
Magtrol 4615B User's Manual

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PLEASE READ

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1. Introduction

Your Model 4615B 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 4615B 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 4615B 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 4615B.

1. Turn on the Power Switch (left side).
2. Spin the dynamometer shaft by hand.

You should see both the Torque and Speed displays respond.

Caution: 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. Dynamometer User's manual.

3. 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.

4. 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 4615B has survived shipping. If you have any questions, or should there appear to be a problem, please contact Magtrol Customer Service.

2. Operation

If the 4615B is used in conjunction with a Magtrol Model 4629B controller, please refer to your Dynamometer User's Manual interconnection diagrams. The Dynamometer should connect directly to the Model 4629B, with the 4615B serviced from the ACCESSORY TORQUE SPEED OUTPUT of the 4629B 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 dynamometer shaft, then proceed with the dynamometer 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.

PUSHBUTTON 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 pushbuttons 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 4615B will flash the RESET LED four 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 PUSHBUTTON

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

If you purchased the 4615B 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 4615B to a dynamometer 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 4615B MPU divides into the product of Torque × Speed from a specific CODE selection, derived from the basic formulas:

$$\text{HP} = (\text{LB.FT.} \times \text{RPM}) / 5250$$

$$\text{Watts} = \text{HP} \times 746$$

The 4615B 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 4615B 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 4615B Dynamometer interconnection is complete. If a Model 4629B controller is used in conjunction with the 4615B Digital Readout, the computer interface should be connected to the 4629B only. Please refer to your 4629B 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 4615B.

All GPIB data acquisition systems require the use of data termination characters. The 4615B uses the Hewlett Packard HPIB standard termination characters "Carriage Return (CR) Line Feed (LF)," in that order. The 4615B looks for these instructions, in HEX format, to terminate communication, reset the interface and continue with normal program execution.

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 4615B 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.

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 4615B 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.

4615B INSTRUCTIONS

Three instructions are accepted by the 4615B.

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 4615B 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 4615B 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 4615B, is in ASCII format and structured (with leading zeros) as follows:

Pdddd.SddddTddd.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 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 4615B 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 4615B, 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.

4. I/O Connectors

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 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 4617 and 4619 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 compatible frequency output of 60 pulses per shaft revolution. The tachometer common is at chassis ground.

TORQUE OUTPUT is a bipolar analog signal, with the common at chassis ground. The signal level is described in the next paragraph.

DYNAMOMETER CONNECTOR

This is a 14 Pin ribbon connector, interconnecting the 4615B and any Magtrol Dynamometer.

Pin 11, Tach supply +9VDC is a filtered bias voltage for the Tachometer Photo Cell. The actual voltage on this pin is not critical and may be anywhere from +9 to +12V, referenced to pin 8.

Pin 10 is the tachometer frequency signal producing 60 pulses per shaft revolution. The signal level has a low voltage of $.2 \pm .1$ and a signal high of $1.0 \pm .2$ VDC. The common to this signal is Pin 8.

Pin 14 is the torque signal, referenced to Pin 13. This is a bipolar analog voltage. Pin 13 (common) is chassis ground. The torque signal amplitude varies with the individual dynamometer. It is equal to the whole number of the torque value, (identified on the dynamometer front panel), in millivolts. Positive polarity occurs with torque applied in CW direction of rotation.

For example; an HD 106 6 with torque applied in a CCW direction: Torque = 2.53 Oz.In. = .253 Volts between pins 14 and (common) pin 13.

Pin 9 – Pin 12 are decimal point locator lines. Each individual dynamometer will have the appropriate line connected to ground that codes the D.P. location for the 4615B and other Magtrol products. The D.P. locator code is:

1 = ddd.d =	Pin 9 N/C	Pin 12 N/C.
dd.dd =	Pin 9 LO	Pin 12 N/C.
d.ddd =	Pin 9 N/C	Pin 12 LO.

Where, N/C = no connection, LO = Common to Pin 8

Pin 7 is 5.0 VDC for the Photo Cell Lamp. It references common to pin 8 as shown.

Pins 3 4 and 5 6 are 20 VDC isolated instrumentation voltages for the torque signal amplifiers and the torque load cell power supply. Within the dynamometer inclosure, these unregulated voltages are converted to regulated ± 15 VDC, and (adjustable) 7–9 VDC for the dynamometer torque transducer load cell.

5. Circuit Description

TACHOMETER

Mounted on the end of the Dynamometer shaft is an encoding disc divided into 60 opaque and clear segments. A Lamp Photocell, 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.

Connector J2 on PC Bd No. TSC 1 receives this signal and applies it to operational amplifiers U2a and U2b. The output of U2b is used by the MPU to establish the CW and CCW shaft direction indication (\pm) on the digital readout. U2a output is applied to U2c, a buffer for the torque signal output applied to the ACCESSORY TORQUE SPEED OUTPUT connector on the rear panel of the 4615B. This same signal is also applied to two V/F converters, U3 and U4. The frequency output is converted to digital, using an integration period identical to the speed conversion time. This results in concurrent integration of both torque and speed for dynamic tracking accuracy. U13 and U14 are the counting elements, their outputs buffered by U15 and U16.

SIGNAL PROCESSING

The primary MPU and GPIB controlling electronic functions are contained on the PC Bd., MCI 2. On this assembly, U5 is the Microprocessor, U9 is the Programmable Read Only Memory containing the 4615B operating system. There is a 2K disc emulation RAM device identified as U10. U11 and U12 are Peripheral Interface Adapters. U1, U2, and U3 are the GPIB interface control elements. U6 and U7 are the LED segmented digital readout drivers. The balance of the components are buffer and timing control devices.

There is a power supply PC Bd., PSB 5 providing +5 logic power, ± 15 Volts for the analog elements.

If you have questions, or require more detailed information, please contact Magtrol Customer Service Technical Information.

6. Calibration and Balancing

There are calibration and offset adjustment controls for most of the analog elements. Normally, no adjustment is anticipated for the life of the instrument. However, all or part of the calibration and balancing procedures may be indicated if any of the following conditions exist:

- A torque difference between CW and CCW full scale readings of greater than 2 least significant digits in standard resolution.
- Inability to zero the torque reading with the ZERO control located on the back panel of the dynamometer. If the dynamometer is new, be sure the load cell restraining bolt (for shipping) has been removed!

There is no calibration for the digital speed reading accuracy. Please refer to MODEL 4615B SPECIFICATIONS in this chapter.

Warning!

The following requires removal of the 4615B top cover. All connections and trimpot adjustments must be made only as specified herein and with **caution**. There is an **electrical shock hazard** inside the 4615B.

PROCEDURE

Routine torque calibration and zero offset adjustments should always be done with the dynamometer back panel controls. The torque signal offset and calibration controls within the 4615B are there to permit standardization to known and precise value inputs.

All calibration and balancing potentiometers are contained on the circuit board identified TSC 1, located in the upper right corner of the 4615B chassis, facing from the front. The sketch shows that portion of the board where the trimpots are located and their identification.

TORQUE ZERO ADJUSTMENT

Caution: Be sure to remove the coupling from the dynamometer shaft!

1. Place a precision voltmeter resolving at least .1 millivolt (D.C.) between pins 13 and 14 on the DYNAMOMETER ribbon connector, pin 13 negative. You may have to remove the connector cap on the cable, or obtain access from inside the dynamometer rear panel.
2. Adjust the dynamometer zero control for best zero (dynamometer torque signal output) on your voltmeter.

The object in the following steps is to alternate between the - and + **Q Bal** trimpots, until you know that each is adjusted such that your output torque reading is just at zero on both trimpots.

While observing the 4615B Torque Reading:

1. Adjust the +**Q Bal** trimpot slowly—try both CW and CCW rotation until the indicated torque value reads higher, then back off very slowly to obtain a minimum or zero value. Repeat this procedure on the -**Q Bal** trimpot. Work back and forth between both trimpots, until you alternately obtain 0000 with 0001 flashing.

FULL SCALE TORQUE CALIBRATION

1. Complete the zero adjustment procedure outlined in the preceding paragraph. Install the Dynamometer Torque Calibration beam, as shown in the sketch.
2. Rotate the TORQUE control on your power supply, full CW for maximum applied torque. With a precision weight, apply a known torque at - or close to - full scale in the CCW direction. Maintain the beam exactly horizontal and perfectly still.
3. Observe the voltage reading on the voltmeter (across pins 13 and 14). Adjust the TORQUE CALIB, on the rear panel of the dynamometer, for a voltmeter (millivolt reading) exactly equal to the true torque applied.
4. Adjust the **-Q Cal** trimpot until the 4615B torque reading is equal to the voltmeter reading and the true torque applied.
5. Place the weight on the opposite side of the beam, adjust the **+Q Cal** trimpot to match the 4615B Torque reading to the true torque applied.

ACCESSORY TORQUE OUTPUT

With zero torque on the dynamometer (open shaft):

1. While reading the torque value, adjust the Dynamometer ZERO Control for best zero reading.
2. With a voltmeter resolving at least .1 millivolt D.C., connected to the TORQUE output on the ACCESSORY TORQUE SPEED OUTPUT connector, adjust trimpot **Qo Bal** for best zero reading.
3. Attach the Calibration beam, energize the brake to hold the beam, attach a weight to apply an amount of torque close to the dynamometer full scale rated value. Adjust **Qo Cal** for a reading exactly equal to the actual torque applied.

MODEL 4615B SPECIFICATIONS

SPEED Accuracy: $\pm 0.05\%$ 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 4615B contribute no more than a temperature related drift of up to $\pm 0.005\%/^{\circ}\text{C}$ 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.



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