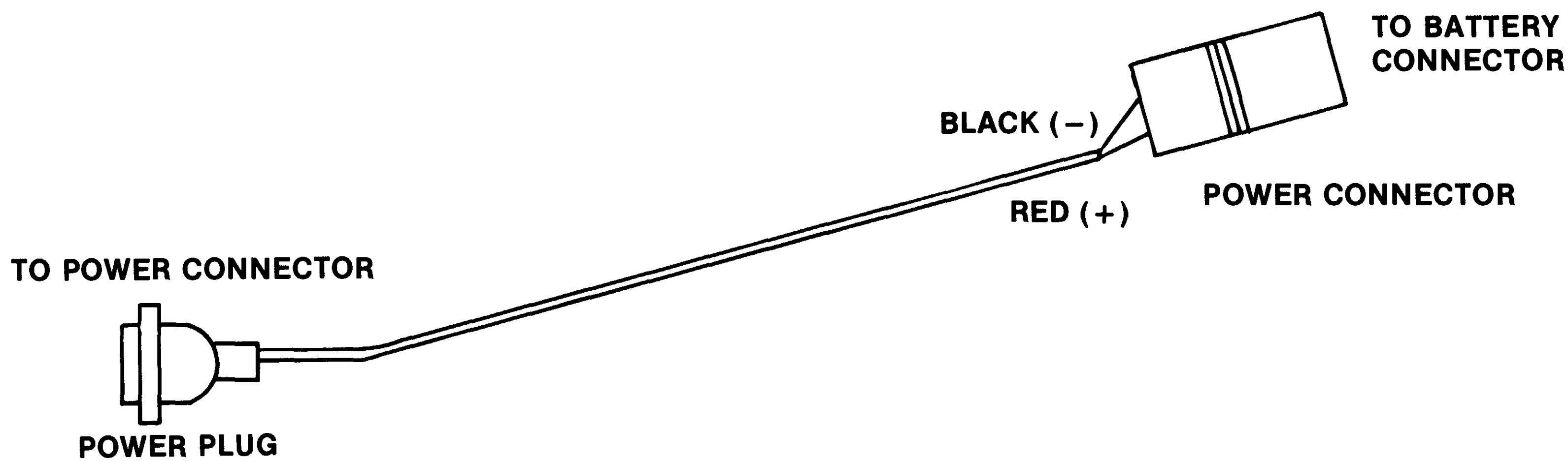


Figure D.--Power-cable assembly.

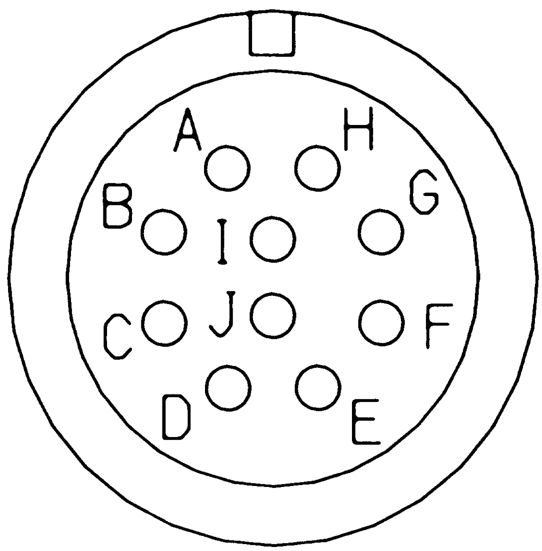
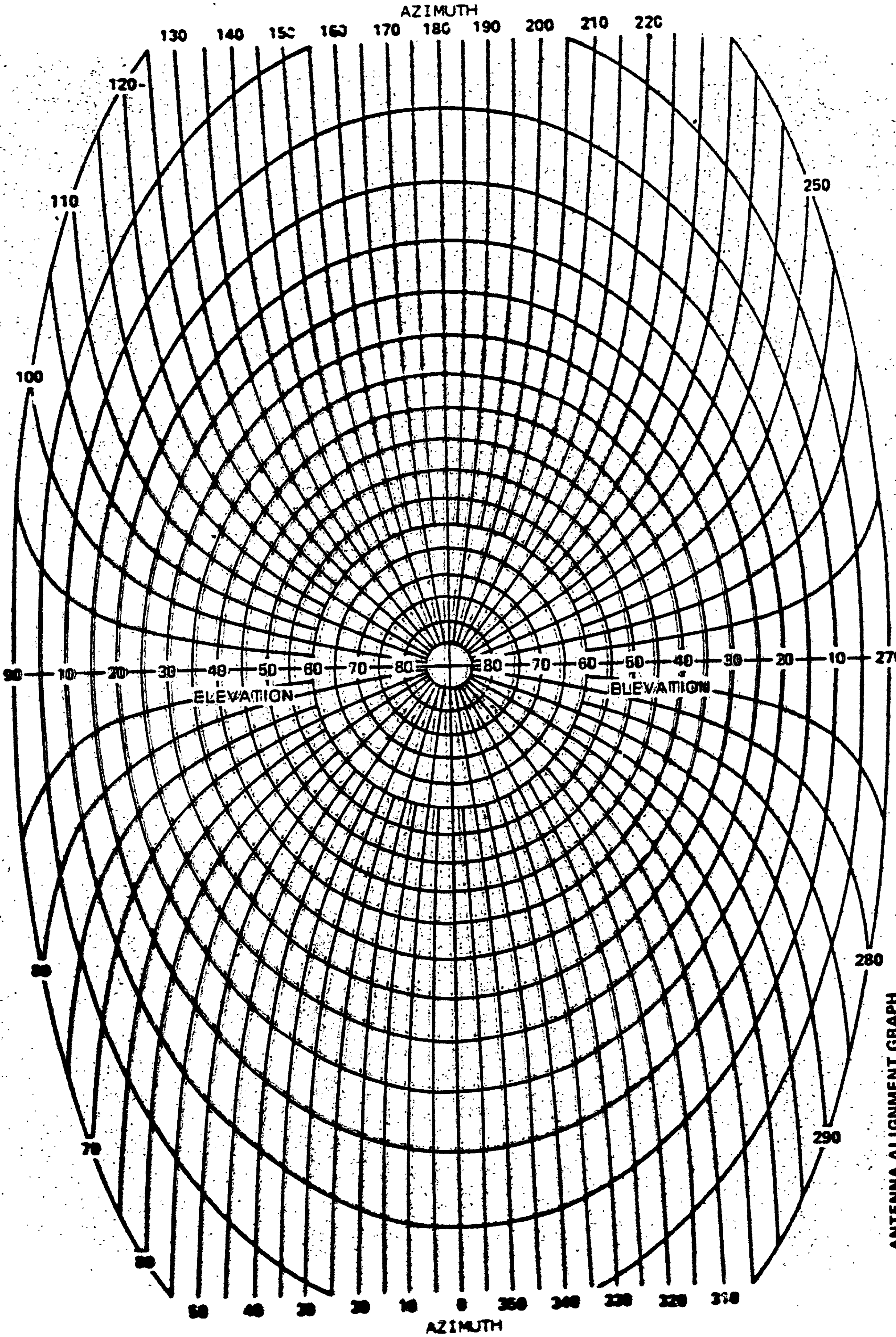


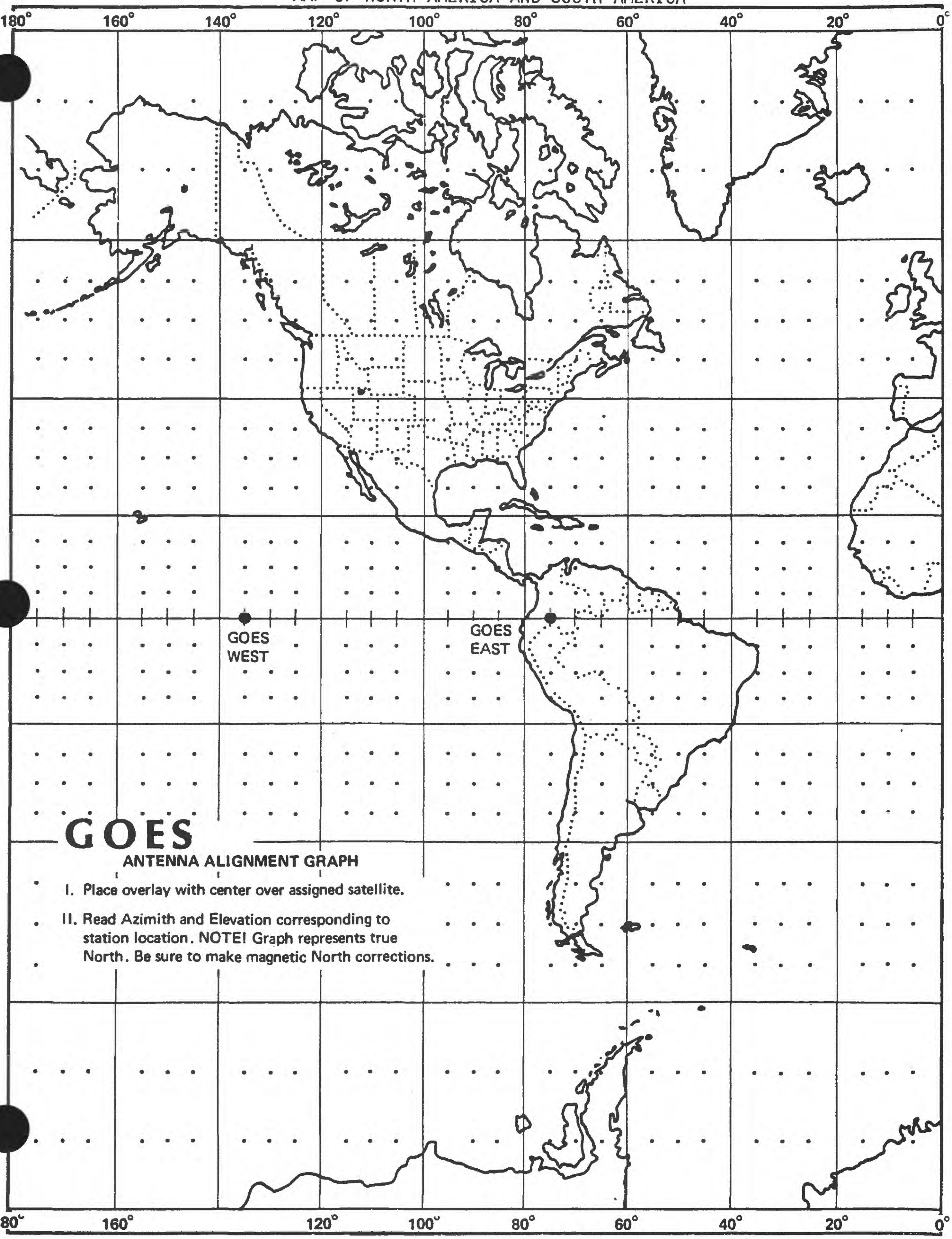
Figure E.--Top view of analog-telemetry connector and channel assignments.

APPENDIX F--ANTENNA ALIGNMENT GRAPH AND OVERLAY



ANTENNA ALIGNMENT GRAPH

MAP OF NORTH AMERICA AND SOUTH AMERICA



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APPENDIX G--DATA-COLLECTION PLATFORM--DIRECT READ-OUT GROUND STATION INFORMATION FORM

DCP/DRGS INFORMATION FORM

PERSON ID:*______________________ NODE:* ______
NAME:*______________________________
ADDRESS:*______________________
ADDRESS: ______________________
CITY:*____________ STATE:*______________ ZIP:*_____
AGENCY: _____
FTS PHONE:*___ ___ ____ NON-FTS PHONE:*___ ___ ____
PRIME DIRECTORY:*________________

**************************** STATION INFORMATION **************************

STATION NAME:*____
STATION NUMBER:*______________ LL SEQUENCE NUMBER: __
NEAREST CITY:*_______________
LATITUDE:* _______ LONGITUDE:*________
COUNTY CODE: ____ STATE CODE:* __ OWNER AGENCY: _____
DISTRICT ID: __ UTC TIME ZONE:* __ HYDRO UNIT CODE: _______
DRAIN AREA:_________ SITE ELEVATION:*________ ACCOUNT NUM:* ________

**************************** DCP INFORMATION ******************************

DCP NAME: ____________________
TRANSMIT INT:** __
ANTENNA AZIMUTH:* ____ ANTENNA ELEVATION:* __
PLATFORM MANUF:* __ PLATFORM MODEL:* ______
TRANSMIT TYPE:* __ NUMBER OF SENSORS:* __
ANTENNA HEIGHT ABOUT SITE:*__

**************************** SENSOR INFORMATION **************************

SENSOR
NUMBER:* __ __ __ __ __ __ __
TYPE :* _ _ _ _ _ _ _
PARAMETER
CODE :* ____ ____ ____ ____ ____ ____ ____
DESC : _____ _____ _____ _____ _____ _____ _____
UNITS : _____ _____ _____ _____ _____ _____ _____
EQUATION
A*X**B+C
A =:* _____ _____ _____ _____ _____ _____ _____
B =:* _____ _____ _____ _____ _____ _____ _____
C =:* _____ _____ _____ _____ _____ _____ _____
VALUE TYPE: ___ ___ ___ ___ ___ ___ ___
DATA TYPE :* _ _ _ _ _ _ _
NUMBER OF
CHARACTERS:* _ _ _ _ _ _ _
NEW VALUES:* ___ ___ ___ ___ ___ ___ ___
OLD VALUES:* ___ ___ ___ ___ ___ ___ ___
DEV UPD INT(HHMM):*____ ____ ____ ____ ____ ____ ____
XMT DLY INT(MMSS):*____ ____ ____ ____ ____ ____ ____

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