

MAGTROL

Model 5310

Single-Phase Power Meter



User's Manual

Purchase Record

Please record all model numbers and serial numbers of your Magtrol equipment, along with the general purchase information. The model number and serial number can be found on either a silver identification plate or white label affixed to each unit. Refer to these numbers whenever you communicate with a Magtrol representative about this equipment.

Model Number: _____

Serial Number: _____

Purchase Date: _____

Purchased From: _____

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Safety Precautions



1. Make sure that all Magtrol dynamometers and electronic products are earth-grounded, to ensure personal safety and proper operation.
2. Securely ground the 5310 Power Meter case by connecting a good earth ground at the ground stud located on the rear panel of the unit. Use a number 12 AWG, or larger wire.
3. Check line voltage before operating.
4. Make sure that dynamometers and motors under test are equipped with appropriate safety guards.

Revisions To This Manual

The contents of this manual are subject to change without prior notice. Should revisions be necessary, updates to all Magtrol User's Manuals can be found at Magtrol's web site at www.magtrol.com/support/manuals.htm.

Please compare the date of this manual with the revision date on the web site, then refer to the manual's Table of Revisions for any changes/updates that have been made since this edition.

REVISION DATE

1st Edition – March 2013

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Preface

PURPOSE OF THIS MANUAL

This manual contains all the information required for the installation and general use of the Model 5310 Power Meter. To achieve maximum capability and ensure proper use of the instrument, please read this manual in its entirety before operating. Keep the manual in a safe place for quick reference whenever a question should arise.

WHO SHOULD USE THIS MANUAL

This manual is intended for those operators who are planning to use the Model 5310 Power Meter for power measurement purposes either as a stand-alone instrument or in conjunction with any Magtrol Hysteresis, Eddy-Current or Powder Brake Dynamometer, any Magtrol Dynamometer Controller and M-TEST Motor Testing Software.

MANUAL ORGANIZATION

This section gives an overview of the structure of the manual and the information contained within it. Some information has been deliberately repeated in different sections of the document to minimize cross-referencing and to facilitate understanding through reiteration.

The structure of the manual is as follows:

- Chapter 1: INTRODUCTION - Contains the technical data sheet for the 5310 Power Meter, which describes the unit and provides its mechanical and electrical characteristics.
- Chapter 2: CONTROLS - Description of the elements located on the front and rear panels of the unit.
- Chapter 3: INSTALLATION/CONFIGURATION - Provides information needed for setup of the 5310 including wiring.
- Chapter 4: OPERATING PRINCIPLES - Information pertaining to theory of operation including analog processing, digital processing, measurement modes and measurement methods.
- Chapter 5: COMPUTER CONTROLLED OPERATION - How to run a test when the 5310 is used with a PC. Includes information on IEEE-488 and RS-232 Interface, data format, programming and command set.
- Chapter 6: CALIBRATION - Provides recommended calibration schedules along with step-by-step instructions for the calibration procedure.
- Appendix A: SCHEMATICS - For the main board and input modules.

CONVENTIONS USED IN THIS MANUAL

The following symbols and type styles may be used in this manual to highlight certain parts of the text:



Note:

This is intended to draw the operator's attention to complementary information or advice relating to the subject being treated. It introduces information enabling the correct and optimal functioning of the product to be obtained.



CAUTION:

THIS IS USED TO DRAW THE OPERATOR'S ATTENTION TO INFORMATION, DIRECTIVES, PROCEDURES, ETC. WHICH, IF IGNORED, MAY RESULT IN DAMAGE BEING CAUSED TO THE MATERIAL BEING USED. THE ASSOCIATED TEXT DESCRIBES THE NECESSARY PRECAUTIONS TO TAKE AND THE CONSEQUENCES THAT MAY ARISE IF THE PRECAUTIONS ARE IGNORED.



WARNING!

THIS INTRODUCES DIRECTIVES, PROCEDURES, PRECAUTIONARY MEASURES, ETC. WHICH MUST BE EXECUTED OR FOLLOWED WITH THE UTMOST CARE AND ATTENTION, OTHERWISE THE PERSONAL SAFETY OF THE OPERATOR OR THIRD PARTY MAY BE PUT AT RISK. THE READER MUST ABSOLUTELY TAKE NOTE OF THE ACCOMPANYING TEXT, AND ACT UPON IT, BEFORE PROCEEDING FURTHER.

1. Introduction

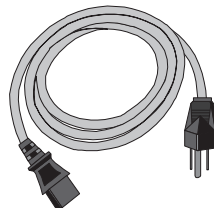
1.1 UNPACKING YOUR 5310 POWER METER

Your 5310 Power Meter was packaged in reusable, shock resistant packing material that will protect the instrument during normal handling.

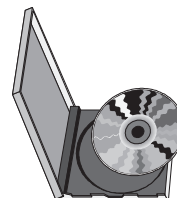
1. Make sure the carton contains the following:



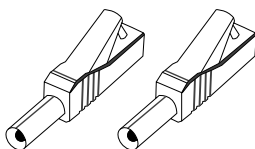
5310 Three-phase Power Meter



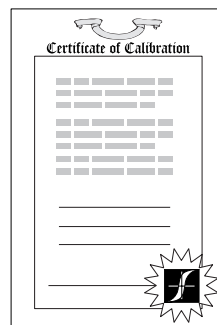
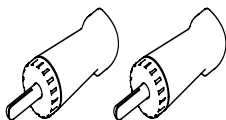
Line cord



Magtrol
User Manual
CD-Rom



Banana Jack Connectors (2 each)
Supercon Connectors (2 each)



Calibration Certificate

2. Inspect the contents for any evidence of damage in shipping. In the event of shipping damage, immediately notify the carrier and Magtrol's Customer Service Department.



Note: Save all shipping cartons and packaging material for reuse when returning the instrument for calibration or servicing.

1.2 NEW FEATURES OF THE 5310 POWER METER

Magtrol's new Model 5310 Power Meter is an upgraded version of the 5100. The new features that make the unit unique include:

1. Fast data acquisition and transfer.
2. GPIB and RS-232 Interfaces.

1.3

DATA SHEET


5310
Data Sheet

Model 5310 Single-Phase Power Meter

FEATURES

- **Ranges:** Up to 600 V_{rms} @ 100 A continuous duty
- **Interfaces:** RS-232 & GPIB
- **Data Transfer Rates:** Up to 100 per second
- **Accuracy:** Up to 0.1%
- **7-segment LED Display:** High-quality, easy-to-read LED displays for Amps, Volts, Power and Power Factor
- **Input Power:** Accepts 85-264 VAC, 50/60 Hz power at 20 VA max
- **Auto Ranging:** Automatically scales instrument for most accurate range
- **Isolation:** 1000 V_{rms} to earth, 750 V_{rms} line-to-line
- **Average:** Displays running average of amps, volts and watts
- **Rack Mounting:** 19" (482.6 mm) with handles



APPLICATIONS

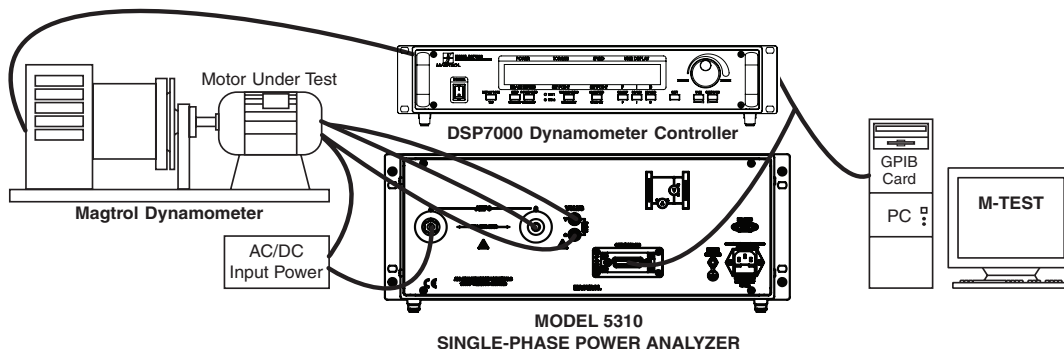
- | | |
|------------------------------|---|
| • Motors and Drives | • Power Tools |
| • Lighting Fixtures/Ballasts | • HVAC Equipment |
| • Office Equipment | • Calibration of Test and Measuring Instruments |
| • Household Appliances | |

The 5310's data transfer rate makes it ideal for both static and dynamic tests.

DESCRIPTION

The Magtrol 5310 Power Meter is an easy-to-use instrument ideal for numerous power measurement applications. From DC to 400 Hz, the 5310 measures volts, amps, watts, volt-amps and power factor in one convenient display. It may be used either as a stand-alone instrument or in conjunction with any Magtrol Hysteresis, Eddy-Current or Powder Brake Dynamometer; any Magtrol Dynamometer Controller and M-TEST Software for more demanding motor test applications.

SYSTEM CONFIGURATIONS



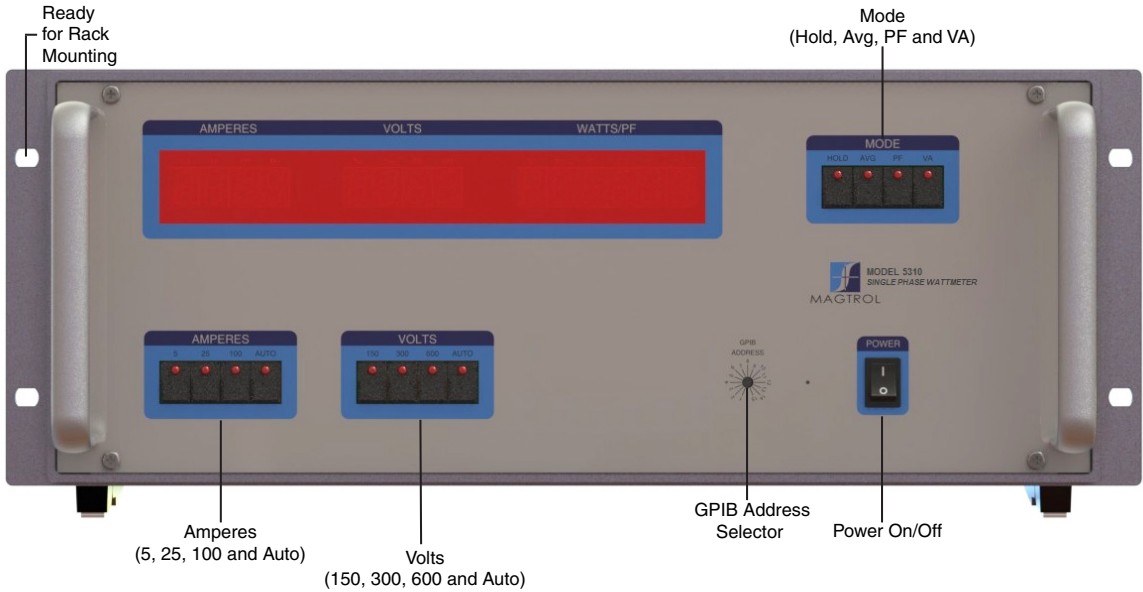
 Specifications

5310

	VOLTAGE INPUT	CURRENT INPUT	POWER
Ranges	150 V, 300 V, 600 V	5 A, 25 A, 100 A	---
Maximum Voltage	750 V AC/DC terminal (V) to terminal (±) and 1000 V AC/DC terminal to earth ground	1000 V AC/DC terminal to ground	---
Crest Factor	1.7 @ full scale input	2.7 @ full scale input	---
Impedance	2 MΩ	0.7 mΩ	---
Display Range	4 digits with 1 mV resolution	4 digits with 1 mA resolution	5 digits with 1 mW resolution
ACCURACY			
DC	±(0.1% Reading + 0.2% Range)		0.4% of VA range
5 Hz – 400 Hz	±(0.1% Reading + 0.1% Range)		0.2% of VA range

DIMENSIONS		
Width	19.0 in	483 mm
Height	7.5 in	191 mm
Depth	14.75 in	375 mm
with handles	16.5 in	420 mm
Weight	21 lb	9.5 kg

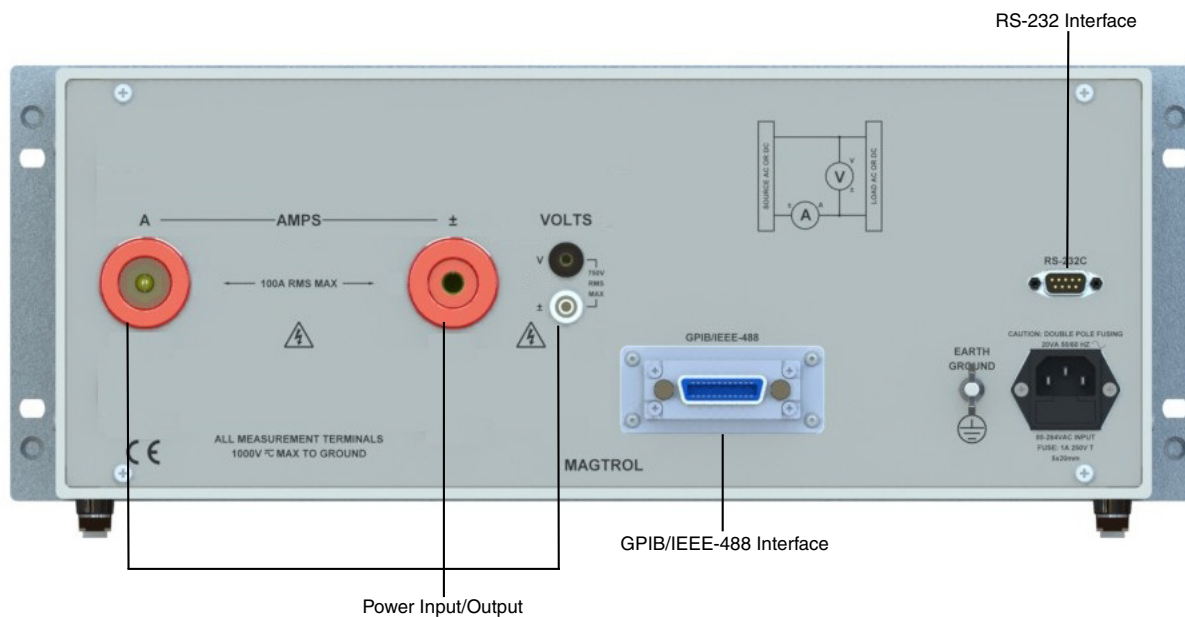
FRONT PANEL



Specifications

5310

REAR PANEL



2. Controls

2.1 FRONT PANEL

The front panel provides a power switch, twelve control buttons and a LED Display.



Figure 2-1 Front Panel

2.2 FRONT PANEL CONTROLS AND BUTTONS

The front panel controls and buttons, from left to right, are:

- Amperes - 5, 25, 100 and AUTO
- Volts - 150, 300, 600 and AUTO
- GPIB Address Selector Switch
- Bootload Enable Switch
- Power On/Off Switch
- Mode - HOLD, AVG, PF and VA.

2.2.1 USING FRONT PANEL CONTROLS AND BUTTONS

2.2.1.1 Controls/Buttons

Button	To Use	Function
5	Press and Release	Sets manual 5 Ampere range
25	Press and Release	Sets manual 25 Ampere range
100	Press and Release	Sets manual 100 Ampere range
AUTO	Press and Release	Sets automatic Ampere range selection
150	Press and Release	Sets manual 150 Volts range
300	Press and Release	Sets manual 300 Volts range
600	Press and Release	Sets manual 600 Volts range
AUTO	Press and Release	Sets automatic Volts range selection
GPIB ADDRESS	Rotate. Cycle power OFF-ON to apply	Sets GPIB Address
POWER	Press	Turns on instrument power
HOLD	Press and Release	Stops display from updating

AVG	Press and Release	Enables moving average of displayed values
PF	Press and Release	Changes WATTS display to POWER FACTOR
VA	Press and Release	Changes WATTS display to VOLT AMPERES

2.3

7-SEGMENT LED DISPLAY

The LED Display provides information about the Amperes, Volts and Watts/PF/VA.

2.4 REAR PANEL

The rear panel provides connectors and receptacles for connecting to appropriate equipment.

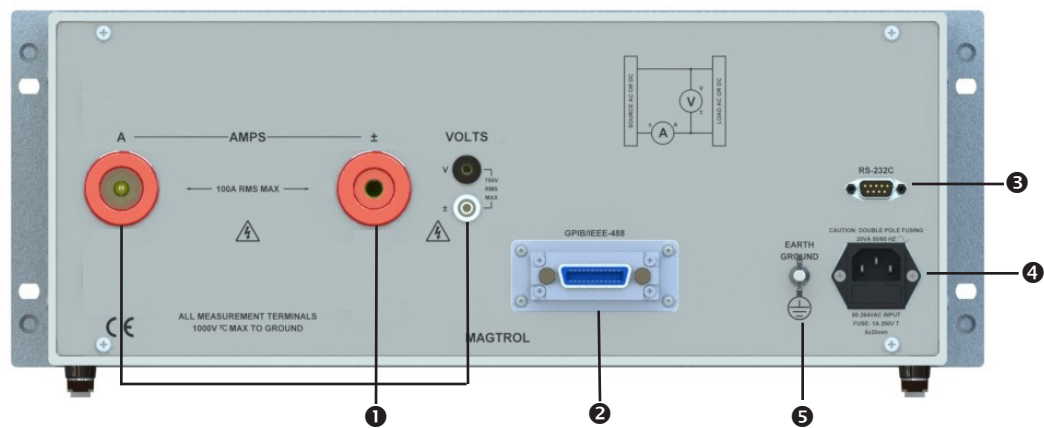


Figure 2-2 Rear Panel

2.5 REAR PANEL INPUTS AND OUTPUTS

- ❶ POWER INPUT/OUTPUT Contains the Voltage Sense and Current Input and Output for each phase.

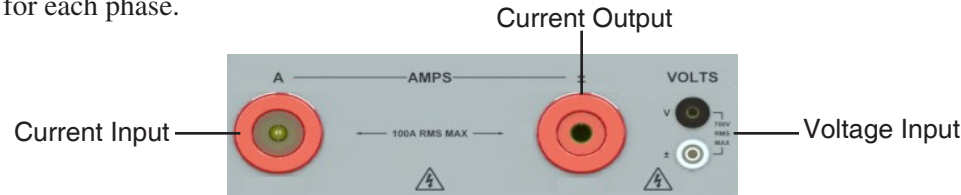


Figure 2-3 Power Input/Output

Voltage Sense Connect wires to measure voltage across the load (parallel).



CAUTION: VOLTAGE SHOULD NOT EXCEED 750 V AC/DC TERMINAL (V) TO TERMINAL (±) AND 1000 V AC/DC TERMINAL TO EARTH GROUND.

Current Input/Output Connect wires to measure amps through one line (series).



CAUTION: AMPS SHOULD NOT EXCEED 100 A CONTINUOUS. VOLTAGE SHOULD NOT EXCEED 1000 V AC/DC TERMINAL TO GROUND.

- 2
- GPIB/IEEE -488
- Use this socket for GPIB cable (meets IEEE-488 specifications).

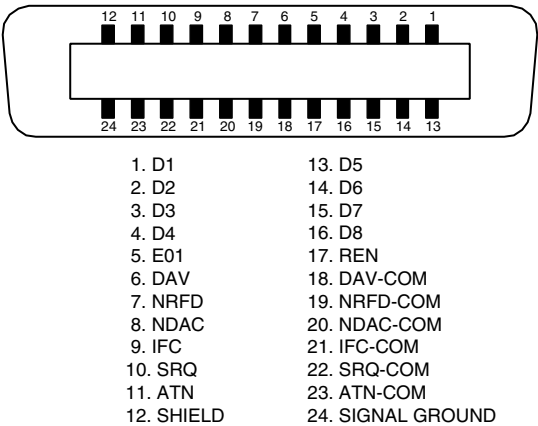


Figure 2–4 GPIB/IEEE-488 Interface

- 3
- RS-232
- Use this socket for RS-232 connector cable.

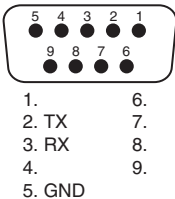


Figure 2–5 RS232 Interface

- 4
- POWER
- Attach power cord here.
- 5
- EARTH GROUND
- Attach earth ground here.



WARNING: MAKE SURE THAT ALL MAGTROL DYNAMOMETERS AND ELECTRONIC PRODUCTS ARE EARTH-GROUNDED, TO ENSURE PERSONAL SAFETY AND PROPER OPERATION. SECURELY GROUND THE 5310 POWER ANALYZER CASE BY CONNECTING A GOOD EARTH GROUND AT THE GROUND STUD LOCATED ON THE REAR PANEL OF THE UNIT. USE A NUMBER 12 AWG, OR LARGER WIRE

3. Installation/Configuration



Note: Before installing the 5310, you should become familiar with the front and rear panels, as outlined in *Chapter 2 – Controls*.

3.1 POWERING UP THE 5310



WARNING! TO REDUCE THE RISK OF ELECTRIC SHOCK, MAKE SURE THE 5310 IS EARTH GROUNDED BEFORE STARTING!

3.1.1 LINE VOLTAGE

The 5310 will operate from 85 to 264 VAC on a 50/60 Hz line voltage.

3.1.2 SELF-TEST

After turning the power on to the 5310, the display panel will show all segments of the LED Display (series of eights) and all button LEDs illuminated, indicating that the 5310 is downloading the program.



Figure 3–1 Program Download Display

When the program download is complete, the Title Display will appear indicating the Firmware Revision of your Magtrol 5310 Power Meter.



Figure 3-2 Title Display

3.1.3 MAIN MENU

When the 5310 is completely powered up and ready for use, the display will indicate the last configuration. This could include one of three different power displays: True Watts, Volt-Amps or Power Factor.

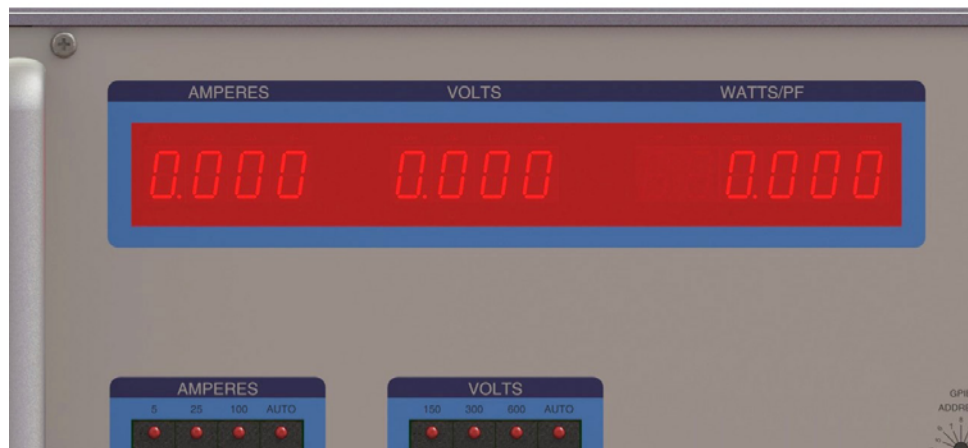


Figure 3-3 Display

3.2 PROTECTING YOUR 5310

Before the 5310 is used for power measurement, guidelines regarding transient overloads, current overload, surge protection and circuit breakers must be followed.

3.2.1 TRANSIENT OVERLOADS

Connect an appropriate transient suppressor in parallel with all inductive loads. Consult the suppressor vendor's application literature for proper selection and sizing.



CAUTION: DAMAGE TO THE 5310 CAN RESULT FROM EXCESSIVE VOLTAGE TRANSIENTS GENERATED BY UNSUPPRESSED INDUCTIVE LOADS. THIS DAMAGE IS NOT WITHIN THE SCOPE OF THE NORMAL INSTRUMENT SERVICE AND IS NOT COVERED BY THE MAGTROL WARRANTY.

3.2.2 CURRENT OVERLOAD

There are no fuses in the 5310 measuring circuits. Therefore, excessive current passed through the amps terminals will cause excessive internal heating and possible unit damage.



CAUTION: THIS OVERLOAD ABUSE IS NOT COVERED BY THE MAGTROL WARRANTY.

Know your load conditions and double check all connections. If an overload should occur, immediately remove all power and locate and correct the problem before re-energizing your circuit. If a circuit breaker is installed, it must be installed on the load side of the 5310 (downstream). This will keep the low impedance of the input line connected to the 5310 for surge suppression. If the line side must also contain a breaker, it should be delayed in operation to open after the load side breaker has opened.

3.2.3 SURGE PROTECTION

Use Metal Oxide Varistors (MOV) or other equivalent transient suppressors connected between lines at the load (across the load). These suppressors are an absolute necessity when inductive loads are used.

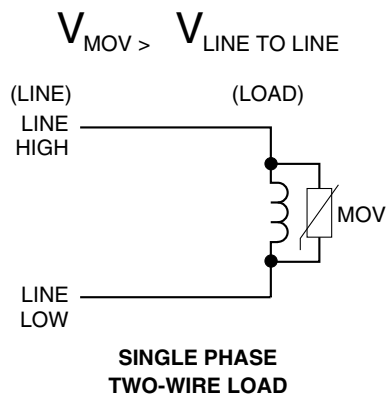


Figure 3–5 Transient Voltage Suppression

3.2.4 **CIRCUIT BREAKERS**

With the circuits described in *Section 3.3.1.1 - Hardware Connections*, use the 5310 remote voltage sense by measuring the voltage at the load. This increases measurement accuracy by eliminating line voltage drop from the power measurement. For safety, an overload circuit breaker removes all load voltage during an over-current condition. The voltage sense lines are connected at the line side of the circuit breaker to help prevent inductive transients from entering the 5310 as the circuit breaker opens. Make sure that connections from the circuit breaker to the load are heavy conductors and short as possible.



CAUTION: If a circuit breaker is used in the input line to the 5310, a circuit should be used that prevents the breaker from opening until after the load side breaker has opened. Otherwise, potentially damaging inductive transients can be applied to the 5310. Damage caused by these transients are outside the scope of the Magtrol Warranty.

3.3 **TESTING INSTRUMENTATION SETUP**

Before the 5310 can be utilized, it must be configured and connected to the devices intended for power measurement.

3.3.1 **WIRING MODE**

The 5310 has the ability to support single-phase circuits.

3.3.1.1 **Hardware Connections**

The following pages provide more detail on the power measurement, as well as wiring connection diagrams and schematics, of the different wiring modes.



Note: Active Power is the sum of the instantaneous volts multiplied by the instantaneous amps inputs.

Apparent Power is the product of volts rms and amps rms.

1-Phase, 2-Wire

- Measures single-phase power.
- Can be wired on any measurement phase.
- The Power Factor is derived from the following equations:
 $\text{Amps rms} = A_n$, $\text{Volts rms} = V_n$; where n = measurement phase number
 $\text{Active Power} = W_n$
 $\text{Apparent Power} = V_{\text{rmsn}} \times A_{\text{rmsn}} = V_n A_n$
 $\text{Power Factor} = W_n / V_n A_n$
- Most commonly used for single phase AC and DC motor applications.

The following diagrams show the connections for a 1-Phase, 2-Wire measurement.

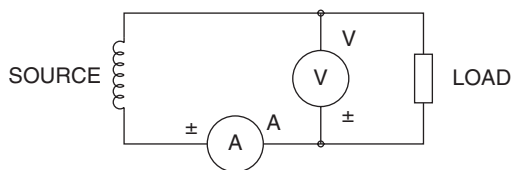


Figure 3-6 Single-Phase, Two-Wire Wiring Schematic

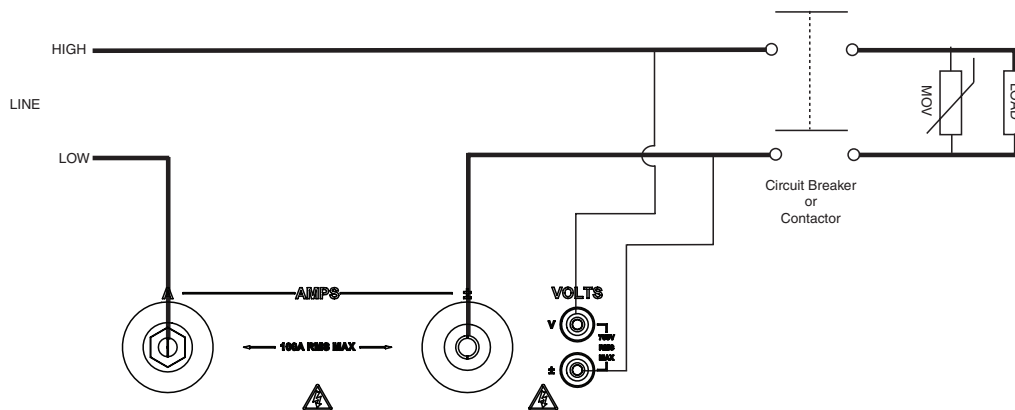


Figure 3-7 Single-Phase, Two-Wire Wiring Connection

3.3.2 AMP SCALING

The current measurement range can be extended by using a current transformer. Frequency response will be determined by the characteristics of the transformer used.

3.3.2.1 Hardware Connection

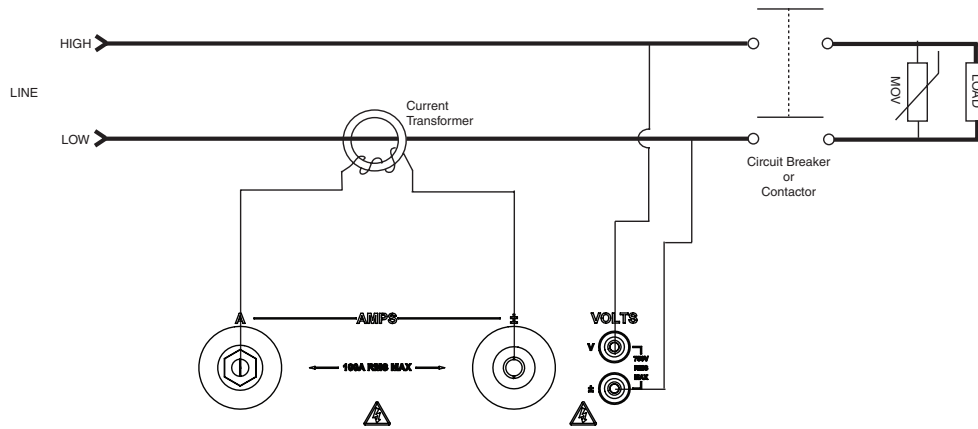


Figure 3-10 Current Transformer Connection

3.3.2.2 Software Configuration

To configure the 5310 amp scaling for a current transformer, complete the following steps utilizing GPIB or RS-232 communication.

1. Turn on the 5310. See *Section 3.1 – Powering Up the 5310*.
2. Using a communication utility, send the amp scaling command to the 5310, SA1,m2, where m2 equals the transformer ratio A_{in}/A_{out} .

3.3.3. VOLTS SCALING

The voltage measurement range can be extended by using a potential transformer. Frequency response will be determined by the characteristics of the transformer used.

3.3.3.1 Hardware Connection

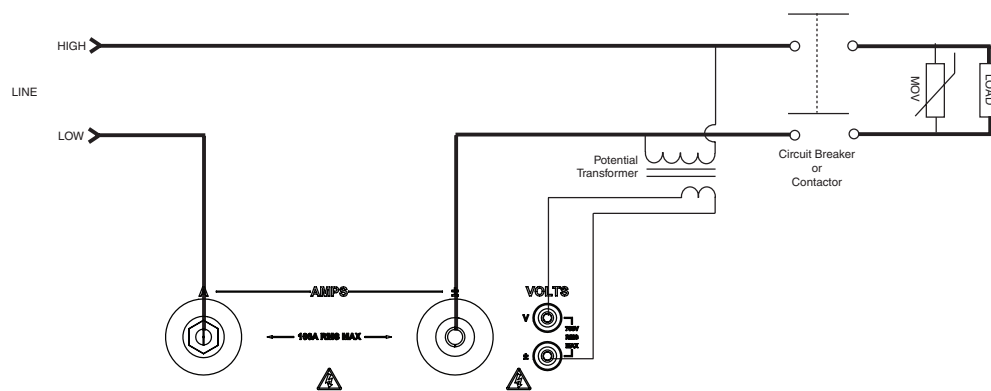


Figure 3-11 Potential Transformer Connection.

3.3.3.2 Software Configuration

To configure the 5310 volt scaling for a potential transformer, complete the following steps utilizing GPIB or RS-232 communication.

1. Turn on the 5310. See *Section 3.1 – Powering Up the 5310*.
2. Using a communication utility, send the volt scaling command to the 5310, SV1,m2 where m2 equals the transformer ratio V_{in}/V_{out} .

3.3.5 SPECIAL FUNCTIONS

3.3.5.1 Hold

- Freezes display values.
- To set, press and release HOLD button.
- To disable, press and release HOLD button.

3.3.5.2 Average

- Mode in which the power analyzer displays the running average of amps, volts and watts.
- Used to stabilize mildly fluctuating readings or to determine watt-hours when used in conjunction with a timer.
- To set, press AVG button and release,
- To disable, press AVG button and release.

4. Computer Controlled Operation

Using the 5310 with a personal computer (PC) enables the unit to perform at its full capacity.

4.1 ABOUT THE GPIB INTERFACE

Magtrol prefers the GPIB (General Purpose Interface Bus)/IEEE-488 Standard for computer-to-instrument interfacing because:

- The GPIB parallel interface is faster than serial interfaces.
- The GPIB enables testers to access up to 15 instruments on one port. Because typical motor testing requires that at least five separate parameters be synchronized, a system of easy, fast access to more than one instrument is essential.
- The GPIB has rigid data formatting and hardware standards. These standards help to ensure that all functions will work properly when the hardware and software are installed.



Note: The GPIB interface is not standard on most personal computers. An interface card and driver software must be installed. An IEEE-488 cable must also be installed between the computer and the 5310. Magtrol recommends National Instruments Corporation hardware and software.

4.1.1 INSTALLING THE GPIB/IEEE-488 CONNECTOR CABLE



CAUTION: MAKE SURE BOTH THE COMPUTER AND 5310 ARE TURNED OFF BEFORE INSTALLING THE GPIB CONNECTOR CABLE.

1. Connect one end of a high-quality, double-shielded cable to the 5310 GPIB connector.
2. Connect the other end to the GPIB interface in your PC.

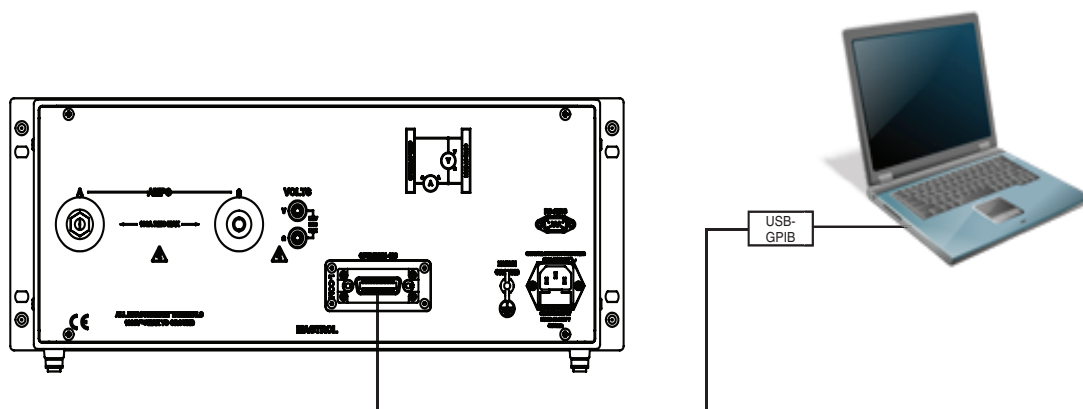


Figure 4-1 GPIB Installation

4.1.2 CHANGING THE GPIB PRIMARY ADDRESS

Each instrument serviced by the GPIB has its own primary address code, which enables the computer to obtain readings from the instrument. The factory default of the GPIB address on the 5310 is 14.



Figure 4–2 GPIB Address Setup Menu

Power down the 5310. Using a small screwdriver, turn the rotary switch to the desired address (1-15). Power up the 5310.

4.2 ABOUT THE RS-232 INTERFACE

The 5310 is equipped with an RS-232 (serial) interface that communicates with the host computer through a DB-9 interface connector. The connector pin-out consists of 2-RX, 3-TX and 5-GND.

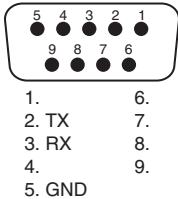


Figure 4–3 RS-232 Interface

4.2.1 CONNECTION

The RS-232 requires null modem wiring. To install use a null modem connector cable, which can be purchased from your local electronics store.

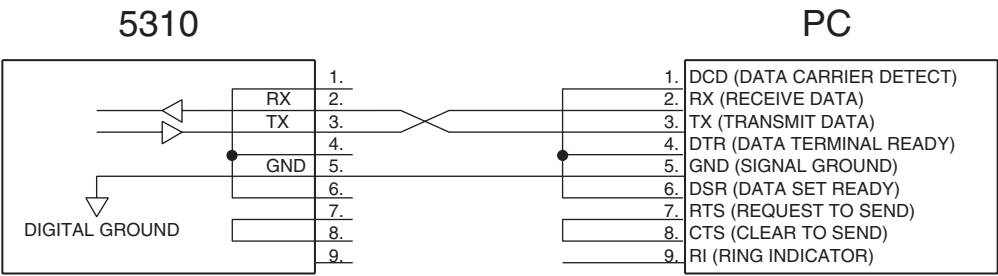


Figure 4-4 Cable Connection Using Null Modem

4.2.2 COMMUNICATION PARAMETERS

- No parity
- 8 data bits
- 1 stop bit

4.2.3 BAUD RATE

The Baud Rate is fixed at 115.2K Baud.

4.3 CHECKING THE 5310-TO-PC CONNECTION



Note: Make sure that the 5310 and its host computer are communicating before acquiring data.

1. Make sure the primary GPIB address is set correctly for the 5310.
2. Set the input variable to 15 characters (13 variable characters and the two required data termination characters CR and LF. See *Section 4.5 – Programming.*)
3. Issue identification query command “*IDN?” and read 15 characters according to the instructions for your GPIB interface or serial.

Desired Results

- output_string = “5310R 2.09”<delimiter>

4.4 DATA FORMAT

- All measurement values are returned as an ASCII-string floating point in E notation.
- The same data format will be used for both IEEE-488 and RS-232 interface. See *Section 4.6 – 5310 Communication Commands*.
- Data is separated by commas.

Character	Definition
\s	space
\r	carriage return
\n	line feed
^	Located in the first returned character position indicating peak input value is above range, user needs to increase range. NOTE: If a space is located in the first returned character position, the input signal is within range and no changes need to be made.

Sections 4.4.1 through 4.4.3 contain return data format examples for the following:

- Output Total (OT)

4.4.1 OT EXAMPLE

Total = 183 characters

Output String: (1-182) = measurement value float E notation (ANSI)

Data Position: A1, V1, W1, , , , , , , Frequency

4.4.1.1 Good Response

```
\s\s1.86707E-01,\s\s1.19568E+02,\s\s1.32201E+01,\s\s0.00000E+00,\s\s0.00000E+00,
\s\s0.00000E+00,\s\s0.00000E+00,\s\s0.00000E+00,\s\s0.00000E+00,\s\s0.00000E+00,
\s\s0.00000E+00,\s\s0.00000E+00,\s\s5.99982E+01\r\n
```

4.4.1.2 Over-Range Condition

```
\s\s1.85048E-01,^\s4.94537E+01,^\s4.20193E+00,\s\s0.00000E+00,\s\s0.00000E+00,
\s\s0.00000E+00,\s\s0.00000E+00,\s\s0.00000E+00,\s\s0.00000E+00,\s\s0.00000E+00,
\s\s0.00000E+00,\s\s0.00000E+00,\s\s5.99860E+01\r\n
```

4.5 PROGRAMMING



Note: Check the manual provided with your software for full instructions.

4.5.1 DATA TERMINATION CHARACTERS

Use the following information to answer the formatting questions asked when installing your GPIB software. All GPIB data acquisition systems require the use of data termination characters. The 5310 uses the GPIB standard termination characters Carriage Return (CR) and Line Feed (LF). Provide them in that order.

4.5.1.2 Codes for CR-LF

	BASIC	HEX	DEC
CR =	CHR\$(13)	OD	13
LF =	CHR\$(10)	OA	10

4.6 5310 COMMUNICATION COMMANDS

IEEE-488 Address: 1-15
Terminator: carriage return followed by a line feed

RS-232 Baud Rate: 115.2K
Terminator: carriage return followed by a line feed

When entering a command code:

1. Type all characters in uppercase ASCII format.
2. End all commands with a carriage return followed by a line feed.
3. Do not string multiple commands together in one line.



Note: If a command is not recognized, a beep will sound.

4.6.1

CONFIGURATION COMMANDS

Command Code	Function	Explanation
Communication Commands		
*IDN? <terminator>	Identification query.	Returns model number and code revision.
OT	OUTPUT TOTAL (DATA)	Returns the full data string.
Configuration Commands		
AA1,m2<terminator>	Sets auto or manual range mode for the amps ranges.	"m2" indicates whether range mode is auto or manual. Values for <i>m2</i> are: 0 = manual range 1 = auto range
AV1,m2<terminator>	Sets auto or manual range mode for the voltage ranges.	"m2" indicates whether range mode is auto or manual. Values for <i>m2</i> are: 0 = manual range 1 = auto range
RA1,m2<terminator>	Sets current range and input source.	"m2" indicates current range. Values for <i>m2</i> are: 0 = 5 A 1 = 25 A 2 = 100 A
RV1,m2<terminator>	Sets voltage range.	"m2" indicates voltage range. Values for <i>m2</i> are: 0 = 150 V 1 = 300 V 2 = 600 V

Command Code	Function	Explanation
SA1,m2<terminator>	Sets the amps scaling constant (current transformer).	"m2" indicates the amps scaling constant in A/A and must be set within the following range: $0.01 < m2 < 10000$ When $m2 = 0$, the amps scaling mode will be cleared.
SV1,m2<terminator>	Sets the voltage scaling constant (potential transformer).	"m2" indicates the voltage scaling constant in V/V and must be set within the following range: $0.01 < m2 < 10000$ When $m2 = 0$, the voltage scaling mode will be cleared.

5. Calibration

5.1 CLOSED-BOX CALIBRATION

The 5310 features closed-box calibration. The advantage of closed-box calibration is that the user does not have to disassemble the case or make mechanical adjustments.

5.2 CALIBRATION SCHEDULE

Calibrate the 5310:

- After any repairs are performed.
- At least once a year; more frequently to ensure required accuracy.

5.3 CALIBRATION COMMANDS

Command Code	Function	Explanation
CA1,m2<terminator>	Calibrates amps measurement value of present input range.	"m2" indicates the calibrated input value applied to the input. When <i>m2</i> is equal to 0, the unit assumes zero calibration is requested and zero amps are on input. When <i>m2</i> is greater than 0, the unit assumes gain calibration is requested and <i>m2</i> amps are on input.
CV1,m2<terminator>	Calibrates volts measurement value of present input range.	"m2" indicates the calibrated input value applied to the input. When <i>m2</i> is equal to 0, the unit assumes zero calibration is requested and zero volts are on input. When <i>m2</i> is greater than 0, the unit assumes gain calibration is requested and <i>m2</i> volts are on input.
CS<terminator>	Saves calibration values to EEPROM.	---
CR<terminator>	Restores all calibration values from EEPROM (used for testing only).	---

5.4 BASIC CALIBRATION PROCESS

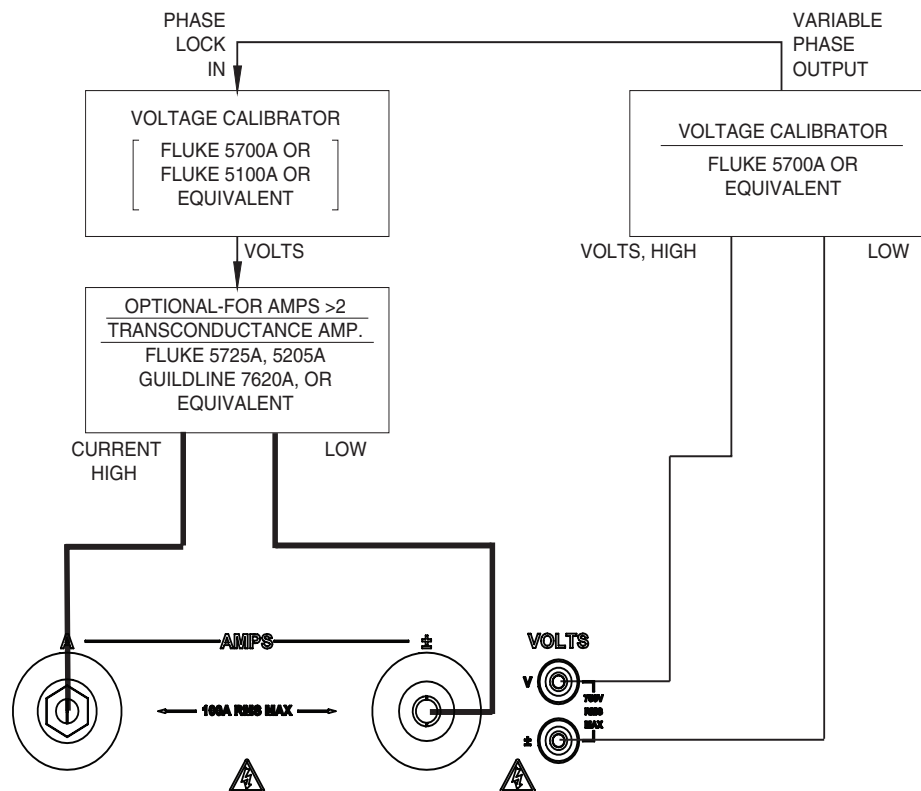


Figure 5-1 Calibration/Verification Test Setup

The 5310 must be used with a personal computer to complete the calibration process.

1. Begin the process with the 5310 turned OFF.
2. Remove any external input connections.
3. Connect the amps and volts.
4. Turn the power ON while depressing the HOLD button. See *Section 3.1 – Powering Up the 5310*. Before the display panel shows the model and Firmware Revision, the following display will appear indicating that the instrument has been placed in the calibration mode.

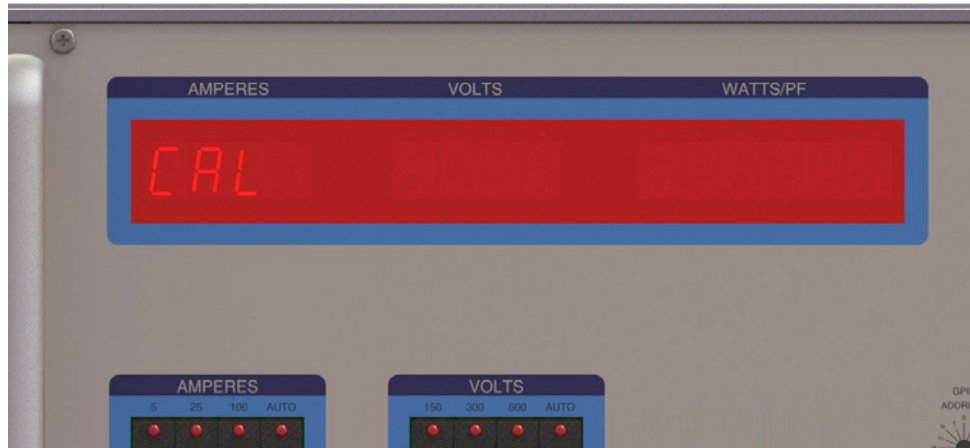


Figure 5-2 Calibration Mode Enabled

5. Set volt and amp range by entering the following command codes.
VOLTS => RV1,m2 where m2 = 0 to 3
AMPS => RA1,m2 where m2 = 0 to 3
6. Set calibrator to 0 volts (DC) and 0 amps (DC).



Note: DC is used for zero.

7. Enter the following commands.
VOLTS => CV1,0
AMPS => CA1,0
8. Set calibrator to full scale range for volts (AC) and amps (AC).



Note: AC 80 Hz is used for gain.

9. Enter the following commands.
VOLTS => CV1,xx.xx
AMPS => CA1,xx.xx
Where xx.xx is the voltage/current on the inputs (full scale).
10. Repeat steps 5 through 9 for all ranges.
11. Remove amp and voltage inputs.
12. Attach external input to calibrator voltage.
13. Set amp range by entering the following command code.
AMPS => RA1, m2 where m2 = 4 to 7
14. Set calibrator to 0 volts (DC).



Note: DC is used for zero.

15. Enter the following command.
AMPS => CA1,0
16. Set calibrator to volts full scale range (AC).

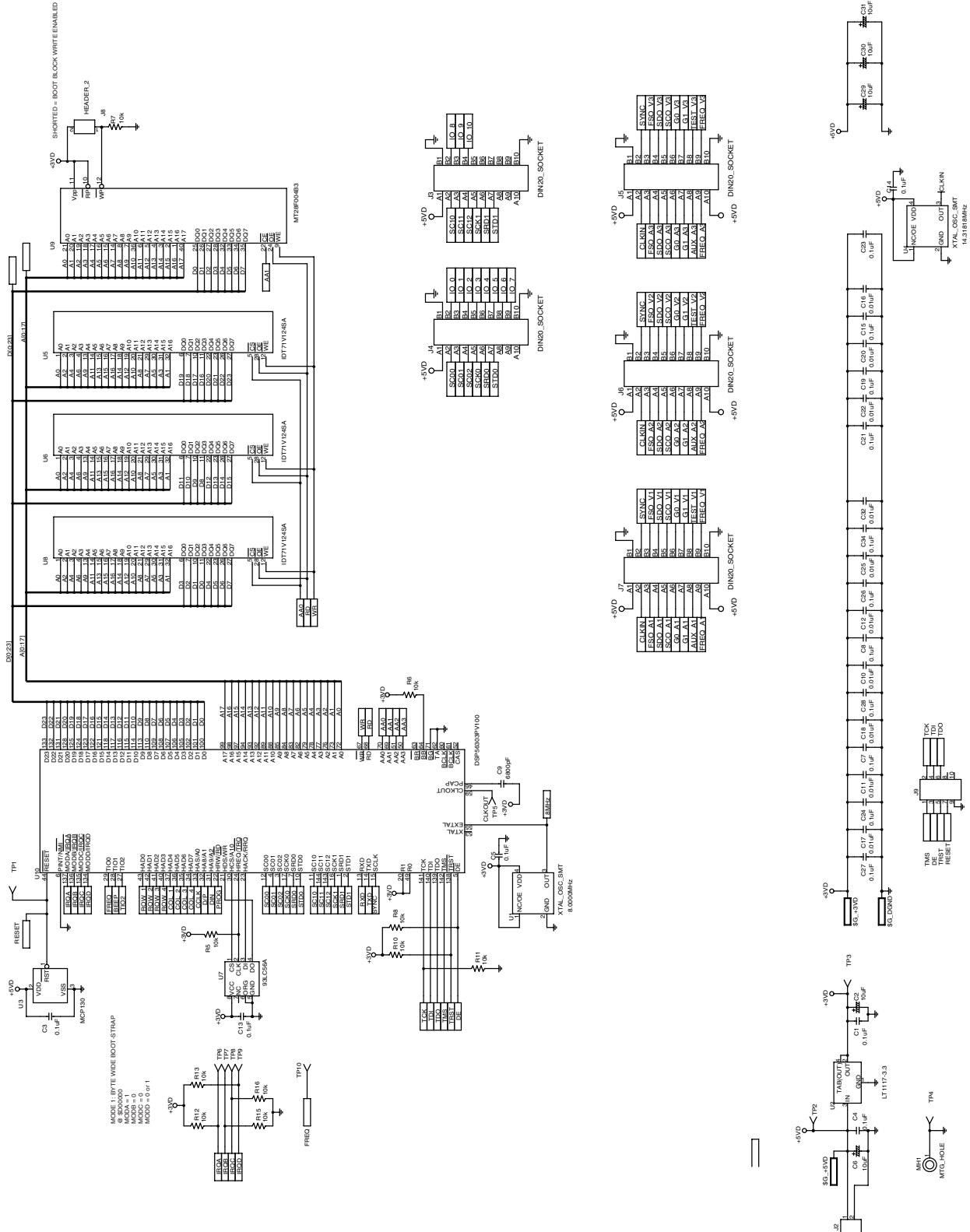


Note: AC 80 Hz is used for gain.

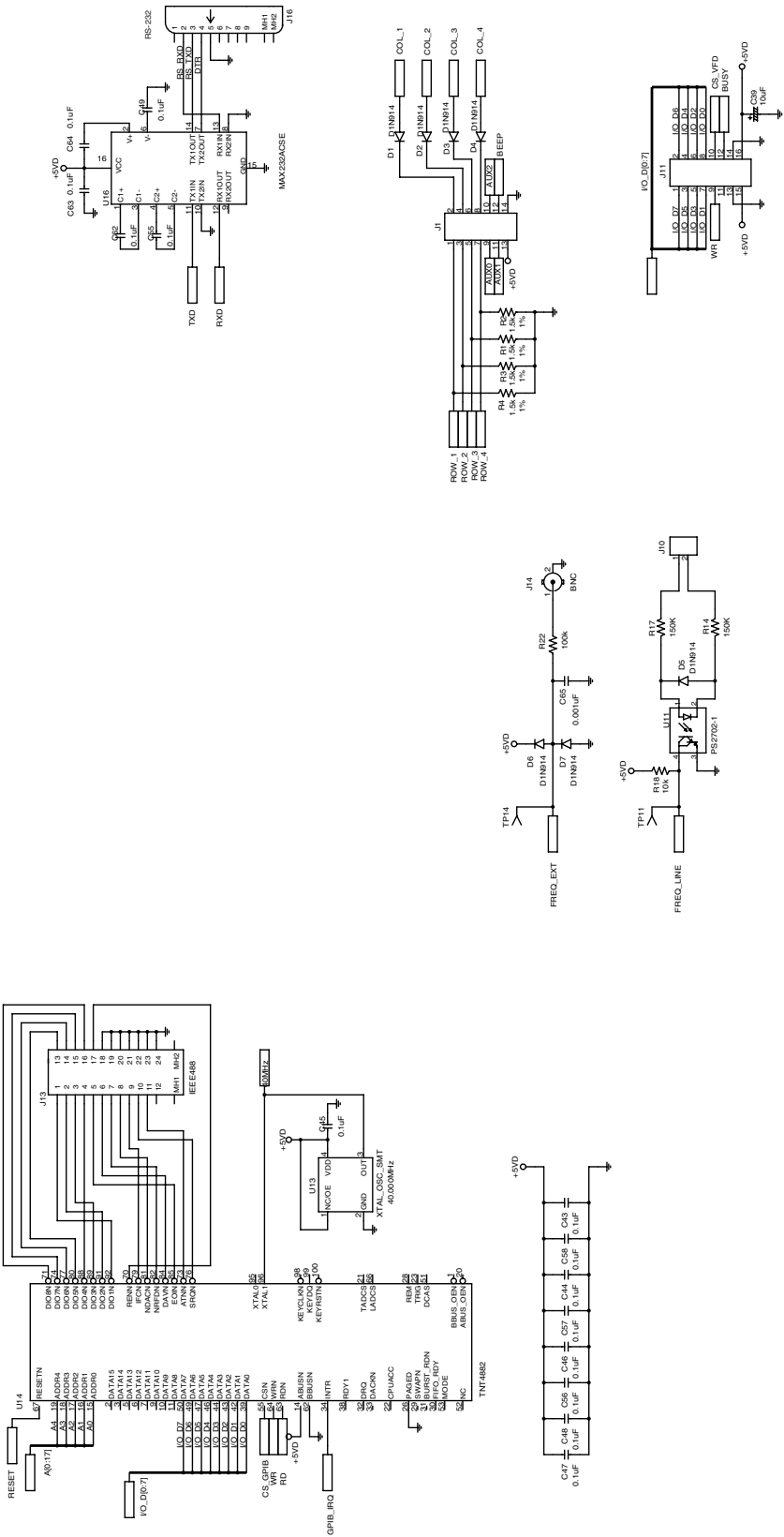
17. Enter the following command.
AMPS => CA1,xx.xx
Where xx.xx is the voltage on the inputs (full scale).
18. Repeat steps 13 through 17 for all ranges.
19. When the calibration for all ranges is complete, enter the CS command to save.

Appendix A: Schematics

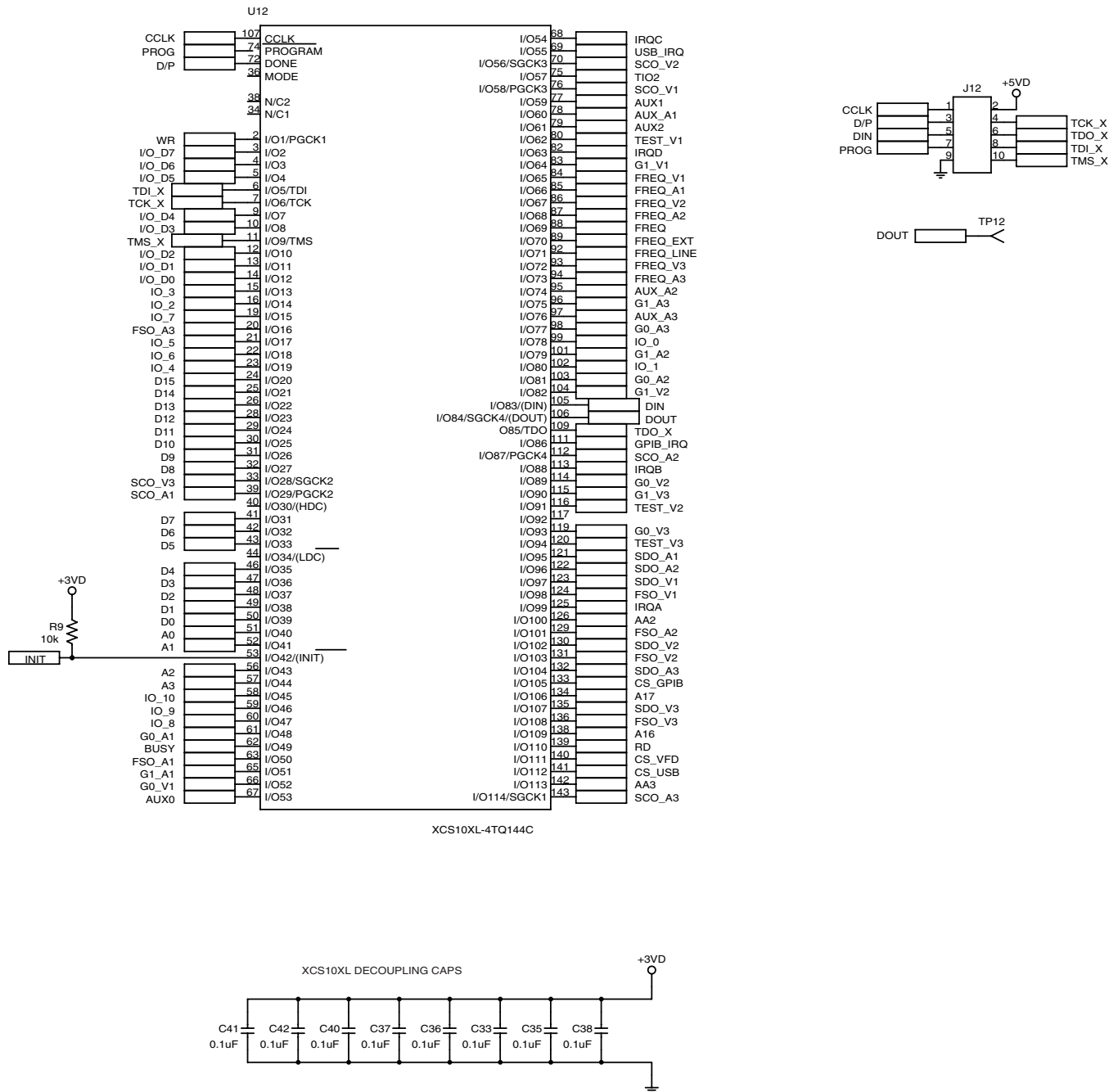
A.1 MAIN BOARD - DSP, RAM, FLASH



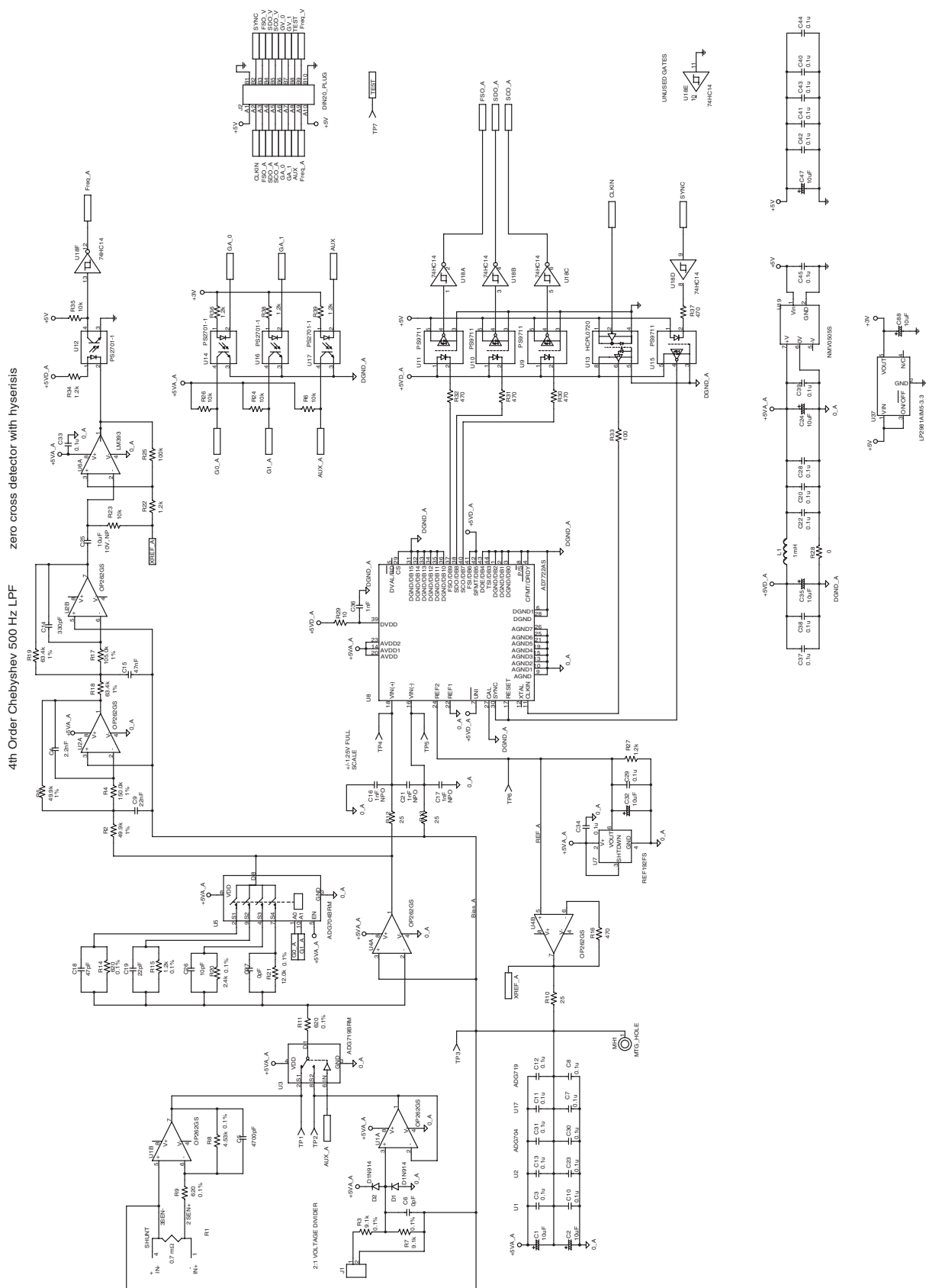
A.2 MAIN BOARD - INPUT/OUTPUT, GPIB, RS-232



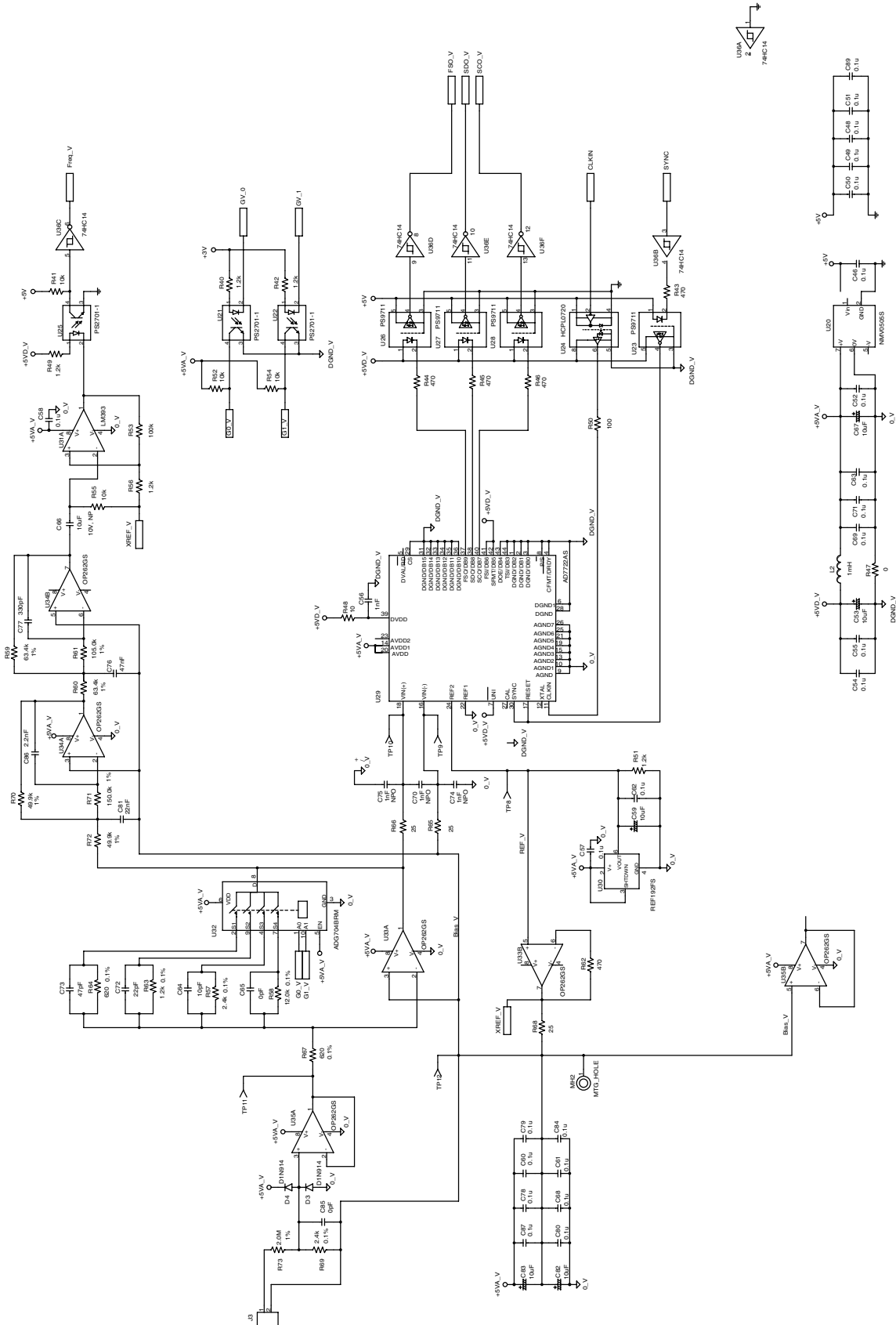
A.3 MAIN BOARD - FPGA



A.4 INPUT MODULE - CURRENT



A.5 INPUT MODULE - VOLTAGE



Service Information

RETURNING MAGTROL EQUIPMENT FOR REPAIR AND/OR CALIBRATION

Before returning equipment to Magtrol for repair and/or calibration, please visit Magtrol's Web site at <http://www.magtrol.com/support/rma.htm> to begin the Return Material Authorization (RMA) process. Depending on where the equipment is located and which unit(s) will be returned, you will be directed to either ship your equipment back to Magtrol, Inc. in the United States or Magtrol SA in Switzerland.

Returning Equipment to Magtrol, Inc. (United States)

When returning equipment to Magtrol, Inc.'s factory in the United States for repair and/or calibration, a completed Return Material Authorization (RMA) form is required.

1. Visit Magtrol's Web site at <http://www.magtrol.com/support/rma.htm> to begin the RMA process.
2. Complete the RMA form online and submit.
3. An RMA number will be issued to you via e-mail. Include this number on all return documentation.
4. Ship your equipment to:
MAGTROL, INC.
70 Gardenville Parkway
Buffalo, NY 14224
Attn: Repair Department
5. After Magtrol's Repair Department receives and analyzes your equipment, a quotation listing all the necessary parts and labor costs, if any, will be faxed or e-mailed to you.
6. After receiving your repair estimate, provide Magtrol with a P.O. number as soon as possible. A purchase order confirming the cost quoted is required before your equipment can be returned.

Returning Equipment to Magtrol SA (Switzerland)

If you are directed to ship your equipment to Switzerland, no RMA form/number is required. Just send your equipment directly to Magtrol SA in Switzerland and follow these shipment instructions:

1. Ship your equipment to:
MAGTROL SA
After Sales Service
Route de Montena 77
1728 Rossens / Fribourg
Switzerland
VAT No: 485 572
2. Please use our forwarder : TNT • 1-800-558-5555 • Account No 154033
Only ship ECONOMIC way (3 days max. within Europe)
3. Include the following documents with your equipment:
 - Delivery note with Magtrol SA's address (as listed above)
 - Three pro forma invoices with:
 - Your VAT number
 - Description of returned goods
 - Noticed failures
 - Value - for customs purposes only
 - Origin of the goods (in general, Switzerland)
4. A cost estimate for repair will be sent to you as soon as the goods have been analyzed. If the repair charges do not exceed 25% the price of a new unit, the repair or calibration will be completed without requiring prior customer authorization.



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