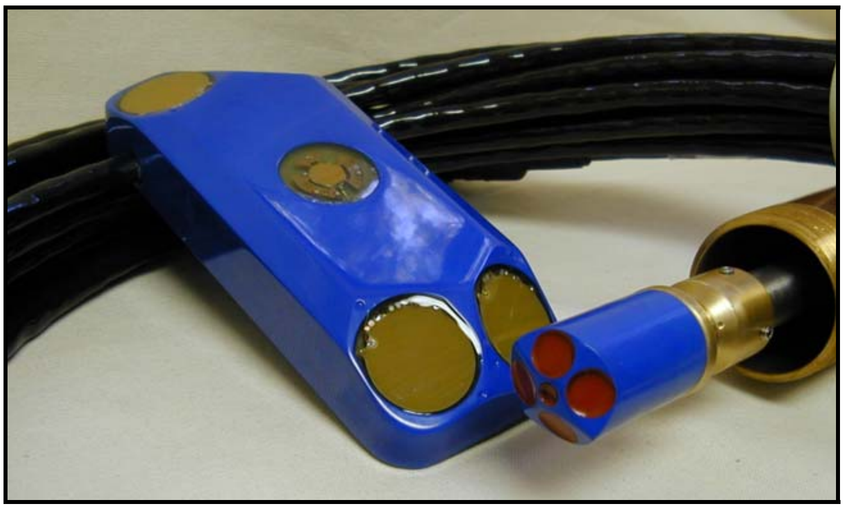
ADFM

Acoustic Doppler Flow Meter

TECHNICAL MANUAL



This manual includes information for the following products:

ADFM Pro20

ADFM Analog Output Module

ADFM Hot Tap

Teledyne Isco P/N 69-7103-001
January 2000

ADFM Velocity Profiler

Technical Manual

January 2000

NOTE. This manual applies to ADFM firmware version 6.37 or higher. When newer firmware versions are released, some commands may be modified or added. Read the README file on the upgrade disk or check MGD's web site for the latest changes.

IMPORTANT NOTICE

MGD Technologies Inc. was acquired as a subsidiary of Teledyne Isco Inc. in December, 2005 and was merged into Teledyne Isco in May, 2006. New contact information is printed below:

Teledyne Isco Inc.

4700 Superior Street
Lincoln, Nebraska, 68504
(800) 228-4373 (402) 464-0231
FAX (402) 465-3022

E-mail (Customer Service): IscoCSR@teledyne.com

E-mail (Technical Service): IscoService@teledyne.com

Web site: www.isco.com

LIST OF EFFECTIVE PAGES

Edition 4 – January 14, 2000 – Firmware version 6.37

New editions are complete revisions of the manual. Update packages, which are issued between editions, contain additional and replacement pages to be merged into the manual by the customer. The dates on the title page change only when a new and revised edition is published.

A software and/or firmware version code may be printed before the issue data; this indicates the revision level of the software and/or firmware of this instrument at the time of the manual or update was issued. Many product updates and fixes do not require manual changes and, conversely, manual corrections may be done without accompanying product changes. Therefore, do not expect a one to one correspondence between product updates and manual updates.

The total number of pages in this manual is 148.

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RECORD OF CHANGES

Edition	Effective	Description
3	February 96	Firmware version 6.17 through 6.30
4	January 00	Firmware version 6.37

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Chapter

1

Introduction to the ADFM Velocity Profiler™

1-1 Overview

This technical manual is intended to be the detailed reference for the ADFM Velocity Profiler™ (ADFM), using the firmware version listed on the title page. This manual contains information on ADFM setup, operation, data retrieval, maintenance, testing, and troubleshooting.

1-2 Getting Started

Please take the time to read these instructions. We have tried to make the ADFM and it's manual easy to use. Before using the ADFM to collect real data:

- Page through this manual to become familiar with its contents;
- Familiarize yourself with ADFM components by looking at diagrams;
- Use Chapter 2 to install, connect, test, and deploy the ADFM;
- Use Chapter 3 to issue software commands and begin collecting data;
- Use Chapter 4 as a maintenance and troubleshooting guide;
- Use Appendices for additional reference.

If you have questions pertaining to a specific ADFM system installed, please have the following information on hand before contacting us:

Serial # of Electronics Unit and Transducer:	Technical Support will need to know the serial number to obtain the system's configuration before they can help you.
Contents of the WinADFM configuration file:	We need to know the setup of the ADFM, and site details.
A detailed description of the problem:	Try to answer what happened and when it happened. What were the circumstances leading to the problem. Be as detailed as possible.

1-3 General Operation

Before applying mains power, verify that the power entry module voltage selection matches the available line voltage, the correct fuse is installed, and safety precautions are taken.

1-3.1 General Warnings and Cautions

This section contains a list of items you should be aware of every time you use your ADFM. *Please refer to this list often.*

- Before mains power is supplied to the ADFM, the protective earth (ground) terminal of the instrument must be connected to the protective conductor of the mains power cord. The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord (power cable) without a protective conductor (grounding). Grounding one conductor of a two-conductor outlet is not sufficient protection.
- Servicing instructions are for use by service-trained personnel. To avoid dangerous electric shock, do not perform any service unless qualified to do so.
- If this instrument is to be supplied via an auto-transformer, make sure the common terminal is connected to the earth terminal of the power source.
- Any interruption of the earthing (grounding) conductor, inside or outside the instrument, or disconnecting the protective earth terminal will cause a potential shock hazard that could result in personal injury.

- Only fuses with the required rated current, voltage, and specified type should be used. Do not repair fuses or short circuit fuse-holders. To do so could cause a shock or fire hazard.
- Do not install substitute parts or perform any unauthorized modifications to the instrument.
- Certain test measurements described in the manual are performed with power supplied to the instrument while protective covers are removed. Energy available at many points may, if contacted, result in personal injury.
- Any maintenance and repair of the opened instrument under voltage should be avoided as much as possible, and when inevitable, should be carried out only by a skilled person who is aware of the hazards involved.
- Capacitors inside the instrument may still be charged even if the instrument has been disconnected from its source of supply.

1-4 ADFM Components Overview

Figure 1-13 illustrates the three major components of a ADFM system. Two components are installed at each site: a transducer, installed in the bottom of a pipe or channel, and its Electronics Unit, installed nearby in a non-hazardous atmosphere. These two components communicate with the third system component, a remote host IBM compatible PC computer, either via a Modem, or a serial data interface (RS-232 or RS-422).

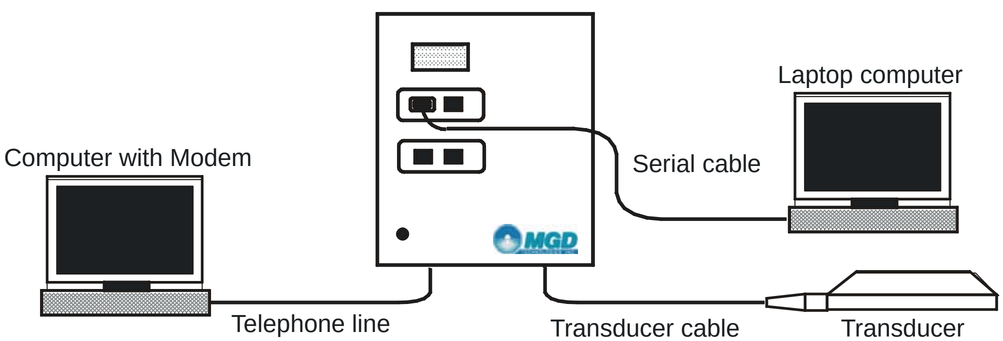

Figure 1-1. ADFM Components

To allow measurements close to the bottom of the pipe or channel and to minimize debris collection on the transducer, the ADFM transducer is designed to have a low profile. It therefore contains a minimum of required electronics. The Electronics Unit and transducer contain all circuitry and systems needed to measure directional flow, the level within the sewer pipe, to record results, and to transfer data from and to local or remote locations.

Use of a laptop computer running Windows 95 and the WinADFM software is recommended for initial setup of the ADFM on-site. Subsequent data collection and re-programming may be performed locally or remotely via modem if a telephone telemetry connection is available.

1-4.1 What is an ADFM?

The ADFM Velocity Profiler™ (ADFM) is a flow meter based on the Doppler principle. The ADFM consists of a transducer assembly mounted in the flow, a signal processing unit and an interface cable

1-4.2 Principles of Operation

Figure 1-24 shows a typical ADFM installation for measuring open channel flow in a pipe. A transducer assembly is mounted on the invert of a pipe or channel. Piezoelectric ceramics emit short pulses along narrow acoustic beams pointing in different directions. Echoes of these pulses are backscattered from material suspended in the flow. As this material has motion relative to the transducer, the echoes are Doppler shifted in frequency. Measurement of this frequency enables the calculation of the flow speed. A fifth ceramic mounted in the center of the transducer assembly, and aimed vertically, is used to measure the depth.

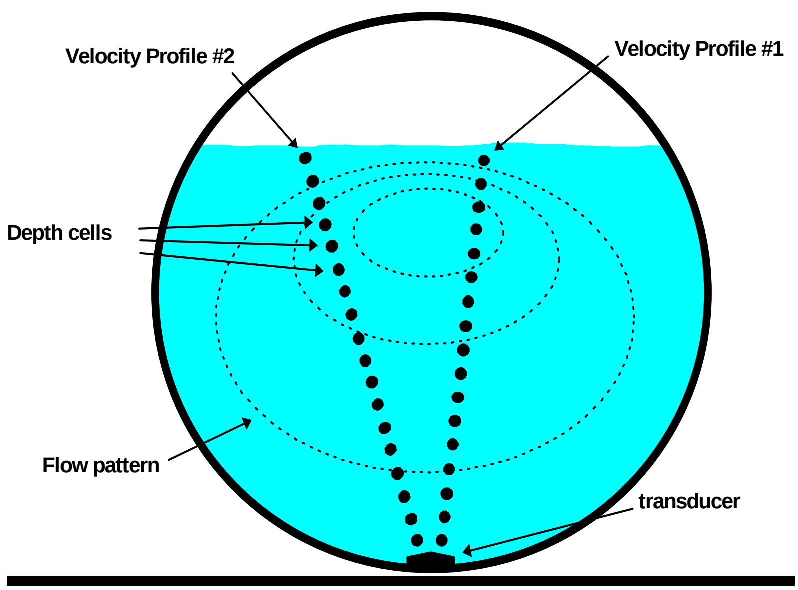

Figure 1-2. Typical ADFM installation

The ADFM divides the return signal into discrete regular intervals that correspond to different depths in the flow. Velocity is calculated from the frequency shift measured in each interval. The result is a profile, or linear distribution of velocities, along the direction of the beam. Each of the small black circles in Figure 1-24 represent an individual velocity measurement in a small volume known as a depth cell.

The directions of the velocity profiles in Figure 1-24 are based on the geometry of the ADFM's transducer assembly. Figure 1-35 shows a side view of the transducer assembly. The profiles shown in Figure 1-24 are generated from velocity data measured by an upstream and downstream beam pair. The data from one beam pair are averaged to generate Profile #1, and a beam pair on the opposite side of the transducer assembly generates Profile #2.

Since Doppler measurements are directional, only the component of velocity along the direction of transmit and receive is measured, as shown in Figure 1-35. Narrow acoustic beams are required to accurately determine the horizontal velocity from the measured component. The narrow acoustic beams of the ADFM insure that this measurement is accurate. Also, the range-gate times are short and the depth cells occupy a small volume - cylinders approximately 5 centimeters (2 inches) long and 5 centimeters (2 inches) in diameter. This insures that the velocity measurements are truly representative of that portion of the flow. Potential bias in the return energy spectrum due to range dependent variables is avoided. The result is a very precise measurement of the vertical and transverse distribution of flow velocities.

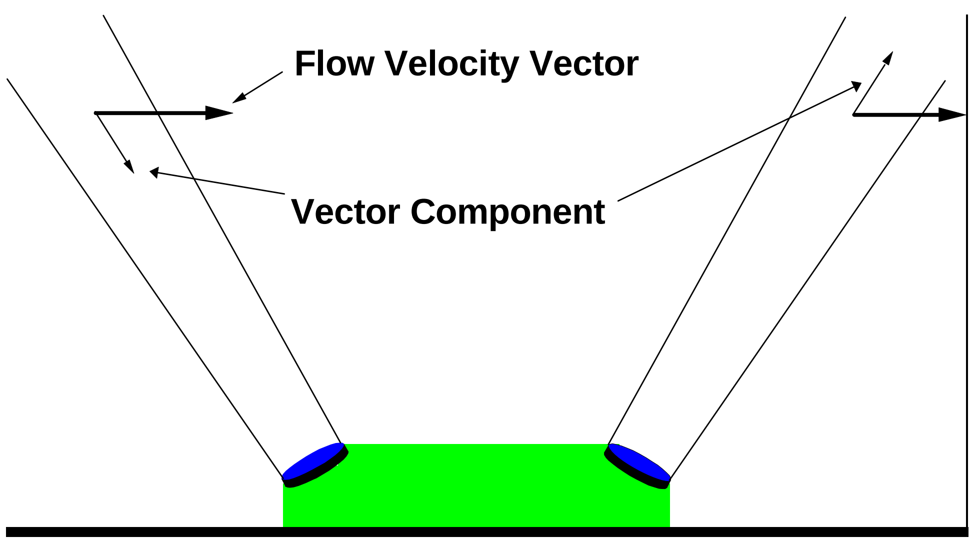

Figure 1-3. ADFM Beam Geometry

The velocity data from the two profiles are entered into an algorithm to determine a mathematical description of the flow velocities throughout the entire cross-section of the flow. The algorithm fits the basis functions of a parametric model to the actual data. The result predicts flow velocities at all points throughout the flow. These results are integrated over the cross-sectional area to determine the discharge.

The key benefit to this approach is that the system will operate accurately under different hydraulic conditions. As hydraulic conditions change, the change will manifest itself in the distribution of velocity throughout the depth of flow. As the ADFM is measuring the velocity distribution directly, it will adapt to the changes in hydraulics, and generate a flow pattern that is representative of the new hydraulic conditions, insuring an accurate estimate of flow rate.

1-4.3 User Data Interfaces

The ADFM has three user data interfaces, which are listed in Table 1-16 below.

Table 1-1: User Data Interface Types

Type:	Description:
RS-232	Serial Data Interface, EIA standard RS-232C, used for local data communication with the ADFM. Not to be used over distances more than 15 meters. Maximum baud rate is 57600 Baud.
RS-422	Serial Data Interface, EIA standard RS-422, used for local or remote data communication over distances up to 1.2 km. Maximum Baud rate is 115 kBaud.
Modem	28800 bps Modem with data compression and error correction capabilities, used for remote data communication with the ADFM.

For a complete set of specifications for the serial data interfaces please refer to the EIA specifications. For more information on available modems, please contact MGD Technologies Inc.

Chapter 2

Equipment Setup and Installation

2-1 Introduction

This section of the manual contains information and instructions for inspection, configuration, testing, installation, and deployment of the ADFM Velocity Profiler™. Included in this section are:

- Initial inspection procedures
- Connecting the ADFM components
- Power supply options
- Built-in tests (BITs)
- Final preparations for use
- Installing and deployment
- Packing and shipping information

The general sequence of events in installing and deployment of an ADFM are:

- Prepare portable computer to be taken to installation site.
- Perform pre-installation equipment and operational checks.
- Connect the ADFM Transducer and Electronics Unit via the Transducer Cable.
- Measure channel dimensions and determine geometry.
- Setup ADFM configuration file for each installation site.
- Install the ADFM transducer and electronics unit, conduct final testing.
- Program desired data logging parameters into the ADFM.
- Connect phone line to ADFM Modem port, if required.

2-2 Initial Inspection

On receipt, inspect the shipping container for damage. If shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the system has been checked both mechanically and electrically. If the contents are incomplete, if there is evidence of mechanical damage or defects, or if the system indicates a failure in some component during the initial testing procedure, please notify MGD Technologies Inc. as soon as possible. If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as MGD Technologies Inc. Keep the shipping materials for the carrier's inspection.

2-3 System Interconnection

Use Figure 2-12 to connect the ADFM cables and the computer.

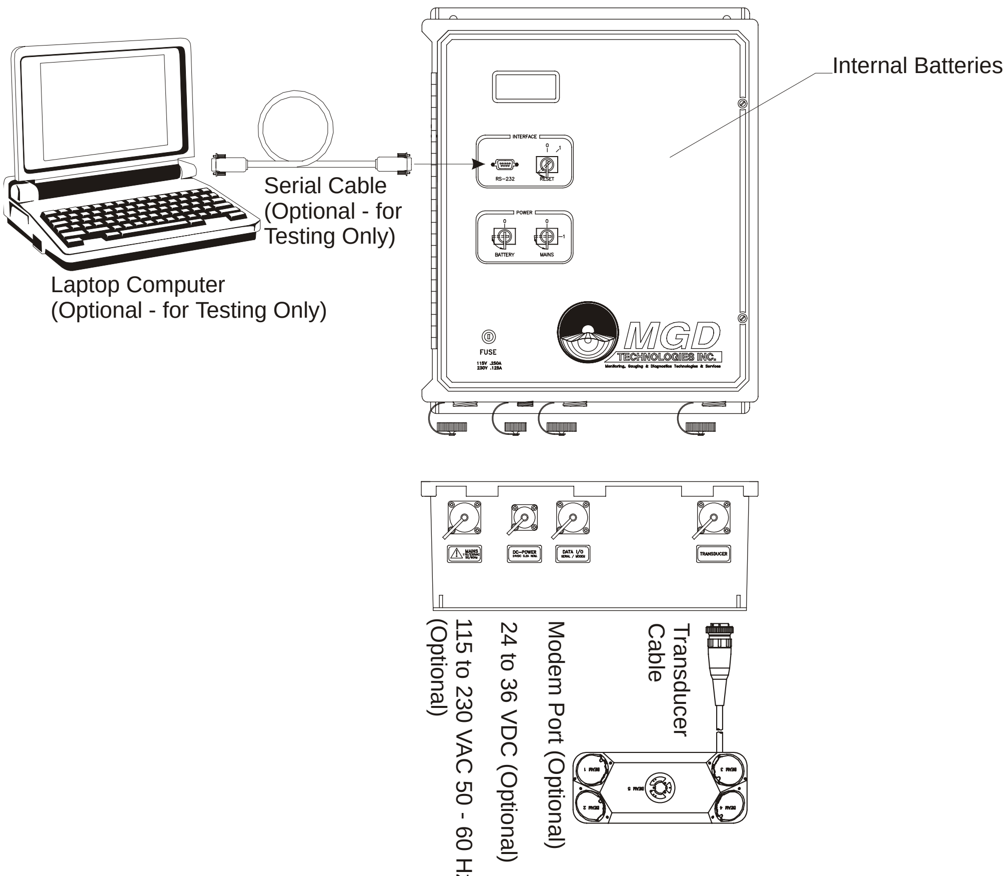

Figure 2-1. ADFM System Interconnection

2-3.1 Connecting the Transducer Cable to the Electronics Unit

The transducer cable is a multi-pair, multi-shielded cable designed specifically for use with the ADFM. The standard cable length is 15 meters (49 feet), but other cable lengths are available. Contact MGD Technologies Inc. for details. Extension cables are not recommended due to EMI/RFI constraints.

> ⚠ **CAUTION.** Use caution when mating or unmating the transducer cable to the transducer assembly and Electronics Unit to avoid damage to the connector hardware. UNDER ALL CIRCUMSTANCES, THE INTRUSION OF WATER OR ANY OTHER FOREIGN MATTER INTO THE CONNECTOR CONTACT AREA MUST BE AVOIDED, SINCE THIS MAY RESULT IN PERMANENT DAMAGE TO THE CONNECTOR AND MAY RENDER THE ADFM INOPERABLE.

The transducer cable connects to the electronics unit using a 14-position keyed connector. The receptacle on the electronics unit is located on the bottom right side of the unit.

To make the connection, remove the blank cap from the receptacle on the electronics unit. Insert the cable connector into the receptacle, rotating it until the keyed portions are properly aligned. Thread the coupling ring onto the receptacle to complete the connection. Reverse this procedure when disconnecting the cable from the electronics unit.

2-3.2 Power Supply to the ADFM

> ⚠ **CAUTION.** BEFORE connecting mains (AC) power to this instrument, be sure the line voltage selector jumpers inside the Electronics Unit is set properly and the correct fuse is installed.

Power Supply Options

The ADFM is designed to operate from one of three independent power sources: internal batteries, external DC power supply, or external AC power supply. All sources may be used concurrently; the source that supplies the highest voltage will automatically supply power to the system. Mains (AC) power is converted to a DC supply of approximately 28-30 VDC after rectification and filtering inside the ADFM. By combining external mains power with internal batteries, one can obtain uninterrupted operation of the ADFM during brief power outages. Both front panel power switches must be in the “On” position for this to occur.

Two internal battery options are available for the ADFM. The standard configuration consists of four 6-volt alkaline lantern batteries with spring terminals. Recommended alkaline batteries are the Eveready Energizer, Model EN529. These alkaline batteries have approximately 2.5 times the power/life of the lead-acid type. An optional conversion kit for using two (2) 12-volt, 7-amp hour sealed lead-acid gel cell batteries is also available.

The ADFM will operate from an external DC power supply of 12 to 35 volts, with a power consumption of 3 watts maximum. A supply voltage of 24 to 35 VDC is recommended to allow operation from the internal batteries when the external power supply is interrupted. Operation from external mains (AC) power requires a power source of 115 or 230 VAC, ±10%; 50 to 60 Hz, with a power consumption of 5 VA maximum.

Line Voltage Selection

The ADFM should be delivered pre-configured for the proper voltage. The current configuration will be indicated by a sticker on the exterior of the Electronics Unit adjacent to the AC input connector. Before applying mains power, verify that the ADFM is configured for the correct line voltage. If the ADFM is configured for the wrong voltage, please contact MGD Technologies Inc. for instructions.

Mains (AC) Power Cable

> **CAUTION.** BEFORE CONNECTING THIS INSTRUMENT TO MAINS, the protective earth (ground) terminal of the instrument must be connected to the protective conductor of the mains power cord. The mains power cable must be connected to a protective earth contact. The protective action must not be negated by use of an extension cord (power cable) without a protective conductor (grounding). Grounding a two-conductor outlet does not provide an instrument ground.

This instrument is provided with a three-conductor power cable for mains supply. When connected to an appropriate power outlet, this cable grounds the instrument unit. The mains power supply cable normally ships as a pigtail assembly for field wiring to the mains power supply. The connector on the cable mates with the left-most receptacle on the ADFM, and that is the only receptacle it will mate with. Wiring assignments for the mains power cable are as follows:

	Pin	Color	Function
(L)	1	Brown	Line
(N)	2	Blue	Neutral
(PE)	3	Green	Protective Earth

DC Power Supply Cable

This instrument is provided with a two-conductor cable for DC power supply. This cable provides no grounding. The DC power supply cable normally ships as a pigtail assembly for field wiring to the DC power supply.

The power supply cable mates with the smallest connector on the ADFM. Wiring assignments for the power cable are as follows:

	Pin	Color	Function
(+)	1	Red	+ DC
(-)	4	Black	- DC

2-3.3 Applying Power

Two key switches on the inner front panel control power to the ADFM. A third momentary key switch provides a reset function. Ensure that both power switches are in the "off" position, and the reset switch is not held in the "reset" position. Connect the appropriate power supply cables to the ADFM and the power source, if required. Ensure that the batteries are securely mounted in the ADFM and that the battery supply wiring harness is attached. Use the supplied switch-key to switch the appropriate power source switch(es) to the On-position, indicated by "1"; this will power-up the ADFM. If you intend to use both mains and battery power, ensure that both switches are on.

2-4 Built In Tests (BITs)

When power is first applied to the ADFM, an internal self-test will automatically be performed. Result messages will scroll on the LCD display, culminating in a display showing the ADFM firmware version number on the first line and a hexadecimal-coded error map on the second line. The software used to operate the ADFM will periodically report and reset the error code map, and to re-run selected tests. By interpretation and further fault isolation, it is possible to isolate a hardware problem to a least replaceable assembly (LRA) level. For a list of LRAs refer to Chapter 4-Table 4-1, page 4-6: List of Least Replaceable Assemblies.

2-4.1 Testing Interval

Routine execution of the built-in tests is not required during normal system operation. Execution of selected built-in tests from software is recommended quarterly or at each battery change, whichever is more frequent. The built-in tests should also be performed whenever a hardware problem with the ADFM is suspected. See Chapter 3 and the software manual for further details.

2-4.2 Test Record

The WinADFM software by default will create a log containing details of all ADFM operations, including the status of the error code map and the results of all built-in tests. No further test record is required unless specifically requested by Technical Support Personnel.

2-4.3 Power-UP BIT Procedure/Sequence

a. Switch power to the ADFM off.

b. Switch power on again; however, make sure at least ten minutes have passed since all power was switched off. The ADFM's LCD display should show firmware version and error code map followed by the "wake up message":

```
RD Instruments:
-------------------
Acoustic Doppler
Flow Meter
```

c. The ADFM's LCD display should begin displaying the results of the power-up BIT, as these tests are executed. The power-up BIT tests will take approximately one or two minutes to perform after which the LCD display will show the firmware version and BIT error code map (see Chapter 5 for details):

```
ADFM  Ver.    V6.xx
09000080
```

d. To repeat the power-up BIT tests you may turn and release the Reset key switch, located on the front panel of the Electronics Unit.

2-5 Final Preparations for Use

2-5.1 Measure Pipe or Channel Geometry

In order for the ADFM to measure flow accurately, it must have information about the pipe or channel in which it is installed. Refer to Figure 2-27 for a diagram of the channel geometries directly supported by the ADFM. The pipe/channel shape must be symmetrical about the vertical centerline. Application of the ADFM in pipes or channels of other geometries may be possible. Please contact MGD Technologies Inc. with specific details of your application for further information.

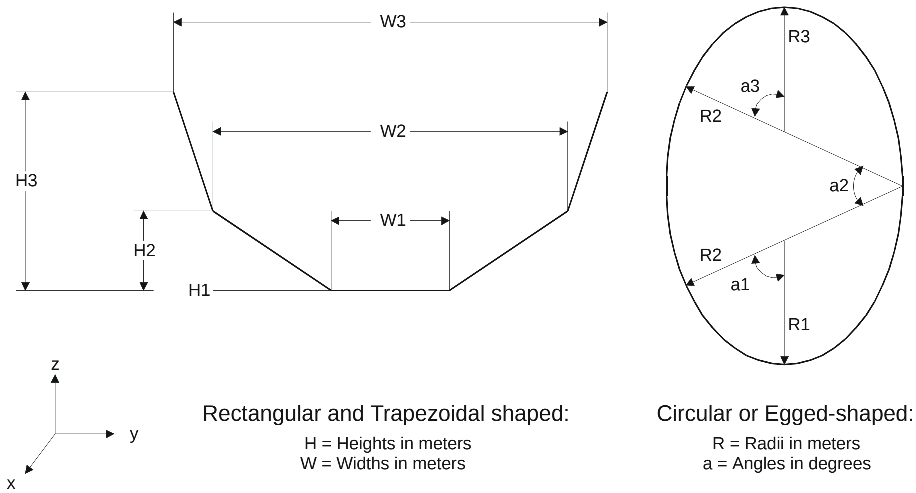

Figure 2-2. Pipe Geometry and Parameters

During installation, the following parameters need to be recorded, as they are needed by the software to estimate discharge:

- Cross-sectional geometry: For rectangular channels, the width (W) and the height (H) need to be recorded. For circular pipes/channels the, radii (R) and angles (a) need to be recorded. These parameters will be entered into software and used to estimate discharge. Note that for a circular channel only the Diameter (D) needs to be recorded.
- Normal distance from the surface of the transducer fifth beam to the invert of the pipe: Enter these dimensions into the "Zero Offset" box in the WinADFM setup screen.
- Level of silt in the pipe or channel should be entered into the "Bed Level" box in the WinADFM setup screen.

2-5.2 Prepare Installation Hardware

Installation hardware is available from MGD Technologies Inc. for a variety of channel shapes and sizes. Please contact MGD Technologies Inc. for further information, or if you desire assistance in applying the ADFM to your specific situation.

The ADFM transducer assembly includes three drilled and tapped mounting holes. To avoid damage to the transducer assembly and ceramics, these holes are the only locations that should be used to mount the transducer assembly to the installation hardware. These mounting holes are drilled and tapped for a metric size machine screw, size M6-1.0. Inserts are available to convert the existing holes from metric M6 to metric M3 and US standard #6-32 size threads.

Installation of the ADFM transducer assembly must also comply with the following parameters to maintain the accuracy of the final installation:

- Transducer must be installed in such a way that the vertical beam (beam 5) is oriented normal with respect to the pipe's or channel's invert. Note that the vertical beam is normal to the transducer's top surface.
- Transducer must not be rotated about the vertical Z-axis. A sighting device or similar should be used to minimize rotational misalignment.
- Transducer must be installed such that positive longitudinal flow direction is from the "non-cable" side of the transducer to the "cable" side. See Figure 2-38 below for further explanation of the flow direction.

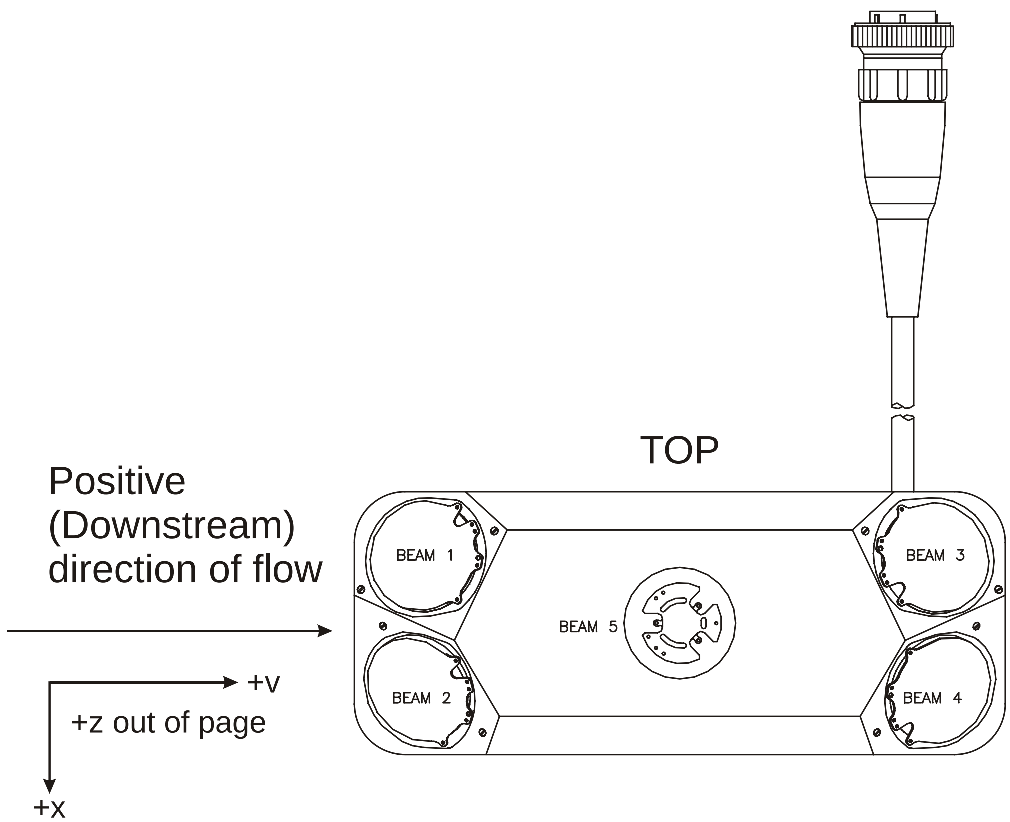

Figure 2-3. Transducer Orientation

2-5.3 Install Software and Configure Station File

Before the ADFM can be used in a specific application, it must be programmed for that application. This is most easily done using the WinADFM software. See Chapter 3 and the Software Manual for further details.

2-5.4 Installing and Deploying the ADFM

Detailed procedures for installing the ADFM in a specific application cannot be provided without detailed knowledge of the application. Please contact MGD Technologies Inc. if you desire information or assistance in your application. "Deployment" refers to the programming of an ADFM with the site, channel, profiling, and data logging characteristics desired at the site. Deployment is discussed in more detail in Chapter 3 and the software manual.

2-6 Packaging and Shipping the ADFM

Clean the Electronics Unit and transducer assembly with mild soap and water prior to packaging and shipment. **DO NOT** use abrasive agents or solvents as they will damage these surfaces. **MILD** chlorine bleach solutions may be used if odors persist or if disinfection of the unit is desired. Use caution to prevent water from entering the Electronics Unit housing while cleaning. Ensure that the unit is completely dry prior to packaging and shipment to avoid corrosion or other damage during shipment. The ADFM may be shipped with batteries installed, however, all key switches should be in the "off" position for shipment. Removal of batteries from the unit may be desirable to reduce the shipping weight.

2-6.1 Tagging For Service

If the instrument is to be shipped to MGD Technologies Inc. for service or repair, attach a tag to the instrument identifying the owner, address of owner, complete instrument model and serial number, and a description of the service required. Mark the container FRAGILE to ensure careful handling. In any correspondence, refer to the system by model and full serial number.

2-6.2 Packaging

The original factory packaging material should be stored for reuse in the event it becomes necessary to transport the ADFM. If the original packaging material is unavailable or unserviceable, materials identical or equivalent to those used in factory packaging are available through MGD Technologies Inc.

For repackaging with commercially available materials follow these instructions:

- Wrap Electronics Unit and transducer assembly separately in bubble wrap or other cushioning material.
- Use strong shipping container suitable for the weight of the ADFM. Shipping containers made of wood or plastic are prefer-

able, but corrugated shipping boxes of at least 200-lb. test may be used.

- Use a layer of shock-absorbing materiel, at least 25 mm (1 in) thick around all sides of the Electronics Unit and transducer assembly to firmly cushion and prevent movement inside the container. Special care must be taken to protect the transducer ceramics on the upper face of the transducer assembly from damage.
- Seal shipping container securely.
- Mark shipping container FRAGILE to ensure careful handling.
- In any correspondence, refer to system by model number and serial number.

Chapter
3

Software Operation

3-1 Introduction

The primary tool used to program, deploy, and operate the ADFM is the software program WinADFM. Additional utility programs are available if required for specific functions, however, their use is not required in normal operation. Most of these utilities are engineering tools used during development and testing of the ADFM. However, if you are experiencing a specific problem with an ADFM or data, you may be provided with one of these utilities and instructions for its use.

3-2 Computer Requirements

The following are requirements for the computer(s) used to interface with the ADFM.

Minimum Requirements:

- IBM Compatible 486 processor or better
- Windows 95
- VGA color or better display monitor
- Hard Drive (minimum 50 MB free disk space)
- Hard Drive data backup method
- 3.5" Floppy Drive
- Serial Port (1)
- Modem (telemetered sites only)

Suggestions:

- IBM Compatible Pentium processor
- Hard Drive (500 megabytes or larger capacity with fast access)
- Zip Drive (or other hard drive data backup system)
- Mouse

3-3 WinADFM

WinADFM is the recommended program for operating the ADFM. Please refer to the separate software manual for further information.

3-3.1 Related Files

ADFM Station File (“<siteid>.stn”)

This file contains the configuration information for a particular monitoring location. See the WinADFM software manual for further information.

ADFM Log File (“<siteid>.log”)

This is an ASCII file containing the results of all logged WinADFM operations for a particular site. See the WinADFM software manual for further information.

ADFM Chart Settings (“<siteid>.ch1”, “<siteid>.ch2”, “<siteid>.ch3”)

These files contain the chart settings for a particular site. See the WinADFM software manual for further information.

ADFM Group File (“<groupname>.sgr”)

This file contains a listing of ADFM station files contained within a group. See the WinADFM software manual for further information.

ADFM Data Files ("###MDDHH.xxx”) (downloaded from internal recorder):

Binary data files containing raw data ensembles as recorded by the ADFM and downloaded by software to a computer. The naming convention is as follows:

###MDDHH.xxx	###	ADFM serial number (labeled on rear of ADFM electronics chassis)
	M	Month data was downloaded (1=Jan,...,9=Sep, A=Oct, B=Nov, C=Dec)
	DD	Day of month data was downloaded from ADFM recorder
	HH	Hour of day data was downloaded from ADFM recorder (00 to 23)
	xxx	ADFM recorder deployment number (001 to 999)

Example:

102A1214.001	102	*ADFM* serial number *102*
	A	Downloaded from recorder on *October*
	12	Downloaded from recorder on October *12*
	14	Downloaded from recorder on October 12 at *2 PM*
	001	*Deployment* number *001* on ADFM recorder

ADFM Data Files ("rtYYMMDD.xxx”) (data collected in real time):

Binary data files containing data measured by the ADFM and collected by software on a computer as the measurement occured. The naming convention is as follows:

rtYYMMDD.xxx	rt	Identifier for “Real Time” data
	YY	Year data was collected from ADFM
	MM	Month data was collected from ADFM
	DD	Day of month data was collected from ADFM
	xxx	Sequential real time data set collected

Example:

rt970206.003	rt	*Real time data*
	97	Data collected in 1997
	02	Data collected in February
	06	Data collected on the 6^{th} of the month
	003	The third real time data set of the day for this site

CSV (Comma Separated Value) Data File (###MDDHH_xxx.CSV”)

Data files containing ADFM data converted to Comma Separated ASCII values for Date/Time, Depth, Velocity, and flow rate.

3-4 Using BBTALK

BBTALK is a dumb terminal emulator program. This IBM-compatible program can capture raw data files and help troubleshoot configuration problems. You can use *BBTALK* for serial or parallel communications in either an ASCII or BINARY mode. A binary-to-hexadecimal conversion feature lets you view and record the binary output data in a hexadecimal format. A LOG feature lets you record data to a disk file.

3-4.1 Running BBTALK

Access the drive/directory containing the *BBTALK* program. Type `BBTALK` at the DOS prompt. The program will load, and a blank communications screen will appear with the following menu at the bottom of the screen.

```
F1-? F2-Script F3-Log F4-ASCII F5- COM1:  9600,N,8,1 F6-Save END-BRK AltX-Exit
```

Figure 3-1. BBTALK Menu

3-4.2 BBTALK Help

BBTALK has a built-in help screen.

- Press `F1` at any time to display *BBTALK's* help menu.
- Press any key when done.

```
═════════ BBTALK v2.25 Help Screen ═════════
  Copyright (c) 1994-1995, RD Instruments
           All rights reserved.
 F1 - This screen
 F2 - Run script file
 F3 - Toggle logging data stream to disk
 F4 - Toggle HEX and ASCII display
 F5 - Setup serial port
                 ↑/↓ - Select Parameter
   <Space> or <Enter> - Change Setting
                <Esc> - Accept entry
 F6 - Save serial port configuration
 F8 - Clear data screen
 Alt-Fx - Run script file "ALT-Fx.SCR"
 <Ctrl-PgDn> - YModem Receive
       <End> - Send BREAK
                     ASCII Data
       COLORS:        HEX Data
                Communications Error
              AltX - Exit BBTALK
═════════ Press any key to continue ═════════
```

Figure 3-2. BBTALK Help Screen

3-4.3 Wakeup the ADFM

Wakeup is the process of establishing communication with the ADFM. Immediately after you apply power to the ADFM, it enters the STANDBY mode. Sending a BREAK signal from a terminal/program awakens the ADFM. When the ADFM receives a BREAK signal, it responds with the wake-up message. The ADFM is now ready to accept commands at the “>” prompt from either a terminal or computer program. Press End to send the wakeup command (BREAK) to the ADFM.

The ADFM wake-up (copyright) message should appear.

```
Broadband ADFM Version x.xx
RD Instruments (c) 1996-1998
All rights reserved.
>
```

If there is no response from the ADFM, check the communications setup in the SETUP MENU and the ADFM. Both setups must be the same.

> **NOTE.** If the Caps Lock, Num Lock, or Scroll Lock keys are activated, this may interfere with the ability to send a valid Break signal when pushing the END key.

3-4.4 Communication Parameters

This menu sets the communications protocol between the ADFM and the computer.

a. Press F5 to view the SETUP MENU.

b. Use the Up/Down arrow keys to select the parameter to change.

c. Use the Enter or Space keys to change the parameter.

d. Press Escape to exit the SETUP MENU.

e. To permanently save this setup to the BBTALK.PTR configuration file, press F6. The configuration file is saved to the directory where *BBTALK* resides.

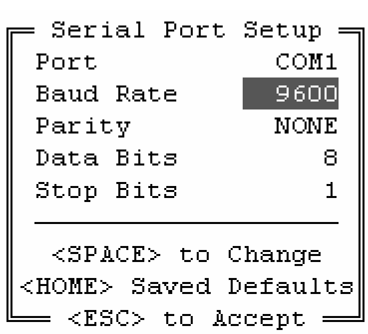

Figure 3-3. BBTALK Communication Setup Menu

3-4.5 BBTALK LOG Files

The LOG feature lets you record data to a disk file. You name the file (DOS convention) by pressing the F3 key. You can enable logging at any time. The help line shows the CAPTURE status. To use LOG, do the following steps.

a. Press F3 to enable the LOG function.

b. Enter the DRIVE (if other than current drive) and FILENAME.EXT. For example, type C:\ADFM\SAMPLE.TXT.

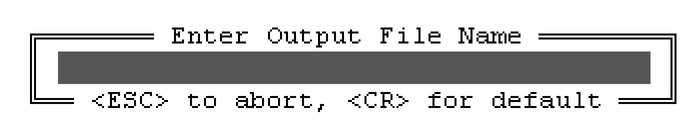

Figure 3-4. BBTALK Log File

c. If the file already exists, the program asks you if you want to overwrite the existing file.

d. All data sent to the screen will now be written to the file you specified. You can enable the CAPTURE feature at any time, even if the ADFM is already sending data.

e. To disable CAPTURE, press F3, and then press Enter without entering a file name.

> **NOTE.** When a high baud rate is being used, LOG may lose some data.

Chapter 4

Maintenance

4-1 Introduction

This chapter describes basic maintenance requirements for the ADFM.

- How to replace or recharge the desiccant
- How to replace and recharge the system batteries
- How to change fuses
- How to change the mains supply voltage selection

CAUTION. Never open the Electronics Housing inside a corrosive atmosphere. Severe damage to the PCBs can occur. Damage may not appear right away, but will shorten the lifespan of all internal components.

4-2 Desiccant

Desiccant is used to dehumidify the electronics housing interior. The factory-supplied desiccant lasts a year. Remember that desiccant rapidly absorbs moisture from ambient room air.

Used desiccant bags may be dried at 250° for 14 hours. As a minimum, replace the desiccant bags (Table 4-16, item 08) whenever the electronics housing is opened, or you are preparing to deploy or store the ADFM for an extended time.

CAUTION. Do not open the desiccant bag. Contact with the silica gel can cause nose, throat, and skin irritation.

NOTE. Desiccant bags are shipped in an airtight aluminum bag to ensure maximum effectiveness. There is a moisture indicator inside the bag. If the moisture indicator is pink, do not use the desiccant bag until it has been dried. MGD recommends replacing the desiccant bag just before the deployment.

a. In a non-corrosive atmosphere, remove the top of the unit.

b. Unscrew the two screws securing the housing cover and open the cover.

c. The desiccant bag holder is attached to the front panel with cable ties. Remove the ties and replace the desiccant.

d. Use cable ties to attach the desiccant holder to the front panel.

4-3 Battery Replacement

The Electronics Unit contains two types of batteries: the system (alkaline lantern or lead acid) batteries and the real-time clock back-up battery.

⚠ **CAUTION.** Before attempting to replace existing batteries, be sure that mains power source is disconnected. It is advised that only qualified personnel attempt this replacement procedure.

4-3.1 Replacing the Alkaline Lantern System Batteries

The ADFM's internal batteries use four 6-volt alkaline lantern type batteries with a nominal capacity of 13 Ah each (see Table 4-16, item 03). The nominal voltage is 24V for all batteries connected in series, while the low voltage is 20V. They are also commonly available. MGD recommends purchasing spare Energizer™ alkaline lantern batteries.

⚠ **CAUTION.** If the Electronics Unit is connected to a mains power, for your own personal safety we recommend that you disconnect mains first before opening the Electronics Unit housing.

a. In a non-corrosive atmosphere, remove the top of the unit.

b. Unscrew the two screws securing the housing cover and open the cover.

c. Remove the battery cover by removing the four screws

d. Replace all four batteries with new batteries.

e. Replace the battery cover.

f. Test the system (see Chapter 5).

⚠ **CAUTION.** Do not short out battery leads when removing the batteries. High currents may flow during shorts, and fire or personal injury may result. THERE IS NO FUSE IN SERIES WITH THESE BATTERIES!

4-3.2 Replacing the Lead-Acid System Batteries

The ADFM's internal batteries are two sealed lead-acid type batteries, with a nominal capacity of 7 Ah each (see Table 4-16, item 04). The nominal voltage is 24V for both batteries connected in series, while the low voltage is 20V. These batteries can be re-charged (see below). They are also commonly available. MGD recommends purchasing spare batteries. That way, when the time comes to change the internal batteries, fully charged batteries can be quickly installed and the drained batteries can be taken to be re-charged.

CAUTION. If the Electronics Unit is connected to a mains power, for your own personal safety we recommend that you disconnect mains first before opening the Electronics Unit housing.

a. In a non-corrosive atmosphere, remove the top of the unit.

b. Unscrew the two screws securing the housing cover and open the cover.

c. Unscrew the bolts securing metal bar and remove bar.

d. Disconnect the harness and reconnect new batteries.

e. Replace the metal bar and bolts.

f. Test the system (see Chapter 5).

CAUTION. Do not short out battery leads when removing the batteries. High currents may flow during shorts, and fire or personal injury may result. THERE IS NO FUSE IN SERIES WITH THESE BATTERIES!

4-3.3 Recharging The Lead-Acid System Batteries

To recharge batteries, follow the instructions below.

NOTE. Recommended charge is 1/20 of the rated capacity, which will maximize battery life and capacity.

The maximum charging current per manufacturer specification for these types of batteries is 3A at 20°C. For a 12-volt battery the charging voltage is 14.1 volts to 15.0 volts maximum. Please contact the specific battery manufacturer for more details if required. Longer battery life and higher capacity results if you charge batteries at a more moderate charging current rate. In general, a charging current of 1/20 of the rated capacity is recommended, which results in 0.6A for these batteries.

4-3.4 Replacing The Real Time Clock Backup Battery

The real-time clock (RTC) is designed to keep time when the power source is turned off. The backup battery is a single 3 volt, 250 mAh Lithium coin cell, and is located near the bottom left corner of the ADFM motherboard in the electronics housing (see Table 4-16, item 05).

a. In a non-corrosive atmosphere, remove the top of the unit. Open the front panel of the Electronic Housing.

b. With a small blade non-conductive screwdriver, gently lift and slip out the coin cell.

c. Replace with a new coin cell (Panasonic PR2330, or equivalent).

d. Test the system (see Chapter 5).

4-4 Fuse Replacement

The electronics chassis contains a mains supply fuse. The fuse is located on the front panel of the Electronics Housing.

⚠	**CAUTION.** Only fuses with the required rated current, voltage, and specified type should be used. Do not repair fuses or short circuited fuse-holders. To do so could cause a shock or fire hazard.

a. Disconnect the mains power cord.

b. In a non-corrosive atmosphere, remove the top of the unit.

c. Use a blade screwdriver to open the fuse holder.

d. Pull out the blown fuse, and replace the fuse. Use only the fuse specified for the selected mains supply voltage (see Table 4-16, item 10 or 11).

e. Make sure that the fuse holder is closed before reconnecting the mains power cord.

f. Test the system (see Chapter 5).

4-5 Changing Mains Supply Voltage

If you need to change the mains supply voltage selection from 230V to 115V or vice-versa, follow the procedure below.

⚠ **CAUTION.** Disconnect the mains power cord before attempting to change the voltage selection. Make sure you install a fuse appropriate for the selected mains supply.

a. Disconnect the mains power cord before attempting this procedure.

b. In a non-corrosive atmosphere, remove the top of the unit.

c. Locate plug P4 on the ADFM motherboard. Use the following table to determine the correct jumpers.

Voltage Selection	Jumper
115 VAC	P4.2 to P4.5
	P4.4 to P4.6
230 VAC	P4.5 to P4.6

d. Label the electronic housing with a label indicating the proper mains supply voltage.

e. Install a fuse appropriate for the selected mains supply (see Table 4-16, item 10 or 11).

f. Re-connect the mains power cord.

g. Test the system (see Chapter 5).

4-6 Replacement Parts

Table 4-16 is a listing of ADFM replacement parts, which include the Least Replaceable Assemblies (LRA), along with other parts such as fuses etc. When practical, you may use parts procured other than through MGD, if MGD is not listed as the manufacturer of these parts, and are considered by MGD to be generic. However, these parts must be direct equivalents to the parts listed. In particular, do not replace fuses with any other type than specified, although you may use a different manufacturer.

Table 4-1: List of ADFM Replacement Parts

Item	Description	Specification	Part Number	Mfgr
01	ADFM Electronics Unit	Assembly		MGD
02	ADFM Motherboard	PCB Assembly		MGD
03	Battery, Alkaline Latern	6 V, 13 Ah		Energizer
04	Battery, Lead Acid	12 V, 12 Ah	975-2000-00	Yuasa, or Power-Sonics
05	Battery, Lithium Coin Cell	3 V, 250 mA	PR2330	Panasonic
06	Cable, Mains Power			n/a
07	Cable, RS-232 Data	DB9-M to DB9-F	971-6092-00	n/a
08	Desiccant	bag	X1220	Mil-Pac
09	Display, LCD	4 x 16 characters	L161400J000	Seiko
10	Fuse, 115 VAC mains	250 mA, 250 V per IEC127-2/III	19195-250MA	Wickmann
11	Fuse, 230 VAC mains	125 mA, 250 V per IEC127-2/III	19195-125MA	Wickmann
12	Interface Board, Front Panel	PCB Assembly		MGD
13	Interface Board, Transducer	PCB Assembly		MGD
14	Modem	PCB Assembly		MGD
15	Recorder, PCMCIA	20 Mb		MGD
16	Transducer	Assembly		MGD
17	Transducer Cable			MGD

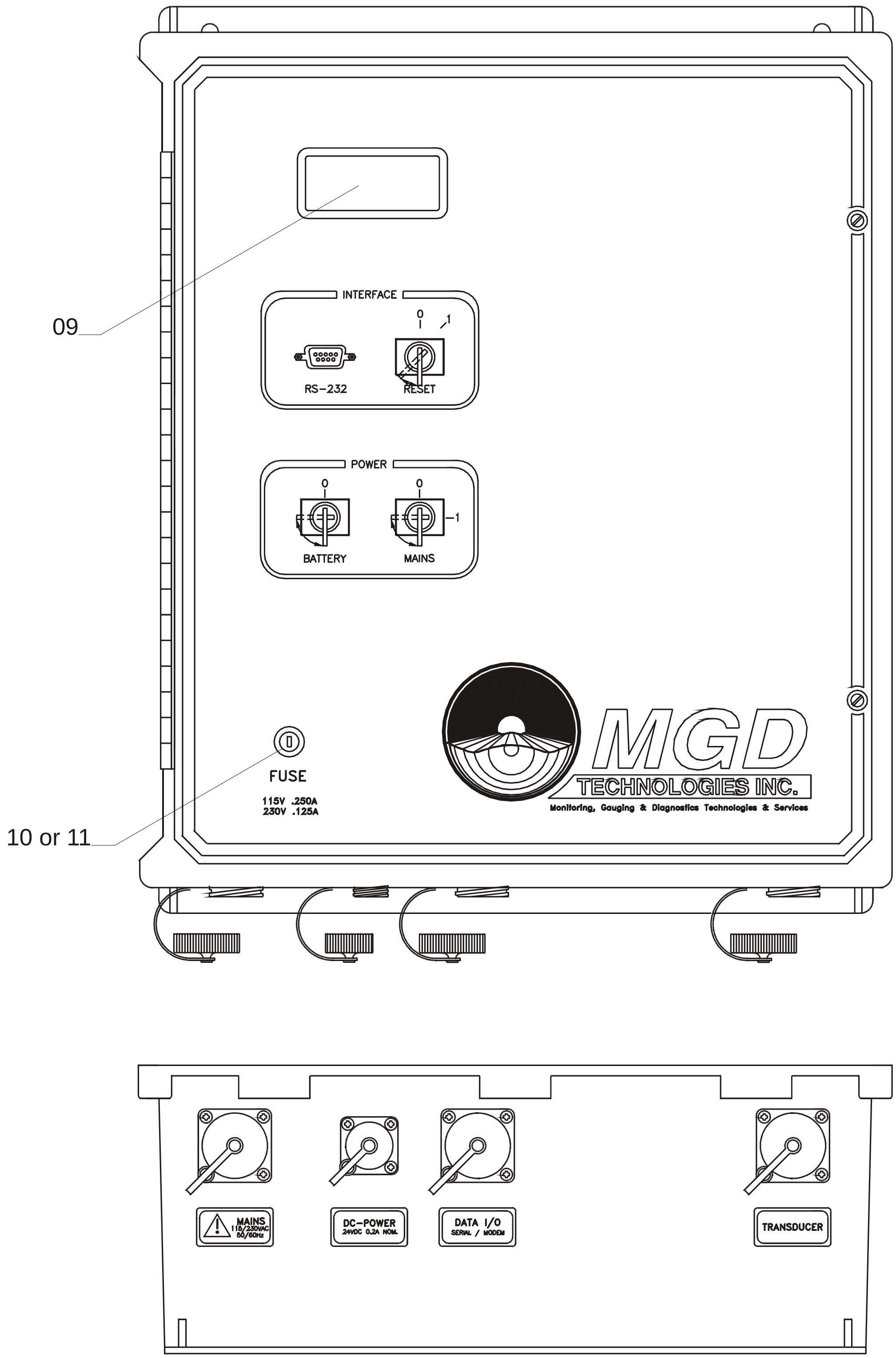

Figure 4-1. ADFM Electronic Housing (Exterior View) – Replaceable Parts Identification

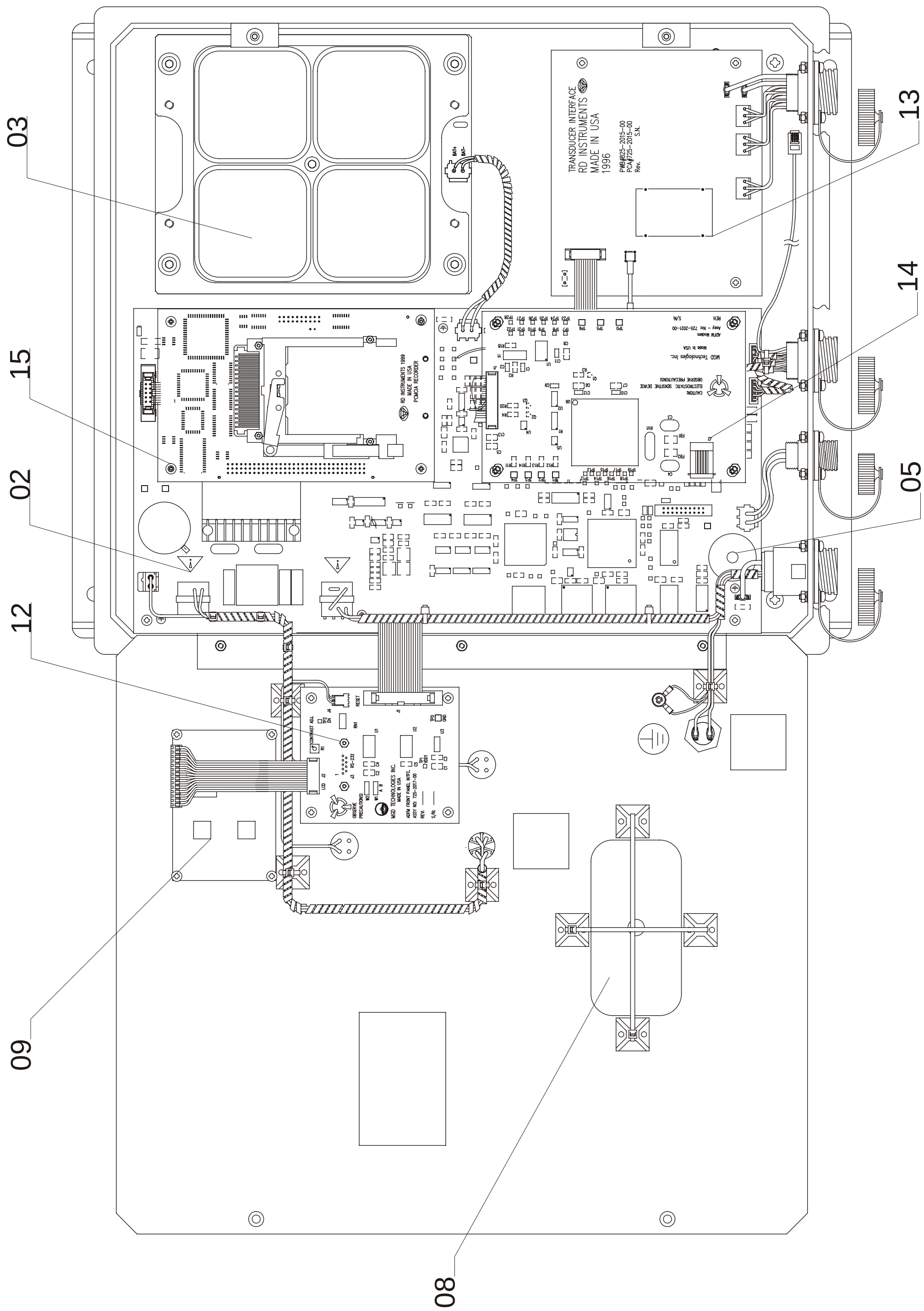

Figure 4-2. ADFM Electronic Housing (Interior View) – Replaceable Parts Identification

Chapter 5

ADFM Test Procedures

5-1 Introduction

This chapter explains how to test the ADFM using *BBTALK* and the *WinADFM* program. These tests thoroughly check the ADFM in a laboratory environment, but are no substitute for a practice deployment. You should test the ADFM:

- When you first receive the ADFM.
- Before each deployment or every six months.
- When you suspect instrument problems.
- After each deployment.

These test procedures assume all equipment is working. The tests can help you isolate problems to a major functional area of the ADFM. For trouble-shooting information, see Chapter 6.

NOTE. The built-in tests require you to immerse the transducer faces in water. If you do not, some of the tests may fail. Running the tests in air will not harm the ADFM.

5-2 Test Setup

Use the following steps to connect the ADFM system and to place the ADFM in a known state.

a. Connect a laptop computer to the RS-232 communication port.

b. Connect and apply power to the system as described in Chapter 2.

c. Place the ADFM transducer in approximately one foot of water.

5-3 Built-In Diagnostic Tests

The following describes how to execute an automatic self-test. In general, if the automatic self-test is successful, no further testing is required. However, if the automatic self-test is not successful, further fault isolation, utilizing individual Built-In Tests is necessary.

5-3.1 Automatic Built-In Test Test

The automatic Built-In Test (BIT) runs whenever the power is applied to the electronic housing or the reset button is cycled.

a. Switch power to the ADFM off.

b. Switch the power on again; however, make sure that at least one minute has passed since power was switched off. The computer screen will display [COLD Wakeup], and the ADFM's LCD display will show the "wake up message":

```
RD Instruments
-------------------
Acoustic Doppler
Flow Meter
```

c. The ADFM's LCD display will begin displaying the results of BIT as these tests are executed. The BIT tests will take approximately one or two minutes to perform after which the computer screen will display the wake up message:

```
Broadband ADFM Version 6.xx
RD Instruments © 1991-94
All rights reserved.
```

d. To repeat the BIT tests you may turn and release the Reset key switch, located at the front panel of the Electronics Unit.

e. To wake up the ADFM without performing the BIT, send a BREAK from *BBTALK*, by pressing the <END> key. The above wake up message will appear on the computer screen in approximately one second; the LCD will not display this message.

5-4 Using BBTALK to Test the ADFM

BBTALK allows you to send direct commands to the ADFM. You may use the following commands to further test the system.

5-4.1 Diagnostic Tests

The diagnostic test checks the major ADFM modules and signal paths. We recommend you run this test before a deployment. If any test fails, call MGD for further troubleshooting information.

a. Start *BBTALK*. Press the `End` key to wake the ADFM.

b. Type `CP` to clear the fault log.

c. Type `PC`. A message similar to the following should appear.

```
>pc
Transducer Communications:                    PASS
Recorder BIT (RT ):                           PASS
Modem (MO ):                                  PASS
System Voltages (PT2):                        PASS
CPU RAM (PI ):                                PASS
Timing Card RAM (PI ):                        PASS
Demodulator RAM (PI ):                        PASS
Checksum Code/Tables (PT8):                   PASS
Receive Test (PT3):                           PASS
Transmit Test (PT4):                          PASS
Electronics Wrap Test (PT5):                  PASS
LPF Bandwidth Test (PT6):                     PASS
Clock Interrupt (PI ):                        PASS
Error Log:
 Power Loss
 Auto Restart Occurred
 Transducer Communications Error
Self Tests Complete
```

Many users tell us their ADFM reports a FAIL condition during the self-tests that check the ADFM's "electronics wrap test." In most cases, the cause of the failure is external interference. A "noisy" environment, such as in a lab usually causes this external interference. You can take a few simple steps to find out if the FAIL condition is being caused by external interference or by a problem with the ADFM.

The following procedure explains how to conduct the PC test to reduce the likelihood of a false failure.

a. Turn off any nearby equipment (monitors, radios, etc.) that is not needed to conduct the test.

b. The electronic housing case should be closed to help shield the circuit boards from external electronic "noise."

c. The ADFM transducer head must be immersed in water. Ensure there are no air bubbles on the transducer faces.

d. If the transducer is immersed in a bucket of water that is resting on the floor, noise can be coupled into the ADFM. As such, you should shield the bucket from the floor by inserting a piece of hard foam between the bucket and the floor.

e. If possible, you may also want to move the ADFM to a different room, or at least to a different part of the lab to see if the fail condition goes away.

f. If after following the above procedure, your ADFM still fails the receive tests, contact MGD for assistance.

5-4.2 Receive Path Test

This test runs a through test on the ADFM's receive path electronic circuits.

a. Start *BBTALK*. Press the `End` key to wake the ADFM.

b. Type `CP` to clear the fault log.

c. Type `PT3`. A message similar to the following should appear.

```
>pt3

Correlation Magnitude:

               Lag  Bm1  Bm2  Bm3  Bm4  Bm5
                 0  255  255  255  255  255
                 1  206  212  207  206  212
                 2  103  118  107  105  119
                 3   31   47   33   33   49
                 4    4   15    9    6   16
                 5    2    3    7    3    7
                 6    2    2    9    1    5
                 7    2    2    6    1    4

  High Gain RSSI:    45   47   44   42   47

  DAC Sin:   182
  DAC Cos:   183
  Duty:       50   50,    LPF:  0

Receive Test Results = $00000000 ... PASS
```

d. Observe the High Gain RSSI values. They should be between 40 to 57 counts with the transducer connected.

e. Disconnect the transducer from the electronic housing by disconnecting the transducer cable.

f. Type `PT3`. A message similar to the following should appear.

```
>pt3

Correlation Magnitude:

               Lag  Bm1  Bm2  Bm3  Bm4  Bm5
                 0  255  255  255  255  255
                 1  192  196  198  192  194
                 2   70   75   88   76   73
                 3    9   11   27   26   11
                 4   16   15   10   26   17
                 5   12   15    6    9   13
                 6   10   11   10   15    8
                 7    9    8   10   19    7

  High Gain RSSI:    21   21   20   21   21

  DAC Sin:   186
  DAC Cos:   187
  Duty:       59   50,    LPF:  0

Receive Test Results = $00000000 ... PASS
```

g. Observe the High Gain RSSI values. They should be between 20 to 25 counts with the transducer disconnected.

h. Leave the transducer cable disconnected if you want to run the next test.

5-4.3 Transmit Test

This test runs a through test on the ADFM's transmit path electronic circuits.

a. Start *BBTALK*. Press the `End` key to wake the ADFM.

b. Type `CP` to clear the fault log.

c. Type `PT4`. A message similar to the following should appear.

```
>pt4

----------- BEAM 1 -----------
IXMT    =      3.1 Ml Amps peak
VXMT    =      4.1 Volts peak
RXMT    =   1335.6 Ohms
Transmit Test Results = $40 ... PASS
----------- BEAM 2 -----------
IXMT    =      3.1 Ml Amps peak
VXMT    =      4.1 Volts peak
RXMT    =   1335.6 Ohms
Transmit Test Results = $40 ... PASS
----------- BEAM 3 -----------
IXMT    =      3.1 Ml Amps peak
VXMT    =      4.1 Volts peak
RXMT    =   1335.6 Ohms
Transmit Test Results = $40 ... PASS
----------- BEAM 4 -----------
IXMT    =      3.1 Ml Amps peak
VXMT    =      4.1 Volts peak
```

```
RXMT    =   1335.6 Ohms
Transmit Test Results = $40 ... PASS
```

d. Observe the RXMT values. They should be above 1300 ohms with the transducer disconnected.

e. Re-connect the transducer to the electronic housing by connecting the transducer cable.

f. Type `PT4`. A message similar to the following should appear.

```
>pt4

----------- BEAM 1 -----------
IXMT    =     30.9 Ml Amps peak
VXMT    =      3.4 Volts peak
RXMT    =    109.7 Ohms
Transmit Test Results = $0 ... PASS
----------- BEAM 2 -----------
IXMT    =     30.6 Ml Amps peak
VXMT    =      3.4 Volts peak
RXMT    =    111.3 Ohms
Transmit Test Results = $0 ... PASS
----------- BEAM 3 -----------
IXMT    =     30.9 Ml Amps peak
VXMT    =      3.4 Volts peak
RXMT    =    109.7 Ohms
Transmit Test Results = $0 ... PASS
----------- BEAM 4 -----------
IXMT    =     30.9 Ml Amps peak
VXMT    =      3.4 Volts peak
RXMT    =    109.7 Ohms
Transmit Test Results = $0 ... PASS
>
```

g. Observe the RXMT values. They should be approximately 109 ohms with the transducer connected.

5-4.4 Sensor Test

This test checks the internal ADFM sensors (temperature and depth).

a. Start *BBTALK*. Press the `End` key to wake the ADFM.

b. Type `CP` to clear the fault log.

c. Type `PA1`) This command lets you view sensor data and scale factor calculations while the ADFM is operating.

```
>pa1

Press any key to quit sensor display ...

Transducer Temp   Depth(mm)
  21.47øC            0
  21.47øC            0
```

d. Verify these readings are present and correct.

5-4.5 Modem Test

This test checks the modem operation.

a. Start *BBTALK*. Press the `End` key to wake the ADFM.

b. Type `CP` to clear the fault log.

c. Type `MP1` to turn the modem power on.

d. Type `MO`.

e. Verify these readings are present and correct.

```
>mp1
>mo
Modem is OK
Modem state/connect status = COMMAND/NOT CONNECTED
Primary Port = RS-232
```

f. Type `MP0` to turn the modem power off.

g. Type `MO`.

h. Verify these readings are present and correct.

```
>mp0
>mo
Modem is NOT OK
Modem state/connect status = OFF/NOT CONNECTED
Primary Port = RS-232
>
```

5-4.6 Recorder Test

This tests the recorder — it does not destroy any data.

a. Start *BBTALK*. Press the `End` key to wake the ADFM.

b. Type `CP` to clear the fault log.

c. Type `RT`.

d. Verify these readings are present and correct for your system.

```
>rt

Recorder Message...  0  1 14  0  0

RAM --------------PASS
Cards Found ------   1
Memory Found -----  20 MB
Write/Read -------PASS
Block Copy -------PASS
Recorder NOT Erased

Recorder BIT...PASS
>
```

5-5 Using WinADFM to Test the ADFM

WinADFM can be used to test the ADFM. Figure 5-18 shows the Operate dialog window. The ADFM can be tested for proper communication, bench test the system to ensure the system electronics are operating properly, and field-test the system after it has been installed.

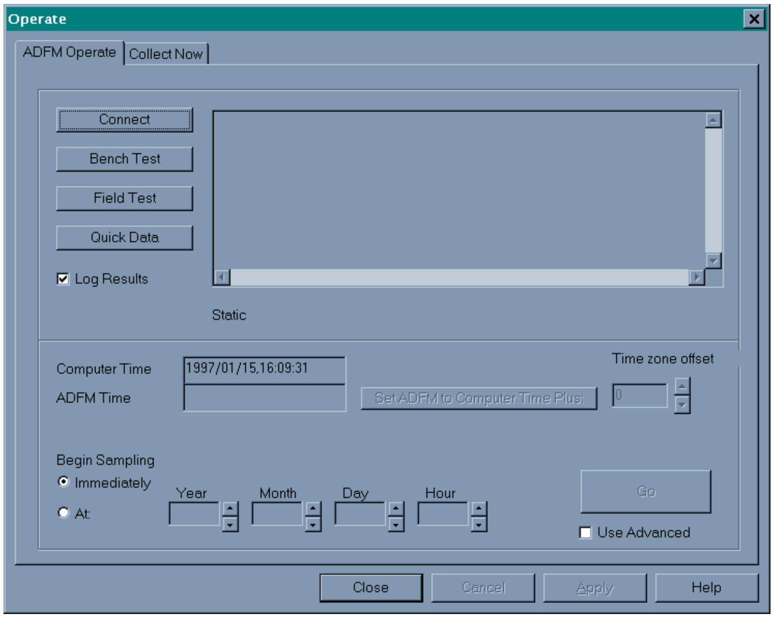

Figure 5-1. WinADFM Operate Dialog Window

The tests are listed in the top half of the window next to the output display. Results of each test are displayed in the terminal screen to the right of the buttons. Test results are recorded in the station's Log File. If checked, the log file keeps a record of all communication between the computer and the ADFM once communications have been established.

5-5.1 Connect

This test establishes communications and determines if the ADFM wake-up message contains any errors. Determines if the system is "ready". This test is for either serial (RS-232) or modem communications between the ADFM and a laptop. The system will return an error declaration (Communication Error) if communications are not obtained.

5-5.2 Bench Test

This test determines if all the required ADFM systems are present and functioning. The bench test does the following.

- Establishes communications and determines if the ADFM wake-up message contains any errors. Determines if the system is "ready".

- Lists the ADFM's serial number and the transducer and electronics firmware versions.
- Determines if an internal recorder is present. Performs a "Recorder Test" and returns an "OK" or an error declaration.
- Determines if a modem is present. Performs a "Modem Test" and returns an "OK" or an error declaration.
- Performs a "Systems Test" and returns an "OK" or an error declaration.
- Performs a Look-up Table "Checksum Test" and returns an "OK" or an error declaration.
- Determines the value of three operating voltages in the ADFM.
  - Battery Voltage,
  - VDD1 Voltage (logic),
  - Transducer Voltage.

5-5.3 Field Test

This test performs internal ADFM system checks that should be performed after installation. This test does the following.

- Establishes communications and determines if the ADFM wake-up message contains any errors. ADFM is "ready".
- Determines if the receive path is operating properly and returns a Pass or Fail with an error. This test will fail if the transducer is not connected to the electronics case.
- Determines if the transmit path is operating properly and returns a Pass or Fail with an error.
- Determines if the electronics signal-processing path is operating properly and returns a Pass or Fail with an error. This test will fail if the transducer is not underwater.

NOTES

Chapter 6

ADFM Troubleshooting

6-1 Introduction

This chapter describes how to isolate faults. The provided information below assumes that faults are isolated with a large degree of certainty to a least replaceable assembly (LRA) level only. Considering the complexity of the ADFM it is MGD Technologies Inc.'s intention to provide as much information as it seems practical for field repair. Fault isolation to the component level is beyond the scope of these instructions.

The time to repair the system in the field will be minimized if an entire replacement unit is available, that is a transducer, an Electronics Unit, and a transducer cable. For efficient field service, MGD Technologies Inc. strongly advises the availability of at least the listed LRAs, but an entire replacement system is recommended (a LRA is either a printed circuit board assembly or a entire module). LRA's are listed for completeness in Chapter 4, including the ordering numbers and other replacement parts and their ordering numbers.

Table 6-1: List of Least Replaceable Assemblies

LRA:	Description:
Front Panel Interface	Front panel interface board
LCD	The front panel LCD display unit.
Modem Interface	Modem interface board, not including the Modem.
Modem	The fax/data Modem unit.
Motherboard	The Electronics Unit motherboard.
Recorder	PCMCIA-Recorder Board.
Transducer	The entire transducer head, which includes transducer electronics, transducer housing, transducer ceramic assemblies, and cable.
ADFM Motherboard	The entire ADFM Motherboard assembly, excluding the Modem and Recorder and its associated components.

6-2 Equipment Required

Special test equipment is not needed for troubleshooting (fault isolation). A list of equipment required for the performance tests is listed below. Any equipment satisfying the critical specification listed may be used.

Table 6-2: Required Test Equipment

Required Test Equipment	Critical Specification
Digital Multi-Meter	3 ½ digit
	DC-Voltage Range: 200.0 mV, 2.000V, 20.00 V, 200 .0V
	DC-Voltage Resolution: 100 uV, 1 mV, 10 mV, 100 mV, 1 V respective
	DC-Voltage Accuracy: ± 1%
	AC-Voltage Range: 200 V, 450 V
	AC-Voltage Resolution: 10 mV @ 20 V range
	AC-Voltage Resolution: 1 V @ 450 V range
	AC-Voltage Accuracy: ± 2%
	Resistance Range: 200, 2 k, 20 k, 200 k, 20 Mohm
	Res.-Resolution: 0.1, 1.0, 10, 100, 1k, 10k respective
	Res.-Accuracy: ± 2% @ 200 Ohm to 200 kOhm
	Res.-Accuracy: ± 5% @ 20 Mohm

6-3 Power On Fault Isolation

Symptom:	No wake up message at LCD display or computer screen.
Possible Cause:	Power
What to Do:	Refer to “Built-in Test is Not Executing,” page 6-6.

Symptom:	No wake up message at LCD, but computer screen displays wake up message when a BREAK is sent, or when a manual Reset is applied (Reset Switch).
Possible Cause:	LCD. Front Panel Interface Board. Cable connection between LCD and front panel. Cable connection between Front Panel Interface Board and ADFM Motherboard. ADFM Motherboard.
What to Do:	Replace LCD. Replace Front Panel Interface Board. Replace ADFM Motherboard.

Symptom:	No wake up message at computer screen, but LCD displays wake up message and completes BIT.
Possible Cause:	RS-232 connection. Computer’s communications port set up wrong. Front Panel Interface Board. ADFM Motherboard.
What to Do:	Troubleshoot cabling. Run BBTEST to set up computer’s COM-port. Replace Front Panel Interface Board. Replace ADFM Motherboard.

6-4 Fault Isolation

Symptom:	“Transducer not found”
Possible Cause:	Transducer Cable. Transducer Cable Connector. Cabling between Motherboard and Transducer Connector of Electronics Unit. Transducer.
What to Do:	Refer to “BIT Determines a Problem Associated with the Transducer,” page 6-10.

Symptom:	“Recorder not found”
Possible Cause:	Recorder cable assembly. Recorder Assembly. ADFM Motherboard.
What to Do:	Check recorder cable connection to motherboard. Replace Recorder Assembly. Replace ADFM Motherboard.

Symptom:	**Recorder found but not recording data correctly.**
Possible Cause:	Recorder Assembly.
What to Do:	In BBTALK type “R?” for the recorder menu. Next type “RT” followed by a CR to perform a non-destructive recorder diagnostics test. The results should look like “0 1 14 0 0 “. The 1st, 4th, and 5th digits should be zero. A non-zero number in one of these digits indicates a failure. The 2nd digit is the number of PCMCIA cards in the recorder (1 or 2). The 3rd digit is the hexadecimal (h14=20, or ha=10) representation of the number of megabytes of recorder memory installed.

Symptom:	**“Modem Not Found”**
Possible Cause:	Modem Interface Board. Modem. ADFM Motherboard
What to Do:	Check Modem Interface Board connections to motherboard and to Modem. Replace if necessary. In BBTALK type “MT” followed by a CR. Then type “AT” followed by a CR. AN “OK” should be displayed; if not the Modem may be defective. If none of the above works the ADFM Motherboard may need replacement.

Symptom:	**Modem found but does not dial out.**
Possible Cause:	Modem. Phone Line. ADFM Motherboard.
What to Do:	In BBTALK type “MT” followed by a CR. Then type “AT” followed by a CR. AN “OK” should be displayed; if not the Modem may be defective. If successful in (2), type “ATDT1” followed by CR. If the message “No Dial Tone” appears the phone line, or phone connections may be defective. If none of the above works the ADFM Motherboard may need replacement.

Symptom:	**Ancillary Data VXDR, VDD1, and VDC are outside the range listed in section “Maintenance and Troubleshooting”.**
Possible Cause:	Batteries or Power Supply. ADFM Motherboard.
What to Do:	Replace batteries. Check power supply.
	Replace Motherboard. Refer to section “Least Replaceable Assembly Fault Isolation,” page 6-6, and “Power,” page 6-7 for further information and trouble shooting.

Symptom:	**Transmit Test Failure**
Possible Cause:	Cabling between the Motherboard and the Electronics Unit’s rear panel Transducer Connector. Transducer Cable or connectors. ADFM Motherboard.
What to Do:	Refer to section “Least Replaceable Assembly Fault Isolation,” page 6-6.

Symptom:	**“Loop Test Failure”. An occasional loop test failure may be normal since this is a statistical test. If the percentage of loop test failures is large (>10%) a problem may have arisen.**
Possible Cause:	Transducer not connected properly, or defective. High interference source. ADFM Motherboard.
What to Do:	Refer to section “Least Replaceable Assembly Fault Isolation,” page 6-6.
	Eliminate interference source[1], or shield transducer environment. From BBTALK type “PT3” followed by a CR. The Correlation Magnitude at Lag 0 should be 255, at Lag 7 it should be typically < 20. Also, the Amplitude should be typically < 65. Otherwise it may indicate a high source of interference.
	Replace Motherboard.

Symptom:	**Any RAM Test failure.**
Possible Cause:	ADFM Motherboard.
What to Do:	Replace Motherboard.

Symptom:	**Clock Interrupt failed.**
Possible Cause:	ADFM Motherboard.
What to Do:	Replace Motherboard.

[1] It is recommended to record the values for Correlation Magnitude, Amplitude, and the results of the transmit test for later reference.

6-5 Least Replaceable Assembly Fault Isolation

The following procedure is intended to assist fault isolation in cases where:

- The Built-in-Test (BIT) can not be executed (no ADFM Wake-Up for example) or
- The BIT determines an ADFM Transducer problem

It is not necessary to follow this procedure for routine maintenance. However, the Built-In Tests may be executed on a routine basis.

CAUTION. The following servicing instructions are for use by service-trained personnel only. To avoid dangerous electric shock, do not perform any service unless qualified to do so. Please read section “GENERAL WARNINGS AND CAUTIONS” for more important information.

For the following procedure the top cover of the ADFM Electronics Unit must be removed from the chassis. This exposes the Electronics Unit’s circuitry. Especially if mains power is used to power the ADFM, dangerous voltages which may cause personal injury due electrical shock are present at various location on the board, in particular where marked with a lightning bolt located inside a triangle.

CAUTION. The ADFM contains Electro Static Sensitive Devices. You must take accepted ESD prevention measures BEFORE OPENING THE ADFM ELECTRONICS UNIT.

The circuitry contains electro-static sensitive devices throughout the ADFM Electronics Unit. To prevent electro-static discharge (ESD) to these components, you must ground the Electronics Unit as well as your self. Use an ESD wrist strap (or other accepted means) to ground your self. Please keep in mind that even if an ESD has occurred the ADFM may still work, but its reliability may be seriously impaired.

6-5.1 Built-in Test is Not Executing

If the built-in test (BIT) can not be executed, most likely it is caused by one of the following:

- Faulty Communication
- No Power or a faulty ADFM power supply

Communication

If the built-in test can not be executed because of a communication problem between the host computer and the ADFM, or at any other time communication can not be established, the following procedure may help you to isolate the problem.

a. Verify that the internal or external power sources are properly connected to the ADFM, and sufficient to supply it.

b. Verify that the computer's serial port is functioning normally. With Windows 95, go to **Start**, **Settings**, **Control Panel**. Double click **System**, go to the **Device Manager** tab and select **Ports** to determine if the computer's serial port is properly operating. Verify line continuity on the RS-232 Serial Communications Cable.

c. Using *BBTALK*, located in the C:\WinADFM root directory, send a break to the ADFM using the <end> key. Make sure that the computer port is set up correctly for port setting, baud rate, parity, number of data-bits and number of stop-bits by pressing the F5 key while in *BBTALK*. The correct parameters are the COM port you are using (typically COM1), 9600, none, 8, 1. Sending a break will establish serial communications between the ADFM and the computer. The wake-up message, and a series of built-in test results should be displayed at the Electronics Unit's LCD (please refer to the self-test description in Chapter 5).

d. If remote communications can still not be established, assert a manual reset at the ADFM Electronics Unit by turning the keyed switch labeled "RESET" to the "1" position; release the switch. This should start the built-in test. The wake-up message, and a series of built-in test results should be displayed at the Electronics Unit's LCD (please refer to the self-test description in Chapter 5).

If the above procedure is not successful, one possible answer is that the Electronics Unit's motherboard is faulty, and may have to be exchanged. If all tests are successful (i.e., the computer screen produces normal, legible results), however, at no time does the LCD display showed any information, or the display was scrambled, the ADFM's LCD display or the front panel interface may be faulty, and may require replacement. It may, however, be the ADFM power supply that is at fault.

6-5.2 Power

If the built-in test can not be executed locally or remotely, nor any other type of communication is possible with the ADFM, follow the procedure below to assist you to isolate the problem.

a. If you tried to use internal batteries to power the ADFM you may alternatively try mains power or DC power if possible. If you are successful, a faulty battery switch, or its wiring most likely causes the problem. Check also the internal batteries' wiring harness for good connection at the battery terminals, and the motherboard battery connector.

NOTE. MGD Technologies Inc. recommends replacing the ADFM Electronics Unit unless the problem is obvious and can be safely repaired in the field.

b. If mains power is used for supplying the ADFM with power, check if your mains outlet has the proper voltage.

   1. Check if the Mains Power Switch at the front panel is in the On-position (“1”-position). You have to use the supplied key to rotate the switch.
   2. Check the mains fuse. The mains fuse is located on the front panel of the ADFM electronic chassis. Remove the mains power cord, and gently prey open the fuse drawer, and check the fuse.

CAUTION. Replace the fuse only with the specified fuse type, and fuse rating. Do not short circuit the fuse or fuse holder, as this presents a fire hazard. PLEASE READ THE WARNINGS AND CAUTIONS AT THE BEGINNING OF THIS MANUAL, AND THE BEGINNING OF THIS SECTION.

c. If an external DC-supply is used to supply the ADFM check if your external supply is functioning, and is able to supply the proper voltage to the ADFM. Proper DC voltage is 12 to 26 VDC. Check if the Battery Switch at the front panel is in the On-position (“1”-position). You have to use the supplied key to rotate the switch.

If the above procedure is not successful in establishing communications with the ADFM, most likely the problem lies within the ADFM’s Electronics Unit. You may have to remove the Electronics Unit’s top cover for further fault isolation.

CAUTION. You must obey all warnings and cautions regarding power and ESD. Please read these warnings at the beginning of this manual, and the beginning of this section.

Regardless of which type of power you are using you can measure the ADFM’s Electronics Unit’s internal voltages at the test points (TP) listed in Table 6-39. If you are facing the front panel, all listed test points are located at the lower left corner of the ADFM motherboard. Also the test/reset switch labeled “S1” is located at these test points.

d. Once you applied power to the system and switched the appropriate power switch into the On-position (“1”-position), you should be able to measure the unregulated (raw) supply voltage VPWR+ at test point TP7. If you are able to measure VPWR+, the power supply connection is OK. You should be able to measure this voltage regardless which type of power you are using, or regardless of any combination of power you are using.

e. You also should be able to measure VDD2 and VDD3 at test point TP2 and TP3 respective.

f. Depress, and release switch S1, and measure the remaining listed voltages.

Table 6-3: List of Test Points

Test Point:	Label:	Description:	Voltage:
TP0	GND	Electrical Ground	0 V
TP1	VDD1	Main supply of electronics	5.0 ± 0.15 VDC
TP2	VDD2	Nonvolatile electronics supply	5.0 ± 0.15 VDC
TP3	VDD3	Auxiliary supply	16.0 ± 1.50 VDC
TP4	VCC	Receiver supply	5.0 ± 0.15 VDC
TP5	VR1	Reference voltage	2.50 ± 0.015 VDC
TP6	VXMT	Transmitter/Transducer supply	5.0 ± 0.15 VDC
TP7	VPWR+	Raw power supply	28 ± 3.0 VDC @ Mains Vbatt - 2 VDC @ DC

If the above test is not successful you may have to replace the Electronics Unit, or the Electronics Unit’s motherboard.

g. If the above voltages can be measured following the procedure above, and communication can still not be established successfully, the problem may still be a faulty communication line, or a faulty Electronics Unit motherboard.

6-5.3 BIT Determines a Problem Associated with the Transducer

The built-in test (BIT) is not able to isolate in all instances the problem exactly. If, with help of BIT you isolated the fault to be within the transducer or the Transmit Test failed, the problem may be associated with the following items.

- Any connection between the ADFM motherboard and the transducer cable
- A faulty transducer

To check any connection between the transducer and the ADFM Electronics motherboard, other than the transducer cable, the Electronics Unit's top cover has to be removed.

> ⚠ **CAUTION.** You must obey all warnings and cautions regarding power and ESD. Please read these warnings at the beginning of this manual, and the beginning of this section.

To check these connections, inspect for proper seating of all connections on the ADFM Electronics Unit's motherboard located in the ADFM Electronics Unit's Chassis. Do not alter the connections made on the motherboard for a reason other than to re-establish a faulty connection.

Appendix
A

ADFM System Overview

A-1 Introduction

The ADFM consists of two units: the Electronics Unit and the transducer. Both Units are described below to a detail necessary for an understanding of their function, and as an aid for troubleshooting.

A-2 Electronics Unit Circuit Description

The following description refers to Figure A-17. The legends used are spelled out more precisely in Table A-18.

A-2.1 Power Supply System

The power supply supplies the ADFM Electronics Unit and the ADFM transducer with power. It is designed to minimize energy consumption, by employing low power circuits, and power strobing of functional circuit modules. In addition, a highly efficient switching regulator generates the ADFM's five-volt main power supply.

The necessary supply voltages are derived from mains, an external DC-supply, or an internal 24-volt supply. Any combination of supplies is also possible. The highest DC-voltage in the system will determine which power source will supply the ADFM. The mains supply will generate approximately 28 VDC. Therefore, if an internal battery is installed (24 VDC) and mains is connected, the ADFM will be supplied by the mains voltage, when the mains power switch is in the “On” position.

Mains enters the system through the power entry module (MAINS PWR ENTRY), which provides the voltage selector switch, the mains fuse, and electro-magnetic interference (EMI) filtering. The mains power switch located at the front panel allows On/Off control of the mains power. A power transformer changes the mains voltage level at the primary winding, which can be configured to accept either 115 or 230 volts ac, to about 20 VAC at the secondary winding. The voltage is rectified, and filtered at the power filter (PWR FILTER). External DC-supply voltage and internal batteries are connected through diodes. A battery power switch located at the front panel is common to both DC supplies. The DC supplies and the rectified mains supply are connected together at the power filter.

This unregulated DC supply voltage is connected to the auxiliary regulator (AUX. REG.), which pre-regulates the supply to about 16 volts (VDD3); it also produces a regulated 5 volts supply (VDD2). These voltages are present as long as mains, or the internal/external DC-sources are connected. The main power control (MAIN PWR CONTROL) enables the DC/DC switching regulator (DC/DC-CONV.) under CPU control. It enables the main 5-volt power (VDD1) to the Electronics Unit; VDD1 supplies the CPU, the timing generator circuitry, bus interface logic, part of the off-board I/O, the recorder, and the front panel interface. VDD2 supplies volatile memory (RAM), volatile configurable logic circuits, and the real time clock (RTC) with standby power. In addition, the RTC is also backup-powered by a 250 mAh Lithium coin cell, which maintains its calendar and alarm settings if all power is off.

To save power also when the Electronics Unit is “awake”, that is if VDD1 is switched on, additional power management is provided. The CPU can enable power via the receiver power strobe switch (RCV PWR STROBE) to the receiver portion of the ADFM, which includes the receiver amplifier (RCV-AMP), the mixers, the low pass filters (LPF) the limiting amplifiers (LIMITER), and the data acquisition circuitry (FIFO, CORRELATOR) as its main components. Also the 2.50-volt reference voltage VR1 is controlled by the same switch. The CPU controls also the transducer power strobe switch (XDCR PWR STROBE), which enables a 7.9-volt regulator. After additional filtering and power supply decoupling, it supplies the transducer and transmit amplifier (XMT-AMP) with power.

To increase reliability and reduce power consumption, all power strobes and controls are solid state devices.

A-2.2 Receiver

The transducer output signal (RCV-SIG) is routed to the receive coupling transformer (RCV-XFMR) that provides isolation and impedance matching. The signal is further amplified and bandwidth limited by a high gain selective log-amplifier (RCV-AMP) circuitry. The amplified receive signal is fed to a frequency mixer, where the signal is mixed multiplicatively with the local oscillator (LO) frequency. The desired base band signal, which is the difference frequency of the receive signal and the local oscillator frequency, is obtained by passing the mixer output signal through a low pass filter. The base band signal contains now the entire Doppler spectrum without the carrier signal.

The mixer is a quatrature mixer, where an in-phase (I), and a quatrature signal (Q) is obtained. Both signals are needed for the correlator, which performs the basic digital signal processing. The I and Q-signals are buffered with a first-in/first-out buffer (FIFO). The signal's echo strength, also named relative signal strength (RSSI) is also low pass filtered and digitized.

The receiver power supply is under CPU control, and is powered by VCC. Bi-directional digital bus transceivers provide the system bus interface where the pre-processed data from the receiver are available for post processing by the CPU.

A-2.3 Timing Generator

The timing generator (TIMING-GEN) generates all signals needed for the transmitter and receiver, such as the transmit signals, transmit enable, and the local oscillator quatrature signal for the mixer.

The transmitter amplifier (XMT-AMP) is considered part of the timing generator. It is a power driver, which buffers the logic level signal generated by the timing generator, and drives the transmitter output transformer (XMT-XFMR). The transmit transformer provides isolation between the Electronics Unit of the ADFM and the transducer; it connects to the transducer transmit input via a IS-barrier (optional). The transmit current is monitored by a current transformer (CURR-XFMR). Its' output signal is scaled and digitized, and is part of the ADFM's build in self test (BIT).

The timing generator interfaces to the system bus through bi-directional digital bus transceivers. All timing generator setups are fully programmable, and are downloaded by the CPU to the timing generator's own RAM. The CPU is able to read back the timing setup data, the digitized current sense data, as well as for monitoring purposes the unregulated DC input voltage (VDC), the transmit voltage (VXMT), and the main 5 volt supply (VDD1).

A-2.4 Central Processing Unit

The central processing unit (CPU) is not shown in detail in the block diagram. The major CPU components are the micro processor unit (MPU), random access memory (RAM) for data storage, read only memory (ROM) for program storage, a real time clock (RTC) to keep time and date, a address decoder, and a CPU supervisor.

The MPU is a power efficient 68000-based HCMOS processor. It provides all housekeeping functions for the ADFM, as well as post processing of the Doppler data, data formatting for data-I/O, and the user command input interface.

The ROM is configurable in size (128 to 512 k-words), uses Flash or EPROM, and is typically factory set to 512 k-words Flash. The RAM is supplied by VDD2, which provides non-volatility, as long as either a DC power, or mains is supplying the ADFM, that is the RAM contents is maintained during the sleep mode (power down mode). RAM contents are lost if none of these sources are present.

The RTC keeps time and date, including leap year. When the RTC's programmed alarm compares with the current time and date, its alarm function generates an interrupt, which in turn wakes the CPU up from an asleep mode (power down mode). It also keeps time for time between ensembles and time between pings for example. The RTC's memory is backed up by a 250-mAh Lithium coin cell for up to 3 years, even if external and internal power sources are not present. However, it is recommended to change the backup battery at least every 2 years.

The address decoder provides all enables and controls for all CPU functions, bus interface enable, timing generator enable and control, receiver enable and control, off-board enable and control (serial interfaces such as RS-422, RS-232), and power supply controls. Interrupt priority encoding and bus-ready control (wait state generator) are also functions of the decoder.

The CPU supervisor monitors power, and generates an un-maskable interrupt for the MPU to signal a power fail. The CPU is able to shut down in a controlled manner. If the supply voltage should fall any further, the supervisor generates a system reset. Further more, it protects RAM and RTC from an erroneous writes during power down or power fail events. When the system is in sleep mode a RTC interrupt sets a supervisor register, which in turn switches the main 5 volt power on (VDD1). The MPU is able to interrogate the source of the interrupt, and will proceed according its instructions.

The CPU interfaces to the system bus through bi-directional digital bus transceivers. Since all of the functional modules are isolated by these transceivers (as described above), fault isolation of this complex system is possible; it would be very difficult, if not impossible in an un-isolated bused system.

A-2.5 User Interface

Several user interfaces are integrated into the ADFM. In particular these are a RS-232 serial data interface, a 9600 baud data Modem, and a LCD display. A solid state recorder is also built into the ADFM. The Modem and serial interface allows the operation of the ADFM without restrictions. However, the host terminal or host computer must be able to send a Break signal width a minimum duration of 400 ms. The Modem must be able to send a Break signal with a minimum duration of 300 ms.

The RS-232 serial data interface is located at the front panel of the ADFM. It is intended for local operation of the ADFM. This single ended interface allows maximum baud rate of 19.2 k-Baud over a distance of 15 meters. Longer distances may be possible at lower data rates. Handshake lines are not available.

The front panel LCD displays the ADFM operating status. Self-test results are indicated as well.

A-3 Transducer Electronics Circuit Description

The following description refers to Figure A-29. The legends used are spelled out more precisely in Table A-210.

A-3.1 Multiplexer

Prior to a ping, the transducer micro controller (XDCR-CTL) selects a beam via a solid state transmit and receive multiplexer, which is part of the transmit/receive switch (T/R-Switch), and the pre-amplifier (PA) respective. The specific beam number the XDCR-CTL selects is set up by the ADFM's Electronics Unit via a half duplex serial communication port (SDIN, and SDOUT) between the Electronics Unit and the transducer controller.

A-3.2 Transmit Path

The transmit signal, generated by the ADFM's Timing Generator, arrives at the transducer electronics terminals labeled XMT. It passes through the transmit coupling transformer (XMT), which provides isolation and impedance matching. The signal then is mutilplexed to one of five beams via the prior selected T/R-Switch, which also isolates and protects the pre-amplifier (PA) during transmit. At the end of transmit the transmit multiplexer is deselected, but the appropriate PA remains selected.

A-3.3 Receive Path

The echo from the water is received through the same selected transducer, band-pass filtered, and amplified by the prior selected pre-amplifier (please notice, only one pre-amplifier is selected at any given time). The PA's output signal is buffered by a buffer amplifier (BUFF) that is common to all five channels. The buffer amplifier provides decoupling and impedance matching. The signal eventually is converted to a differential signal by a wide-band signal transformer, and is available at the transducer terminals, labeled RCV-SIG. After the signal is received, the transducer controller deselects the pre-amplifier.

A-3.4 Temperature Interface

The transducer's ambient temperature is sensed by an accurately linearized termistor (T_SENSE). The termistor's temperature dependent output voltage is connected to an amplifier (S_AMP), where it is scaled, and buffered. The transducer then digitizes the scaled buffered output voltage. The result is available for the ADFM's Electronics Unit via the serial interface port. Since the temperature signal (TEMP) is ratiometric to the temperature sensor's supply voltage, the transducer controller also digitizes the sensor's supply voltage.

A-3.5 Transducer Power Supply

The transducer power supply terminals are labeled VXDR. The supply voltage is lowpass filtered and regulated by a low-dropout linear voltage regulator (PWR-REG). The 5.0-volt output VAA1 of the regulator is the primary supply for all transducer modules. A 2.50-volt reference voltage VREF provides all bias voltages needed for the pre-amplifier and the buffer stage. For build-in self-test purposes, it is also provided to the transducer controller's A/D-converter. To save energy, the temperature sense circuitry and its scaling amplifier are power strobed, that is, power is only provided when a temperature measurement is needed. A solid state switch (T-EN) connects VAA1 to the power supply of the temperature circuitry under the controller's command.

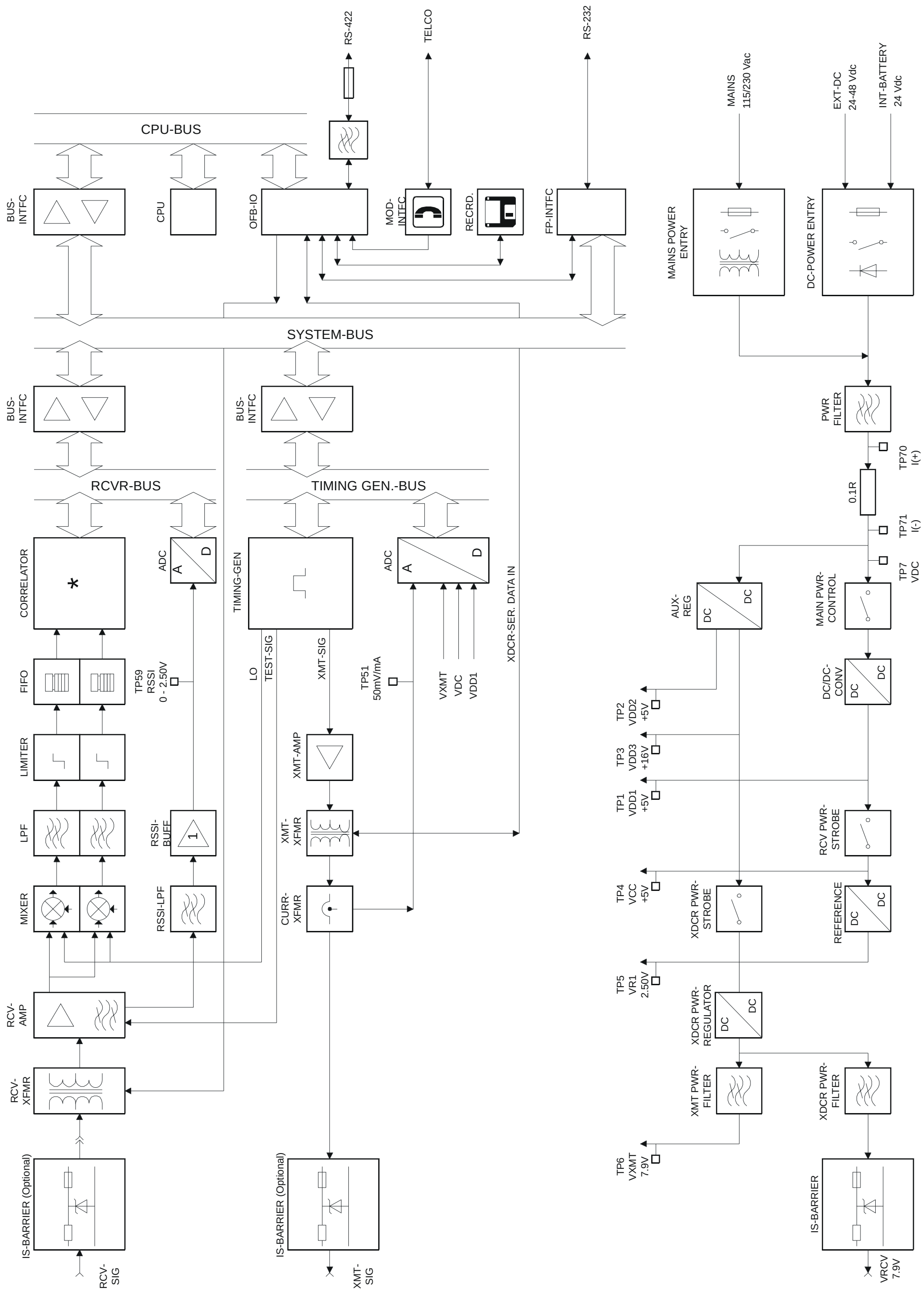

Figure A-1. Electronics Unit Block Diagram

Table A-1: Electronics Unit Block Diagram Legend

Block Diagram Legend	Description
ADC	Analog to Digital converter
AUX. REG.	Auxiliary regulator
BUS-INTFC	Bus interface circuit
CORRELATOR	Correlator, digital signal processor
CPU	Central processing unit
CURR-XFMR	Current sense transformer
DC PWR ENTRY	DC power entry circuit
DC/DC-CONV.	DC/DC switching regulator
FIFO	First In - First Out Register
FP.-INTFC	Front panel Interface
LIMITER	Amplitude Limiter
LO	Local oscillator frequency signal
LPF	Lowpass filter
MAIN PWR CONTROL	Main power control of system
MAINS PWR ENTRY	Mains power entry circuit
Mixer	Frequency mixer
MOD.-INTFC	Modem interface and Modem
OFB-I/O	Off board input/output device
PWR FILTER	Filter for mains and DC-power supply
RCV PWR STROBE	Power control of on-board receiver functions
RCV-AMP	Receiver amplifier
RCV-XFMR	Receive channel input coupling transformer
RECORDER	Solid state recorder for data storage
REFERENCE	Reference voltage
RSSI	Relative signal strength indicator
TEST-SIG	Test signal
TIMING-GEN	Timing generator
TP(xx)	Test points
XDCR PWR FILTER	Transducer power supply filtering
XDCR PWR REGULATOR	Transmitter and transducer supply voltage regulator
XDCR PWR STROBE	Power control of transmitter power and transducer supply voltage
XDCR-SER. DATA IN	Serial data signal from electronics to transducer
XDCR-SER. DATA OUT	Serial data signal from transducer to electronics
XMT PWR FILTER	Transducer power filter
XMT-AMP	Transmitter amplifier
XMT-SIG	Transmit signal waveform
XMT-XFMR	Transmitter output transformer

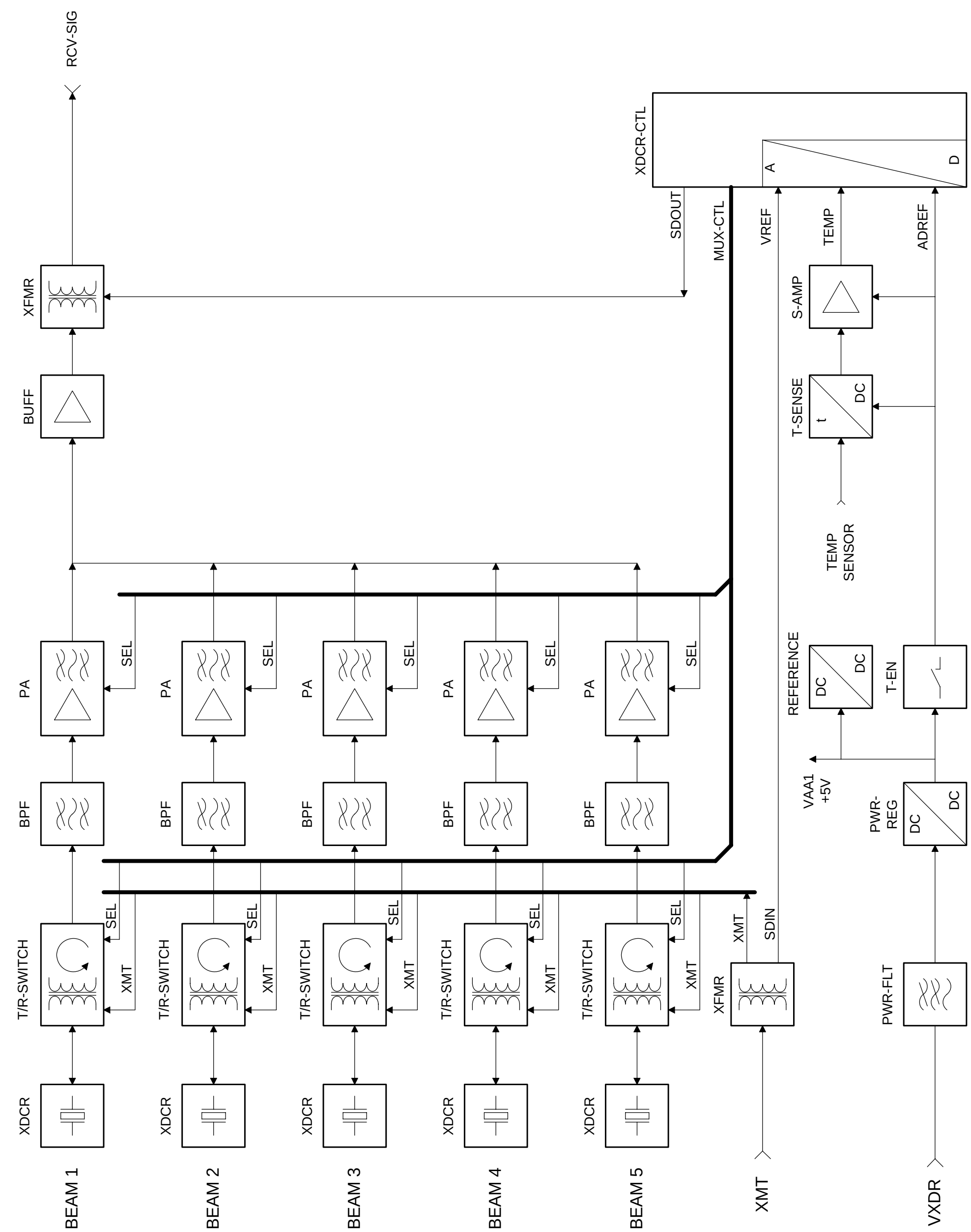

Figure A-2. Transducer Block Diagram

Table A-2: Transducer Block Diagram Legend

Block Diagram Legend	Description:
XDCR	Transducer element, or beam
T/R-SWITCH	Transmit/Receive Switch
BPF	Bandpass filter
PA	Pre-Amplifier
BUFF	Buffer amplifier
XFMR	Transformer
XDCR-CTL	Transducer controller
PWR-FLT	Transducer power supply input filter
PWR-REG	Transducer power supply regulator
REFERENCE	Reference
T-EN	Temperature interface power strobe
T-SENSE	Temperature sensor
S-AMP	Temperature scaling amplifier
MUX-CTL	Multiplexer control
XMT	Transmit signal
SDIN	Transducer serial data input from Electronics Unit
SDOUT	Transducer serial data output to the Electronics Unit
VXDR	Transducer supply input voltage
RCV-SIG	Transducer output signal
TEMP	Scaled temperature sensor signal
VAA1	Regulated transducer supply voltage
ADREF	Analog/Digital converter reference

Appendix

B

Specifications

B-1 Physical Specifications

The ADFM consists of a transducer assembly placed in the flow connected to a controlling set of electronics by a waterproof cable. The transducer assembly is designed to be intrinsically safe (IS) compliant. An optional IS zener diode barrier may be mounted in an electronics assembly for interface to the transducer. The electronics can record data in a stand-alone mode, output data real-time via modem or serial communications, or do both. External AC, DC, or internal alkaline batteries power the system.

The ADFM Velocity Profiler™ transducer assembly (shown in Figure B-12) contains four individual velocity transducers that use piezoelectric ceramics for emitting and receiving acoustic signals. These four transducers measure velocity throughout the depth of flow. A fifth transducer is mounted in the center, pointed vertically, to measure the depth of flow. The transducer assembly casing is manufactured of plastic to provide years of corrosion free service.

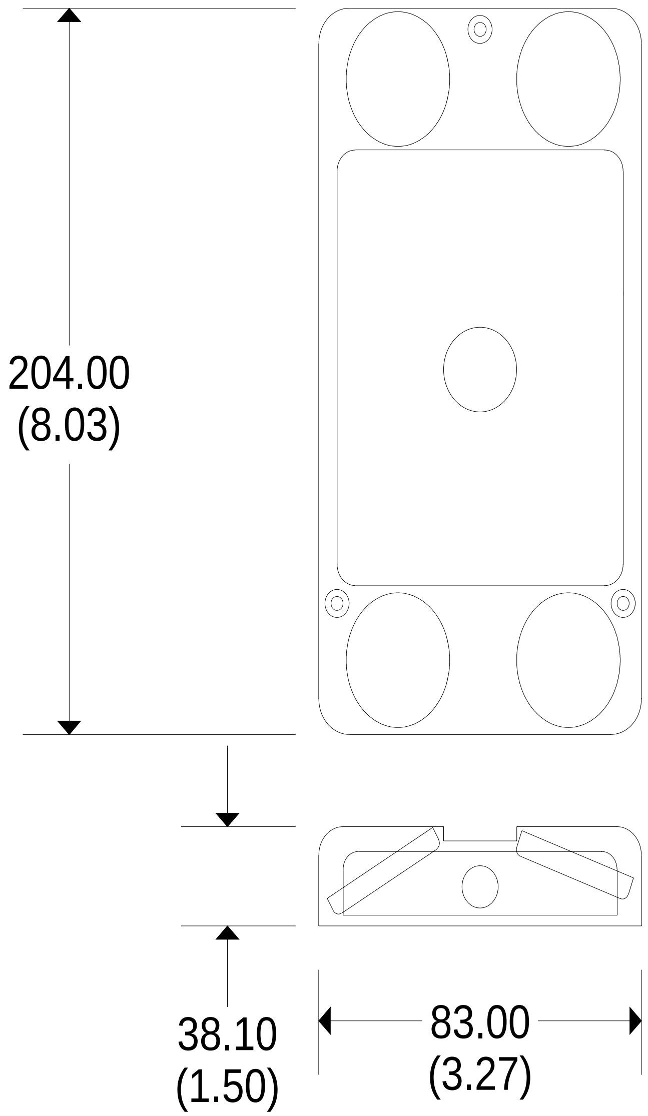

Figure B-1. ADFM Transducer Dimensions

The field housing contains the signal processing system (Figure B-23). The housing contains all signal processing boards, the battery supply, and available options – a modem for telemetry, solid state memory for stand alone operation, and IS zener diode barriers. An RS-422 and 232 serial interface is standard, as is a 4 line by 16 character LCD for quick determination of the system's status. The field housing is compliant with IP 67 (equivalent to NEMA 6P) and is suitable for mounting in a manhole.

NOTE. All Dimensions are in millimeters (in.).

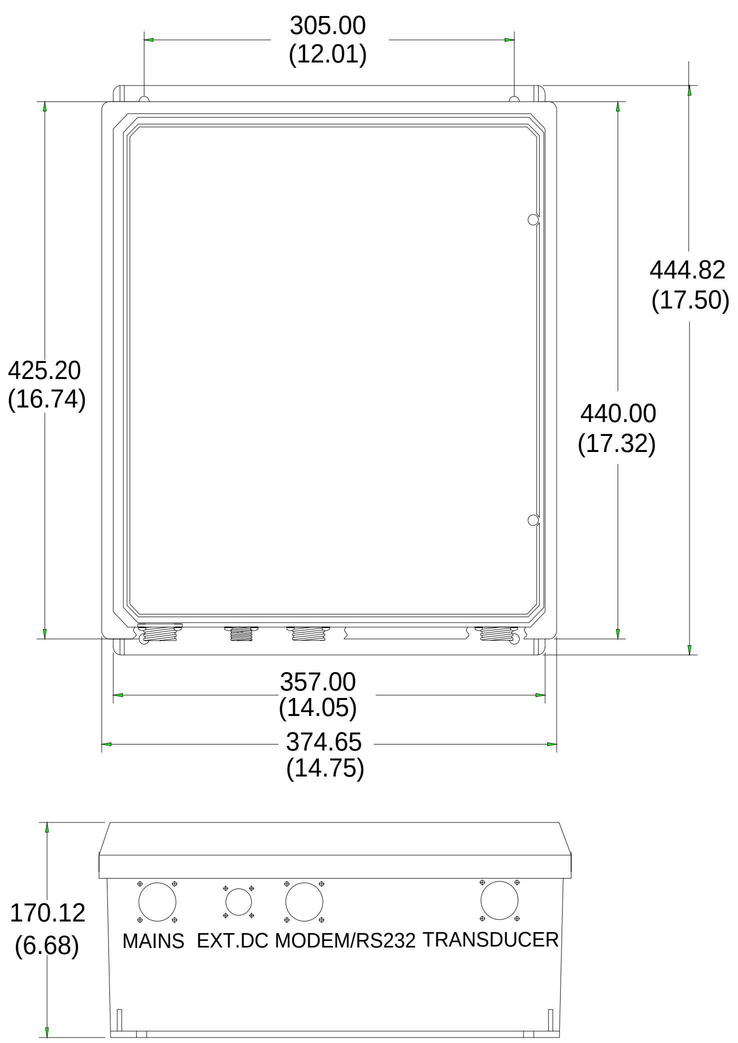

**Figure B-2.	ADFM Field Housing Dimensions**

B-2 Performance Specifications

NOTE. All specifications shown are in Imperial units.

B-2.1 Measurement Precision

Flow Accuracy	2% of reading
Velocity	
Horizontal Velocity Range	± 30.0 ft/s
Depth Cell Size	2 to 12 in. – user selectable
Vertical Profiling Range	Up to 20 ft., for particle concentrations of 50 to 1000 ppm
Accuracy	1.0% ± 0.01 ft/s of reading
Water Level	
Measurement Range	4.7 in. to 20 ft
Accuracy	0.5% ± 0.2 in. of reading

B-2.2 Packaging and Environmental

Transducer	
Operating Temperature	23 to 95° F
Housing Material	Plastic – corrosion resistant stainless steel optional
Static Pressure	250 psi Nominal (~17 atmospheres, ~550 feet)
Weight	2.2 lb
Electronics Unit	
Operating Temperature	-15 to 125° F
Storage Temperature	-65 to 160° F
Packaging	IP 67 (NEMA 4X) compliant
Weight	30 lb.

Transducer Signal Cable

Operating Temperature	-40 to 125° F
Physical	Polyethylene jacket.
Static Pressure	45 psi
Length	50 ft std. (up to 150 ft optional)
Minimum Bend Radius	0.5 ft.
Weight	0.08 lb/ft nominal
Outer Diameter	0.5 in. nominal

Acoustic Frequency

Frequency	1.23 MHz

B-2.3 Data Management

ADFM Velocity Profiler™ Data Output

Q, V, D	Discharge, average velocity, depth
Velocity	Velocity profile data per beam and bin (velocity data relative to the acoustic beam's coordinate system)
Echo Intensity	Echo intensity data (relative backscatter intensity) per beam and bin
Data Qualifier	Profile data quality indicator (Correlation magnitude, %-Good) per beam and bin
Temperature	Transducer temperature output over a range of $20 \leq T \leq 125°$ F
Sound Speed	One output for speed of sound data
Leader	Outputs of general leader information (time, data, record number, etc.), and for vertical beam data

ADFM Velocity Profiler™ Software

WinADFM software for Windows '95

Data Storage (optional)

Storage Capacity	20 Mbytes

Data Interfaces

Data I/O	- RS-232; - RS-422; - Modem port (optional) - 4-20 mA (optional)

B-2.4 Power and Frequency

Power

External AC	230 ± 10% VAC 115 ± 10% VAC 50/60 Hz
External DC	24 VDC - 12 VDC absolute minimum; 36 VDC absolute maximum
Internal Battery Voltage	24 VDC nominal
Internal Battery Capacity	13 Ah @ 75° F - Alkaline 7 Ah @ 75° F - SLA
Battery Life @ 15 minute sampling interval	Alkaline - 22 weeks SLA - 7 weeks

Appendix
C

ADFM Commands

C-1 Introduction

This Appendix defines the commands used by the ADFM. These commands let you set up and control the ADFM without using an external software program such as our *WinADFM* program. However, we recommend you use *WinADFM* to control the ADFM because entering commands directly from a terminal can be difficult. Most ADFM settings use factory-set values (see Table C-13). If you change these values without thought, you could ruin your deployment. *Be sure you know what affect each command has before using it*. Call MGD if you do not understand the function of any command.

In special cases these commands can be added to the **Advanced** window in WinADFM. The ADFM will use these commands as part of the configuration file if the **Use Advanced** check-box is enabled in the ADFM **Operate** window. Again, only use commands if you know what affect the command will have on your deployment.

This appendix does not list all of the commands available for the ADFM. Only the commands that are required for a successful deployment are documented. If you need information on other commands, contact MGD.

> **NOTE.** This appendix applies to firmware version 6.37. When newer firmware versions are released, some commands may be modified or added. Read the README file on the upgrade disk or check MGD's web site for the latest changes.

> **NOTE.** The information in this Appendix is provided for reference purposes only. Using *WinADFM* to develop the configuration file will ensure that the ADFM is set up correctly. Users should consult with MGD if they believe they need to use a customized command set or override the settings generated by *WinADFM*.

C-1.1 ADFM Data Communication and Command Format

You can enter commands with either a dumb terminal or an IBM-compatible computer running a terminal emulator program such as RDI's *BBTALK.EXE*. The ADFM communicates with the terminal/computer through an RS-232 (or RS-422) serial interface. We initially set the ADFM at the factory to communicate at 9600 baud, no parity, and 1 stop bit.

Immediately after you apply power to the ADFM, it enters the STANDBY mode. Sending a BREAK signal from a terminal/program awakens the ADFM. The BREAK signal must last at least 400 ms. When the ADFM receives a BREAK signal, it responds with a wake-up message similar to the one shown below. The ADFM is now ready to accept commands at the ">" prompt from either a terminal or computer program.

```
Broadband ADFM Version 6.xx
RD Instruments (c) 1991-94
All rights reserved>
```

C-1.2 Command Input Processing

Input commands set ADFM operating parameters, start data collection, run Built-In tests (BIT), and ask for output data. All commands (Table A-1) are ASCII character(s) and must end with a carriage return (CR). For example,

```
>WS030 <CR>  [Your input is underlined.]
```

If the entered command is valid, the ADFM executes the command. If the command is one that does not provide output data, the ADFM sends a line feed <LF> and displays a new ">" prompt. Continuing the example,

```
>WS030 <CR> [Your original input]
<LF>>       [ADFM response to a valid, no-output command]
```

If you enter a valid command that produces output data, the ADFM executes the command, displays the output data, and then redisplays the ">" prompt. Some examples of commands that produce output data are ? (help menus) and CS (start pinging).

If the command is not valid, the ADFM responds with an error message similar to the following.

```
>WSA<CR>  [Your input]
>WSA  ERR 002:  NUMBER EXPECTED<CR><LF> \_ [ADFM response]
>
```

After correctly entering all the commands for your application, you would send the CS-command (or <Tab>) to begin the data collection cycle.

C-1.3 Data Output Processing

After the ADFM completes a data collection cycle, it sends a block of data called a *data ensemble*. A data ensemble consists of the data collected and averaged during the ensemble interval (see TE-command). A data ensemble can contain header, leader, velocity, correlation magnitude, echo intensity, and vertical-beam data (selected by the WD-command).

ADFM output data can be in either hexadecimal-ASCII (HexAscii) or binary format (set by CF-command). The HexAscii mode is useful when you use a terminal to communicate with, and view data from, the ADFM. The binary mode is useful for high-speed communication with a computer/program, or when you want to record densely packed data. You would not use the binary mode to view data on a terminal because the terminal could interpret some binary data as control codes.

When data collection begins, the ADFM uses the settings last-entered (user settings) or the factory-default settings.

The ADFM automatically stores the last set of commands used in non-volatile RAM. The ADFM will continue to be configured from battery-backed RAM until it receives a CR-command or until the RAM loses its backup power. If the ADFM receives a CR0, it will load into battery-backed RAM the command set you last stored in EEPROM (semi-permanent user settings) through the CK-command. If the ADFM receives a CR1, it will load into battery-backed RAM the factory default command set stored in ROM (permanent or factory settings).

Table C-13 gives a summary of the ADFM input commands, their format, a brief description of the parameters they control, and lists the factory default.

NOTE. This table applies to firmware version 6.37. When newer firmware versions are released, some commands may be modified or added. Read the README file on the upgrade disk or check MGD's web site for the latest changes.

Table C-1: ADFM Commands

Command	Default	Description
CA	00300	Communication Timeout (0=Off,10-65536 sec)
CB	411	Serial Port Control (Baud; Par; Stop)
CF	11111	Flow Ctrl (EnsCyc;PngCyc;Binry;Ser;Rec)
CK		Keep Parameters as USER Defaults
CL	1	Leapfrog (0 = ON, 1 = OFF)
CN		Site Number
CP		Clear BIT Log
CR #		Retrieve Parameters (0 = USER, 1 = FACTORY)

Command	Default	Description
CS		Go (Start Pinging)
CT	1	Turnkey (0 = OFF, 1 = ON)
CV	012	Shut Off Voltage (volts)
CZ		Power Down BBADCP
EA	+00000	Heading Alignment (1/100 deg)
EC	1500	Speed Of Sound (m/s)
ED	0000	Transducer Depth (0 - 9999 dm)
EE	0020	Secondary Depth Max. Probable Error (Tenths%)
EO	0008	Secondary Depth Zero Offset (8 - 9999 mm)
ER	00000	Secondary Depth Span (0 – 30000 mm)
ES	00	Salinity (0-40 pp thousand)
ET	+2500	Temperature (1/100 deg Celsius)
EX	00000	Coord Transform (Xform:Type; Tilts; 3Bm; Map)
EZ	1011111	Sensor Source (C;D;H;P;R;S;T)
MC s		Modem Command (s = command string)
MH	1	Hangup on Ping Start (0=No, 1=Yes)
MI		Modem Answer Init
MM	0	Modem Monitor (0 = OFF, 1 = ON)
MN	0000000	Dial out Phone Number
MO		Check to see if the modem is ok
MP #		Modem Power (0 = OFF, 1 = ON)
MT		Modem Terminal
MZ		Modem Reset
PA #		User Interactive Tests (0 = help)
PC		Diagnostic Tests
PD	00	Data Stream Select (0-6)
PF		Display Fault Log
PI	011111	Built in Tests (Rpt;CPU;Clk;TC;DSP;Loop)
PS #		Show Sys Parms (0=System)
PT ###		Built In Tests, PT 0 = Help
QB	0000	Bed Level (0-2000 mm)
QC	000	Channel Type (0=rect,1=circ)
QD	100 011 110	Algorithm Select (Resrv;...;IHRW;ModAV;Mann;AV;HRW)
QF	00000	Force Depth (0 = Off,1-10000 mm)
QH	0000,0050,0100	Pipe Heights/Epsilons (cm)
QO	+0000	Xducer Offset from Pipe Bottom (-50-2000mm)

Command	Default	Description
QP	0500,0250	Disc Params*10000 (Delta,N :0=Calculate,not0=Fixed)
QR	006	QVD Structure Only Rate (1=Both Always:1-256)
QU	0	Channel Geometry Units (0 = cm, 1 = mm)
QW	0100,0100,0100	Pipe Widths/Radii (cm)
QZ		Zero Discharge Accumulation
RA	009	Number of Deployments Recorded
RB ###		Blank Check 1 MB of Recorder Memory (0 = ALL)
RD	000	Current Deployment Selected (0 = NONE)
RE ErAsE		Erase Recorder
RJ +#####		Number of Ensembles to Jump (+/- 99999)
RS	001,019	Rec Space Used (MB), Avail (MB), (999 = Erasing)
RT		Recorder BIT
RY ###		Start YModem (Batch) Xfer Deployment # (0=All)
TE	00:05:00.00	Time per Ensemble (hrs:min:sec.sec/100)
TF		Time of First Ping (yr/mon/day,hour:min:sec)
TP	00:00.00	Time per Ping (min:sec.sec/100)
TS		Time Set (yr/mon/day,hour:min:sec)
VC	000	Proofing of depth (0:Off, 2-12 Pings)
VD	001 000 000	Data Out (Vel;Cor;Amp PG; Ldr;P0 P1;P2;P3)
VM	3	Surface Track Mode (1 = Amp,2 = NA, 3 = Auto,4 = Shal, 5 = Deep)
VN	128	Number of depth cells (1-128)
VP	00010	Pings per Ensemble (0-16384)
VS	0005	Depth Cell Size (cm)
VX	0000	Transmit Length (cm) [0 = Bin Length]
WC	080	Correlation Threshold (1-255%)
WD	100 000 000	Data Out (Vel;Cor;Amp PG;St;P0 P1;P2;P3)
WE	9999	Error Velocity Threshold (0-5000 mm/s)
WF	0005	Blank After Transmit (cm)
WG	025	Percent Good Minimum (1-100%)
WM	1	Profiling Mode (1-10)
WN	025	Number of depth cells (1-128)
WO	0	Single Beam Mode Select (0:Off,1-5)
WP	00100	Pings per Ensemble (0-16384)
WS	0005	Depth Cell Size (cm)
WU	000 000 011	Mode 5,8 Setup ()
WV	250	Ambiguity Velocity (cm/s radial)

Command	Default	Description
WX	000	Mode 5 Depth (cm radial)
WY	127	Mode 5 Correlation Threshold (0..255))
WZ	010	Mode 5 Ambiguity Velocity (cm/s radial)

C-2 Command Descriptions

This section lists all ADFM commands. Each listing includes the command's purpose, format, range, and description. When appropriate, we include amplifying notes and examples. Most commands have a two-letter identifier. The first letter identifies the command group (see Table C-26). The second letter identifies the command function. If a numeric value follows the identifiers, the ADFM uses it to set a processing value (time, range, percentage, processing flags). All measurement values are in metric units (mm, cm, dm).

Table C-2: ADFM Command Groups

First Letter	Command Group
C	CONTROL Commands
E	ENVIRONMENTAL SENSORS Commands
M	MODEM Commands
P	PERFORMANCE Commands
Q	DISCHARGE Commands
R	RECORDER Commands
T	TIMING Commands
V	VERTICAL BEAM Commands
W	WATER PROFILING Commands

? - Help Menus:

Purpose: Lists the major help groups.

Format: *x*? (see description)

Description: Entering ? by itself displays all command groups. To display help for one command group, enter *x*?, where *x* is the command group you wish to view. When the ADFM displays the help for a command group, it also shows the format and current setting of those commands. To see the help or setting for one command, enter the command followed by a question mark. For example, to view the WS-command setting enter WS?.

Break:

Purpose: Interrupts ADFM without erasing current settings.

Format: <BREAK>

Description: A BREAK signal interrupts ADFM processing. It is leading-edge triggered and must last at least 100 ms. A BREAK initializes the system, sends a wake-up (copyright) message, and places the ADFM in the DATA I/O mode. The BREAK command does not erase any settings or data.

Example: <BREAK>

```
BROADBAND ADFM VERSION 6.37
RD INSTRUMENTS (C) 1991-94
ALL RIGHTS RESERVED. >
```

C-2.1 Control System Commands

The ADFM uses the following commands to control certain system parameters:

CA - Communication Timeout

Purpose: Sets the length of the communication timeout wait.

Format: CA*nnnnn*

Range: *nnnnn* = 10 to 65536 sec (0 = Off,)

Default: CA00300

Description: The communication timeout determines when the ADFM will stop waiting for command input and restart. The restart behavior is dependent on the CT command.

CB - Serial Port Control (Baud Rate/Parity/Stop Bits)

Purpose: Sets the RS-232/422 serial port communications parameters.

Format: CB*nnn*

Range: *nnn* = baud rate, parity, stop bits (see description)

Description: The ADFM and your external device (dumb terminal, computer software) MUST use the same communication parameters to *talk* to each other. After you enter valid CB parameters, the ADFM responds with a ">" prompt. You may now change the external device's communication parameters to match the ADFM parameters <u>before</u> sending another command.

Baud Rate	**Parity**	**Stop Bits**
0 = Default (9600)	0 = Default (None)	0 = Default (1 Bit)
1 = 1200	1 = None	1 = 1 Bit
2 = 2400	2 = Even	2 = 2 Bits
3 = 4800	3 = Odd	4 = High
4 = 9600		5 = Low
5 = 19200		
6 = 38400		
7 = 57600		

> **NOTE.** If you send a break before changing the external device's communication parameters, the ADFM returns to the communication parameters stored in EEPROM (user settings). To save the new ADFM communication parameters, use the CK-command after changing the external device's communication parameters to match the new values.

CF - Flow Control:

Purpose: Selects when/how/where/what water-current data to collect.

Format: CF*nnnnn*

Range: Firmware switches (see description)

Description: CF defines whether the ADFM: generates data ensembles automatically or manually; generates pings immediately or manually; sends output data in binary or HexAscii format; sends or does not send output data out the serial interface; sends or does not send output data to the recorder (if installed); retrieves or does not retrieve data from the recorder.

Table C-3: CMD Description

Command	Description
CF1xxxx	Automatic Ensemble Cycling – Automatically starts the next data collection cycle after data transmission is completed. Only a <BREAK> can stop this cycling
CF0xxxx	Manual Ensemble Cycling - Enters the STANDBY mode after transmission of the data ensemble, displays the > prompt, and waits for a new command
CFx1xxx	Automatic Ping Cycling - Pings immediately when ready.
CFx0xxx	Manual Ping Cycling - Sends a < character to signal ready to ping, and then waits to receive an <Enter> before pinging. The <Enter> sent to the ADFM is not echoed. This feature lets you manually control ping timing within the ensemble
CFxx1xx	Binary Data Output - Sends the ensemble in binary format.
CFxx0xx	HexAscii Data Output - Sends the ensemble in readable hexadecimal-ASCII format.
CFxx1x	Enable Serial Output - Sends the data ensemble out the RS-232/422 serial interface.
CFxx0x	Disable Serial Output - No ensemble data are sent out the RS-232/422 interface.
CFxxx1	Enable Data Recorder - Records data ensembles on the recorder (if installed). The RD-command also must be set to zero to enable the recorder.
CFxxx0	Disable Data Recorder - No data ensembles are recorded on the recorder.
	Example:
	CF1010 selects manual ensemble cycling, automatic ping cycling, HexAscii data output, enables serial output, and disables data recording.

CK - Keep Parameters

Purpose: Stores current parameters to EEPROM.

Format: CK

Description: CK saves the current user command parameters to an EEPROM on the CPU board. The ADFM maintains data stored in the EEPROM (user settings) even if power is lost. It does not need a battery. You can recall parameters stored in EEPROM with the CR0-command

CL – Leapfrog

Purpose: Prevents the ADFM from going to sleep.

Format: CL*n*

Range: *n* = 0 or 1 (0 = on, 1 = off)

Default: CL1

Description: The leapfrog command prevents the ADFM from going to sleep. Whenever the unit tries to sleep, it will instead wait in a non-power saving state.

CN - Site Number

Purpose: Identifies the ADFM site number.

Format: CN*aaaaaaaa*

Range: 8-character string

Description: An 8-character string identifying the ADFM.

CP - Clear BIT Log

Purpose: Clears the BIT Log stored in EEPROM on the MainBoard.

Format: CP

Description Clears the BIT Log stored in EEPROM on the MainBoard. The log is updated whenever an error occurs.

CR - Retrieve Parameters

Purpose: Resets the ADFM command set to EEPROM or factory settings.

Format: CR*n*

Range: *n* = 0 to 1 (see description)

Description: The ADFM automatically stores the last set of commands used in battery-backed RAM. The ADFM will continue to be

	configured from battery-backed RAM unless it receives a CR-command or until the RAM loses its backup power.
Example:	CR0 = loads into non-volatile RAM the command set last stored in EEPROM (semi-permanent or user settings) using the CK-command.
	CR1 = loads into non-volatile RAM the factory default command set stored in ROM (permanent or factory settings).
	CR keeps the present baud rate and does not change it to the value stored in EEPROM or ROM. This ensures the ADFM maintains communications with the terminal/computer.

CS - Start Pinging (Go)

Purpose:	Starts the data collection cycle or recorder playback (same as <Tab>
Format:	CS
Description:	Data Collection - Use CS (or <Tab> key) to tell the ADFM to start pinging its transducers and collecting data as programmed by the other commands. If the TF-command is set (time of first ping), the ADFM waits until it reaches the TF time before beginning the data collection cycle. If you try to record data (CFxxxx1), and data already exist on the recorder, or the recorder is erasing, the ADFM will not start pinging and will return a RECORDER NOT READY message.
	Recorder Playback - This command also plays back the data recorded to the recorder when the RD-command is a nonzero value. The CF-command settings determine ensemble cycling (manual or automatic) and output format (HexAscii or binary). After the ADFM plays back the last ensemble, it sends a NO MORE ENSEMBLES message.

CT – Turnkey

Purpose:	Determines how the ADFM responds to a restart event.
Format:	CT*n*
Range:	*n* = 0, 1 (0 = off, 1 = on)
Default:	CT1
Description:	If Turnkey mode is on, the ADFM will attempt to ping at the next chronological ensemble time.

CV - Shut Off Voltage

Purpose: Sets the shutoff voltage level.

Format: CV*nnn*

Range: *nnn* = 0 to 999 volts.

Default: CV012

Description: The shutoff voltage determines at what voltage the ADFM will stop pinging during the deployment cycle. If the system detects a low voltage condition for five consecutive ensembles, the ADFM will shutdown. The recommended shutoff voltage level for alkaline batteries is 12 volts and 20 volts for lead acid batteries.

CZ - Power Down ADFM

Purpose: Tells the ADFM to power down.

Format: CZ

Description: An ESC interrupts ADFM processing and returns it to the STANDBY mode. An ESC does not remove the settings stored in battery-backed RAM.

Example: >CZ

```
[POWERING DOWN]
```

C-2.2 Environmental Sensor Commands

The ADFM uses the following commands to control the environmental and positional information that affects internal data processing.

EA Heading Alignment

Purpose: Corrects for physical misalignment between the long axis of the ADFM transducer and the channel it is deployed in.

Format: EA+*nnnnn*

Range: ±nnnnn = -179.99 to 180.00 degrees

Default: EA00000

Description EA is an alignment angle (referenced to the long axis of the ADFM transducer) used as a new zero reference for heading output and for transformation to earth coordinates.

EC - Speed Of Sound

Purpose: Sets the speed of sound value used for ADFM data processing.

Format: EC*nnnn*

Range: *nnnn* = 1400-1600 meters per second

Description: EC sets the sound speed value used by the ADFM to scale velocity data, depth cell size, and range to the surface. The ADFM assumes the speed of sound reading is taken at the transducer head

ED - Depth Of Transducer

Purpose: Sets the ADFM transducer depth.

Format: ED*nnnn*

Range: *nnnn* = 0 to 9999 decimeters (meters x 10)

Description: ED sets the ADFM transducer depth. This measurement is taken from sea level to the transducer faces. The ADFM uses ED in its speed of sound calculations. The ADFM assumes the speed of sound reading is taken at the transducer head.

EE - Secondary Depth Max. Probable Error

Purpose: Sets the maximum probable error of the secondary depth sensor.

Format: EE*nnnn*

Range: *nnnn* = 0 to 1000 (o to 100%)

Default: EE0020 (2%)

Description: The EE command allows the user to set the maximum probable error (MPE) of the secondary depth sensor. If the depth as determined by the vertical beam is within the MPE of the secondary sensor, the vertical beam depth is used. Otherwise, the secondary depth sensor depth is used. The secondary depth sensor must be selected with EZ=x1xxxxx.

EO - Secondary Depth Zero Offset

Purpose: Sets the secondary depth zero offset in the ADFM.

Format: EO*nnnn*

Range: 8 to 9999 mm

Default: EO0008

Description: The secondary depth zero offset determines the distance above the bottom of the channel at which the secondary depth sensor is placed. The default setting of 8 mm is half the diameter of the recommended secondary sensor.

ER - Secondary Depth Span

Purpose: Sets the operating range of the secondary depth sensor.

Format: ER*nnnnn*

Range: 0 to 30000 mm

Default: ER00000

Description: Sets the full-scale depth of the secondary depth sensor in millimeters. If this value is unchanged (i.e. left at zero), all depths will be zero + zero offset (EO-command).

ES - Salinity

Purpose: Sets the water's salinity value.

Format: ES*nn*

Range: *nn* = 0 to 40 parts per thousand

Default: ES00

Description: ES sets the water's salinity value. The ADFM uses ES in its speed of sound calculations. The ADFM assumes the speed of sound reading is taken at the transducer head.

ET - Temperature

Purpose Sets the water's temperature value.

Format ET±*nnnn*

Range ±*nnnn* = -5.00 C to +40.00 C

Default ET+2500

Description ET sets the temperature value of the water. The ADFM uses ET in its speed of sound calculations. The ADFM assumes the speed of sound reading is taken at the transducer head.

Example Convert temperatures of +14 C and -3.5 C to ET-command values.

```
ET = 14.00 × 100 = 1400 = ET1400 (+ is understood)
ET = -3.50 × 100 = -350 = ET-0350
```

EX - Coord Transform

Purpose: Sets the coordinate transformation processing flags.

Format: EX*nnnnn*

Range: Firmware switches (see description)

Default: EX00000

Description: EX sets firmware switches that control the coordinate transformation processing for velocity and percent-good data.

Table C-4: Coordinate Transformation Processing Flags

Setting	Description
EX00xxx	No transformation. Radial beam coordinates, I.E., 1, 2, 3, 4. Heading/Pitch/Roll not applied.
EX01xxx	Instrument coordinates. X, Y, Z vectors relative to the ADFM. Heading/Pitch/Roll not applied.
EX10xxx	Ship coordinates (Note 1) X, Y, Z vectors relative to the ship. Heading not applied. EA-command used, but not the EB-command. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EX11xxx	Earth coordinates (Note 1) East, North, Vertical vectors relative to Earth. Heading applied. EA command used. If Bit 3 of the EX-command is a 1, then Pitch/Roll applied.
EXxx1xx	Use tilts (pitch and roll) in transformation (Note 2)
EXxxx1x	Allows 3-beam solutions if one beam is below the correlation threshold set by WC
EXxxxx1	Allow bin mapping

Notes

1. For ship and earth-coordinate transformations to work properly, you must set HEADING ALIGNMENT (EA) correctly. You also must ensure that the tilt and heading sensors are active (EZ).

2. Setting EX bit 3 (Use Tilts) to 1 lets you collect tilt data without using it in the ship or earth-coordinate transformations.

3. Each ADFM uses its own beam calibration matrix to correct data for beam pointing errors (e.g., if the beams erroneously point toward 21 deg. instead of 20 deg.). Correction is applied when the data are converted from beam coordinates to earth coordinates. If you output beam-coordinate data, you will need to apply the beam corrections yourself if you want the best possible data. MGD has no software that uses the beam calibration matrix to correct data in a personal computer.

EZ - Sensor Source:

Purpose: The EZ-command selects the source of environmental sensor data.

Format: EZcdhprst

Default EZ1011111

Range: Firmware switches (see description)

Description Setting the EZ-command firmware switches tells the ADFM to use data from a manual setting or from an associated sensor. When a switch value is non-zero, the ADFM overrides the manual E-command setting and uses data from the appropriate sensor. If no sensor is available, the ADFM defaults to the manual E-command setting. The following table shows how to interpret the sensor source switch settings.

Table C-5: Sensor Source Switch Settings

Field	Value = 0	Value = 1	Value = 2
c	Manual EC	Calculate using ED, ES, and ET	N/A
d	Vertical beam only	Vertical beam and secondary depth sensor	N/A
h	Manual EH	Heading	N/A
p	Manual EP	Pitch (Tilt 1)	N/A
r	Manual ER	Roll (Tilt 2)	N/A
s	Manual ES	N/A	N/A
t	Manual ET	Transducer Sampled	N/A

Example EZ1111101 means calculate speed of sound from readings, use secondary depth sensor, transducer heading, internal tilt sensors, and transducer temperature.

C-2.3 Modem Commands

This section describes the menu commands that are available for controlling Modem operation in the ADFM.

MC - Modem Command

Purpose: Sends a command string to the remote modem.

Format: MC*s*

Range: *s* = command string

Description: The MC command is used by the host to send a command string to the remote Modem (i.e. the one in the ADFM unit). The ADFM puts its Modem in command mode, sends the command string, and then sets its Modem back to on-line mode. This command can be used to send any of the 'AT' commands recognized by the ADFM Modem. For example the sending 'MC AM0&W0' to the ADFM will cause the ADFM to send the string 'ATM0&W0' to its Modem. This string contains two Modem commands: The first, 'M0', sets the Modem to disable its internal speaker, and the second command, '&W0', causes the currently active internal Modem parameters to be saved in non-volatile memory (internal to the Modem), so that the speaker will remain disabled between power-ups. The 'AT' at the beginning of the command string stands for 'Attention', and is required by the Modem to precede any command, except for additional commands in the same command line.

MH - Hangup on Ping Start

Purpose: Hangs modem up after the ADFM starts pinging.

Format: MH*n*

Range: *n* = 0,1 (0 = no, 1 = yes)

Default: MH1

Description: Use this command to set whether or not the modem hangs up after the ADFM starts pinging.

MI - Modem Answer Init

Purpose: The MI command is used to set the dial-out interval.

Format: MI

Description: This is the amount of time, in seconds, that should elapse between scheduled calls that the ADFM makes to the host computer. The syntax for this command is as follows:

MI? Displays the current dial-out interval setting.

MI 3600 Sets the dial-out interval to 3600 seconds (1 hour).

Example: For example, if you want to set the ADFM to call the host once per day, send the following:

```
MI 86400
```

The dial-out interval takes effect only when the ADFM unit is actively pinging. At the end of each ensemble, the time of the next ping is compared to the time of the next call to the host. If the next ping comes first, the ADFM remains in ping mode, sets the alarm to wake it up at the next ping time, and goes back to sleep. If the time to call the host comes before the next ping, the ADFM suspends ping operation, sets the alarm to wake it up at the time to call the host, and goes back to sleep. During this time comparison at the end of an ensemble collection, if it is determined that the time to call the host has passed, the call will be made immediately. It is important to note that it is the ping cycle time that determines when and how often the ADFM will wake up to check to see if it is time to call the host. In order for this mechanism to work properly, the time between ensembles (TE) plus the time required for the ping must be less than the dial-out interval (MI).

The dial-out interval defaults to one day (86400 seconds) at cold power up (i.e. not wakeup from sleep mode). Once set to a new value, it does not need to be reset until another cold power up occurs.

MM - Modem Monitor

Purpose: This command enables and disables the Modem communications monitor.

Format: MM*n*

Range: *n* = 0,1 (0 = off, 1 = on)

Default: MM0

Description: If enabled (MM 1), all data traffic between the ADFM and its onboard Modem is echoed to the ADFM RS-232 port. If a PC is set up to log data from the RS-232 port, enabling the Modem monitor can help to resolve communication problems with the Modem. If the Modem monitor is disabled (MM 0), Modem traffic is not echoed to the RS-232. The Modem monitor is disabled by default at cold power up, and every time a BREAK is received, but will remain as set by this command between wakeups.

MN - Dial out Phone Number

Purpose: Displays the currently programmed phone number.

Format: MN*nnnnnn*n

Range: The phone number can be up to 15 digits in length.

Default: MN0000000

Description: Hyphens and spaces can be used if desired, but are not necessary and should be eliminated if the number has many digits. The phone number can be stored in non-volatile memory like other ADFM parameters by issuing the 'CK' command.

Setting the phone number to an empty string (i.e. 'MN' with no argument can disable the dial-out function. This will cause the dial-out logic to be bypassed.

MO - Check to see if the Modem is OK

Purpose: Tests the modem.

Format: MO

Description: Entering 'MO' and the ADFM command prompt will cause the ADFM to send the attention (AT) command to the Modem. If the Modem is on and in command mode and functioning well, it will respond with an 'OK' message to the ADFM. The ADFM will then display a message indicating that the Modem is okay. If the Modem is on-line when this command is given (i.e. it is connected to the host), the ADFM will report that the Modem is ON-LINE. Otherwise the ADFM will report that the Modem is not okay, and may indicate a failure (e.g. Modem is turned off, data cable is disconnected, etc.).

MP - Modem Power

Purpose: Turns modem power on or off.

Format: MP*n*

Range: *n* = 0,1 (0 = off, 1 = on)

Default: MP1

Description: The MP command can be used to turn on (MP 1) or off (MP 0) the power to the Modem, and can only be used when communicating to the ADFM via one of the local interfaces (i.e. RS-232 or RS-422). This command can be useful for conserving battery power by turning off the Modem when communicating to the ADFM over one of the local interfaces (when performing testing, for example). This command is disabled if given remotely over the Modem interface since turning off the Modem would cause communications with the ADFM to be lost.

MT - Modem Terminal

Purpose: Allows for a direct connection to the modem.

Format: MT

Description: Entering ‘MT’ at the ADFM command prompt will cause the ADFM to go into a mode where it passes all input via the RS-232 to the Modem, and passes all input from the Modem to the RS-232. This gives the operator connected to the RS-232 interface a direct connection to the Modem, and is just like talking to a local Modem from a PC. The operator can give any valid ‘AT’ commands and see all responses from the Modem, including dialing out and communicating with a host. This command is normally only used for troubleshooting, and is disabled if given remotely over the Modem interface.

MZ - Modem Reset

Purpose: Resets the modem.

Format: MZ

Description: This command will cause the ADFM to reset the Modem to its factory default settings. See the Modem instruction manual for more details.

C-2.4 Performance and Test Commands

The ADFM uses the following commands for testing.

PA - User Interactive Tests

Purpose: Displays results of the ADFM sensor data diagnostic tests.

Format: PA*n*

Range: *n* = 0 (help), 1 = Sensor Data

Default: PA

Description: This diagnostic test verifies the sensor operation. We recommend you run this command before a deployment.

Example:

```
>pa0

User Interactive, Built In Tests
--------------------------------
PA0 = Help
PA1 = Sensor Data

>pa1

Press any key to quit sensor display ...

Transducer Temp   Depth(mm)
  21.47øC           0
  21.47øC           0
  21.47øC           0
  21.47øC           0
  21.47øC           0
  21.47øC           0
  21.47øC           0
  21.47øC           0
```

PC - Diagnostic Tests

Purpose: Sends/displays results of a series of ADFM system diagnostic tests.

Format: PC

Description: These diagnostic tests check the major ADFM modules and signal paths. We recommend you run this command before a deployment.

Example:

```
>pc
Transducer Communications:                 PASS
Recorder BIT (RT ):                        PASS
Modem (MO ):                               PASS
System Voltages (PT2):                     PASS
CPU RAM (PI ):                             PASS
```

```
Timing Card RAM (PI ):                     PASS
Demodulator RAM (PI ):                     PASS
Checksum Code/Tables (PT8):                PASS
Receive Test (PT3):                        PASS
Transmit Test (PT4):                       PASS
Electronics Wrap Test (PT5):               PASS
LPF Bandwidth Test (PT6):                  PASS
Clock Interrupt (PI ):                     PASS
Error Log:
 Power Loss
 Auto Restart Occurred
 Transducer Communications Error
Self Tests Complete
```

PD - Data Stream Select

Purpose: Selects the type of ensemble output data structure.

Format: PDnn

Range n = 0 to 3 (see description)

Default PD00

Description: PD selects either the normal output data structure, a special application data structure, or a fixed data set for transmission/display as the data ensemble.

Table C-6: Data Stream Selections

Format	Description
PD0	Sends The real water-current data set
PD1	Sends an RDI-defined data set that always uses the same data (except for parts of the leader data). This data set is useful during user-software development.
PD2	Not used.
PD3	Sends reduced discharge output data structure.

PF - Display Fault Log

Purpose: The PF-command displays the fault log.

Format: PF

Description: Displaying the fault log will list why a built-in test failed. This may aid in troubleshooting.

Example:

```
>pf
 Power Loss
 Auto Restart Occurred
 Transducer Communications Error
```

PI Run Individual Built-In Tests

Purpose: The PI BIT selects the individual built-in tests to run.

Format: PI*nnnnn*

Range: Firmware switches (see description).

Description: PI sets firmware switches that select the individual tests of the Built-In Test function. When a bit is not set (0), the corresponding test is not run; a set bit (1) runs the test. Entering only PI runs the previously selected tests.

Command	Description
PI1xxxxx	Run selected test/s continually.
PIx1xxxx	Run CPU RAM test.
PIxx1xxx	Run CPU Real-Time Clock Test.
PIxxx1xx	Run Timing Generator RAM Test.
PIxxxx1x	Run Receiver RAM Test.
PIxxxxx1	Run the Electronics End To End Test; this test takes a timing generator test signal and feeds it to the receiver input; it compares the result with pre-determined values. This test does not test the transducer electronics.

Example:

```
>pi
[BEGIN Built In Tests]
   CPU RAM Test ........... PASS
   Realtime Clock Test .... PASS
   Timing Card RAM Test ... PASS
   Demod RAM Test ......... PASS
[END Built in Tests]
```

PS - Show System Parameters

Purpose: Snds/displays ADFM system configuration data.

Format: PS*n*

Range: *n* = 0 (system)

Default: PS0

Description: PS0 sends the ADFM hardware/firmware information. For example, the output may look like this:

```
>ps0
  ----------- ADFM SERIAL #:  65535 -----------

TRANSDUCER
     Xducer Ser #:  0
        Frequency:  1228800 Hz
    Configuration:  5 Beam
      Beam Angles:  30/20, 20/10 Degrees
     Beam Pattern:  Convex
      Orientation:  Up
        Sensor(s):  Temperature
    XDCR Firmware:   2.0

MOTHERBOARD 725S2020-00  Rev. A1
          CPU Firmware:  6.37
        PT LCA Version:  85d3
     Demod LCA Version:  ad47
Low Power Unit w/o Scale Resistors Upgrade

PERIPHERALS:
20 MB PCMCIA Recorder: Firmware 4.5
Modem Installed
```

PT - Built-In Tests

Purpose: Sends/displays result of the ADFM system diagnostic tests.

Format: PT*nnn*

Range: Firmware switches (see description)

Description: These diagnostic tests check the major ADFM modules and signal paths. Most of the tests give their final results in the format "xxxxxxxxxx TEST RESULTS = $hhhh ... rrrr"

Where:

xxxxxxxxxx	=	Module or path being tested.
$hhhh	=	Hexadecimal result code; $0 = pass; see individual tests for description of bit results.
rrrr	=	overall test result ("PASS" or "FAIL")

NOTE. To find what bits are set when an error occurs, use the following tables.

Table C-7: Error Code Hex to Binary Conversion

Hex Digit	Binary	Hex Digit	Binary
0	0000	8	1000
1	0001	9	1001
2	0010	A	1010
3	0011	B	1011
4	0100	C	1100
5	0101	D	1101
6	0110	E	1110
7	0111	F	1111

To convert error code $32CF (note: the dollar sign "$" signifies hexidecimal), convert 32CF to binary. Error code $32CF has the following bits set: 13, 12, 9, 7, 6, 3, 2, 1, 0.

Hex Digit $	3				2				C				F			
Binary	0	0	1	1	0	0	1	0	1	1	0	0	1	1	1	1
Bit #	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0

PT0 – Help

Purpose: Displays the test menu (shown below).

Format: PT0

Description: As implied by the NOTE, adding 100 to the test number repeats the test continually until the ADFM receives a <BREAK>. Sending PT200 runs all tests. PT300 runs all tests continually until the ADFM receives a <BREAK>.

```
>pt0

Built In Tests
----------------
PT0 = Help
PT1 = Board Level Receive Test
PT2 = Ancillary System Data
PT3 = Receive Path
PT4 = Transmit Path
PT5 = Electronics Wrap Around
PT6 = Receive Bandwidth
PT7 = NA
PT8 = Checksum Lookup Tables
NOTE: Add 100 for automatic test repeat
PT200 = All tests
```

PT1 – Board Level Receive Test

Purpose: This test displays receive path characteristics with lower thresholds than PT3 since the preamplifier in the transducer is disconnected during the test.

Format: PT1

Description: The test result is given as four nibbles (1 nibble = 4 bits). Each nibble represents the result for a particular beam (most significant nibble = beam 1, least significant nibble = beam 4). In this example, we only describe which bit is set for beam 4 for a given failure type. This test has three parts:

Part 1: The ADFM pings without transmitting and displays the result of an auto-correlation function performed over 0 to 7 Lag periods. Ideally, we should see high correlation at near-zero lags, and then see the correlation magnitude get smaller quickly toward larger Lags. High correlation values at larger Lags may indicate interference.

Part 2: The ADCP compares the RSSI value at high-gain vs. low-gain. This is not applicable to the ADFM. However, the recorded RSSI value is applicable, and is compared to a factory threshold. High RSSI levels may also indicate interference.

Part 3: The ADFM displays the Demodulator Hard-limiter bias values (DAC values. These values should be consistent between beams and tests; however, some number of counts deviation are allowed.

```
>pt1

Correlation Magnitude:

               Lag  Bm1  Bm2  Bm3  Bm4  Bm5
                 0  255  255  255  255  255
                 1  235  230  232  231  241
                 2  187  171  176  174  207
                 3  140  110  121  115  171
                 4  106   69   79   73  141
                 5   82   46   57   46  117
                 6   63   33   42   30   92
                 7   46   26   29   21   71

  High Gain RSSI:    50   48   51   49   56

  DAC Sin:   200
  DAC Cos:   198
  Duty:       48   48,    LPF:  0

Receive Test Results = $00006000 ... PASS
```

PT2 - Ancillary System Data

Purpose: This test displays the values for ambient temperature and the VDD3, VDD1, and VDC voltages.

Format: PT2

Description: This test reads Timing Generator ADC channels 3 through 6 (see PT1 test for a description of each channel), performs a conversion, and displays the values for ambient temperature, VDD3, VDD1, and VDC. Here is a sample test with the conversion factors for each ADC channel in brackets. NOTE: These values may be "noisy" from sample-to-sample, but are useful for detecting long-term trends.

```
>pt2

AMBTEMP =     29.1 Degrees C
VMVXDR  =      6.5 Volts
VMVDD1  =      5.0 Volts
VMVDC   =     56.8 Volts
```

PT3 - Receive Path

Purpose: This test displays receive path characteristics.

Format: PT3

Description: The test result is given as four nibbles (1 nibble = 4 bits). Each nibble represents the result for a particular beam (most significant nibble = beam 1, least significant nibble = beam 4). In this example, we only describe which bit is set for beam 4 for a given failure type. This test has three parts:

Part 1: The ADFM pings without transmitting and displays the result of an auto-correlation function performed over 0 to 7 Lag periods. Ideally, we should see high correlation at near-zero lags, and then see the correlation magnitude get smaller quickly toward larger Lags. High correlation values at larger Lags may indicate interference.

Part 2: The ADCP compares the RSSI value at high-gain vs. low-gain. This is not applicable to the ADFM. However, the recorded RSSI value is applicable, and is compared to a factory threshold. High RSSI levels may also indicate interference.

Part 3: The ADFM displays the Demodulator Hard-limiter bias values (DAC values. These values should be consistent between beams and tests; however, some number of counts deviation are allowed.

```
>pt3

Correlation Magnitude:

               Lag  Bm1  Bm2  Bm3  Bm4  Bm5
                 0  255  255  255  255  255
                 1  235  230  232  230  244
                 2  189  171  176  173  217
                 3  141  110  119  117  188
                 4  104   68   77   76  159
                 5   76   43   50   52  132
                 6   53   31   32   38  105
                 7   34   22   18   26   81

  High Gain RSSI:    53   49   49   50   56

  DAC Sin:   203
  DAC Cos:   199
  Duty:       46   47,    LPF:  0

Receive Test Results = $00002000 ... PASS
```

PT3 Failure Description

You can determine failure results ($>0) by the individual bit settings:

BIT #	***PT3 Failure Description*:**
0,4,8,12	Low Correlation – Correlation at lag 1 is <70% (130 counts) for beams 4,3,2,1.
1,5,9,13	High Correlation - A correlation at lag 11 or above is >63 counts for beams 4,3,2,1
2,6,10,14	High Noise Floor – Noise floor for high gain is >59 for beams 4,3,2,1.
3,7,11,15	Low Differential Gain - not applicable to the ADFM

PT4 - Transmit Path

Purpose: This test displays transmit path characteristics.

Format: PT4

Description: During the test, the ADFM pings and measures the resulting transmit current and voltage.

For example:

```
>pt4

----------- BEAM 1 -----------
IXMT    =     44.5 Ml Amps peak
VXMT    =      5.4 Volts peak
RXMT    =    120.4 Ohms
Transmit Test Results = $0 ... PASS
----------- BEAM 2 -----------
IXMT    =     40.2 Ml Amps peak
VXMT    =      5.5 Volts peak
RXMT    =    135.8 Ohms
```

```
Transmit Test Results = $40 ... PASS
----------- BEAM 3 -----------
IXMT    =     40.9 Ml Amps peak
VXMT    =      5.4 Volts peak
RXMT    =    133.0 Ohms
Transmit Test Results = $40 ... PASS
----------- BEAM 4 -----------
IXMT    =     38.1 Ml Amps peak
VXMT    =      5.5 Volts peak
RXMT    =    144.8 Ohms
Transmit Test Results = $40 ... PASS
```

PT4 Failure Description

You can determine failure results ($>0) by the individual bit settings:

BIT #	PT4 Failure Description
0	ADC Timeout Error - The Timing Generator ADC was not ready for reading when the CPU was ready to read the ADC.
1	Transmit Timeout - The Timing Generator never indicated completion of transmission.
2	Sample Timeout - The Timing Generator never indicated completion of sampling.
3	LCA Registers Corrupted - The contents of the Timing Generator's registers is corrupted.
4	Overcurrent Shutdown.
5	Overtemperture Shutdown. Not applicable to the ADFM
6	Incorrect Transducer Impedance. Could be caused by a short or an open connection in the transmit circuit, including the transducer.
7	Low Transmit Voltage And/Or Current. The transmit voltage and/or the transmit current was to low.

PT5 - Electronics Wrap Around

Purpose: This tests runs a through test on the ADFM electronic circuits.

Format: PT5

Description: This test sets up the ADFM in a test configuration in which the test output lines from the Triple Board timing generator are routed directly to the demodulators. The demodulators then process this signal. Test failures indicate possible problems with the Receiver, Demodulator, or Timing Generator.

Example:

```
>pt5

    0    0
    0    0
    0    0
    0    0
```

```
  255  255
    0    0
    0    0
  255  255
    0    0
    0    0
    0    0
  255  255
Electronics Test Results = $00000000 ... PASS
```

PT5 Failure Description

You can determine failure results ($>0) by the individual bit settings:

BIT #	PT5 Failure Description
0	Beam 1 Failure - A high value (normally 255) was <254, or a low value (normally 0) was >20.
1	Beam 2 Failure - See Bit 0
2	Beam 3 Failure - See Bit 0.
3	Beam 4 Failure - See Bit 0.
4	Correlator Timeout - The CPU never received a "processing done" signal from the Correlator.

PT6 – Receive Bandwidth

Purpose: This test measure the receive bandwidth of the system.

Format: PT6

Description: This test measure the receive bandwidth of the system. The bandwidth varies with system frequency and the WB command setting. Beam fails if <75% or >125% of nominal value.

Example:

```
>pt6
Receive Bandwidth: Narrow
    Sample      bw
      rate  expect   Bm1   Bm2   Bm3   Bm4   Bm5
    307200      45    31    36    34    35    26 Khz
   results         PASS  PASS  PASS  PASS  PASS
Receive Bandwidth: Middle
    Sample      bw
      rate  expect   Bm1   Bm2   Bm3   Bm4   Bm5
    614400      89    60    73    68    71    52 Khz
   results         PASS  PASS  PASS  PASS  PASS
Receive Bandwidth: Wide
    Sample      bw
      rate  expect   Bm1   Bm2   Bm3   Bm4   Bm5
   1228800     178   125   145   138   143   102 Khz
   results         PASS  PASS  PASS  PASS  PASS
```

PT8 - Checksum Lookup Tables

Purpose: Checks the integrity of the embedded Correlation and ArcTan lookup tables, as well as the firmware.

Format: PT8

Description: PT8 computes a checksum on the firmware (or Flash) and compares it to an internally stored checksum written during the flash download process. If the two are different, the firmware has become corrupted and should be downloaded again. The same is done to the embedded Correlation and ArcTan lookup tables. The tables can also be downloaded again if they have become corrupted.

Example:

```
>pt8
Calculated Flash Checksum:  C5B6
Flash Checksum .... PASS
Table Checksum .... PASS
>
```

C-2.5 Discharge Commands

The ADFM uses the following commands to calculate the discharge.

QB - Bed Level

Purpose: Sets the bed level in the pipe or channel.

Format: QB*nnnn*

Range: 0 to 2000 mm

Default: QB0000

Description: Use this command if the bottom of the pipe or channel has filled in with silt. Water flow under the transducer is not possible and is not calculated for the total discharge.

QC - Channel Type

Purpose: Sets the pipe or channel type between rectangular or circular.

Format: QC*nnn*

Range: *nnn* = 0, 1 (0 = rectangle, 1 = circle)

Default: QC000

Description: Use this command to set the pipe or channel type between rectangular or circular.

QD - Algorithm Select

Purpose: This command turns on or off various methods used to calculate the flow rate.

Format: QD*abc def ghi*

Range: Firmware switches (see description)

Default: QD100 011 110

Description: See table below for descriptions.

Switch	Description
a = Qmain	Do other selected algorithms (order of priority e, f, h, and g) and output a single best answer.
b = not used	
c = not used	
d = not used	
e = IHRW	Data adaptive fit
f = QmodVA	Average Velocity x Average Area with $R^{1/7}$ power law applied to velocity near the boundry.
g = QManning	(not implemented)
h = Qva	Average Velocity x Average Area
i = not used	

QF - Force Depth

Purpose: Force the depth of the channel or pipe to a set value.

Format: QF*nnnnn*

Range: *nnnnn* = 1 to 10000 mm (0 = off)

Default: QF00000

Description: Force the depth of the channel or pipe to a set value.

QH - Pipe Heights/Epsilons

Purpose: Sets the height/epsilons value of the pipe or channel.

Format: QH*nnnn*,*nnnn*,*nnnn*

Range: *nnnn* = 0 to 9999

Default: QH0000,0050,0100

Description: Use this command to describe the height/epsilon values of the pipe or channel.

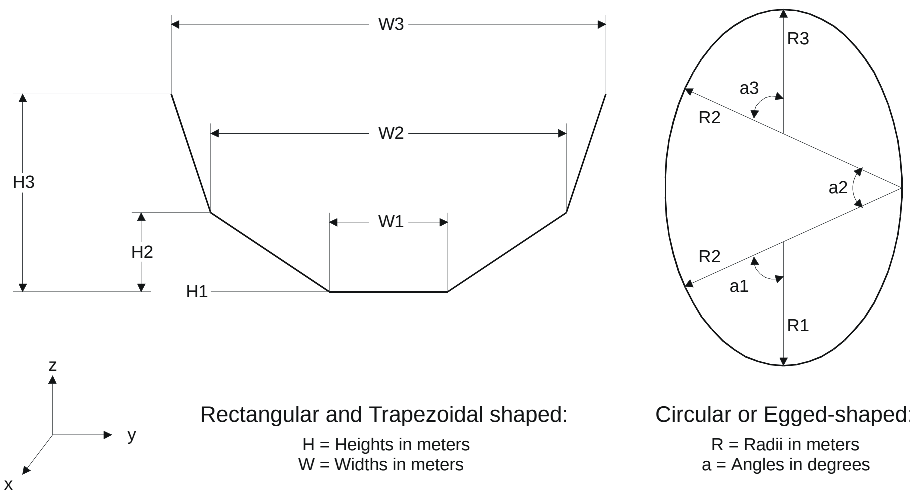

Figure C-1. Pipe Heights/Epsilons

QO - Transducer Offset from Pipe Bottom

Purpose: Sets the transducer offset from the pipe or channel bottom.

Format: QO+*nnnn*

Range: *nnnn* = -50 to 2000 mm

Default: QO+0000

Description: If the transducer is not resting on the bottom of the pipe or channel and water flow *is* possible under the transducer, use this command to set the depth of the transducer from the bottom of the pipe or channel to the top of the transducer face.

QP - Disc Params

Purpose: Sets the values used in the profiling algorithm and the power law exponent used in the ModVA flow rate algorithm.

Format: QP*nnnn*,*nnnn*

Range: *nnnn* = Delta, N (0 = calculate, not 0 = fixed)

Default: QP0500,0250

Description: Contact MGD Technologies Inc. for further details.

QR - QVD Structure Only Rate

Purpose: Sets the rate at which full “PD0” zero ensembles are interleaved between “PD3” ensembles.

Format: QR*nnn*

Range: *nnn* = 1 to 256 (1 = both always)

Default: QR006

Description: If PD3 is selected, a PD0 ensemble is output for ensemble #1 followed by several reduced discharge format ensembles. When the ensemble is evenly divided by QR a full PD0 ensemble is output.

Example: PD = 3, QR = 4. Ensemble output order: FE, RD, RD, FE, RD, RD, RD, FE, RD, RD, RD, FE, where FE = Full Ensemble and RD is a reduced discharge output ensemble.

QU - Channel Geometry Units

Purpose: Sets the units the QH and QW (distances, not epsilons) are entered in.

Format: QU*n*

Range: *n* = 0, 1 (0 = cm, 1 = mm)

Default: QU0

Description: Allows the ADFM to be set up using centimeters or millimeters for heights, widths, or radii.

QW - Pipe Widths/Radii

Purpose: Sets the width/radii value of the pipe or channel.

Format: QW*nnnn*,*nnnn*,*nnnn*

Range: *nnnn* = 0 to 9999

Default: QW0100,0100,0100

Description: Use this command to describe the width/radii values of the pipe or channel (see Figure C-134).

QZ - Zero Discharge Accumulation

Purpose: Zeros the discharge accumulation.

Format: QZ

Description: Zeros the discharge accumulation

C-2.6 Recorder Commands

The following paragraphs list all the ADFM recorder commands. Here is the basic sequence for an ADFM deployment using the data recorder.

a. Use the RA, RB, and RS-commands to display the current number of deployments stored in the recorder, to blank-check recorder memory, and to check the free space available on the recorder.

b. If necessary (or desired), erase recorder memory (see RE-command).

c. Set up the ADFM with the desired deployment parameters using the commands listed in Appendix-C.

d. Set the CF-command to allow the recording of data (CFxxxx1).

e. Send the CS-command to start pinging (and data collection).

f. Deploy the ADFM.

g. Recover the ADFM when the deployment is complete.

h. Send a <BREAK> to stop pinging (and data collection).

i. Turn off data recording (CFxxxx0).

j. Use the RD-command to extract the data from the recorder. Send RD*x* (*x* is the number of the deployment you want to retrieve). There may be a slight delay before the prompt returns because the ADFM is loading its buffer with the first ensemble.

k. Send the CS-command. Data ensembles for the selected deployment will be output from the ADFM as if it were pinging.

RA - Number Of Deployments Recorded

Purpose: Lists the number of deployments recorded on the data recorder.

Format: RA

Description: RA lists the number of deployments recorded on the data recorder.

Example: >RA

```
RA = 003 ------------- NUMBER OF DEPLOYMENTS RECORDED
```

The ADFM increments RA and uses it as the deployment number starting with the first ensemble recorded after a <BREAK> is sent. For the above example, if you set the ADFM to record (CFxxxx1), then when pinging begins (CS-command), the ADFM saves data to the recorder as deployment #4. If you use the MANUAL Ensemble Cycling mode (CF0xxx1) to record data, the ADFM will continue to record ensembles as deployment #4 until a <BREAK> is sent to the ADFM; also, RA will retain its current value (3 here) until a <BREAK> is sent.

RB - Blank Check Megabyte #

Purpose: Verifies recorder memory is fully erased (blank).

Format: RB*nnn*

Range: *nnn* = 000 to 999 (0 = check all recorder memory)

Description: RB lets you check the status of recorder memory. RB tells you whether the selected megabyte of memory is BLANK (no data stored) or USED (data stored).

Example 1: *RB0* checks the entire recorder:

```
>RB 0
[BEGIN BLANK CHECK]
Checking: 40 MB  (- = Blank, # = Data)
 MB #:  1  2  3  4  5  6  7  8  9 10
  0 +:  -  -  -  -  -  -  -  -  -  -
 10 +:  -  -  -  -  -  -  #  -  -  -
 20 +:  -  -  -  -  -  -  -  -  -  -
 30 +:  -  -  -  -  -  #  -  -  -  -
[END BLANK CHECK]
```

In the above example, megabytes #17 and #36 contain data. On 40-MB UV EPROM recorders, each board contains 2 MB, so board 9 (17 MB / 2 MB = 8.5 = 9 rounded up) located in slot J8 and board 18 (36 MB / 2 MB = 18) located in slot J16 both need further erasure. NOTE: If there are boards missing from the UV EPROM recorder, then the order in which memory is checked is sequential - slot J0 to slot J19).

In PCMCIA recorders, *RB0* shows the first *x* MB used, where *x* = MB used per RS-command. Remaining MB fields are blank.

Example 2: Different RB*nnn* values display the results for the selected megabyte.

```
>RB5
Megabyte #5: Blank
>RB 34
Megabyte #36: Used
```

Blank checking 1 Mb of memory can take up to 30 seconds, so there may be a delay before blank-check results are given. If the ADFM is in binary mode (CFxx1xx), RB returns a message consisting of four binary bytes, where:

Byte 2 = 06h or 15h; blank or used, respectively;
Byte 3 = [CSUMLO]; LSB of 16-bit checksum of bytes 1-2;
Byte 4 = [CSUMHI]; MSB of 16-bit checksum of bytes 1-2.

RD - Current Deployment Selected

Purpose: Selects the current deployment to retrieve.

Format: RD*nnn*

Range: *nnn* = 000 to 999

Description: RD lets you select the recorded deployment to retrieve. When the CS-command is sent after an RD>0 command, recorder data are output from the recorder in the format selected by the CF-command. If the recorder is currently enabled for recording data (CFxxxx1), and a deployment selection is attempted (RD>0), the ADFM sends ERR 015: *DISABLE RECORDER WRITE (CF COMMAND) TO SELECT DEPLOYMENT*.

Example: *RD003* selects deployment number 3 for retrieval. See previous page for an example on the sequence of steps used to record and playback deployment ensemble data.

RE - Erase Recorder

Purpose: Erases/initializes recorder memory

Format: RE ErAsE

Description: RE ErAsE erases <u>all</u> memory on Intel recorder board/s or resets the directory in PCMCIA recorders (i.e., no physical erasure of data). This command <u>IS</u> case sensitive. The RE erase sequence looks like this:

Example:

```
>RE ErAsE
[ERASING...]
```

While the recorder is erasing, the RS-command displays "999,999" as its parameters. It takes just a few seconds per megabyte to erase recorder memory. Sending a <BREAK> aborts this process.

RJ - Number Of Ensembles To Jump

Purpose: Moves an ensemble pointer within recorder memory.

Format: RJ*nnnnn*

Range: *nnnnn* = -99999 to +99999; if RJ=0, ADFM repeats last ensemble that was output

Description: RD forces the ensemble pointer for the current deployment to be moved through the deployment data by Ò*nnnnn* ensembles (Note: Negative values are not valid in PCMCIA recorders).

In ASCII mode (CFxx0xx), the ADFM returns the message "Jumped: *xxxxx*", where *xxxxx* is the actual number of ensembles skipped. Usually, *xxxxx* = *nnnnn*, except when trying to jump beyond a deployment boundary.

Example:

```
>CF 01010              {SET MANUAL ENSEMBLE CYCLING}
>RJ 99999  ERR 021:  SELECT DEPLOYMENT FIRST (RD ###)
>RD 3                {DEPLOYMENT "3" SELECTED}
>RJ 99999
Jumped:  +324   {SHOWS THERE ARE 324 GOOD ENSEMBLES IN DEPLOYMENT
RECORD}
>CS  ERR 022:  NO MORE ENSEMBLES {BECAUSE "END OF DEPLOYMENT" MARKER
REACHED}
>RJ -1
>CS
{...Data for ensemble #324 (last ensemble) shown here...}
>RD 3                 {GO TO BEGINNING OF DEPLOYMENT #3, ENSEMBLE #1}
>RJ 57                {JUMP TO ENSEMBLE #58 [#1 + 57]}
Jumped:   +57
>RJ -10               {JUMP TO ENSEMBLE #48 [#58 - 10]}
Jumped:   -10
>CS
{...Data for ensemble #48 shown here...}
>CS
{...Data for ensemble #49 shown here...}
>RJ 0                 {REPEAT LAST ENSEMBLE}
Jumped:   +0
>CS
{...Data for ensemble #49 shown again...}
>RJ -999              {IN EFFECT, JUMP TO BEGINNING...}
Jumped:   -48         {...BECAUSE ENTRY EXCEEDED DEPLOYMENT BOUNDARY}
>CS
{...Data for ensemble #1 shown here...}
```

If the ADFM is in BINARY mode (CFxx1xx), RJ returns a message of seven binary bytes, where:

```
Byte 1 = 05h          (size of message, not including checksum)
Byte 2 = LSB of xxxxx
Byte 3 = mid-LSB of xxxxx
Byte 4 = mid-MSB of xxxxx
Byte 5 = MSB of xxxxx
Byte 6 = [CSUMLO]     (LSB of 16-bit checksum of bytes 1-5)
Byte 7 = [CSUMHI]     (MSB of 16-bit checksum of bytes 1-5)
```

RS - Recorder Space Used/Free

Purpose: Lists the amount of used and free recorder space.

Format: RS

Description: RS lists the amount of recorder space used and free in 1-MB increments (1 MB = 1,048,576 bytes)

Example:

```
>RS
RS = 002,022 ---- REC SPACE USED (MB), FREE (MB), (999 = ERASING)
```

This shows the ADFM contains a 24-MB recorder (2 + 22). Up to 2 MB of space is used with 22 MB of free space. If at least one byte is written to recorder memory, RS will show that a full megabyte is used. While the recorder is erasing, RS = 999,999.

RT - Recorder Bit

Purpose: Tests the recorder using either non-destructive or destructive methods.

Format: RT

Description: RT tests recorder RAM, detects the number of memory cards, checks card communication, and checks recorder functions using either non-destructive or destructive methods.

This command is not implemented in Intel recorders.

Example 1: Non-destructive test - This test checks recorder operation without destroying previously recorded data. Write operations are done on "free" areas of the recorder. This test writes to and verifies low and high recorder RAM, detects the number of recorder cards installed, determines the total recorder memory capacity, tests write/read/block copy operations. This test takes less than 30 seconds to run. The format and output display are as follows.

Example 2: Destructive test - This test fills all recorder memory space with a pattern, and then verifies the pattern. During the test, the number of sectors tested is also displayed. This test must immediately follow the RE ErAsE command. This test takes about one minute per megabyte of recorder memory to run. The format and output display are as follows.

```
>RE ErAsE   <- Must immediately precede the rt-command for destruc-
tive testing
[Erasing...]
>RT
  0  2 14  0  0  0  0   <-- Output format is same as non-destructive
test
Sectors Checked   40960  <--- 2096 x Number of recorder memory mega-
bytes
```

Sending a <BREAK> aborts this test.

RY - Start YModem

Purpose:	Uploads recorder data to a host computer using standard YMODEM protocol.
Format:	RY*nnn*
Range:	*nnn* = 1 to 999 (0 = all)
Default:	RY000
Description:	RY uploads the entire contents of the recorder via the serial interface to a host computer using the standard YMODEM protocol for binary file transfer. Any communications program that uses the YMODEM protocol may be used to upload the recorder data. The data is transferred to the host and stored as DOS files. This command may be used to recover deployment data without opening the electronics housing.

C-2.7 Timing Commands

The following commands let you set the timing of various profiling functions.

TE - Time Per Ensemble

Purpose: Sets the minimum interval between data collection cycles (data ensembles).

Format: TE*hhmmssff*

Range: hh = 00 to 23 hours
mm = 00 to 59 minutes
ss = 00 to 59 seconds
ff = 00 to 99 hundredths of seconds

Description: During the ensemble interval set by TE, the ADFM transmits the number of pings set by BP and WP. If TP=0, the ADFM pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs during both ensemble storage and output.

Example: TE01153000 tells the ADFM to collect data ensembles every 1 hour, 15 minutes, 30 seconds.

TF - Time Of First Ping

Purpose: Sets the time the ADFM wakes up to start data collection.

Format: TF*yymmddhhmmssff*

Range: yy = 00-99 years
mm = 01-12 month
dd = 01-31 day (leap years ARE accounted for)
hh = 00-23 hour
mm = 00-59 minute
ss = 00-59 second
ff = 00-99 hundredths of seconds

Description: TF delays the start of data collection. This lets you deploy the ADFM in STANDBY mode and have it automatically start data collection at a preset time (typically used in battery operated instruments). When the command is given to the ADFM to start pinging, TF is tested for validity. If valid, the ADFM sets its alarm clock to TF, goes to sleep, and waits until time TF before beginning the data collection process.

Example: If you want the EXACT time of the first ping to be on November 23, 1994 at 1:37:15.00 pm, you would enter TF94112313371500. If you want the ADFM to begin pinging im-

	mediately after receiving the CS-command (see note), do NOT enter a TF-command value.
Notes:	Even though you may send a TF command to the ADFM, you must also send the CS command before deploying the ADFM. If the entry is not valid, the ADFM sends an error message and does not update the wake-up time. If the TF entry is a time that has already passed, the ADFM may have to wait 100 years before awakening, so *be careful when entering the TF value*.

TP - Time per Ping

Purpose:	Sets the *minimum* time between pings.
Format:	TP*mm*:*ss*.*hh*
Range:	*mm* = 00-59 minute *ss* = 00-59 second *ff* = 00-99 hundredths of seconds
Default:	TP00:00.00
Description:	The ADFM interleaves individual pings within a group so they are evenly spread throughout the ensemble. During the ensemble interval set by TE , the ADFM transmits the number of pings set by the WP-command. TP determines the spacing between the pings. If TP = 0, the ADFM pings as quickly as it can based on the time it takes to transmit each ping plus the overhead that occurs for processing. Several commands determine the actual ping time (WF, WN, WS, and actual water depth).

TS - Set Real-Time Clock

Purpose: Sets the ADFM's internal real-time clock

Format: TS*yymmddhhmmss*

Range:
yy = 00-99 year
mm = 01-12 month
dd = 01-31 day
hh = 00-23 hour
mm = 0-59 minute
ss = 00-59 second

Description: Sets the real time clock.

Example: TS941123131500 sets the real-time clock to 1:15:00 pm, November 23, 1994.

When the ADFM receives the carriage return after the TS-command, it enters the new time into the real-time clock and sets hundredths of seconds to zero. The internal clock does account for leap years. If the entry is not valid, the ADFM sends an error message and does not update the real-time clock.

C-2.8 Vertical Beam Commands

The following commands define the vertical beam criteria used to track the surface.

VC - Proofing of depth

Purpose: Requires *nnn* successful surface detections before outputting a new surface range.

Format: VC*nnn*

Range: *nnn* = 0 to 12 (0 = Off, 2-12 Pings)

Default: VC000

Description: If the VC command is set to VC012, then 12 successful surface detections would have to occur before a new surface range was output.

VD - Data Out

Purpose: Selects the data types for the vertical beam collected by the ADFM.

Format: VD*00n n00 000*

Range: Firmware switches (see description)

Default: VD001 000 000

Description: VD uses firmware switches to tell the ADFM the types of data to collect. The ADFM always collects header data, fixed/variable leader data, and checksum data.

Example: VDxx1 xxx xxx = collect Amplitude Switch data
VDxxx 1xx xxx = collect vertical beam Variable Leader data

VM - Surface Track Mode

Purpose: Sets the ADFM Surface Tracking Mode

Format: VM*n*

Range: *n* = 1 to 5 (1 = Amp, 2 = NA, 3 = Auto, 4 = Shallow, 5 = Deep)

Default: VM3

Description: The ADFM has 2 different surface tracking modes. Mode 1 is user configured and not recommended. Mode 3 is the Auto-Tracking mode which selects between Shallow (Mode 4) and Deep (Mode 5) surface tracking modes. Modes 4 and 5 are for forcing shallow or deep, but it is recommended that the AutoTracking be allowed to evaluate and select shallow or deep tracking. This allows the ADFM to change with conditions during the course of the deployment.

VN - Vertical Beam Number Of Depth Cells

Purpose: Sets the number of depth cells over which the ADFM collects data for the vertical beam.

Format: VN*nnn*

Range: *nnn* = 001 to 128 depth cells

Description: The range of the ADFM is set by the number of depth cells (VN) times the size of each depth cell (VS).

VP - Pings per Ensemble

Purpose: Sets the number of pings for the vertical beam to average in each data ensemble.

Format: VP*nnnnn*

Range: *nnnnn* = 0 to 16384 pings

Default: VP00010

Description: VP sets the number of vertical beam pings to average in each ensemble before sending/recording the water-track data.

VS - Vertical Beam Depth Cell Size

Purpose: Selects the volume of water for one measurement cell for the vertical beam

Format: VS*nnnn*

Range: *nnnn* = 0 to 9999 cm

Description: The ADFM collects data over a variable number of depth cells. VS sets the size of each cell in vertical centimeters

VX - Vertical Beam Transmit Length

Purpose: Sets the vertical beam transmit length in centimeters.

Format: VX*nn*

Range: *nn* = 0 to 99 cm

Description: Sets the vertical beam transmit length in centimeters.

C-2.9 Water-Profiling Commands

The following commands define the water-track (WT) criteria used to collect the water current velocity data throughout the water column.

WC - Correlation Threshold

Purpose: Sets the minimum threshold of water-track data that must meet the correlation criteria.

Format: WC*nnn*

Range: *nnn* = 1 to 255%

Default: WC080

Description: The ADFM uses WC to screen water-track data for the minimum acceptable correlation requirements. The nominal (maximum) correlation depends on system frequency and depth cell size (WS). WC sets the threshold of the correlation below, which the ADFM flags the data as bad and does not average the data into the ensemble.

WD - WT Data Out

Purpose: Selects the data types collected by the ADFM.

Format: WD*nnn n00 000*

Range: Firmware switches (see example)

Description: WD uses firmware switches to tell the ADFM the types of data to collect. The ADFM always collects header data, fixed/variable leader data, and checksum data.

Example: WD1xx xxx xxx = collect velocity data
WDx1x xxx xxx = collect correlation magnitude data
WDxx1 xxx xxx = collect echo intensity data
WDxxx 1xx xxx = collect percent good data

WE - Error Velocity Threshold

Purpose: Sets the maximum error velocity for good water-current data.

Format: WE*nnnn*

Range: *nnnn* = 0 to 5000 mm/s

Default: WE9999

Description: The WE-command sets a threshold value used to flag water-current data as good or bad. If the ADFM's error velocity value exceeds this threshold, it flags data as bad for a given depth cell. WE screens for error velocities in both beam and transformed-coordinate data.

WF - WT Blank After Transmit

Purpose: Moves the location of first depth cell away from the transducer head to allow the transmit circuits time to recover before the receive cycle begins.

Format: WF*nnnn*

Range: *nnnn* = 0-9999 cm

Description: WF positions the start of the first depth cell at some radial distance from the transducer head. This allows the ADFM transmit circuits time to recover before beginning the receive cycle. In effect, WF blanks out bad data close to the transducer head, thus creating a depth window that reduces unwanted data in the ensemble.

WG - Percent Good Minimum

Purpose: Sets a good-data qualifier for water-track data.

Format: WG*nnn*

Range: *nnn* = 1 to 100%

Default: WG025

Description: WG sets the minimum percentage of water-track pings that must be good in an ensemble before the ADFM flags the data as good. If the percentage of water-track pings that are good in an ensemble is below WG, the ADFM flags the data as bad.

WM - WT Profiling Mode

Purpose: Selects the application-dependent profiling mode used by the ADFM.

Format: WM*n*

Range: *n* = 1,3,5

Description: WM lets you select an application-dependent profiling mode. The chosen mode selects the types of pings transmitted. The ping type depends on how much the water current is changing from ping-to-ping and from cell-to-cell.

WN - WT Number Of Depth Cells

Purpose: Sets the number of depth cells over which the ADFM collects data.

Format: WN*nnn*

Range: *nnn* = 001 to 128 depth cells

Description: The range of the ADFM is set by the number of depth cells (WN) times the size of each depth cell (WS).

WO - Single Beam Mode Select

Purpose: Selects a single beam to ping from.

Format: WO*n*

Range: *n* = 0 to 5 (0 = off, 1-5)

Default: WO0

Description: Selects a single beam to ping from. If the single beam command is not zero all water profiling and vertical pings come from the same ceramic transducer.

WP - WT Pings Per Ensemble

Purpose: Sets the number of pings to average in each data ensemble.

Format: WP*nnnnn*

Range: *nnnnn* = 0 to 16384 pings

Description: WP sets the number of water-track pings to average in each ensemble before sending/recording the water-track data.

WS - WT Depth Cell Size

Purpose: Selects the volume of water for one measurement cell.

Format: WS*nnnn*

Range: *nnnn* = 0 to 9999 cm (328 feet) measured radially from each beam.

Description: The ADFM collects data over a variable number of depth cells. WS sets the size of each cell in vertical centimeters.

WV - WT Mode 1 Ambiguity Velocity

Purpose: Sets the radial ambiguity velocity for profiling Mode 1 (WM1) and the Mode 1 portion of profiling Mode 4 (WM4).

Format: WV*nnn*

Range: *nnn* = 020 to 999 cm/s

Description: Set WV as low as possible to attain maximum performance, but not too low or ambiguity errors will occur. Rule of thumb: Set WV to the maximum relative horizontal velocity between water-current speed and ADFM speed.

NOTES

Appendix D

ADFM Hot Tap Insertion

D-1 Introduction

The ADFM Hot Tap Insertion (HTI) flow meter is a variant of the standard, open channel ADFM flow monitoring system. The HTI transducer is a miniaturized version of the standard ADFM transducer. Designed specifically for use in closed or pressurized pipes, the HTI transducer enables installation while a pipe is still fully pressurized and in service. Installation of the HTI transducer is accomplished through an industry standard two-inch tap through the pipe wall.

The ADFM HTI transducer uses the standard ADFM electronics for data collection and storage. For the customer already familiar with the standard ADFM system, any differences between the two systems are transparent. The ADFM HTI flow monitoring system operates essentially like the standard ADFM flow monitoring system.

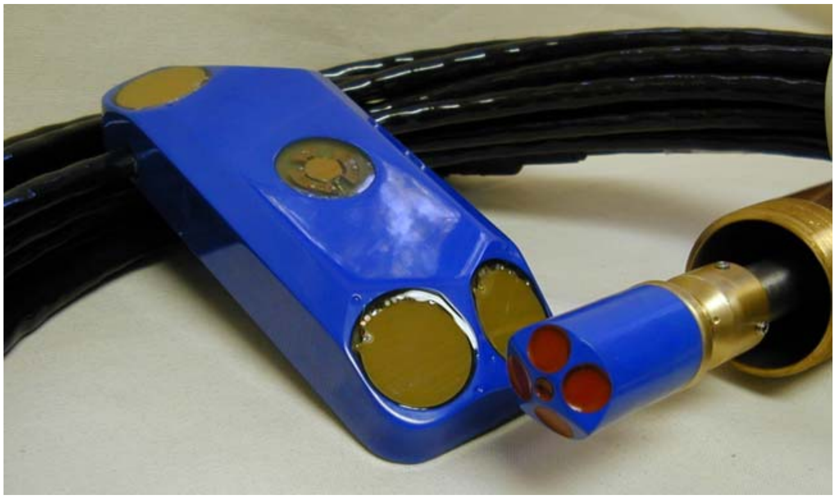

Figure D-1. Size Comparison between a HTI Transducer (Right) and a Standard ADFM Transducer (Left)

D-2 Power Requirements

The ADFM Hot Tap insertion transducer is designed to operate using the standard ADFM electronics package and enclosure. The system can operate with either 12 to 36 VDC or 110 VAC power. No special power requirements are necessary. Please refer to Chapter 2 in the ADFM Technical Manual for specific power requirements of the standard, open channel ADFM flow monitoring system.

D-3 Maintenance and Repair

The ADFM Hot Tap insertion transducer requires no routine maintenance. Please refer to Chapter 4 of the ADFM Technical Manual for general ADFM maintenance and repair instructions.

D-4 Installation and Setup

The major installed component of the ADFM HTI is the transducer. The transducer consists of the sensor head and insertion shaft, mounting and sealing assembly, end housing, and cable (see Figure -35). The HTI transducer comes with a 2” female NPT threaded fitting for attachment to the tapping valve assembly. Additional 2” NPT threaded nipples and fittings may be required to transition from the valve assembly to the HTI fitting, and to ensure adequate clearance between the valve and the mounting assembly for the sensor head.

Installation and operation of the ADFM Hot Tap insertion transducer can be divided into two basic functions. The two basic functions are:

1. Physical installation of the transducer
2. ADFM HTI system setup and testing

D-4.1 Physical Installation

Physical installation of the transducer consists of attaching the transducer to the pipe tap assembly, opening the valve and inserting the transducer into the proper position, and securing the transducer in position.

Placement of the sensor head is the key concern during physical installation of the transducer (see Figure -24). Proper positioning of the HTI transducer is critical to proper operation of the ADFM HTI flow monitoring system. Proper positioning is accomplished by aligning the scribed marks on the transducer end housing with the flow axis of the pipe. The tip of the sensor head should protrude approximately 1/8” beyond the interior pipe wall into the flow stream. This insures that all ceramic elements of the HTI transducer are not obstructed, nor obscured by the pipe wall.

Proper insertion distance can be determined by selecting a reference point on the end housing, measuring the distance from that reference point to the end of the sensor head, and subtracting from that distance the thickness of the pipe wall and lining PLUS 1/8”. The sensor will be inserted correctly when the measured distance from the reference point on the end housing to the pipe wall equals the calculated length.

A typical pipe tap assembly will include a valve or corporation stop and will end in a threaded nipple. The female mounting fitting on the HTI transducer can be attached directly to that threaded nipple. If the pipe tap assembly terminates in a female fitting, a threaded nipple of the appropriate length must be placed between the pipe tap assembly and the female mounting fitting on the HTI transducer. Teflon tape or other sealant must be used in all threaded connections to ensure watertight operation. All threaded connections **MUST** be securely tightened before proceeding with the installation.

Once the transducer is physically attached to the tapping assembly, the valve or corporation stop can be opened.

CAUTION. Keep all body parts clear of the HTI transducer when opening the gate valve. The HTI transducer may move if the setscrews on the mounting and sealing assembly are not firmly tightened.

After verifying that all joints are watertight, the sensor head can be positioned in the flow stream as described above. Once the transducer is properly placed, the setscrews on the mounting and sealing assembly must be securely tightened to keep the sensor head locked in place.

NOTE. A light coat of silicone grease applied to the stainless steel pipe will make it easier to position the HTI transducer.

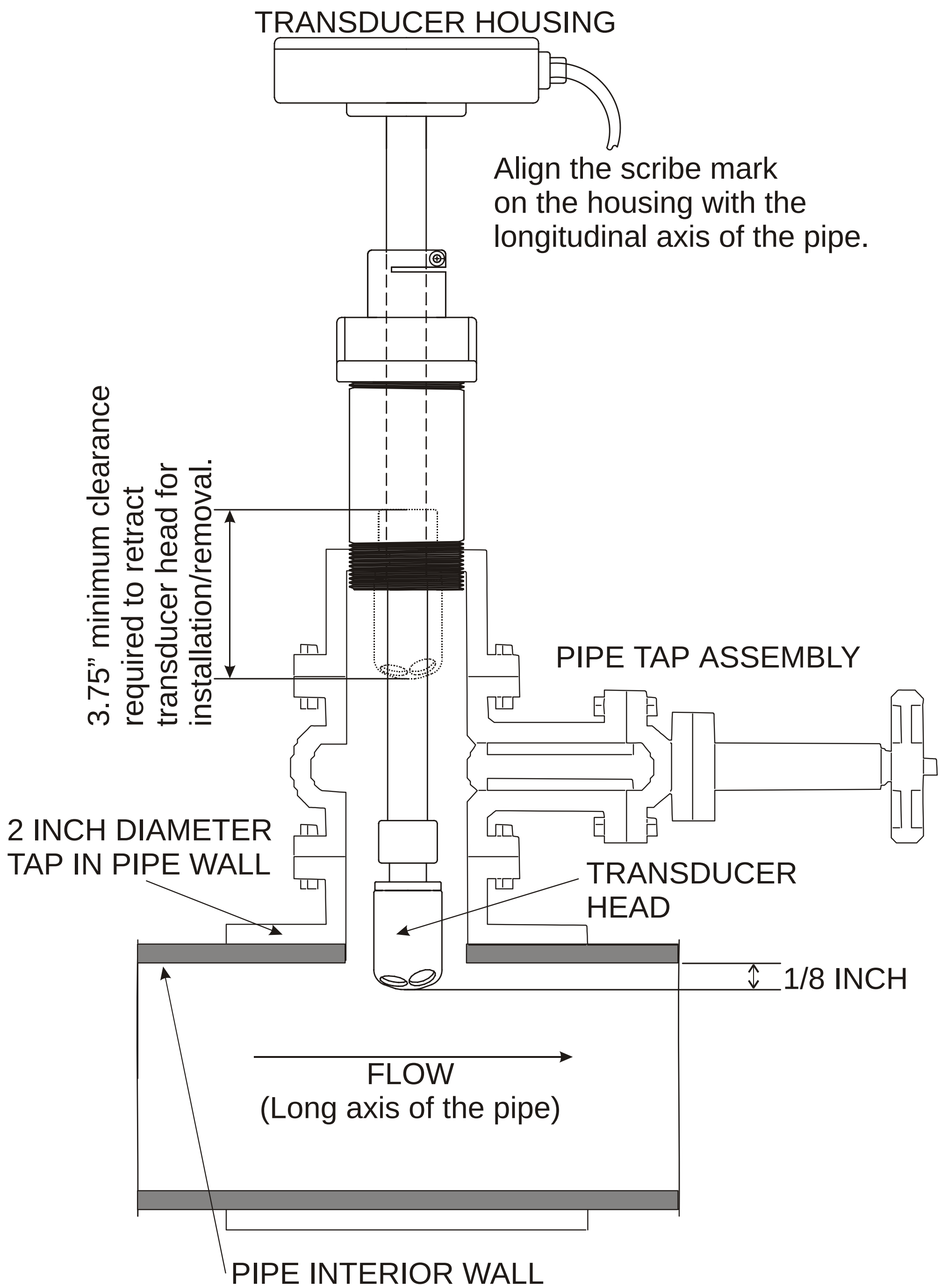

Figure D-2. Physical Installation

D-4.2 System Setup and Testing

Setup and testing of the ADFM HTI system is identical to that of the standard ADFM. Please refer to Chapter 2 in the ADFM Technical Manual for setup and operation guidelines.

D-5 Technical Specifications

NOTE. The specifications and dimensions listed in this section are subject to change without notice.

D-5.1 Physical Specifications

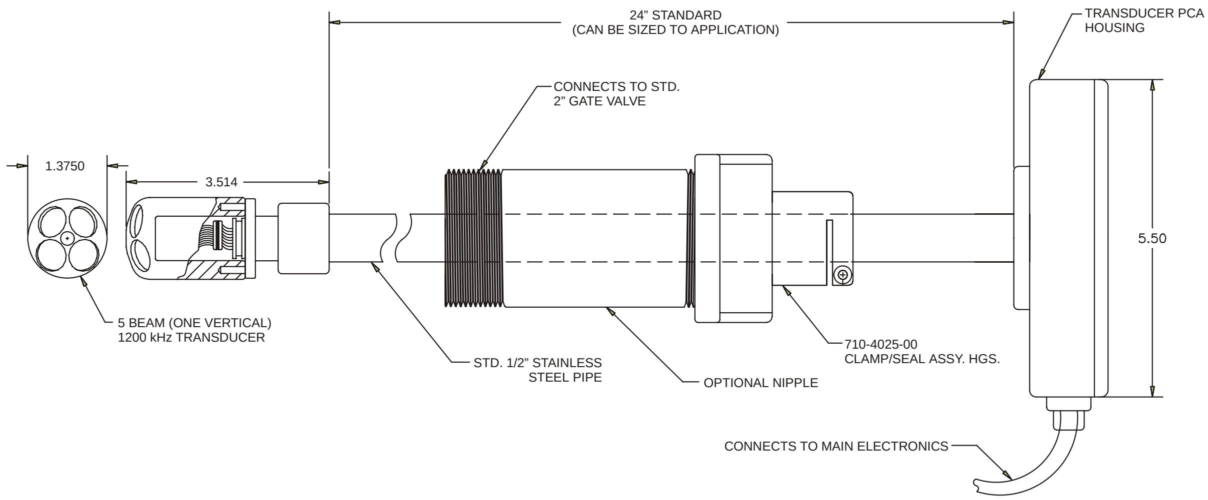

Figure D-3. Outline Installation Drawing

D-5.2 Packaging and Environmental Specifications

Transducer

Operating Temperature	23 to 95º F (-5 to 35º C)
Housing Material	Plastic transducer assembly on corrosion resistant stainless steel stem
Static Pressure	250 psi (1700 kPa) Nominal - 17 atmospheres, ~550 ft (165 m)
Weight	9 lb (4.1 kg)

Transducer Signal Cable

Operating Temperature	-40 to 125º F (-40 to 50º C)
Physical	Polyethylene jacket
Static Pressure	45 psi (310 kPa)
Length	50 ft standard (15 m) up to 150 ft (45 m) optional
Minimum Bend Radius	0.5 ft (15 cm)
Weight	0.08 lb/ft (120 gm/m) nominal
Outer Diameter	0.5 in (1.3 cm) nominal

Acoustic Frequency

Frequency	1.23 MHz

D-5.3 Performance Specifications

Flow Accuracy 2% of reading

Velocity

Horizontal Velocity Range	± 30.0 ft/s (9 m/s)
Velocity Bin Size	2 to 12 in (5 to 30 cm/s) – user selectable
Vertical Profiling Range	0.75 to 20 ft (0.22 to 6.0 m) nominal, for particle concentrations of 50 to 1000 ppm
Accuracy	0.5% ± 0.01 ft/s (0.3 cm/s) of reading

Water Level

Measurement Range	4.5 in (11.4 cm) to 30 ft (9 m)
Accuracy	0.5% ±0.2 in (0.5 cm) of reading

Appendix

E

ADFM Analog Output Module

E-1 Introduction

The ADFM Analog Output Module is an optional component of an ADFM (Acoustic Doppler Flow Monitor) flow monitoring system. It enhances the operation of a standard ADFM by providing a local data display and additional output options. The ADFM Analog Output Module is designed to accept a serial RS-232 data stream from an ADFM, parse the data stream to obtain depth, velocity, flow rate, and total flow information, display that information on a local LCD display, generate analog output signals according to user-defined scaling parameters (1 channel standard, 2^{nd} and 3^{rd} channels optional), and generate an output pulse at selected total flow increments (optional). LCD data displays, analog output ranges, and total flow pulse outputs are all provided in user-selectable engineering units.

Major components of the ADFM Analog Output Module include a programmable controller module, an LCD display panel, and one or more analog signal generator modules housed in a NEMA 4X enclosure. The controller module used is the Parallax BASIC Stamp IISX (BS2), based on the Scenix SX micro-controller. As the name implies, the BS2 is programmed using the Parallax PBASIC2 variant of the BASIC programming language. Operation of the unit is controlled by the loaded BS2 program code, and in-circuit reprogramming can be accomplished at any time.

Analog outputs from the ADFM Analog Output Module are generated using DGH Corporation D3000 series analog output modules. These modules are microprocessor controlled and programmed using ASCII commands and the RS-232 communications protocol. DGH Model D3251 current output modules are used, with the useable signal scaled from 4-20 mA and error conditions signaled by outputs in the 0-4 mA range. Current outputs are easily converted to voltage outputs using the appropriate precision resistor. In operation, ASCII commands from the BS2 set the DGH module output levels based on the data stream from the ADFM.

Totalized flows can be reported on the LCD display, and can be output as a pulse per unit volume. Processor and display limitations currently do not allow totalized flow and velocity to be displayed and output simultaneously. Pulse outputs are available as both dry contact closures and +5v pulses for driving an external totalizer or sampler.

E-1.1 Power Requirements

The ADFM Analog Ouput Module is designed to operate using externally supplied DC power. Standard operation of the unit requires +10 to +30 VDC, unregulated. Limited operation of the unit from the internal 9v battery is possible, however, analog outputs will not function and the battery life is estimated as six hours or less. Total power requirements will vary depending on configuration but should never exceed 4 watts; please consult MGD Technologies Inc. for more information.

E-1.2 Installation Overview

Installation and operation of the ADFM Analog Output Module can be divided into five (5) basic functions. Details concerning each of these functions are covered in detail in the following sections. The five basic functions are:

a. Physical installation of enclosure and components
b. Connect wiring to ADFM, power supply, and external devices
c. Setup and calibrate the DGH Modules
d. Program the micro-controller, configure switches
e. Verify output scaling and confirm system operation

Two versions of the printed circuit board (PCB) in the module have been manufactured. Installation and operation is very similar for both, and they are functionally equivalent. Pertinent differences are documented where appropriate.

E-1.3 Maintenance and Repair

The ADFM Analog Output Module requires no routine maintenance other than replacement of the internal 9-volt battery, if installed. The equipment should be checked periodically to ensure that it is operating properly, and that the electronics are clean, dry, and properly protected from harmful exposure to moisture, corrosive atmospheres, and physical damage. Certain components of the unit can be replaced by the end user. Please consult the troubleshooting and repair information in this manual, or contact MGD Technologies Inc. for further information.

CAUTION. Installation, programming, calibration, and servicing of this device should be performed by properly trained and qualified personnel. Potential shock hazards may exist when operating this device with the front cover removed. Power should be removed from this device during installation and servicing.

E-2 Physical Installation

The ADFM Analog Output Module is housed in a polycarbonate NEMA 4X enclosure with a translucent cover, approximately 10.0" high x 7.1" wide (254mm x 180mm). The enclosure is typically fitted with two (2) cable sealing glands for routing the ADFM communications cable and all field wiring into the enclosure. An Amp CPC connector is also fitted to the enclosure, to permit connection of additional devices to the ADFM flow monitoring system. This connector will not normally be used.

E-2.1 Mounting Location

The specific arrangement of components in an ADFM flow monitoring system can vary greatly, and will depend to a large extent on the physical parameters of the monitoring location. In a typical installation, the ADFM Analog Output Module's enclosure would be mounted adjacent to the ADFM Electronics Enclosure. Remote mounting is possible within the limits of the RS-232 communications protocol. Specifications for the RS-232 protocol limit the cable length to a distance of 25 feet, but substantially longer cables have been applied successfully in some applications.

A minimum clearance of two inches (50mm) should be provided on the top and both sides of the module's enclosure, with the minimum clearance increased to six inches (150 mm) on the bottom of the enclosure to provide access for cable entry. The enclosure may be installed in any orientation, however, readability of the display will suffer if the enclosure is not oriented vertically.

E-2.2 Mounting Options

Two options are available for mounting the ADFM Analog Output Module's enclosure. The simplest, and recommended option, is to mount the enclosure using the mounting holes in each corner of the enclosure. These mounting holes are directly in line with the cover screws, with an approximate hole spacing of 9.41" by 6.50" (239mm x 165mm). These mounting holes do not penetrate into the interior of the enclosure, thus protecting the interior of the enclosure from moisture and corrosion.

A second set of mounting holes is provided in the back of the enclosure. Removal of the module's circuit board and its mounting bracket from the enclosure is required to access this set of mounting holes. The hole pattern for this set of mounting holes is approximately 7.48” x 4.72” (190mm x 120mm). These mounting holes should only be used in dry, interior locations as the mounting screws directly penetrate the enclosure wall.

E-2.3 Enclosure Disassembly/Assembly

Disassembly of the ADFM Analog Output Module for access to the mounting holes on the back of the enclosure, or for component replacement, is accomplished using the following sequence. Re-assembly of the module follows the same sequence in reverse order.

a. Remove the front cover.

b. Disconnect all power sources from the module.

c. Remove the LCD mounting plate and disconnect the LCD wiring harness.

d. Remove the DGH module(s).

e. The circuit board is held in position by six (6) nylon standoffs. Carefully depress the detent on each stand off and lift the circuit board slightly. When all six standoffs are freed, the circuit board can be lifted free of the standoffs.

f. Disconnect field wiring as required. It may also be necessary to disconnect the external communications connector, J1, and the ADFM communications cable.

g. Remove the six (6) screws securing the circuit board mounting bracket to the enclosure.

E-2.4 Wiring Connections

Wiring connections to the ADFM Analog Output Module consist of the ADFM communications cable and field wiring for the DC power supply, analog current loop(s), and pulse output(s) if used. All wiring connections to the module are made through two terminal blocks, TB1 and TB2. The ADFM communications cable is wired to TB1 using the color coding marked on the circuit board. Pin numbers, wire colors, and functions are as follows:

Table E-1: Wiring Connections

Pin #	Wire #-Color	TB1 pin	Function
1	1-Black	1	RS-422, RX+
2	2-White	2	RS-422, RX-
3	3-Red	3	RS-422, TX-
4	4-Green	4	RS-422, TX+

Pin #	Wire #-Color	TB1 pin	Function
5	5-Orange	5	RS-422, DATCOM
6	NC	NC	Not Used
7*	6-Blue	6	RS-232, RX
8*	7-White/Black	7	RS-232, TX
9*	8-Red/Black	8	RS-232, SG
10	9-Green/Black	9	Depth2, GND
11	10-Orange/Black	10	Depth2, DC+
12	11-Blue/Black	11	Depth2, A+
13	12-Black/White	12	Phone, C1
14	13-Red/White	13	Phone, Tip
15	14-Green/White	14	Phone, Ring
16	15-Blue/White	15	Phone, C2

NOTE. *Essential for ADFM Analog Output Module operation

All of the above signals may not be present in all systems. If you have questions about any of the above functions, or wish to determine what functions are implemented in your system, please contact MGD Technologies Inc. NOTE: A 10k-ohm resistor should be installed between the RS-232 RX and SG lines. This resistor will typically be installed on TB1 for Rev A systems, and is pre-installed on the printed circuit board for Rev B systems.

E-2.5 Field Wiring/Power Supply

Field wiring to the ADFM Analog Output Module is connected to the terminal block marked TB2. Each position within TB2 is marked with its function rather than a terminal number, for ease of connection in the field. The only required connections are to the DC power supply terminals, marked DC+ and DC-. For full operation, the unit requires +10 to +30 VDC, unregulated. Partial operation can be obtained with supply voltages between +5 and +10 VDC, however, the analog outputs will not be functional. NOTE: DC power can be supplied to the ADFM electronics assembly from these terminals using the appropriate cable; however, the module CANNOT be powered from the internal batteries in the ADFM electronics assembly.

E-2.6 Field Wiring/Analog Channels

The ADFM Analog Output Module can be equipped with up to three independent analog channels, each capable of driving up to 600 ohm load. Analog outputs on these channels are generated using DGH Corporation Model 3251 current output modules. These modules act as four wire transmitters, i.e. power to the analog loop is provided by the DGH module. Each analog output is electrically isolated from the remainder of the unit's circuitry. Analog output channels are designated as Flow (QA+, QA-), Depth (DA+, DA-), and Velocity (VA+, VA-). Connect each analog output channel to the appropriate external loads/devices, consistent with standard current loop wiring practices for 4-wire transmitters, and ensuring that the total load for each loop does not exceed 600 ohms. NOTE: Although each of the three available current loops has a distinct name, customized programming can assign any function to any channel regardless of the naming convention on the module's circuit board. Please consult any system-specific documentation or contact MGD Technologies, Inc. if you suspect your system may not conform to the standard channel assignments.

E-2.7 Field Wiring/Pulse Outputs

Pulse outputs suitable for driving an external totalizer, sampler, or other similar device are available with the appropriate microprocessor programming. Pulse outputs are available as either +5vdc pulses (P5+, P5-) or as dry contact closures (NO, Comm). The +5vdc pulse, if used, can source a maximum current of 15 mA.

NOTE. Rev A: Dry contact closures are provided by a dry reed relay rated for 200 million closures, with a maximum switching loads of 10 va, 100 volts, and/or 0.50 amps.

Rev B: Dry contact closures are provided by a solid state relay rated 3-60 vDC, 0.02 - 1.0 amps.

E-3 Setup and Calibrate the DGH Modules

The DGH Corporation modules (model D3251) used in the ADFM Analog Output Module generate an isolated analog output signal based on ASCII text commands received from the micro-controller. Software provided by DGH can also be used to communicate directly with the modules for setup and calibration purposes. Detailed information on the DGH modules is provided in the D3000/D4000 Users Manual. If you did not receive a copy of this manual, please contact MGD Technologies Inc.

Standard DB-9 connector(s) are provided on the module's circuit board for communicating with the DGH modules. These connectors are identified by their nominal channel function, i.e. P2-Flow, P3-Depth, and P4-Vel. Connectors may not be installed in unused analog output channels. Communication to the DGH modules can only be established when the module is disconnected from the unit's micro-controller. Setting dipswitches SW2-4, 5, and 6 to the "Off" position accomplishes this.

NOTE. Remember to return these switches to the “On” position when setup or calibration is complete, or the ADFM Analog Output Module will not function as intended.

E-3.1 Standard DGH Module Setup

All DGH modules used in the ADFM Analog Output Module should be configured for operation at 2400 baud using channel address “1”. If the DGH module does not respond at those settings, the factory default setting of 300 baud should be tried. Contact MGD Technologies Inc. or refer to the D3000/D4000 Users Manual if communications with the module cannot be established at either setting. The basic setup procedure is as follows:

a. Start the DGH software, check the “Host, RS-232 Port” settings. NOTE: Some laptop computers must be restarted in MS-DOS mode to use the DGH software.

b. Connect the computer to the appropriate DB-9 connector.

c. Select “Setup” from the menu, enter the channel address and model number.

d. If communication with the module is successfully established, the current module settings will appear in the setup window. If communication with the module is NOT successfully established, a communications timeout error message will appear, followed by the same setup window. NOTE: You will not be able to successfully change the setup of the DGH module until you have successfully established communications with the DGH module.

e. Enter revised parameters in the setup window as desired. Limit checking will typically be turned on, and high and low limits will typically be set to 21.00 and 3.50 ma, respectively. NOTE: Use caution to avoid changing the DGH module address and baud rate unintentionally, as inadvertent changes to these parameters will make it impossible to communicate with the module using normal procedures.

f. When finished entering revised parameters in the setup window, program the module with the revised settings using the <F10> key. When the revised settings have been saved to the module, a prompt will appear asking if the module should be reset. NOTE: The revised settings will not actually take effect until the module is reset, either via this software command or by temporarily removing power to the module.

g. Test the revised settings using the “Misc, Terminal Simulator” menu option. Ensure that the baud rate setting for the terminal simulator matches the baud rate programmed into the DGH module. A typical command will begin with “$1”, followed by a two or three letter command and its parameters. The command syntax used to set the analog output level of the DGH module is “AO+nnnnn.nn”, where “nnnnn.nn” is the desired output level in milli-amps.

NOTE. Commands sent to the DGH modules MUST be entered precisely correct, or the module will not respond to the command. Typographical errors in entering the command cannot be corrected-attempting to do so will result in an error message such as “?1 COMMAND ERROR” or “?1 SYNTAX ERROR”. Simply re-enter the command, taking particular care to enter the command correctly. When a command has been correctly entered, the DGH module will return the asterisk character (“*”) to acknowledge the command.

NOTE. Rev B only: With switch SW2-2 set to the “ON” position, all installed DGH modules are forced into their “Default” mode. In this mode, any module should respond at 300 baud to any address and model number. The module can then be programmed with the appropriate operating parameters. Refer to the D3000/D4000 Users Manual or consult MGD Technologies Inc. for more information.

E-3.2 Current Loop Calibration

Calibration of the output from any DGH module can easily be accomplished using the DGH software and a calibrated ammeter; no calibration potentiometers or other hardware adjustments are required. The calibration procedure is described in detail in Chapter 9 of the D3000/D4000 Users Manual. The basic calibration procedure is as follows:

a. Start the DGH software, go to “Misc, Terminal Simulator”. Ensure that the baud rate setting matches that programmed into the DGH module

b. Connect the computer to the appropriate DB-9 connector.

c. Set the zero scale analog output value (4.0 mA) using the “AO” command.

   Example: Enter “$1AO+00004.00”

d. Measure the actual current output; if the output is in error send the “WE” command followed by the “TMN” command. Repeat step 4 until the actual output is correct.

   Example: Output value is measured as 4.02 mA instead of 4.0 mA.
   Enter “$1WE”
   Enter “$1TMN+00004.02”
   Check revised output value, repeat if necessary.

e. Repeat steps c and d, substituting the full scale output value (20.0 mA) for the zero scale output value and the “TMX” command for the “TMN” command.

Example: Enter “$1AO+00020.00”-output value is measured as 19.85 mA
Enter “$1WE”
Enter “$1TMX+00019.85”
Check revised output value, repeat if necessary.

f. It may be desirable to re-check the calibration of the zero-scale output after adjusting the full-scale output.

> **NOTE.** The DGH modules are rated for 12-bit precision, or 1 part in 4096, while the command used to program their output has a resolution of 0.01 mA, or 1 part in 1600. The accuracy of the actual data being represented by the analog output will typically be no better than 1-2% of the current reading. At a reading equivalent to 10% of full scale, this equates to approximately +/- 0.016 to 0.032 mA. Thus, extreme precision in calibration of the DGH modules is generally not warranted.

E-4 Programming the Micro-Controller

The micro-controller currently used in the ADFM Analog Output Module is the Parallax Basic Stamp IISX (BS2). This micro-controller is programmed is the Parallax PBASIC2 variant of the BASIC programming language. Operation of the module is controlled by the loaded BS2 program code, and in-circuit reprogramming can be accomplished at any time. Additional information on the BS2 micro-controller can be obtained from the Parallax web site, www.parallaxinc.com. Also available from their web site are programming tools for both DOS and Windows, PBASIC reference guides, software and hardware manuals, and links to other resources and reference materials.

Initial programming for each unit will normally be provided by MGD Technologies Inc. based on the configuration of the system, the desired user units, and the output scaling provided by the customer. The programmability of the unit adds both power and complexity to the system; revision of the programming apart from input parameter changes is not recommended unless the user has experience with BASIC programming, using a very limited number of variables, and is familiar with the principles of 16-bit unsigned integer mathematics.

E-4.1 General Operation of the ADFM Analog Output Module

Once programmed, the ADFM Analog Output Module follows a defined sequence of operation. Most simply expressed, it will:

a. Wait for data from its associated ADFM

b. Parse the incoming data stream to obtain the depth, velocity, and flow rate

c. Update each analog output channel based on the incoming data and the desired scaling

d. Update the local LCD display with the current data

Several error-handling procedures are incorporated into the standard programming. Foremost among them are the actions to be taken if either a) no data, or b) bad/missing data, is received from the ADFM. While waiting for data from the ADFM, the first line of the LCD display will show the word "Waiting" followed by a series of three numbers. The first of these numbers is the number of consecutive bad or missing flow rate readings from the ADFM. The second is the number of consecutive bad or missing depth readings from the ADFM. The third is a count of how long, in 20-second increments, it has been since data was received from the ADFM. If data is not received from the ADFM within the specified time window, it is treated as having received bad or missing data. When the number of consecutive bad or missing readings reaches or exceeds a specified threshold, the output(s) are set to a user-specified level for warning and diagnostic purposes.

> **NOTE.** Customized programming can be used to change the error handling procedures and/or the data shown on the local display. Please consult any system-specific documentation or contact MGD Technologies Inc. for further information if you suspect your system may not conform to the standard display and error-handling characteristics described above.

E-4.2 User Input Parameters

User Input Parameters to the ADFM Analog Output Module's BASIC code are grouped at the beginning of the program file. Typical inputs include zero scale and full scale values for each analog output channel, the number of consecutive bad or missing input values to allow before reporting an error condition, the values to be output as signals of an error condition, the amount of time to wait between successive input values, and the amount of smoothing to be applied to the incoming data. Minor changes in these parameters can easily be made by most users, however, changes in user units and large scaling factors may affect other portions of the program. Please contact MGD Technologies Inc. for assistance if you have questions about changing the user input parameters.

E-4.3 Programming and Operation

The micro-controller in the ADFM Analog Output Module is most easily programmed using the Windows95 based software available from Parallax. Programming the micro-controller consists of the following steps:

a. Starting the software, opening the program file for the site

b. Connecting your computer to the DB-9 connector on the module labeled P5-BS2

c. Rev B only: Switch SW2-1 must be in the "ON" position.

d. Loading and running the BASIC program in the micro-controller using the software menu functions

e. Rev B only: Switch SW2-1 may be set to the "OFF" position to avoid inadvertently resetting the micro-controller.

E-4.4 ADFM Analog Output Module Configuration

Certain functions of the ADFM Analog Output Module are enabled or disabled using a series of DIP switches on the circuit board. This switch bank is labeled SW2. Individual switch functions are as follows:

Table E-2: ADFM420 Module Configuration

Switch	Function	Settings
SW2-1	Enables micro-controller programming (Rev B only)	0-disabled, 1-enabled
SW2-2	Force default mode in DGH modules (Rev B only)	0-normal, 1-default
SW2-3	Isolate micro-controller from ADFM data stream	0-isolated, 1-connected
SW2-4	Isolate DGH module (flow) from micro-controller	0-isolated, 1-connected
SW2-5	Isolate DGH module (depth) from micro-controller	0-isolated, 1-connected
SW2-6	Isolate DGH module (velocity) from micro-controller	0-isolated, 1-connected

For normal operation, switches 1&2 should be in the "OFF" position and switches 3-6 should be in the "ON" position. If necessary, the module's micro-controller can be reset using the SW1 momentary pushbutton switch, located just above the P5-BS2 connector. When reset, the micro-controller will go through its initialization procedure and resume normal operation.

E-5 Troubleshooting

The ADFM Analog Output Module performs a relatively simple function; that of converting data from the ADFM's binary data format to an analog current signal proportional to flow. The module will normally be installed and configured by a trained technician, and should continue to function indefinitely. The following troubleshooting information is provided in the unlikely event that problems arise with the completed installation.

Table E-3: Symptom: No analog signal received at plant equipment

Possible Cause(s)	Test/Corrective Action(s)
Field wiring/Plant equipment	Disconnect field wiring from TB2, check for signal
	Check continuity of field wiring
	Test inputs of plant equipment using signal generator
Improper configuration	Check position of switch SW2-2 (Rev B only)
	Check position of switch SW2-3
	Check position of switch SW2-4, 5, and 6
	Check field wiring termination(s) at TB2
DGH signal generator module failure	Test communications with DGH module(s) (restart computer in MS-DOS mode if necessary)
	Check/set parameters and calibration of DGH module(s)
	Test DGH module(s) output using software
RS-232 communications lost between ADFM and ADFM Analog Output Module	Test RS-232 link with ADFM using DB-9 connector P1-ADFM
	Check position of switch SW2-3
ADFM Analog Output Module failure	Check input power
	Reset using switch SW1
	Monitor LCD display for activity
	Reprogram micro-controller
ADFM failure	Check ADFM input power/batteries
	Test ADFM communications
	Reprogram ADFM, monitor real-time output
	Verify that ADFM is set to output data serially
	Verify that ADFM is not logging internally, or that adequate recorder space is available

Table E-4: Symptom: Unusual or Erroneous Output Readings

Possible Cause(s)	Test/Corrective Action(s)
Improper Calibration	Compare analog output(s) with display values
	Check calibration of DGH module(s)
	Test DGH module output(s)
	Test/verify plant equipment inputs
Improper Scaling	Compare ADFM output data to ADFM Analog Output Module's display and analog output(s)
	Verify module's units and scale settings
	Verify plant equipment scaling
Unusual or Erroneous ADFM data	Compare ADFM output data to ADFM Analog Output Module's display and analog output(s)
	Review raw ADFM data for possible cause(s)
	Contact MGD Technologies Inc.
Data reduction errors in ADFM Analog Output Module or in the ADFM	Contact MGD Technologies Inc.

Table E-5: Symptom: Noisy or Erratic Output Readings

Possible Cause(s)	Test/Corrective Action(s)
Normal fluctuations in flows	None
Hydraulic influence from upstream or downstream facilities	None
Limits of precision for ADFM, ADFM Analog Output Module, or plant equipment	Review scaling of analog outputs
	Contact MGD Technologies Inc.
Insufficient velocity signal strength	Check for sediment accumulation at transducer
	Increase acoustical reflectivity of flow stream
	Contact MGD Technologies Inc.

NOTES

*Teledyne Isco One Year Limited Factory Service Warranty **

Teledyne Isco warrants covered products against failure due to faulty parts or workmanship for a period of one year (365 days) from their shipping date, or from the date of installation by an authorized Teledyne Isco Service Engineer, as may be appropriate.

During the warranty period, repairs, replacements, and labor shall be provided at no charge. Teledyne Isco's liability is strictly limited to repair and/or replacement, at Teledyne Isco's sole discretion.

Failure of expendable items (e.g., charts, ribbon, tubing, lamps, glassware, seals, filters, fittings, and wetted parts of valves), or from normal wear, accident, misuse, corrosion, or lack of proper maintenance, is not covered. Teledyne Isco assumes no liability for any consequential damages.

This warranty does not cover loss, damage, or defects resulting from transportation between the customer's facility and the repair facility.

Teledyne Isco specifically disclaims any warranty of merchantability or fitness for a particular purpose.

This warranty applies only to products sold under the Teledyne Isco trademark and is made in lieu of any other warranty, written or expressed.

No items may be returned for warranty service without a return authorization number issued from Teledyne Isco.

The warrantor is Teledyne Isco, Inc.
4700 Superior, Lincoln, NE 68504, U.S.A.

*** This warranty applies to the USA and countries where Teledyne Isco Inc. does not have an authorized dealer. Customers in countries outside the USA, where Teledyne Isco has an authorized dealer, should contact their Teledyne Isco dealer for warranty service.**

In the event of instrument problems, always contact the Teledyne Isco Service Department, as problems can often be diagnosed and corrected without requiring an on-site visit. In the U.S.A., contact Teledyne Isco Service at the numbers listed below. International customers should contact their local Teledyne Isco agent or Teledyne Isco International Customer Service.

Return Authorization

A return authorization number must be issued prior to shipping. Following authorization, Teledyne Isco will pay for surface transportation (excluding packing/crating) both ways for 30 days from the beginning of the warranty period. After 30 days, expense for warranty shipments will be the responsibility of the customer.

Shipping Address: Teledyne Isco, Inc. - Attention Repair Service
4700 Superior Street
Lincoln NE 68504 USA

Mailing address: Teledyne Isco, Inc.
PO Box 82531
Lincoln NE 68501 USA

Phone: Repair service: (800)775-2965 (lab instruments)
(800)228-4373 (samplers & flow meters)
Sales & General Information (800)228-4373 (USA & Canada)

Fax: (402) 465-3001

Email: iscoservice@teledyne.com **Web site:** www.isco.com

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