MAGTROL
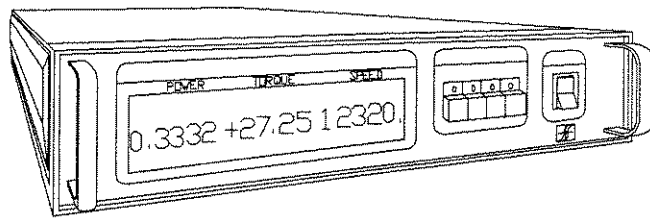

MODEL 5420

User's Manual

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Manufacturers of:
Electrical Power Measurement
Friction Clutches and Brakes
Hysteresis Clutches and Brakes
Motor Analysis Systems
Precision Spindle Drives

Table of Contents

1. Introduction

Your Model 5420 is adequately packaged for shipping. We recommend that you save all cartons and packing material until the unit has been operationally checked.

If there is any evidence of shipping damage, notify the carrier and Magtrol Customer Service as soon as possible. Please be sure to check the carton and packing material carefully for cord sets or other loose items.

LINE VOLTAGE

Warning! Please check the line voltage setting.

The Model 5420 operates from either a 120V/60Hz or 240V/50Hz power source. If the point-of-destination line power is 240/50Hz, please check that the voltage is set properly. Adjustment is made from a switch contained within the line cord receptacle on the rear panel.

The line cord is a detachable NEMA Standard 3 wire. All Magtrol Dynamometer and Electronic Products require that the cabinets and hardware be earth grounded for proper equipment operation and personnel safety.

INITIAL CHECKOUTS

In order to check out the 5420 it will be necessary to have a Magtrol Dynamometer. A 14 pin/14 pin Instrumentation Ribbon Connector Cable, supplied with the unit, will interconnect the two. Please install this cable *before* turning on any equipment.

OPERATIONAL CHECK

Please note: For the balance of this reference manual, the term "LED" refers to the Light Emitting Diode indicators on the push button switches of the 5420.

(1) Turn on the Power Switch (left side).

(2) Spin the dynamometer shaft by hand.

(3) You should see both the Torque and Speed displays respond.

If you are installing a new dynamometer, and if the *torque reading* is frozen at a high value; have you removed the load cell restraining (shipping) bolt? Ref.-Dyna' User's manual.

(4) Depress the PROGRAM Push Button.

The LED on the PROGRAM button should go on, and the POWER display show one or two digits only - any number from 1 though 18.

(5) Press the PROGRAM button again, and the POWER display will revert to the original reading, the PROGRAM LED should go out.

If the above checks out satisfactorily, it may be assumed that the 5420 has survived shipping. If you have any questions, or should there appear to be a problem, please contact Magtrol Customer Service. Telephone   800-828-7844.

```
┌─────── MEMORY ───────┐
        ┌── CLEAR ──┐
     SAVE   RESET  RECALL
```

┌─────────────────────┐
│   │
│ 2.   Operation   │
│   │
└─────────────────────┘

```
  ●     ●     ●       ●

     UP   DOWN  PROGRAM
     └─────┴──────── SELECT
```
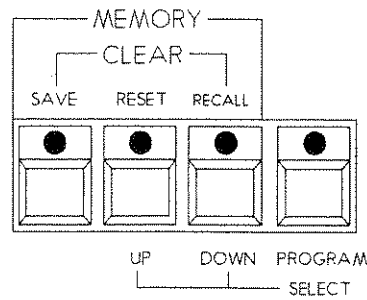
If the 5420 is used in conjunction with a Magtrol Model 5240 controller, please refer to your Dynamometer User's Manual interconnection diagrams. The Dynamometer should connect directly to the Model 5240, with the 5420 serviced from the ACCESSORY TORQUE SPEED OUTPUT of the 5240 Controller. You must have a 7 Pin Din to 14 Pin Ribbon Cable, Magtrol P.N. 88CS09.

SPEED DISPLAY

Shaft RPM is indicated on 5 digits, with resolution of ± 1.0 RPM. Data integration and update rates on both the speed and torque display is synchronized - at 0.5 seconds. Chapter 4., contains additional technical information.

TORQUE DISPLAY

Dynamometer torque is displayed with 4 digits, in floating point notation. Left of the MSD is a "$\pm$" sign indicating the shaft rotation direction of applied torque. The "+" sign indicates clockwise direction, "-" counter clockwise.

When you first connect the dynamometer, and turn the equipment on, the torque display may not indicate exactly zero.

If you have *not* coupled a motor to the dyna' shaft, then proceed with the dyna' rear panel ZERO and CALIB procedure covered in your Dynamometer Manual - Chapter 1. If you have coupled a motor, it is normal for the torque display to indicate a

residual value. This is do to shaft bearing friction in both the motor and dynamometer.

SETTING THE TORQUE RESOLUTION

Rated full scale torque value - in standard resolution - is shown on the dynamometer front panel. However, in normal operation if the most significant digit is zero, the TORQUE DISPLAY shifts 1/2 digit to the left increasing the resolution by 5 times. This means that the least significant digit displays in increments of 0-2-4-6-8. With certain torque units, the increased resolution could cause the reading to exceed four digits. In this event the display temporarily shifts one digit to the right, returning to standard resolution.

Torque resolution may be fixed to the standard value (shown on the dynamometer front panel) by either of two methods: First, by outputting an instruction character via the GPIB, as described in the next chapter, or secondly; with the unit turned OFF - wait a few seconds, simultaneously hold the PROGRAM and DOWN push buttons ON - turn the unit ON - then release the buttons. The default, "best resolution" operation will be restored when the unit has been switched OFF - and then ON again.

PUSH BUTTON FUNCTIONS:

SAVE

The first time you press the SAVE button, the LED will go ON - and stay on. If you switch the unit off, when it is turned back on again, the SAVE LED will return to ON, indicating there is data in memory. To lose it, you must erase it.
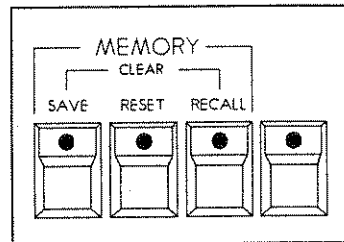
Each time you press the SAVE button, currently displayed data is appended to any existing data. There are 380 Power-Torque-Speed data values before you run out. In the unlikely event you should, a parameter on the display will flash "HELP" to signal that you have consumed all available memory.

CLEAR

To clear data memory; the SAVE and RECALL push-buttons must be pressed simultaneously. If you have nothing in memory worth saving - try it - you will find you have to be fairly synchronized when pressing both buttons. When CLEAR is accepted, all three - SAVE-RESET-RECALL LEDs will go on - while you are holding the buttons in. If they are not, then the CLEAR was not accepted - try again.

RECALL

When the SAVE LED is ON, if you depress RECALL, the SAVE LED will go OFF - the RECALL LED goes ON - placing the unit in RECALL mode. The Power-Torque-Speed display changes to memory data. The first data point saved is now displayed.

As you repeatedly depress the RECALL button, the display advances to the next data value - and so on - exactly in the order you originally saved them. When you have advanced through all of the data contents of memory, the last reading will remain unchanged, but the RESET LED will flash ON-OFF four times; indicating, "out of data." You may start over by depressing the RESET - then RECALL button again.

If you press the SAVE LED while in RECALL mode, the 5420 will flash the RESET LED four times. (It is not logical to save data already saved.)

times. (It is not logical to save data already saved.)

RESET

RESET is functional in RECALL mode only. Two things happen: First, the RECALL mode is exited, restoring the display to immediate data. Secondly, the memory *recall* data pointer resets to the beginning of the data memory stack. The SAVE LED will go back on.
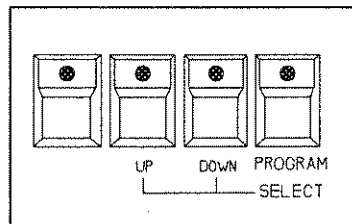
PROGRAM PUSH BUTTON

The purpose of the PROGRAM mode is to calibrate the POWER reading only.

If you purchased the 5420 with a Magtrol Dynamometer, the unit will be factory set, reading in HP, as you receive it. If there is more than one dynamometer, the unit may be set up for either.

If you connect the 5420 to a dyna' reading in different torque units from those previously calibrated; or, if you desire to change the POWER reading to WATTS - then you must remember to program the POWER readout with a new DIVISOR CONSTANT value. The operation is simple, but if you forget to do it you may obtain a peculiar POWER reading - usually fairly obvious. Please proceed as follows:

POWER CALIBRATION

(1) Pull out the card from the bottom plate. A similar

chart is shown on the next page.

(2) Depress and release the PROGRAM push button. The LED will go ON, and the POWER display will indicate the current two digit code number.

(3) From the Divisor Constant Table list, select the Torque units that the Dynamometer *in use* is calibrated. This is shown on the front plate of the Dynamometer.

(4) Press either the UP or DOWN push button until the correct CODE # - (1 thru 9 for HP, 10 thru 18 for WATTS) is displayed on the POWER readout.

(5) Press the PROGRAM push button again to exit the Mode, the LED will go OFF saving the value, and the power readout will be calibrated. This calibration selection is non-volatile, ie; it is retained after the unit line power is turned off.

The HP and WATTS "C" values are shown for your reference. They represent the value that the 5420 MPU divides into the product of Torque × Speed - from a specific CODE selection, derived from the basic formulas:

POWER = $(N \times Q) \div C$ Where $N = RPM$				
			$Q = Torque$	
(Q)UNITS:	C	HP CODE	C	WATTS CODE
OZ.IN.	1.008×10^6	(1)	1351.2	(10)
OZ.FT.	84000.	(2)	112..6	(11)
LB.IN.	63000.	(3)	84.45	(12)
LB.FT.	5250.	(4)	7.0375	(13)
G.CM.	7.2584×10^7	(5)	97297.	(15)
KG.CM	72584.	(6)	97.297	(15)
N.mm	7.118×10^6	(7)	9.541.6	(16)
N.cm	7.118×10^5	(8)	954.16	(17)
N.m	7118.	(9)	9.5416	(18)

$$HP = (LB.FT. \times RPM) \ 5250,$$

$$Watts = HP \times 746.$$

The 5420 is interchangeable with all Magtrol Dynamometers. It has no information regarding the specific *units* of torque - ie; Oz.In., Kg.cm., N.m etc. Therefore the PROGRAM function is to inform the POWER display (only) as to what it is working with. Neither the TORQUE or SPEED displays are affected.

If, at some future date, you should wish to re-calibrate any Magtrol Dynamometer for different *units of torque*, the process is not difficult. Consult Magtrol Customer Service.

3. Computer Interfacing
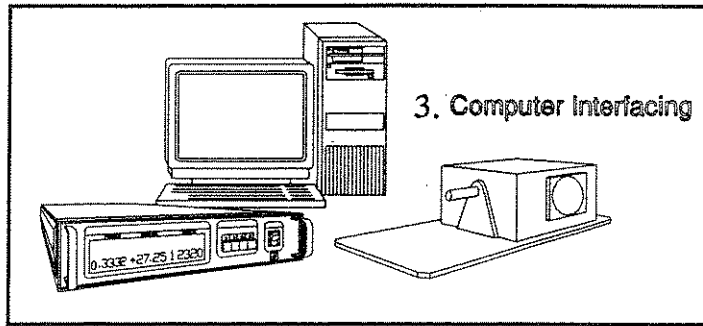
GPIB (IEEE-488)   Please be sure that the computer and the 5420 are both turned OFF when you install the GPIB connector cable.

If you have completed the equipment check-out as outlined in Chapter 1, the 5420 - Dynamometer interconnection is complete. If a Model 5240 controller is used in conjunction with the 5420 Digital Readout, the computer interface should be connected to the 5240 only. Please refer to your 5240 User's Manual.

GPIB-COMPUTER INSTALLATION   On most computers, the GPIB interface is not a standard item. An interface card must be installed and the driver software made resident on disc. There are several manufacturers of these products, and some systems exchange data much more rapidly than others. In motor testing, the test rate and speed of data acquisition is very important. One recommendation, is National Instruments Corp., PN GPIB-PC2A, for IBM® or compatible PC's. The IEEE-488 Cable is normally supplied with the interface.

SOFTWARE INSTALLATION   There are usually a number of formatting questions to be answered the first time that the GPIB interface control software is installed. The following items pertain to the 5420.

All GPIB data acquisition systems require the use of data termination characters. The 5420 uses the

Hewlett Packard - HPIB™ standard termination characters "Carriage Return (CR)-Line Feed (LF)," in that order. The 5420 looks for these instructions, in HEX format, to terminate communication, reset the interface and continue with normal program execution.

Codes for CR - LF			
	BASIC	HEX	DEC
CR =	CHR$(13)	0D	13
LF =	CHR$(10)	0A	10

There may be another formatting question relating to a communication fault delay timeout. This is done in order to alleviate a computer hang-up. Do not set this period under three seconds. If the computer resets the interface prematurely, the host instrument can hang-up waiting for the never-to-happen "CR-LF."
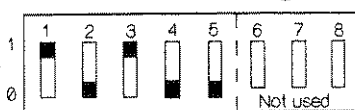
PRIMARY ADDRESS

All instruments serviced on the GPIB have a separate primary address code. On the rear panel, next to the GPIB connector, there is an opening providing access to the code selection switch. The default setting (from the factory) on the 5420 is five (05). If you wish to change the code, the chart will help in obtaining the setting you want. Please note that the MSB is on the right. Switch segment identification (hardware) resulted in the binary code notation reversed from the standard convention where the MSB is normally on the left.

CODE SWITCH	
Segment #	
1 2 3 4 5	Code
0 0 0 0 0	0
1 0 0 0 0	1
0 1 0 0 0	2
1 1 0 0 0	3
0 0 1 0 0	4
1 0 1 0 0	5
0 1 1 0 0	6
1 1 1 0 0	7
0 0 0 1 0	8
1 0 0 1 0	9
0 1 0 1 0	10
1 1 0 1 0	11
0 0 1 1 0	12
1 0 1 1 0	13
0 1 1 1 0	14
1 1 1 1 0	15
0 0 0 0 1	16

Some PC interfaces (National GPIB-PC2A) will access 0 to 15 (4 Bit) primary address numbers only. Others, may access up to 31 (5 Bit) codes; even though the GPIB capability is limited to 16 instruments. The 5420 Primary Address uses the 5 bit format.

Before selecting a value greater than 15, check with your particular interface's primary address code range capability.

5420 INSTRUCTIONS

Three instructions are accepted by the 5420.

H (CR-LF) will set Hi - Resolution operation.
S (CR-LF) will set Standard Resolution.
1 (through) **18** (CR-LF) will set the divisor constant value.

Memory control of the 5420 is not GPIB addressable, since the same data is available to the computers more extensive resources, via the BUS.

Example: A program to output an instruction to fix the Torque resolution exactly equal to that shown on the dynamometer front panel. The language is Microsoft Quick Basic® using a National Instruments Corp., GPIB-PCIIA, P.N. 320043-01 IEEE-488 Interface.

```
'*************************************************
CLS
N$ = "DEV5"    'Assign the primary address, .
wrt$ = "S" +CHR$(13) +CHR$(10)
CALL IBFIND(N$, BD%)    'Subrtn Call - Init. Pri Addr.
CALL IBWRT(BD%, wrt$)    'Subrtn Call, output data
END
*************************************************
```

DATA ACQUISITION

If your primary address is set and addressed correctly, the 5420 will respond. It probably will be necessary to dimension your input variable to 22 (20 data characters plus CR-LF). Speed - Torque data, from the 5420, is in ASCII format and structured (with leading zeros) as follows:

Pddddd.SdddddTdddd.L

Where d = Decimal digit, 0 thru 9. "P" indicating that the following 5 digits + D.P., is the Power display, "S" indicating that the next 5 digits are

ing that the following 5 digits + D.P., is the Power display, "S" indicating that the next 5 digits are RPM, "T" indicating that the next 4 digits + D.P., is Torque. The last character, (shown "L") may be either "L" or "R". "L" = CCW dynamometer *torque application*, "R" = CW.

The 5420 requires no specific input instruction in order to output immediate torque and speed data. Simply follow your Computer/GPIB interface instructions, and issue a data input command.

The following is a simple - single input instruction - source program written in Microsoft Quick Basic® using a National Instruments Corp., GPIB-PCIIA, P.N. 320043-01 IEEE-488 Interface. It will access the 5420, fetch immediate data and display it exactly as received.

```
'*********************************************
********
CLS
N$ = "DEV5"   'Assign the primary address,
rd$ = SPACE$(22)      'Make room for the data.
CALL IBFIND(N$, BD%)      'Subrtn Call - Init. Pri Addr.
CALL IBRD(BD%, rd$)     'Subrtn Call, Input data to rd$
PRINT rd$          'Let's have a look!
END
*********************************************
********
```
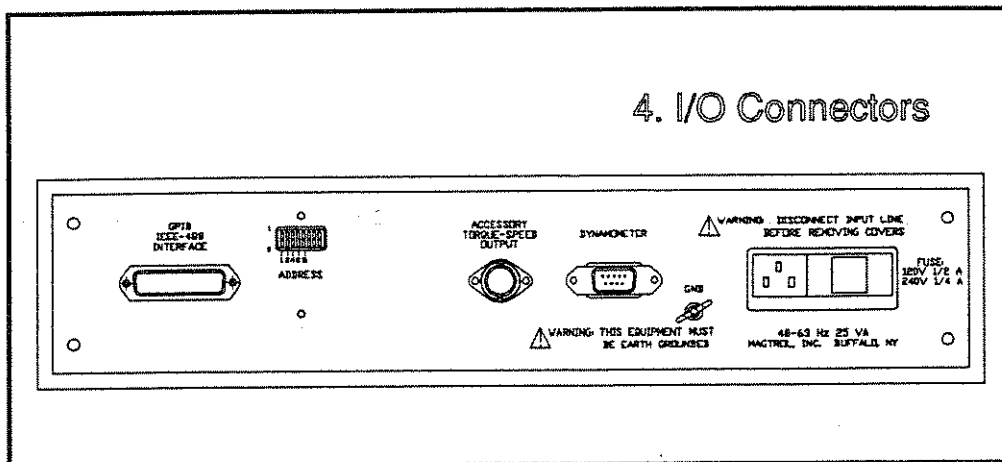
DATA ACQUISITION PROBLEMS

Usually a failure to communicate is a result of incorrect primary address, improper computer input variable (word) size, none or incorrect termination characters (CR-LF).

You may save time by contacting Magtrol Customer Service, ask for GPIB software assistance.

Following is a description of the electrical connectors contained on the rear panel. There is additional information on the 14 Pin Dynamometer ribbon connector in your Dynamometer User's Manual.

IEEE-488 INTERFACE

Computer to Instrument interconnection uses the standard IEEE-488 Instrument Cable available from instrumentation cable manufacturers, computer hardware outlets, Magtrol Inc., or Hewlett Packard dealers. It is normally supplied with the IEEE-488 computer interface hardware.

Following is a brief description of the interface lines. For more thorough information, there are various publications on the IEEE-488 from Intel, Motorola, IEEE, National Semiconductor and Hewlett Packard - just to name a few.
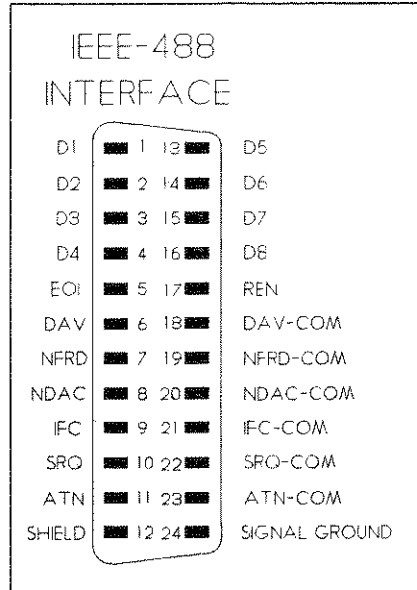
Two bytes form the composition of the GPIB - 8 bits for data transfer, and 8 bits for interface control.

D1 - D8 - are the data signal lines. The data format is 8 bit ASCII.

DAC, RFD, DAV - are byte transfer lines.

RFD - Ready For Data, goes passively high.

DAV - Data Valid, an instrument may signal that

```
IEEE-488
INTERFACE
```

DI	▉ 1	13 ▉	D5
D2	▉ 2	14 ▉	D6
D3	▉ 3	15 ▉	D7
D4	▉ 4	16 ▉	D8
EOI	▉ 5	17 ▉	REN
DAV	▉ 6	18 ▉	DAV-COM
NFRD	▉ 7	19 ▉	NFRD-COM
NDAC	▉ 8	20 ▉	NDAC-COM
IFC	▉ 9	21 ▉	IFC-COM
SRQ	▉ 10	22 ▉	SRQ-COM
ATN	▉ 11	23 ▉	ATN-COM
SHIELD	▉ 12	24 ▉	SIGNAL GROUND

its data is valid, by pulling this line low.

DAC - will go passively high, signaling that the data has been accepted.

ATN, IFC, SRQ, EOI, REN - are the bus management lines that control the orderly movement of information across the interface lines.

ATN - (attention) monitored continually, and a change results in activation of the transmit/receive control signals.

IFC - interface clear, used by the system controller to place the GPIA (General Purpose Interface Adapter chip) into a known quiescent state.

SRQ - service request signals a need for service by requesting the controller to interrupt the current sequence of events.

REN - Remote Enable selects an alternate source for device programming data. This converts the GPIA into another state of operation.

EOI - End or Identify has a dual purpose. It may signal the end of a multibyte transfer, or when used in conjunction with ATN places the contents of the parallel poll register on the bus.

ACCESSORY TORQUE-SPEED OUTPUT

This is an *output* only connector, for *input* signal provision to Magtrol Model 5220 and 5230 Dynamometer Controllers. The connector is a standard 5 Pin DIN type.

The cord set required for interconnecting is Magtrol PN 88CS08 - normally supplied with the controllers.

The TACHOMETER SIGNAL is a TTL

5. Circuit Description

TACHOMETER

Mounted on the end of the Dynamometer shaft is an encoding disc divided into 60 opaque and clear segments. A LED and phototransistor, in combination with the disc, produces a pulse train signal of 60 Bits/revolution for RPM indication.

This frequency, proportional to speed, is applied to a counter under control of an MPU. The elements comprising the counter, shown in the following block diagram, are contained on PC Bd., TSC-1. Q1 is the input detector, U1a,b and c are buffers. The basic counter is comprised of elements U8 and U9. With the time base composed of elements U5, U6 and U7. The time base input frequency is 1.0MHz, reduced to a precise .5 second period. Additionally, there are buffers and interface elements U10 and U11.
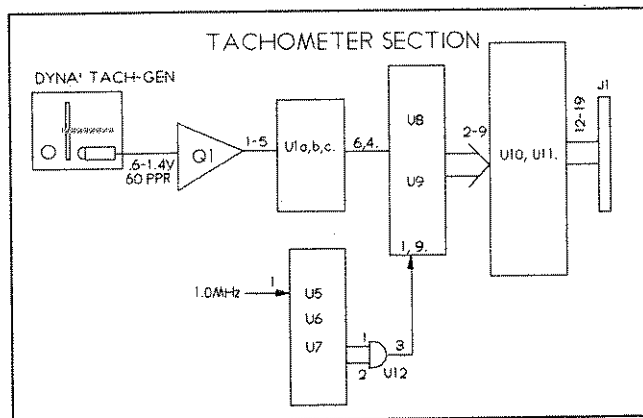
TORQUE TRANSDUCING

All Magtrol load cell equipped dynamometers produce an analog torque signal, where the signal level is exactly equal to the torque value in millivolts. For example; an HD-400-6 with 43.42 Oz.In., of torque applied, will output a voltage of 0.4342 volts.

MODEL 5420
SPECIFICATIONS

SPEED Accuracy:

±0.05% of the SPEED reading, ±1.0 RPM.

TORQUE: Basic torque accuracy is controlled by the dynamometer ZERO and CALIBRATION controls. The level of care and frequency of adjustment is important. Please refer to your Dynamometer User's Manual.

The Torque conversion elements within the 5420 contribute no more than a temperature related drift of up to ±.005%/$^{\circ}$C ambient change - of reading

POWER: This value is digitally calculated from the torque and speed values, and will contain the product of any errors within these parameters.

MAGTROL LIMITED WARRANTY

Magtrol, Inc. warrants its products to be free from defects in material and workmanship under normal use and service for a period of 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.**

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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.
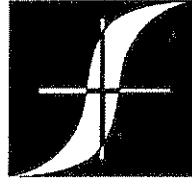
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