MAGTROL

DYNAMOMETER CONTROLLER
MODEL 4629B

USER'S MANUAL

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Manufacturers of:

Motor Analysis Systems
Hysteresis Clutches and Brakes
Friction Clutches and Brakes
Electrical Power Analyzers
Precision Spindle Drives

Rel 4 - d/92100 - rtt

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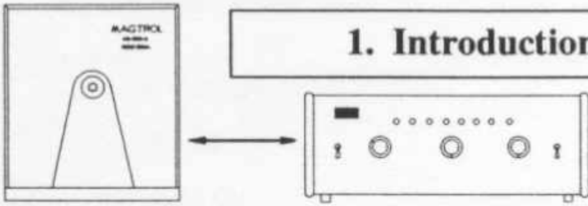
1. Introduction



Your Model 4629B is adequately packaged for shipping. We recommend that all cartons and packing material be saved until the unit has been checked out. If there is evidence of shipping damage, please notify the carrier and Magtrol Customer Service as soon as possible.

Be sure to check the carton and packing material carefully for cord sets or other hardware.

LINE VOLTAGE

Warning! Please check the line voltage setting.

The Model 4629B 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 by 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 fixtures be earth grounded for proper equipment operation and personnel safety.

INITIAL CHECK-OUT

Please note: For the balance of this reference manual the following terms are used:

✍ LED refers to the Light Emitting Diode indicators on the front panel of the 4629B.

✍ The term GPIB (General Purpose Interface Bus) is interchangeable with IEEE-488.

✍ "Q" refers to Torque.

✍ "N" refers to Speed.

In order to perform the following it will be necessary to have a Magtrol Dynamometer with a test motor installed. No computer interface or digital torque-speed readout equipment is necessary. Two cables are required to interconnect the 4629B and the dynamometer:

❒ 14 pin/14 pin Instrumentation Ribbon Connector Cable.
❒ 2 pin Dynamometer Brake Power Cable.

Your Dynamometer User's Manual Chapter 1, shows the interconnection details.

OPERATIONAL CHECK

Before the unit is turned ON, with the line cord and dynamometer inter-connection cables installed, set up the unit as follows:

❶ Set the Dynamometer BRAKE (right side) switch OFF.
❷ Adjust both the TORQUE and SPEED potentiometers full CCW.
❸ Adjust the STABILITY control to approximately 10 o'clock.
❹ Turn ON the POWER SWITCH (left side).
❺ Start the test motor - allow a few seconds for the speed to stabilize.
❻ Flip the BRAKE switch ON.
❼ Rotate the SPEED control CW slowly.

The DYNO BRAKE LED should go on, the dynamometer should load the test motor, indicated by an audible decrease in speed.

❽ Rotate the SPEED control off. (CCW)
❾ Remove the power to the test motor.

With the BRAKE switch still on, the front panel LED's should display as follows:

DYNO BRAKE	OFF
GPIB ERROR	OFF

GPIB TRANSFER	OFF
SPEED SYNC	OFF
AUTO RANGE	ON
GPIB TORQUE	OFF
GPIB SPEED	OFF
CTLS ACTIVE	ON

Switch the BRAKE Switch OFF, and the AUTO RANGE LED should go OFF.

If the above checks out satisfactorily, it may be assumed that the 4629B has survived shipping - accepts the dynamometer/motor combination and is working satisfactorily.

MODEL 4629B CAPABILITIES:

This unit is a computer interfaced speed controlled power supply. It is designed to control any Magtrol Load Cell Dynamometer from any type of computer incorporating the IEEE-488 instrument controller.

In addition to control, on command, it will return current Torque-Speed data to the computer. The unit may be used without a computer, however it will function at only a fraction of its capability, and a Magtrol digital readout device will be required to display torque and speed.

In a computer controlled environment, the following motor testing capabilities are available:

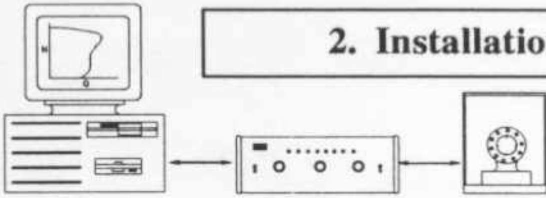
- ❑ Torque(Q) Vs Speed(N) data acquisition at a rate of 10 readings per second.
- ❑ Automatic Q-N continuous (progressive) loading in either a decreasing or increasing speed mode.
- ❑ Capability of removing the EFFECTS OF INERTIA - from the data obtained dynamically. See Appendix B.
- ❑ Either Q (torque) *or* N (speed) programmable test points.

❑ Data storage (non-volatile) within the 4629B of up to 500 Q-N test points.

❑ Complete curve capability for most types of motors. This includes single/poly phase induction, AC/DC series, PMDC, Brushless DC, air and (suitably coupled) internal combustion.

Please note: Speed mode, closed loop control, between locked rotor and 60 RPM may be erratic, depending on the test motor. Therefore, programmed loading (*in the speed mode*) for very low speed gear-head and stepper motors may not be possible.

2. Installation



Please be sure that the computer and the 4629B 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 4629B - Dynamometer interconnection is complete. If an optional Magtrol Digital Readout is to be interfaced with the unit, it will be necessary to have a Magtrol 7 Pin DIN to 14 pin Ribbon Connector Cable. This Cable assembly is Magtrol P.N. 88CS09 and in stock at the factory. If a readout was supplied with the 4629B, the cable will be included. Please refer to Page 1-2 of your Dynamometer User's Manual for interconnection details.

Although there are numerous computer interfacing methods, all Magtrol electronic instuments use the IEEE-488 (GPIB) Standard for the following reaons:

- GPIB byte parallel is inherently faster than serial interfaces.

- In motor testing, at least five separate parameters must be *synchronized*. A system of easy, fast access to more than one instrument is essential. With the GPIB, up to 15 instruments may be accessed on one port.

- The GPIB has rigid data formatting and hardware standards. This increases the chances for things to work when the hardware/software is installed.

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 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® compatible PC's. Additionally, it will be necessary to install a IEEE-488 Cable between the computer and the 4629B.

SOFTWARE INSTALLATION

There are usually a number of formatting questions to be answered during the GPIB software installation. The following items pertain to the 4629B.

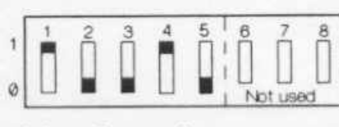
All GPIB data acquisition systems require the use of data termination characters. The 4629B utilizes the Hewlett Packard HPIB standard termination characters "Carriage Return (CR)-Line Feed (LF)" (in that order), looking for these symbols to terminate communication.

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

There may be another programming setup requirement relating to a communication fault delay timeout, in order to alleviate a computer hang-up. Do not set this period too short, leave at least one second. 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 4629B is nine (09). If you wish to change the code, the chart will help in obtaining the setting you want. Please note that the MSB is to the right. Switch segment identification resulted in the binary code notation reversed from the standard convention



CODE SWITCH	
Segment #	
12345	Code
00000	0
10000	1
01000	2
11000	3
00100	4
10100	5
01100	6
11100	7
00010	8
10010	9
01010	10
11010	11
00110	12
10110	13
01110	14
11110	15
00001	16

where the *LSB* is normally on the right.

Some PC interfaces (National GPIB-PC2A) will access 1 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 15 instruments. The 4629B 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.

DATA ACQUISITION

When the systems are interconnected, the first thing you might want to verify is that the 4629B and host computer are communicating.

The 4629B 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 or read command. If your primary address is set and addressed correctly, the 4629B will respond. It will probably be necessary to dimension your input variable to 15, ie; 13 characters plus CR-LF.

Speed-Torque data is a fixed length string, ASCII format, floating piont decimal - structured as follows:

SdddddTdddd.L

Where d = Decimal digit, 0 thru 9. "S" indicating that the following 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 decimal point location will depend upon the specific dynamometer and torque range in use. The CR-LF are symbolic and will not display.

For example; suppose a motor is running at 1725 RPM clockwise, with the dynamometer loading the motor to 22.6 Oz.In. The 4629B will transmit:

S01725T022.6R
- or -
S01725T22.60R

By string manipulation, the speed - torque and shaft direction (if required) may be extracted and assigned separate numerical variables for data processing. No Decimal Point is used in the speed value. The torque always contains a DP.

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 4629B, fetch immediate data and display it exactly as received.

```
CLS
N$ = "DEV9"   'Assign the primary address, (assume) 09.
rd$ = SPACE$(15)     'Make room for the data.
CALL IBFIND(N$, BD%)     'Subrtn Call - Init. Pri Addr.
CALL IBRD(BD%, rd$)    'Subrtn Call, Input data to rd$
PRINT rd$        'Place it on the CRT
END
```

If the communication check-out is functioning properly, skip the following.

DATA ACQUISITION PROBLEMS

These problems are typically frustrating, but not difficult. The following may provide a clue to some possible causes.

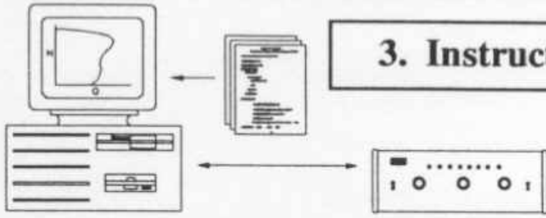
☞ Whenever communication is complete - *and properly terminated* - the GPIB TRANSFER LED will be OFF.

☞ The GPIB ERROR LED simply means an instruction character was not understood, ie; does not match the units programmed set. The LED extinguishes upon acceptance of any subsequent character(s).

☞ If GPIB TRANSFER LED remains ON, this would indicate that communication *has* occurred but the computer either has not accepted the data (probably the CR-LF) or otherwise has not released the bus - for some reason. Check your interface installation software instructions. The 4629B will probably be "hung up." You must turn the main power switch OFF (left side), *wait a few seconds,* then ON again to reestablish operation. The only time that the GPIB TRANSFER LED will remain ON - *in proper operation* - is when your program contains a continuous loop and communication runs uninterrupted.

☞ If the GPIB TRANSFER LED is off, repeat the data acquisition instruction, only keep an eye on the LED to see if it flashes. If it does not, look for a primary address or interface hardware problem. If it flashed ON then OFF; - *you're very close* - recheck your program, especially how you handle the input variable.

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



3. Instruction Set

Before proceeding with the instruction set - to avoid look-ahead type of references, some fundamental operating principles should be covered.

DYNAMOMETER CONTROL MODES

Dynamometer torque load is applied to a test motor by *either* of two modes of operation:

1. Direct torque control, where regulated and fixed current is applied to the Dynamometer Hysteresis Brake.

2. Speed control, where the immediate value of speed is compared to a reference, and brake current is proportioned to the difference.

In the speed mode (2), the Dynamometer/4629B, becomes a closed loop system forcing the test motor to operate at a fixed speed. Two digital to analog converters form an integral part of this function, controlled by the system microprocessor. For reference within this manual, these elements are identified as Q-D/A for torque and N-D/A for the speed digital to analog control elements.

SPEED CONTROL RANGING

It is necessary to prcgram the 4629B with the test motor's maximum RPM to establish the speed range value. This is required because of the wide range of motor operating speeds accommodated. There are two methods available for accomplishing this:

1. Non-instructed: If the following three conditions are met, the unit will establish the correct RPM operating range automatically.

- ❒ No previous GPIB SPEED range instruction.
- ❒ BRAKE switch OFF.
- ❒ Test motor installed - and running - with the Dyna' shaft speed above 256 RPM.

The 4629B will assume the current RPM value to be the free-run motor speed, and will select and retain the correct speed range. The acceptance will be signaled by the AUTO RANGE LED - going ON.

2. GPIB Specified: This method of range control has precedence, and the instruction suspends the AUTO RANGE function described above. To recover the AUTO RANGE capability, refer to the "R" or an "N" instruction. "Set An Operating Speed Range" is described below.

MODEL 4629B INSTRUCTION SET

Following is a condensed listing of the control characters recognized by the 4629B - in alphabetical order. The characters dddd represent a variable numerical value following the identifier. Leading zeros are not required.

A	M	PUddS
B	M1	PR
C	M0	Q
D	N	Qdddd
E	Nddddd	R
Fddddd	O	S
H	PDdd	X
HS	PUdd	Y
Idddd	PDddS	Z

All characters must be in uppercase and ASCII format. All entries must end with a CR-LF (Hex 0D-0A), as previously outlined in the GPIB - Computer Installation, Section 2. If a string or character is not recognized the GPIB ERROR LED will go ON. The ERROR LED will reset OFF upon a valid instruction.

Set An Operating Speed Range:

A=2,000 RPM
B=4,000 RPM
C=8,000 RPM
D=16,000 RPM
E=32,000 RPM
Fddddd Where ddddd is a specified speed range value between 256 and 32,000 RPM, and the motor speed is not to exceed. Leading zeros are not required. The AUTO RANGE LED will go OFF with any of the above range values - when accepted.

Speed Testpoint:

Nddddd Where ddddd is any value up to 32,000 RPM. Leading zeros are not required.

Example: Force the motor to operate at 1787 RPM. Enter: **N1787** (CR-LF).

The GPIB SPEED LED and SPEED SYNC LED go ON; the motor will decelerate (with some overshoot) to 1787 RPM. The SPEED SYNC LED may be somewhat intermittent, refer to Chapter 4, Para., STABILITY CONTROL.

Note: If the BRAKE switch is **OFF**, the DYNO BRAKE LED will flash ON-OFF-ON, signaling the inability to comply with the instruction, until the brake switch is set **ON**.

Reset From GPIB Speed Control:

N (only) Sets GPIB SPEED LED off, resets the 4629B to the highest speed range, enabling the AUTO RANGE capability.

Torque Testpoint:

In the following, the actual torque values selected (dddd) must be within the capability of the dynamometer in use. This value, (full scale rating) is shown on the dynamometer front panel.

Qdd.dd Where, the torque value, in any units = dd.dd. Floating point notation, leading zeros are not required - but the value entered must contain a decimal point (d.ddd, dd.dd , ddd.d or dddd).

The GPIB TORQUE LED will go ON. The motor will be loaded to the value specified.

Example: **Q32.5** Load the motor with 32.5 of whatever torque unit is applicable, as specified on the dynamometer front panel, ie; OZ.IN., GM.CM., mNm, etc. If the BRAKE switch is off, the DYNO BRAKE LED will flash ON-OFF-ON until the switch is closed.

Reset To Zero Torque:

Q (only) Removes the torque load from the motor, the GPIB TORQUE LED will go OFF.

Apply Fixed Brake Power:

Idddd Numerical value (dddd), to be any whole number between 1 and 4095, is converted to 12 bit binary and applied directly to the Q-D/A converter. Do not use a decimal point. This results in a fixed application of voltage (and torque) on the Dyna' brake. The value (dddd) translates to 0 to 28 V.D.C. The GPIB TORQUE LED will go ON.

This instruction is a very fast method of loading a motor to a specific value of torque. However the value (dddd) must be predetermined. There will be long term torque drift (subject to effects of hysteresis brake heating) since the function is open-loop. In the programming examples of Appendix A, a method for establishing an Idddd to Torque Calibration is shown.

Provide The Immediate Q-D/A Value:

X This entry instructs the 4629B that upon the next computer-read/4629B-write function; instead of current Speed-Torque data, the contents of the Q-D/A converter be returned. The number returned will be the decimal equivalent of the binary 12 bit Q-D/A word. This information is useful when establishing a correct Idddd instruction. After the single data write instruction, the unit automatically resets to provide standard speed-torque data on subsequent write (data output) instructions. See Appendix A for further information.

Apply Fixed Speed:

Zdddd dddd is converted to a 12 bit binary value, and applied directly to the speed N-D/A converter. The value of dddd must be from 0 to 4095. For this instruction to work properly, the speed range A thru F *must have been previously output.*

This instruction is a very fast method of loading a motor to a specific value of speed. However the value (dddd) must be predetermined. In the programming examples of Appendix A, a method for establishing a Zdddd to speed value is shown.

Provide The Current N-D/A Value:

Y This entry instructs the 4629B that upon the next computer read cycle, instead of speed-torque data, the contents of the N-D/A converter be returned. This information is useful when establishing a correct Zdddd instruction. After the single data write instruction, the 4629B automatically resets to provide standard speed-torque data on subsequent write (data output) instructions. Appendix A contains additional information.

Programmed Load Testing:

PDdd Program down (speed mode) from free-run to locked rotor at a rate proportional to dd. Where: dd is any number from 1 to 99, relating *indirectly* to RPM per second where 1 is the slowest - 99 the fastest. The SPEED SYNC LED goes ON if the instruction is accepted.

The absolute rate of speed decrease, or test time, is dependent upon the free run speed of the test motor, and the speed range setting. Therefore, the rate specified by "dd" must be established by test. ☞ Try 20 to start with - then adjust up or down from there.

Prior to the instruction, if the speed range information was *not* established, the GPIB ERROR LED will go ON indicating failure of the instruction to execute. To correct, command an "A thru F" instruction. Please note: As a rule; *either* the AUTO RANGE LED or the GPIB SPEED LED must be ON, indicating that a speed control range has been specified, in order for a "PDdd" instruction to execute,

PUdd Program Up at a rate of dd, same as "PDdd" except that the RPM is increasing. To be accepted, this instruction must have been preceded by an **N** or **PD** instruction.

PDddS or **PUddS** Same as "PDdd-PUdd above," except that up to 500 blocks of Speed-Torque data is stored within the 4629B memory for future retrieval. This releases the host computer for other processing as a test is taking place.

In order not to overrun the memory, the total test time must be maintained under 45 seconds. As long as the memory is not overrun, multiple PD/PU(S) instructions will accumulate. See "O" command and Appendix A for further information.

Cancel PD/PU Routine:

PR Resets to free run speed from a PD/PU instruction, providing the shaft is still rotating. The current speed range status is retained. If there was a previous "Nddddd" instruction, the unit will return to that. Please note that the PR instruction will fail, resulting in a locked rotor condition, if the shaft speed was below 100RPM when the instruction was issued.

Retrieve Memory Data:

O (not zero) This entry instructs the 4629B to output the contents of memory obtained from a previous PDddS or PUddS function. After an "O" instruction is received, upon the next computer read cycle, instead of current Q-N data, there will be 6000 bytes of data plus CR-LF from memory. Dimension the input variable to 6002.

Data in memory is retained indefinitely even if the 4629B is switched OFF. The memory is automatically, *and only* erased after a successful "O" command has been executed.

Appendix A provides a programming example.

Set Standard Resolution:

S All torque data will be formatted, and fixed, to exactly the resolution of the dynamometer front panel torque identification.

Set High Resolution:

H Fixes the torque resolution from that shown on the dynamometer front panel, by an additional 1/2 LS digit (0-2-4-6-8), but not greater than 1 part in 9999 resolution.

Set Automatic resolution control:

HS Allows the torque value to increase resolution by 10 automatically. The D.P. will shift right or left one digit to maintain at least 1 part in 2000 resolution. This is the default mode of operation (at power up).

Manual Controls Off:

M0 (M zero) Disables the manual TORQUE and SPEED controls. The CTLS LED will extinguish. The STABILITY control is not affected.

Manual Controls On:

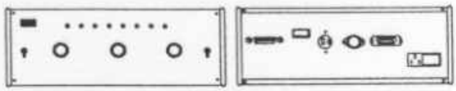
M1 Enables the TORQUE and SPEED controls. The CTLS LED will go ON.

M (only) Toggle the front panel controls, ie; On if Off - Off if On.

Reset All:

R Restores the unit to power up state. Clear all previous instructions.

4. Controls, LEDS and I/O



This chapter describes the front panel controls, LED indications and rear panel Input/Output connector details.

CONTROL POTENTIOMETERS

TORQUE: This is an open loop, general purpose control for applying torque to a test motor, essentially independent of speed. This ten turn potentiometer applies regulated current to the dynamometer hysteresis brake, up to .7 Amps. A half turn on the control may be necessary before the brake responds. Total rotation of the control, to obtain maximum dynamometer torque, varies depending upon the Model Dynamometer in use.

SPEED: This control mode is a *closed loop* system, where the 4629B automatically adjusts the dynamometer torque, such that a test motor is forced to operate at a fixed speed. This control method permits full performance data through the unstable (below the knee) region of induction motor operation.

There is a special requirement for speed control, necessitating that the free run RPM must be programmed in memory, (within the 4629B) to establish an overall operating range. As a general rule, before speed control may be used, either the GPIB SPEED LED or the AUTO RANGE LED must be ON.

When the 4629B is first turned on, it defaults to the 32,000 RPM (maximum) range. Without speed ranging - for example; if one attempted to speed control a 60Hz 4 pole induction motor on this range, it would be necessary to rotate the 10 turn SPEED control potentiometer 9 2/3 turns before anything happened!

The following procedure will establish the speed range by activating the AUTO RANGE capability. The GPIB SPEED LED must be OFF for the AUTO RANGE to function. That means that no prior *GPIB instructed* range information can be in effect. An "N" or "R" instruction will clear GPIB entered range information.

With the TORQUE and SPEED controls set full CCW:
- ❒ Turn the BRAKE switch OFF.
- ❒ Start the test motor, allow a few seconds.
- ❒ Turn the BRAKE switch ON.

The AUTO RANGE LED will go ON, indicating that an operating speed range is established. As long as the brake switch remains ON, the established speed range will remain in effect. If the shaft RPM attempts to rise above this value, restraining torque will automatically apply.

Since the SPEED Control Potentiometer operates from free run speed down to a few RPM's, *locked rotor torque* may require application of some TORQUE Control.

STABILITY CONTROL

This (single turn) control is required because of the range of motor-dynamometer combinations possible. If the response-gain characteristics of the system are such that instability occurs, speed-torque oscillations may result.

This control provides damping, by proportioning a rate-feedback signal in the speed control system. It only functions in the SPEED control mode.

If you have not "fine tuned" the STABILITY control, start with the following.

❒ For Magtrol Models HD-106 and HD-100, set the STABILITY control to a position between 11 and 12 o'clock.

❒ For Magtrol Models HD-400, HD-500 and HD-700 use a setting of 10 to 11 o'clock.

❒ For Magtrol Models HD-705, HD-800 and HD-805 use a setting of 9 to 10 o'clock.

Since the type of test motor may influence stability, slight (1/8 turn) adjustments from the above recommended settings may enhance stability and data consistency. Another method to "fine tune" this control is to output a Nddddd instruction, then *slowly* adjust the STABILITY control for best response and continuity of the SPEED SYNC LED.

Please note: Excessive CW positioning of the control will produce slow response, ie; "sluggishness," and "speed hunting" of the system. Conversely, insufficient signal typically results in dynamometer instability with torque-speed oscillations, usually more pronounced in unstable regions of induction motor operation. Please be very carefull here, an unstable system can become spectacular!

LED INDICATORS

The following is a detailed explanation of the front panel LED functions.

DYNO BRAKE - This is a red color LED indicator that goes ON anytime the dynamometer has - *or is calling for* - torque, regardless of the BRAKE switch position. With the BRAKE switch OFF this indication serves as notice (or warning) to the operator, that if the BRAKE switch is closed, torque - *possibly full* - will be instantly applied; sometimes with violent results.

Another function of the DYNO BRAKE LED is to signal a GPIB instruction incapability. For example, if a speed or torque instruction is transmitted, with the BRAKE switch OFF, this LED will flash on - off - on until the BRAKE switch is turned ON.

GPIB ERROR - Anytime an unrecognizable instruction character is received by the 4629B, the unit will set this red LED ON. Additionally, if a "PD" or "PU" type of instruction is entered without previously establishing range information, the GPIB ERROR LED will go ON. Any valid instruction received after the LED is ON will clear the error indication.

GPIB TRANSFER - While the 4629B is either receiving or sending data this amber color LED in turned ON. It remains on for 1/2 second after GPIB cessation of activity.

If the 4629B or host computer should "hang-up," and this LED remains on, it serves as an indication that a GPIB communication transfer was incomplete. Look for a missing CR-LF from the computer to 4629B, early computer sign-off or other software or hardware defect. There is more on this in SOFTWARE INSTALLATION Chapter 2.

SPEED SYNC - When this amber LED is ON; the shaft RPM is within a few RPM's of an "Nddddd" specified value, or a PU/PD instruction is accepted - and in progress.

AUTO RANGE - This green LED signals that the 4629B has set the free run speed of the test motor automatically. If the speed range is GPIB specified, then the AUTO RANGE LED is OFF.

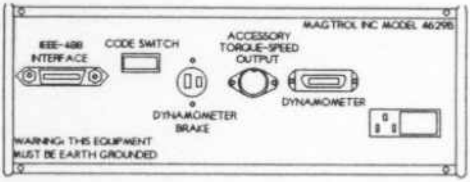
GPIB TORQUE - This green LED signals that the unit is presently operating under a computer directed torque control mode of operation. The "Q" or "I" type of instruction sets this mode. If the manual TORQUE control is active it can over ride the GPIB instruction.

GPIB SPEED - This green LED signals that the unit is under a computer directed speed control mode, and that the operating speed range is established. All "A thru F" or "N," type of instructions will turn this LED ON. AUTO RANGE control is disabled, regardless of the brake switch setting. If the Manual SPEED control is active it can over ride the the GPIB instruction.

CTLS ACTIVE - This green LED signals that the unit will accept manual TORQUE and SPEED control. If the TORQUE and SPEED controls are de-activated by a GPIB instruction "M0" the CTLS ACTIVE LED will be off.

4629B ELECTRICAL I/O

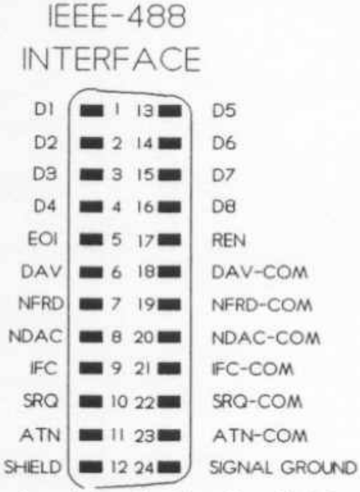
Following is a description of the electrical Input/Output. All connectors are contained on the rear panel of the 4629B.



GPIB 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 - 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.

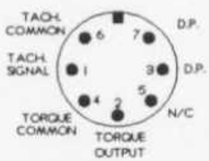
ATN - (attention) monitored continually, and a change results in activation of the transmit/receive control signals.
IFC - interface clear, used by the system controller to place the GPIA (General Purpose Interface Adapter chip) into a known quiescent state.
SRQ - service request signals a need for service 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.

DYNAMOMETER BRAKE

The 4629B applies power to the dynamometer load brake through a cable fitted with Cinch type, 2 pin connectors. These lines connect

directly to the dynamometer hysteresis brake coil in Magtrol Dynamometer Models HD-100, HD-106, HD-400, HD-500, HD-700 and HD-705. On the Models HD-800 and HD-805 there is an intermediate booster power supply contained within the dynamometer cabinet. The applied voltage is 0 - 28 VDC, at up to .7 amps dependant upon dynamometer size.

ACCESSORY TORQUE-SPEED OUTPUT



This is an *output only* connector. It is for input provision to other Magtrol Digital Torque-Speed products. The connector is a standard 7 Pin DIN type.

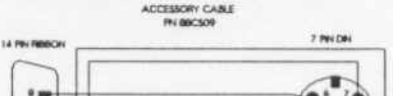
D.P. Pin 7, D.P. Pin 3: These are decimal point locator lines. They have pull-up resistors to +5 VDC. Each individual dynamometer will have the appropriate line connected to ground that codes the D.P. location for the 4629B - and other Magtrol products. The D.P. locator code is:

ddd.d = Pin 7 HI, Pin 3 HI.
dd.dd = Pin 7 LO, Pin 3 HI.
d.ddd = Pin 7 HI, Pin 3 LO.

Tachometer signal: This is a TTL compatible frequency output of 60 pulses per shaft revolution. The tachometer common is chassis ground.

Torque Output: This is a bipolar analog voltage. The torque common is chassis ground. The torque signal amplitude varies with the individual dynamometer connected to the 4629B. It is equal to the whole number of the torque value, (identified on the dynamometer front panel), in millivolts. Positive polarity would be indicative of torque applied in CW direction of rotation. For example; for a HD-700-6 with full scale torque applied in a CW direction; Torque = 425. Oz.In., and .425 Volts between pins 4 and 2, with pin 2 positive.

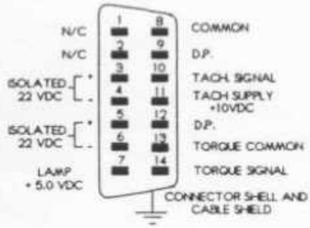
ACCESSORY CABLE



The cord set required to interconnect the 4629B to another Magtrol Digital Readout is Magtrol P.N. 88CS09. This has a 7 pin DIN connector on one end, with a 14 Pin ribbon connector on the other. *Do not* use this cord set to interconnect a dynamometer to the 4629B. No damage will result - but nothing will work!

DYNAMOMETER

This is a 14 Pin ribbon connector, interconnecting the 4629B 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 providing 60 pulses per shaft revolution. The signal level has a low voltage of .2 ±.1 and a signal high of 1.0 ±.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 connected to the 4629B. It is equal to the whole number of the torque value, (identified on the dynamometer front panel), in millivolts. Positive polarity would be indicative of torque applied in CW direction of rotation.

For example; an HD-106-6 with full scale torque applied in a CCW direction; Torque = 2.50 Oz.In. = -.250 Volts between pins 14 and 13, with pin 14 negative.

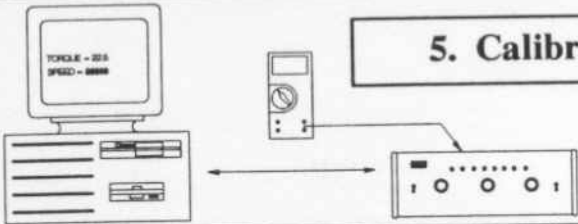
Pin 9 - Pin 12: These are decimal point locator lines. Each individual dynamometer will have the appropriate line connected to ground that codes the D.P. location for the 4629B - and other Magtrol products. The D.P. locator code is:

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 regulatede ±15VDC, and (adjustable) 6-8 VDC for the dynamometer torque transducer load cell. Your Dynamometer User's Manual Chapter 4, covers this in greater detail.



5. Calibration

There are calibration and balancing controls for most of the analog elements in the 4629B. Normally, no adjustment of these elements 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:

✍ Slight torque loading - with the DYNO BRAKE LED ON, *when not called for.*

✍ A torque difference between the GPIB indicated value and another Magtrol Digital Readout of greater than ±.25%

✍ A torque difference between CW and CCW full scale readings, of greater than 2 least significant digits, in standard resolution.

There is no calibration for the digital speed reading. Please refer to MODEL 4629B SPECIFICATIONS in this chapter.

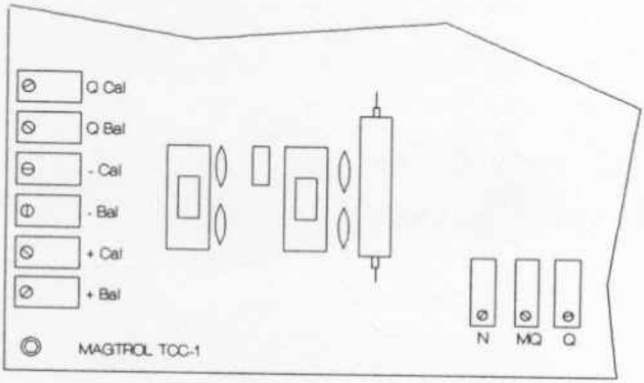
Before proceeding:

Routine Torque calibration and zero offset adjustments should always be done on the Dynamometer. The torque signal offset and calibration controls within the 4629B are there to permit standardization with other Magtrol Digital Readouts, as well as agreement between full scale values in both CW and CCW directions.

The torque value produced by the dynamometer should read within tolerance on all instruments. If a dissimilarity exists between the 4629B and another digital readout, before proceeding with zero offset or calibration adjustment it will be necessary to establish *which* of the two instruments require the service adjustment. This must be done first, by standardization of the dynamometer signal output.

WARNING! The following requires removal of the 4629B 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 4629B. Do not touch, or connect instrumentation to any elements of the circuit boards, front panel or chassis components.

All calibration and balancing potentiometers are contained on the circuit board identified TCC-1. This is located in the lower left corner of the 4629B chassis, facing from the rear panel. The following sketch shows that portion of the board where the trimpots are located, their identification and function.



Trimpot function:

Q Cal	- Accessory output torque calibration.
Q Bal	- Accessory output torque signal zero.
- Cal	- CCW torque full scale calibration.
- Bal	- CCW torque zero.
+ Cal	- CW torque full scale calibration.
+ Bal	- CW Torque zero.
N	- Speed control op-amp null.
MQ	- Front panel TORQUE control zero.
Q	- Torque (Q-D/A) zero.

To perform the following, it will be necessary to write a short - continuous loop - program to have the 4629B Torque output reading displayed by the controlling computer. All references to "CRT" in the following pertain to this reading. APPENDIX A contains a short program example, CONTINUOUS Q-N DISPLAY, for your reference.

TORQUE ZERO (NULL) ADJUSTMENT

❶ Remove any couplings from the dynamometer shaft.

❷ 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.

❸ Adjust the dynamometer zero control for best zero (dynamometer torque signal output) on your voltmeter.

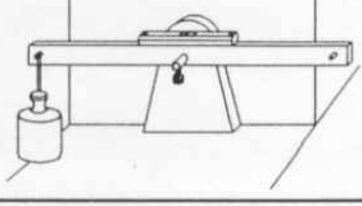
While observing the 4629B Output Torque Reading (CRT):

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

❹ Adjust the **+Bal** trimpot slowly - try both CW and CCW rotation until the indicated torque value reads higher, then back off very slowly until the reading is zero, *or* returns to the original value. Repeat this procedure on the **-Bal** trimpot - work back and forth and set zero with a 1 flashing occasionally.

FULL SCALE TORQUE CALIBRATION

❶ Complete the zero adjustment procedure outlined in the preceding paragraph. Install the Dynamometer Torque Calibration beam, as shown in the sketch.



❷ Turn on the BRAKE switch. Rotate the TORQUE control 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.

❸ 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.

❹ Adjust the **- Cal** trimpot until the 4629B Output (CRT) torque reading is equal to the voltmeter reading.

❺ Place the weight on the opposite side of the beam, adjust the **+ Cal** trimpot to match the 4629B CRT Output Torque and voltmeter reading.

Please Note:

As you changed the torque direction, if there is an excessive CW to CCW difference, ie; greater than 2 LSD at standard resolution, a need for adjustment of the pivot bearing assembly within the dynamometer could be indicated. However, before you become resigned to do this, be sure your voltmeter repeats a reading after a polarity reversal - *many do not.* Please consult Dynamometer Customer Service at Magtrol before attempting mechanical alignment of the dynamometer pivot assembly.

ACCESSORY TORQUE OUTPUT CALIBRATION

With zero torque applied to the dynamometer, and nothing connected to the shaft:

❶ While reading the 4629B Output (CRT) Torque Value, adjust the Dynamometer ZERO Control for best zero reading.

❷ With a voltmeter resolving at least .1 millivolt D.C., connected between pins 2 and 4 on the ACCESSORY TORQUE-SPEED OUTPUT connector, or using the Magtrol Digital Readout Instrument, adjust trimpot **Q Bal** for best zero reading.

➍ Attach a 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 **Q Cal** for the correct torque reading.

MANUAL TORQUE CONTROL ZERO

➊ At zero RPM rotate the TORQUE control 1/2 turn CW (ON).

➋ Rotate the **MQ** trimpot CCW, until the DYNO BRAKE LED *just* goes OFF. Or CW until the DYNO BRAKE LED goes ON then CCW until it goes OFF.

GPIB "Q" COMMAND TORQUE NULL

➊ Output an "I16" command to the 4629B.

➋ If the DYNO BRAKE LED is OFF, no adjustment is necessary, otherwise adjust the **Q** trimpot until the LED *just* goes out.

Please do not adjust the "N" trimpot. This is a factory setting of the Speed Control OP AMP described in Chapter 6. Special instrumentation is required, so please consult Magtrol Customer Service (4629B instrumentation) if there is a problem.

This completes the balancing and torque calibration procedure.

MODEL 4629B SPECIFICATIONS

Speed:

Accuracy: ±0.05% of the SPEED reading.

Resolution in RPM:

Range	Resolution
0 - 4000	1.0
0 - 8000	2.0
0 - 16000	4.0
0 - 32000	8.0

Torque:

Basic torque accuracy is controlled by the Dynamometer and the ZERO and CALIBRATION controls thereon. The Torque conversion elements within the 4629B contribute no more than a temperature related drift of up to ±.005%/°C (of ambient change), that may add or subtract.

Please refer to your Magtrol Dynamometer User's manual for Torque accuracy.

A WORD ON SPEED VARIATIONS

Instantaneous speed measurements, required for rapid data acquisition, produce some aspects of motor shaft velocity not normally encountered with typical averaging methods of RPM indication.

A factor encountered in most induction motors - and all motors to some extent - is the lead/lag of the rotor in relation to the magnetic field that is pulling it around. It's sort of like the rotor were connected to the pulling force by a rubber band, resulting in a slow rotational oscillation, rate dependant upon the rotor's inertia and other factors. This is a *change in velocity occurring within a single revolution*.

With velocity measurement extracted from only a few degrees of rotation, and not necessarily in a fixed radial position, (speed is variable), the measurement window will occur at random locations of the rotor's angular position. Therefore, when a reading is "snapshot" it may be higher or lower than the longer term averaged speed.

These combinations can produce velocity variations, appearing as data scatter. They may occur rapidly, or sometimes very slowly.

One of the more startling examples is when a synchronous induction motor displays a motor speed *greater* than the synchronous speed! No, it's not inaccuracy and not to despair, if the data is averaged over a sufficient time period, one or two seconds (10 or 20 readings is usually adequate) the variations will integrate resulting in an RPM precisely equal to the synchronous speed.

In any event, we may not like these variations, but they really are what the motor is doing - within the short time frame that we must control and produce data.

6. Circuit Description

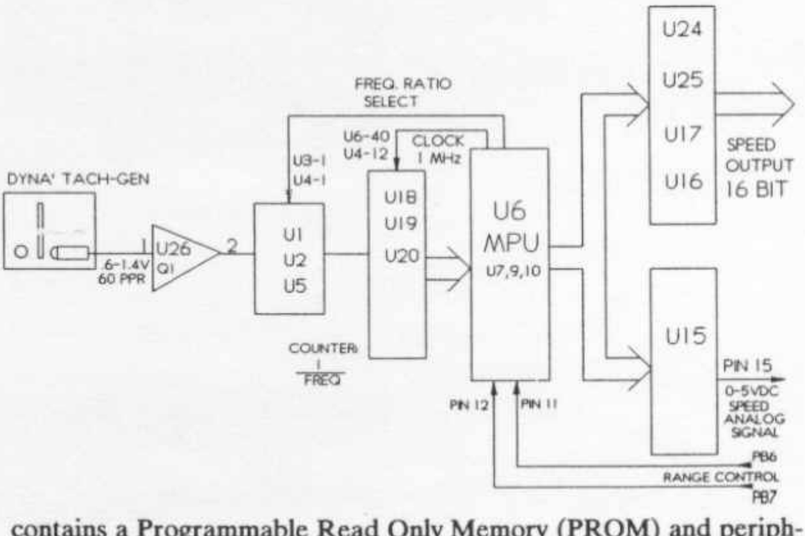
TACHOMETER

Simultaneous - analog and digital - speed data is required in the 4629B. Digital format is required for RPM as data; analog for the dynamometer speed control signal. Both signals must be highly responsive and noise free.

PCB No. SCC-1 is the tachometer section producing speed information. The basic method consists of a clock, gated on-off by the period of time between pulses generated by the dynamometer tachometer generator. Because of the overall RPM range, (0 - 32000) the time period must be selectively staged, dependant upon the immediate shaft speed, between 1, 1/10 or 1/60 of a shaft revolution.

Since RPM is now a reciprocal value, a math function is required to convert it back to true RPM. All functions are under command of a microprocessor that performs ranging decisions, math and calibration processes - in microseconds.

The block diagram identifies the basic elements. The MPU section

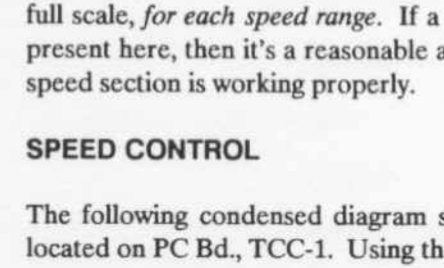


contains a Programmable Read Only Memory (PROM) and peripheral Interface Adaptor (PIA) for program and I/O control. Additionally, there are buffers and other "hand-shaking" elements.

The speed transducing function is complex, and only elemental measurements for adequate power supply voltages and speed signal output may be done easily. The analog speed output signal may be measured between pin 15 and 17 on U15. This voltage is between 0 to 5.0 VDC, full scale, *for each speed range*. If a voltage proportional to speed is present here, then it's a reasonable assumption that everything in the speed section is working properly.

SPEED CONTROL

The following condensed diagram shows the speed control section located on PC Bd., TCC-1. Using the analog speed information from U15, pin 15 of SCC-1, this signal is applied to the *inverting* input of differential operational amplifier - U1b. The *non-inverting* input is the reference input "N-D/A," established by the main processor from external instructions. The difference, amplified, commands the torque level of the Dynamometer Hysteresis Brake.



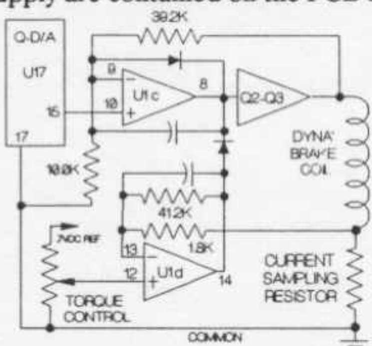
In series with N-D/A, is the front panel manual SPEED CONTROL. With CW rotation, this control decreases the MPU specified value and determines the value of the speed control input. It is not shown on the diagram, but it is essentially in series with the "N-D/A" signal.

As in any closed loop system; to maintain stability the *rate of change* of dynamometer torque must never exceed the ability of the control system to respond to it. On the other hand, excessive rate control results in a system so sluggish, you can go out and have lunch waiting for things to happen. On small dynamometers, response rates are quite different from those on larger dynamometers. Therefore, a magnitude adjustment for the rate feedback signal - to suit the individual motor-dynamometer combination, must be provided - *and set properly.* This is the function of the STABILITY control.

Since current in a Hysteresis Brake is proportional to torque, a small value resistor in series with the brake will provide a signal that is proportional to torque. When the D.C. component is removed, we end up with a signal proportional to the *rate of change* of torque. This is (negatively) fed back to the controlling amplifier, by U1a; quantitatively determined by the STABILITY control.

TORQUE CONTROL

Torque controlling elements and the dynamometer brake driver power supply are contained on the PCB No. TCC-1.



The front panel TORQUE control adjusts a voltage input to a differential operational amplifier - U1d. This voltage is compared against a voltage analogous to the brake current. The difference is amplified and applied to the Dynamometer Brake.

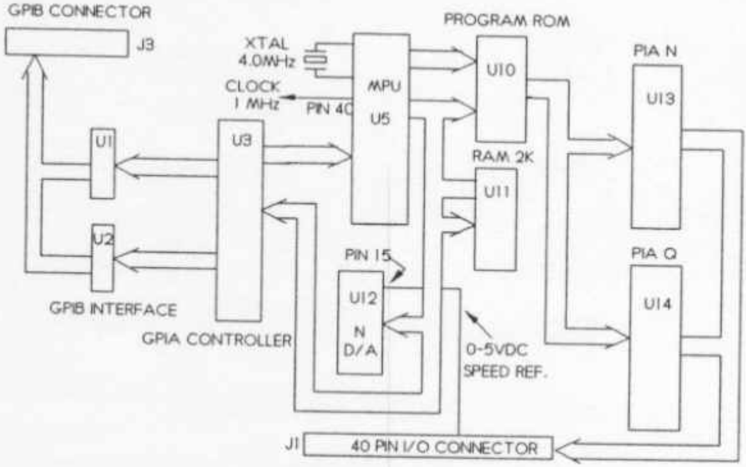
There is a second operational amplifier U1c, which also drives the dynamometer brake. The MPU, by external instructions, controls this element from the D/A converter "Q-D/A". When either a [Q] or [I] type instruction is active, the dynamometer brake current is continuously adjusted to maintain the actual torque equal to the specified value.

SALIENT POLE "COGGING"

If a specified torque level cannot be maintained, (stalled motor) then the system will saturate and load the brake - full on. A Hysteresis Brake, with current applied, in the absence of rotation, will temporarily have salient poles when the power is subsequently removed. Your Magtrol Dynamometer User's Manual contains a description of this effect - sometimes referred to as "cogging."

I/O AND MAIN DATA PROCESSING

The primary MPU and GPIB controlling electronic functions are contained on the PC Bd., MCI-1. On this assembly, U5 is the Microprocessor, U10 is the Programmable Read Only Memory containing



the 4629B operating system. There is a 2K non volatile RAM device identified as U11. The N-D/A speed reference D/A is U12. U13 and U14 are Peripheral Interface Adapters. U1, U2, and U3 are the GPIB interface control elements. The balance of the components are buffer and timing control devices.

There is a power supply PC Bd., PSB-2 providing +5 logic power, ±15 Volt for the analog elements and 70 VDC - 50 Watt source of power for the dynamometer brake.

Hysteresis brakes used on all Magtrol Dynamometers are 28 VDC units. However, since they operate in a current controlled mode, the driver power supply has a 70 VDC compliance voltage to produce a high source impedance for the brake.

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

APPENDIX A : Programming examples

MAGTROL MOTOR TEST SOFTWARE

Magtrol offers, as an option, a comprehensive motor test software package available on either 5-1/4 or 3-1/2 floppy discs. To demonstrate the capabilities of this package, a (free) demo disc is also available. For further information, or a copy of the demo disc, contact Magtrol Sales: (716) 668-5555.

PROGRAMMING EXAMPLES

Most of us involved in computer programming are familiar with BASIC. In order to show the programming techniques in as simple a context as possible all of the following are given in Microsoft Quick BASIC 4.5,® using a National Instruments PC2A interface.

If you are using some other IEEE-488 interface system; modification of the assembly language CALL subroutines will be required.

Except for the SPEED - TORQUE CRT DISPLAY program, immediately following, the primary address used in all of the other examples is the default factory setting of 9. If you modify the code switch setting, you will have to correct the "dev9" operands to reflect the change. Look for the line BDNAME$ = "dev9", and modify the 9 to whatever you selected, ie; 1 thru 15.

SPEED - TORQUE CRT DISPLAY

In the following example the program will ask for the GPIB primary address. If you haven't changed it - enter 9 - and speed-torque values should display on the CRT, updating continuously:

```
    CLS : LOCATE 10, 20
    INPUT "Enter the primary address (1-15)... ", an$
    BDNAME$ = "DEV" + an$
    CLS
DO:
    CALL IBFIND(BDNAME$, BD%)  ' Initialize the GPIB
    rd$ = SPACE$(15)  'Dimension the input.
    CALL IBRD(BD%, rd$)
        spd = VAL(MID$(rd$, 2, 5)) 'Extract N
        tor = VAL(MID$(rd$, 8, 5)) 'Extract Q
    LOCATE 10, 20: PRINT "Speed =  "; spd
    LOCATE 11, 20: PRINT "Torque = "; tor
    LOCATE 20, 50: PRINT "Any key ends..."
LOOP WHILE INKEY$ = ""
SYSTEM : END
```

RECALL 4629B DATA FROM MEMORY

If a PDddS or PUddS instruction was issued, all the data from the test run will be retained in 4629B memory; providing that the total test time did not exceed 50 seconds (500 test points @ .1 Sec.). Another PDddS/PUddS instruction will append data to that already in 4629B memory. The memory is cleared (only) when an "O" command is issued and the data transfer successfully completed.

In the following program fragment, the variable QNdata$ receives the test data from the 4629B memory. The data format is similar to that shown on page 2-3, *except that the shaft direction character (L or R) is eliminated.* Each individual test point block is always 12 characters long.

```
' Routine to access 4629B Memory after a PDddS or PUddS command
CLS
BDNAME$ = "DEV9"
eos$ = CHR$(13) + CHR$(10)  'assign the CR-LF
QNdata$ = SPACE$(6502)   'Make room for torque-speed data.
wrt$ = "O" + eos$'O+CR-LF command to 29B.
CALL IBFIND(BDNAME$, BD%)  ' Initialize the GPIB
CALL IBWRT(BD%, wrt$)'Output command :
CALL IBRD(BD%, QNdata$)'Fetch all memory
' QNdata$  now contains all 4629B test data...
```

What you have is a long data string structured as shown in the following example. Just to fill in some numbers, let's assume a speed of 1752 RPM and 85.64 Oz.In. torque. A block of 3 data samples, anywhere in the string will look like:

.......S01752T85.64S01752T85.64S01725T85.64......

One simple method to extract individual data points, would be to create a FOR-NEXT loop to "walk through" the single variable labeled "QNdata$." Within the loop, assign two numerical data arrays; one for "Speed" and one for "Torque." Since it is unlikely that all of the memory was filled with data, there will be zeros output where the test stopped. You could omit these by making the array assignment conditional on both torque and speed being equal to something greater than zero. This step is not included in the example.

```
      DIM Speed(600), Torque(600)
      n = 1 ' Initialize array number.
  FOR I = 2 TO 6005 STEP 12 ' Step a block at a time
      Speed(n) = VAL(MID$(QNdata$, I, 5))
      Torque(n) = VAL(MID$(QNdata$, I + 6, 5))
      n = n + 1
  NEXT
```

PROGRAMING EXAMPLE FOR "I" COMMAND USE.

To apply a torque value to the test motor as rapidly as possible, the **Idddd** command provides a method of directly addressing the Q-D/A converter. The **I** instruction requires that the numerical value used with it, be a number from 1 to 4095. In order to relate this to torque, first output a "Qdd.dd" command, make dd.dd equal to the value of torque you want (2.0 is selected in the example), delay a few seconds for the system to respond and settle, then ask for the contents of the Q-D/A converter with the "X" command. Concatenate the number returned, with the I command.

```
'Routine to use the "I" command.
'TOR$ = Torque value you wish to emulate with the I command.
CLS : eos$ = CHR$(13) + CHR$(10)   ' CR-LF
wrt$ = "Q" + "2.0" + eos$   ' "2.0" is arbitrary here.
BDNAME$ = "DEV9"   'primary address = 9
CALL IBFIND(BDNAME$, BD%)
CALL IBWRT(BD%, wrt$)' Loading Q2.0 (2.0 units of torque)
SLEEP (7)      ' Wait 7 seconds to settle down.
wrt$ = "X" + eos$   'Q-D/A  Data request.
CALL IBWRT(BD%, wrt$)
QDA$ = SPACE$(6)    ' always returns 4 digits + CR-LF
CALL IBRD(BD%, QDA$)   ' D/A converter value.
FASTQ$ = "I" + QDA$    ' = Idddd
CALL IBWRT(BD%,FASTQ$)' - this  may go anywhere for fast Q loading..
```

PROGRAMING EXAMPLE FOR "Z" COMMAND USE.

To apply a value of speed to the test motor as rapidly as possible, the **Zdddd** command directly addresses the N-D/A converter. The **Z** instruction requires a numerical value of 1 to 4095. In order to establish this value relative to the speed you wish to apply, use the Nddddd instruction first. After the speed has settled output a "Y" data request. The 4 digit value returned, may then be concatenated with "Z" for fast speed loading.

Be sure that the *speed range* has been previously established!

```
'Routine to use the "Z" command.
CLS
eos$ = CHR$(13) + CHR$(10)   ' CR-LF
wrt$ = "N" + "1750" + eos$
BDNAME$ = "DEV9"     'primary address = 9
CALL IBFIND(BDNAME$, BD%)
CALL IBWRT(BD%, wrt$)
SLEEP (7) : wrt$ = "Y" + eos$
CALL IBWRT(BD%, wrt$)
NDA$ = SPACE$(6)
CALL IBRD(BD%, NDA$)
FASTN$ = "Z" + NDA$
CALL IBWRT(BD%,FASTN$) 'this may go anywhere for quick N loading.
```

If you have questions regarding any of the above examples, or if you have suggestions regarding software development, please feel free to contact Magtrol Software Engineering any time.

APPENDIX B: Inertia Correction

INERTIAL EFFECT ON MOTOR TEST DATA:

A major advantage of the Magtrol Speed Controlled System, is the ability to obtain full (free run to locked rotor) motor performance data by continuous load application with an absorption dynamometer. Data acquisition is fast, resulting in minimal motor IR losses, and loading characteristics simulate actual end-use applications.

When a motor is accelerating or decelerating, the measured torque is the sum of the true motor torque ± the inertial torque (stored energy) of the system. Unless inertial torque is excluded, motor performance data will be in error; since the measured torque will vary in proportion to the *rate* of acceleration/deceleration.

This type of an error can produce startling test results. For example; during rapid deceleration, system inertia can produce apparent efficiency greater than 1.0! This may occur as output power is divided by input power - without extracting the stored energy in the system. Alluding to perpetual motion causes most technically oriented people to suspicion the data.

DATA TIMING FACTOR

Since "inertial effect" is only a factor as speed is changing - and inertial torque is proportional to rate of change, inertial value may be expressed as a unit of torque *per* change in RPM - *in a given period of time*.

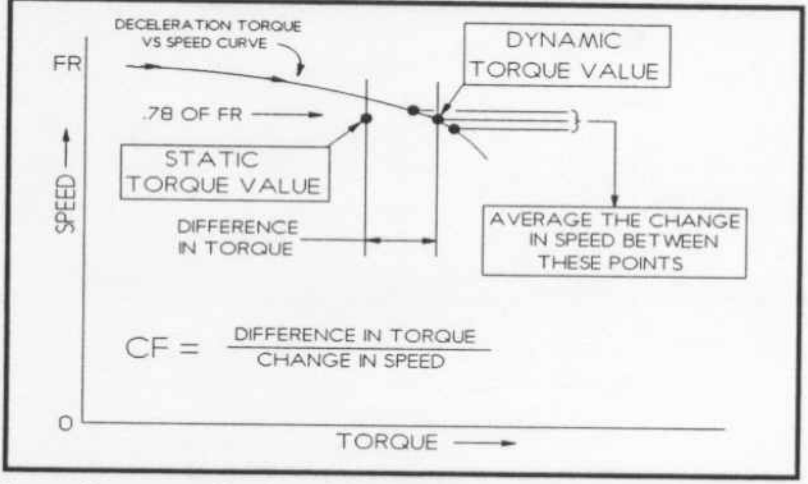
The 4629B accumulates and outputs test data at fixed intervals of 0.10 second. Therefore, change in RPM is always over that fixed period, regardless of testing rates. It might seem desirable if data were output at fixed intervals of speed or torque, like every 100 RPM's, or something nice to work with. But that would preclude the ability to extract inertial error effects, unless we could somehow accurately measure - and rapidly output - the elapsed time between every data point! If you must have speed/torque data in even decades, there are various computer software routines for fast and accurate curve fitting techniques to do this for you.

PROCEDURE

In order to create a torque Correction Factor (CF), we need:

1. A torque value equal to the inertial torque.
2. The difference in RPM (per .1 sec.) that created *that* value.

In the following graph example we have arbitrarily selected a data point on the performance curve. What we want to do is program down by



increasing torque load, and fetch a group of test points. We have selected the first data point where the speed will be just less than 78% of the Free Run speed. Call this the *dynamic speed value*. Additionally, save one test point before this value, and one after. Immediately program the 4629B (Nddddd) to a speed exactly equal to this "dynamic" value. When the speed has stabilized, fetch this as the *static torque value*.

To calculate CF, first average the speed change *between* 3 test points. Next, calculate the difference in torque between the static speed value and the dynamic speed value. Divide this torque difference by the *average* change in speed - and that's all there is to it.....

A few key conditions:

❐ The test point selection of ".78," is fairly typical for an induction motor. In any event, select this value in an area where the performance curve is fairly linear, and there is a substantial torque change with speed.

❐ The data must be acquired rapidly, so that motor heating does not degrade performance adding a false difference between the static and dynamic torque values.

❐ The input line voltage must be stable for 1 or 2 seconds that this test requires. Torque varies by the *square* of the change in line voltage: use a regulated power source.

INERTIA CANCELLATION PROGRAM

The following nine steps outline a computer program, in Quick Basic, to control the 4629B for the acquisition of a "CF" value.
Initialization:

```
'fr = free run speed. You must assign this value.
BDNAME$ = "DEV9" 'Primary addr = default code 9.
CALL IBFIND(BDNAME$, BD%)' Initialize the GPIB
eos$= CHR$(13)+CHR$(10)  'CR-LF termination char's.
```

Programming steps:

1. With the system up and running, command a PD70 instruction to Program Down to 78% of the free run speed:

```
wrt$ = "PD70" + eos$     'Program Down at a fast rate.
CALL IBWRT(BDNAME$, wrt$) 'Send it to the 4629B.
rd$ = SPACE$(15) ' Assign room for the data + CR-LF
```

2. Collect data in an array. (Single data point = SddddTddd.dL.)

```
     X = 0 ' X is our array # = selected speed point.
DO: X = X + 1
     CALL IBRD(BD%, rd$)      'rd$ is the data from 29B.
     ND(X) = VAL(MID$(rd$, 2, 5))     'SPEED
     QD(X) = VAL(MID$(rd$, 8, 5))     'TORQUE
LOOP UNTIL ND(X)  <.78 * fr      'fr = free run RPM assigned.
```

MAGTROL LIMITED WARRANTY

Magtrol products are warranted against defects in materials and workmanship for a period of ninety (90) days from the date of delivery. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Magtrol. Additionally, any repairs which may become necessary beyond the ninety (90) day warranty period will be made subject to review by our quality control department. No other warranty is expressed or implied. We are not liable for consequential damages.

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