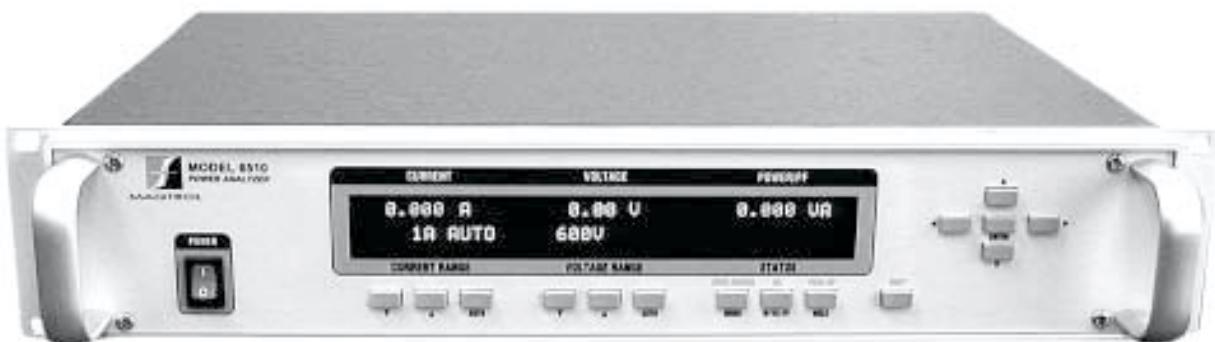


**MAGTROL**

**Model 6510**

*Single Phase  
Power Analyzer*



**User's Manual**

# MAGTROL

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Motor Test Equipment and Hysteresis Brakes & Clutches

Torque Transducers, Displacement Sensors, Rotary Transmitters

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# 1 - Introduction

## ABBREVIATIONS

<b>PA</b>	Model 6510 Power Analyzer
<b>GPIB</b>	IEEE-488 Instrument Bus Standard
<b>A</b>	Amperes
<b>V</b>	Volts
<b>W</b>	Watts
<b>PF</b>	Power Factor
<b>VA</b>	Volt Amperes
<b>DSP</b>	Digital Signal Processor
<b>CMRR</b>	Common Mode Rejection Ratio
<b>VFD</b>	Vacuum Fluorescent Display
<b>PC</b>	Personal Computer

## UNPACKING

The Model 6510 is packed in reusable, shock resistant packing material that will protect the instrument during normal handling. In the event of shipping damage, immediately notify the carrier and MAGTROL Customer Service Dept. Save all shipping materials for reuse when returning the instrument for calibration or servicing.

## POWER

The 6510 PA will accept either 120 or 240 Vrms, 50/60 Hz, power at 20 VA, max. The line cord is a detachable NEMA standard 3 wire that plugs into the rear access power entry and filter module of the 6510 PA. The line cord must be detached from the PA during servicing.

---

**NOTE:** The standard 6510 is set up at the factory for 120 Vrms power. 240 Vrms can be selected by removing the line cord and carefully prying up the fuse holder. Inside the fuse compartment, reconfigure the jumper.

---

## FUSE REPLACEMENT

Remove the line cord and carefully pry up and remove the fuse holder. Use a 250 ma slow blow fuse for 120 Vrms or a 100 ma slow blow fuse for 240 Vrms power.

## SAFETY

**SECURELY GROUND** the 6510 PA case by connecting a good earth ground at the ground stud that is located on the rear panel. Use a number 12 AWG, or larger wire.

## CONNECTORS

For your convenience, the following connectors are supplied with your 6500 PA.

<i>Plugs that mate with 6510 PA connectors ( Standard 4mm shrouded banana plugs )</i>		
		Mueller PN#
AMPS +	plug, black, male	BU-31101-0
AMPS -	plug, black, male	BU-31101-0
VOLTS -	plug, black, male	BU-31101-0
VOLTS +	plug, red, male	BU-31101-2
SHUNT INPUT	Isolated BNC	BU-5656-B-48-0

The following connectors / cables are not included and must be ordered separately:

- EXT SYNC (BNC) - Standard BNC
- GPIB (IEEE-488) - 24 Pin bus male standard
- SERIAL (RS232) - 9 Pin female standard

## MAXIMUM RATINGS

Load Voltage: 750 Vrms line to line, or 1000 Vrms line to earth.

Load Current: 20 Amperes rms, continuous. 30 Amperes rms, 30 sec. max.

Shunt Input:  $\pm 10$  Vrms.

## INSTALLATION

- Orientation: No special requirements.
- Electrical Load: Use wire and connectors rated for the maximum load current and voltage expected.
- IEEE-488 (GPIB): Use only high quality shielded cable conforming to the bus standards.

## INITIAL CHECKOUT

Make sure the circuit is completely de-energized by removing all voltage sources.

Plug the 6510 PA into the 50/60 Hz power mains. Switch the POWER rocker switch (red) to ON and observe that the VFD reads "MAGTROL 6510" and displays the revision of the software. After approximately 1 second the display will change to the last saved display configuration. Your 6510 PA has passed the initial check.

## 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 6510 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.

## CURRENT OVERLOAD

NO FUSES are in the 6510 PA 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, 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 6510 (downstream). This will keep the low impedance of the input line connected to the 6510 PA 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.

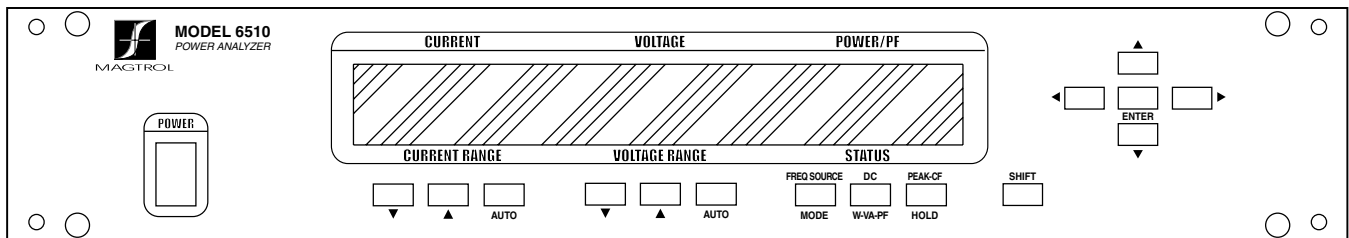


Figure 1. 6510 Front Panel

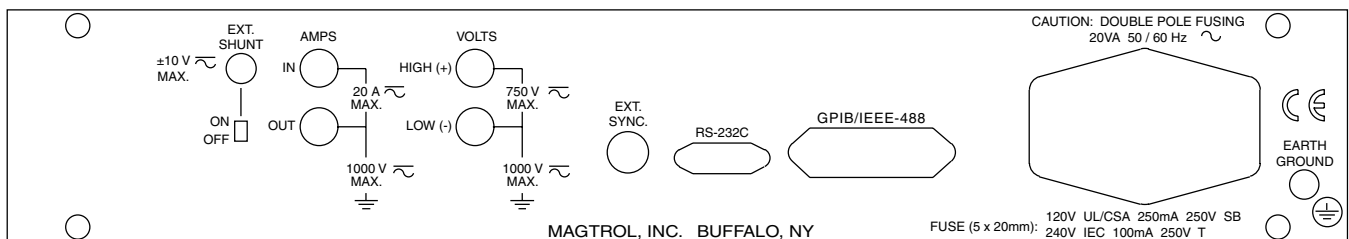


Figure 2. 6510 Rear Panel

## 2 - Specifications

### MEASUREMENT FUNCTIONS

- Volts RMS (AC+DC)
- Amps RMS (AC+DC)
- Volts DC
- Amps DC
- Volts Peak
- Amps Peak
- Volts Crest Factor
- Amps Crest Factor
- Watts
- VA
- Power Factor
- Frequency (Volts, Amps, Line, Ext.)

### MEASUREMENT MODES

#### CONTINUOUS MODE

Measurement values are determined from continuously processed and filtered V & I input values.

#### CYCLE-BY-CYCLE MODE

Measurement values are determined from an integration of one complete input cycle.

Fundamental frequency input: Can be selected from V, A, Line, or EXT.

---

NOTE: For V or A frequency measurement minimum input must be >10% of range setting.

---

### VOLTAGE

#### FOUR DC AND AC RANGES

30, 150, 300 and 600 Volts DC and Volts rms, each with a crest factor of 2.

### CURRENT

#### FOUR DC AND AC RANGES

1, 5, 10, and 20 Amps DC and Amps rms, each with a crest factor of 2.

### REMOTE CURRENT SENSING

Differential input: 110 dB CMRR.

Maximum of 10 Volts RMS.

### IMPEDANCE

#### VOLTAGE, DC OR AC

1.5 MegOhm load on all voltage ranges

#### CURRENT, DC OR AC RANGES

12 mOhm shunt resistance all ranges

### MEASUREMENT ACCURACY

Specified test conditions: Ambient temperature of 68° ± 5°F and Power Factor of 0.1 to 1.0, lead or lag. Unit allowed 10 minute warm-up time.

Calibration interval is six months for specified accuracy.

### ACCURACY SPECIFICATIONS

Effective Range: 10 to 110% of full range.

### VOLTAGE INPUT

Ranges	30V, 150V, 300V, 600V
Crest Factor	2.0 @ full scale input
Impedance	1.5 MegOhm
Display Range	4 digits with 10 mV resolution
<b>Accuracy:</b>	
DC	±(0.1% Reading + 0.2% Range)
5 - 500Hz	±(0.1% Reading + 0.1% Range)
500 - 100kHz	±(0.02 x F (kHz)% Reading + 0.3% Range)
>100kHz	N/A measurement band limited to DC-100kHz

## CURRENT INPUT

Ranges	1A, 5A, 10A, 20A
Crest Factor	2.0 @ max range
Impedance	12 mOhm
Display Range	4 digits with 1 mA resolution
<b>Accuracy:</b>	
DC	$\pm(0.1\% \text{ Reading} + 0.2\% \text{ Range})$
5 - 500Hz	$\pm(0.1\% \text{ Reading} + 0.1\% \text{ Range})$
500 - 100kHz	$\pm(0.02 \times F \text{ (kHz)}\% \text{ Reading} + 0.3\% \text{ Range})$
>100kHz	N/A measurement band limited to DC-100kHz

## EXTERNAL SHUNT INPUT

Ranges	50 mV, 250 mV, 500 mV, 1.0 V
Crest Factor	2.0 @ full scale input
Impedance	17 kOhm
Display Range	4 digits with 0.1 mV resolution
<b>Accuracy:</b>	
DC	$\pm(0.1\% \text{ Reading} + 0.2\% \text{ Range})$
5 - 500Hz	$\pm(0.1\% \text{ Reading} + 0.1\% \text{ Range})$
500 - 100kHz	$\pm(0.02 \times F \text{ (kHz)}\% \text{ Reading} + 0.3\% \text{ Range})$
>100kHz	N/A measurement band limited to DC-100kHz

NOTE: User definable scaling from 0.001 mV/Amp to 10,000 mV/Amp

## POWER

Display Range	6 digits with 1 mW resolution
<b>Accuracy:</b>	
DC	0.4% of VA range
5 - 500Hz	0.2% of VA range
500 - 10kHz	0.6% of VA range
10kHz - 100kHz	$0.6\% + 0.03\% \times F \text{ (kHz)}\%$ of VA range
>100kHz	N/A measurement band limited to DC-100kHz

## FREQUENCY

Source	V, A, LINE, or EXT (For V or A, source input must be >10% of range setting)
Accuracy	10 - 500Hz 0.05%
EXT. Input	BNC non-isolated, earth ground referenced
Input Resistance	100 kOhm
Voltage Level	TTL / CMOS.
Maximum Voltage	50V

## ISOLATION

1000 Vrms input to GND.

## TEMPERATURE COEFFICIENT

$\pm 0.01\%$  of range per degree C, maximum.

## ACCURACY CERTIFICATION

All instruments are shipped with a CERTIFICATE of CALIBRATION from MAGTROL Inc. Magtrol policies and procedures comply with MIL-STD-45662A. Measurement standards are traceable to the National Institute of Standards and Technology (NIST). Instrument calibration every six calendar months is necessary to maintain full compliance with all specifications. If a one year calibration cycle is used, all accuracy specifications are reduced by 0.1%. After one calendar year, the instrument is considered to be out of calibration.

## DISPLAY AUTO ZERO

When in continuous mode and when the A and V display indication is less than 1.0% of range, the displayed value is set to ZERO.



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## 3 - Connecting the 6510

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**CAUTION** Always install a properly rated circuit breaker or fuse between the 6510 Power Analyzer and the load. Also, make sure that your power source has it's own disconnect and overload protection that has an operating time lag that insures the load breaker always operates first. Wire according to all applicable wiring codes, making sure the wire gauge and insulation ratings are adequate for your application.

---

### 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. In three phase systems, each load must have a suppressor.

### CONNECTORS

Use the supplied connectors. For replacement, see "*Connectors*" in *Chapter 1* for manufacturer and part numbers.

### SINGLE PHASE

#### AC OR DC CONNECTIONS

*Figure 7*

This circuit utilizes the 6510 PA 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 (CB) removes all load voltage during an over current condition. Make sure that connections from the remote voltage sense lines are connected very close to the circuit breaker and the lines from the breaker to load are as short as possible.

---

**CAUTION** If a circuit breaker is used in the input line to the 6510 PA, a circuit should be used that prevents the breaker from opening until after the load side breaker has operated. Otherwise, potentially damaging inductive transients will be applied to the 6510 PA. Damage caused by these transients are outside the scope of the MAGTROL WARRANTY.

---

For voltage sense lines less than 25 feet in length, a twisted pair of #20 gauge (or larger) wire can be used. For lines longer than 25 feet or lines grouped with other AC conductors, shielded cable should be used. Connect the shield at the 6510 PA GND terminal. If the wires connecting the load to the 6510 PA Amps terminals are short and the resulting voltage drop is insignificant, the voltage sense connections can be made at the rear panel of the 6510 PA.



### WARNING

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**Connect the chassis ground terminal to a good earth ground. Use at least #12 gauge insulated copper wire.**

---

*Drawings referred to in this chapter can be found in Appendix A - Connection Diagrams.*

---

## THREE PHASE

### 3 WIRE DELTA CONNECTIONS

*Figure 8*

Load true power is the algebraic sum of the two wattmeter readings (  $W = W1 \pm W2$  ) regardless of load power factor or balance. The general discussion from Figure 7 applies.

---

NOTE: For a load power factor of 0.5, one wattmeter reads zero. As the power factor goes less than 0.5, its power is negative and is subtracted in the algebraic watts summation. The 6510 PA will not display a minus sign for this condition. For power factors greater than 0.5, the polarity of both wattmeters will be the same. Therefore, true power in watts is simply the unsigned sum of the wattmeter readings.

---

### 3 WIRE WYE, 2 WATTMETER CONNECTIONS

*Figure 9*

True power is the algebraic sum of the two wattmeter readings regardless of power factor and degree of load balance - see NOTE for Figure 2, concerning power factors less than 0.5. Also, the general discussion from Figure 7 applies.

### 4 WIRE WYE, 3 WATTMETER CONNECTIONS

*Figure 10*

Three wattmeters are required for unbalanced loads. Total power is the algebraic sum of the three wattmeter readings. The general discussion from Figure 7 and the power factor discussion of Figure 8 applies.

## CURRENT & POTENTIAL TRANSFORMER CONNECTIONS

*Figure 11*

Voltage and current measurement ranges can be extended by using current and potential transformers. Frequency response will be determined by the characteristics of the transformers used. The general discussion from Figure 7 applies. Three phase lines can be measured by using the two or three wattmeter techniques previously illustrated.

### 4 WIRE BALANCED LOAD, 1 WATTMETER

*Figure 12*

With a balanced load, one wattmeter connected in one phase reads 1/3 of the total power consumed.

$$\text{WATTS}_{\text{TOTAL}} = 3 \times \text{WATTMETER READING}$$

The general discussion from Figure 7 applies. The three load impedances are equal for balanced loads.

### 3 WIRE BALANCED LOAD, 1 WATTMETER

*Figure 13*

$$\text{WATTS}_{\text{TOTAL}} = 3 \times \text{WATTMETER READING}$$

An artificial neutral is formed by a star connection of three identical resistors (R). The value of these resistors should be high enough to avoid loading the lines and affecting the power measurement. The general discussion from Figure 7 applies. The three load impedances are equal for a balanced load.

*Drawings referred to in this chapter  
can be found in Appendix A -  
Connection Diagrams.*

# 4 - Operation

## GENERAL

Using *Chapters 1 and 3* as a guide, connect the 6510. Before connecting the power mains, double check all connections using an Ohmmeter. Verify that the over current circuit breaker is open and connect the power mains. Observe the 6510 front panel indicators. Turn

the 6510 power switch ON and confirm proper operation - refer to *“Initial Checkout” in Chapter 1.*

Energize the power mains and apply power to the load by closing circuit breaker CB. If improper operation occurs, immediately disconnect power mains, locate and correct the problem.

## 6510 MENU NAVIGATION

MENU NAVIGATION	FUNCTION
CURRENT RANGE: ▲	Increments current range
▼	Decrements current range
AUTO	Selects / deselects current auto range (except in EXT ranges)
VOLTAGE RANGE: ▲	Increments voltage range
▼	Decrements voltage range
AUTO	Selects / deselects voltage auto range
SHIFT then FREQ SOURCE	Selects the signal that the cycle by cycle measurement will be synchronized with. Continue to press SHIFT then FREQ SOURCE and the source toggles through: VOLT (voltage input) AMP (current input) EXT (external sync input) LINE (incoming ac line) <b>Note:</b> Selecting SHIFT then FREQ SOURCE will automatically switch unit to cycle by cycle mode.
SHIFT then DC	Selects DC measurement. <b>Note:</b> Selecting DC will automatically set continuous mode.
SHIFT then PEAK-CF	Selects displayed measurement. Continue to press SHIFT then PEAK-CF and the displayed values toggle through: RMS readings ( A, V ) PEAK readings ( Apk, Vpk ) Crest Factor readings ( ACF, VCF )
MODE	Selects continuous or cycle by cycle measurement mode.
W-VA-PF	Selects what calculated value is to be displayed. Continue to press W-VA-PF and the displayed values toggle through: W Watts VA Vrms x Arms PF Power factor
HOLD	Holds current value until hold is pressed again.
SHIFT	Used to select FREQ SOURCE, DC, PEAK
ENTER	<b>Note:</b> The up/down, left/right switches are inactive until the MENU switch is pressed. Once the MENU switch has been pressed the left and right arrows will toggle though these functions: CURRENT SCALING, VOLTAGE SCALING, EXTERNAL INPUT, I/O SETTINGS, AC/DC FILTER & SAVE SETUP. (These are described in further detail in the Function Table on the next page.) Pressing ENTER will select the displayed function.

## 6510 FUNCTIONS

FUNCTION	DESCRIPTION
CURRENT SCALING	Scaling is turned ON by pressing the UP key and then pressing ENTER. This allows setting of the scaling factor using the arrow keys. UP and DOWN keys will increase or decrease the selected number. LEFT and RIGHT keys change the position of the number that is selected. Pressing ENTER will enable the set scale factor. <b>Note:</b> This value is saved to nonvolatile ram. Scaling is turned OFF by pressing the DOWN key and then pressing ENTER
VOLTAGE SCALING	Scaling is turned ON by pressing the UP key and then pressing ENTER. This allows setting of the scaling factor using the arrow keys. UP and DOWN keys will increase or decrease the selected number. LEFT and RIGHT keys change the position of the number that is selected. Pressing ENTER will enable the set scale factor. <b>Note:</b> This value is saved to nonvolatile ram. Scaling is turned OFF by pressing the DOWN key and then pressing ENTER.
EXTERNAL INPUT	Allows setting of the external shunt input scaling factor using the arrow keys. Pressing ENTER will enable the set scale factor. <b>Note:</b> This value is saved to nonvolatile ram.
I/O SETTINGS	Pressing left or right arrow buttons toggles through the following selections: CONTRAST: UP or DOWN keys select display contrast BAUD RATE: UP or DOWN keys select baud rate for RS-232 GPIB: UP or DOWN keys select GPIB address.
AC / DC FILTER	Pressing the UP or DOWN keys select filter value.
SAVE SETUP	Saves set up values to non volatile ram.

### VACUUM FLUORESCENT DISPLAY (VFD)

The 6510 is shipped with the Contrast setting at zero (lowest) in order to prolong display life. If it is necessary to increase the contrast for improved readability, use the lowest possible setting to achieve that result. Using a setting higher than necessary may cause display segments to burn-in over a period of time, resulting in uneven illumination from segment to segment.

### AMPERES DISPLAY

The AMPS display is a four digit, floating point display. The 6510 defaults to AUTO (auto ranging) at turn on. AUTO up-ranging occurs if the RMS current exceeds the top of the range value plus about 5% or, if a peak value exceeds full range RMS value x 1.414 plus approximately 5%. AUTO down-ranging occurs when the current is just less than full range value of the next lower range.

Selection of any amps range push-button activates the selected range by overriding the AUTO range selection - AUTO indication is removed from display.

### VOLTAGE DISPLAY

The VOLTS display is a four digit, floating point display. If AC is selected, a selection can be made to display True RMS, Peak, or Crest factor. If DC is selected, a minus sign will be shown to indicate a negative number.

The voltage input, between the rear panel VOLTS + (red) and VOLTS - (black) terminals, is differential (neither terminal tied to common) allowing connection at a remotely located load. This remote connection removes the voltage drop in the load connection wires from the power measurement.

The AUTO and manual VOLTS range selection is identical in operation to the AMPS as described above.

---

## WATTS DISPLAY

The WATTS display is a five digit, unsigned floating point display of power in WATTS, POWER FACTOR or VA as a decimal number.

WATTS is the power ON default MODE; press the W-VA-PF button to toggle through the three selections. Watts measurements are from milliwatts through 30 kilowatts, and Power Factors are from 0.0001 through 0.9999.

The WATTS range is set by the AMPS and VOLTS active ranges.

$$VA = V_{rms} \times I_{Arms} = V \times I$$

$$WATTS = V \times I \times \cos \theta = \text{TRUE POWER}$$

$$\text{Power Factor} = \frac{\text{True Power}}{V \times I}$$

## MODE HOLD

The HOLD push-button may be depressed at any time. When depressed, all internal machine functions are halted except auto-ranging.

## EXTERNAL SHUNT INPUT

An external shunt may be used with the 6510. Attach the shunt to the "EXT SHUNT" BNC on the rear panel. Turn the switch to the ON position (located directly under the "EXT SHUNT" BNC). Using the front panel buttons, input the scale factor for the shunt used. *See figure 14.* Set the front panel current range to 50 mV EXT, or the appropriate external range for the shunt being used.

# 5 - Communication

## GPIB (IEEE-488)

The IEEE-488 or GPIB (General Purpose Interface Bus) provides direct connection and control of the 6510 from any appropriately equipped computer for the purpose of data acquisition and display. MAGTROL factory assistance is available.

## HARDWARE INSTALLATION

A GPIB interface requires installation of an interface card in the host computer and driver software resident on the PC's hard disk. MAGTROL can supply the National Instruments Corp. PCI-GPIB interface, for personal computers.

## SOFTWARE INSTALLATION

Formatting and initialization assistance is available from MAGTROL Customer Service.

All GPIB data acquisition systems require the use of termination characters to signal the conclusion of a data exchange. The 6510 uses the Hewlett Packard - HPIB™ standard ASCII termination characters "Carriage Return (CR) and Line Feed (LF)", in that order. On a write cycle, the 6510 looks for the CR-LF to signal completion of an instruction and transmits these characters upon conclusion of a data read cycle.

## PRIMARY ADDRESS

All instruments serviced on the bus have a separate primary address code. The factory setting for the 6510 is twelve (12). This code can be changed by pressing the ENTER key and choosing I/O settings. Choose the GPIB parameter then increase or decrease until the desired address is obtained.

## SERIAL (RS-232)

The 6510 communicates with the host computer through a DB-9 interface connector. The connector pinout is: 2-RX, 3-TX, 4-DTR, 5-GND. No other pins are connected. Important communication parameters are:

- No parity
- 8 Data Bits
- 1 Stop Bit

## COMMUNICATION COMMANDS

GPIB	Address:	0 - 15
	Delimiter:	CR + LF
SERIAL (RS-232)	Baud Rate:	300, 600, 1200, 2400, 4800, 9600, 19.2K
	Delimiter:	CR + LF

## CONFIGURATION COMMANDS

	FUNCTION	SYNTAX
AA	Sets auto or manual range mode for the current ranges.	AAm <terminator>
		m = 0 : Manual range
		= 1 : Auto range
AV	Sets auto or manual range mode for the voltage ranges.	AVm <terminator>
		m = 0 : Manual range
		= 1 : Auto range
FS	Sets the input to be used as the fundamental frequency for cycle-by-cycle mode.	FSm <terminator> "m" indicates the input to be used as the fundamental source
		m = 0 : Volt
		= 1 : Amp
		= 2 : EXT (external input)
		= 3 : LINE (50/60 Hz)
MF	Sets the AC & DC measurement mode filter.	MFm <terminator> "m" indicates the measurement filter low-pass frequency (response time)
		m = 2 : 1 Hz
		= 3 : 2 Hz
		= 4 : 5 Hz
		= 5 : 10 Hz
		= 6 : 20 Hz
		= 7 : 50 Hz
		= 8 : 100 Hz
MM	Sets the measurement mode ("m").	MMm <terminator>
		m = 0 : AC RMS (AC+DC)
		= 1 : DC = 2 : Cycle-by-cycle (update rate - fundamental frequency, 20Hz-600Hz)

	FUNCTION	SYNTAX
MP	Sets the peak measurement mode ("m").	MPm <terminator>
		m = 0 : Normal
		= 1 : Peak
		= 2 : Crest-Factor
RA	Sets current r.	RAm <terminator>
		m = 0 : 20 A
		= 1 : 10 A
		= 2 : 5 A
		= 3 : 1 A
		= 4 : 1 V External shunt input range
		= 5 : 500 mV External shunt input range
		= 6 : 250 mV External shunt input range
RV	Sets voltage range.	RVm <terminator> "m" indicates input element
		m = 0 : 600 V
		= 1 : 300 V
		= 2 : 150 V
		= 3 : 30 V
SA	Sets the current scaling constant (current transformer).	SAm <terminator> "m" indicates the current scaling constant in A/A, and must be set within the following range: 0 < m < 10000
		m = 0 clears current scaling mode
SV	Sets the voltage scaling constant (potential transformer).	SVm <terminator> "m" indicates the voltage scaling constant in V/V, and must be set within the following range: 0 < m < 10000
		m = 0 clears voltage scaling mode
SE	Sets the external current shunt scaling constant.	SEm <terminator> "m" indicates the external current sensor scaling constant in mV/A, and must be set within the following range: 0.001 < m < 10000
		Note: Current input values are multiplied by this value in external shunt input current ranges.

## DATA OUTPUT COMMANDS

	FUNCTION	SYNTAX
OB?	Request output of A, V, W & Freq. data in binary floating-point form.	OB? <terminator> *
OA?	Request output of currently displayed Amps measurement in ASCII form. (A,Apk,CF)	OA? <terminator> *
OV?	Request output of currently displayed Volts measurement in ASCII form. (V,Vpk,CF)	OV? <terminator> *
OW?	Request output of currently displayed Watts measurement in ASCII form. (W,VA,PF)	OW? <terminator> *
OF?	Request output of Frequency in ASCII form.	OF? <terminator> *
HS	Sets high speed I/O mode (ON/OFF)	HSm <terminator>
		m = 0 : Off = 1 : On (front panel display blanked for high speed I/O, ASCII output format disabled)

\* See "Data Output Format" for response example.

## DATA OUTPUT FORMAT

### ASCII DATA FORMAT

Measured data returned as an ASCII string floating-point number.

Example: 1.000 <terminator>

A, V, F = 8 bytes

W = 9 bytes

## BINARY DATA FORMAT

Measured data consists of 4 single precision floating-point binary numbers.

Total =16 bytes data (no <terminator> characters sent)

Amps	Volts	Watts	Frequency
------	-------	-------	-----------

## CALIBRATION MODE COMMANDS

The following commands are accessible when the instrument is placed in calibration mode by holding in the SHIFT key while the power is turned on. "CALIBRATE" will be displayed.

	FUNCTION	SYNTAX	"m" INDICATES
GA	Sets the gain calibration factor of the present Amp input range.	GAm <terminator>	Current scaling constant in (raw A/D input value) per Amp
GV	Sets the gain calibration factor of the present Volt input range.	GVm <terminator>	Voltage scaling constant in (raw A/D input value) per Volt
ZA	Sets the zero offset calibration value of the present Amp input range.	ZAm <terminator>	Integer offset added to the raw A/D Amp input value.
ZV	Sets the zero offset calibration value of the present Volt input range.	ZVm <terminator>	Integer offset added to the raw A/D Volt input value.
X	Writes the present calibration values to EEPROM	X <terminator>	---

## SPECIAL FUNCTIONS

Three special functions are available at power turn on:

NOTE: These functions are provided for the 6510 PA performance evaluation and are not of use to the average user.

## WIRING DIAGRAMS

### CONNECTOR PINOUT

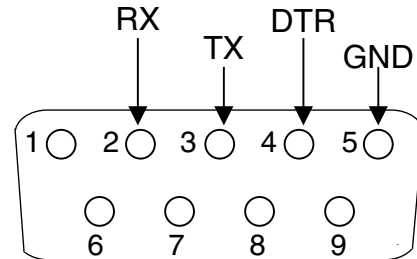


Figure 3. Connector Pinout

### SERIAL COMMUNICATIONS CABLE

To wire your own serial communications cable, use the following wiring diagram:

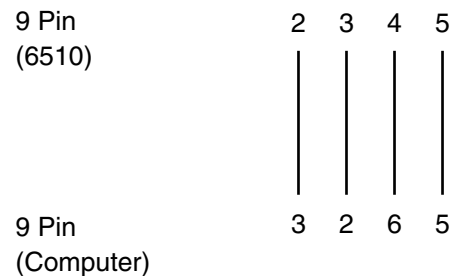


Figure 4. Serial Communications Cable

You may also purchase a cable from your local electronics store. A RadioShack #26-152 cable and #26-264 null modem adapter are known to work. You must use the null modem adapter on the computer end of the cable.

### GENERAL PURPOSE INTERFACE BUS (GPIB)

Magtrol prefers to use the GPIB (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.

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NOTE: The GPIB interface is not standard on most computers. An interface card and driver software must be installed. Magtrol recommends National Instruments Corporation's hardware and software.

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- An IEEE-488 cable must also be installed between the computer and the 6510.

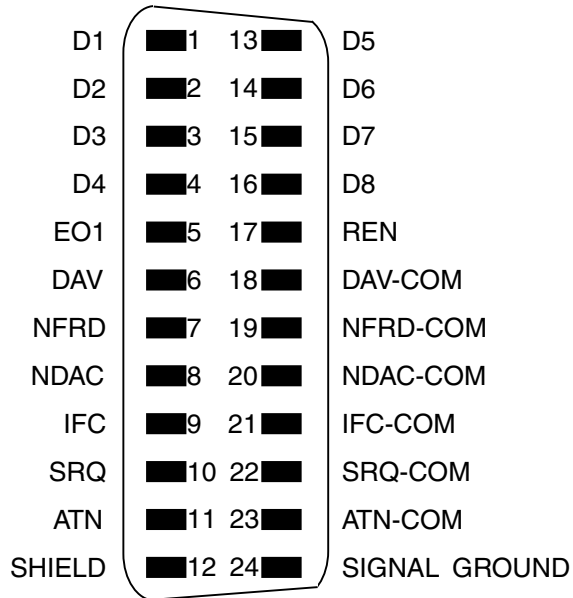


Figure 5. IEEE-488 Interface

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## 6 - Operating Principles

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### **AMPERES TRANSDUCING**

Current measuring is accomplished using a calibrated shunt. For all ranges, 0.012 Ohms resistance from the shunt provides a voltage to a differential input calibration amplifier.

### **VOLTAGE SENSING**

The VOLTS input terminals connect a 1.5 MegOhm voltage divider providing voltage to a differential input calibration amplifier. See Figure 10.

### **ANALOG PROCESSING**

Contact MAGTROL Customer Service for more information.

### **DIGITAL PROCESSING**

Contact MAGTROL Customer Service for more information.

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# 7 - Calibration

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## GENERAL

Complete calibration of the 6510 PA is beyond the capabilities of most users. MAGTROL Inc. recommends that the 6510 PA be returned to the factory for calibration, in order to certify the instrument to full specifications.

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NOTE: There are no internal adjustments. Breaking the factory CAL VOID sticker voids the MAGTROL WARRANTY - Please call the MAGTROL Service Department before you break this seal.

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NOTE: Performing these steps VOIDS the factory CALIBRATION CERTIFICATION that comes with the 6510 PA.

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## TEST SETUP

The recommended test setup is shown by Figure 6 on the following page. The accuracy of the voltage and current standards used for calibration should be at least four times the accuracy of the 6510 PA specifications. The equipment shown in this test setup meets this requirement.

To accurately measure AC power it is important that the current source have a phase shifting control. With such a phase adjustment, phase shift caused by incidental circuit inductance can be compensated for by adjusting the phase of the current wave form to be exactly in phase (zero phase shift) with the voltage wave form. Sources of incidental circuit inductance include the current shunts within the 6510, output impedance of the calibrators, impedance of the load and wiring inductance. Since the current calibrator output is usually a low impedance with low compliance voltage, the 6510's current measuring shunts are the circuit's major resistance.

## Example of resulting phase shift:

Let  $L = 10 \mu\text{henries}$  (wiring, etc.)

Let  $R_{\text{SHUNT}} = 0.012 \text{ Ohm}$ ;  $R_{\text{WIRING}} = 0.01 \text{ Ohm}$   
 $R = 0.012 + 0.01 = 0.022 \text{ Ohms}$

Let  $F = 60 \text{ Hz}$   $\therefore 2\pi FL \approx 0.004$

$\theta = \text{Arctan}(2\pi FL/R) = \text{Arctan}(0.004/0.022)$

$\theta = 10 \text{ degrees}$ , or about 1.5 % measurement error.

This error can be eliminated by adjusting the calibrators variable phase shift control. This demonstrates the need for care in making power analyzer calibration measurements.

## CALIBRATION

Refer to Figure 6 on the next page, for the recommended test setup.

## VERIFICATION

If other test equipment is used, appropriately modify the test steps for your equipment.



**WARNING**

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**Potentially lethal voltages are used in the following test steps. To avoid electrical shock, refer to your calibrator operator manual for operating instructions. These calibrators generate lethal voltages - extreme care is necessary.**

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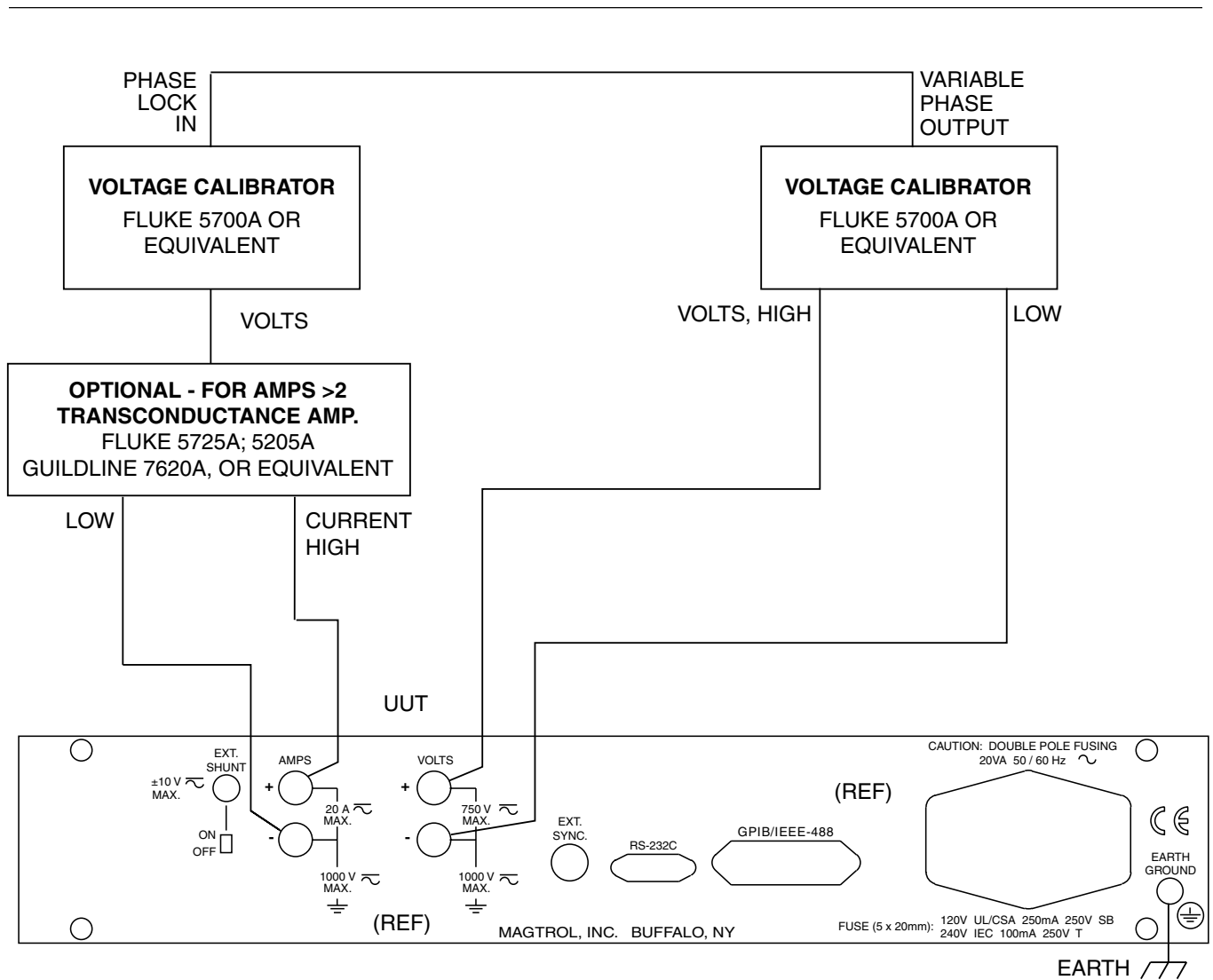


Figure 6. Calibration Verification Test Setup

# Appendix A - Connection Diagrams

Figure 7. Single Phase AC or DC with Remote Voltage Sense

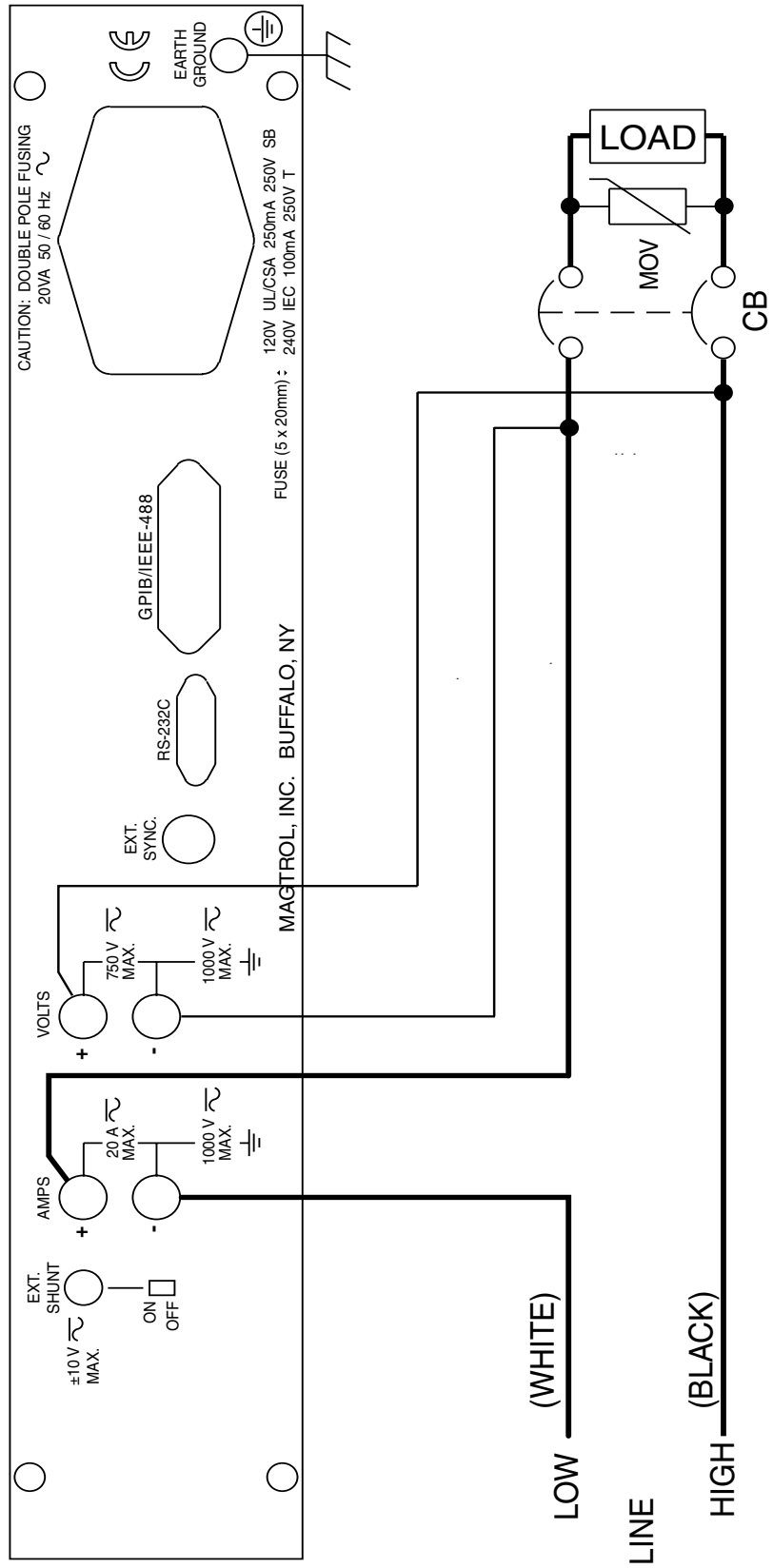


Figure 8. Three Phase, 3 Wire Delta, 2 Wattmeter with Remote Voltage Sense

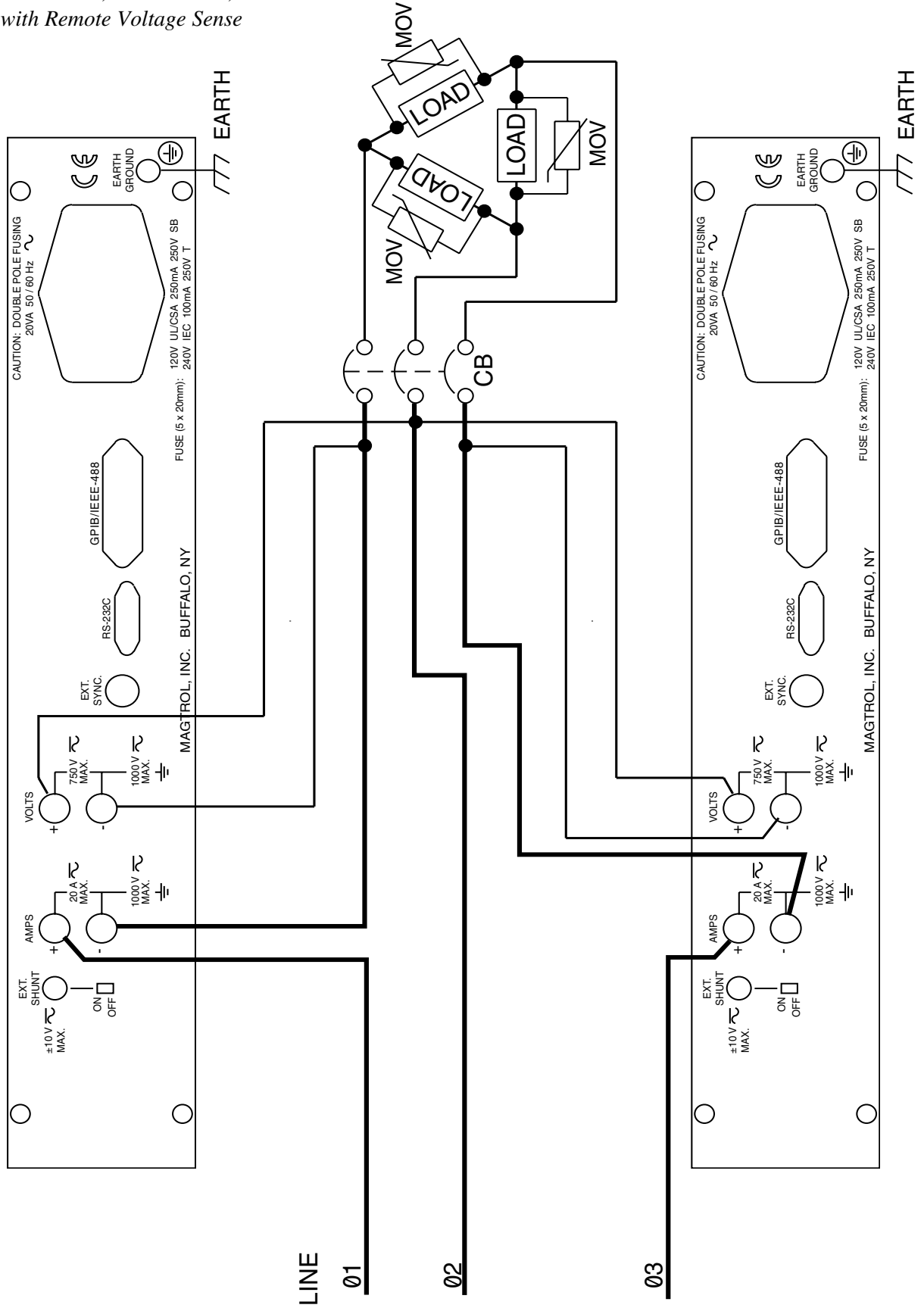


Figure 9. Three Phase, 3 Wire WYE, 2 Wattmeter with Remote Voltage Sense

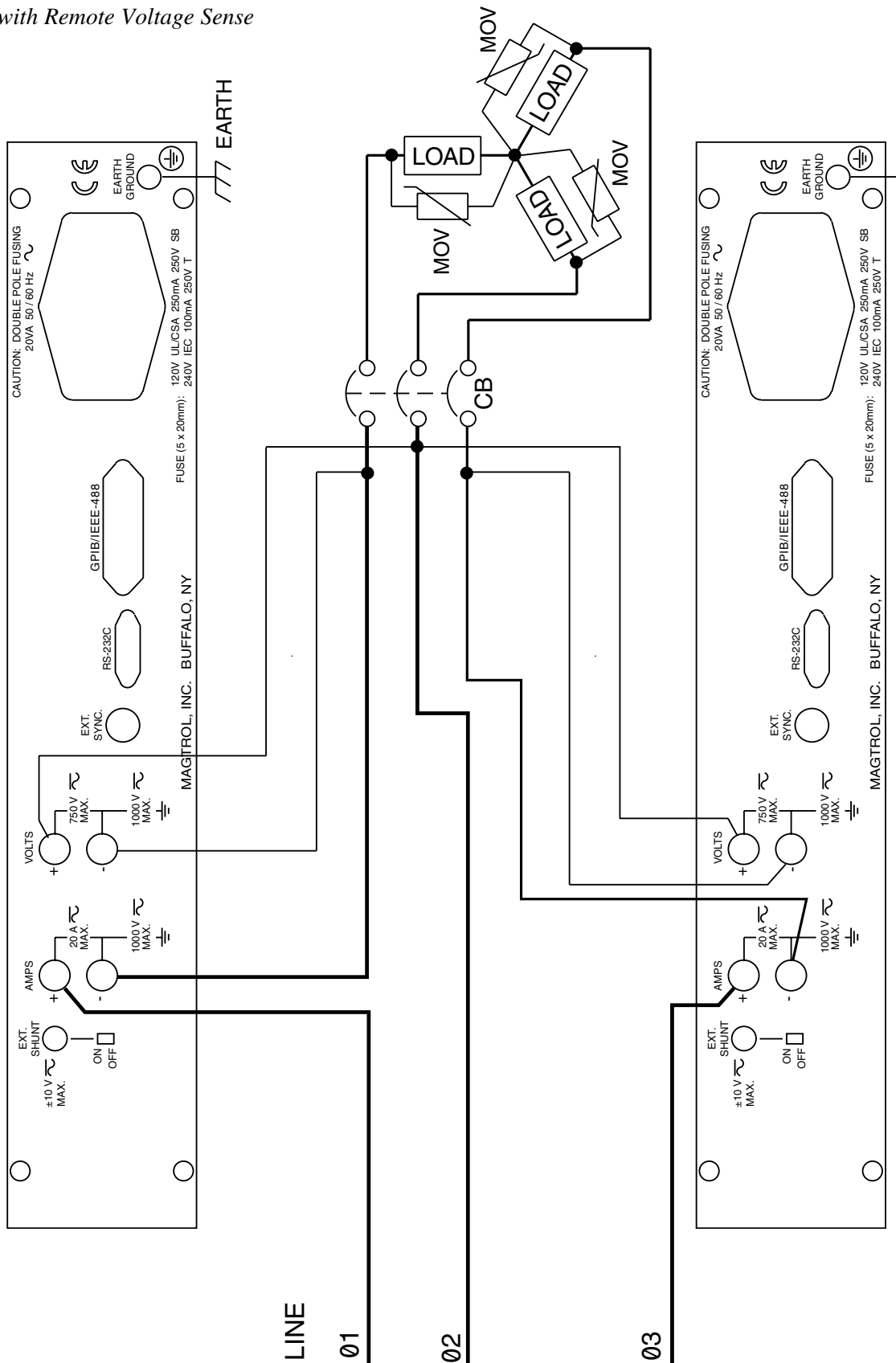


Figure 10. Three Phase, 4 Wire WYE, 3 Wattmeter with Remote Voltage Sense

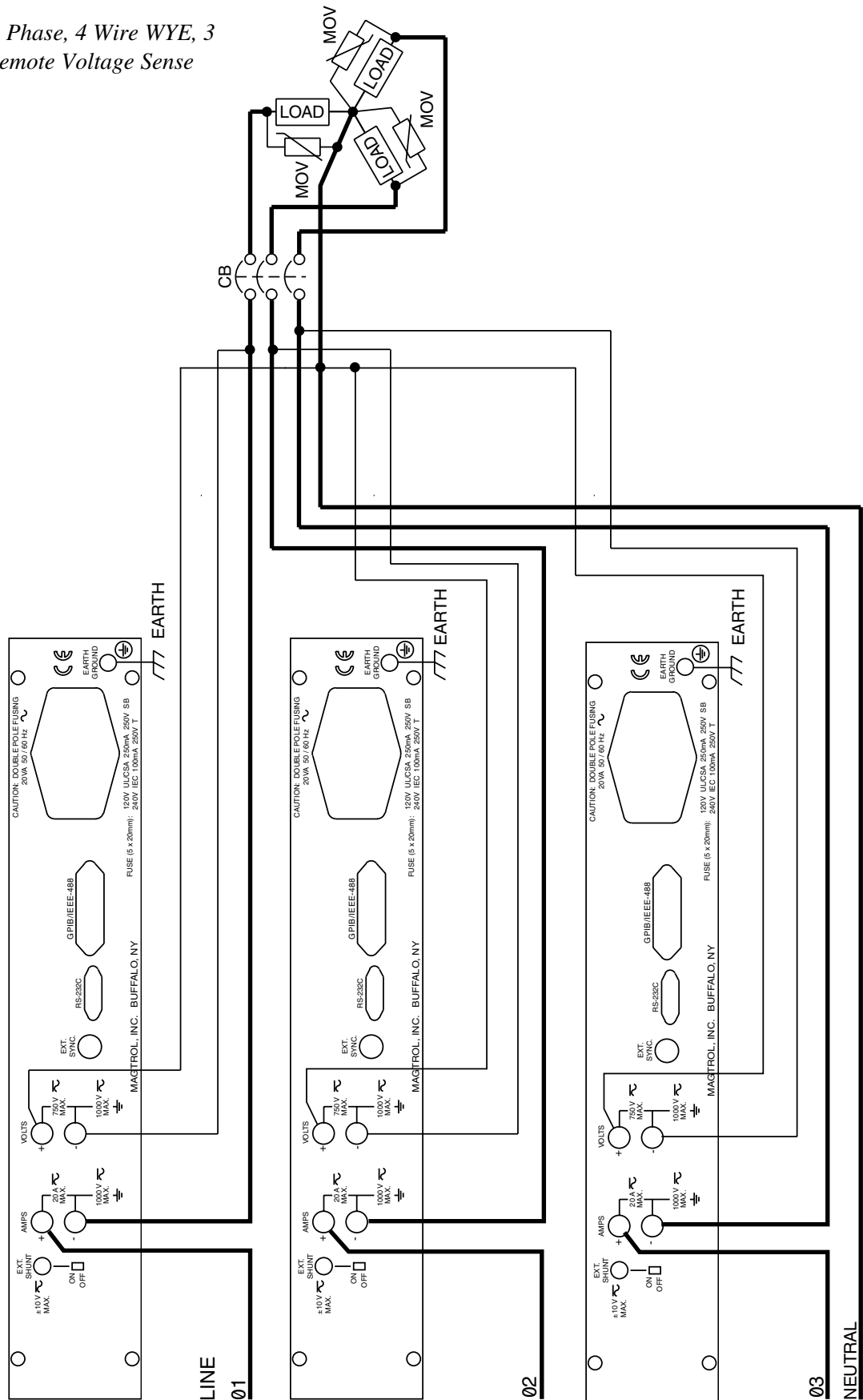




Figure 11. Current & Potential Transformer - Single Phase

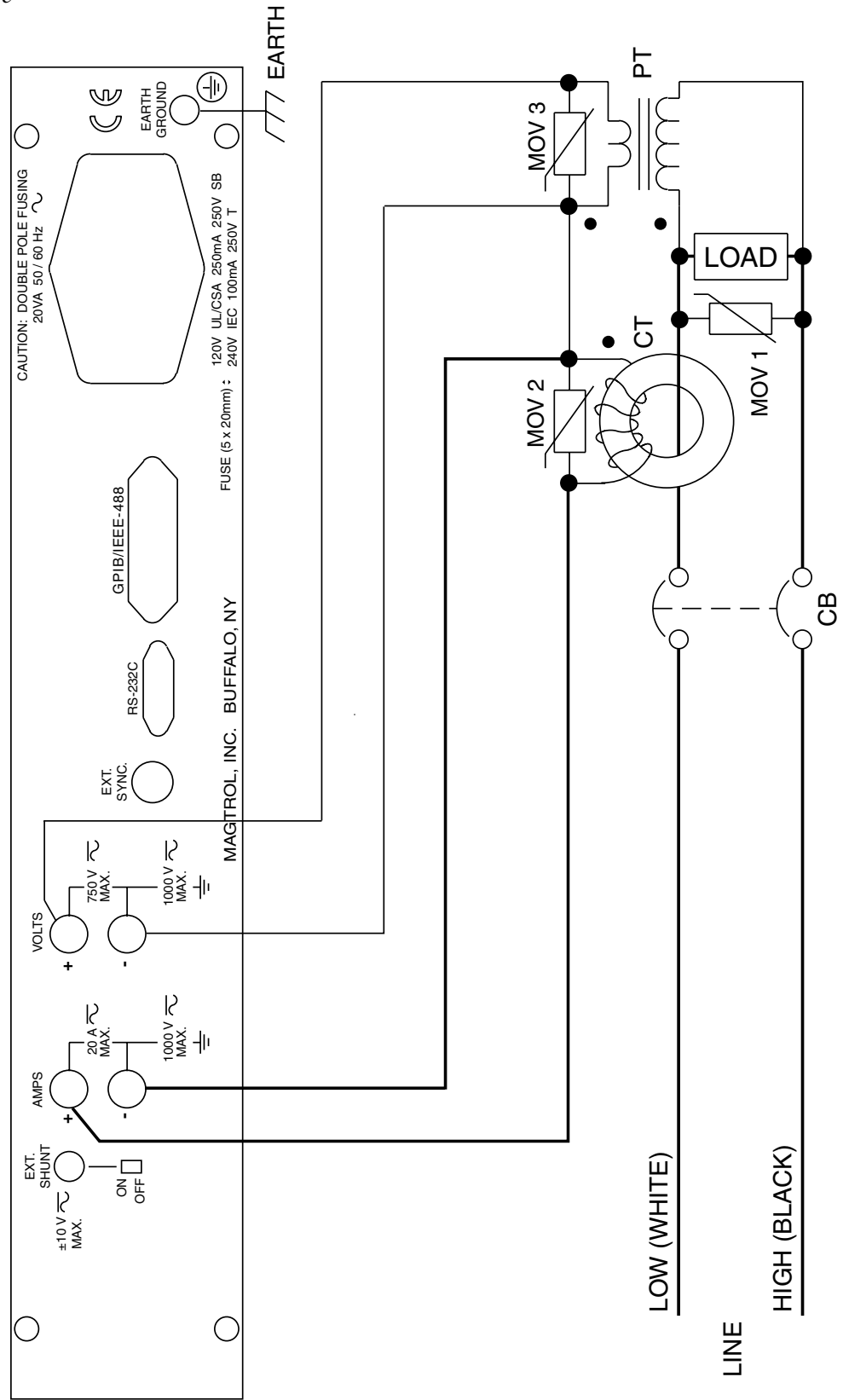


Figure 12. Three Phase, 4 Wire WYE,  
Balanced Load, 1 Wattmeter

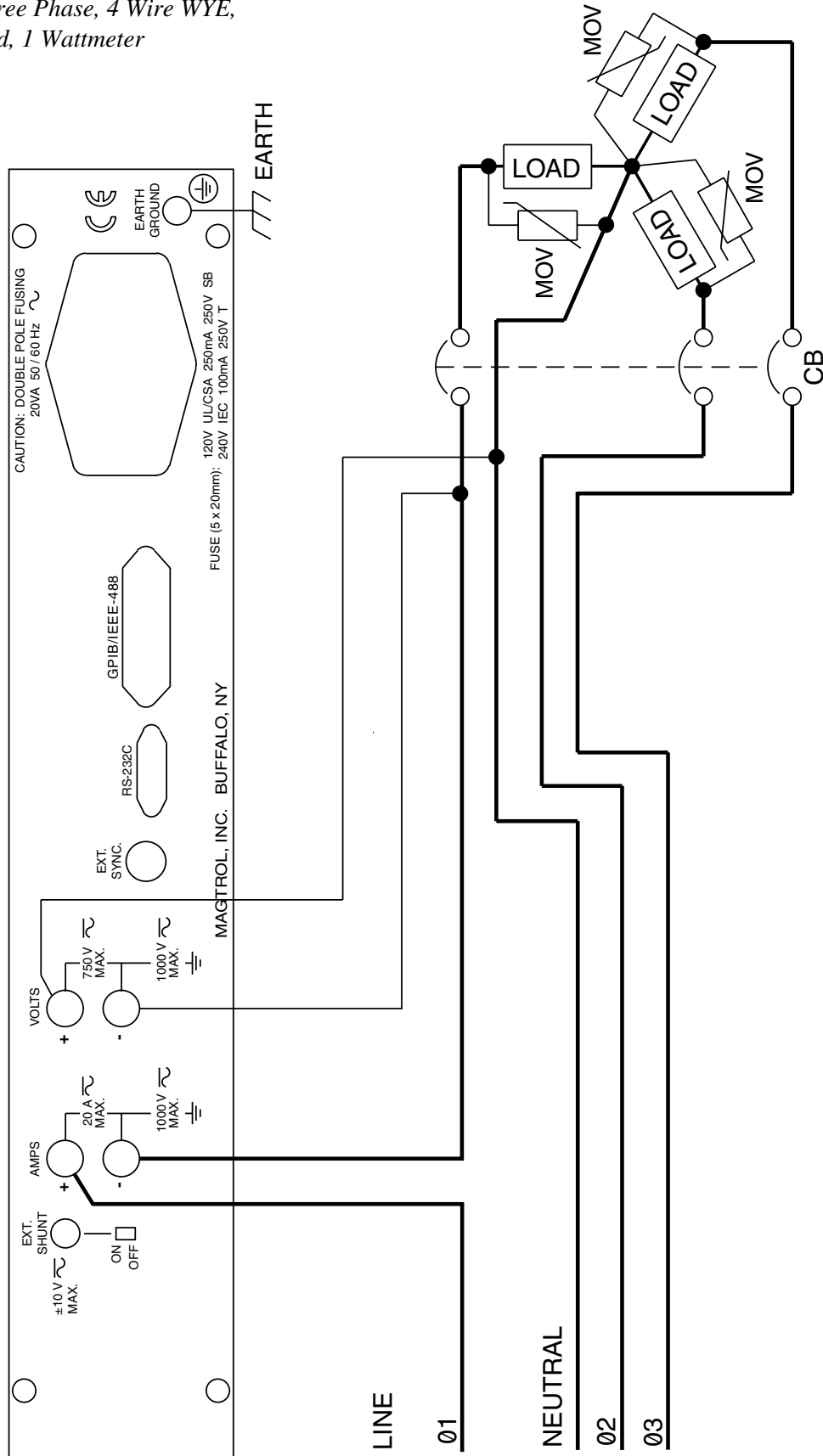


Figure 13. Three Phase, 3 Wire,  
Balanced Load, 1 Wattmeter

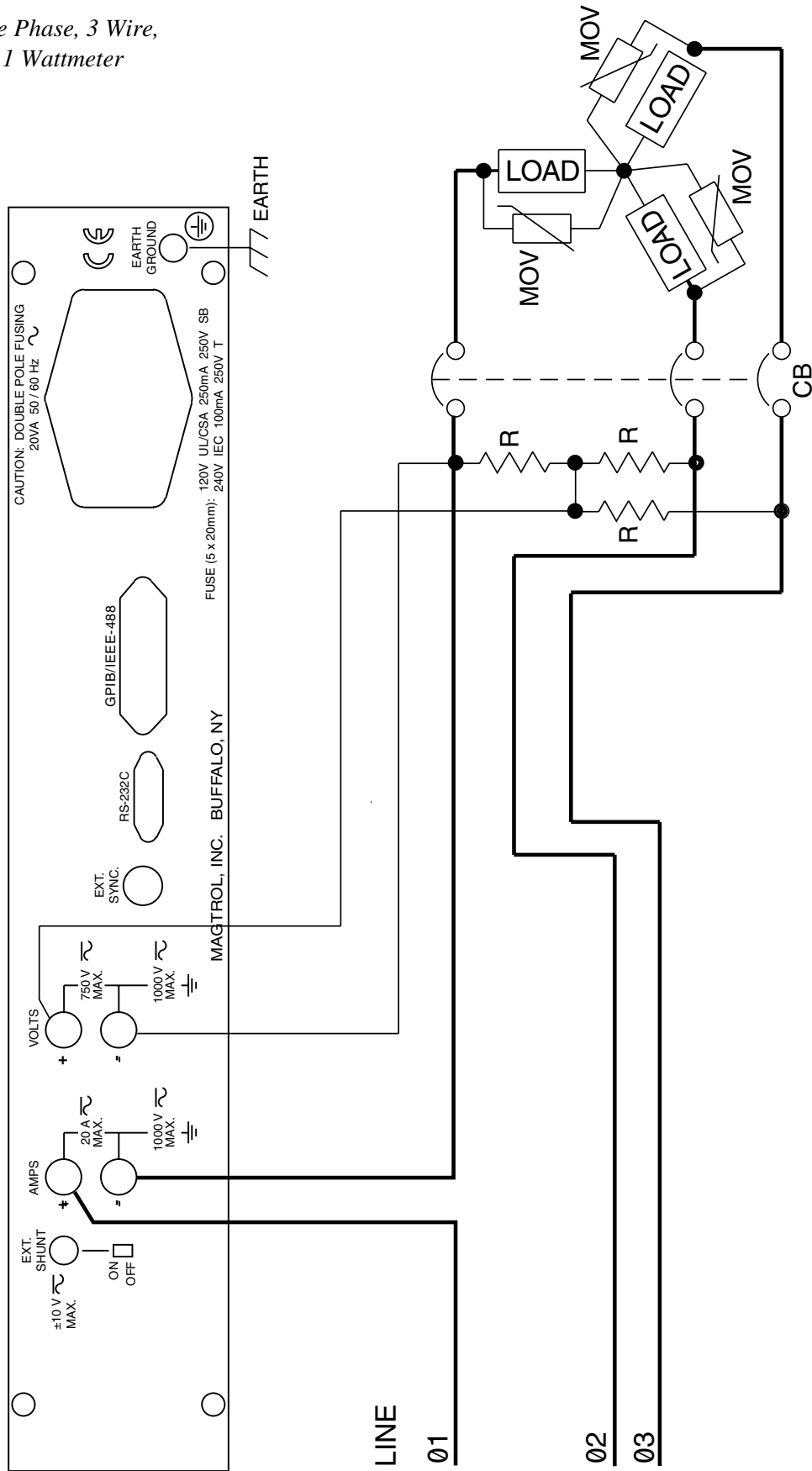
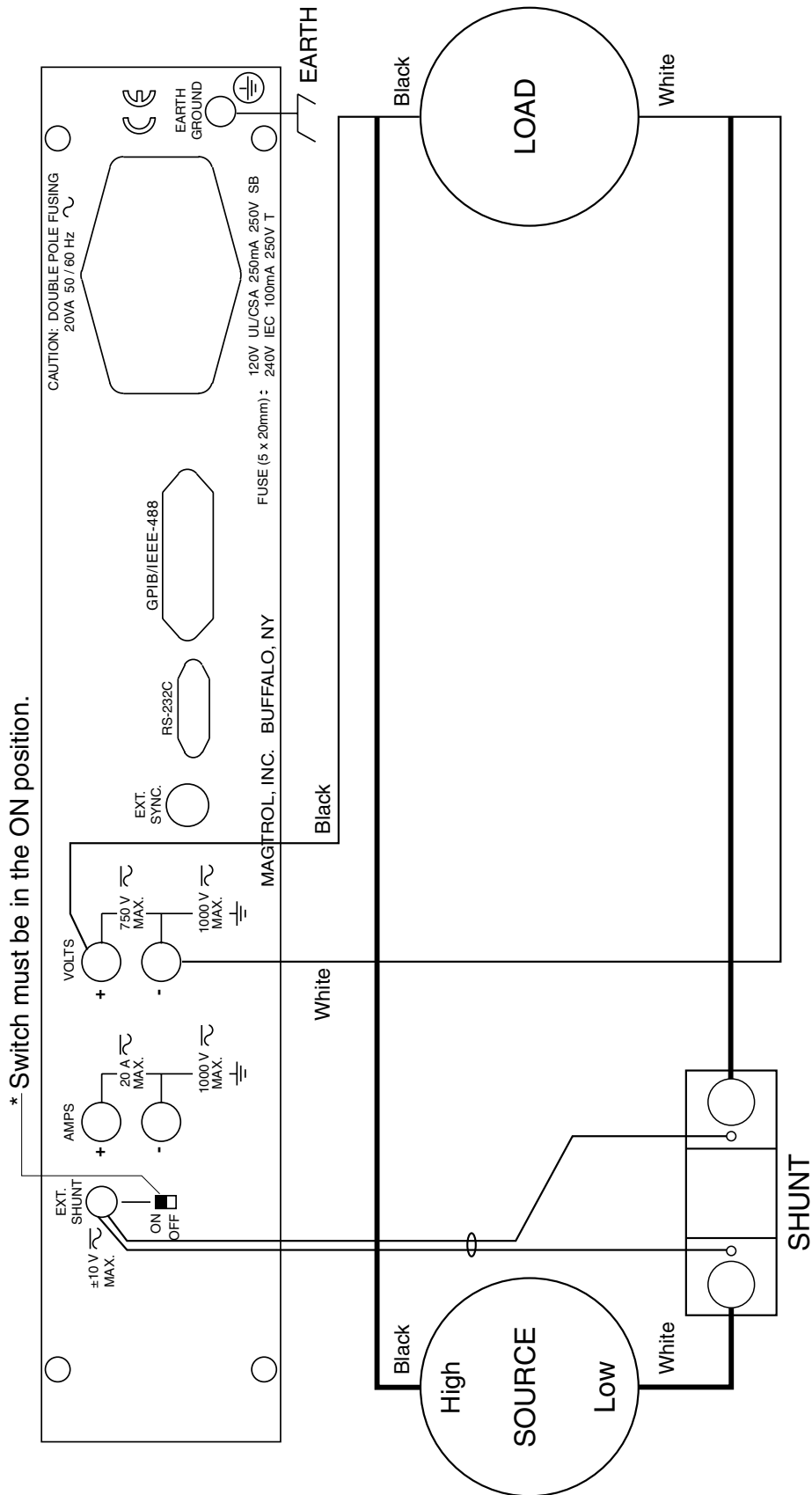


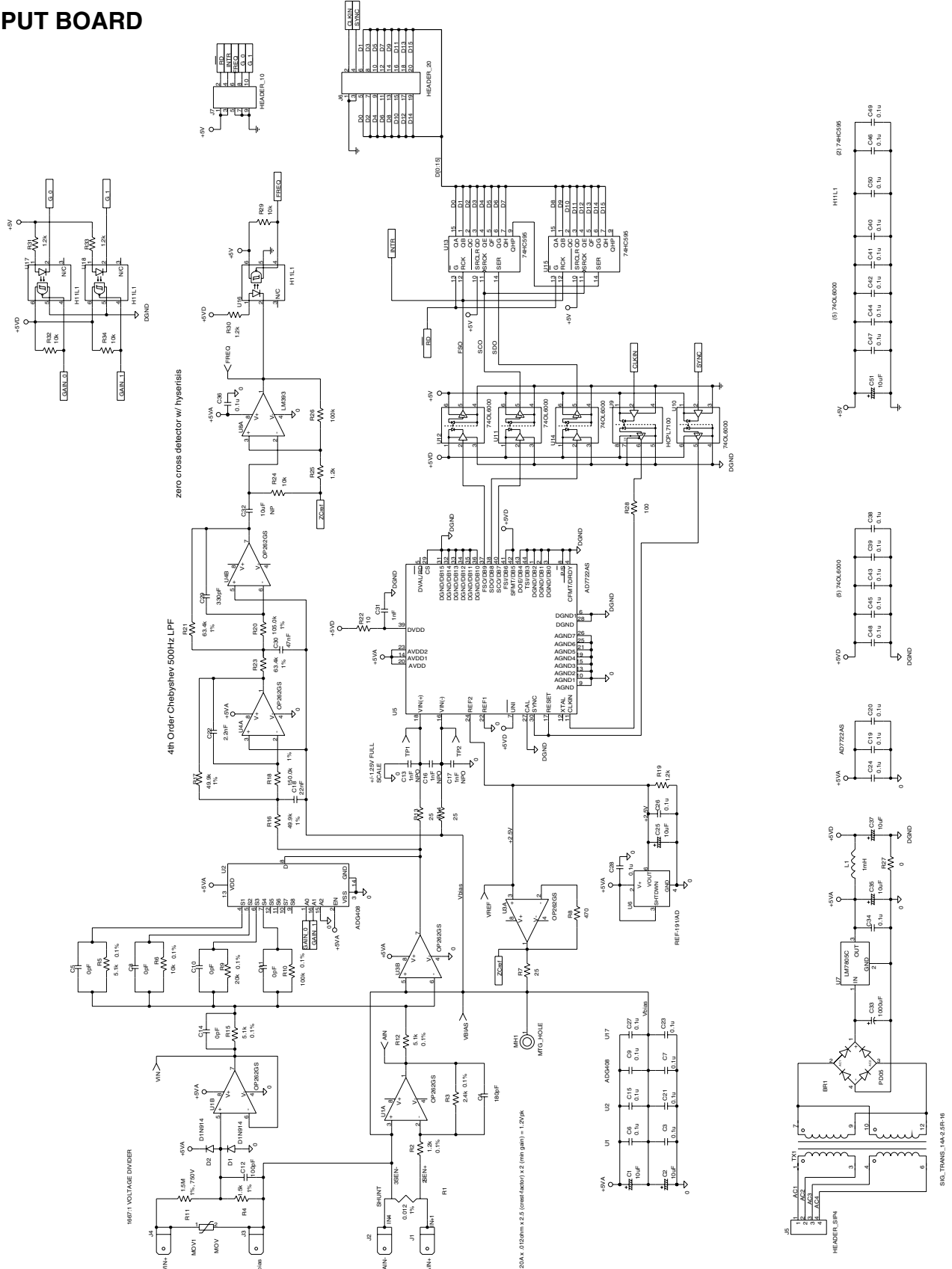
Figure 14. External Shunt Connection



# Appendix B - Schematics

## INPUT BOARD

F00  
F02  
F01







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# Notes

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# Magtrol Limited Warranty

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Magtrol, Inc. warrants its products to be free from defects in material and workmanship under normal use and service for a period of one (1) year from the date of shipment. Software is warranted to operate in accordance with its programmed instructions on appropriate Magtrol instruments. This warranty extends only to the original purchaser and shall not apply to fuses, computer media, or any other product which, in Magtrol's sole opinion, has been subject to misuse, alteration, abuse or abnormal conditions of operation or shipping.

Magtrol's obligation under this warranty is limited to repair or replacement of a product which is returned to the factory within the warranty period and is determined, upon examination by Magtrol, to be defective. If Magtrol determines that the defect or malfunction has been caused by misuse, alteration, abuse or abnormal conditions of operation or shipping, Magtrol will repair the product and bill the purchaser for the reasonable cost of repair. If the product is not covered by this warranty, Magtrol will, if requested by purchaser, submit an estimate of the repair costs before work is started.

To obtain repair service under this warranty, purchaser must forward the product (transportation prepaid) and a description of the malfunction to the factory. The instrument shall be repaired at the factory and returned to purchaser, transportation prepaid. **MAGTROL ASSUMES NO RISK FOR IN-TRANSIT DAMAGE.**

**THE FOREGOING WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTY OF MERCHANTABILITY, OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE. MAGTROL SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL, OR CONSEQUENTIAL DAMAGES OR LOSS WHETHER IN CONTRACT, TORT, OR OTHERWISE.**

## **CLAIMS**

Immediately upon arrival, purchaser shall check the packing container against the enclosed packing list and shall, within thirty (30) days of arrival, give Magtrol notice of shortages or any nonconformity with the terms of the order. If purchaser fails to give notice, the delivery shall be deemed to conform with the terms of the order.

The purchaser assumes all risk of loss or damage to products upon delivery by Magtrol to the carrier. If a product is damaged in transit, **PURCHASER MUST FILE ALL CLAIMS FOR DAMAGE WITH THE CARRIER** to obtain compensation. Upon request by purchaser, Magtrol will submit an estimate of the cost to repair shipment damage.

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**MAGTROL**

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