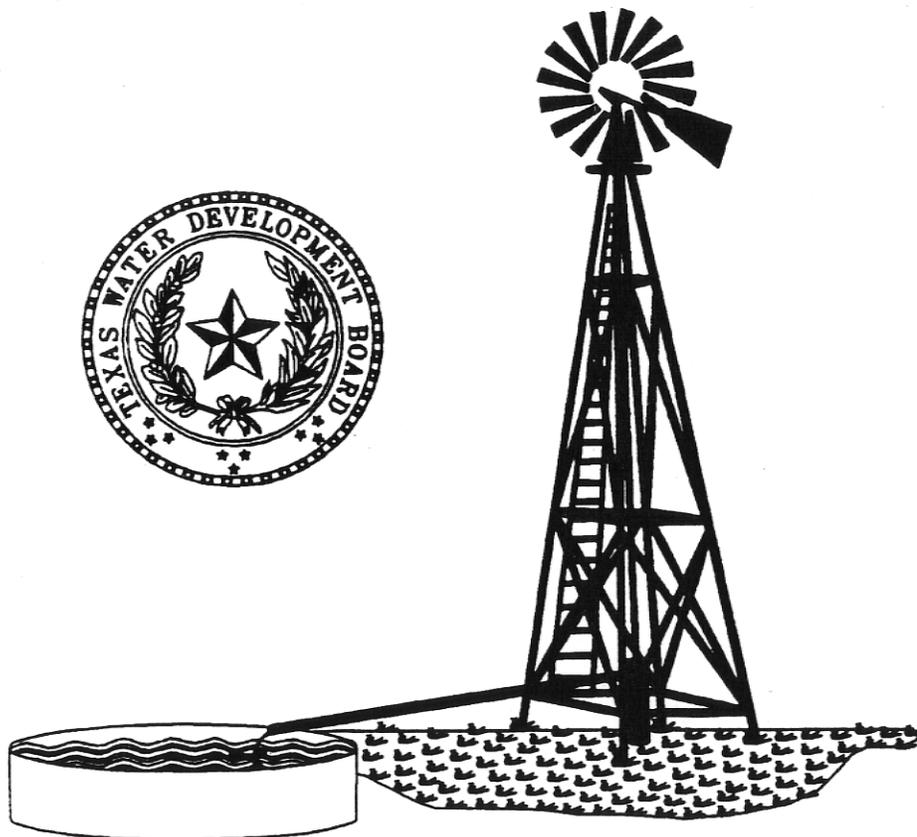# UM - 54

A FIELD MANUAL FOR SERVICING RECORDERS WITH DATA LOGGERS

by

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INTRODUCTION

The purpose of this manual is to provide an explanation of the installation, operation, and maintenance of the Stevens type A/F Data Loggers. The TWDB gratefully acknowledges help from outside agencies who help the TWDB maintain data loggers attached to recorders in more than 30 water-level observation wells throughout the state including the High Plains, Panhandle, Hill Country, Permian Basin, Glasscock, Lipan-Kickapoo, and Plateau Water Conservation Districts, and the Soil Conservation Service in Carrizo Springs. Hydrographs, included at the end of the manual, illustrate one of the most useful ways in which continuous water-level data can be displayed.

The A/F Logger is a solid-state data logger used with the Stevens Type A or F recorders. The A/F Logger is a single-input recorder which features removable memory data cards, permitting faster and more cost-effective data collection. The system encoder attaches to the A Recorder without disrupting the function of the recorder and records data while leaving the paper chart record intact.

The features of the A/F Logger include a large memory capacity in a removable module (data card), built-in display and keyboard, and a real time clock and calendar. The A/F Logger can operate in severe field environments and does not require a computer or terminal for setup in the field. The system (Figure 1) typically consists of an attachable incremental encoder (A/F Encoder), a logger in "Data Logger" mode, a logger in "Data Port" mode, and a removable data-card module. Selection between modes is made using the selector switches accessible on the bottom of the logger.
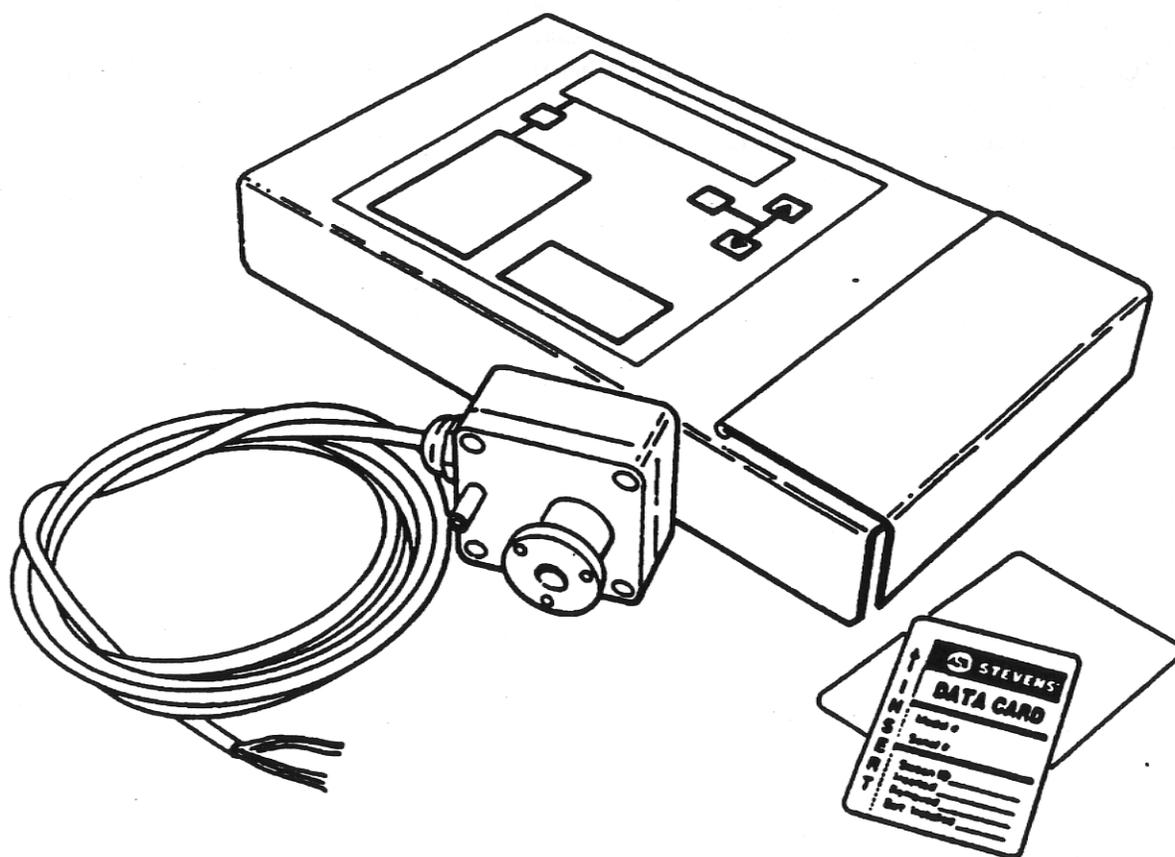

Figure 1. A/F Logger system

1

The A/F Logger is designed to provide single input electronic data logging to augment or replace the traditional paper-chart recording that is currently used with the Stevens type A Recorders. The primary function of the logger in Data Logger mode is to accept the single A/F Encoder input, convert it to water-level information, and maintain a water-level history in a removable data card. In addition, the logger software offers user interface via a four-key keypad and an eight-digit numeric display. The primary function of the logger's Data Port mode is to upload data from the removable data card modules to an IBM personal computer or compatible host via the serial channel. The Data Port mode erases the data cards after the water-level information is uploaded.

A/F Logger and Encoder Specifications

Serial Channel: Serial ASCII through RS-232 interface at a minimum of +5 volt levels. Provides telemetry of current level when the logger is configured in Data Logger mode. Provides total memory readout of the data card when the logger is in Data Port mode.

Format (fixed): 7 data bits, 1 stop bit, even parity

Power: 10-17 VDC

Current: Less than 5 mA DC, during normal recording. Logger in Data Logger mode enters a low current Sleep mode when no activity is required. (For an explanation of Sleep mode, see the technical notes section.)

Typical Battery Life: 45 days for 5 AH lead acid battery

Transformer Supply: For logger in Data Port mode: 120 VAC operation/12 VDC (0.2 A) wall plug. The logger in Data Port mode may be powered by a battery, but the unit will not go into a Sleep mode and will deplete the battery's energy.

In-line fuse: External 1/4 A, fast-acting, 3AG or equivalent.

Real-time Clock: Accuracy +3 minutes per month. Built-in leap year correction.

Display: Eight-digit numeric LCD. Integral four-key touchpad.

Encoder: Optical encoding with quadrature output. 400 increments per revolution. For use with 18-inch circumference pulley.

Operating Temperature: Operation and storage from 40° to +70° C.

Relative humidity: 0 - 95%, non-condensing

Size: 11 x 6-1/2 x 2 inches

Weight: Less than 3 pounds

INSTALLATION

Installing the A/F Logger

The A/F Logger can be used with Stevens type A Recorder units. Install the system as indicated in Figure 2. Refer to the operation section for information on the operation of the data logger.

Configuring the A/F Logger with the A Recorder

It is important not to lose any parts during installation. Please exercise appropriate care to avoid this problem. Refer to Figure 2 and complete the following procedures:

1. Remove the cable/tape from the float pulley on the recorder.

2. Remove the float pulley, and float pulley nut and washer. You may wish to save the nut and washer for future use.

3. Remove the wingnut from the under side of the recorder (under the pulley shaft). Install the encoder bracket and replace the wingnut.

4. Install pulley spacer (provided in kit).

5. Reinstall the float pulley.

6. Install new cup washer from installation kit.

7. Thread the A/F Encoder onto the pulley shaft.

8. Engage the lock pin at the base of the A/F Encoder in the slot of the encoder bracket.

9. Tighten securely (with fingers) the aluminum disk of the A/F Encoder onto the pulley shaft.

10. Secure the cable from the A/F Encoder to the bracket with a cable tie. If desired, the cable may be fastened to one of the recorder legs for additional strain relief.

11. Verify that the selector switches (refer to Fig. 3) on the Data Logger unit are set to the Data Logger mode and to the appropriate pulley size (English or metric).

    NOTE: Unit must be powered down if selector switches are changed.

12. Connect the four wires and shield from the A/F Encoder cable to the Logger I/O connector (see Figs. 4 and 5). If desired, the cable may be fastened to the Logger, using the tie wraps and adhesive pads (provided).

13. Connect the cable from the battery unit to the power cable which is attached to the Data Logger unit (see Figure 5).
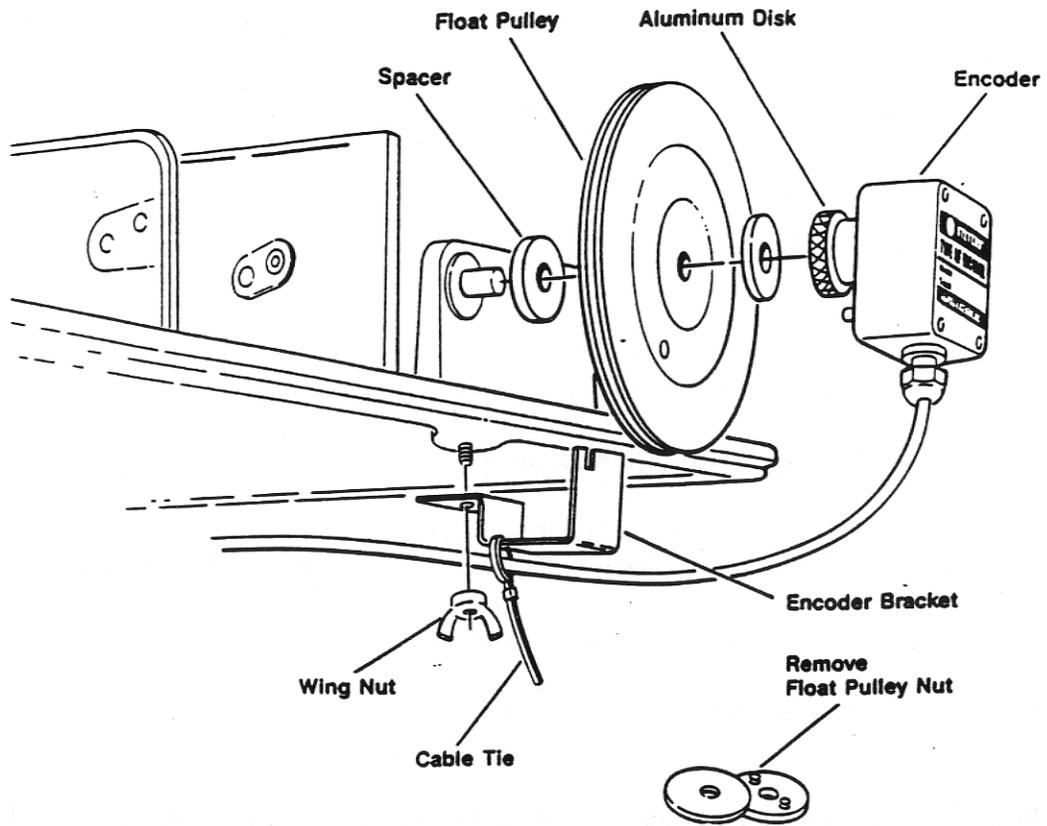
Figure 2. Installation on the type A Recorder

SWITCH SETTINGS

Note:
Change settings
only when power
is disconnected.

MODE		1	2
Logger, Normal		ON	ON
Logger, Cont. Display		OFF	ON
Data Port		ON	OFF
Reserved		OFF	OFF

SCALE		3	4	5
English		ON	ON	ON
Metric		OFF	ON	ON

BAUD RATE		6	7
300 Baud		ON	ON
1200 Baud		OFF	ON
2400 Baud		ON	OFF
9600 Baud		OFF	OFF

Figure 3. Selector switches

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Figure 4. I/O Connector orientation

To Encoder

Black (−)
Red (+)
White
Green

Black (−)
Rea (+)

-In-Line Fuse

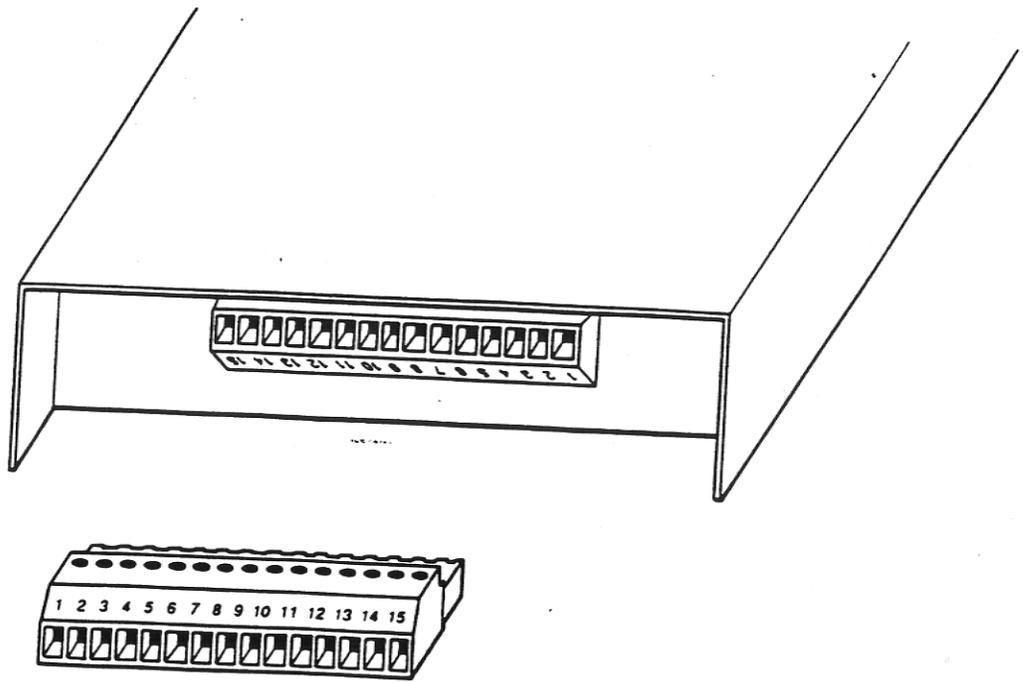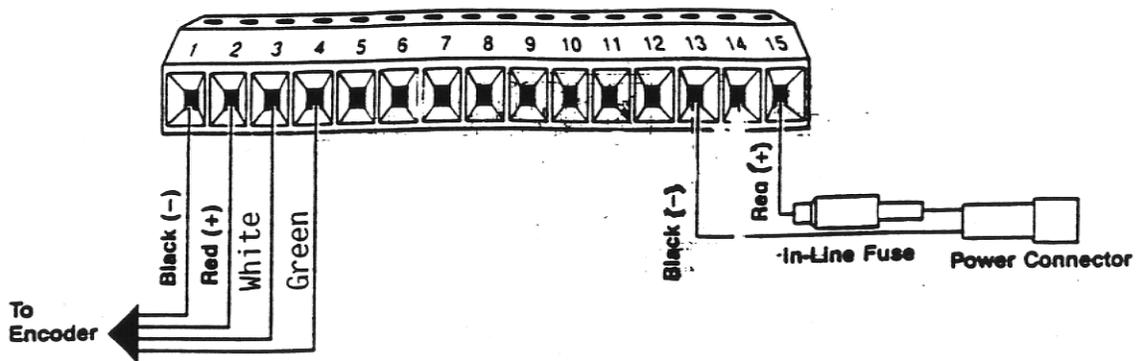Power Connector

Figure 5. Battery/Encoder wire connections

NOTE: Connections shown are for clockwise rotation of float pulley

OPERATION

The A/F Logger operates in two modes: Data Logger and Data Port. Selection between the two operations is made with a selector switch (see Fig. 3) in the unit's hardware. The primary function of the logger in Data Logger mode is to accept the single encoder input, convert it to water-level information, and maintain water-level history on the data card. The primary function of the logger in Data Port mode is to upload data from the removable data card to an IBM personal computer, compatible host, or printer. The logger in Data Port mode is used for erasure of the data cards before they are returned to the field. There are three interfaces in the A/F Logger system: encoder, keypad, and display.

Encoder Interface

The A/F Encoder interface is functional while in Data Logger mode only. The unit will not encode while in the Data Port mode. The encoder interface performs several functions including sampling, evaluating the resulting input, buffering the results in a hardware counter, and notifying the software when the counter limits have been reached. The system software reads the counter, converts the net encoder change to net water-level change, and updates the current water-level value in the software itself.

The logger supports a minimum of 500 updates per second, which meets or exceeds an equivalent rate of change of 2 ft/sec (English) with an 18-inch circumference pulley.

Keypad/Display Interface

Because the keypad and display functions are so closely related, they will be discussed together in this section. The keypad/display interface is a menu-driven system consisting of seven menu items. The items can be selected by pressing the SELECT MENU key. The digit on the left side of the numeric display always displays the current active menu. The next digit is blank. The remaining six digits, called the parameter field, display different types of information depending on the current active item. The keypad is only functional when the logger is in Data Logger mode.

Edit Mode

The parameter field can be edited in several of the menu items, although only one digit at a time may be edited. Digit selection should be done via the SELECT DIGIT key. By pressing the SELECT DIGIT key once, the user causes the first digit in the field to begin to flash. By pressing the key again, the user advances one digit to the right, skipping over any blanks and decimal points. If the SELECT DIGIT key is pressed when a flashing indicator is on the digit at the far right, the flashing indicator will return to the digit at the left. To increase or decrease the value of the selected digit, press the UP or DOWN arrow keys, respectively.

To store the modified parameter, press the SELECT MENU key. If the SELECT MENU key is not pressed and the unit goes into power-save mode, the unit will save the parameter if it is valid. Until that time, the originally displayed parameter will be used by the software, regardless of what is displayed.

The LEVEL Menu
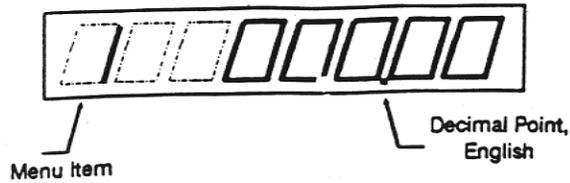
The LEVEL menu is displayed as "1." If the system is configured for English operation, then "XXX.XX" will be displayed in the parameter field, with the X's representing the current water-level in feet. The allowable range is 0 to 499.99 feet.
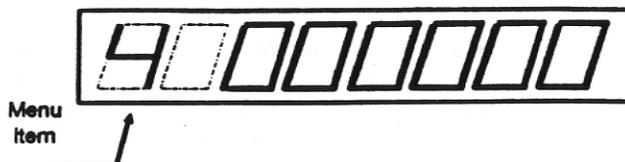
The TIME Menu
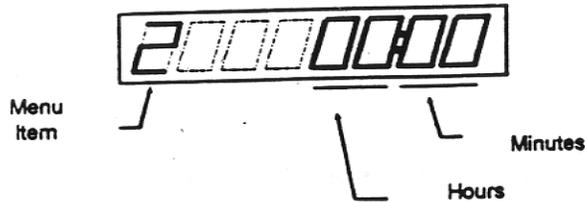
The TIME menu is displayed as "2." The parameter field will show "XX:XX," with the X's representing the current time in 24-hour format. The allowable range is 0 to 2359.

The YEAR/MONTH/DAY Menu
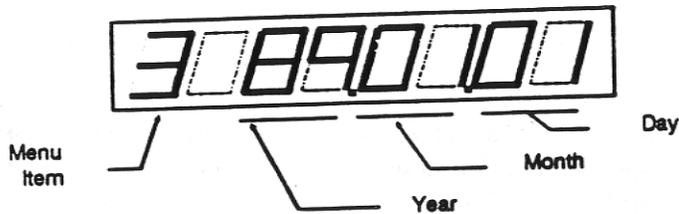
The YEAR/MONTH/DAY menu is displayed as "3." "YY.MM.DD" is displayed in the parameter field, with YY representing the current year, MM representing the current month, and DD representing the current day.

The IDENTIFICATION Menu

The IDENTIFICATION menu is displayed as "4." The parameter field will show "XXXXXX" with the X's representing the numeric ID of the unit. The allowable range is 000000 to 999999.

The TIME INTERVAL Menu

Menu Item | Hours | Minutes
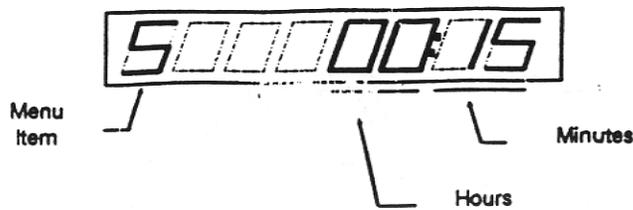
The TIME INTERVAL menu is displayed as "5." The parameter field will display "HH:MM," with HH representing the hour portion and MM representing the minute portion of the current time interval. The allowable time intervals are 1, 5, 6, 10, 15, 30, and 60 minutes. When the SELECT DIGIT key is pressed, the entire parameter field will flash, instead of flashing individual digits. Press the UP or DOWN arrows to increase or decrease the parameters.

The DAYS REMAINING Menu

Menu Item | Number of Days
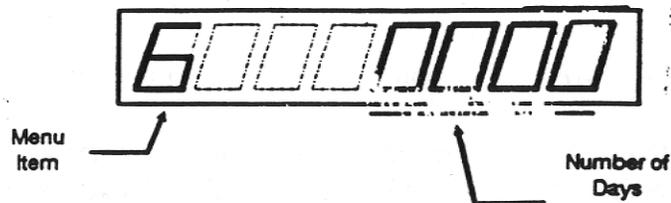
The menu digit for the DAYS REMAINING menu is "6." The parameter field will display "XXXX", with the X's representing the estimated days left before the data card memory is full. The calculation for days remaining is based upon the amount of data card memory remaining and the current time interval. This is not a user programmable feature.

The DATA VIEW Menu

The DATA VIEW menu is displayed as "7." The parameter field cycles continuously through the following loop:

Menu Item | Decimal Point, English
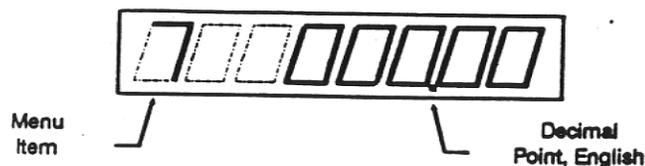
a.   Displays the appropriate LEVEL reading from the data card for 2 seconds.
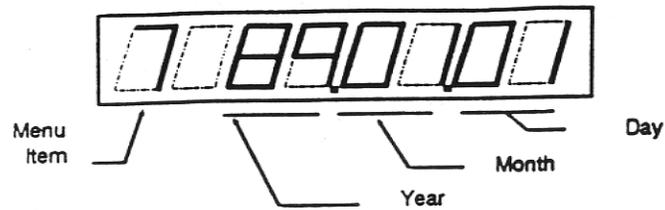
b.   Displays the YEAR/MONTH/DAY for 1 second.
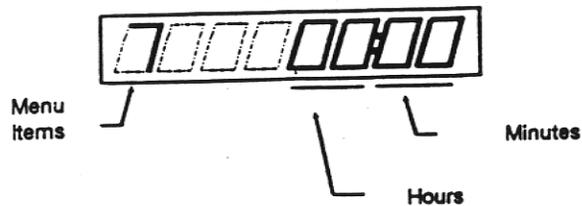
c.   Displays the TIME for the appropriate LEVEL reading for 1 second.

When accessing the DATA VIEW menu, the most recent level stored in the data card is displayed, along with the YEAR/MONTH/DAY and TIME. The UP or DOWN arrow keys are used to move forward or backward, respectively, by single reading in the Data Card history. If the SELECT DIGIT key is held down, the UP or DOWN arrow keys are used to move forward or backward to the next midnight reading in the data card memory.

MAINTENANCE

The A/F Logger system should be maintained in a clean, dust-free environment. Keep the access panel closed during system operation. The system is designed to provide years of trouble-free operation. To ensure this level of performance, the following items should be checked on a regular basis:

1. Check the battery or other power source voltage to the A/F Logger at each visit to the site. If the operating voltage of the rechargeable battery falls below 12.0 VDC, it should be replaced and recharged. The A/F Logger will continue to operate at voltages below this level, but intermittent operation from a poorly charged lead acid battery may cause loss of data.

2. Check the mounting of the A/F Encoder to the type A Recorder. Make sure that it is tight, and that the pulley turns freely.

3. If the system is operated in an area subject to blowing dust or sand, the dust or sand around the A/F Encoder bushing should be blown off at each visit to the site. Sand or dust can cause excess bushing wear, as well as shaft binding.

4. Take care to mount the unit where dripping water from condensation or other sources will not flow into connectors or access panels. Check all contacts on the I/O connectors for corrosion at each visit to the site.

5. **DO NOT ATTEMPT TO OPEN THE ENCODER HOUSING.** There are no user serviceable parts inside, and you may damage the unit's alignment or introduce dirt or moisture.

6. Do not attempt to force the data card into the logger. It should go in easily. If there is resistance, check that the card is oriented properly and that nothing has fallen into the access slot. If the membrane keyboard and display window get soiled, they can be cleaned with a mild window cleaner or isopropyl alcohol and a clean cloth or tissue.

7. The data card battery must be replaced on a semiannual basis when the operating temperature is 25° C, and every 3 months for temperatures of 45° C. This is accomplished by opening the battery compartment with the screwdriver supplied in the installation kit. Install the battery, then reinstall the cover.

TROUBLESHOOTING

The following is a guide to use for troubleshooting various operational problems with the A/F Logger. These are things that should be checked before contacting the factory for assistance. If you cannot solve the problem in the field, technical assistance is available from the factory by phone, or if needed, the instrument can be returned for repair.

Symptom	Probable Problem	What to Check
No display	No Power to unit	Fuse Battery Connections Battery voltage
No level change or level errors	Encoder not working properly	Encoder connections Encoder mounting on pully is tight Encoder standoff is engaged in bracket English/metric switch in proper position Level rate of change should not exceed 2 ft/sec Float moves freely
Flashing menu digit persists after setup complete	Data card error	Data card fully inserted Access panel fully closed Write protect-switch enabled on data card Data card battery low Magnett dislodged from underside of access panel
No serial communications	Serial port error	Configuration wrong (Logger or Port Mode) Wrong cable for configuration Cable connections
Display does not turn off	Sleep mode error	Unit set up for continuous display Serial port active (due to modem or other device)

TECHNICAL NOTES

This section covers various technical aspects of the A/F Logger system. This information is provided for those who desire a deeper technical knowledge of the system operation.

A/F Logger

The A/F Logger is a microprocessor-based, low-power unit designed specifically to work with an A/F Encoder and Stevens data card. It incorporates a full-function, real-time clock with built-in leap year. It has NO on-board data storage. All data is stored in the data card, with the exception of current level and various setup parameters which are maintained in on-board Random Access Memory (RAM). This on-board RAM is not battery backed, and in the event of loss of power, all setup parameters must be reentered.

The display is an LCD numeric, 8-digit display. The first digit is used to display a menu item number. The second digit is normally blank. The remaining digits display the menu item information field. The display is activated and changed by use of the four membrane keys integral to the front panel. These keys initiate action by pressing a key on the logger. Holding down a key will not cause the display to "scan through" the data. This is also true for entry of any of the program parameters. Holding down an arrow key will NOT cause the selected digit to continuously increment or decrement.

Power Consumption

The A/F Logger uses several schemes to reduce power consumption and ensure maximum battery life. One such scheme involves buffering the encoder input. For this reason, the level display function will appear to "jump" when the encoder shaft is turned. The A/F Logger will only update the display after a certain number of input counts have been received. Thus the display will appear to jump several increments when the shaft is turned slowly. This does not affect either accuracy or resolution during normal recording operations. The buffer holds eight counts from the Encoder, which produces 400 counts per revolution. The A/F Logger will update the display after each eight counts are received. The scaling of the English increment typically is 0.03 to 0.04 ft.

Factory Switch Settings and Power-on Defaults
When the unit is first received from the factory, the following switch settings will apply (these are the Selector switches located under the small panel on the bottom of the unit):

Scale: English (Ft.)
Bit Rate: 300 bits per second.

When the unit is first powered up in the Logger Mode, the following default parameters will apply:

LEVEL: 000.00 (English)
TIME OF DAY: 00:00
YY/MM/DD: 90:01.01
IDENTIFICATION: 000000
TIME INTERVAL: 00:15

Remember, if for some reason the unit loses power while operating, and the power is then restored, the above parameters will become the current operating parameters.

Additional features

Two important additional features are available on the A/F Logger. The first is the "Continuous Display" mode. This mode is selected using the Selector switches on the bottom of the unit. In this mode, the unit will not go into a low-power sleep mode of operation and will maintain a continuous display of the current water level. While this is convenient, it does draw more power; power consumption in this mode is typically 40 mA from the 12 V source, as compared to less than 6 mA in the normal sleep mode.
Normally, the A/F Encoder is set up to sample the logger periodically and to determine if there has been a water-level change. The sampling rate is sufficient to handle changes up to 2 feet per second. However, the logger can be set to continuously monitor the encoder. This will also result in a substantial increase in power consumption (typically 25 mA versus 5 mA in Sleep mode). To select this option, the unit must be opened and the selector switches in the back of the unit moved after powering down.

NOTE: SELECTOR SWITCH POSITIONS SHOULD NOT BE CHANGED WHILE THE UNIT IS POWERED UP. The unit will not be damaged, but the settings are only checked when power is first applied. Changing them after the power is applied will have no effect on the unit's operation.

Sleep mode

The Type A/F Logger is designed to go into a low-power sleep mode under the following conditions: when the unit is in "Logger Normal" mode; when there has been no keyboard activity for 2 minutes; or when a functional data card has been inserted and the access panel is closed. A unit in Logger, Continuous Display or Data Port mode will NEVER go into Sleep mode. Please remember this when operating in these modes. If battery power is used, the battery may discharge quickly if not connected to the solar panel.

Stevens Data Card

The Stevens Data Card (Fig. 6) is a battery-backed memory storage device for use with the Stevens A/F Logger. It provides all of the memory storage for the logger. It contains 64K bytes of storage, typically capable of storing 30,000 readings. There are several important system features of the card that should be noted. A small screwdriver is required to access the battery compartment of the data card. Open the compartment cover to change the batteries. The data card is also equipped with a write-protect switch, as shown in Figure 7. If the write-protect function is enabled, no data can be written to the card by the logger. This condition will also result in a flashing menu digit when the card is installed.
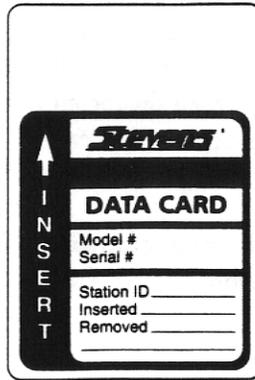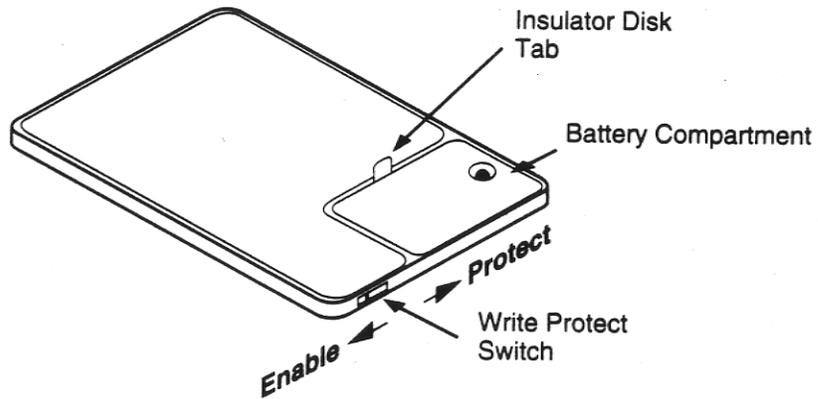
Figure 6. Stevens data card

Figure 7. Data card write-protect switch/battery compartment

Data Card Operation

A header is written to the data card any time it is inserted in a unit. For example, if a data card is removed from a field unit and then reinserted into that same field unit, a new header should be written on the card, **WHETHER ANY PARAMETERS HAVE CHANGED OR NOT**. In fact, opening the access panel triggers this action; if the panel is opened and the card is not removed, a new header is written to the data card. It is, however, easy to tell if the data card is in place without lifting the access panel. If the data card is not in place, the menu digit on the display will be flashing. If a data card is in place and a parameter is changed, a new header is written to the data card. If no readings have been recorded since the last header entry, that header is written over with the new header. This avoids imbedding multiple headers in the data card with no data in between them. The historic water-level data will not be overwritten on the card when the logger is used in the Data Logger mode; once the data card is full, the card will not store any additional data. The card can be cleared by using the logger in Data Port mode. Recording always occurs at the end of the last recorded valid data.

The data card features a label for indicating the following information: Station ID, Date Inserted, Date Removed, and Date Battery Installed. Be sure to correctly annotate this information on the label in pencil.

Data Card Specifications

Capacity: 64K bytes. Sufficient storage for approximately 30,000 readings, non-circulating

Power: CR2016 type 3V Lithium battery

Battery replacement interval: 6 months at 25° C operating temperature 3 months at 45° C operating temperature

Operating temperature: -20 to + 50° C

Relative humidity: 0-95%, non-condensing

Size: 3-1/2 x 2-1/4 x 1/8 inches

SERVICING DATA LOGGERS

1. Measure the water level with a steel tape. Next check the current water level on the band tape against the data logger. If the band reading is off from the logger reading than use steel tape water level measurement and change the reading on the data logger. Tape the well several times if unsure of taped reading.

2. Check the water level rise. To do this turn the wheel clockwise and the water level should be decreasing on the data logger.

3. Next check the time, date, identification number, and time interval on the data logger. The time interval should be 1 hour.

4. Check the black battery with a battery tester; it should read 12 volts or greater. If the battery is not charging, disconnect the wires from the solar panel and measure the output from the solar panel. It should be 15 volts or greater.

5. Check the yellow fuse holder to see if the fuse needs to be replaced.

6. Examine the wires to make sure they are not loose; if they are than follow the diagram for the battery/ encoder hookup section. The battery must be disconnected from the logger before it is rewired.

7. Pull the old card from the logger and write on the card with a pencil the date it was removed. Next write on the new card the date it was inserted. Make sure the new card is firmly in place. Check to see that the days remaining are over 1125 days. Return select menu to the 1 level position.

8. If there are any additional problems with the logger, check the troubleshooting section.

HYDROGRAPHS

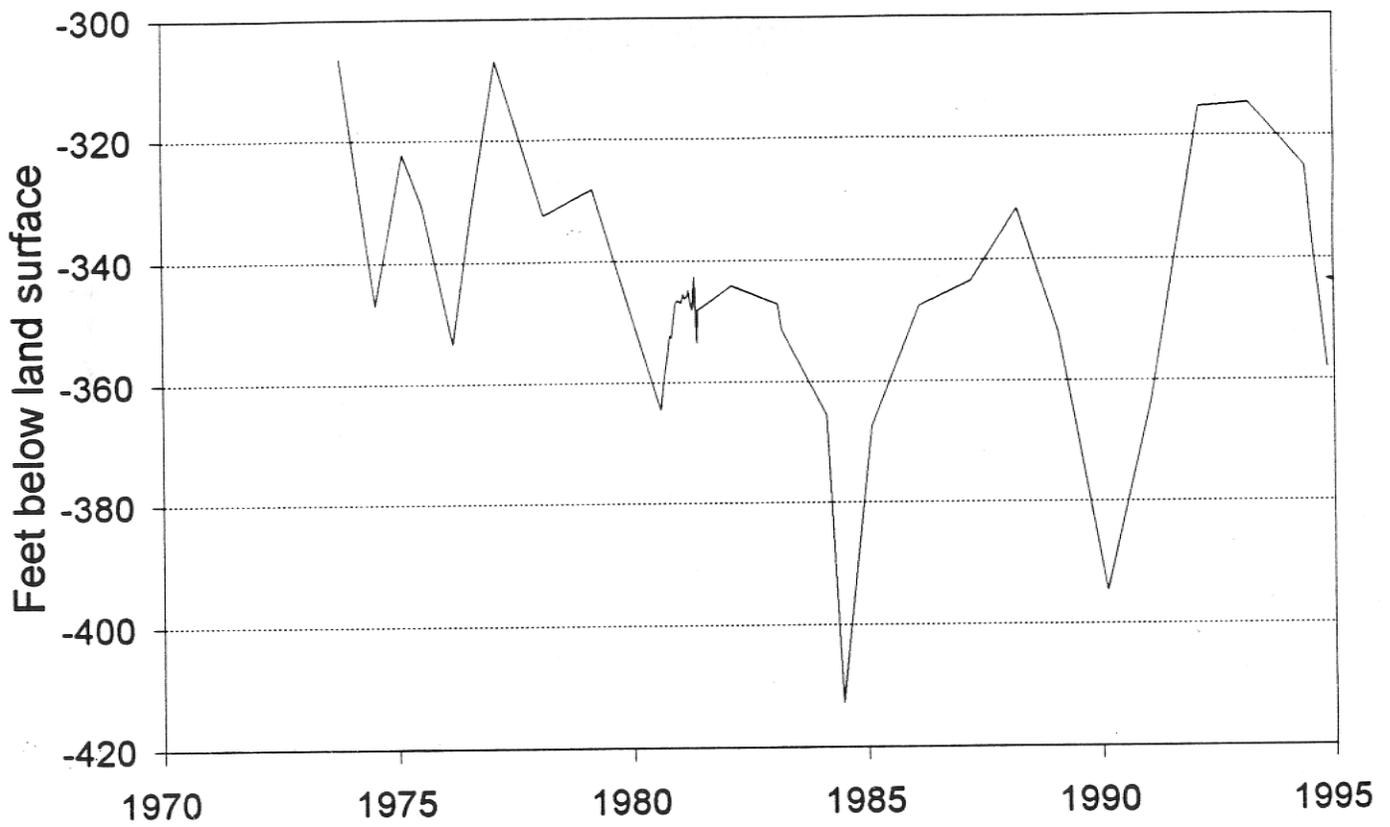# Hydrograph of Edwards (BFZ) well #68-34-506 in east Medina County

Figure 8. Hydrograph of Edwards (BFZ) well #68-34-506 in east Medina County

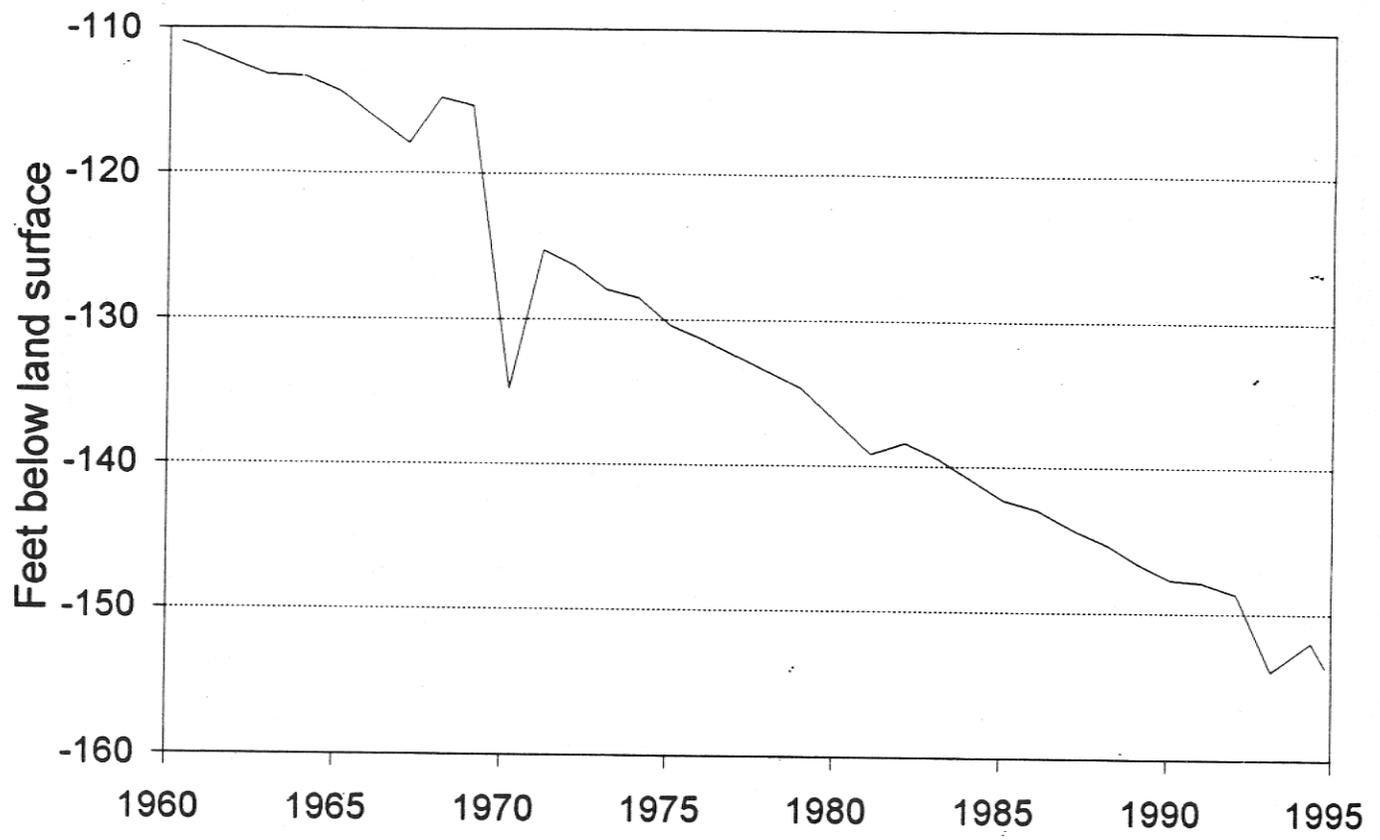# Hydrograph of Carrizo well #68-58-101 near Devine in Medina County

Figure 9. Hydrograph of Carrizo well #68-58-101 near Devine in Medina County

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