500 Series

Measurement and Control Systems

KEITHLEY

WARNING

This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause interference to radio communications. It has been tested and found to comply with the limits for a Class A computing device pursuant to Subpart J of part 15 of FCC Rules, which are designed to provide reasonable protection against such interference when operated in a commercial environment. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

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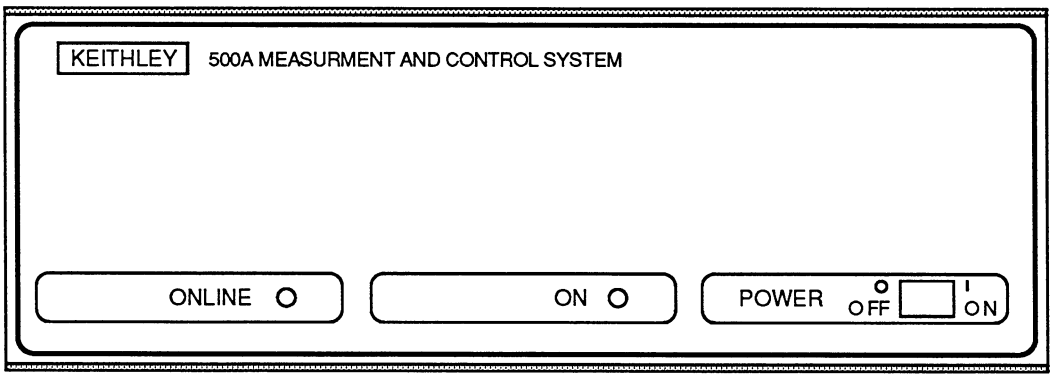
Preface

Welcome to the 500-Series Measurement and Control System

The Model 500 is a general purpose data acquisition and control device – an interface between the computer and the real world. With this system you can use the personal computer for direct data acquisition and intelligent process control.

The Model 500 is a complete system – the hardware, software, and documentation are integrated to make powerful measurement and control technology simple and easy to use.



500-Series Mainframe

SECTION 1
Introduction and Setup

This manual is a comprehensive introduction to the 500-Series scientific workstations, a set of integrated measurement and control systems for use with microcomputers.

Even if you haven't worked with computerized data acquisition before, you will find the 500 to be easy to use. If you already know exactly what you want from a measurement and control system you will appreciate the 500 as an intelligent partner in computerized research and automated testing. Whatever your experience, the 500 hardware system will provide all that you need to set up sophisticated measurement and control applications.

Terms and Conventions used in the Manual

The 500-series data acquisition mainframes consist of the 500A AC-powered model and the 500P DC-powered potable model. The chief difference in these units is the power supply. Otherwise, most electronic and mechanical subassemblies in the 500-series are identical.

This manual will refer to the 500-series generically as "500-series", "Model 500", etc. Where information concerns a specific model, that model will be identified as "500A" or "500P".

IMPORTANT: refer to the appropriate "Power Supply" section of this manual for additional power supply information before you set up the Model 500.

The 500-series is compatible with the IBM, PC, XT, AT, Personal System/2, and compatible personal computer families. Some information in this manual applies generically to all models. In such cases, the computer will be referred to as a "PC" or "computer". In cases where information or instructions apply to a specific computer, that computer will be identified by model name.

The 500-IBIN-A, 500-IBIN-LP, and 500-IBIN-PS/2 interface cards provide compatibility with these computers. This manual will reference interface types collectively as "IBIN". In cases where information applies to a specific interface, "500-IBIN-A" or "500-IBIN-PS/2" will be used.

This manual will instruct you to enter commands into the computer. The text you must enter will be broken out from the main text of a paragraph. Specific keys on the computer, such as the space bar, enter key, Ctrl, Alt, and Del keys will be enclosed in brackets, that is <Spacebar>, <Enter>, <Ctrl>, <Alt>, <Del>, etc.

Using This Manual

This manual is not a replacement for documentation which came with your personal computer or BASIC. The

PC comes with specific documentation which includes reference guides to BASIC, DOS (Disk Operating Systems), and general operations. Consult these guides for any and all information relating to the computer itself or the use of BASIC.

With that exception, every effort has been made to explain all important theoretical ideas, unfamiliar terms, and useful formulas. If a topic is important but lengthy you may be referred to another source for additional information.

When you first look through the manual, you will notice that it is divided into an Introduction and Setup section, a Reference section and a Servicing Information Section:

Introduction

The introduction section, which you are now reading, provides information on unpacking, setting up, and testing the 500 system. It also contains safety-related information to help you operate the 500 system and modules properly.

Reference

The Reference Section follows the Introduction and describes in detail the hardware components in the 500 system. You will find this reference section extremely useful and important; specific technical details are supported by general theoretical information.

Interface Cards

This section contains a space where you may insert the manuals corresponding to the 500 series IBIN card(s) that you have purchased.

Modules

The Modules section provides a space where you may insert the manuals from the respective modules you've purchased for the 500. The section also contains power consumption data for the various modules.

Servicing Information

The Servicing Information Section provides information necessary for calibrating and repairing the 500 circuitry. It is included as an aid for the engineer and technician. Generally, you will be able to troubleshoot the system to the module level. Board repair should be left to a qualified technician. Specific calibration instructions are included in the manuals for respective modules.

Unpacking Your System

Before going any further, check the packing slip and make sure you have received the correct modules, hardware, and software.

Now take the 500 unit out of its packing box and remove the cover from the system.

You may remove the cover by first unscrewing the two knurled screws at the top rear of the unit. Then slide the cover back about one inch and lift it off.

Look at the inside of your 500 system. Sit in front of the system for a moment, facing the front panel. On the far right you will see the power supply. The power switch for the system is on the front panel.

At the bottom of the case you will see the mother board with ten slots for installing 500-series modules. The slots are numbered 1 to 10, starting at the left. For convenience these numbers are imprinted on the mother board, on the side of the slot nearest the front panel.

Mounted at the back of the mother board, on the lower rear panel, are two connectors. The 25-pin connector toward the center is for the cable to the IBIN Interface card. The 9-pin connector is an accessory power output source. The accessory power source provides +5V, +15V, and –15V from the system power supply. It can be used to power external circuitry or to provide excitation for sensors.

Installing Modules

You will find that the modules you ordered are not installed in the mother board slots. Before you install the

modules, you should review the manual accompanying each module for any special instructions and switch setting information.

CAUTION
The power should always be off when removing or replacing modules, or setting switches. If you try to set switches or replace modules while the power is on you may damage the system.

NOTE
When installing modules make sure that components always face toward the power supply.

When you are handling the modules take care not to accidentally change any of the switch settings. The module manuals describe the functions which are controlled by these switches.

You may install any module in any slot in the 500 within the following guidelines:

1. If you intend to perform analog input measurements, slot 1 must be occupied by an AMM1F, AMM1A, AMM2, or other compatible analog input module.
2. If analog input measurements are not to be performed, slot 1 may be used for any module.

You may need to remove the modules periodically to change the settings of the on-card switches. The modules should not, however, be removed and replaced needlessly. If removed too often the gold plating on the sockets and connecting fingers of the modules may wear thin. If you do remove the cards frequency and notice a discoloration of the connecting fingers, wipe then with alcohol to clean them.

When you have checked the modules and placed then in their proper slots, please fill out your purchaser registration card and mail it to:

Keithley/Metrabyte
440 Myles Standish Blvd.
Taunton, MA 02780

Setting up

The following hardware is required to use the 500 system:

1. A microcomputer with at least two disk drives. One must be a floppy drive.
2. A monitor for your computer.
3. The 500-IBIN Interface card and connecting cable.

The 500-series data acquisition systems can be used with 100% IBM-compatible computers based on the 8086, 8088, 80286, 80386 microprocessors. The computer must have at least one half-length or full-length expansion slot.

If you have just purchased a PC, take the time to review its documentation before continuing.

In general, the 500 can be used under the same environmental conditions as the PC. It should be kept at normal room temperatures, out of strong sunlight. If exposed to extreme heat or cold, the system should be allowed to return to room temperature before it is turned on. Otherwise, performance may be outside the specified tolerances, or the system may be damaged.

The 500 should be set up in a place where it has several inches of space at the rear of the system for ventilation. Never close off the rear panel or cooling fan.

NOTE
If you plan to run a portable computer from the 500P DC power supply, please refer to the Reference — DC Power Supply - section now for connection instructions.

WARNING
Before installing the 500-IBIN interface, disconnect power from the computer prior to removing its cover.

To install the interface in to the PC, first be sure that both the computer and the 500 are turned off and disconnected from the main source of power. Now remove the interface card and cable from their packing box.

You will need to install the IBIN interface card in your computer. This requires removing the computer's outer

cover (and any inner covers as needed) to gain access to its mother board and expansion slots. Computer mechanical designs and assembly methods vary widely. If you are unsure of any disassembly steps, consult the documentation which came with your computer. If necessary, get a technician to assist you.

Normally, you may place the interface card in any of the computer's expansion slots (except slot 8 of an IBM PC/XT). Note that some computers have specialized slots which, through form or function, cannot accept the IBIN card. Consult your computer documentation if you are in doubt on this matter. The documentation included with the IBIN card describes installation of the interface in more detail.

NOTE

Before installing a 500-IBIN-A card, make sure the switches controlling the interface address are set to an address which is compatible with your hardware. Keithley recommends the address CFF80, which is compatible with the majority of computers and accessories. The switch settings for CFF80 are: switches 3 and 4 ON; switches 1, 2, and 5-8 OFF.

NOTE

Some computers using "VGA" display adapters may use the "C" block of memory for video functions. You may have to use another address to avoid conflicts with the IBIN-A. Addresses in the "D" or "E" block are recommended in this case. Consult the IBIN-A manual for more details.

The 500-IBIN-PS/2 is programmed for address and interrupt usage after it has been installed in the computer. There are no hardware switches to set.

The IBIN card has a mounting bracket which contains the connector for the cable leading to the 500. To install the IBIN card, you will first need to remove the blanking cover for the chosen slot from the rear panel of the computer. Save the screw which holds this cover in place.

Carefully plug the IBIN into the computer's mother board such that its mounting bracket occupies the space left by the blanking bracket. Replace and securely tighten the screw.

You may now reassemble the computer in the reverse order of disassembly.

Now take the connecting cable that came with the interface card. The cable has connectors on either end which enable you to make the connection to the interface card in the PC and to the 500 mother board. The connectors are designed so they will fit only one way. First, connect the cable to the interface card.

Make the connection to the 500 mother board in exactly the same way by attaching the cable to the connector that sits at the rear of the 500 mother board (refer back to the illustration which is located at the end of the preface). If you have followed these instructions you have now completed the connection between the 500 and the PC.

Power and Safety Considerations — 500A

The 500A can be set for line voltage of 100, 120, 220, or 240V ac at 50-60Hz according to the local mains voltage. The 500A should be connected to a grounded outlet capable of supplying 1A of current. Ideally, you should have a dedicated line for the 500A and the computer.

WARNING

A standard grounded outlet must be used to avoid possible shock hazards, and to minimize interference-causing electromagnetic radiation.

WARNING

The 500A AC power supply is covered by a protective screen. Never remove this screen unless the power cord in unplugged.

WARNING

Do not operate the system at an incorrect line voltage or a shock hazard may result.

WARNING

As shipped, the 500A system is set for nominal 120V AC power sources. Operation at line voltages outside this range may create a

shock hazard. Changing the line voltage setting is covered in the Power Supply section of this manual.

WARNING

The correct line fuse value for 120V operation is 1A. Do not install a fuse with larger value or a shock hazard may result.

CAUTION

The mother board power supply is a standard UL unit with ratings of 5V @ 3A, 15V @ 0.8A, and –15V @ 0.8A. Exceeding these values may cause the system to malfunction or damage the system.

WARNING

Heat sinks on the power supply may become hot after extended operation. Avoid touching the power supply.

Power and Safety Considerations — 500P

The 500P can be ordered with power supplies for 9.5V-18V dc or 18-36V dc operation. An accessory for the 9.5-18V model supplies isolated 12V output for powering the computer. The 18-36V model includes this option as standard equipment.

WARNING

Operate the 500P system from the correct supply voltage or damage may result.

CAUTION

The 500P DC power supply does not include a cover. While its maximum internal voltage will not normally exceed 24-36V, you should still avoid touching any power supply components. Avoid dropping any objects into the power supply or damage may result.

CAUTION

Make sure any power cabling you use is heavy enough to supply the required current without any significant voltage drop.

Completing Setup

After the modules and IBIN interface have been installed, you may apply power to the system.

Once connected and plugged in, the PC and 500 can be turned on and off in any order. The computer can, of course, be operated normally with the 500 interface card installed, or with the interfacing cable disconnected.

Your system is now set up and ready for use.

General Precautions

Even though it is convenient when setting up an experiment or process to leave the case top off, the system should not normally be operated in this way. Dirt and small objects can easily become lodged in the 500 connectors and circuitry. This can very easily cause unreliable performance and a shortened life for your system.

CAUTION

To minimize electromagnetic interference, operate the system only with the cover in place and secured with screws.

A second precaution concerns connection of signals with voltages that exceed the specified ranges. Information on the voltage ranges accepted by each module can be found in the Specifications section of each module's documentation. Damage to the system caused by connecting voltages which exceed these ranges is not covered by the product warranty. If necessary, replacement parts are available from Keithley/Metrabyte. (See Servicing Information sections for parts information.)

Following these warnings will reduce the chances of personal injury or system damage.

CAUTION

Do not exceed the input ratings of the various modules, or damage may result. The non-isolated analog module inputs are limited to as low as ±15V with power applied, or ±10V with the power off. Consult the individual module manuals for these ratings.

CAUTION

"Non-isolated" as used in this manual means that internal circuit common is at power line ground potential, and that external circuit common must also be at power line ground potential.

Designing Safe Control Set-Ups

Keithley Instruments manufacturers its data acquisition and control products to the highest technical and safety standards. However, you, the user of this equipment, have ultimate control over how the equipment is used in the field. Always use techniques and procedures which result in safe operation of external equipment and processes.

CAUTION

For proper initialization of 500 and external equipment, consult the Keithley software manual section "Initializing Hardware at Power Up with HARDINIT" for instructions on using HARDINIT. HARDINIT can be used to initialize the system even if you plan to use another software package for normal operation. Modify the AUTOEXEC.BAT file on your fixed disk or boot floppy diskette to execute HARDINIT automatically at boot-up. Power up the computer, 500, and external equipment as follows:

1. **Before beginning power up, make sure computer, 500 and all external equipment are off.**
2. **Simultaneously turn on the computer and 500 and boot from fixed or floppy diskette containing AUTOEXEC.BAT file with HARDINIT command.**
3. **When AUTOEXEC.BAT completes execution, turn on the external equipment or process.**
4. **For power-down, turn off or otherwise prepare external equipment before turning off computer or 500.**

Please consider the following points about the 500 and your particular applications when you design control configurations:

1. Where loss of power, interruption of the control program, or failure of any equipment can lead to unsafe conditions, do not leave equipment unattended.
2. Beginning with DOM1 rev D, PCM1 rev D, and PCM2 rev D, a power-on reset circuit holds digital output lines off for approximately five seconds after power is applied. Output lines will not respond to programmed changes during this time. After the power-on reset period, the output lines will remain off until programmed to change state. This circuitry does not affect analog output lines.
3. Older revisions of the DOM1, PCM1, and PCM2 do not contain a power-on reset. Output lines may power up in a random state under some circumstances. Do not use older versions of these products where random output at power up is undesirable.
4. DIO1 modules do not contain a power-on reset. Use the DIO1 only to sense TTL- level digital signals, or for digital applications where random output at power-up is of no consequence. The DIO1A does contain a power-on reset.
5. 500 analog output modules AOM1-AOM4 do not contain a power-on reset. Therefore, analog output channels on these modules may power up to a random level. Properly initialize all analog output channels with HARDINIT or a program before applying power to external equipment or processes.
6. AIM7 modules do not incorporate an "open thermocouple sense". Make sure thermocouple used with the AIM7 are in good condition and operating properly.
7. If initialization of outputs is important, use the KDAC500 HARDINIT utility in the DOS AUTOEXEC.BAT file to initialize all digital and analog output channels to 0 at boot-up. Consult the KDAC500 Software Manual "Initializing Hardware at Power Up with HARDINIT.EXE" for instructions on using HARDINIT. Note that there will be a short period between power-on of the computer and 500, and execution of HARDINIT, where output of digital or analog output modules may be at random levels. make sure HARDINIT has initialized all output hardware before applying power to external equipment or processes.
8. In some cases, external equipment or processes must be returned to a particular state before control can be interrupted or power can safely be removed. Take all necessary precautions and make all necessary preparations before you interrupt a control program or switch off external equipment or processes.
9. The KDINIT command will initialize digital and analog output channels to 0 if called after KDAC500 and BASIC have loaded. You may include a KDINIT in the KDAC500 file AUTOEXEC.BAS.

   (Users who run KDAC500 RESIDENT and RE-ENTER modes, NOTE: If executed while data acquisition is in progress, CALL KDINIT will halt data acquisition and erase data arrays in memory.)

Sample Techniques for Different Power-On Reset Requirements

The following techniques can be used for implementing automatic hardware initialization and program recovery under many circumstances.

CAUTION

When some personal computers are switched off or lose power, they must remain off for a short period to permit the computer supply to "bleed down" and reset. This period is specified by the computer manufacturer, and may be up to 30 seconds or more. If power is restored before the specified reset period has elapsed, the computer will not resume operation. Under these conditions, a Model 500, which contains its own power supply, will power on when power is restored, regardless of computer. Do not leave equipment unattended where power failures may result in undesirable operation of equipment.

1. To execute a test program automatically when KDAC500 loads:
   A. Write and debug a program to perform a desired measurement or control.
   B. Modify AUTOEXEC.BAS to run your application program automatically. Do this by substituting the "NEW" statement (line 280) with: RUN "<your program name>.
   C. Boot the computer and run KDAC500. The KDAC500 program will execute automatically when KDAC500 is done loading.
2. To initialize all output modules to 0 when the computer and data acquisition system are turned on – system pauses and prompts for data acquisition system to be turned on:
   A. Modify the AUTOEXEC.BAT file on disk from which computer boots to execute HARDINIT utility. Include HARDINIT pause option ("-p") to remind that data acquisition system must be on.
   B. Make sure all external equipment is turned off.
   C. Boot the computer from AUTOEXEC.BAT file containing HARDINIT command.
   D. When HARDINIT instructs, confirm that data acquisition system is on, and press the <Enter> key.
   E. When AUTOEXEC.BAT completes execution, turn on the external equipment.
3. To initialize all output modules to 0 when the computer and data acquisition system are re-energized after a power failure - system automatically initializes data acquisition system, but control program is not restored:

   NOTE
   Output channels may produce random levels until HARDINIT initializes hardware.

   A. Modify the AUTOEXEC.BAT file on disk from which computer boots to execute HARDINIT utility. DO NOT use HARDINIT's pause option ("-p").
   B. When power is restored, AUTOEXEC.BAT will execute HARDINIT and automatically initialize output hardware to 0.
4. To initialize all output modules to 0 when the computer and data acquisition system are re-energized after a power failure - system automatically initializes data acquisition system and restores control program:

   NOTE
   Output channels may produce random levels until HARDINIT initializes hardware.

   A. Modify the AUTOEXEC.BAT file on disk from which computer boots to execute HARDINIT utility. DO NOT use HARDINIT's pause option ("–p").
   B. Add as last line of the AUTOEXEC.BAT file a command to execute KDAC500. If necessary, include a DOS CHDIR command before the KDAC500 command to move to the directory containing KDAC500.
   C. Write and debug a KDAC500 program to perform the desired measurement or control function.
   D. Modify AUTOEXEC.BAS to run your application program automatically. Do this by substituting the "NEW" statement (line 280) with: RUN "<your program name>.
   E. When power is applied or restored to the computer, AUTOEXEC.BAT will execute HARDINIT. HARDINIT will initialize all output channels to 0 automatically. AUTOEXEC.BAT will then run KDAC500 which will automatically execute user-written KDAC500 program.

This manual will instruct you to open the case of the 500 when making connections to the system.

WARNING

User supplied lethal voltage may be present on module connections. To avoid electric

shock disable external power sources before making any adjustments or connections to this product. The 500 is not for use in electrically sensitive areas, or for connection to humans.

ALWAYS observe the following safety rules.

1. If you need to open the computer:
   A. Disconnect the Model 500 from the computer.
   B. Turn off the computer and disconnect the power cord.
2. If you need to open the 500:
   A. Turn off or disconnect any equipment connected to the inputs of the 500.
   B. Set the ON/OFF switch to OFF before opening the 500 case.

NOTE
It is not necessary to turn off the computer when you open only the 500.

WARNING
To avoid electric shock, use only the supplied cable to connect the 500 to the IBIN interface card. This is a specially designed cable that is part of the safety ground on the 500. If the computer is AC-powered, note that this safety ground uses the third wire ground on the computer, and that the computer must be plugged into a properly grounded 3-wire outlet.

CAUTION
The 500, like the computer, is a delicate electronic device. Keep and operate both at room temperature. If the 500 or computer have been subjected to extreme heat (>110°F) or cold (<50°F), allow them to return to normal room temperature (60 to 90°F) before you turn them on. Otherwise, serious damage may result.

CAUTION
Maintain enough space around each part of the system to provide ample cooling air. Do not block ventilation grillwork at the front or back of the computer, or on any other equipment.

CAUTION
Do not exceed the input ratings of the various modules, or damage may result. The non-isolated analog module inputs are limited to as low as ±15V with power applied, ±10V with the power off. Consult the individual module manuals for these ratings.

CAUTION
Do not apply more than +5.5V DC or negative voltages to any non-isolated digital input module plugged into the 500.

CAUTION
Do not install or remove a module from the 500 while power to the System is on.

In Case of Problems or Malfunctions

This manual will provide you with all the information you need to set up your system quickly and correctly. If you do have problems, however, call the Keithley/Metrabyte Technical Support Department at 1-508-880-3000.

If a module in the system is determined to be defective you will receive a return authorization (R.M.A.) number. Pack the module carefully in the original antistatic bag and mark the R.M.A. number on the outside of the box. If at any time the entire unit must be returned for servicing be sure to pack it in the original shipping materials.

SECTION 2
Reference

Introduction
Theory of Operation (System Overview)
Mother Board
500A AC Power Supply
500P DC Power Supply

Introduction

In the sections that follow, you will find discussions of the 500 mother board. Each module that you purchased with your system comes with a documentation package describing its features, capabilities, and use. This package is three-hole punched, and should be inserted into the binder in the section reserved for module manuals. Familiarity with this information will allow you to realize the full potential of the 500 module library. Information of a more technical nature (schematics, calibration information, procedures, etc.) is given at the end of the manual which accompanies each module package.

Prefacing each module reference section is a general introduction to the module, outlining the major features of the hardware. Next, a summary of user-configured components is given, followed by more detailed descriptions of how to make signal connections and how to install and use optional hardware.

Finally, all the command locations used with the module are listed and then described with appropriate tables that summarize the protocol for using them.

Theory of Operation (System Overview)

This section contains a description of the operating theory for the various components in the 500. An overall functional description is presented, including a discussion of analog and digital signal paths.

Overall Functional Description

An overall block diagram of the 500 is shown in Figure 2-1. A personal computer supervises system operation through the interface card. The interface card contains data and address bus buffers, address decoding circuits, and programmable interval timers.

After the required control and data processing, signals are fed through the interface cable to the 500 mother board. Additional logic circuitry further decodes the control signals into the various command signals that control operation. The purpose of the various commands such as CMDA and CMDB will depend on the particular module. With the DIM1 and DOM1 modules, for example, commands are used to read or write data bits out of or into the channels on the board. With a PCM module, these commands control latching of data to turn the PCM outputs on or off. With the AOM modules, various commands latch data into DACs (Digital-to-Analog Converters).

Digital commands also control the analog input modules and the analog-to-digital conversion process that transforms analog signals into digital information that can be used by the computer. With the AMM1A or AMM2, for example, these commands help control which slot and channel are selected, as well as the gain applied by the programmable gain amplifier (PGA). These commands are also used to trigger A/D conversion and aid in reading the converted data.

Analog signal processing centers around the AMM1A, AMM2, or AMM1F as shown in Figure 2-2. In any system with analog input, the AMM1A, AMM2, or AMM1F module must be present in slot 1 of the mother board.

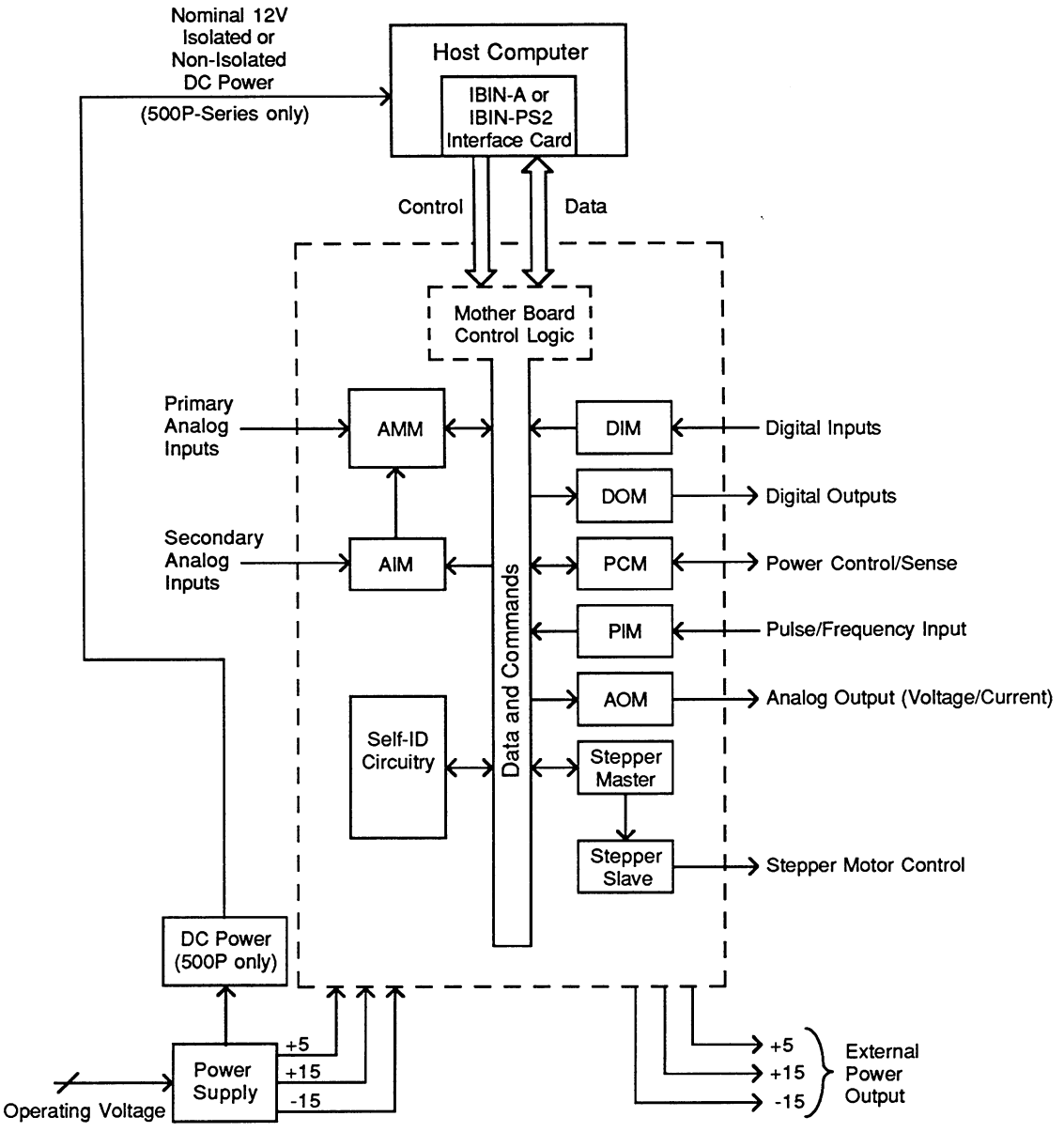


Figure 2-1. 500 Block Diagram

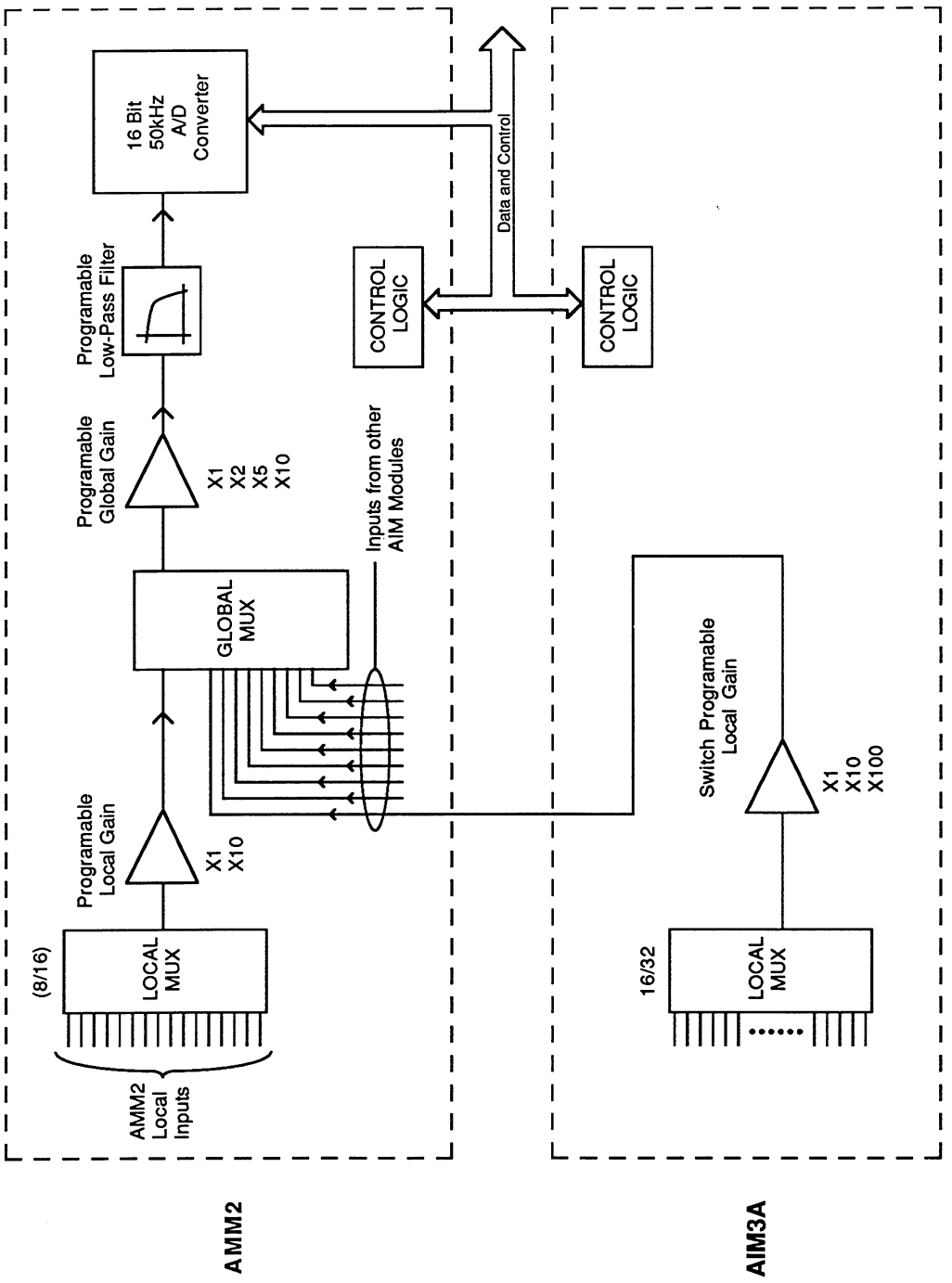


Figure 2-2. Analog Signal Processing

Mother Board

The 500 mother board (Figure 2-3) acts as an interface between all other assemblies in the system, hosting connections to the power supply, front panel, computer interface, and 500-series modules. All incoming commands from the computer are decoded and directed through mother board circuitry. In addition, the mother board channels the power that drives the circuits and provides signal paths between modules.

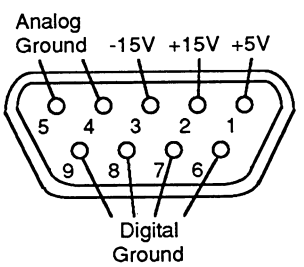
The mother board design incorporates established digital bus techniques and an original vectored analog pathway which eliminates analog/digital noise and degradation of signal integrity. Modules plug into 10 slots in the mother board.

+5V, +15V, and –15V supplies are available on the rear panel for powering external circuitry.

Table 2-1 lists the pin functions for the DB-9 external power connector. Table 2-2 summarizes the mother board signal lines. Figure 2-4 illustrates a pin out diagram of a typical mother board connector.

Table 2-1. Pin Descriptions for External Power Output Connector

Pin 1	+5V*
Pin 2	+15V*
Pin 3	–15V*
Pin 4	Analog Ground
Pin 5	Analog Ground
Pin 6	Digital Ground
Pin 7	Digital Ground
Pin 8	Digital Ground
Pin 9	Digital Ground



*See power supply sections for maximum current for a typical configuration. The actual current available will depend on the number and types of modules in the system.

LTR.	ECO NO.	REVISION	ENG.	DATE
C	12759	RELEASED	SZ	4-27-88
D	12857	REVISED		7-11-88
D'	13008	ADDED (2) CS-490		10-8-88

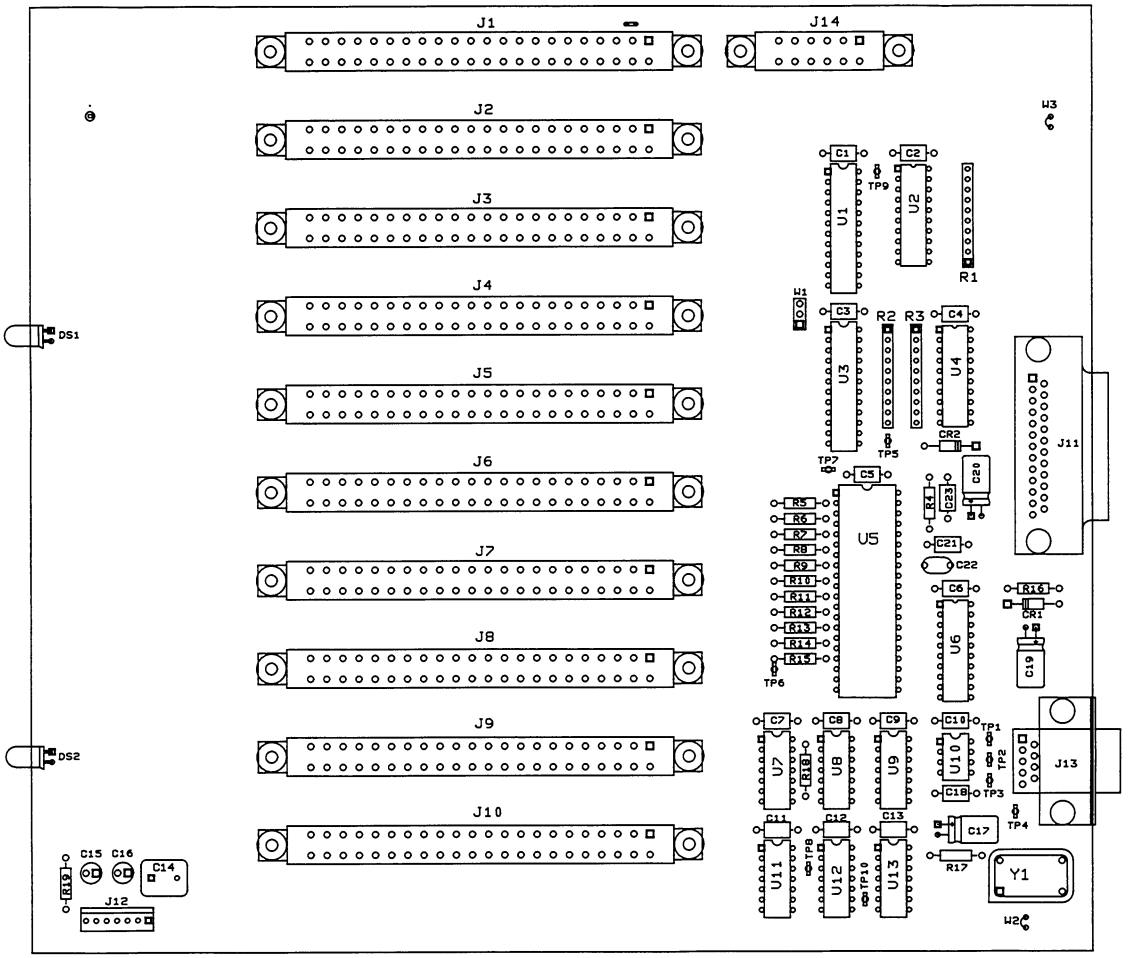
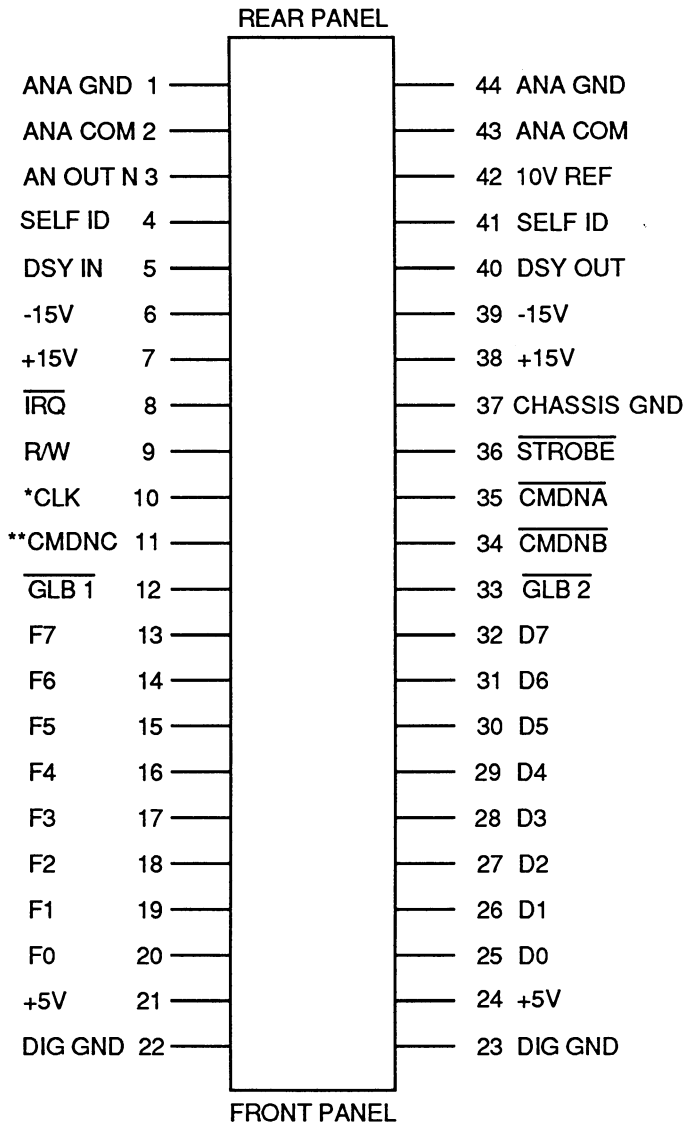


Figure 2-3. Mother Board



* In slot 1 pin 10 carries CMDC and pin 11 carries CMDD.
\+ In slots 2 and 3 pin 11 carries CMDC.

Figure 2-4. Pin Out Diagram of Typical Connector

Table 2-2. Mother Board Signal Lines

Signal Name	Description
ANALOG OUTPUT (AN OUT)	A private analog path to the primary multiplexer of the AMM1A, AMM2, or AMM1F module (when such a module is installed), used to direct input signals to the measurements modules, and to monitor internal D/A conversion.
CLOCK (CLK)	A TTL level signal with a frequency of 1MHz and 50% duty cycle.
COMMAND (CMDA-CMDD)	Locations through which commands from the microprocessor are relayed to the functional modules. CMDA and CMDB apply to all slots. Slot 1 has two additional command locations, CMDC and CMDD, and slots 2 and 3 have a single additional location, CMDC.
DATA (D0-D7)	Data lines used to transmit or receive 8 bits of data to or from the host computer.
DAISY (DSY IN - DSY OUT)	A special purpose electrical path that transmits information to adjacent slots in a daisy chain format.
FUNCTION (F0-F7)	Unassigned function location utilized differently by each module.
GLOBAL (GLB1 & GLB2)	Two command locations global to the entire system, that change function according to which module makes use of them.
INTERRUPT (IRQ)	An interrupt request line to the host computer. Normally high, when pulled low by a request from a system module this signal line will initiate an interrupt in the microprocessor.
READ/WRITE (R/W)	A TTL level signal which indicates the direction of data flow in the system. When high, this indicates that a Read cycle is in progress and data is moving from the 500 mother board to the microprocessor.
10V REFERENCE (10V REF)	A reference voltage shared by the conversion components as the primary measurement standard.
STROBE (STROBE)	A third global command used by the analog output module to implement simultaneous updating of several analog output channels.

Communicating with the PC

Communication between the 500 and the computer is based on a memory-mapped input/output system, where each command function is mapped to a memory location in system memory. The 500 command location is a segment of memory 128 bytes long, which falls at the end of a 4K block of system memory.

The specific locations for the 500 Input/Output commands are determined by the address set or programmed on the IBIN interface card. Theoretically, 256 regions of memory are available, but in fact, many regions of memory are inappropriate for the 500 command locations. The address CFF80 is the suggested address, and the command information given in this manual assumes its use. If the IBIN is re-configured, and the memory-mapped locations changed, the information given in this manual must be modified.

Commands

Commands used by the 500-series modules are keyed to the 500 mother board slots. Each slot of the mother board is assigned two command locations, CMDA and CMDB, which vary in function depending on which module makes use of them. In addition to CMDA and CMDB, slot 1 has been assigned another command CMDC for use when the AMM1A, AMM2, or AMM1F modules are in the system. Slots 2 and 3 have also been assigned the third command.

Besides the command locations associated with the 500 mother board and installed modules, there are a number of locations assigned to the interval timer located on the interface card.

Table 2-3 lists the locations of slot dependent commands (CMDA, CMDB, CMDC - where CMD1A indicates command A for slot one, CMD2A indicates command A for slot two, etc.) Detailed descriptions of the commands as they apply to each module are included in the reference sections for the modules.

Theory of Operation

The components on the mother board can be divided into four functional groups: the ten slots that accept the modules, the circuitry for the system controller, the self-ID circuitry, and various connectors which link the mother board to other assemblies. For the following discussion refer to the mother board schematic and component layout drawings number 500A-106 and 500A-100 at the end of this manual.

Slots and Module Connectors

Across the center of the mother board are ten 44-pin dual connectors. These connectors, or slots, accept plug-in modules from the 500 module library. The slots are numbered 1-10. The number of each slot is printed onto the circuit board for easy reference.

Each mother board slot is allotted two command addresses that allow the host computer to direct the activities of the installed modules. These command addresses are slot-specific and vary in function according to the module installed. The first three slots have been allotted additional commands: slot 1 has two extra command addresses for a total of four, and slots 2 and 3 have an extra command address each for a total of three. When the AMM1A, AMM2, or AMM1F is used, it must be installed in slot 1. Note, however, that when analog input is not required, slot 1 can be occupied by any module for D/A conversion, digital input/output, or AC/DC device control.

Table 2-3. Locations of Slot-dependent Commands

Command	Location*
CMD1A	xxx80
CMD1B	xxx81
CMD2A	xxx82
CMD2B	xxx83
CMD3A	xxx84
CMD3B	xxx85
CMD4A	xxx86
CMD4B	xxx87
CMD5A	xxx88
CMD5B	xxx89
CMD6A	xxx8A
CMD6B	xxx8B
CMD7A	xxx8C
CMD7B	xxx8D
CMD8A	xxx8E
CMD9A	xxx90
CMD9B	xxx91
CMD10A	xxx92
CMD10B	xxx93
CMD2C	xxx98
CMD3C	xxx99
CMD1C (GLOBAL GAIN)	xxx9A

*xxx normally = CFF

In addition to the slot-specific commands, there are three command addresses that apply to all slots. Two of these addresses, GLOBAL 1 and GLOBAL 2, are unassigned and change function depending on which module makes use of them. The third global address, STROBE (Global 3), is used with analog output modules to enable simultaneous strobing out (updating) of several analog output channels. Detailed descriptions of all 500 hardware commands are included in the individual manuals for each module.

Each connector taps into an electrical pathway which permits a module in one slot to pass information to an adjacent module.

Additionally, each slot has a private analog path, ANALOG OUTPUT, which leads to the global multiplexer on

the analog input module (slot 1) when that module is installed. Signals from secondary analog input modules located in slots 2-10 can reach the global multiplexer along this path, and then move on to the A/D converter. Signals generated by the microprocessor—INTERRUPT REQUEST, and READ/WRITE— are also available for each connector.

The mother board provides each slot with three voltage levels from the power supply: +5V, +15V and –15V. The +5V line powers the digital circuitry and provides 3A, maximum, while the +15 and –15 lines drive the analog circuitry, providing 0.8A maximum each.

System Control Circuitry

At the rear of the mother board are several integrated circuits that make up the self-ID circuitry, and the system controller which is responsible for the generation of commands. This controller circuitry decodes address information transmitted by the host computer and directs commands to the appropriate slots.

Self-ID Circuitry

An automatic module identification ("Self-ID") feature has been implemented on all 500-series modules. This feature enables the CONFIG program in the KDAC500 software to automatically determine the presence and slot location of these modules when they are plugged into a 500 mainframe.

The identifying element on Self-ID modules is a precision resistor connected between card-edge positions 4 and 41 on each module. Circuitry on the 500 mother board reads the voltage drop across these connectors, and deduces the module type. The following values are used for Self-ID:

There are additional resistor values which are reserved for future modules.

Module	Resistor Value (ohms)	ID Number
AMM1A	845	29
AMM1F	845	29
AMM2	976	31
AIM2	1050	32
AIM3A	1090	33
AIM4	1150	34
AIM6	1320	36
AIM7	1400	37
AIM8	1520	38
AIM9	1600	39
PIM1	1740	40
PIM2	1870	41
AOM1/5	2430	45
AOM2/2	2910	47
AOM3	3160	48
AOM4	3440	49
AOM5	10700	58
DIM1	3790	50
DOM1	4070	51
DIO1A	4530	52
PCM2	5690	54
PROTO	7590	56
TRG1	8760	57
WAV1	13300	59

Other Connectors

Various connectors link the mother board to other assemblies. At the front right corner of the mother board is a 7-pin connector (P103) with leads exiting to the power supply. A 9-pin connector (J116) has been provided at the rear of the mother board as a source of power to drive external circuitry added by the user.

Also located at the rear of the mother board is a 25-pin connector, which provides the link to the host computer.

500-Series Measurement and Control System Specifications

INTERFACE: For use with IBIN-A, IBIN-LP, or IBIN-PS/2 PC bus interface cards.
MAINFRAME MODULE CAPACITY*: User configurable up to 10 modules per mainframe.
MAXIMUM NUMBER OF MAINFRAMES PER HOST COMPUTER: 4.
MAXIMUM CHANNEL CAPACITY PER MAINFRAME:**
Analog Input: 304 single-ended, 152 differential.
Analog Output: 50.
Isolated Digital Input: 160.
Isolated Digital Output: 160.
Non-Isolated Digital: 320
Frequency Input: 10.
Pulse Counting: 40.
SELF-ID A/D CONVERTER: For identification of any module in the Series 500 module library.
SELF-ID RESOLUTION: 8 bits.
POWER SUPPLY CAPACITY*:**
+5V @ 3A maximum.
+15V @ 0.8A maximum.
–15V @ 0.8A maximum.
AC POWER REQUIREMENTS:
Line Voltage: Selectable: 100V, 120V, 220V, and 240V.
Line Frequency: 50Hz to 60Hz.
OPERATING TEMPERATURE: 0° to 50°C.
STORAGE TEMPERATURE: –20° to +60°C.
ISOLATION: Mainframe and non-isolated cards are referenced to chassis ground. Isolated cards can accommodate ±500V peak common mode voltage.
DIMENSIONS, WEIGHT: 114mm high × 330mm wide × 286mm deep (4-1/2 in. × 13 in. × 11-1/4 in.). Net weight 5.7kg (13 lbs.).
CERTIFICATION: Meets FCC part 15J, Class A.

*Restrictions exist on card slot location and combinations. Refer to manual for details. Some combinations require external power.
**Maximum channel capacity is with entire system dedicated to that function. Refer to manual for individual card capacity to determine specific system capacity.
***Derate output current 10% for 50Hz operation.

Accessories Available:

500-AMM1A	AMM1A 16-Channel (8 differential) Master Measurement Module w/12-bit 62.5kHz A/D
500-AMM1F	AMM1F 16–Channel (8 differential) Master Measurement Module w/12-bit 100kHz A/D
500-AMM2	AMM2 16-Channel (8 differential) Master Measurement Module w/16-Bit 50kHz A/D
500-AIM2	AIM2 32-Channel s/e High Level Analog Input Module
500-AIM3A	AIM3A 32-Channel (16 Differential) High Sensitivity Analog Input Module
500-AIM4	AIM4 4-Channel Isolated Analog Input Module
500-AIM6	AIM6 4-Channel RTD Analog Input Module
500-AIM7	AIM7 16-Channel Thermocouple Input Module
500-AIM8	AIM8 4-Channel Strain Gage Analog Input Module
500-AIM9	AIM9 2-Channel LVDT/RVDT Analog Input Module
500-AOM1/5	AOM1/5 12-Bit D/A, 5-Channel Analog Output Module
500-AOM2/2	AOM2/2 16-Bit D/A, 2-Channel High Resolution Analog Output Module
500-AOM3	AOM3 4-Channel Current Loop Output Module
500-AOM4	AOM4 4-Channel Programmable Excitation Output Module
500-AOM5	AOM5 High-speed 13-bit D/A, 5 channel analog output module
500-DIM1	DIM1 16-Channel Isolated Digital Input Module
500-DIO1A	DIO1A 32-Channel TTL Digital Input/Output Module
500-DOM1	DOM1 16-Channel Isolated Digital Output Module
500-EXTND	Module Extender Board
500-PCM2	PCM2 16-Channel AC/DC Power Control & Sensing Module (no relays)
500-PIM1	PIM1 8-Channel Frequency Measurement Module
500-PIM2	PIM2 4-Channel Event Counting Module
500-PROTO	Prototyping Module
500-TRG1	TRG1 Hardware trigger module
500-WAV1	WAV1 1-Channel waveform generator module

MOTHER BOARD, PARTS LIST

CIRCUIT DESIG.	DESCRIPTION	KEITHLEY PART NO.
	FASTENER PLUG	FA-47
	FASTENER	FA-131
	STANDOFF	ST-144-1
	KEYING PLUG	CS-490
	CONN,3-PIN-BERG	CS-339-3
	#4-40 x 1/4 PHILLIPS PAN HD.	4-40x1/4PPH
C1..C13,C18,C21	CAP,.1µF, 20%,50V,CERAMIC	C-64-100P
C14	CAP,100µF,10%,15V,TANTALUM	C-228-100
C15,C16	CAP,4.7µF,-20+100%,25%,ALUM ELEC	C-314-4.7
C17,C19,C20	CAP,10µF,-20+100%,25%,ALUM ELEC	C-314-10
C22	CAP,100pF,10%,1000V,CERAMIC	C-64-100P
CR1,CR2	DIODE,SILICON,IN4148 (D0-35)	RF-28
DS1	PILOT LIGHT,GREEN,LED	PL-82
DS2	PILOT LIGHT,RED,LED	PL-67
J1..J10	22-PIN DUAL CONNECTOR	CS-481-6
J11	CONN,FEMALE,25 PIN	CS-484
J12	STRAIGHT POST HEADER ASS'Y	CS-533-7
J13	CONN,9-PIN SOCKET CONNECTOR	CS-483
J14	CONN,RIGHT ANGLE,6 PIN DUAL	CS-481-1
R1	RESISTOR NETWORK	TF-181-1
R15	RES,47,5%,1/4W,COMPOSITION OR FILM	R-76-47
R16	RES,10K,5%,1/4W,COMPOSITION OR FILM	R-76-10K
R17	RES,2.7K,5%,1/4W,COMPOSITION OR FILM	R-76-2.7K
R18	RES,220,5%,1/4W,COMPOSITION OR FILM	R-76-220
R19	RES,330,5%,1/4W,COMPOSITION OR FILM	R-76-330
R2,R3	RES NET,10K,5%,1.25W	TF-99
R4	RES,100,5%,1/4W,COMPOSITION OR FILM	R-76-100
R5..R14	RES,1K,.1%,1/8W,METAL FILM	R-176-1K
TP1..TP10	CONN,TEST POINT	CS-553
U1,U3	IC,4-16 LINE DECODER/DEMULTI,74HC154	IC-476
U10	IC,TIMING CIRCUIT,NE555V	IC-71
U11	IC,QUAD 2 INPUT POS AND,74LS08	IC-215
U12	IC,QUAD BUS BUFFER, 74LS126	IC-384
U13	IC,QUAD 2-INPUT NOR GATE,74HCT02	IC-510
U2	IC,OCT TRI-STATE BUFFER 74HC240	IC-617
U4	IC,OCTAL BUS TRANSCEIVER,74LS645	IC-307
U5	IC,A/D CONVERTER (ADC0816)	IC-597
U6	IC,OCT BFR/LINE DRIVER/REC,74HCT244	IC-483
U7	IC,DUAL D-TYPE FLIP FLOP,74LS74	IC-144
U8,U9	IC,HEX INVERTER,74HCT04	IC-444
W1	CONN,JUMPER	CS-476
W2,W3	#22 GA. WIRE JUMPER	
Y1	OSCILLATOR,1MHZ	CR-23

MECHANICAL BOARD, PARTS LIST

DESCRIPTION	KEITHLEY PART NO.
STANDOFF	ST-173-3
FEET	FE-17-1
#6-32×1/4 LG. PHIL. PAN HD. SCR	6-32×1/4PPH
OVERLAY FRONT PANEL	500A-307
#8-32×5/16 PHIL PAN HD SEMS	8-32×5/16PPHSEM
#4-40×1/2 PHIL PAN HD	4-40×1/2PPH
POWER SUPPLY ASSY	500A-050
POWER SUPPLY	500A-317
HEAT SHIELD	500A-309
FASTENER	FA-18
CARD GUIDE	CS-641
SHIELD, POWER SUPPLY	500A-313
#6-32×1/4 LG. PHIL. PAN HD SEMS	6-32×1/4PPHSEM
LABEL, WARNING	MC-221
BRACKET	500A-320
PEM NUT	FA-68
#6-32×1/4 PHIL PAN HD SEMS	6-32×1/4PPHSEM
P.C. BOARD ASSY	500A-010
SYSTEM BASEBOARD	500A-102
BASEBOARD SHIELD	500A-310
FASTENER	FA-18
#6-32×1/4 LG. PHIL,.PAN HD. SEMS	6-32×1/4PPHSEM
WASHER, SHOULDER	WN-21
REAR PANEL ASSY	500A-030
REAR PANEL	500A-311
FASTENER	FA-18
FASTENER	FA-132
BINDING POST	BP-25
#6-32×1/4 PHIL PAN HD SEMS	6-32×1/4PPHSEM
FILTER	FL-10
#6-32¥1/4 PHIL FLAT HD	6-32×1/4PFH
SCREWLOCK KIT	CS-49
#6-32×5/16 PHIL PAN HD SEMS	6-32×5/16PPHSEM
#4-40×3/16 PHIL PAN HD	4-40×3/16PPH
LABEL, FCC	MC-357
SERIAL NO. LABEL	MC-285
LABEL, REAR	MC-504
COVER, TOP	500A-315
PANEL FASTENER	FA-154-1
FASTENER	FA-169-2
COVER PANEL	500A-312
#6-32×1/4 PHIL PAN HD SEMS	6-32×1/4PPHSEM
LINE CORD	CO-19
LINE CORD, EUROPEAN ALTERNATE	CO-26
MANUAL PACKAGE	500A-904-00
CABLE ASS'Y	CS-28
HOOD	CS-494
CONN. PLUG, 9-PIN	CS-489
INSTRUCTION MANUAL PACKAGE	501-914-00

500A AC Power Supply

AC Line Voltage Selection

The line voltage selector switch is part of the power entry module on the back of the power supply under the fan. To change the selected voltage, perform the following steps. Disconnect the power cord. Open the fuse/line voltage selector cover using a small blade screwdriver to pry up on the tab at the left edge of the cover. Remove the voltage selector wheel from the unit. Replace the wheel with the desired voltage facing outward. If necessary, replace the fuse with the properly rated fuse for the desired voltage as noted in Table 2-4 below. Close the cover, making sure the selected voltage appears in the window.

Fuse Replacement

If the mother board is totally inoperative, the problem may be a blown fuse. The fuse is in the power entry module on the back of the power supply under the fan. To replace the fuse, perform the following steps. Disconnect the power cord. Open the fuse/line voltage selector cover using a small blade screwdriver to pry up on the tab at the left edge of the cover. The fuseholder is in the top center of the power entry module. Slide out the fuseholder and remove the fuse. The fuse may be checked for continuity with an ohmmeter. If the fuse is bad, replace it with the recommended type listed in Table 2-4. Replace the fuseholder and close the cover of the power entry module.

CAUTION

Make sure the proper line voltage appears in the window or damage may occur.

CAUTION

Never install a fuse with a higher rating than indicated in Table 2-4 or equipment damage may occur.

Power Supply Requirements and Performance

Table 2-4. Recommended Fuse Types

Operating Voltage	Fuse Rating	Keithley Part Number
100V ac ±10%, 50-60Hz	1A 250V 3AG Slo-Blow	FU-10
120V ac ±10%, 50-60Hz	1A 250V 3AG Slo-Blow	FU-10
220V ac ±10%, 50-60Hz	0.5A 250V 3AG Slo-Blow	FU-4
240V ac ±10%, 50-60Hz	0.5A 250V 3AG Slo-Blow	FU-4

Table 2-5. Power Supply (Typical)

	±15V	+5V	Remarks
System Capability			
60Hz	800mA	3A	At < = 40°C ambient temperature
50Hz	720mA	2.7A	At < = 40°C ambient temperature
Mother Board Consumption	0	300mA	
Available Module Power			
60Hz	800mA	2700mA	
50Hz	720mA	2400mA	
Auxiliary Power Connector			
60Hz	800mA*	1A*	
50Hz	720mA*	700mA*	

*Depends on modules in system.

500P DC Power Supply

General Information

The 500P-series consists of three models which are configured at the factory for operation from either 12V DC or 24V DC nominal power sources. Each model must be operated from a DC power source within the voltage range specified for the model. Changing the power operating range in the field requires a complete power supply replacement.

500P Models and Power Requirements

Model	500P-1 and 500P-2	500P-3
Input V Range	9.25VDC-18VDC	18VDC-36VDC

Use power cabling of adequate gauge, and keep power cables as short as possible. Twelve- to 14-gauge wiring is sufficient under normal conditions. Inadequate power cables will cause excessive voltage drop, which may, in turn, cause the 500P to malfunction. Light-duty cabling may also become dangerously hot.

All models in the 500P-series include two levels of power input conditioning and protection. The first level of protection filters out "load dumps" and other relatively long-lived transients which occur in alternator-driven DC power systems. The second level of protection is a metal oxide varistor (MOV) circuit which absorbs fast transients ("spikes") of 60V or more. In no case should any 500P model be operated at input voltages above the specified limit.

CAUTION

Application of more than the maximum specified voltage to the 500P for more than one second will cause overheating and possible damage to over voltage protection components. Application of more than 60VDC will permanently damage the MOV transient suppression device.

The 500P-series rear panel also contains a power output receptacle which provides 12VDC to operate a portable computer. In the Model 500P-1, this receptacle is driven directly from the 500P power input and offers only the MOV protection against spikes. In the 500P-1, the computer power receptacle is not controlled by the front panel power switch.

In the 500P-2, the computer power receptacle is driven by a power isolation module which provides full regulation and MOV protection as well as isolated 12VDC for the computer. The isolated supply is controlled by the 500P front panel switch.

The 500P-3 model is identical to the 500P-2, except that the 500P-3 power supply operates from a 24VDC nominal voltage input.

Figure X-Y shows pinout data for the 500P power input and computer power output receptacles.

CAUTION

Observe the proper polarity when connecting the 500P to a power source. Be particularly careful if you use the 500P computer power output to run your computer.

Power Supply Considerations — Models 500P-1 and 500P-2

The 500P-1 and 500P-2 are designed to operate from a 12VDC nominal power source, such as an automobile electrical system. The permissible voltage supply range is 9.25VDC - 18VDC as measured at the 500P power input connector on the back panel. The input current draw under fully loaded conditions can approach 10A.

The 500P-1 and 500P-2 can be powered from an automobile's cigarette lighter using the supplied cable. In some cases it may be desirable to avoid using the vehicle wiring and wire the 500P directly to the vehicle's battery. Wiring directly to the vehicle battery will eliminate any voltage drop in the vehicle wiring and reduce some of the voltage transients caused by vehicle accessories. You may cut the cigarette lighter plug from the supplied cable, and use the remaining cable/connector assembly for this purpose. While the 500P is protected against most vehicle electrical transients, an undervoltage transient of sufficient duration may cause loss of data due to temporary power supply shutdown.

Power Supply Considerations — Model 500P-3

The 500P-3 is set up for 24VDC nominal power sources. It will operate properly with 18VDC - 36VDC input as measured at the 500P power input connector on the back panel. Fully loaded current draw will be less than five amps, but the same precaution for adequately-gauged power cabling still applies.

The 500P-3 must be connected directly to a 24 volt power source. You may cut the cigarette lighter plug from the supplied cable, and use the remaining cable/connector assembly for this purpose.

Fuse Replacement

If the 500P is inoperative, the fuse may be blown. To replace the fuse, disconnect the input power connection and remove the 500P top cover. The fuse holder is visible near the front edge of the power supply circuit board. Use a screwdriver to twist the fuseholder insert 1/4 turn counterclockwise. Remove the fuseholder insert and fuse. A blown fuse is generally obvious upon inspection. If you are in doubt, test the fuse with an ohmmeter. if the 500P blows the fuse the first time it is powered up in a new installation, recheck the input power polarity. Reversed input power connections will cause the fuse to blow. If everything seems to be in order, replace the fuse with one of the proper rating and reassemble the system.

Recommended Fuse Types

Nominal Voltage	Operating Voltage	Fuse Rating
12 VDC	9.25 to 18 VDC	10A, 32V AGC-10
24 VDC	18 to 36 VDC	5A, 125V AGC-5

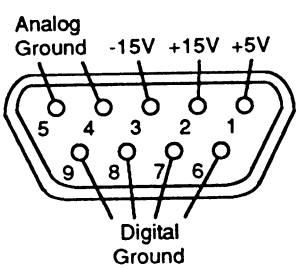
Power Supply

	±15	+5	+12
Power supply output	800m	4.3A	
Available module power	800mA	3A	
Computer power			2.5A
Auxiliary power connector	800mA*	1A	

*Depends on modules in system.

Pinout – Auxiliary Power Output Connector (DB-9S)

Pin 1 – +5V
Pin 2 – +15V
Pin 3 – –15V
Pin 4 – Analog ground
Pin 5 – Analog ground
Pin 6 – Digital ground
Pin 7 – Digital ground
Pin 8 – Digital ground
Pin 9 – Digital ground



Special Considerations for Portable Installations

Environment

The 500P is designed to operate in the same environment as the portable computer used to control it. The unit should not be operated at ambient temperatures of less than 0°C or greater than 50°C.

The 500P's internal components and power supply will provide some degree of internal self-heating within the 500P chassis. Operation at ambient temperatures between –20 and 0°C is possible if sufficient time is allowed for the internal temperature to rise to at least 0°C.

The fan in the 500P is thermostatically controlled and will turn on when the interior temperature of the unit rises to approximately 50°C. This helps speed the heating of the interior in cold environments. Do not block the fan intake or the bottom rear exhaust openings. The fan is required for cooling in even moderate environmental conditions. With the power switched off, do not expose the 500P to temperatures outside the range of –20 to +70°C.

Mounting

While the 500P is not constructed for use in hostile or high-vibration environments, it will normally work in any environment suitable to the portable computer.

The suggested mounting location for the 500P is on a shock-absorbent surface such as on a vehicle seat or foam rubber pad. Be careful not to block the ventilation holes in the bottom of the unit. The 500P must be mounted and operated with the bottom facing downward.

500P POWER SUPPLY BOARD, PARTS LIST

CIRCUIT DESIG.	DESCRIPTION	KEITHLEY PART NO.
	STANDOFF	ST-4
	STANDOFF	ST-139-15
	CABLE TIE	CC-38-2
	GROMMET	GR-1
	CONTACT MALE	CS-665
	DUST COVER	CS-535-7
	CONNECTOR	CS-649
	CONNECTOR	CS-648
	GROMMET	GR-6
C1,C5,C8,C14, C16,C19,C20	CAP,220µF,-20+100%,25V,ALUM ELEC	C-314-220
C2,C6,C13	CAP, 1µF, 20%,50V,CERAMIC	C-237-1
C3,C4	CAP,10µF,-20+100%,25V,ALUM ELEC	c-314-10
C7,C9,C12,C18, C21	CAP,.01µF,10%,1000V,CERAMIC	C-64-.01
CR1,CR2	DIODE,SILICON,1N4006 (DO-41)	RF-38
CR3,CR5,CR6	DIODE,SILICON,1N4148	RF-28
CR4	DIODE,HI CURRENT,MR754	RF-61
F1	FUSE HOLDERR	FH-21
J1	CONN, STRAIGHT POST HEADER, 8-PIN	CS-533-8
J17	CONNECTOR	TE-110
L1..L5	CHOKE,10µH	CH-20-1
L6	CHOKE, 220µH	CH-33
L7	CHOKE	CH-29
	WIRE, 14GA BLK FOR L7	SC-114-0
	WIRE, 14GA WHT FOR L7	SC-114-9
P12	CONNECTOR HOUSING	CS-534-7
P17	CONTACT	CS-627
P18	LUG	LU-108-2
	WIRE, 22GA BLU (*FOR P18)	SC-113-6
Q1	TRANS,N-CHANNEL FET,SGSP472	TG-220
Q2	TRANS,NPN SILICON,2N3904 (TO-92)	TG-84
Q3	TRANS,PNP,HI-V,ANNULAR,MPS-U60	TG-147
R1,R3	RES,1.3K,1%,1/8W,METAL FILM	R-88-1.3K
R10	RES,1K,1%,1/8W,METAL FILM	R-88-1K
R11	RES,1K,10%,1W,COMPOSITION	R-2-1K
R12	RES,4.7K,5%,1/4W,COMPOSITION OR FILM	R-76-1.3K
R13	RES,100,5%,1/4W,COMPOSITION OR FILM	R-76-100
R14	RES,47,5%,1/4W,COMPOSITION OR FILM	R-76-4.7K
R2,R4	POT,100,10%,.75W,NON-WIREWOUND	RP-89-100
R5,R6	RES,121,1%,1/8W,METAL FILM	R-88-121
R9	RES,22,5%,1/4W,COMPOSITION OR FILM	R-76-22

U5	I.C.,NEG.,VOLTAGE REGULATOR,7912	IC-685
	HEAT SINK (FOR U5)	HS-38
	#4-40x1/4 PHIL PAN HD SEMS (FOR U5)	4-40x1/4PPHSEM
	#4x40 KEPNUT (FOR U5)	4040 KEPNUT
VR1	DIODE,ZENER 15V,1N4744A (TO-41)	DZ-75
VR2	DIODE,ZENER 15V,1N4744A (FOR 500P-1 AND 500P-2)	DZ-75 OR DZ-68
VR2	DIODE,ZENER 33V (FOR 500P-3)	DZ-68
VR3	VAR,38V,METAL OXIDE	VR-3
W1,W2	JUMPER (FOR 500P-1)	J-7-2

SECTION 4
500-Series Modules

Module Library

AMM1A	16 channel (8 Differential) Master Measurement Module with 62.5kHz 12-bit A/D
AMM1F	16 channel (8 Differential) Master Measurement Module with 100kHz 12-bit A/D
AMM2	16 channel (8 Differential) Master Measurement Module with 50kHz 16-bit A/D
AIM2	32 single-ended analog inputs
AIM3A	16 differential analog inputs, IA, high-speed at all gain settings.
AIM4	4 channels, isolated analog input, 1-10V, 500V CMR
AIM6	4 channels, /RTD input with 10V excitation and gain
AIM7	16 channels, thermocouple input with isothermal input block, noise filtering, cold junction reference sensor
AIM8	4 channels, Strain Gage Input Module
AIM9	2 channels, LVDT/RVDT Input Module
AOM1/5	5 channels of 12-bit D/A conversion, 5 ranges
AOM2/2	2 channels of 16-bit D/A conversion, 2 ranges
AOM3	4 channels 4-20mA current loop output, 12-bit D/A converters
AOM4	4 channels programmable excitation, 12-bit D/A, 40mA current
AOM5	High-speed 4 channels, 13-bit D/A conversion, 4 ranges
DIM1	16 channels, optically isolated digital input, TTL or other levels to 28V @ 50mA
DIO1A	32 channels, non-isolated digital input and/or output, TTL Software programmable configuration
DOM1	16 channel, optically isolated digital output, TTL or other levels to 28V @ 50mA
PCM2	16 channels of ac or dc switching or sensing via solid-state opto-isolated relays
PCM3	AC/DC 16-channel power control relay mounting board
PIM1	8 channels of high-speed pulse/frequency/event input and counting
PIM2	4 channel event counting module
PROTO	Prototyping Module
TRG1	1 channel, hardware trigger module
WAV1	1 channel, waveform generator module

Table 4-1. Module Current Requirements (mA)

Module	±15V	+5V	Remarks
AMM1A	65	125	
AMM1F	65	125	
AMM2	65	125	
AIM2	2	20	
AIM3	18	30	
AIM4	30	30	
AIM6	30	30	Plus strain edge excitation current.
AIM7	15	15	
AIM8	75	75	
AIM9	125	60	
AOM1/5	90	60	
AOM2/2	30	180	
AOM3	150	65	
AOM4	200	75	
AOM5	35	180	
DIM1	0	277 max[1]	Value shown with all inputs on.
DIO1A	0	330mA	
DOM1	0	650 max[2]	Value shown with all outputs on, internal power.[4]
PCM2	0	415 max[3]	Value shown with all outputs on.
PCM3	0	0	Power supplied by PCM2.
PIM1	0	380mA	
PIM2	0	475	
TRG1	22	135	
WAV1	85	65	

[1] 14mA for each input on
[2] 15mA for each output on (EXT), 35mA (INT).
[3] 12mA for each output on.
[4] 350mA when used with external supply.

SECTION 5
Service Information

Introduction
General Calibration
Troubleshooting
Replaceable Parts

Introduction

This section contains important information necessary to service your 500 Measurement and Control System. Included in the following pages are instructions for calibrating the various modules; a theory of operations section which describes the circuitry of the various components; guidelines for troubleshooting the mother board, modules, and interface card; and a listing of replaceable parts. At the end of each module, you will find schematic drawings for all the modules, the mother board and the interface card.

Some of the information presented is intended for skilled technical personnel who are familiar with sophisticated equipment and the necessary servicing procedures. You should not attempt these procedures unless you are qualified. As shipped, your 500 is ready for use: this section will be applicable only if certain hardware alterations are desired.

WARNING

Some of the procedures described in this section may expose you to potentially lethal voltages. Use standard safety practices when such dangerous voltages are encountered.

CAUTION

Always follow the indicated procedure exactly as written. Failure to do so may damage equipment, possibly voiding the warranty.

General Calibration

This section contains general field information for the 500 with 500-series modules. The actual calibration procedures for each module are listed in the manuals for the repsective modules. The procedures given assume a certain amount of expertise on the part of the user. If you are not familiar with calibrating equipment, it is recommended that you not attempt calibration. The procedures in this section assume that you are familiar with general module operation. Refer to the appropriate manual for details on calibrating each module.

When Should You Calibrate the Model 500

The 500 and all 500-series modules are calibrated at the factory, and should require no further calibration before use. Calibration is necessary only under the following conditions:

1. If you change the output range of a D/A converter on an analog output module.
2. If you are performing periodic calibration as part of an established maintenance procedure.
3. If you suspect 500 or a module of fault or inaccurate operation.

NOTE
If an input or output function which had been working correctly suddenly becomes inaccurate by more than a few percent, the problem is more likely a malfunction and not a calibration problem. If you cannot calibrate the equipment after one or two attempts, you should return it to Keithley for repair or calibration at the factory.

Environmental Conditions

Calibration should be performed at an ambient temperature of 23° ±5°C. Turn on the system power and allow it to warm up for at least ten minutes before beginning the calibration procedure. Consult the manual for the calibration equipment listed below for similar required warm-up periods.

Recommended Calibration Equipment

The following equipment is recommended for calibration. Other equipment may be substituted as long as accuracy specifications are at least as good as those given below:

1. Keithley Model 175 DMM (±0.03% basic DC accuracy).
2. Electro Development equipment with a basic accuracy of ±0.05%.

Troubleshooting

This section contains information necessary to troubleshoot the 500 system. Information is presented on two levels: A procedure designed to aid the typical user in isolating faults to specific modules; and more detailed information intended for the skilled technician who has access to electronic test equipment.

If a defective module or component is found, replacement parts may be obtained from Keithley Instruments, Inc. If factory service is desired, the item may be returned for repair. For information on replacement parts or factory service, see the Replaceable Parts section.

Isolating the Problem

The following five symptoms suggest specific system problems:

1. System dead (POWER indicator not on): Check to see that the system is connected to a live source of power of the correct voltage and that the unit is turned on. Check for blown fuses and replace if necessary. Check for a shorted module by removing modules one at a time until the trouble clears. If these checks fail to remedy the problem, the power supply may be defective.
2. System inoperative (POWER indicator turns on, but ON LINE does not respond during data acquisition): Check to see that the system is connected to the computer. Check for a shorted module by removing modules one at a time until the trouble clears. Other possible causes include defective interfacing cable, defective interface card, defective baseboard logic circuits, or improperly addressed interface.
3. All modules bad in a specific slot: Check for a bad mother board slot connector, or bad baseboard logic circuit.
4. All analog input modules inoperative, but other modules OK: Check for bad slot connectors for slots 1, 2, and 3. Check for malfunctioning A/D converter circuit. If the problem persists check the ±15V power supply and replace power supply if necessary.
5. Module inoperative in all slots: The module is defective and should be repaired.

Troubleshooting Process

The following troubleshooting information is intended for skilled electronics servicing personnel who are familiar with electronics test equipment. Information is provided to enable troubleshooting to the module level. Troubleshooting to the component level is left up to the technician. Use the component layouts and schematic diagrams located at the end of this manual as an aid in troubleshooting. In some cases, information contained in the Theory of Operation section may also be helpful.

The success of any troubleshooting procedure depends on the use of accurate, reliable test equipment. The following equipment is recommended as an aid in troubleshooting the 500: 4-1/2 digit DMM with 0.03% basic DC accuracy. A dual-trace triggered-sweep oscilloscope with 25MHz bandwidth will also be necessary in

monitoring digital waveforms. In addition, a logic probe may be useful in tracing digital signals.

Power Supply Checks

A good technique is to always check the power supply voltages first, since improper voltages could cause partial or complete system failure. The following steps describe the procedure for checking the +5V and ±15V supplies. Note that the supply voltages should be checked both at the rear panel power connector as well as each of the module slot connectors to ensure there are no bad power connections at any of the slots. Figure 5-1 shows the pin numbers for slot connectors while Figure 5-2 shows pin connections for the rear panel auxiliary power jack.

1. Connect the DMM to the Power Jack (J116) by connecting DMM low to pin 4, and DMM high to pin 1 +5V supply.
2. Turn on the line power and check for a +5V reading ±50mV.
3. Disconnect the DMM from pin 1 and connect to pin 2 (+15V supply); check for +15V reading ±0.1V.
4. Disconnect the DMM form pin 2 and connect to pin 3 (–15V supply); check for –15V reading ±0.1V.
5. To check the +5V power arriving at each module slot, connect DMM high to pin 21 of each slot connector, and DMM low to chassis ground. Repeat for pin 24 of each slot connector. Readings should be +5V ±0.1V.
6. To check the +15V power arriving at each module slot, connect DMM high to pin 7 of each slot connector and DMM low to chassis ground. Repeat for pin 38 of each slot connector. Readings should be +15V ±0.1V.
7. To check the –15V power arriving at each module slot, connect DMM high to pin 6 of each slot connector and DMM to chassis ground. Repeat for pin 39 of each slot connector. Readings should be –15V ±0.1V.

Mother Board

Operation of the various 500-series modules is supervised by the mother board command signal lines. These logic signals are derived from information sent to the interface card from the host computer. Integrity of the various command lines can be verified by entering the program in Table 5-1 into the computer and then testing the points listed in Table 5-2.

For all the signal checks, connect the oscilloscope low signal lead to the mother board chassis, and connect the high signal lead to the indicated baseboard slot connector terminal. Adjust the time base, triggering and input attenuator controls as required. Timing of the wave forms is not critical since failure is most likely to be seen as a complete absence of signal. A storage scope may be necessary to catch short pulses. Alternatively, a logic probe may be used to verify the presence of signals.

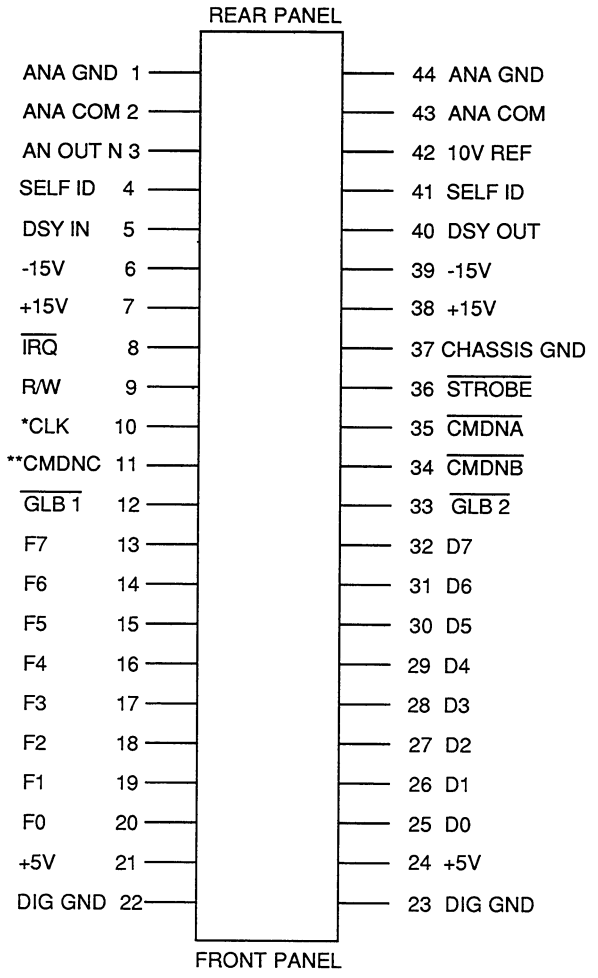
Table 5-1. Test Program for Mother Board Command Lines

```
10  DEF SEG = &HCFF0:CA=&H80:CLS
20  PRINT"RUNNING TEST"
30  FOR 1 = 0 TO 31
40  POKE I+CA, 0;I=I+1:POKE 1+CA,255
50  NEXT I
60  GOTO 30
```

Table 5-2. Mother Board Signal Checks

Slot(s)	Terminal(s)	Command
All	20, 25	D0
All	19, 26	D1
All	18, 27	D2
All	17, 28	D3
All	16, 29	D4
All	15, 30	D5
All	14, 31	D6
All	13, 32	D7
1	35	CMD1A
1	34	CMD1B
2	35	CMD2A
2	34	CMD2B
3	35	CMD3A
3	34	CMD3B
4	35	CMD4A
4	34	CMD4B
5	35	CMD5A
5	34	CMD5B
6	35	CMD6A
6	34	CMD6B
7	35	CMD7A
7	34	CMD7B
8	35	CMD8A
8	34	CMD8B
9	35	CMD9A
9	34	CMD9B
10	35	CMD10A
10	34	CMD10B
2	11	CMD2C
3	11	CMD3C
1	10	CMD1C
1	11	CMD1D
All	36	STROBE
All	12	GLOBAL 1
All	33	GLOBAL 2
All	9	R/W

Note: All signal pulses generated with program in Table 5-1.



* In slot 1 pin 10 carries CMDC and pin 11 carries CMDD.
\+ In slots 2 and 3 pin 11 carries CMDC.

Figure 5-1. Top View of Slot Connector

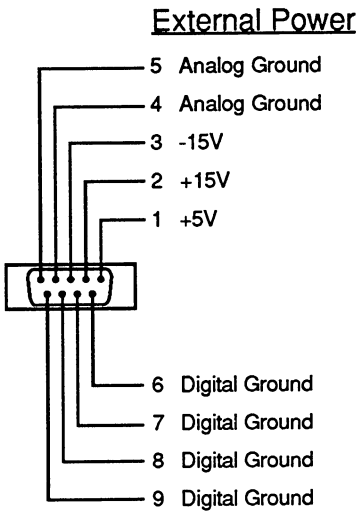


Figure 5-2. External Power Output Connector

Analog Input Module

All analog input signals are routed to the module in slot 1 to be selected as an input for the A/D converter. The first test to be done should be to verify the proper operation of the module in slot 1. Remove all other modules except the module in slot 1, then perform the troubleshooting procedure provided for that particular module in its manual.

If the first module is OK, then check the remaining AIM Modules one at a time, using the procedure provided in their manuals.

Analog Output Modules (AOM1, AOM2, and AOM5)

These analog output modules convert 12-bit (AOM1), 13-bit (AOM5) or 16-bit (AOM2) digital values into analog voltages. Use the procedure listed below to troubleshoot these modules.

1. Place the AOM in any baseboard slot. Connect the DMM to the output terminals of the channel to be tested.
2. Set the range switches as required, and program the module for minimum output (for example: –10V on the ±10V range - see the module manual for programming information). Check the DMM for an accurate reading.
3. Program the module for a mid-range output (e.g. 0V on ±10V range) and read the DMM.
4. Program the module for maximum range value and read the DMM, reading should be approximately 9.997V on ±10V range, or 1 bit less than the nominal maximum output.

Digital Modules (DIM1, DOM1, DIO1A, and PCM2)

Trouble within these modules can be traced simply by writing all 0's and then all 1's to the various channel bit positions. A logic probe or DMM can be used to trace through the circuitry for each channel to determine the location of the fault.

Table 5-3 lists the command locations for the various modules. To store all 0's POKE a value of 0 in the required location. To store all 1's POKE in a value of 255. The addresses shown assume the module is in slot 10.

Table 5-3. DIM1 and PCM2 Command Locations

Module	Statement**	Remarks
DIM1 xxx92	X=PEEK (A)	Read channels 0-7
DIM1 xxx93	X=PEEK (A)	Read channels 8-15
DOM1 xxx92	POKE A, 0	Set channels 0-7 to 0
DOM1 xxx92	POKE A, 255	Set channels 0-7 to 1
DOM1 xxx93	POKE A, 0	Set channels 8-15 to 0
DOM1 xxx93	POKE A, 255	Set channels 8-15 to 1
PCM1 xxx92	POKE A, 15	Turn on channels 0-3
PCM1 xxx92	POKE A, 0	Turn off channels 0-3
PCM2 xxx92	POKE A, 255	Turn on channels 0-7
PCM2 xxx92	POKE A, 0	Turn off channels 0-7
PCM2 xxx93	POKE A, 255	Turn on channels 8-15
PCM2 xxx93	POKE A, 0	Turn off channels 8-15
PCM2 xxx92	X=PEEK (A)	Read channel status (0-7)
PCM2 xxx93	X=PEEK (A)	Read channel status (8-15)

xxx=CF, normally

*Address shown assume module is placed in slot 10.
**A=address shown on that particular line.

Channels 0-7	7	6	5	4	3	2	1	0
Channels 8-15	15	14	13	12	11	10	9	8
Decimal Weight	128	64	32	16	8	4	2	1

Special Handling of Static Sensitive Devices

CMOS devices are designed to operate at very high impedance levels for low power consumption. As a result, any normal static charge that builds up on clothing or shoes may be sufficient to destroy these devices if they are not handled properly. When handling these devices, use precautions below to avoid damaging them.

1. The devices should be transported and handled only in containers specially designed to prevent static build-up. Typically, these parts will be received in static-protected containers or conductive foam. Keep these devices in their original containers until ready for installation.
2. Remove the devices from their protective containers only at a properly grounded work station. Also ground yourself with a suitable wrist strap.
3. Handle the devices only by the body; do not touch the pins.
4. Any printed circuit board into which the device is to be inserted must also be grounded to the bench or table.
5. Use only anti-static type soldering and de-soldering tools.
6. Once the device is installed on the PC board, the device is normally adequately protected and normal handling may resume.

Replaceable Parts

This section contains replacement parts information for the 500A system.

Part numbers for individual components are listed on the component layout for the individual boards. Do not confuse the component designation with the part number. A typical part number could be R-76-10k, while the component designation might be R105. Additional available parts are listed in Table 5-4.

Keithley/Metrabyte maintains an inventory of all normal replacement parts. To place an order, or to obtain information concerning replacement parts, first contact the Keithley/Metrabyte Customer Support Department. When ordering parts, include the following information:

1. Model number
2. Serial number
3. Module type and part number (as marked on the board).
4. Part Description
5. Circuit designation, including schematic and component layout designations (if applicable).
6. Part number

Table 5-4. 500 Replacement Parts

Part Number	Description
500-260	PCM2 External Module without Relay
Call for Part Number	500 Mainframe Mainframe Mother Board AC Mainframe Power Supply (500A) DC Mainframe Power Supply, 12V nominal input (500P) DC Mainframe Power Supply, 24V nominal input (500P) DC Isolation Module for computer power (500P) Mainframe to Computer Interface Cable, 5 feet (500A) Mainframe to Computer Interface Cable, 2 feet (500P)

KEITHLEY

Service Form

Model No. _____ **Serial No.** _____ **Date** _____

Name and Telephone No. _____

Company _____

List all control settings, describe problem and check boxes that apply to problem. _____

_____

_____

- ❑ Intermittent
- ❑ Analog output follows display
- ❑ Particular range or function bad; specify _____
- ❑ IEEE failure
- ❑ Obvious problem on power-up
- ❑ Batteries and fuses are OK
- ❑ Front panel operational
- ❑ All ranges or functions are bad
- ❑ Checked all cables

Display or output (check one)

- ❑ Drifts
- ❑ Unable to zero
- ❑ Unstable
- ❑ Will not read applied input
- ❑ Overload

- ❑ Calibration only
- ❑ Certificate of calibration required
- ❑ Data required

(attach any additional sheets as necessary)

Show a block diagram of your measurement system including all instruments connected (whether power is turned on or not). Also, describe signal source.

Where is the measurement being performed? (factory, controlled laboratory, out-of-doors, etc.)

_____

_____

What power line voltage is used? _____ Ambient temperature? _____°F

Relative humidity? _____ Other? _____

Any additional information. (If special modifications have been made by the user, please describe.)

_____

_____

Be sure to include your name and phone number on this service form.