MAGTROL

Model DSP7000

High Speed Programmable Dynamometer Controller

User's Manual

Purchase Record

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

Model Number: _____

Serial Number: _____

Purchase Date: _____

Purchased From: _____

2nd Edition rev. O – March 2020

MAGTROL

Safety Precautions

1. Make sure that all Magtrol dynamometers and electronic products are earth-grounded, to ensure personal safety and proper operation.
2. Check line voltage before operating the DSP7000.
3. Make sure that dynamometers and motors under test are equipped with appropriate safety guards.

Revisions To This Manual

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

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

REVISION DATE

2nd Edition revision O– March 2020

TABLE OF REVISIONS

Date	Edition	Change	Section(s)
03/17/20	2 nd Edition rev. O	USB driver setup updated.	7.1.1
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04/05/16	2 nd Edition rev. K	Torque Commands updated.	7.4.6
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07/07/15	2 nd Edition rev. H	Installation instructions and commands updated throughout chapter.	Chapter 7
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07/03/13	2 nd Edition rev. B	Step number 4 updated in Calibration Prodedure of Analog to Digital Converters.	9.3.2
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Date	Edition	Change	Section(s)
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12/02/11/	1st Edition - rev B	STAT command was updated in section 7.4.7 to include ramp down, ramp up, and mode input. The OP command was added in section 7.4.8.	7.4.7, 7.4.8
11/14/11	1st Edition - rev A	Contact Rating changed from 1 amp, 24 VDC to 24 VDC, 1 amp max.	5.1.1, 8.1.2

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Preface

PURPOSE OF THIS MANUAL

This manual contains all the information required for the installation and general use of the Model DSP7000 Dynamometer Controller. To ensure proper use of the instrument, please read this manual thoroughly before operating it. Keep the manual in a safe place for quick reference whenever a question arises.

WHO SHOULD USE THIS MANUAL

This manual is intended for bench test operators who are going to use the Model DSP7000 Dynamometer Controller in conjunction with any Magtrol Hysteresis, Eddy-Current or Powder Brake Dynamometer, Magtrol In-Line Torque Transducer or auxiliary instrumentation.

MANUAL ORGANIZATION

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

The structure of the manual is as follows:

Chapter 1: INTRODUCTION - Contains the technical data sheet for the DSP7000 Dynamometer Controller, which describes the unit and provides its technical characteristics.

Chapter 2: CONTROLS - Description of the elements located on the front and rear panels of the unit.

Chapter 3: INSTALLATION/CONFIGURATION - Provides setup options available with the DSP7000 Dynamometer Controller. Illustrates and outlines the hardware connection setup and software configurations for each option.

Chapter 4: PID SETTINGS - Describes the Proportional Integral Derivative (PID) Loop and provides information on theory, setup and use.

Chapter 5: ALARM SYSTEM - Describes the new built-in alarm feature providing the user with information on how each different alarm operates along with instructions for setup and use.

Chapter 6: MANUALLY CONTROLLED OPERATION - How to run a test when the DSP7000 is used as a stand-alone unit. Includes information on setting power and torque units, torque and speed control and open loop control.

Chapter 7: COMPUTER CONTROLLED OPERATION - How to run a test when the DSP7000 is used with a PC. Includes information on data format, programming and command set.

Chapter 8: OPTIONAL EQUIPMENT - Information on the optional I/O cards, GPIB Interface, RS-232 Interface,

Chapter 9: CALIBRATION - Provides recommended calibration schedules along with step-by-step instructions for the calibration procedure.

Chapter 10: THEORY

Chapter 11: TROUBLESHOOTING - Solutions to common problems encountered during setup and testing.

Appendix A: INERTIA CORRECTION - Describes the inertial effect on motor test data providing solutions for correction.

Appendix B: FRONT PANEL/DISPLAY MENU FLOW CHARTS - A visual display of various setup procedures.

Appendix C: SCHEMATICS - For Encoder/Switch Board, Power Supply, DSP & Memory and Analog I/O.

Appendix D: ADDITIONAL SCALE FACTOR TABLE - Provides additional scale factor values based on test instrument selection.

CONVENTIONS USED IN THIS MANUAL

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

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

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

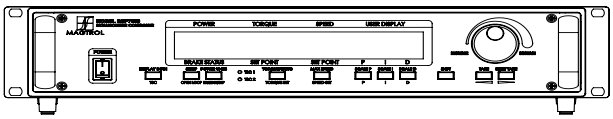
WARNING! THIS INTRODUCES DIRECTIVES, PROCEDURES, PRECAUTIONARY MEASURES, ETC. WHICH MUST BE EXECUTED OR FOLLOWED WITH THE UTMOST CARE AND ATTENTION, OTHERWISE THE PERSONAL SAFETY OF THE OPERATOR OR THIRD PARTIES MAY BE PUT AT RISK. THE READER MUST ABSOLUTELY TAKE NOTE OF THE ACCOMPANYING TEXT, AND ACT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

1. Introduction

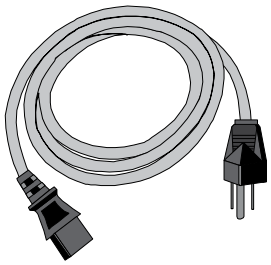
1.1 UNPACKING YOUR DSP7000

Your DSP7000 was packaged carefully for shipping. Please notify your carrier and Magtrol Customer Service if you believe your unit was damaged in shipping.

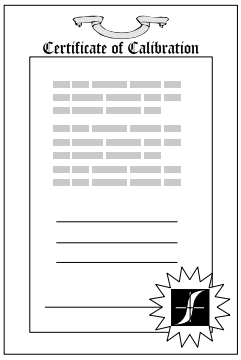
1. Save all shipping cartons and packaging material until you inspect the DSP7000.
2. Inspect the DSP7000 for any evidence of damage in shipping.
3. Make sure the carton contains the following:



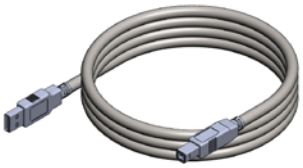
DSP7000 Dynamometer Controller



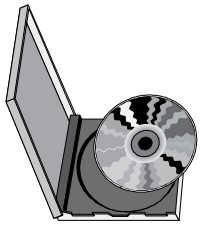
Line cord



Calibration Certificate



USB Cord



Magtrol User Manual CD-Rom

1.2 NEW FEATURES OF THE DSP7000

Magtrol's new Model DSP7000 Dynamometer Controller is an upgraded version of the DSP6001, providing superior motor testing capabilities by using state-of-the-art digital signal processing technology. Designed for use with any Magtrol Hysteresis, Eddy-Current or Powder Brake Dynamometer, Magtrol In-Line Torque Transducer or auxiliary instrumentation, the DSP7000 both controls the dynamometer and provides digital readouts on the front panel. The features that make the DSP7000 unique include:

- Two Channels - Enables unit to support a combination of up to two testing instruments with independent or tandem configurations.
- Built-In Alarm System - To caution the user when problems occur, there are automatic electrical and temperature alarms programmed into the unit. Also inherent to the unit are optional power, speed, torque, air flow, water flow and external input alarms that become active when enabled by the user.
- Torque/Speed Analog Outputs - Able to interface with a data acquisition system
- Digital Filter - Removes undesired noise from torque signals.
- Saving - Allows user to save programmed values within their configurations.

1.3 DATA SHEET

MAGTROL

DSP7000 SERIES

DSP7000 SERIES
PROGRAMMABLE CONTROLLER

FEATURES

- **DSP7001 Single Channel:** Low cost and easy to use
- **DSP7002 Dual Channel:** Enables the support of two testing instruments with independent or tandem configurations and two fully independent control loops
- **Built-in Alarm System:** For power, speed, torque, temperature, air flow, water flow, electrical overload and external inputs
- **High Speed Data Acquisition:** Up to 500 torque and speed points per second of both channels with time stamp
- **High Quality, Easy-to-Read Vacuum Fluorescent Readout:** Displays torque, speed, power, auxiliary and PID (proportional gain, integral and derivative) values
- **Fast Full-Curve Data Acquisition:** Free-run to locked rotor in seconds
- **Speed & Torque Operating Modes:** PID settings for exceptional dynamometer control
- **Programmable Digital PID Values:** Controlled and stored via M-Test Software or controlled manually
- **Built-in Current-Regulated Supply:** For use with Hysteresis Dynamometer or brakes up to 1amp
- **Adjustable Torque Units:** English, Metric and SI are standard
- **Digital Filter:** Removes undesired noise from torque signals
- **Saving:** Currently used configuration can be saved and recalled at power up
- **Single or Multi-point Torque and Speed Stabilized Testing:** Via M-TEST 7.0 Software
- Closed Box Calibration
- **Rack Mounting:** 19" (482.6 mm) with handles
- Backwards Compatible: Compatible with the DSP6001 (in DSP6001 mode)
- **HD5 dynamometers:** Supported
- **USB:** Standard
- **Low RPM:** calculation from angle (quadrature signal) and time designed to capture RPM's as low as .001 RPM
- **Position Measurement:** Two quadrature decoders

Fig.1 : DSP7000 Series Programmable Controller

OPTIONS

- Interfaces: RS-232 and IEEE-488
- I/O card accessible programmatically (LabVIEW™, Visual C)

DESCRIPTION

Magtrol's Model DSP7000 High Speed Programmable Dynamometer Controller employs state-of-the-art Digital Signal Processing Technology to provide superior motor testing capabilities. Designed for use with any Magtrol Hysteresis, Eddy-Current or Powder Dynamometer, Magtrol In-Line Torque Transducer or auxiliary instrumentation, the DSP7000 can provide complete PC control via the USB or optional IEEE-488 or RS-232 interface. With up to 500 readings per second, the DSP7000 is ideally suited for both the test lab and the production line.

APPLICATIONS

In the laboratory, the DSP7000's high sample rate provides superior resolution for data acquisition and curve plotting. This allows for capturing more usable motor test data during switching, breakdown and other transitional areas of the motor test curve. For production and incoming inspection, the DSP7000 displays torque, speed and power at all times, allowing the Controller to be used as a manual stand alone unit or as part of a complete PC system.

MAGTROL **DSP7000 SERIES**

MOTOR TESTING SOFTWARE

Magtrol's M-TEST 7 Software (sold separately) is a state-of-the-art motor testing program for Windows®-based data acquisition. Used with the Magtrol DSP7000 Controller, Magtrol M-TEST 7 Software provides the control of any Magtrol Dynamometer and runs test sequences in a manner best suited to the overall accuracy and efficiency of the Magtrol Motor Test System. The data that is generated by Magtrol's Motor Testing Software can be stored, displayed and printed in tabular or graphic formats, and can be easily imported into a spreadsheet.

Written in LabVIEW™, M-TEST 7 has the flexibility to test a majority of motor types in a variety of ways. Because of LabVIEW's versatility, obtaining data from other sources (e.g. thermocouples), controlling motor power and providing audio/visual indicators is relatively easy.

Magtrol's M-TEST 7 Software is ideal for simulating loads, cycling the unit under test and motor ramping. Because it is easy to gather data and duplicate tests, the software is ideal for use in engineering labs, production testing and incoming/outgoing inspection.

SPECIFICATIONS

MEASUREMENT CHARACTERISTICS

Maximum Torque	99,999 units
Maximum Speed	199,999 rpm
Accuracy	Speed: 0.01% of reading from 5 rpm to 200,000 rpm Torque: 2 volt range ± 0.05% of range (±1 mV) *(used on all HD Series other than HD5 Series)* 10 volt range ± 0.05% of range (±5 mV) *(used on all except HD Series)*

ELECTRICAL CHARACTERISTICS

Voltage Requirements	85-264 VAC 50/60 Hz
Power Requirements	210 VA
Fuses (5 × 20 mm)	Brake: IEC .25 A 250 V T Main Power: IEC 2.5 A 250 V T
Max. Compliance Voltage	48 V DC, Brake Output
Max. Brake Output Current	1 Amp, Calibrated that 100% OL = 1 Amp
TSC1 and TSC2 User Power Supplies	24 Volt DC 450 mA (power supply fault protected) 5 Volt DC 200 mA (internal fuse at 500 mA)

ENVIRONMENT

Operating Temperature	5 ºC to 40 ºC
Relative Humidity	< 80%
Temperature Coefficient	0.004% of range/°C of 5 V DC for both channels

Optional equipment may be factory installed or purchased separately and user installed.

DIMENSIONS

Width	19.0 in	483 mm
Height	3.5 in	89 mm
Depth with handles	12.4 in 13.8 in	315 mm 351 mm
Weight	15.2 lb	6.9 kg

MAGTROL DSP7000 SERIES

OPTIONAL EQUIPMENT

COMMUNICATIONS

RS-232 Interface

The RS-232 Interface provides backwards compatibility for older systems. 300, 600, 1200, 2400, 4800, 9600, 19200 and 115200 Baud rates are supported.

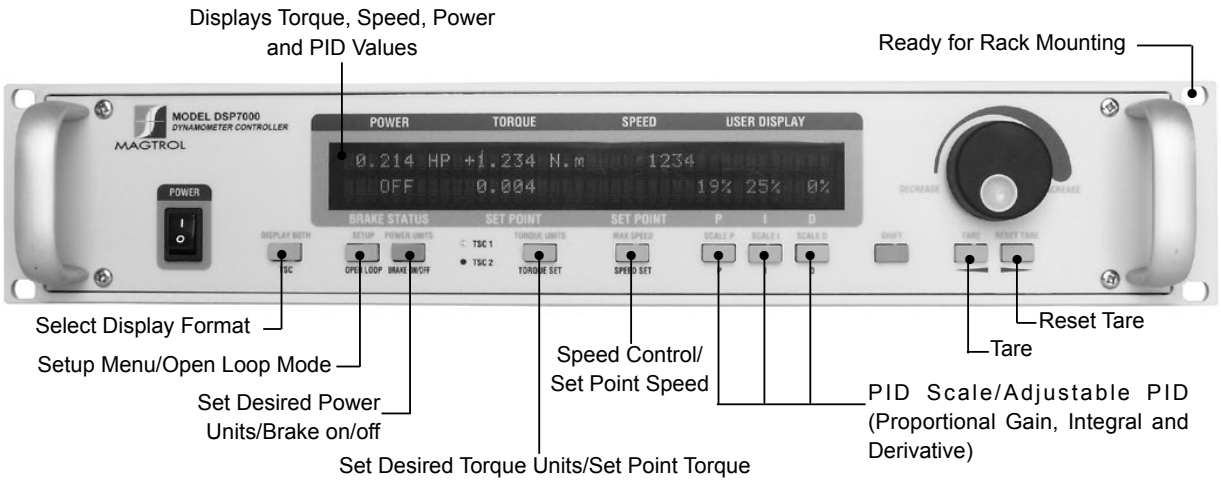
GPIB IEEE-488 Interface

The GPIB IEEE-488 Interface provides standard GPIB communications.

I/O CARD

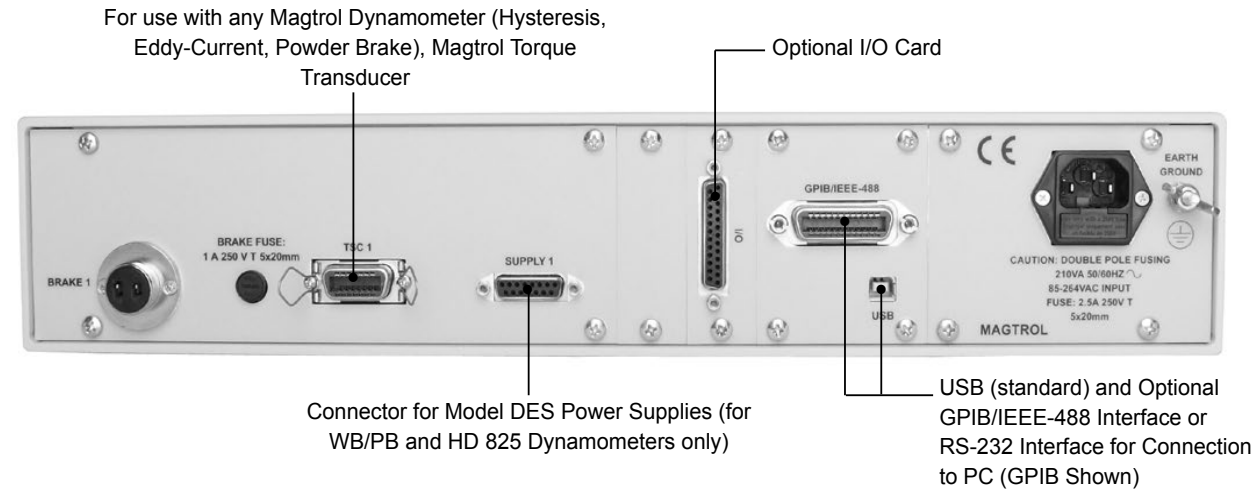
- Torque/Speed Analog Outputs: For interface with a data acquistion system
- Analog Signal such as tachometer can be routed to PID loop
- External alarm input
- Alarm relay contacts
- 2 Relays
- 3 Digital inputs
- 2 Digital outputs
- 2 Analog inputs
- 2 Analog outputs
- 5 Volts available to user fused at 500 mA. Nominal 200 mA
- All I/O data can be accessed by LabVIEW™

FRONT PANEL

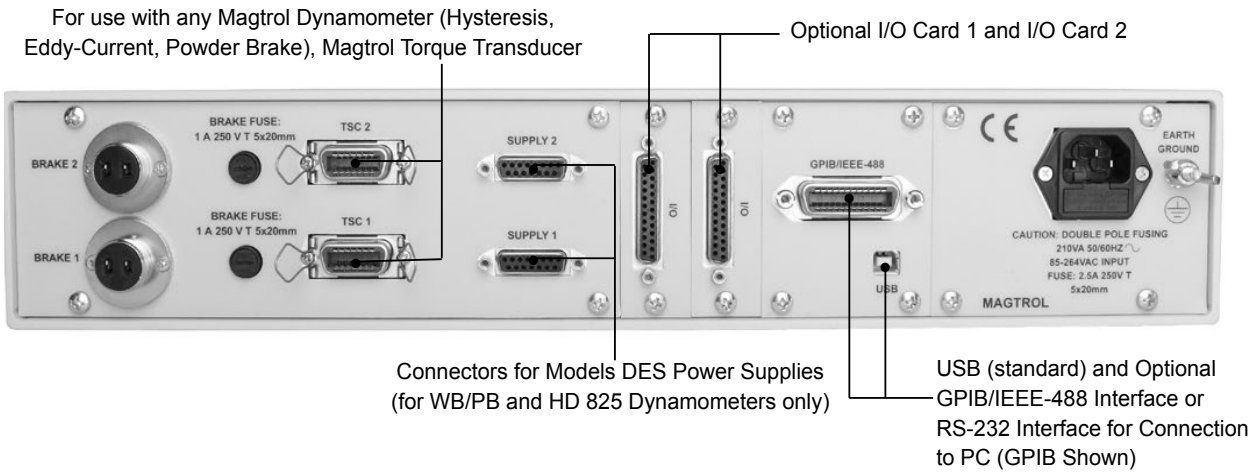


MAGTROL DSP7000 SERIES

REAR PANELS



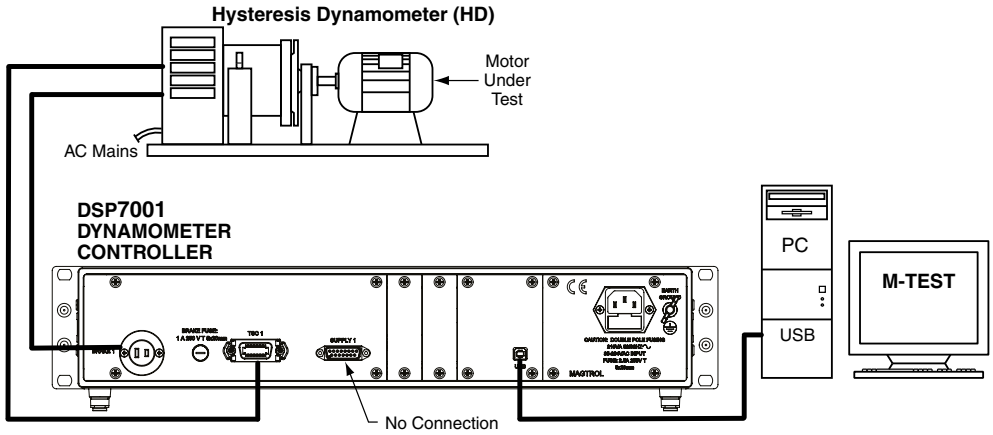
DSP7001 REAR PANEL



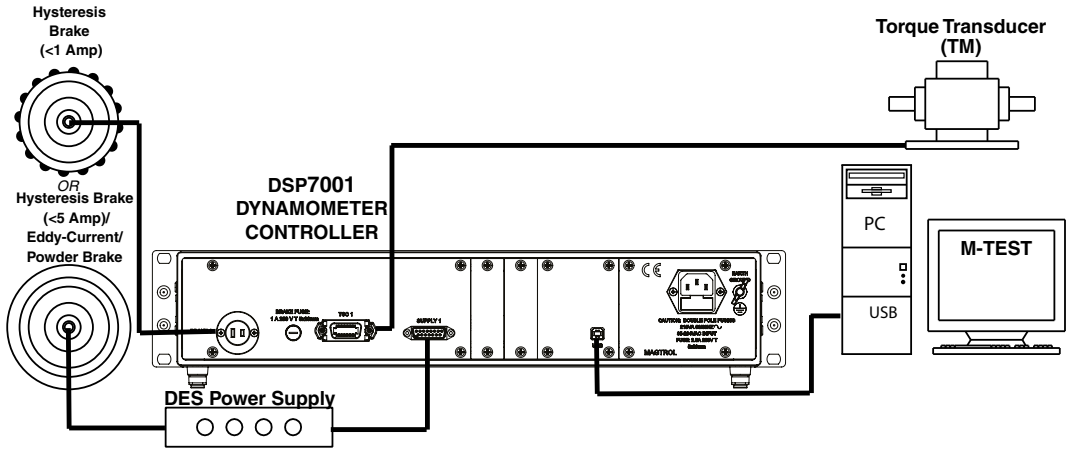
DSP7002 REAR PANEL

MAGTROL **DSP7000 SERIES**

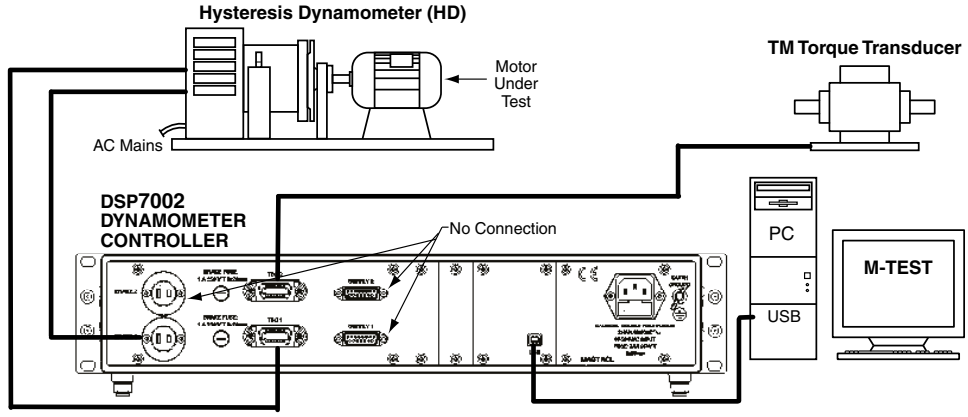
SYSTEM CONFIGURATIONS



DSP7001 CONNECTED TO HYSTERESIS DYNAMOMETER



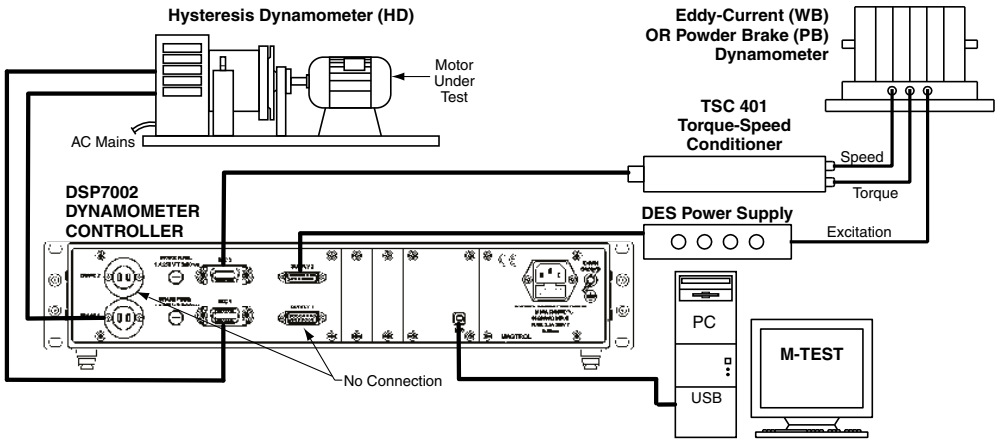
DSP7001 CONNECTED TO A HYSTERESIS OR EDDY-CURRENT/POWDER BRAKE WITH IN-LINE TORQUE TRANSDUCER



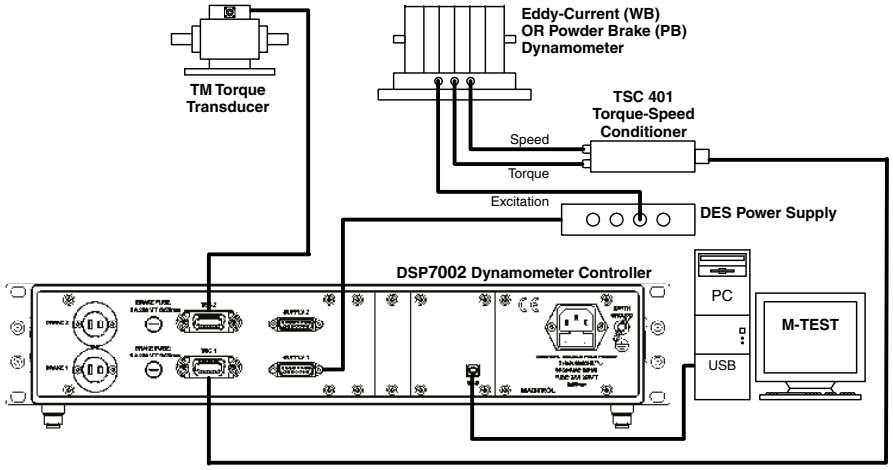
DSP7002 CONNECTED TO HYSTERESIS DYNAMOMETER WITH IN-LINE TORQUE TRANSDUCER

MAGTROL **DSP7000 SERIES**

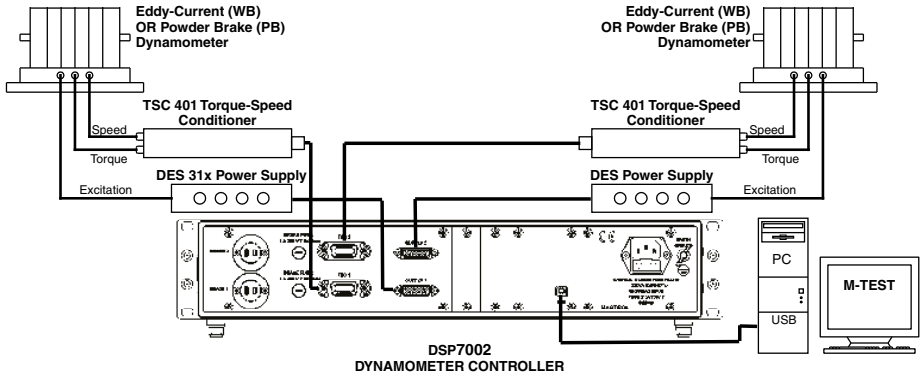
SYSTEM CONFIGURATIONS



DSP7002 CONNECTED TO HYSTERESIS DYNAMOMETER AND EDDY-CURRENT OR POWDER BRAKE DYNAMOMETER



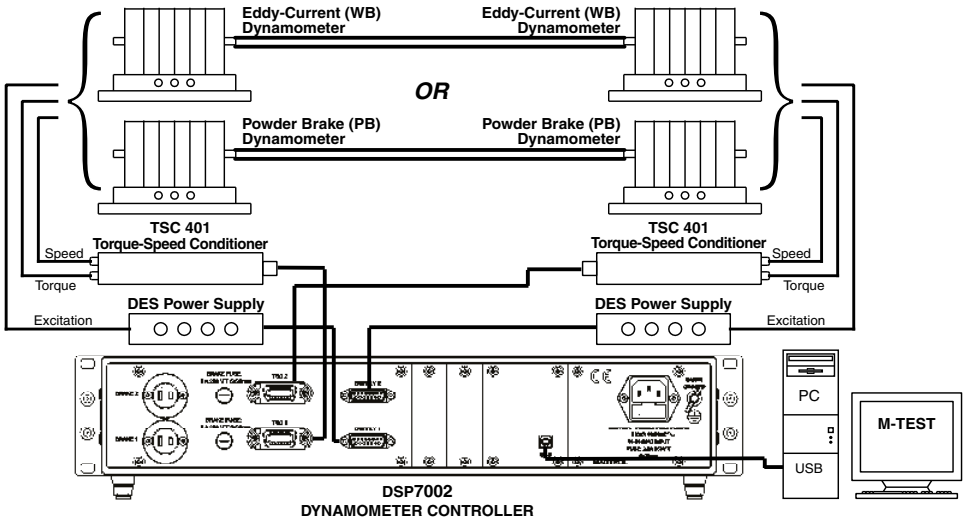
DSP7002 CONNECTED TO EDDY-CURRENT OR POWDER BRAKE DYNAMOMETER (WB/PB) WITH IN-LINE TORQUE TRANSDUCER



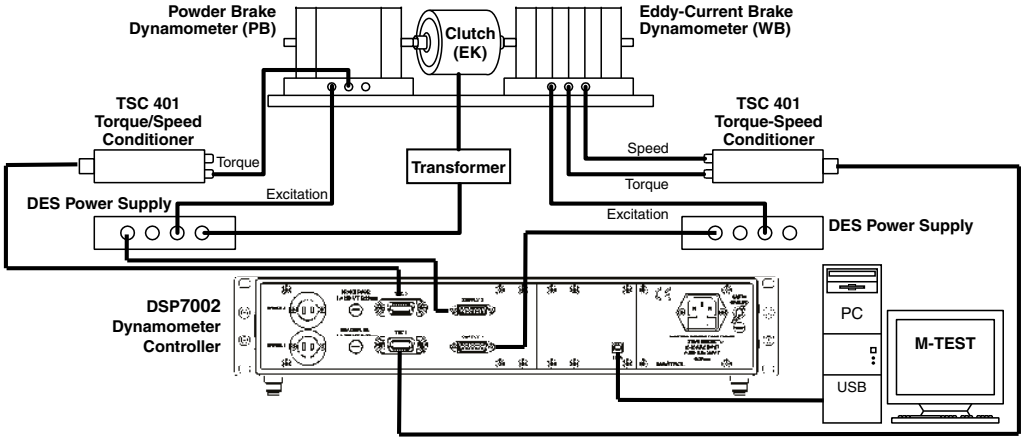
DSP7002 CONNECTED TO 2 EDDY-CURRENT OR POWDER BRAKE DYNAMOMETERS (INDEPENDENT SETUP)

MAGTROL DSP7000 SERIES

SYSTEM CONFIGURATIONS



DSP7002 CONNECTED TO 2 EDDY-CURRENT OR 2 POWDER BRAKE DYNAMOMETERS (TANDEM SETUP)



DSP7002 CONNECTED TO EDDY-CURRENT AND POWDER BRAKE DYNAMOMETER (TANDEM SETUP)

The USB Driver required for communication between the PC and DSP7000 is available for download at Magtrol's website:

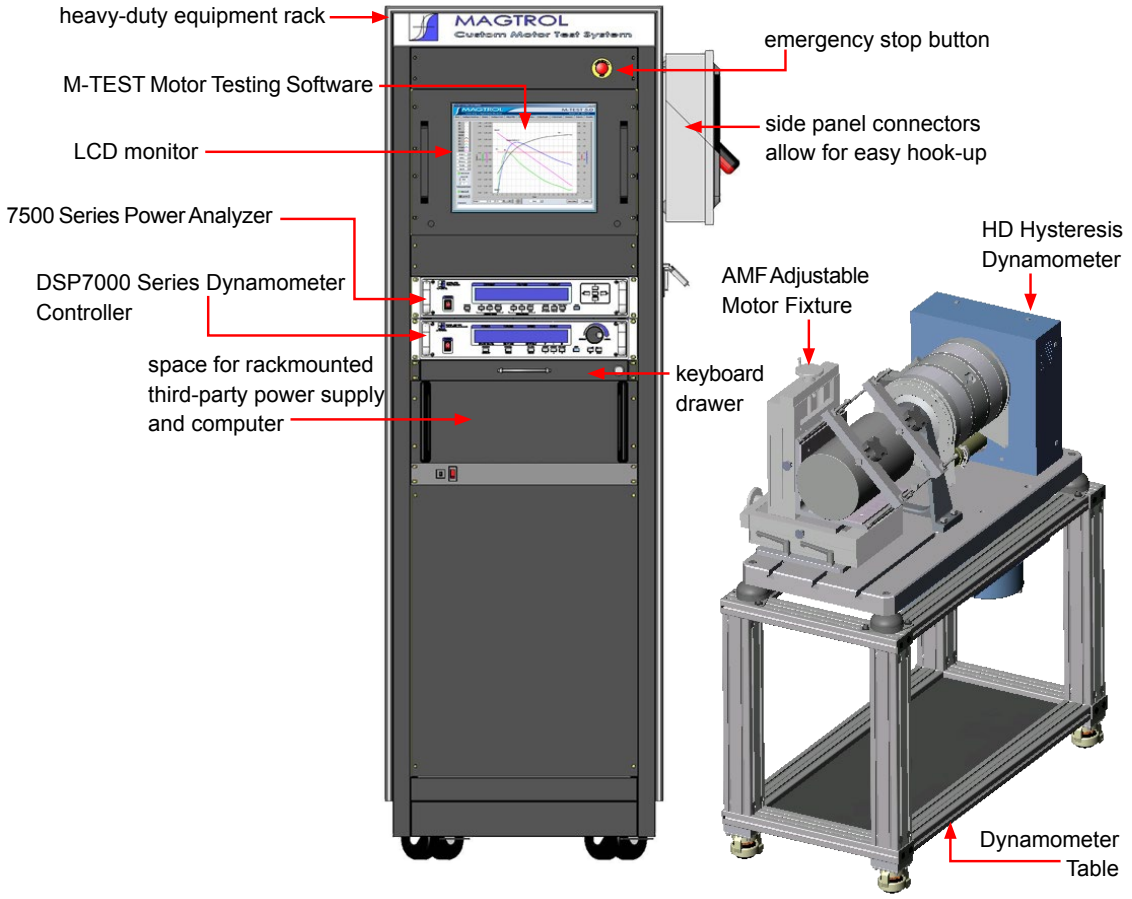
www.magtrol.com/support/downloads.html

MAGTROL

DSP7000 SERIES

CUSTOM MOTOR TEST SYSTEM

HD Series Hysteresis Dynamometers can be incorporated into a Customized Motor Test System. These PC based, turn-key systems are custom designed and built to meet specific user requirements.



MAGTROL

DSP7000 SERIES

ORDERING INFORMATION

DSP7001	High-Speed Programmable Dynamometer Controller - single channel
DSP7002	High-Speed Programmable Dynamometer Controller - dual channel

MODEL NUMBER DSP700_ - _ - _

Channel Type
1 : Single Channel
2 : Dual Channel

Communications Options
0 : none (standard USB)
1 : USB port and GPIB
2 : USB port and RS-232

I/O Options
0 :none (standard)
1 : I/O card in slot 1 (7001)
3 : I/O card in slot 1 and 2 (7002)

SYSTEM OPTIONS AND ACCESSORIES

CATEGORY	DESCRIPTION	MODEL/PART #
TESTING DEVICES	Hysteresis Dynamometers	HD Series
	Eddy-Current Dynamometers	WB Series
	Powder Brake Dynamometers	PB Series
	In-Line Torque Transducers	TM Series
POWER ANALYZERS	High-Speed Single-Phase Power Analyzer	7510
	High-Speed Three-Phase Power Analyzer	7530
SOFTWARE	M-TEST 7 Motor Testing Software	M-TEST 7
POWER SUPPLIES	Power Supply	5200
	Current-Regulated Power Supply	5210
	Power Amplifier (required for HD-825 Dynamometer only)	5241
	Power Supply for WB & PB Dynamometers	DES 410 & DES 411
MISC.	Torque/Speed Conditioner (required for connecting WB/PB Series Dynamometers to DSP6001)	TSC 401
	Temperature Testing Hardware	HW-TTEST
CARDS & CABLES	GPIB Interface Card (PCI)	73M023
	GPIB Cable, 1 meter	88M047
	GPIB Cable, 2 meters	88M048
	Torque Transducer Connector Cable	ER 113/01
	DSP7000 GPIB Card	006579
	DSP7000 RS-232 Card	006578
	DSP7000 I/O Card	006577

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Offices in: Germany
France - China - India
Worldwide Distribution Network

ISO 9001 BUREAU VERITAS Certification

2. Controls

2.1 FRONT PANEL

The front panel provides a power switch, eleven control buttons, a Decrease/Increase Dial, and Vacuum Fluorescent Display (VFD).

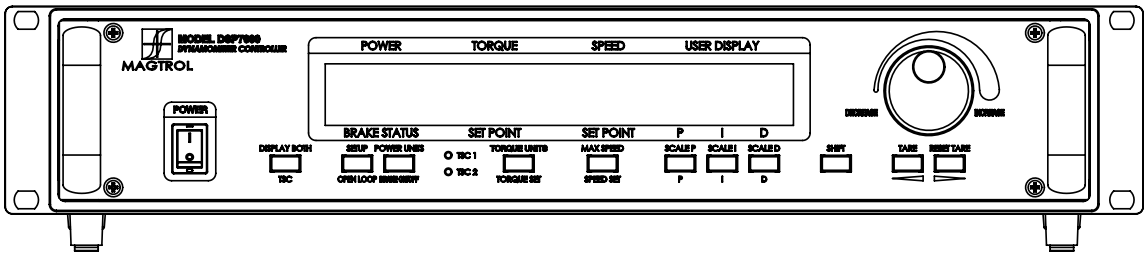


Figure 2–1 Front Panel

2.2 FRONT PANEL CONTROLS AND BUTTONS

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

- Power switch
- Ten double-function control button:

Primary Function	Secondary Function
TSC	DISPLAY BOTH
OPEN LOOP	SETUP
BRAKE ON/OFF	POWER UNITS
TORQUE SET	TORQUE UNITS
SPEED SET	MAX SPEED
P	SCALE P
I	SCALE I
D	SCALE D
◀	TARE
▶	RESET TARE

Note: The TSC/DISPLAY BOTH button has no function on the DSP7001 Programmable Controller.

- One single-function control button:
  - SHIFT (enables saving function and secondary functions printed in blue above control buttons)
- Decrease/Increase Dial (decreases or increases the selected parameter)

2.2.1 Enabling Secondary Functions

To enable the secondary function of the double-function control buttons:

1. Press the blue SHIFT button and release it. The word "SHIFT" appears in the display:

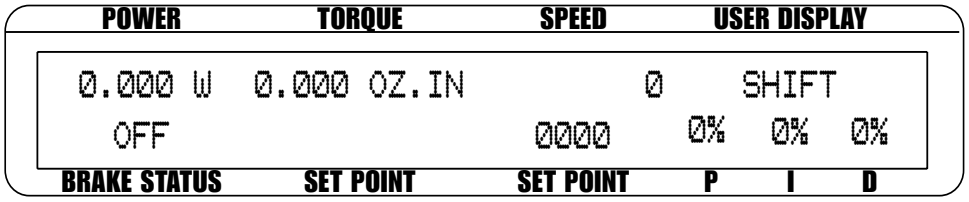


Figure 2–2 Secondary Function Menu

2. Press any control button to enable the function shown in blue letters above the button.
3. Press the SHIFT button again to exit the secondary function and return to main menu.

Note: If the brake status is ON, the SHIFT button will be ignored.

2.2.2 Enabling Saving Function

To save all current programmed settings:

1. Press the SHIFT button two times. The word "SAVING" will appear in the display, as shown in *Figure 2–3 Saving Function Menu.*

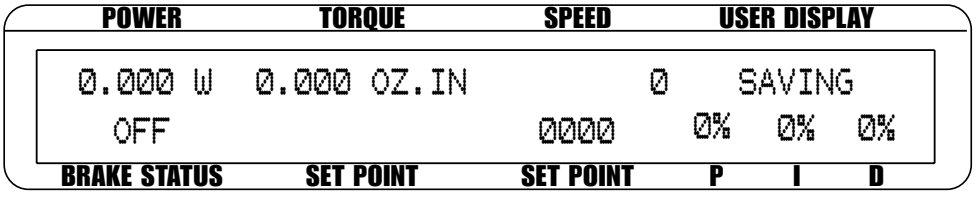


Figure 2–3 Saving Function Menu

2. After a few seconds, the menu will automatically return to the main menu display and all configurations of the unit will be saved into a non-volatile memory.

2.2.3 How to Use Front Panel Controls and Buttons

2.2.3.1 Controls/Single-Function Buttons

Button	To Use	Function
POWER	Press I to turn power ON Press O to turn power OFF.	Turns power ON or OFF.
SHIFT	Press this button and release; then press desired control button.	Enables the function written in blue above control button.
	Press this button two times and release.	Saves current configuration of unit to non-volatile memory.
DECREASE / INCREASE DIAL	Turn clockwise or counterclockwise.	Increases or decreases the parameter selected.

2.2.3.2 Double-Function Buttons

Button	To Use	Function
DISPLAY BOTH	Press SHIFT and release; then press this button.	Displays both TSC1 and TSC2 measurments.
TSC	Press this button	Switches between TSC1 and TSC2 setup.
SETUP	Press SHIFT and release; then press this button.	Displays setup menu for dynamometer, autotune, I/O, system, and user.
OPEN LOOP	Press this button	Enables Open Loop mode (if brake is off).
POWER UNITS	Press SHIFT and release; then press this button.	Sets desired unit of power. Press UP ◀ or DOWN ▶ button to see options. Press SHIFT to enable option.
BRAKE ON/OFF	Press this button.	Turns brake ON or OFF.
TORQUE UNITS	Press SHIFT and release; then press this button.	Sets desired unit of measure. Press UP ◀ or DOWN ▶ button to see options. Press SHIFT to enable option.
TORQUE SET	Press this button.	Enables adjustment of set point for torque loading.
MAX SPEED	Press SHIFT and release; then press this button.	Sets the speed range of the Controller.
SPEED SET	Press this button.	Enables adjustment of set point for speed loading.
SCALE P	Press SHIFT and release; then press this button.	Turns auxiliary/torque transducer display ON or OFF. Enables adjustment of scale factors for torque and speed DAC'S.
SCALE I	Press SHIFT and release; then press this button.	Adjusts GPIB primary address and RS-232 baud rate. Also adjusts display contrast.
SCALE D	Press SHIFT and release; then press this button.	Provides options to set maximum power, dynamometer settings (input units, maximum torque and scale factor), speed encoders and alarms.
TARE/LEFT ◀	Press SHIFT and release; then press this button.	
RESET TARE/ RIGHT ▶	Press SHIFT and release; then press this button.	

2.3 VACUUM FLUORESCENT DISPLAY (VFD)

The VFD provides information about the control functions, the motor under test, and an auxiliary input device or In-Line Torque Transducer (if connected). The displays, from left to right, are:

Top Row	Bottom Row
POWER	BRAKE STATUS (ON or OFF)
TORQUE	SET POINT (TORQUE)
SPEED	SET POINT (SPEED)
USER DISPLAY	P
	I
	D

2.3.1 CONTRAST SETTINGS

The DSP7000 is shipped with the Contrast Setting at zero (lowest) in order to prolong display life. If it is necessary to increase the Contrast for improved readability, execute the following steps:

1. Press SHIFT.
2. Press SETUP button.
3. Select SYSTEM
3. Select CONTR until desired brightness is reached.
4. Press SHIFT 2 times to return to main menu.

Note: Make sure the lowest possible setting is used to achieve desired result. Using a setting higher than necessary may cause display segments to burn-in over a period of time, resulting in uneven illumination from segment to segment.

2.3.2 STATUS DISPLAY MESSAGES

Message	Meaning
SHIFT	Shift button was pressed.
MAX SPEED	Maximum motor RPM.
UNITS	Torque unit of measurement.
REMOTE	Remote control via PC enabled.
RAMP DOWN	Decrease motor speed by increasing load on motor.
RAMP UP	Increase motor speed by decreasing load on motor.
SAVING	Saves current configuration of unit to non-volatlie memory.
RAMP DU	Decrease motor speed and then increase motor speed
POWER UNITS	
UNITS	Torque units

2.4 REAR PANEL

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

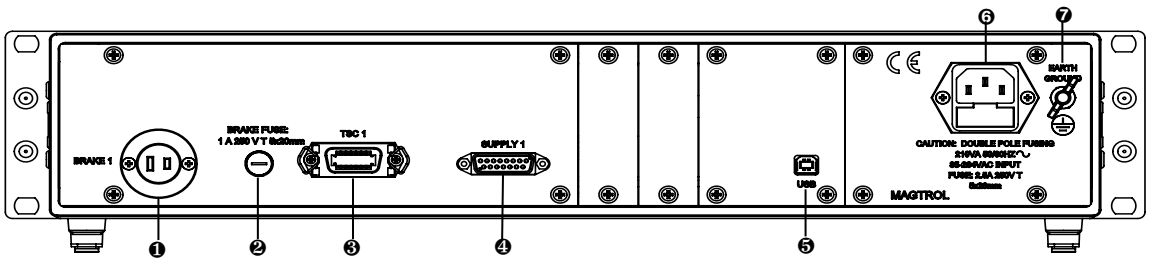


Figure 2–4 DSP7001 Rear Panel

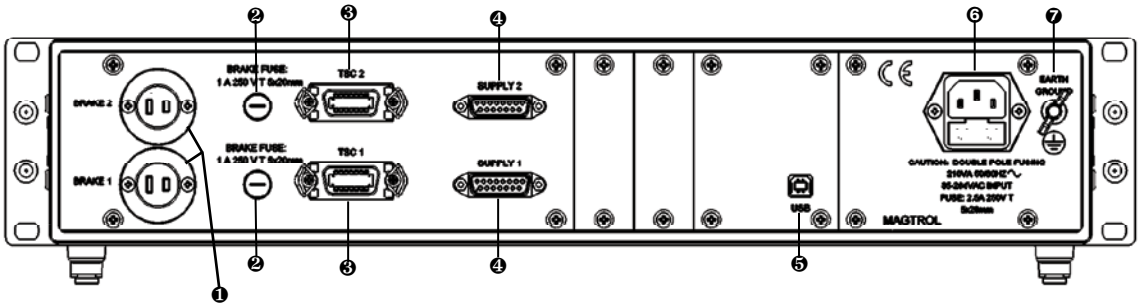


Figure 2–5 DSP7002 Rear Panel

2.4.1 REAR PANEL INPUTS AND OUTPUTS

❶ BRAKE 1/BRAKE 2 — Connect dynamometer brake cable here.

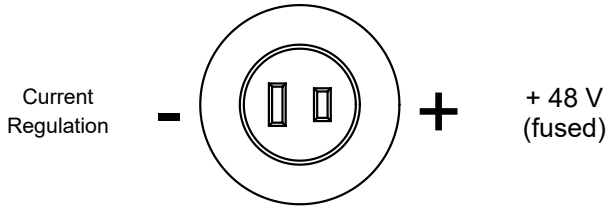
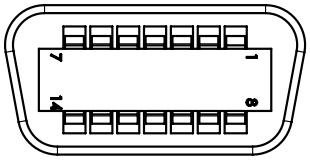


Figure 2–6 Dynamometer Brake Output

❷ BRAKE FUSE — Contains brake fuse (1A 250 VT 5 x 20 mm)

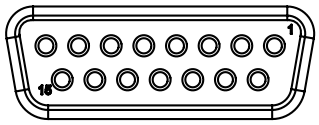
❸	TSC1/TSC2	Connect torque signal cable here.



1. FLOW/CLUTCH
2. TACH. B
3. +24 VDC
4. +24 VDC COM
5. -24 VDC COM
6. -24 VDC
7. +5.0 VDC
8. +5.0 VDC COM
9. D.P. A
10. TACH. A
11. NC
12. D.P. B
13. TORQUE COMMON
14. TORQUE SIGNAL

Figure 2–7 TSC1/TSC2 Connector

❹	SUPPLY 1/SUPPLY 2	Connect WB/PB DES supply for TSC1/TSC2 here.



1. SHIELD (EARTH)
2. ELECTRICAL ALARM
3. SUPPLY 1-N/C / SUPPLY 2-CLUTCH
4. SUPPLY +24VDC
5. N/C
6. +24 VDC COM
7. CURRENT SET POINT (SIGNAL)
8. WATER FLOW ALARM
9. N/C
10. TEMPERATURE ALARM
11. STAND-BY
12. N/C
13. +24 VDC COM
14. CURRENT SET POINT (ANALOG OV)
15. N/C

Figure 2–8 Supply 1/Supply 2 Connector

❺	USB	Connect PC USB cable here.

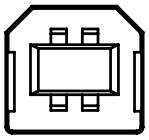
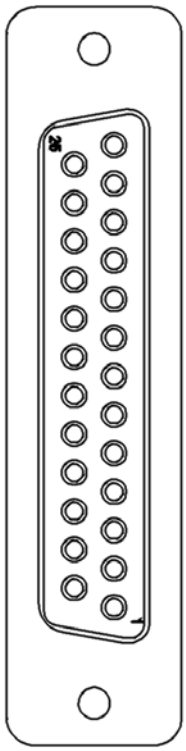


Figure 2–9 USB Connector

❻	POWER	Attach power cord here.
❼	EARTH GROUND	Attach earth ground here.

2.4.2 OPTIONAL IO

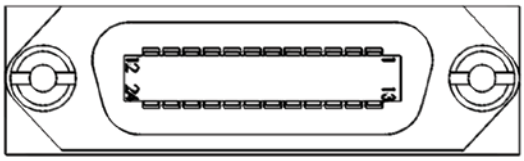
1. IO Card 1 and IO Card 2



1. DAC 1 Analog Torque out OR user DAC 1	14. DAC 1 common
2. DAC 2 Analog Speed out OR user DAC 2	15. DAC 2 common
3. AIN1+	16. AIN1-
4. AIN2+	17. AIN2-
5. 5 Volts	18. 5 Volts Common
6. External Alarm	19. External Alarm Common
7. DI1	
8. DI2	20. 5 Volts Common
9. DOUT1	21. 5 Volts Common
10. Relay1 NO	22. DOUT2
11. Relay1 NC	23. Relay1 Common
12. Relay2 NO	24. 5 Volts Common
13. Relay2 NC	25. Relay2 Common

Figure 2–10 I/O Interface Card 1 and Card 2

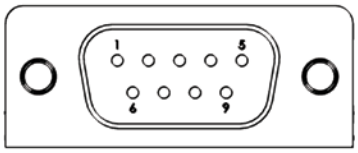
2.4.3 OPTIONAL GPIB



1. D1	13. D5
2. D2	14. D6
3. D3	15. D7
4. D4	16. D8
5. E01	17. REN
6. DAV	18. DAV-COM
7. NRFD	19. NRFD-COM
8. NDAC	20. NDAC-COM
9. IFC	21. IFC-COM
10. SRQ	22. SRQ-COM
11. ATN	23. ATN-COM
12. SHIELD	24. SIGNAL GROUND

Figure 2–11 GPIB Interface

2.4.4 OPTIONAL RS-232



1. DCD
2. TX
3. RX
4. DTR
5. GND
6. DSR
7. RTS
8. CTS
9. RI

Figure 2–*12 RS-232 Interface*

3. Installation/Configuration

Note: Before installing the DSP7000, you should become familiar with the front and rear panels, as outlined in *Chapter 2–Controls*.

3.1 POWERING UP THE DSP7000

WARNING! TO REDUCE THE RISK OF ELECTRIC SHOCK, MAKE SURE THE DSP7000 IS EARTH GROUNDED BEFORE STARTING!

3.1.1 SELF-TEST

After turning the power on to the DSP7000, the display panel will show the message "SERIAL KEY PAD REV X.X" while the DSP7000 is downloading the program.

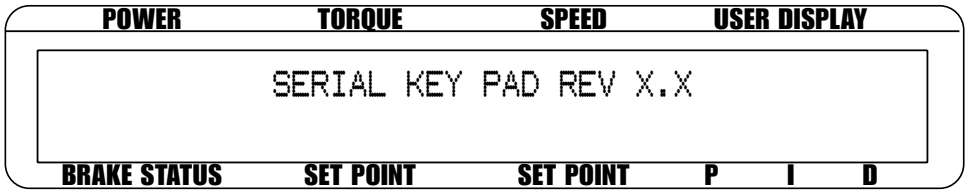


Figure 3–1 Program Download Display

When the program download is complete, the message "MAGTROL MODEL DSP700X, FW REV:XX, FPGA REV:XX" appears.

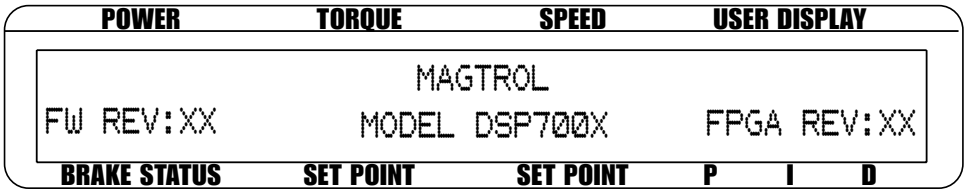


Figure 3–2 Revision Display

If the alarms are disabled, the following display message will appear at this time.

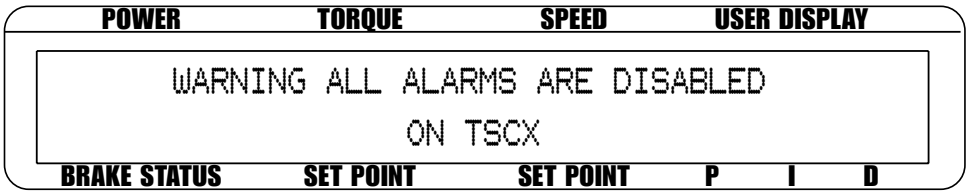


Figure 3-3 Alarm Warning Display

To activate the alarms, refer to *Chapter 6 - Alarm System*.

3.1.2 MAIN MENU

When the DSP7000 is completely powered up and ready for use, the main menu will appear on the display.

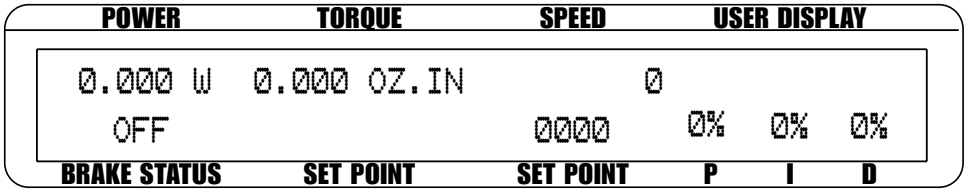


Figure 3–4 Main Menu

3.2 INSTRUMENTATION SETUP (TORQUE)

The DSP7000 has the ability to support a combination of up to two testing instruments with independent or tandem configurations.

Note: In the TSC1 (WB/PB) and TSC2 (WB/PB) combination, the instruments can be configured independently or as a tandem unit.

The setup of your unit will depend on which option you choose. The following sections will illustrate and outline the hardware connection and software configurations needed to begin your testing, based on your selection. For additional reference, see *Appendix C: Front Panel/Display Menu Flow Charts*.

Each channel of the DSP7000 can support the following dynamometers:

TSC 1/TSC 2
HD
WB
PB
TM/TF
HD5

3.2.1 DYNAMOMETER CONFIGURATION MENU

To reach the dynamometer configuration menu:

1. Turn on DSP7000 power. See *Section 3.1 – Powering Up the DSP7000*.
2. Press SHIFT. The word "SHIFT" will appear in the display.
3. Press the SETUP button. The display should appear as follows:

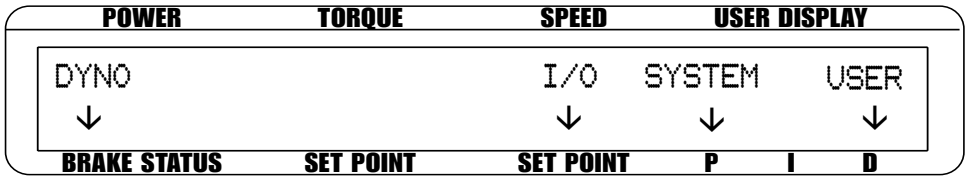


Figure 3–5 Setup Menu

4. Select DYNO. The display should appear as follows:

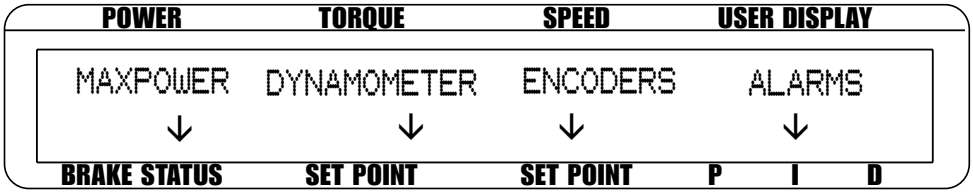


Figure 3-6 Dyno Setup Menu

5. Select DYNAMOMETER. The display should appear as follows:

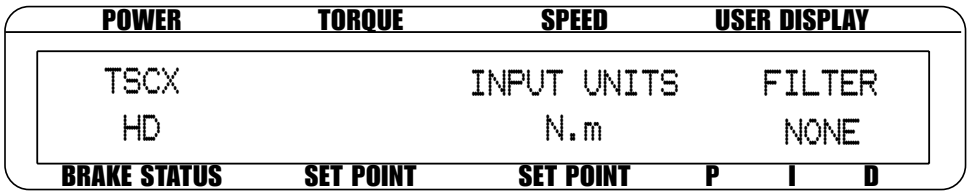


Figure 3–7 Dynamometer Configuration Menu

If a HD5, WB, PB, TM/TS/TF is selected, enter rated torque in N·m of the the selected device into scale factor.

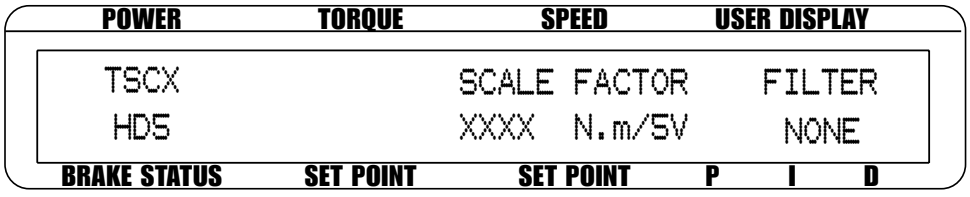


Figure 3–8 Dynamometer Configuration Menu for HD5, WB, PB, TM/TS/TF

6. Pressing the POWER UNITS button allows selection of the preferred testing device (HD, WB, PB or HD5) for TSC1. Pressing the MAX SPEED button allows selection of the input units (N·m, oz·in, oz·ft, lb·in, lb·ft, g·cm, kg·cm, mN·m, cN·m). Pressing SCALE I allows selection of a filter if desired. Refer to the remainder of this chapter for more detailed instructions on setup and configuration of the different testing devices.

NOTE: For information on Filters, *see Section 3.3 – Torque Filter Setup.*

3.2.2 HYSTERESIS DYNAMOMETER SETUP

3.2.2.1 Hardware Connection

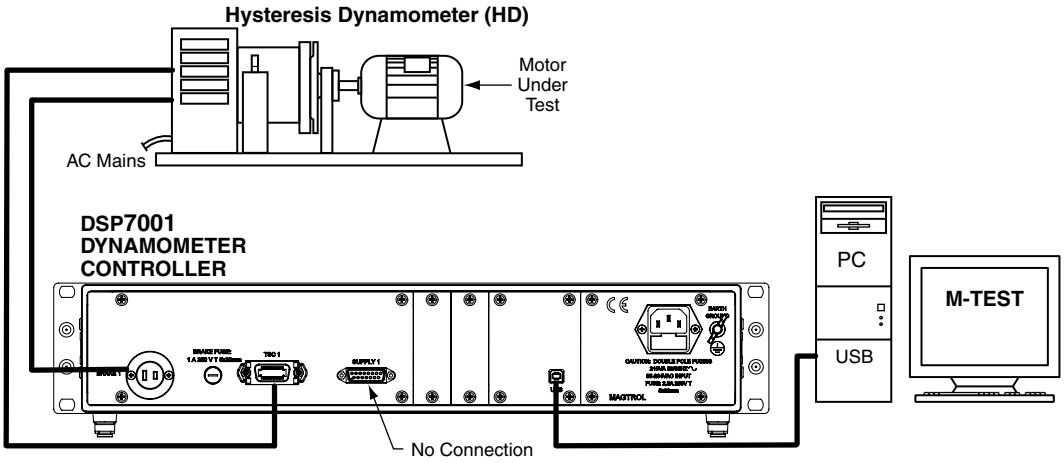


Figure 3–9 Hysteresis Dynamometer Setup

3.2.2.2 Software Configuration

1. Turn on the DSP7000 and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until HD is reached.
3. Press MAX SPEED until the desired input unit for TSC.
4. Press SCALE I to add a filter if desired.
5. Press SHIFT. The display should appear as follows:

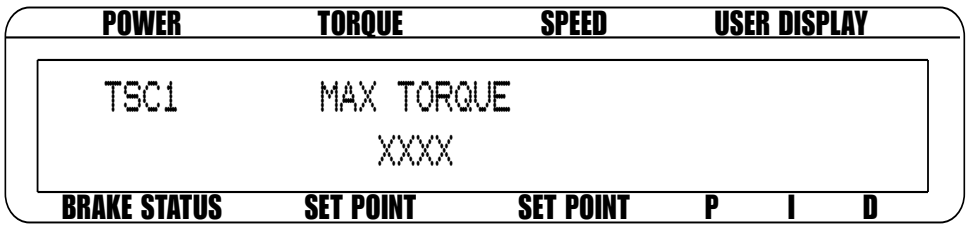


Figure 3–10 Hysteresis Setup Menu

6. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque for TSC1.
7. Press SHIFT 3 times to complete the initial setup and return to the main menu.

3.2.3 HYSTERESIS DYNAMOMETER WITH TRANSDUCER SETUP

3.2.3.1 Hardware Connection

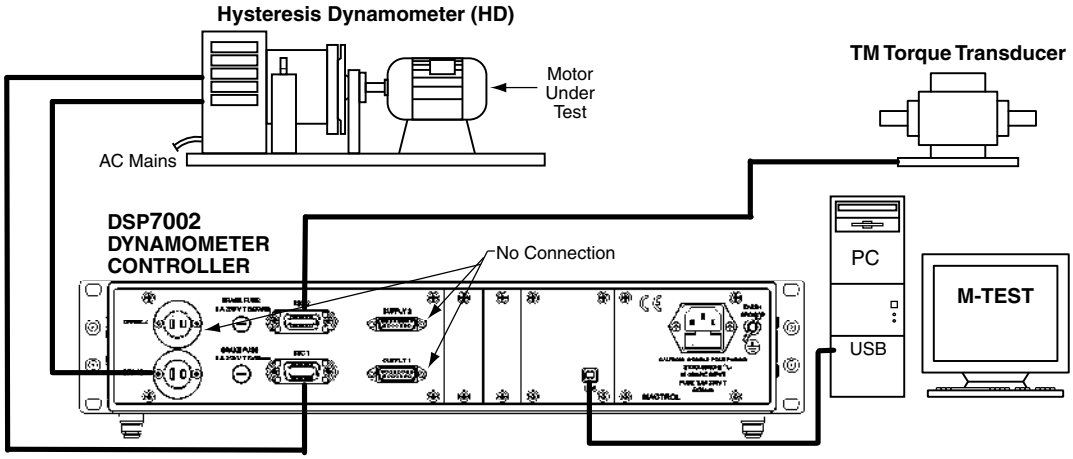


Figure 3–11 Hysteresis Dynamometer with Torque Transducer Setup

3.2.3.2 Software Configuration

1. Turn on the DSP7000. Set up TSC1 as described in section *3.2.2 - Hysteresis Dynamometer Setup*. Press TSC to switch to TSC2 setup and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until TM/TF is reached for TSC2.
3. Press TORQUE UNITS until HB is reached.
4. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor for TSC2.
5. Press SCALE I to add a filter if desired.
6. Press SHIFT. The display should appear as follows:

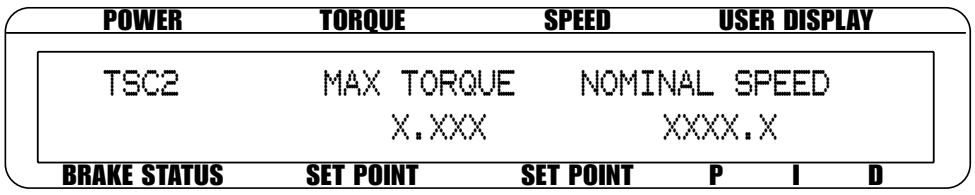


Figure 3–12 Torque Transducer Setup Menu

7. Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed.
8. Press SHIFT 3 times to return to the main menu.

3.2.4 HYSTERESIS DYNAMOMETER WITH EDDY-CURRENT OR POWDER BRAKE SETUP

3.2.4.1 Hardware Connection

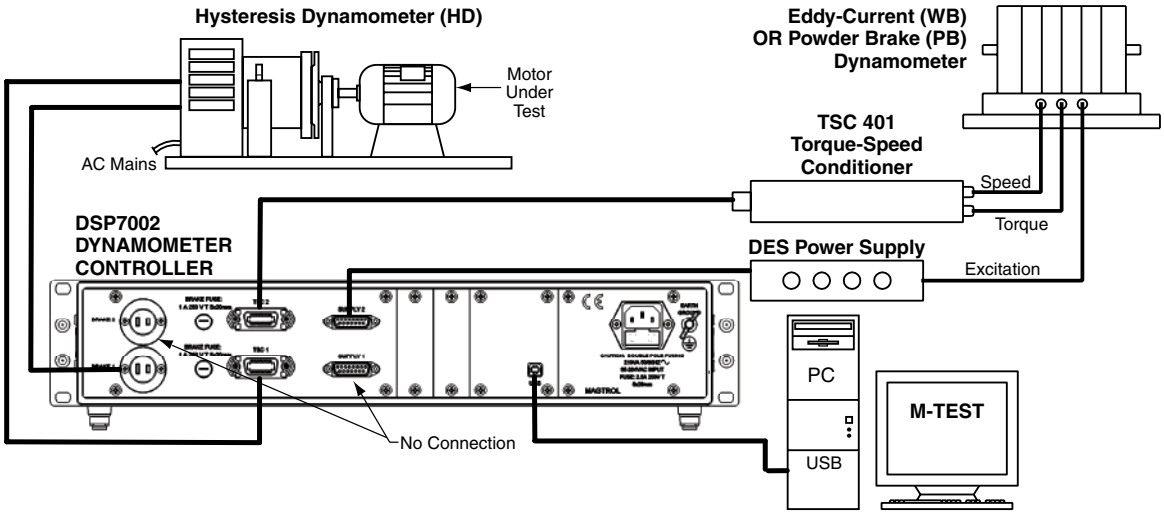


Figure 3–13 Hysteresis Dynamometer with Eddy-Current or Powder Brake Setup

3.2.4.2 Software Configuration

1. Turn on the DSP7000. Set up TSC1 as described in section *3.2.2 - Hysteresis Dynamometer Setup*. Press TSC to swtich to TSC2 setup and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until WB or PB is reached.
3. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor for TSC2.
4. Press SCALE I to add a filter if desired.

5.a. If using an Eddy Current Dynamometer, press SHIFT. The display should appear as follows:

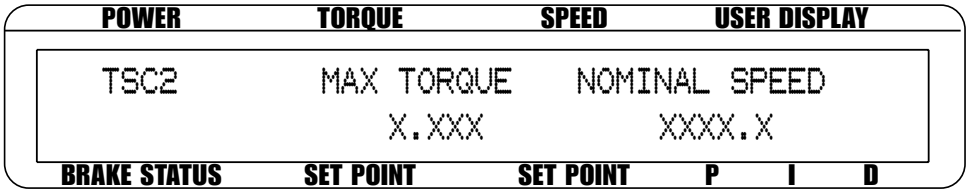


Figure 3–14 TSC2 Eddy-Current Setup Menu

Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed. Press SHIFT 4 times to complete the initial setup and return to the main menu.

5.b. If using a Powder Brake Dynamometer, press SHIFT. The display should appear as follows:

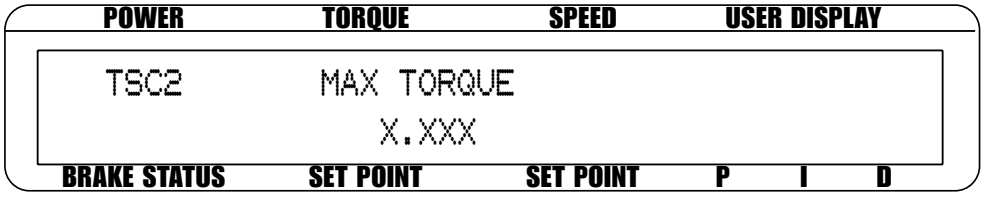


Figure 3–15 TSC2 Powder Brake Setup Menu

Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press SHIFT 3 times to complete the initial setup and return to the main menu.

3.2.5 EDDY-CURRENT OR POWDER BRAKE DYNAMOMETER SETUP

3.2.5.1 Hardware Connection

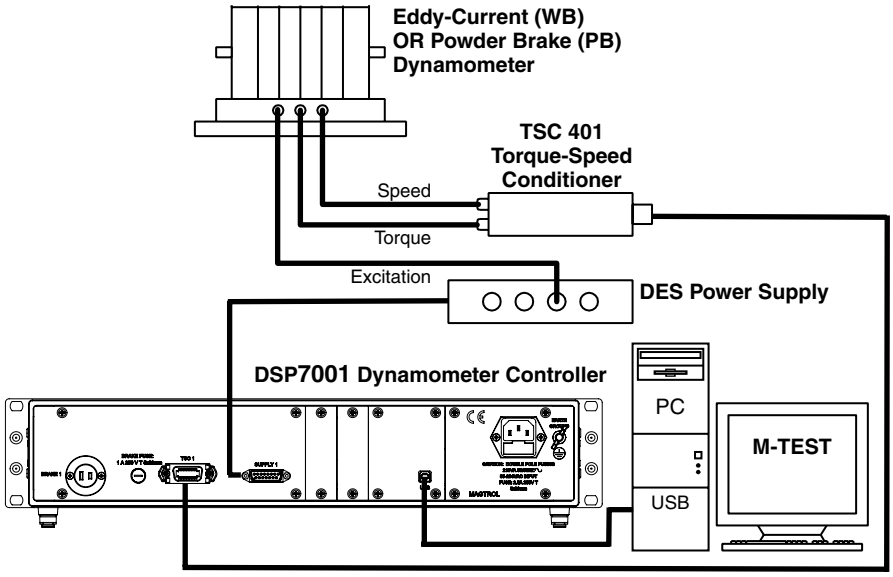


Figure 3–16 Eddy-Current or Powder Brake Dynamometer Setup

3.2.5.2 Software Configuration

1. Turn on the DSP7000 and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until WB or PB is reached.
3. Press the MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor. Press SCALE I to add a filter if desired.

4.a If using an Eddy Current Dynamometer, press SHIFT. The display should appear as follows:

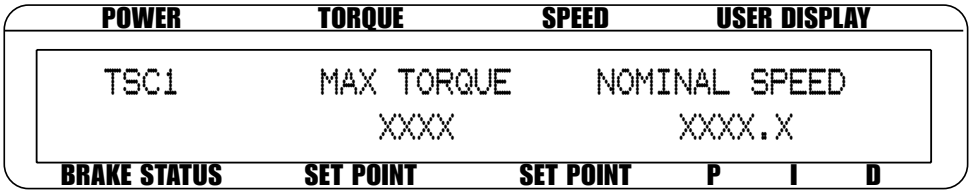


Figure 3–17 TSC1 Eddy-Current Setup Menu

Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed. Press SHIFT 3 times to complete the initial setup and return to the main menu.

4.b If using a Powder Brake Dynamometer, press SHIFT. The display should appear as follows:

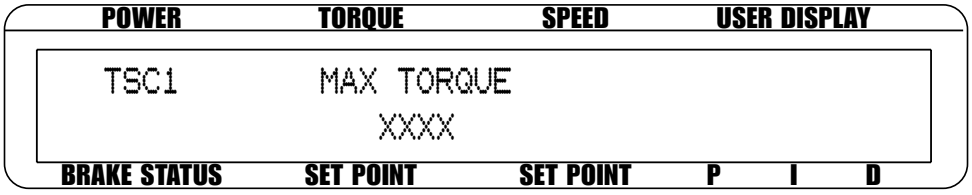


Figure 3-18 TSC1 Powder Brake Setup Menu

Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press SHIFT 3 times to complete the initial setup and return to the main menu.

3.2.6 EDDY-CURRENT OR POWDER BRAKE DYNAMOMETER WITH TORQUE TRANSDUCER SETUP

3.2.6.1 Hardware Connection

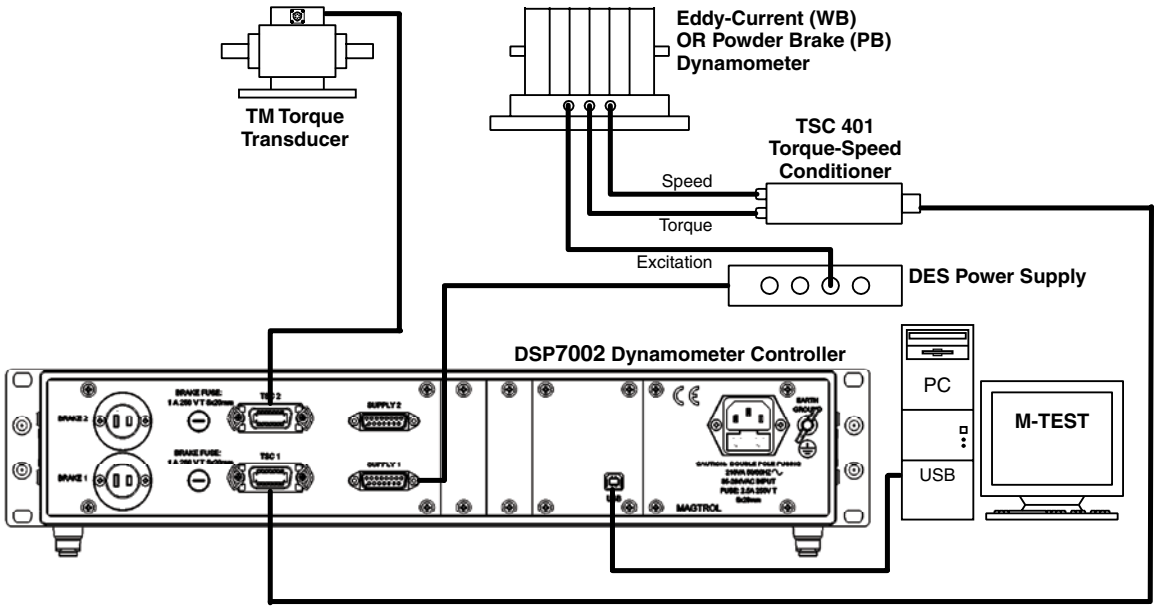


Figure 3–19 Eddy-Current or Powder Brake Dynamometer with Torque Transducer Setup

3.2.6.2 Software Configuration

1. Turn on the DSP7000. Set up TSC1 as described in section *3.2.5 Eddy-Current or Powder Brake Dynamometer Setup*. Press TSC to swtich to TSC2 setup and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until TM/TF is reached.
3. Press TORQUE UNITS until WB or PB is reached.
4. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor.
5. Press SCALE I to add a filter if desired.
6. Press SHIFT. The display should appear as follows:

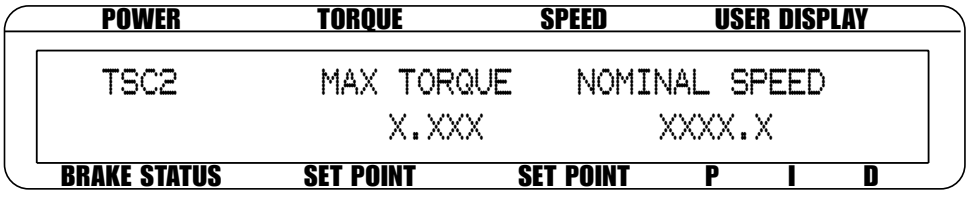


Figure 3-20 TSC2 torque transducer setup menu

Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed. Press SHIFT 3 times to complete the initial setup and return to the main menu.

3.2.7 TWO EDDY-CURRENT/POWDER BRAKE DYNAMOMETERS (INDEPENDENT SETUP)

3.2.7.1 Hardware Connection

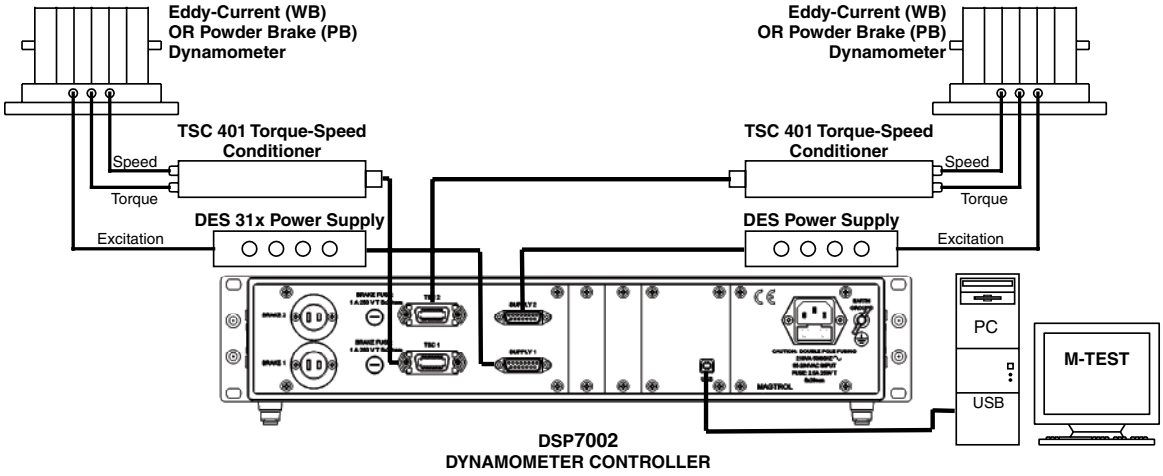


Figure 3–21 Two Eddy-Current/Powder Brake Dynamometers (Independent Setup)

3.2.7.2 Software Configuration

1. Turn on the DSP7000. Set up TSC1 as described in section *3.2.5 Eddy-Current or Powder Brake Dynamometer Setup*. Press TSC to swtich to TSC2 setup and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until WB or PB is reached.
3. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor for TSC2.
4. Press SCALE I to add a filter if desired.

5.a. If using an Eddy Current Dynamometer, press SHIFT. The display should appear as shown in *Figure 3–13 TSC2 Eddy-Current Setup Menu*. Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed. Press SHIFT 2 times to return to the setup menu. The display will appear as follows:

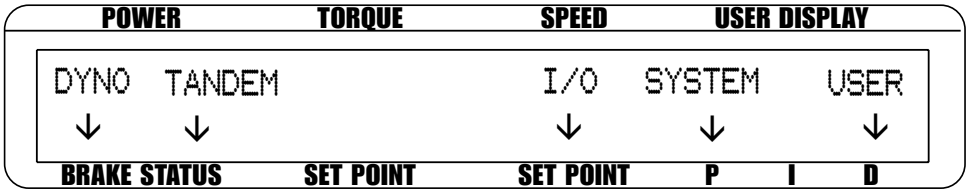


Figure 3-22 Tandem Setup Menu

5b. If using a Powder Brake Dynamometer, press SHIFT. The display should appear as shown in *Figure 3-14 TSC2 Powder Brake Setup Menu*. Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press SHIFT 2 times to return to the setup menu. See *Figure 3-21 Tandem Setup Menu*.

6. Press POWER UNITS to select tandem.

7. The menu will appear as follows:

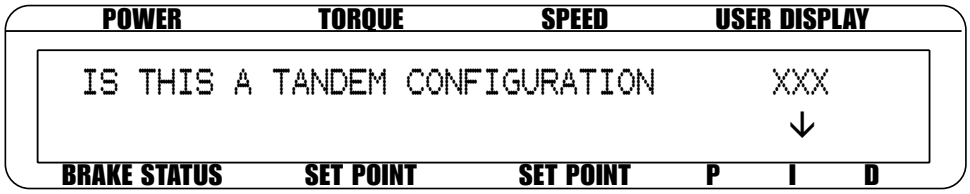


Figure 3–22 Tandem Configuration Menu

8. Press the SCALE I button until the menu says "NO".

9. Press SHIFT 2 times to complete the initial setup and return to the main menu.

3.2.8 Two Eddy-Current/Powder Brake Dynamometers (Tandem Setup)

3.2.8.1 Hardware Connection

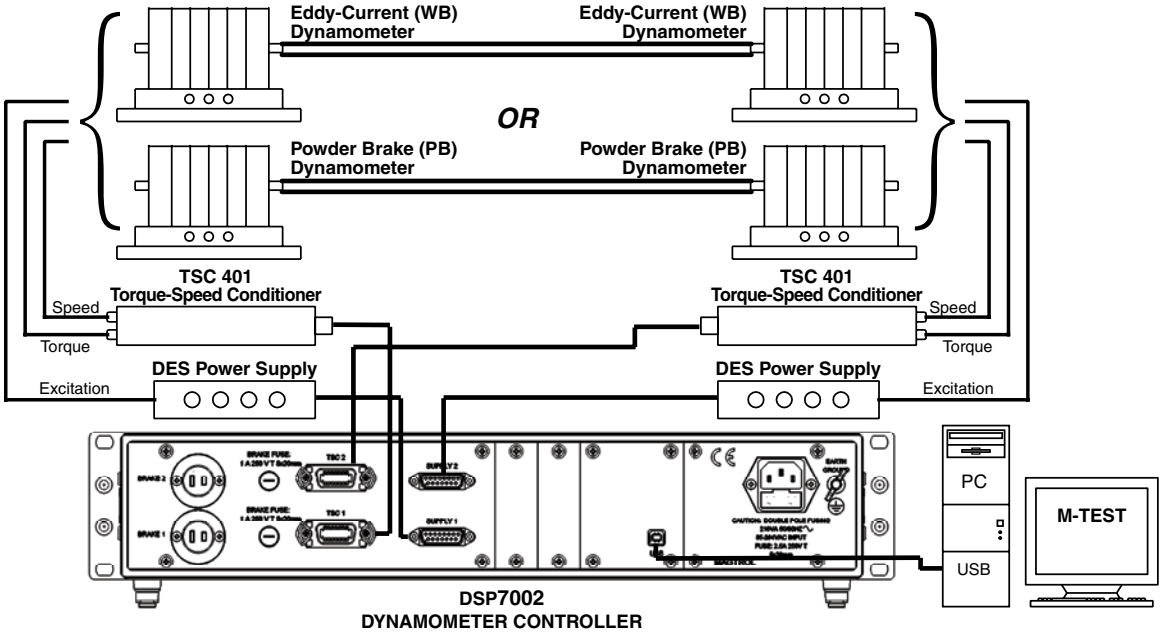


Figure 3–23 Two Eddy-Current/Powder Brake Dynamometers (Tandem Setup)

Note: This particular tandem configuration is only applicable to a WB-WB or PB-PB combination.

3.2.8.2 Software Configuration

1. Turn on the DSP7000. Set up TSC1 as described in section *3.2.5 Eddy-Current or Powder Brake Dynamometer Setup*. Press TSC to swtich to TSC2 setup and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu*.
2. Press POWER UNITS until WB or PB is reached.
3. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor for TSC2.
4. Press SCALE I to add a filter if desired.

5.a. If using an Eddy Current Dynamometer, press SHIFT. The display should appear as shown in *Figure 3–13 TSC2 Eddy-Current Setup Menu*. Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed. Press SHIFT 2 times to return to the setup menu. See *Figure 3-21 Tandem Setup Menu.*

5b. If using a Powder Brake Dynamometer, press SHIFT. The display should appear as shown in *Figure 3-14 TSC2 Powder Brake Setup Menu*. Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press SHIFT 2 times to return to the setup menu. See *Figure 3-21 Tandem Setup Menu*.

6. Press POWER UNITS to select tandem. See *Figure 3-22 Tandem Configuration Menu*.
7. Press the SCALE I button until the menu says “YES”.
8. Press SHIFT 2 times to complete the initial setup and return to the main menu.

3.2.9 EDDY-CURRENT DYNAMOMETER WITH POWDER BRAKE DYNAMOMETER (TANDEM SETUP)

3.2.9.1 Hardware Connection

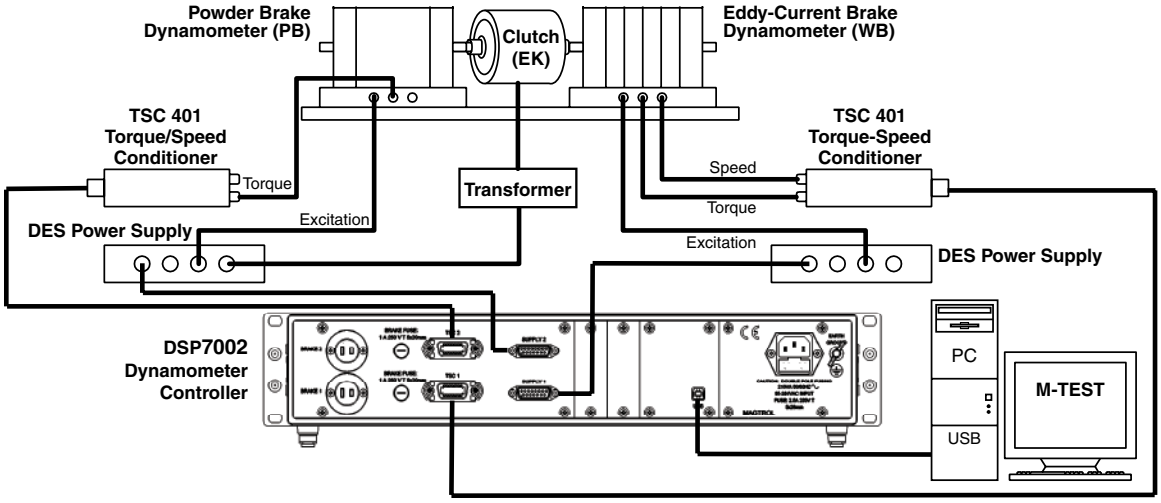


Figure 3–24 Eddy-Current Dynamometer with Powder Brake Dynamometer (Tandem Setup)

3.2.9.2 Software Configuration

1. Turn on the DSP7000 and proceed to the dynamometer configuration menu. See *Section 3.2.1 – Dynamometer Configuration Menu*.
2. Select POWER UNITS until WB is reached for TSC1.
3. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor.
4. Press SCALE I to add a filter if desired.
5. Press SHIFT to get to the TSC1 Eddy-Current Setup Menu. See *Figure 3-16 TSC1 Eddy-Current Setup Menu.*
6. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque. Press SCALE P button use ◀ and ▶ buttons and Decrease/Increase dial to set desired nominal speed. Press SHIFT 3 times to complete setup and return to the main menu.
7. Press TSC to switch to TSC2 setup and proceed to the dynamometer configuration menu.
8. Select POWER UNITS until PB is reached for TSC2.
9. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired scale factor.
10. Press SCALE I to add a filter if desired.
11. Press SHIFT to get to the TSC2 Powder Brake Setup Menu. See *Figure 3-14 TSC2 Powder Brake Setup Menu.*
12. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired max torque.
13. Press SHIFT 2 times. The menu will appear as shown in *Figure 3–21 Tandem Setup Menu*.

14. Select TANDEM. The display will appear as shown in *Figure 3-22 Tandem Configuration Menu.*
14. Press the SCALE I button until the menu says "YES".
15. Press SHIFT once to reach the Maximum Speed Excited Menu as shown below.

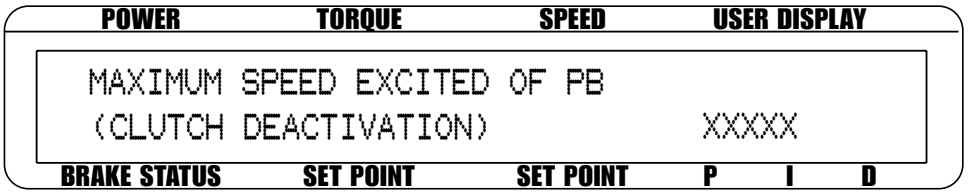


Figure 3–25 Maximum Speed Excited Menu

16. Press the SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set maximum speed excited of PB.
17. Press SHIFT 3 times to complete initial setup and return to the main menu.

Note: The TSC key is disabled in tandem configuration.

3.2.10 In-Line Torque Transducer with Brake

3.2.10.1 Hardware Connection

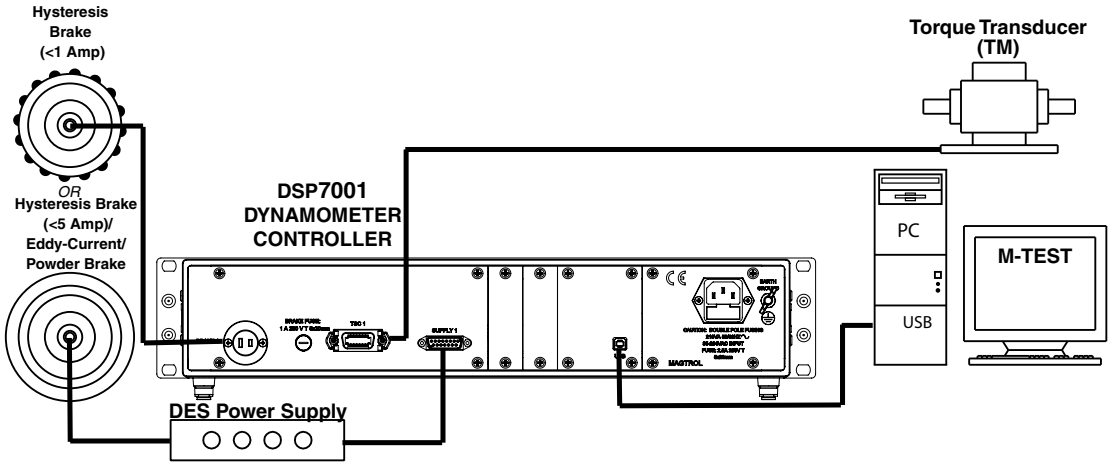


Figure 3-26 In-Line Torque Transducer with Brake

3.2.10.2 Software Configuration

1. Turn on the DSP7000 and proceed to the dynamometer configuration menu. *See Section 3.2.1 – Dynamometer Configuration Menu.*
2. Press POWER UNITS until TM/TF is reached.
3. Press TORQUE UNITS until the desired brake is selected.
4. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set the Scale Factor.

5. Press SCALE I to add a filter if desired.
6. Press SHIFT. The display should appear as follows:

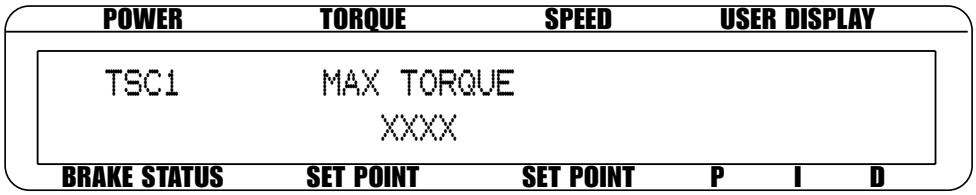


Figure 3–27 TSC1 Setup Menu

7. Press the TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set maximum torque.
8. Press SHIFT 3 times to complete the setup and return to the main menu.

3.3 TORQUE FILTER SETUP

Note: Filter setup should take place after hardware installation and software configuration of the chosen testing instruments has been completed. *See Chapter 3 – Installation/Configuration*.

There are six different Filter settings to choose from including 2 Hz, 5 Hz, 10 Hz, 20 Hz, 50 Hz, 100 Hz and NONE. The following instructions show how to select the desired Filter for each channel:

1. Starting from the main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4. Select DYNAMOMETER.
5. Press SCALE I button until the desired filter setting is reached.
6. Press SHIFT repeatedly until the main menu is reached. The number of times will vary depending on testing instrument selection.
7. To setup a filter for TSC2, press TSC to switch to TSC2 setup and follow the instructions above.

3.4 INSTRUMENTATION SETUP (SPEED)

Note: Regardless of the input selected for the speed, the speed calculated is made available to the USB/GPIB/RS-232 control loop at a rate of 488 samples per second and to the display at a slower rate of about 1/4 second.

Tach A is designed to be used with a single output speed transducer. The maximum frequency into the system when using the Tach A selection is 200 kHz. The pulse per revolution (ppr) can be set from 1 to 99999 ppr.

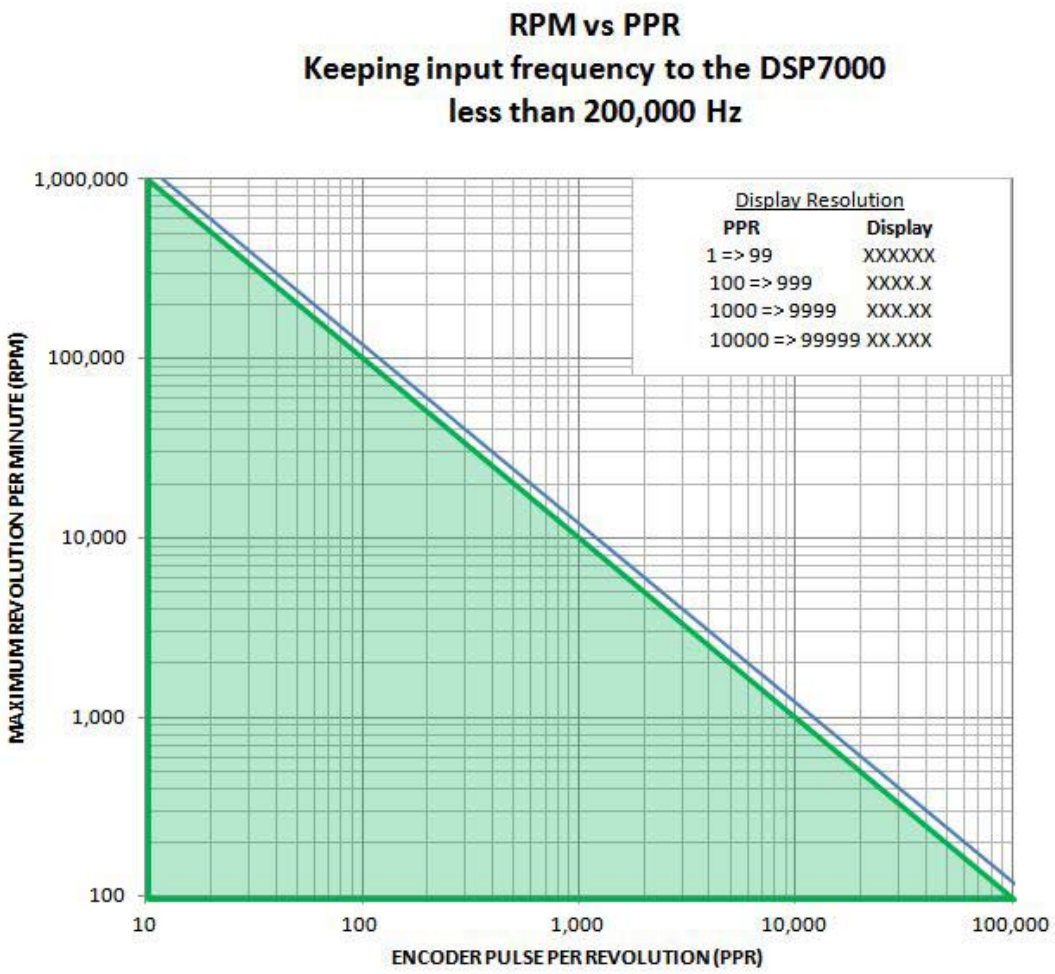


Figure 3–28 RPM vs PPR Chart

Figure 3–27 provides a reference for allowable maximum RPMs when using an encoder with a given PPR. Theses combinations keep the input frequency within the allowable limits for the DSP7000.

Quad Deg is designed to be used with very slow RPM applications with a quadrature encoder in the system. The speed of the system is limited to 100 RPM. The pulse per revolution (ppr) can be set from 1000 to 99999 ppr. The angle to perform the measurement can be set from 10 to 90 degrees. The maximum frequency from the encoder can be as high as 200 kHz.

AI 1 is designed to take the analog voltage from the IO card associated with the channel being setup and use that analog voltage as the speed input. A scale factor can be applied to the input.

1. Starting from main menu, press SHIFT.
2. Press SETUP to display the setup menu.
3. Select DYNO to display the dynamometer setup menu.
4. Select ENCODERS. The display should appear as follows:

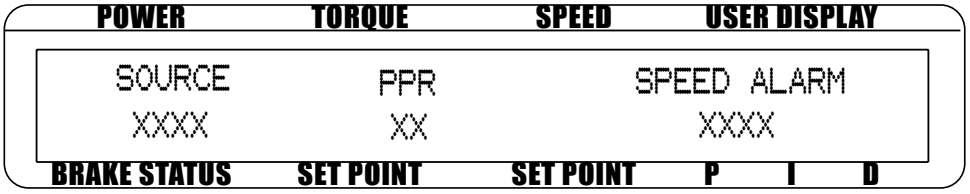


Figure 3–29 Encoder Menu

5. Press POWER UNITS button until the desired source selection for the TSC is reached (TACH A, QUAD DEG, AI 1).

3.4.1 TACH A

1. From the main menu follow the instrumentation setup instructions. *See Section 3.4 - Instrumentation Setup (Speed) and Figure 3–28 Encoder Menu.*
2. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set the PPR.
3. Press SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set the Speed Alarm.
4. Press SHIFT 3 times to complete the setup and return to the main menu.

3.4.2 QUAD DEG

1. From the main menu follow the instrumentation setup instructions. *See Section 3.4 - Instrumentation Setup (Speed).* The display should appear as follows:

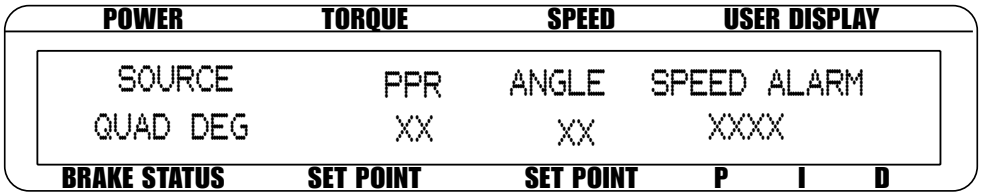


Figure 3–30 QUAD DEG Menu

2. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set the PPR.
3. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set the Angles.
4. Press SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set the Speed Alarm.
5. Press SHIFT 3 times to complete the setup and return to the main menu.

3.4.3 AI 1

1. From the main menu follow the instrumentation setup instructions. *See Section 3.4 - Instrumentation Setup (Speed).* The display should appear as follows:

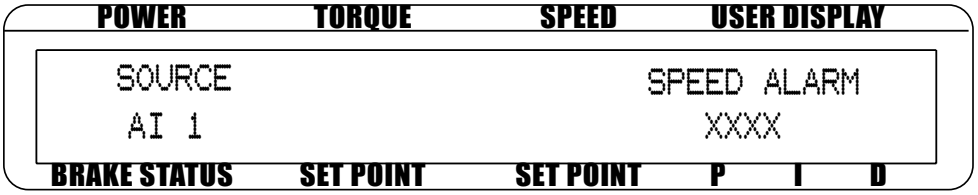


Figure 3–31 AI 1 Menu

2. Press SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set the Speed Alarm.
3. Press SHIFT 3 times to complete the setup and return to the main menu.

3.5 CONFIGURE COMMUNICATION

3.5.1 GPIB Address

1. Starting from the main menu, press SHIFT.
2. Press SETUP to display the setup menu.
3. Press SCALE P to display the System setup menu. The display should appear as follows:

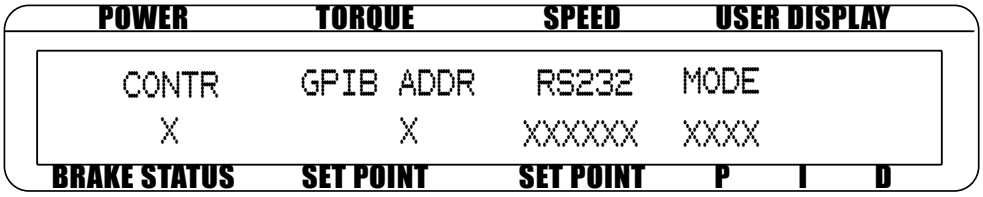


Figure 3–32 System Setup Menu

4. Press TORQUE UNITS button to select the desired GPIB Address.
5. Press SHIFT 2 times to complete the setup and return to the main menu.

3.5.2 RS-232 Interface

1. Starting from the main menu, press SHIFT.
2. Press SETUP to display the setup menu.
3. Press SCALE P to display the System Setup Menu. *See figure 3-31 System Setup Menu.*
4. Press MAX SPEED button to select the desired RS-232 interface.
5. Press SHIFT 2 times to complete the setup and return to the main menu.

4. PID Settings

4.1 ABOUT THE PID LOOP

The DSP7000 has PID adjustment capability for both the speed and torque modes to provide the best system response. The PID Loop comprises the following three variables:

P = proportional gain
I = integral
D = derivative

Other important variables include:

- Set point - desired load or speed
- Error - difference between the set point and the actual measurement

4.1.1 P (Proportional Gain)

With proportional gain, the controller output is proportional to the error or to a change in measurement. Deviation from the set point is usually present. Increasing the proportional gain will make the PID loop unstable. Increasing the integral value will eliminate this instability. For best loop control, set the proportional gain as high as possible without causing the loop to become unstable.

4.1.2 I (Integral)

With integral, the controller output is proportional to the amount of time the error is present. Increasing the integral value eliminates the offset from the set point. If the response becomes oscillatory increase the derivative value.

4.1.3 D (Derivative)

With derivative, the controller output is proportional to the rate of change of measurement or error. Derivative can compensate for a changing measurement. Derivative takes action to inhibit more rapid changes of the measurement than proportional gain.

4.2 SETTING PID VALUES

4.2.1 How To Set P (Proportional Gain) Value

1. Starting at the main menu press the P button.
2. Use the Decrease/Increase dial until the desired percentage is reached (ranges from 0-99).

4.2.2 How to Set I (Integral) Value

1. Starting at the main menu press the I button.
2. Use the Decrease/Increase dial until the desired percentage is reached (ranges from 0-99).

4.2.3 How to Set D (Derivative) Value

1. Starting at the main menu press the D button.
2. Use the Decrease/Increase dial until the desired percentage is reached (ranges from 0-99).

4.3 SETTING THE CORRECT PID'S FOR YOUR MOTOR

Note: Each type of motor will have it's own optimum PID setting at different load points.

4.3.1 SETTING THE PID WITH AN UNKNOWN MOTOR OR SYSTEM

If the user is unfamiliar with the characteristics of the motor under test, it is recommended to begin in Open Loop Control mode. In doing so, the user can safely get an idea of the motor's performance.

1. To enter Open Loop Control mode, begin with the motor and brake OFF. Press the OPEN LOOP button. The display will appear as follows:

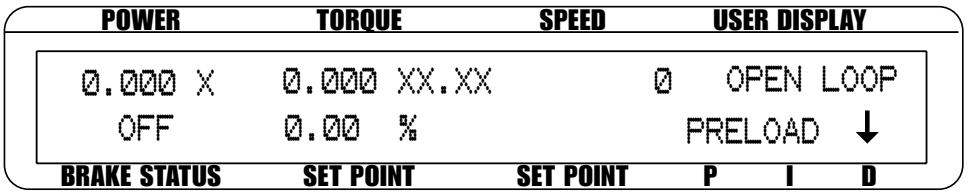


Figure 4–1 Open Loop Control Menu

2. Set the percent excitation to zero using the decrease/increase dial.
3. Start the motor.
4. Turn on the brake power.
5. Slowly increase the excitation current to the brake.
6. Make a note of the torque and speed values of which the motor is capable.
7. To exit the Open Loop Control mode and return to the main menu, turn the motor and brake OFF and press the OPEN LOOP button.

4.3.2 SETTING THE PID FOR TORQUE CONTROL

1. With the motor and brake OFF, set the desired Torque Set Point by pressing the TORQUE SET button and using the ◀ and ▶ buttons and Decrease/Increase dial.
2. Set the P, I and D values to zero.
3. Turn the motor ON.
4. Turn the brake ON.
5. Slowly increase the P term until the torque read is about 25% of the desired load point.

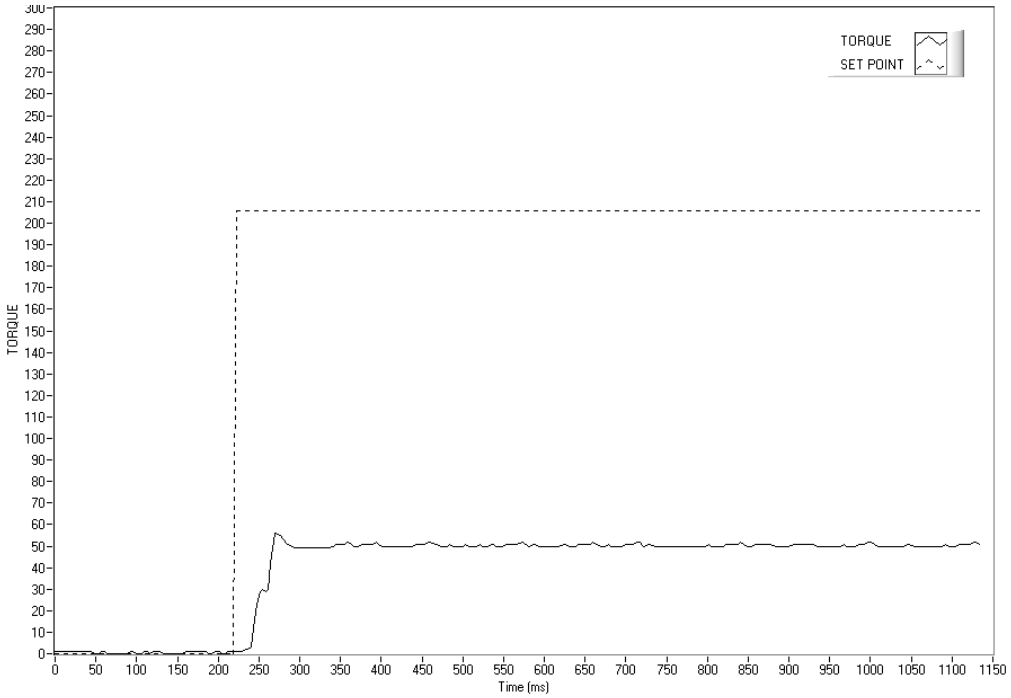


Figure 4–2 Initial P Setting for Torque Control at 25%

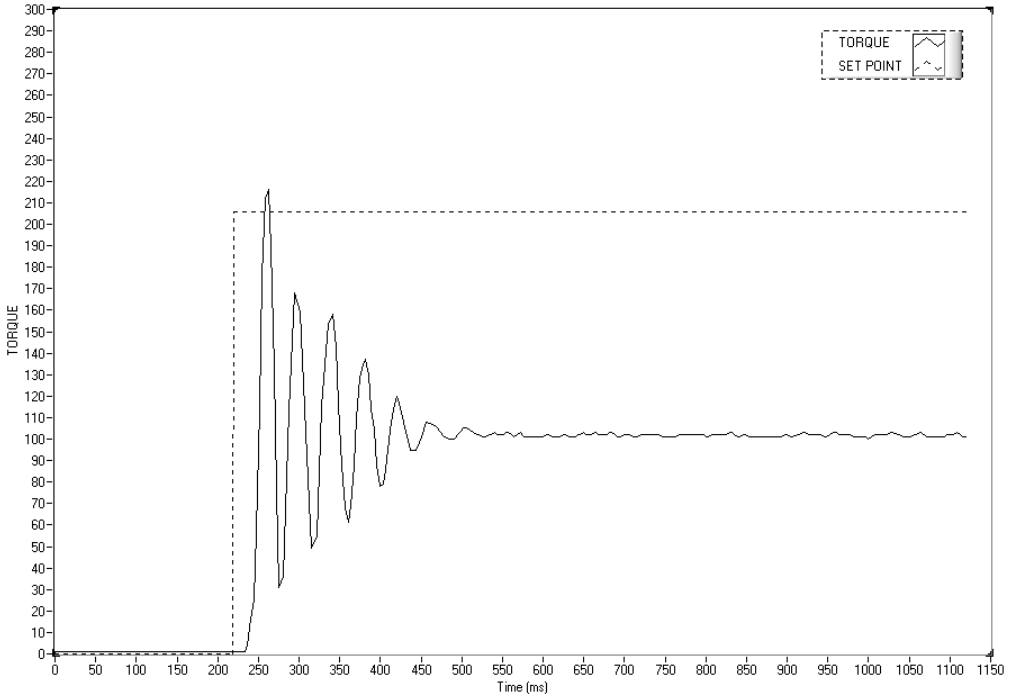


Figure 4–3 High Initial P Setting for Torque Control

6. Turn the brake OFF.
7. Increase the I term to 10%.
8. Turn the brake ON and observe response, then turn the brake OFF. Desired Result is a fast response with some over shoot.

a. If the response was too slow, increase the I term in 1-5% increments and repeat #8.
b. If the response was too fast, decrease the I term in 1-5% increments and repeat #8.

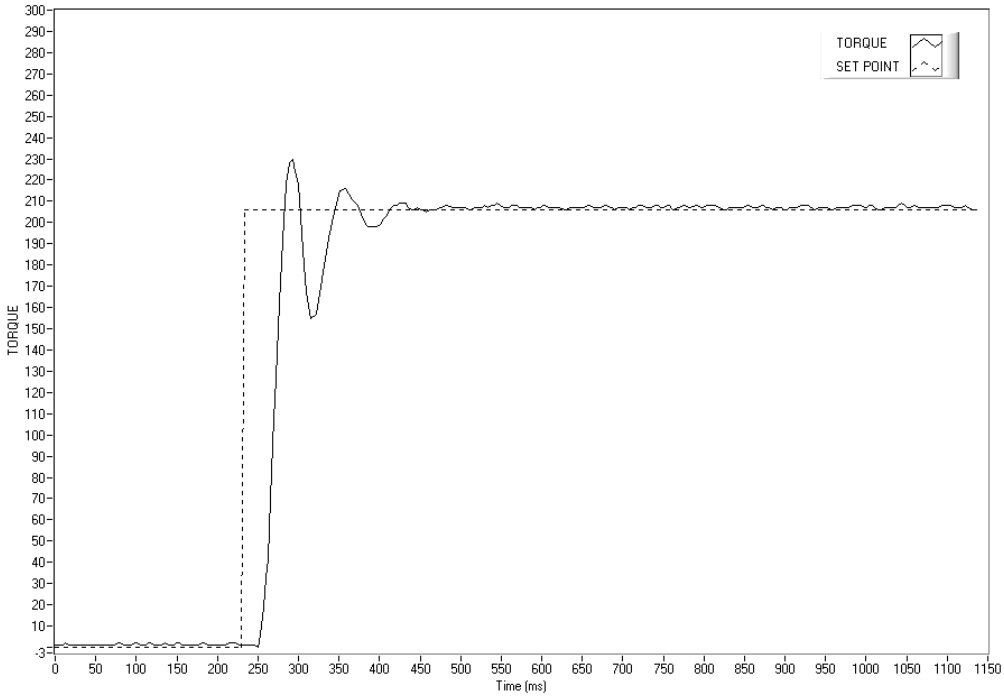


Figure 4–4 Initial I Setting for Torque Control

c. If there is too much over shoot, increase the D term in 1% increments and repeat #8. For each incremental increase of the D term, reduce the P term by a proportional amount.

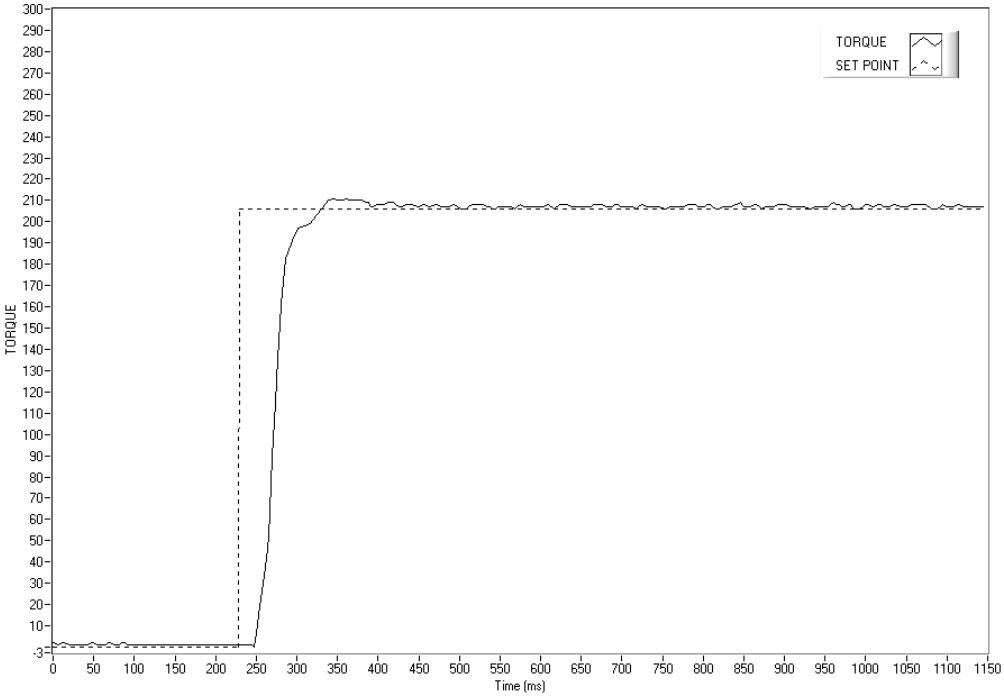


Figure 4–5 Initial D Setting for Torque Control

4.3.3 SETTING THE PID FOR SPEED CONTROL

1. With the motor and brake OFF, set the desired Speed Set Point by pressing the SPEED SET button and using the TARE ◀ and RESET TARE ▶ buttons and Decrease/Increase dial.
2. Set the P, I and D values to zero.
3. Turn the motor ON.
4. Turn the brake ON.
5. Slowly increase the P term until the speed read is about 25% of the desired load point.

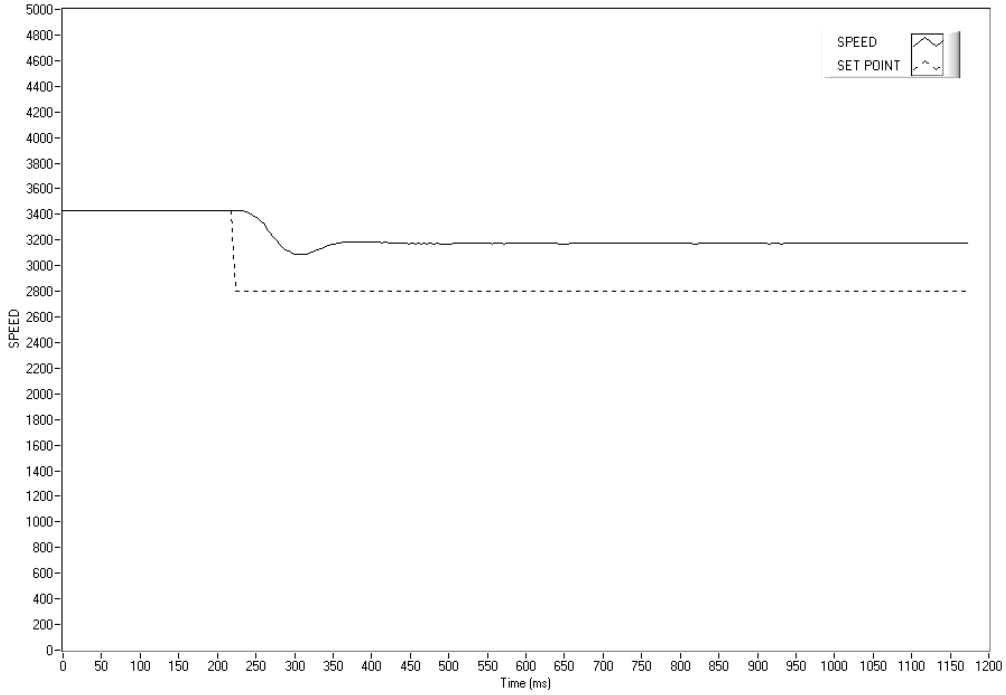


Figure 4–6 Initial P Setting for Speed Control at 25%

6. Turn the brake OFF.
7. Increase the I term to 10%.
8. Turn the brake ON and observe response, then turn the brake OFF. Desired Result is a fast response with some over shoot.
   a. If the response was too slow, increase the I term in 1-5% increments and repeat #8.
   b. If the response was too fast, decrease the I term in 1-5% increments and repeat #8.

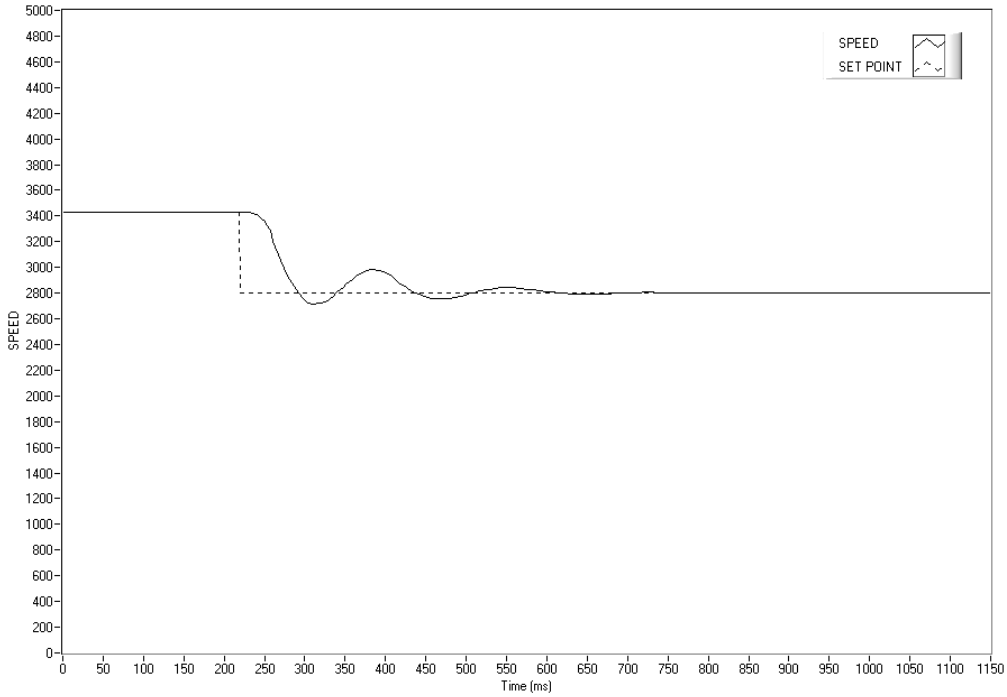


Figure 4–7 Initial I Setting for Speed Control

c. If there is too much over shoot, increase the D term in 1% increments and repeat #8. For each incremental increase of the D term, reduce the P term by a proportional amount.

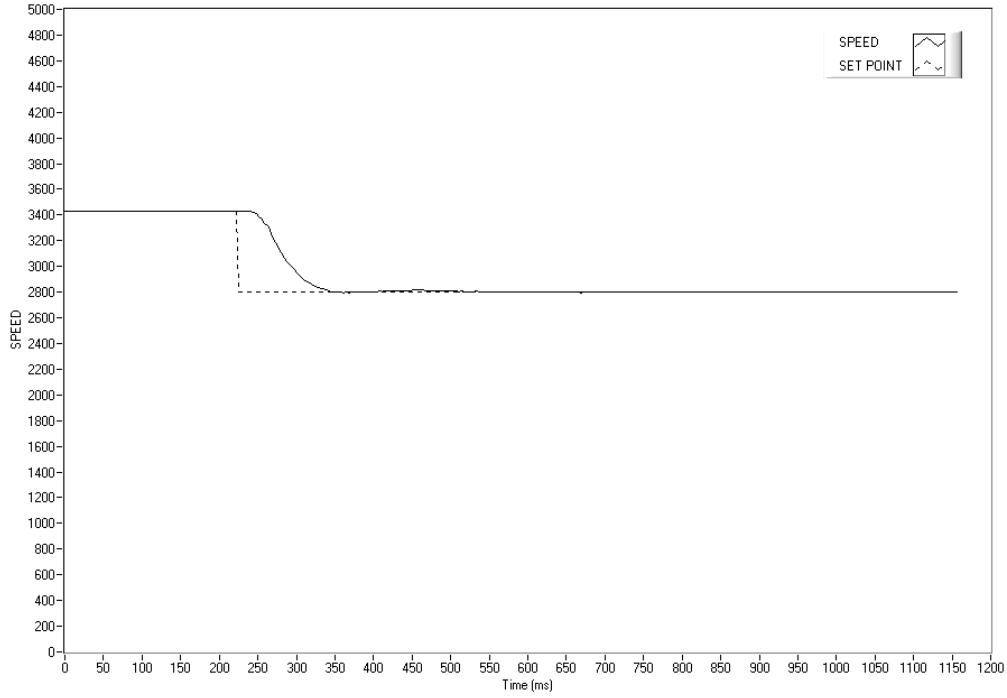


Figure 4–8 Initial D Setting for Speed Control

4.3.4 SETTING THE PID FOR RAMP DOWN

It is nearly impossible to select a PID value that optimizes the control loop over a wide range of speed. With Magtrol's experience in motor test, their engineers have developed a dynamic PID algorithm. The PID values change with the Speed Set Point. In most cases, the PID values are high when the motor is lightly loaded and tend to decrease at higher loads.

Magtrol's M-TEST Software provides a setup PID function in the setup for the ramp test. In the M-TEST Software, the dynamic scaling can be enabled or disabled and the span of the scaling can also be selected.

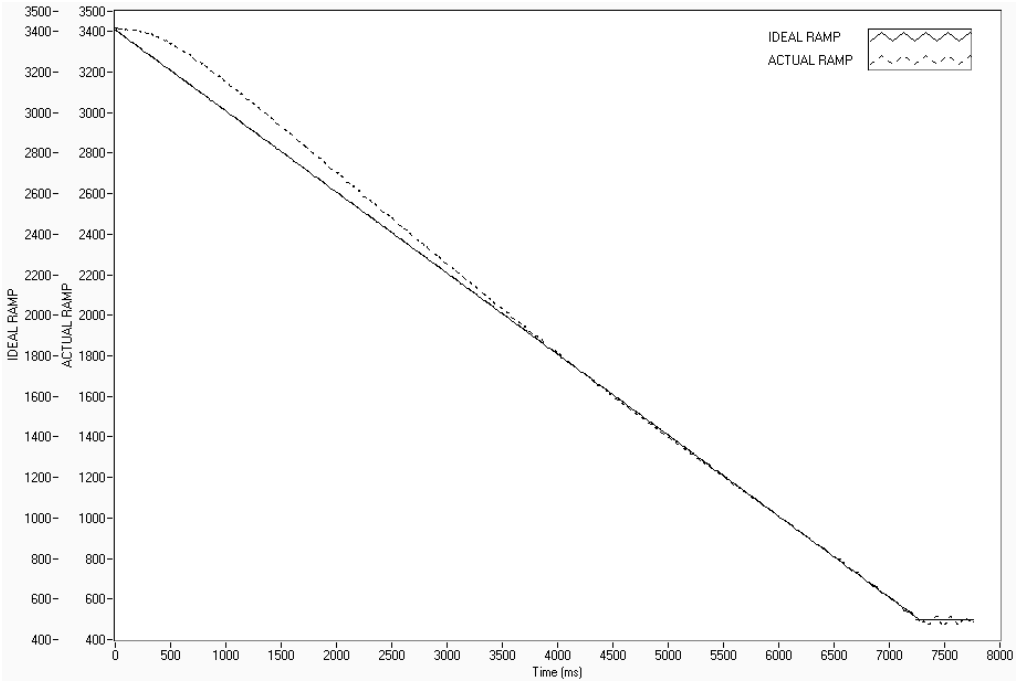


Figure 4–9 Ramp Down Low I

Ramp shows low value for I term. Note "bump" at beginning of ramp and good results toward end of ramp.

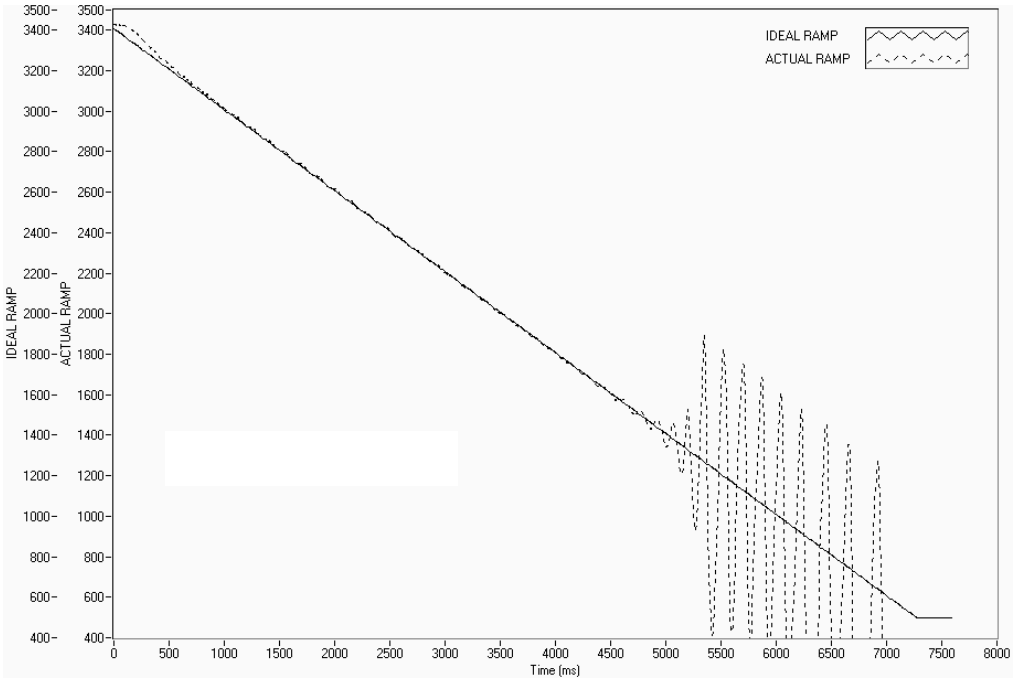


Figure 4–10 Ramp Down High I

Ramp shows higher value for I term. Note "bump" at beginning of ramp has been reduced but there are poor results toward end of ramp.

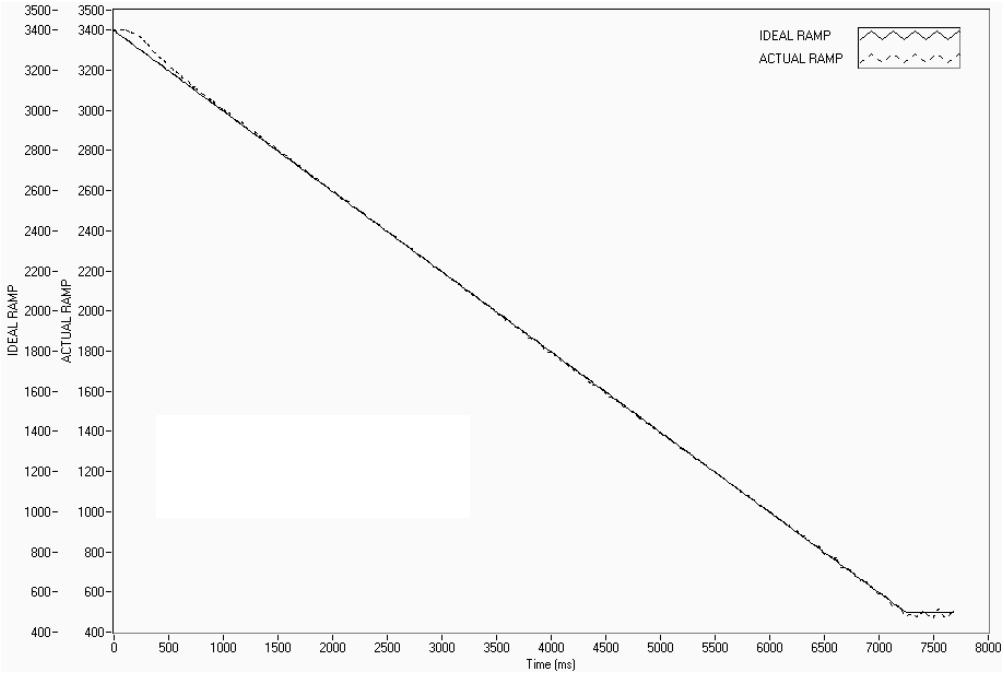


Figure 4–11 Ramp Down Dynamic I

Ramp shows Dynamic Scale effect. Note "bump" at beginning of ramp has been reduced and there are good results toward end of ramp. DIL was set to .01. At the end of the ramp, the I term is 1/100th of the starting value.

5. Alarm System

5.1 GENERAL INFORMATION

New to the DSP7000 is a built-in alarm system, designed to caution the user when problems occur. An automatic electrical and temperature alarm is programmed into the unit to protect against electrical overloads and overheating equipment when using a Magtrol DES 3XX Power Supply. There are also power, speed, torque, air flow, water flow and external input alarms internal to the unit, which only become active when enabled by the user. Instructions on how to set up and activate these alarms are included in this chapter.

5.1.1 ALARM RELAY (IO CARD OPTION)

One of the two relays on the optional IO card can be set to operate in conjunction with the alarms.

Relay Specifications:

- Contact Configuration: 1 FORM C SPDT
- Contact Rating: 24 VDC, 1 amp max
- Manufacturer P/N: OMRON G5V-2-H1-DC24

The relay has normally open and normally closed contacts. Under normal conditions, the relay is energized as shown in *Figure 5–1*.

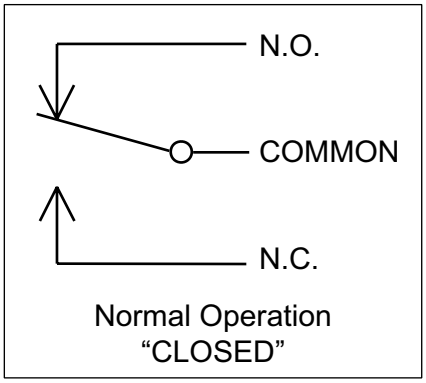


Figure 5–1 Normal Condition “Energized Relay”

In an alarm condition (or power failure), the relay is de-energized as shown in *Figure 5–2*.

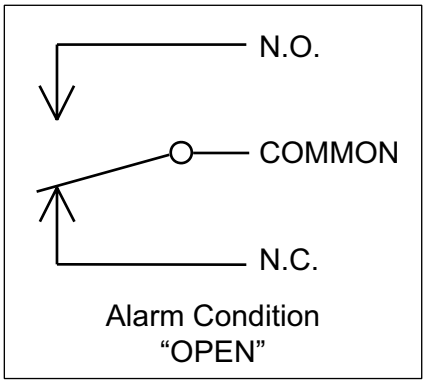


Figure 5–2 Alarm Condition “De-Energized Relay”

The relay contacts are made accessible on the IO Card connector. See *Figure 2–10 I/O Interface Card 1 and Card 2.*

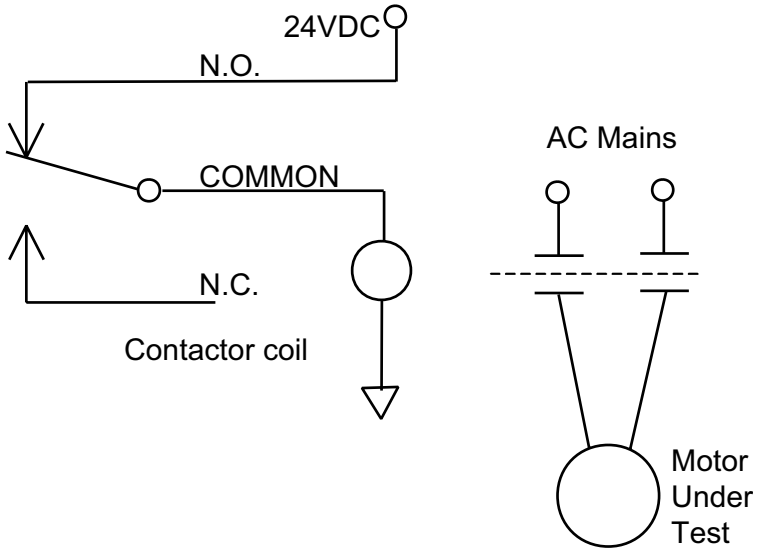


Figure 5–3 Typical Application

5.1.2 Alarm Operation

The DSP7000 gives the user the ability to enable or disable the alarms in the unit. The default is set in the OFF position. In order for the alarms to be operative the user must enable them.

5.1.2.1 How to Enable/Disable Alarms

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4.. Select ALARMS.
5. Press SHIFT 2 times. The display should appear as follows:

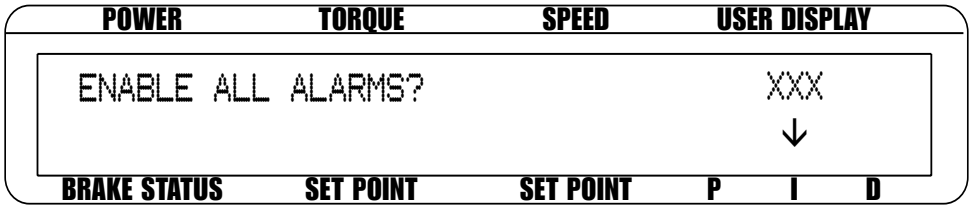


Figure 5–4 Alarm Enable/Disable Menu

6. Press SCALE I button until you reach desired selection (YES or NO).
7. Press SHIFT 3 times to return to the main menu.

Note: Once the alarms are activated on both channels, they are monitored on both channels.

5.1.3 ALARM PRIORITY

While in an alarm condition, a higher priority alarm will be acknowledged, while lower priority alarms are ignored. The priority order is as follows.

Priority	Alarm	Availability	
		Hysteresis Dynamometer	Eddy-Current/ Powder Brake Dynamometer
1	Temperature Alarm	N/A	X
2	Electrical Alarm	N/A	X
3	External Alarm	X	X
4	Air Flow Alarm	X	N/A
5	Water Flow Alarm	N/A	X
6	Clutch Alarm	N/A	
7	Maximum Torque	X	X
8	Maximum Speed	X	X
9	Power	X	X

5.2 POWER ALARM

- Used to indicate an over power condition
- Default is set at 1 kW

5.2.1 INSTRUCTIONS FOR POWER ALARM SETUP

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4. Select MAXPOWER. The display should appear as follows:

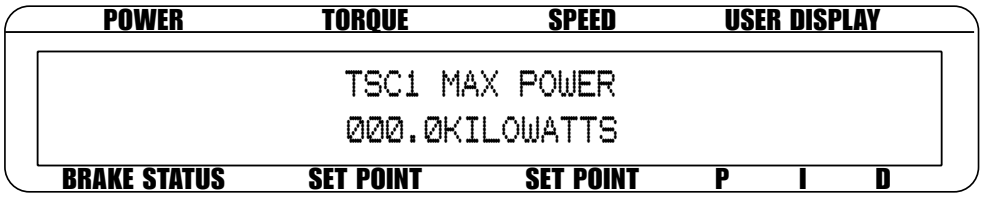


Figure 5–5 Max Power Menu

5. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired maximum power value for TSC1.
6. Press SHIFT 3 times to complete Power Alarm setup and return to the main menu.
7. To setup power alarm for TSC2, press TSC button to switch to TSC2 setup and follow the instructions above.

5.2.2 POWER ALARM ACTION

A. When the power exceeds that of the maximum power setting, the message -OL- will appear and blink in the power section of the display (as indicated in *Figure 5–6*).

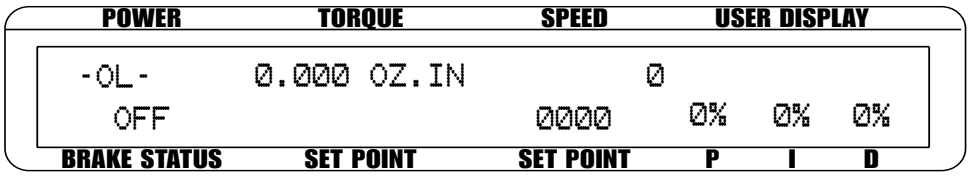


Figure 5–6 Power -OL- Display

B. If power is greater than 120% of the maximum power setting or in condition A for greater than 5 seconds, the display will flash "POWER ALARM TSCx" (as indicated in Figure 5–7) The alarm relay will open, excitation current will hold at last value for 3 seconds then drop to zero. Standby signal is not cycled.

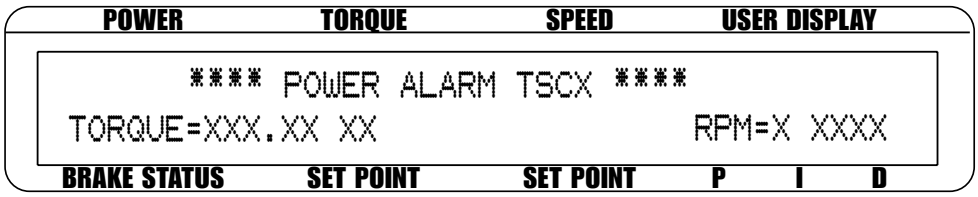


Figure 5–7 Power Alarm Display

5.2.3 To Reset Power Alarm

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in Section 5.2.1 – Instructions for Power Alarm Setup.

5.3 GLOBAL POWER ALARM

5.3.1 Instructions for Global Power Alarm Setup

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select TANDEM.
4. Press "SCALE I" button to select "YES" and then press SHIFT.

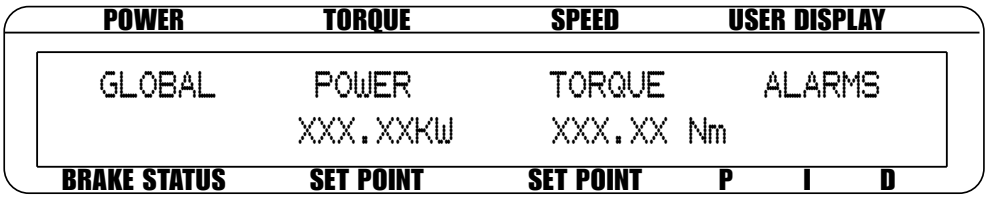


Figure 5–8 Global Power Alarm Setup

NOTE: Global power alarm is only enabled when WB/WB or PB/PB dyno tandem configuration.

5. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired global power value.
6. Press SHIFT 2 times to complete Global Power Alarm setup and return to the main menu.

5.3.2 GLOBAL POWER ACTION

If power is greater than the maximum setting the display will flash "GLOBAL POWER ALARM" (as indicated in Figure 5–9) The alarm relay will open, excitation current will hold at last value for 3 seconds then drop to zero. Standby signal is not cycled.

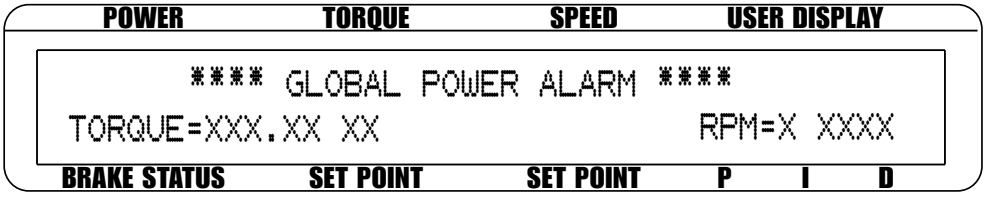


Figure 5–9 Global Power Alarm Disply

5.3.3 TO RESET GLOBAL POWER ALARM

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.3.1 – Instructions for Global Power Alarm Setup*.

5.4 MAXIMUM SPEED ALARM

- Used to limit speed of system (motor, dynamometer, couplings, etc.)
- Default is set at 4000 rpm

5.4.1 INSTRUCTIONS FOR MAXIMUM SPEED ALARM SETUP

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4. Select ENCODERS. The display should appear as follows:

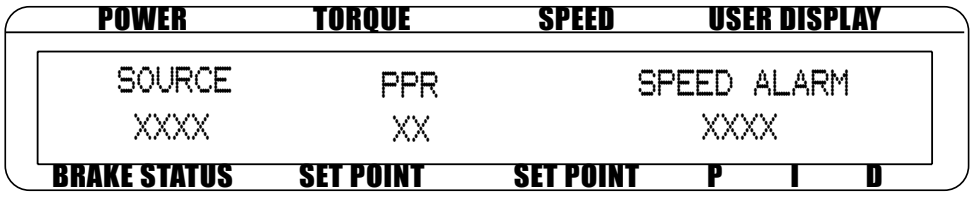


Figure 5–10 Speed Alarm Setup Menu

5. Press SCALE P button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired maximum speed for TSC1.
6. Press SHIFT 3 times to complete Maximum Speed Alarm setup and return to the main menu

7. To setup maximum speed alarm for TSC2, press TSC to switch to TSC2 setup and follow the instructions above.

5.4.2 Maximum Speed Alarm Action

A. If speed is greater than the maximum speed setting but less than 120%, -OL- will flash on the display where the speed reading was (as indicated in Figure 5–11)

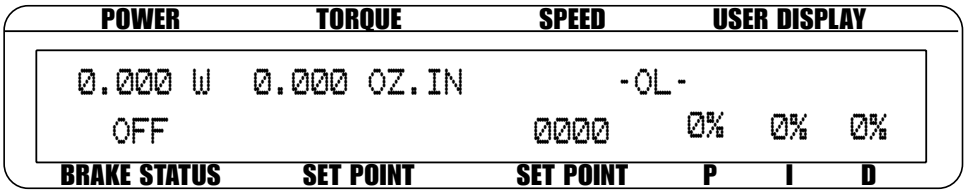


Figure 5–11 -OL- Speed Alarm Display

B. If speed is greater than 120% of the maximum speed setting or in condition A for greater than 5 seconds, the display will flash "OVER SPEED ALARM TSCx" (as indicated in Figure 5–12) The alarm relay will open, excitation current will hold at last value for 3 seconds then drop to zero. Standby signal is not cycled.

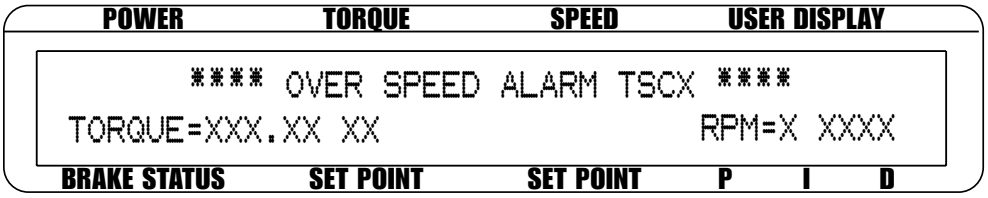


Figure 5–12 Over Speed Alarm Message Display

5.4.3 To Reset Maximum Speed Alarm

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.4.1 – Instructions for Maximum Speed Alarm Setup*.

5.5 MAXIMUM TORQUE ALARM

- Used to protect the system (motor, dynamometer, couplings, etc.) from over torque condition
- Default is set at 1 input unit

5.5.1 Instructions for Maximum Torque Alarm Setup

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4. Select DYNAMOMETER.
5. Press SHIFT. The display should appear as follows:

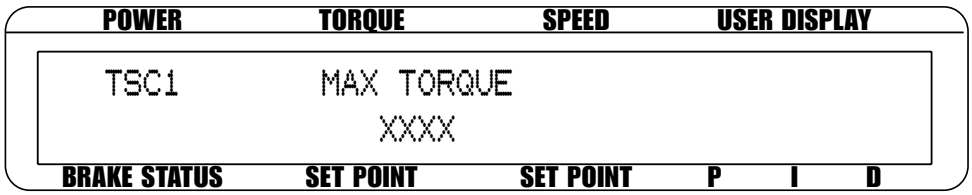


Figure 5–13 Torque Alarm Setup Menu

6. Press TORQUE UNITS button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired maximum torque for TSC1.
7. To complete Maximum Torque alarm setup, continue pressing SHIFT until main menu is reached.
8. To setup the torque alarm for TSC2, press TSC to switch to TSC2 setup and follow instructions above.

5.5.2 Maximum Torque Alarm Action

A. If torque is greater than the maximum torque setting but less than 120%, -OL- will flash on the display where the torque reading was.

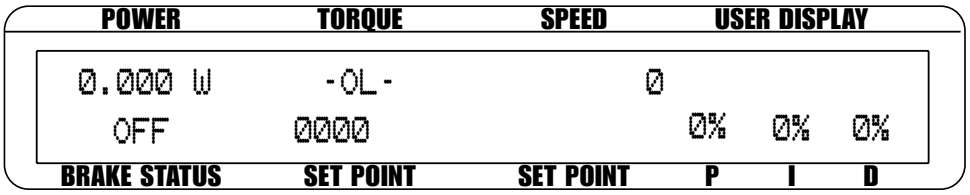


Figure 5–14 -OL- Torque Alarm Display

B. If torque is greater than 120% of the maximum torque setting or in condition A for greater than 5 seconds, the display will flash "OVER TORQUE ALARM TSCx". The alarm relay will open, excitation current will hold at last value for 3 seconds then drop to zero. Standby signal is not cycled.

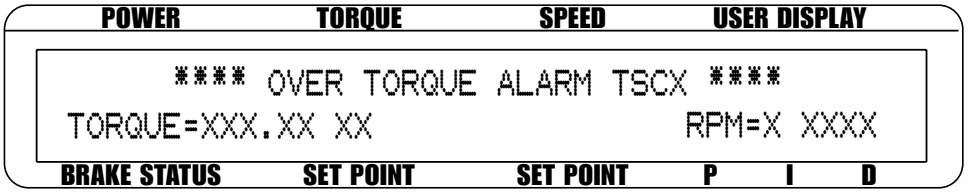


Figure 5–15 Over Torque Alarm Message Display

5.5.3 To Reset Maximum Torque Alarm

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.5.1 – Instructions for Maximum Torque Alarm Setup*.

5.6 GLOBAL TORQUE ALARM

5.6.1 Instructions for Global Torque Alarm Setup

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select TANDEM.
4. Press SCALE I button to select "YES" and then press SHIFT.

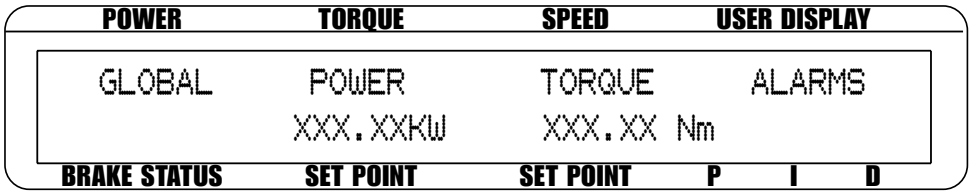


Figure 5 –16 Global Torque Alarm Setup

NOTE: Global torque alarm is only enabled when WB/WB or PB/PB dyno tandem configuration.

5. Press MAX SPEED button and use ◀ and ▶ buttons and Decrease/Increase dial to set desired global torque value.
6. Press SHIFT 2 times to complete Global Torque Alarm setup and return to the main menu.

5.6.2 Global Torque Action

If torque is greater than the maximum setting the display will flash "GLOBAL TORQUE ALARM" (as indicated in Figure 5–9) The alarm relay will open, excitation current will hold at last value for 3 seconds then drop to zero. Standby signal is not cycled

5.6.3 To Reset Global Torque Alarm

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.6.1 – Instructions for Global Torque Alarm Setup*.

5.7 AIR FLOW ALARM

- Used to indicate a lack of air flow from a blower or air line
- Only for use with Hysteresis Dynamometers
- Monitored only when the brake is ON
- Default is set in "OFF" mode

5.7.1 Instructions for Air Flow Alarm Setup

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4. Select ALARMS. The display should appear as follows:

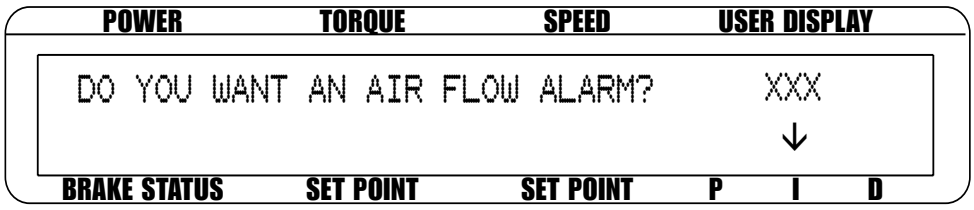


Figure 5–17 Air Flow Alarm Setup Display

5. Press SCALE I button to select YES.
6. Press SHIFT 5 times to complete Air Flow Alarm setup and return to the main menu.

5.7.2 Air Flow Alarm Action

When there is a lack of air flow, the display will flash "LOW AIR FLOW" (as indicated in Figure 5–18) . The alarm relay will open and the excitation current will automatically drop to 10% of the last excitation current. Standby signal is not cycled.

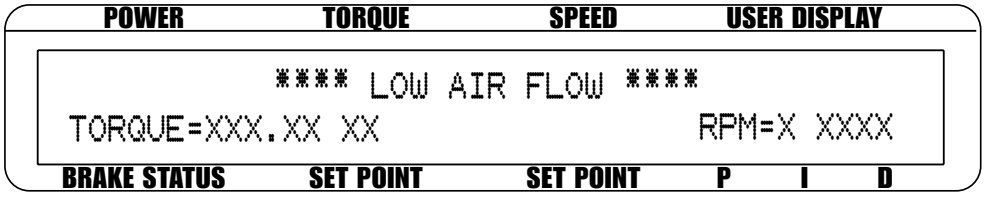


Figure 5–18 Air Flow Alarm Message Display

5.7.3 To Reset Air Flow Alarm

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.7.1 – Instructions for Air Flow Alarm Setup*.

5.8 WATER FLOW ALARM

- Used to indicate lack of water flow
- Only for use with Eddy-Current or Powder Brake Dynamometers
- Default is set in "OFF" mode
- Monitored only when the brake is "ON"

5.8.1 Instructions for Water Flow Alarm Setup

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select DYNO.
4. Select ALARMS.
5. Press SHIFT. The display should appear as follows:

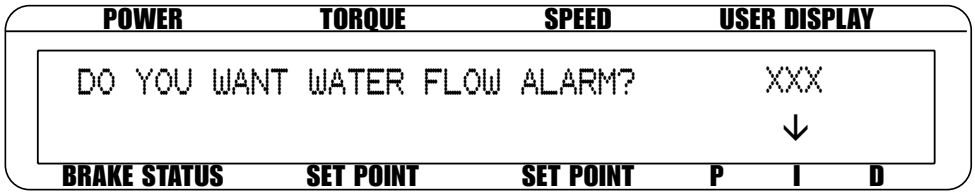


Figure 5–19 Water Flow Alarm Setup Display

6. Press SCALE I button to select YES.
7. Press SHIFT 4 times to complete Water Flow Alarm setup and return to the main menu.

5.8.2 Water Flow Alarm Action

When there is a lack of water flow, the display will flash "LOW WATER FLOW" (as indicated in Figure 5–20. The alarm relay will open and the excitation current will automatically drop to 10% of the last excitation current. Standby signal is not cycled.

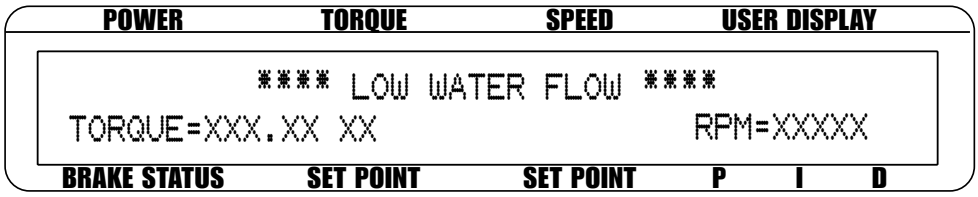


Figure 5–20 Water Flow Alarm Message Display

5.8.3 To Reset Water Flow Alarm

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.8.1 – Instructions for Water Flow Alarm Setup*.

5.9 EXTERNAL ALARM (I/O CARD OPTION)

- Used to shut down system based on additional user input
- Default is set in "OFF" mode

5.9.1 INSTRUCTIONS FOR EXTERNAL ALARM SETUP

1. Starting from main menu, press SHIFT.
2. Press SETUP button.
3. Select I/O.
4. Press SHIFT 3 times. The display should read as follows:

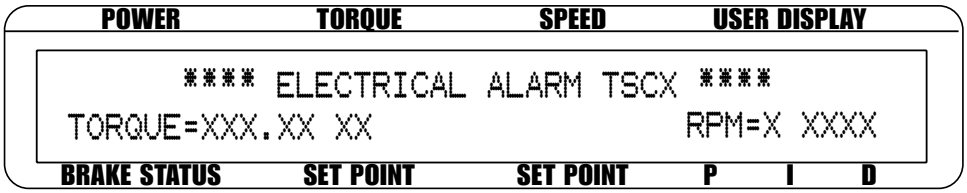


Figure 5–21 External Alarm Setup Display

6. Press SCALE I button to select YES.
7. Press SHIFT 4 times to complete External Alarm setup and return to the main menu.

5.9.2 EXTERNAL ALARM ACTION

If the external input is at a high level, the display will flash "EXTERNAL ALARM" (as indicated in Figure 5–22). The alarm relay will open and the excitation current will automatically drop to 10% of the last excitation current. Standby signal is not cycled

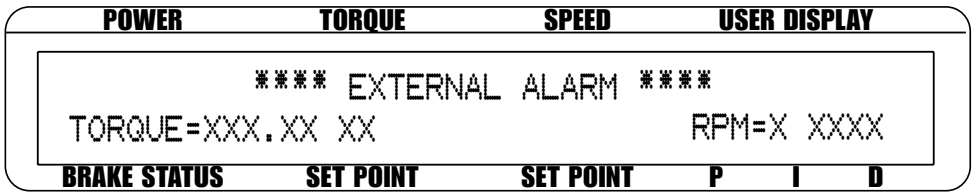


Figure 5–22 External Alarm Message Display

5.9.3 TO RESET EXTERNAL ALARM

Press any front panel button other than SHIFT. If the alarm condition is clear, the unit will return to normal operation. Although not recommended, another option would be to disable the alarm by following the alarm setup instructions in *Section 5.9.1 – Instructions for External Alarm Setup*.

5.10 TEMPERATURE ALARM (WB/PB ONLY)

- To alert user when dynamometer gets too hot and thermal switch opens
- Only available for use with WB or PB dynamometers
- Default - always active

5.10.1 Instructions for Temperature Alarm Setup

No setup needed.

5.10.2 Temperature Alarm Action

When the dynamometer in use becomes too hot, the display will flash "TEMPERATURE ALARM TSCx". The alarm relay will open and the excitation current will immediately decrease to 10%. After approximately 3 seconds, the current will drop to 0. Standby signal is cycled for approximately one second after resetting of the alarm.

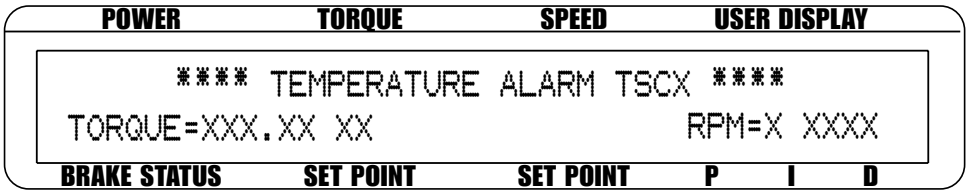


Figure 5–23 Temperature Alarm Message Display

5.10.3 To Reset Temperature Alarm

Press any front panel button other than SHIFT. The alarm condition must be cleared before the unit will return to normal operation.

5.11 ELECTRICAL ALARM

- Used to protect the DES supply
- Monitors electrical input (mains) and circuitry of the DES
- Only available for use with WB or PB dynamometers
- Default - always active

5.11.1 Instructions for Electrical Alarm Setup

No setup needed.

5.11.2 Electrical Alarm Action

When there is an electrical overload, the display will flash "ELECTRICAL ALARM TSCx". The alarm relay will open and the excitation current will immediately decrease to zero. Standby signal is cycled for approximately one second after resetting of the alarm.

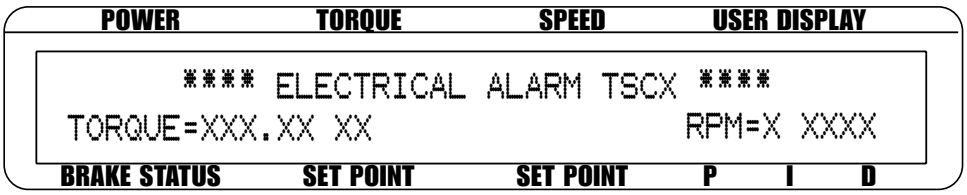


Figure 5–24 Electrical Alarm Message Display

5.11.3 To Reset Electrical Alarm

Press any front panel button other than SHIFT. The alarm condition must be cleared before the unit will return to normal operation.

5.12 CLUTCH ALARM (WB/PB ONLY)

In tandem setup, the clutch close signal will be sent. After 0.5 seconds, check the clutch closed signal. If the clutch is open try resending the clutch close signal two more times. If the clutch is still open go to the alarm.

5.12.1 Clutch Alarm Action

When there is a clutch failure, the display will flash "CLUTCH FAILURE" (as indicated in *Figure 5–25*).

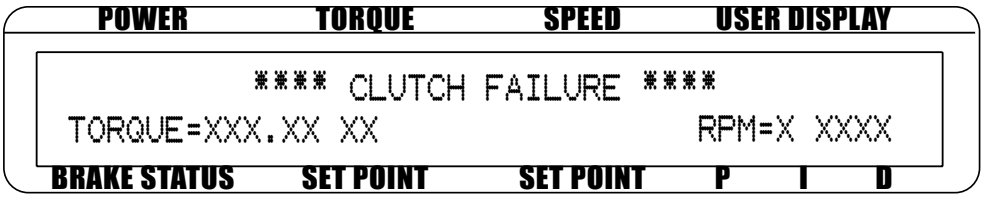


Figure 5–25 Clutch Alarm Message Display

5.12.2 To Reset Clutch alarm

Press any front panel button other than SHIFT. The alarm condition must be cleared before the unit will return to normal operation.

6. Manually Controlled Operation

Note: Using the DSP7000 without a computer will limit its testing capabilities.

6.1 HOW TO SET DESIRED POWER UNITS

To select the desired power units (W, kW or HP):

1. Press the TSC button to select the desired channel.
2. Press SHIFT.
3. Press POWER UNITS button. The display should appear as follows:

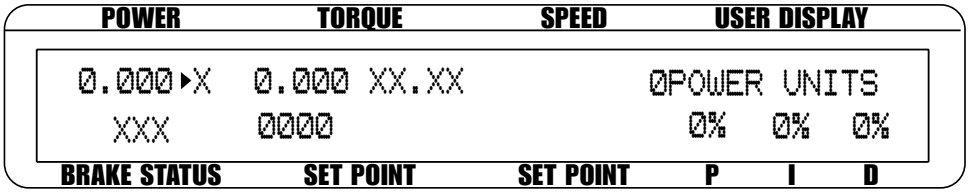


Figure 6–1 Power Units Menu

4. Use ◀ and ▶ buttons to select desired Power Units.
5. Press SHIFT to return to main menu.

6.2 HOW TO SET DESIRED TORQUE UNITS

To select the desired torque units (N·m, cN·m, mN·m, kg·cm., g·cm., lb·ft., lb·in., oz·ft., oz·in.):

1. Press SHIFT.
2. Press TORQUE UNITS button. The display should appear as follows:

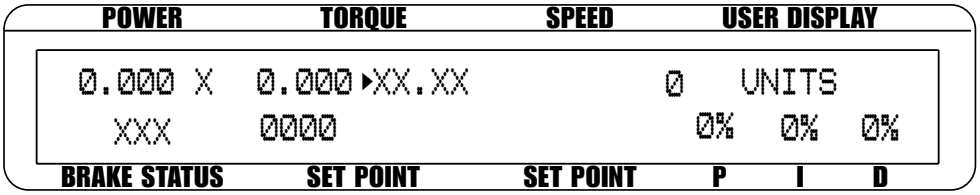


Figure 6–2 Torque Units Menu

3. Use ◀ and ▶ buttons to select desired Torque Units.
4. Press SHIFT to return to main menu.

6.3 HOW TO SET TORQUE CONTROL

1. Beginning with the brake in the OFF position, press the TORQUE SET button. The display should appear as follows:

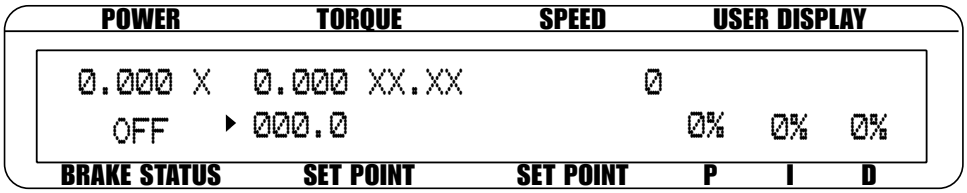


Figure 6–3 Torque Control Menu

2. Use ◀ and ▶ buttons and the Decrease/Increase dial to adjust the setpoint to zero.

Note: PID values should be set at this time. See *Section 4.3 – Setting the Correct PID's for Your Motor*.

3. Use the BRAKE ON/OFF button to turn the brake ON.
4. Start the motor under test.
5. Press the TORQUE SET button and adjust the set point to the desired load.
6. Check the torque display to make sure that the dynamometer loads the motor under test to that torque load.

Desired Results

The dynamometer should load the motor under test to the load point quickly with little or no overshoot when the BRAKE function cycles ON or OFF.

Note: If the response is too slow or oscillatory, adjust the values for P, I and D. (For more detailed instruction, refer to *Chapter 4– PID Settings*.)

CAUTION: DO NOT EXCEED THE CAPABILITIES OF THE DYNAMOMETER OR THE POWER SOURCE IN USE. MOTORS DRAW VERY LARGE CURRENTS WHEN HELD AT LOCKED ROTOR AND OVERHEATING MAY RESULT. WHEN USING TORQUE CONTROL, INDUCTION MOTORS CANNOT BE TESTED BEYOND BREAKDOWN, EXCEPT AT LOCKED ROTOR. REFER TO *SECTION 6.4 – HOW TO SET SPEED CONTROL*.

OPERATION

6.4 HOW TO SET SPEED CONTROL

Note: When using speed control, motors between 0 and 100 rpm cannot be tested unless the dynamometer is equipped with an optional, high resolution speed encoder.

1. Beginning with the brake in the OFF position, press SHIFT.
2. Press MAX SPEED button. The display should appear as follows:

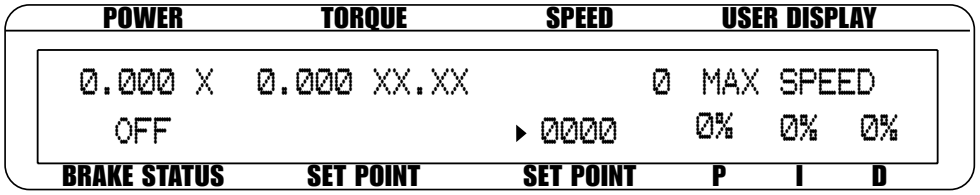


Figure 6–4 Max Speed Menu

3. Use ◀ and ▶ buttons and the Decrease/Increase dial to set a value equal to or slightly greater than the free-run speed of the motor under test.
4. Press the SHIFT button to exit the MAX SPEED function.
5. Press the SPEED SET button.
6. Use ◀ and ▶ buttons and the Decrease/Increase dial to set a speed equal to the max speed.

Note: PID values should be set at this time. See *Section 4.3 – Setting the Correct PID's for Your Motor*.

7. Use the Brake ON/OFF button to turn the brake ON.
8. Start the motor under test.
9. Press the SPEED SET button and adjust the set point to the desired speed.

Desired Results

The dynamometer should load the motor under test to the desired speed quickly with little or no overshoot when the BRAKE button is cycled ON or OFF.

Note: If the response is too slow or oscillatory, adjust the values for P, I and D. For more detailed instruction, refer to *Chapter 4 – PID Settings*.

6.5 HOW TO SET OPEN LOOP CONTROL

1. Beginning with the brake in the OFF position, press the OPEN LOOP button. The open loop control menu should appear. See *Figure 4–1 Open Loop Control Menu*.
2. Use ◀ and ▶ buttons and the Decrease/Increase dial to set a value of current equal to the percent of full scale output.
3. If needed, POWER UNITS and DISPLAYED UNITS can be changed while in OPEN LOOP mode. (For further instruction, refer to *Section 6.1 – How to Set Desired Power Units*.)
4. Use the BRAKE ON/OFF button to turn the brake ON. (Note: When the brake is on, the only thing that can be adjusted is the set point. There are no other active settings at this time.)
5. To exit the Open Loop Control mode and return to the main menu, turn the brake OFF and press the OPEN LOOP button.

Desired Results

The dynamometer should load the motor under test. Because the mode is open loop, the controller will not stabilize on speed or torque, but will apply a constant current to the dynamometer brake. The actual loading will change as the brake heats up or as other external factors change. The PID's have no effect in this mode.

6.6 HOW TO SET PRELOAD CONTROL

1. Beginning with the brake in the OFF position, press the OPEN LOOP button. The open loop control menu should appear. See *Figure 4–1 Open Loop Control Menu.*
2. Use ◀ and ▶ buttons and the Decrease/Increase dial to set the preload value of current equal to the percent of full scale output.
3. Enable or disable PRELOAD function by pressing Scale D button.
4. If the preload function is enabled, "*" indicator will be displayed as shown in *Figure 6–5 Preload function enabled.*

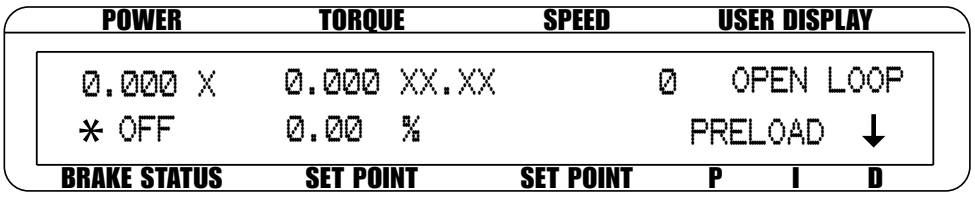


Figure 6–5 Preload Function enabled

5. After the preload function has been enabled, and the preload value has been set, the set point the open loop will be initialized to 0.00 % and preload settings is saved to non-volatile memory.
6. If Scale D button is pressed and the preload function is disabled, the last preload percentage value will be displayed in set point.

6.7 HOW TO SET AND RESET TARE FUNCTION

6.7.1 Setting the Tare Function

1. Press SHIFT button.
2. Press TARE button.
3. "*" indicator will be displayed as in *Figure 6–6 Tare function enabled*.

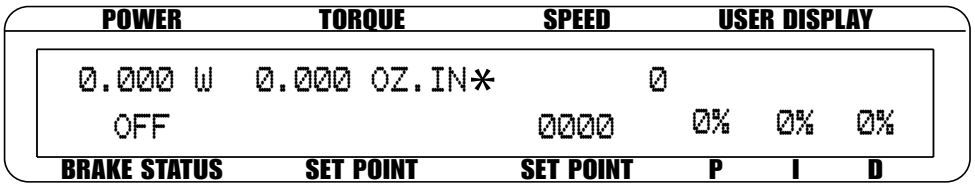


Figure 6–6 Tare function enabled

Note: If the tare value is greater than 10% of full scale, the tare function cannot be enabled.

6.7.2 Resetting the Tare Function

1. Press SHIFT button.
2. Press RESET TARE button.
3. "*" indicator will disappear.

6.8 HOW TO SET THE TM/TF INVERT FLAG

1. See *Section 3.2.1 - Dynamometer Configuration*. When the TM/TF torque sensor is chosen, after the max torque screen, the TM/TF torque reading invert flag screen will be displayed as in *Figure 6–7 Torque Invert Flag Screen*.

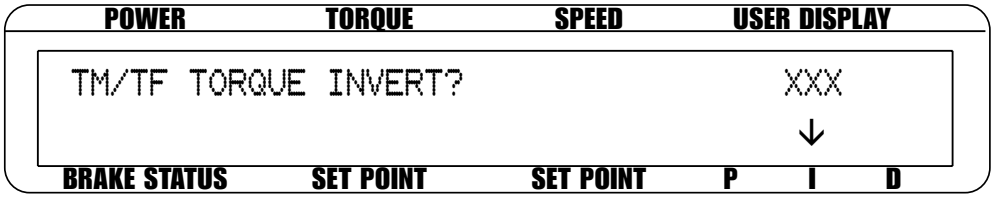


Figure 6–7 Torque Invert Flag Screen

2. Press SCALE I button to select yes or no.
3. Press SHIFT three times to complete configuration and return to the main menu.

7. Computer Controlled Operation

The DSP7000 can be used with a computer to control a dynamometer and to transmit data from the motor testing device directly to the computer. Using the DSP7000 with a computer enables the unit to perform at its full capacity.

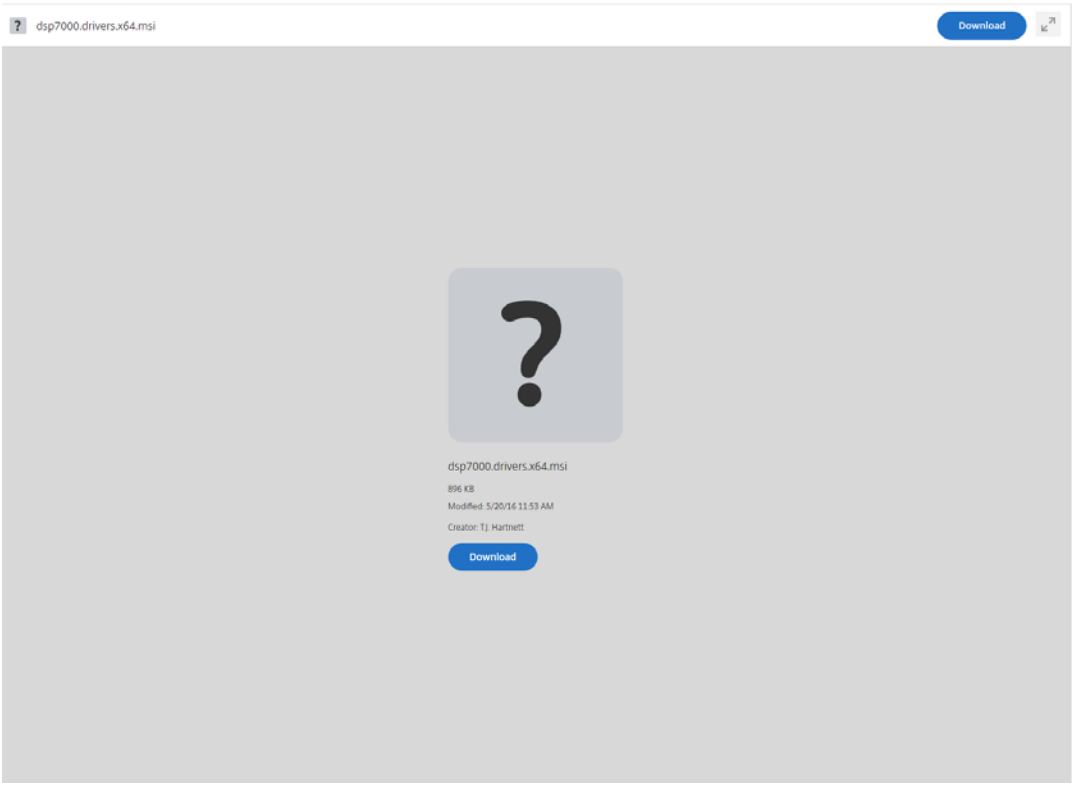
7.1 ABOUT THE USB INTERFACE

The USB interface is standard on the DSP7000. The USB interface will be converted to a serial port in the PC. The USB driver must be installed in order for the DSP7000 to communicate with the PC.

7.1.1 USB DRIVER SETUP FOR WINDOWS OPERATION SYSTEM

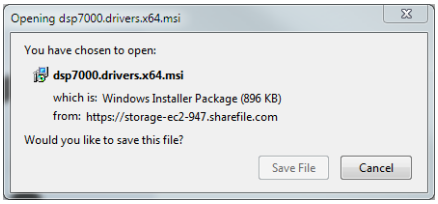
Go to the software downloads page on the Magtrol website: www.magtrol.com/software-downloads/. Scroll down to DSP7000 USB Drivers.

1. Select the proper number of bits for your operating system, and the firmware revision of your DSP7000. The revision can be seen on the front panel display, lower left corner, when powering up.
2. You will be asked for some basic information about yourself. Complete the fields and press continue.
3. On the next screen press download.

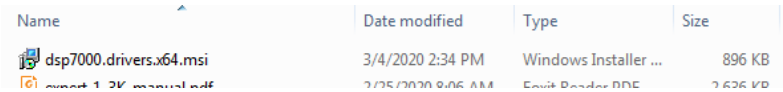


OPERATION

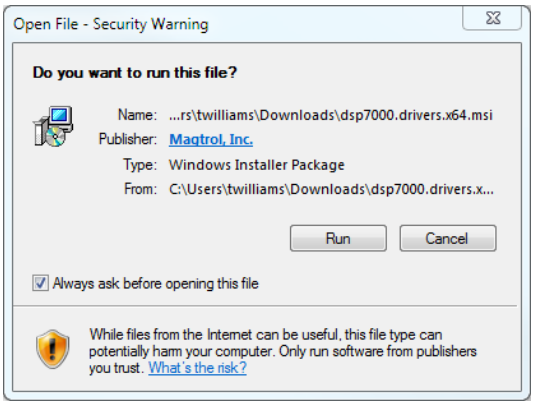
4. Save the file when asked.



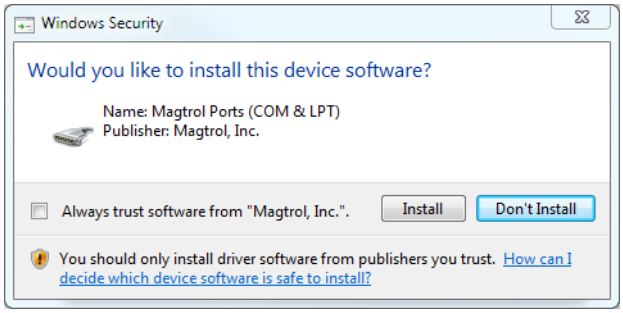
5. A self-installing MSI file will be located in your downloads folder.



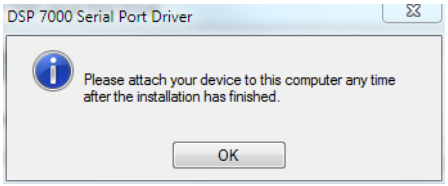
6. Double-click dsp7000.drivers.x64.msi for the 64-bit operating system (dsp7000.drivers.x86.msi for 32-bit) and press run.



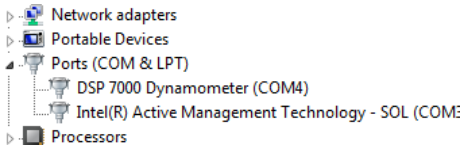
7. Windows security will ask if you would like to install the device software. Press install.



8. After successful installation you may plug in the USB cable from your DSP7000 to the computer.



9. Checking device manager, you should now see the DSP7000 showing as a COM port.



7.1.2 CHECKING THE DSP7000-TO-PC CONNECTION FOR GPIB SETUP

Note: Make sure that the DSP7000 and its host computer are communicating before acquiring data.

1. Make sure the primary GPIB address is set correctly for the DSP7000.
2. Set the input variable to 15 characters (13 variable characters and the two required data termination characters CR and LF. See *Section 7.3 – Programming*.)
3. Issue output data command "OD" and read 15 characters according to the instructions for your GPIB interface or serial.

Desired Results

- Torque/speed data will be returned.
- The error message I/O ERROR does not appear on the display panel.

Note: If the desired results did not occur, please see *Chapter 11 – Troubleshooting*.

7.2 DATA FORMAT

7.2.1 OUTPUT DATA (OD)

OD (output data) Speed-torque data is a fixed-length string in ASCII format with a floating point decimal. Use the following string format:

SdddddTdddd.R(cr)(lf)

Or

SdddddTdddd.L(cr)(lf)

Where…

S = Speed in rpm. (No leading zeroes are used.)

d = Decimal digit 0 through 9.

T = Torque in units selected during setup. (The torque value always contains a decimal point.)

L = Counterclockwise dynamometer shaft rotation (left).

R = Clockwise dynamometer shaft rotation (right).

. = Decimal point. (The decimal point location depends on the specific dynamometer and torque range in use.)

Note: When an "A" is in the R/L position (e.g. SddddTdddd.A(cr)(lf)), it is an indication that the unit is in an alarm condition.

Note: The (cr) and (lf) characters will not display.

OPERATION

EXAMPLE

If a motor is running at 1725 rpm clockwise, with the dynamometer loading the motor to 22.6 oz.in., the DSP7000 will return:

S 1725T22.60R

By manipulating the string, the speed-torque and shaft direction (if required) can be extracted. Then separate numerical variables can be assigned to them for data processing.

7.2.2 OUTPUT BINARY COMMAND (OB)

A list of paramaters can be created using the COB (Configure Output Binary) Table. The list can be retrieved at a rate of 488 samples per second. Up to 35 paramaters can be added to the list making it possible to read 488 × 35 = 17080 parameters per second all synchronized in time.

1. The user used the COB table to configure the DSP7000 to package the required data. Minimum command is the return of the timers (COB,0,1).

Number	Data	Description	Data Type
0.	TimeH	Time Stamp HIGH	Integer
1.	TimeL	Time Stamp LOW	Integer
2.	CNL1 Speed	Channel 1 speed	Float
3.	CNL1 Torque	Channel 1 torque	Float
4.	CNL1 Speed SET POINT	Channel 1 set speed	Float
5.	CNL1 Torque SET POINT	Channel 1 set torque	Float
6.	CNL2 Speed	Channel 2 speed	Float
7.	CNL2 Torque	Channel 2 torque	Float
8.	CNL2 Speed SET POINT	Channel 2 set speed	Float
9.	CNL2 Torque SET POINT	Channel 2 set torque	Float
10.	AI11	I/O card 1 analog input 1	Float
11.	AI12	I/O card 1 analog input 2	Float
12.	AI21	I/O card 2 analog input 1	Float
13.	AI22	I/O card 2 analog input 2	Float
14.	Not Defined		Float
15.	Not Defined		Float
16.	Not Defined		Float
17.	Not Defined		Float
18.	Status 1	Mix channel 1 of DIs and alarms … TBD	Integer
19.	Status 2	Mix channel 1 of DIs and alarms … TBD	Integer
20.	Filter_out1		Float
21.	Filter_out2		Float
22.	Quad_cnt_1	Quadrature position counter 1	Integer

Number	Data	Description	Data Type
23.	Quad_time_1	Quadrature position time 1	Integer
24.	Quad_cnt_2	Quadrature position counter 2	Integer
25.	Quad_time_2	Quadrature position time 2	Integer
26.	Display speed1	Channel 1 display speed	Float
27.	Display speed2	Channel 2 display speed	Float
28.-35	PA DATA (13)	Power analyzer data	Not Defined

2. Second the user used the OB command to retrieve the data. The data received from the Ob command is all the data acquired since the last OB command. The user must read the data before 0.5 seconds elapses to avoid missing any data. The data can be read in intervals as small as 50 ms to as long as 500 ms relieving the data acquisition system from timing problems

EXAMPLE

COB,0,1,2,3

Note: The OB command is only applicable to the USB Configuration.

7.3 PROGRAMMING

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

7.3.1 DATA TERMINATION CHARACTERS

Use the following information to answer the formatting questions asked when installing your GPIB software. All GPIB data acquisition systems require the use of data termination characters. The DSP7000 uses the GPIB standard termination characters Carriage Return (CR) and Line Feed (LF). Provide them in that order.

7.3.1.1 Codes for CR - LF

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

7.3.2 TIMEOUT

Set the timeout for at least one second if asked to set a communication fault delay timeout.

Note: If the communication fault delay timeout is too short, or if the computer resets the interface too quickly, the host instrument may stop responding.

7.4 DSP7000 COMMAND SET

When entering a command code:

1. Type all characters in uppercase ASCII format.
2. End all commands with a CR-LF (hex 0D-0A).
3. Do not string multiple commands together in one line.

The character # represents a floating-point numerical value following the command. Leading zeroes are not required.

Note: If a command is not recognized, the I/O ERROR message will appear in the Status Display accompanied by a beep.

7.4.1 ALARM COMMANDS

Command Code Channel 1-	Command Code Channel 2	Function	Explanation

ALA1,#	ALA2,#	Enables or disables air flow alarm.	Values for # are:
			0 = disable
			1 = enable

ALC,#	ALC,#	Enables or disables clutch alarm.	Values for # are:
			0 = disable
			1 = enable

ALE1,#	ALE2,#	Enables or disables external alarm.	Values for # are:
			0 = disable
			1 = enable

ALL1,#	ALL2,#	Enables or disables all alarms.	Values for # are:
			0 = disable
			1 = enable

ALP1,xx.xx	ALP2,xx.xx	Sets power alarm.	Sets maximum power in kilowatts. Range is 0 to 99,999. Setting is applied to current channel.
ALS1,xx.xx	ALS2,xx.xx	Sets speed alarm point.	Sets maximum speed in rpm. Range is 0 to 99,999. Setting is applied to current channel.
ALT1,xx.xx	ALT2,xx.xx	Sets torque alarm point.	Sets maximum torque in input units. Range is 0 to 10,000. Setting is applied to current channel.

ALW1,#	ALW2,#	Enables or disables water flow alarm.	Values for # are:
			0 = disable
			1 = enable

ALR1,#	ALR2,#	Set up the Relay 1 on the IO card, either channel one or two, to be used in conjunction with that channels alarm system. See section 5.1.1 Alarm Relay	Values for # are:
			0 = disable
			1 = enable

GP, xx.xx		Set up the global power alarm on WB/WB or PB/PB tandem configuration.	Set maximum global power in Kilowatts. Range is from 0 to 99,999..
GT, xx.xx		Set up the global torque alarm on WB/WB or PB/PB tandem configuration.	Set maximum global torque in N·m. Range is from 0 to 99,999..

7.4.2 COMMUNICATION COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation
*IDN?	*IDN?	Returns Magtrol Identification and software revision.	
OD1	OD2	Prompts to return speed-torque-direction data string.	Output Data prompt to return data string with this format: SxxxxxxTxxxxxRcrlf or SxxxxxxTxxxxxLcrlf or SxxxxxxTxxxxxAcrlf R or L is the shaft direction indicator, as viewed looking at the dynamometer shaft where: R = right; clockwise (CW) L = left; counterclockwise (CCW) A = alarm condition The speed will equal the displayed value and the torque will be in the same units as displayed on the front panel.
OB	OB	Output Binary Data	Please see section 7.2.2 for details

7.4.3 RAMP COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation
DIL1,xx.xx	DIL2,xx.xx	Sets dynamic scale coefficient.	When using dynamic scaling, XX.XX is multiplied by the I term to give the end I value.
DPL1,xx.xx	DPL2,xx.xx	Sets dynamic scale coefficient.	When using dynamic scaling, XX.XX is multiplied by the P term to give the end P value.

DS1,#	DS2,#	Enable or disables dynamic scaling.	Values for # are:
			0 = disable
			1 = enable

PD1,#,xx.xx	PD2,#,xx.xx	Program Down (Linear or Cosin)	Values for # are:
			0 = linear
			xx.xx = rpm/sec
			1 = cosin
			xx.xx = length of test in seconds

PDU1,#,xx.xx	PDU2,#,xx.xx	Program Down Up (Linear or Cosin)	Values for # are:
			0 = linear
			xx.xx = rpm/sec
			1 = cosin
			xx.xx = length of test in seconds

PR1	PR2	• Resets ramp up or down. • Sets speed to maximum speed. • Turns brake off.	This command resets the ramp function, halting the ramp's progress, and returns the motor to free run.

PU1,#,xx.xx	PU2,#,xx.xx	Program Up (Linear or Cosin)	Values for # are:
			0 = linear
			xx.xx = rpm/sec
			1 = cosin
			xx.xx = length of test in seconds

S1,xx.xx	S2,xx.xx	Sets start or stop speed for ramp to #RPM.	When this command is used with the PD (Program Down) command, the Controller will ramp down to this speed and halt. When this command is used with the PU (Program Up) command, the Controller will load immediately to this speed and ramp up to free-run.

7.4.4 SETUP COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation

AF1,#	AF2,#	Sets the analog filter for channel 1 or channel 2.	Values for # are:
			0 = NONE
			1 = 2 Hz
			2 = 5 Hz
			3 = 10 Hz
			4 = 20 Hz
			5 = 50 Hz
			6 = 100 Hz

BT1,#	BT2,#	Sets the brake type.	Values for # are:
			0 = HD
			1 = WB
			2 = PB

COB,X,X	COB,X,X	Configures output binary	

DIN1,#	DIN2,#	Selects insturment type connected to channel 1 or channel 2.	Values for # are:
			0 = HD
			1 = WB
			2 = PB
			3 = TM/TF
			4 = HD5

M#	M#	Enables or disables front panel controls.	Values for # are:
			0 = disable
			1 = enable
			NOTE: The brake ON/OFF switch on the front panel still functions.

NS1,xx.xx	NS2,xx.xx	Sets nominal speed for WB Dynamometer.	Range is 0 to 99,999. Setting is applied to current channel.
R1	R2	Resets as follows: • Manual control ON. • Brake OFF.	Use this command to cancel any previous commands. Note: These settings are the power-on default settings.

SFT,#		Enables or disables tandem function	Values for # are:
			0 = disable
			1 = enable

TAC1,#	TAC2,#	Selects the tachometer source for the PID loop	Values for # are:
			0 = TachA
			1 = Quad RPM
			2 = AI1 (I/O Card)

TQS1,xx.xx	TQS2,xx.xx		

TSC,#	TSC,#	Selects the TSC channel to be displayed	Values for # are:
			1 = display CNL1
			2 = display CNL2
			3 = display CNL1 &2

TSF1,xx.xx		Sets scale factor for TSC1	Range is 0 to 99,999.
	TSF2,xx.xx	Sets scale factor for TSC2	Range is 0 to 99,999.
UE1,xx.xx	UE2,xx.xx		xx.xx is the number of slots on the bit wheel

Command Code Channel 1	Command Code Channel 2	Function	Explanation

UI1,#	UI2,#	Sets dynamometer torque units to #.	**NOTE:** For Hp and watts calculations to be correct, the correct dynamometer torque units must be specified.
			Values for # are:
			0 = oz.in.
			1 = oz.ft.
			2 = lb.in.
			3 = lb.ft.
			4 = g.cm.
			5 = kg.cm.
			6 = mN.m.
			7 = cN.m.
			8 = N.m.
			Torque units default to 0 (oz. in.) if out of range.
			Programmed value # is not saved at power down.

UR1,#	UR2,#	Sets readout torque units to #.	This command sets the torque unit conversion for the torque readout.
			Values for # are
			0 = oz.in.
			1 = oz.ft.
			2 = lb.in.
			3 = lb.ft.
			4 = g.cm.
			5 = kg.cm.
			6 = mN.m.
			7 = cN.m.
			8 = N.m.
			Torque units default to 0 (oz. in.) if out of range.
			Programmed value # is not saved at power down.

7.4.5 SPEED COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation
F1,xx.xx	F2,xx.xx	Sets maximum speed to xx.xx rpm.	Sets a speed range for the controller. Must be specified before using the speed or ramp mode.
	CO,xx.xx	Sets maximum excited speed of PB dynamometer.	Sets maximum excited speed of PB dynamometer for clutch deactivation on WB and PB dynamometer tandem application.

Command Code Channel 1	Command Code Channel 2	Function	Explanation
N1	N2	• Resets speed point to maximum speed. • Sets speed mode OFF. • Sets brake OFF.	Use this command, sent alone, to reset any previous speed-stabilized setting to the maximum speed range.
N1,xx.xx	N2,xx.xx	• Sets speed point to #. • Sets brake ON.	Use this command to load the motor under test to a specific speed value #. Issue a speed range command (F#) first for best dynamic response. The Controller is functioning with the dynamometer as a closed loop system. Adjust the speed PID values to tune the response.
ND1,xx	ND2,xx	Sets speed derivative to #.	Derivative value # can be any number from 0 to 99.
NDS1,#	NDS2,#	Used as a multiplier for the D coefficient in the PID equation.	Values for # are A, B, C, D, E, F, G, H or I.
NI1,xx	NI2,xx	Sets speed integral to #.	Integral value # can be any number from 0 to 99.
NIS1,#	NIS2,#	Used as a multiplier for the I coefficient in the PID equation.	Values for # are A, B, C, D, E, F, G, H or I.
NP1,xx	NP2,xx	Sets speed proportional to # gain.	Proportional gain value # can be any number from 0 to 99.
NPS1,#	NPS2,#	Used as a multiplier for the P coefficient in the PID equation.	Values for # are A, B, C, D, E, F, G, H or I.

7.4.6 TORQUE COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation
Q1	Q2	• Resets torque to 0.0. • Turns torque mode OFF. • Turns brake OFF.	This command resets any previous torque-stabilized command, and returns the motor to free run.
Q1,xx.xx	Q2,xx.xx	• Sets torque point to #. • Turns brake ON.	This is a closed loop command with its own set of PID parameters. The units defined will be the same as those displayed by the Controller.
QD1,xx	QD2,xx	Sets torque derivative to #.	Derivative value # can be any number from 0 to 99.
QDS1,#	QDS2,#	Used as a multiplier for the D coefficient in the PID equation.	Values for # are A, B, C, D, E, F, G, H or I.
QI1,xx	QI2,xx	Sets torque integral to #.	Integral value # can be any number from 0 to 99.
QIS1,#	QIS2,#	Used as a multiplier for the I coefficient in the PID equation.	Values for # are A, B, C, D, E, F, G, H or I.
QP1,xx	QP2,xx	Sets torque proportional to # gain.	Proportional gain value # can be any number from 0 to 99.
QPS1,#	QPS2,#	Used as a multiplier for the P coefficient in the PID equation.	Values for # are A, B, C, D, E, F, G, H or I.

7.4.7 MISCELLANEOUS COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation

FRZ1,#	FRZ2,#	Freezes the PID loop.	Values for # are:
			0 = off
			1 = freeze PID

I1	I2	Reset Current output to 0.00%	
I1,xx.xx	I2,xx.xx	Sets current output to xx.xx%.	The power supply outputs a fixed value of current. Use any value # between 0 and 99.99%. (99.99% = 1 Amp).
IO1,xx.xx	IO2,xx.xx	Sets current offset. (sums xx.xx% to output of DAC)	Values for # range from 0 to 99.99.

SAVE,#	SAVE,#	Saves present configuration of unit to non-volatile memory.	Values for # are:
			0 = main board
			1 = DSP7002 board
			2 = I/O Card 1
			3 = I/O Card 2

MODE#	MODE#	Allows the user to swtich from 7000 mode to 6001 mode and back.	Values for # are:
			0 = 7000 mode
			1 = 6001 mode

OS,#	OS,#	Read speed in four decimal digits.	Values for # are:
			1 = Channel 1
			2 = Channel 2

OV,#	OV,#	Reads voltage applied to A/D channel in mV.	Values for # are:
			1 = Channel 1
			2 = Channel 2
			3 = I/O Card 1 channel 1
			4 = I/O Card 1 channel 2
			5 = I/O Card 2 channel 1
			6 = I/O Card 2 channel 2

TS1	TS2	Enables tare function.	
TR1	TR2	Disable tare function.	

TMV1,#	TMV2,#	TM torque reading invert flag	Values for # are:
			0 = Normal
			1 = Invert

Command Code Channel 1	Command Code Channel 2	Function	Explanation
	STAT	Read up to 32 bits status flags	0 = DPA1 1 = DPB1 2 = DPA2 3 = DPB2 4 = External Alarm 1 5 = DSP7002 6 = IO Card 1 7 = IO Card 2 8 = Electrical Alarm 1 9 = Electrical Alarm 2 10= Water Alarm 1 11= Water Alarm 2 12= Temperature Alarm 1 13= Temperature Alarm 2 14= Airflow Alarm 1 15= Airflow Alarm 2 (Clutch Alarm) 16= Alarm Contact 1 17= Alarm Contact 2 18= Ramp Down Complete 1 19= Ramp Down Complete 2 20= Ramp Up Complete 1 21= Ramp Up Complete 2 22= Mode Input (6001 or 7000) 23 = Speed Alarm 1 24 = Speed Alarm 2 25 = Torque Alarm 1 26 = Torque Alarm 2 27 = Power Alarm 1 28 = Power Alarm 2 29 = Global Power Alarm 30 = Global Torque Alarm 31 = External Alarm 2

7.4.8 QUADRATURE COMMANDS

Command Code Channel 1	Command Code Channel 2	Function	Explanation
QR1	QR2	Resets the position counter. Timer is not reset.	The zero of the system will be set to the position at the time of this command.
OP1	OP2	Sets the output of the quadrature position counter	Quadrature position counter will be used to calculate the angle position

Command Code Channel 1	Command Code Channel 2	Function	Explanation
OB*	OB*	User can read position counter and position time at a rate of 488 times per second. Timing is accurate to 25 ns.	*Use COB and OB commands to get position and time data.

7.5 6001 MODE

1. Turn on the DSP7000 power. *See section 3.1 – Powering Up the DSP7000.*
2. Press SHIFT. The word "SHIFT" will appear in the display.
3. Press the SETUP button. The display should appear as follows:

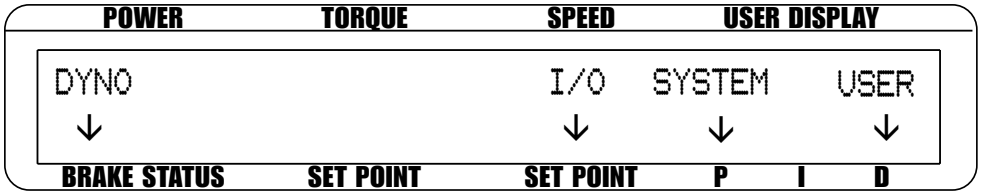


Figure 7–1 Setup Menu

4. Press SCALE P button. The display should appear as follows:

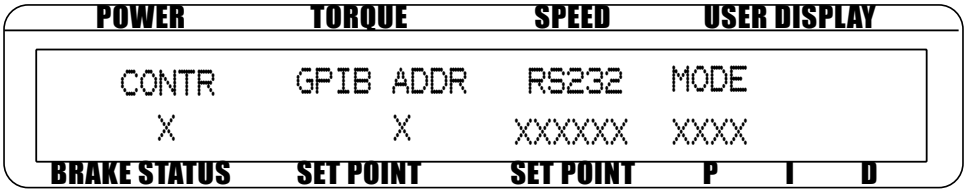


Figure 7–2 System Setup Menu

5. Press SCALE P button to switch to 6001 mode.
6. Press SHIFT 2 times to save and return to the main menu.

Refer to the DSP6001 users manual for operation of the DSP7000 in 6001 mode. For further support in 6001 mode contact Magtrol.

NOTE: The DSP7000 in DSP6001 mode no longer supports the following configurations: Cross loop function (both channels can now support TM's and any brake type) and Angle Measurement (the DSP7000 now has 32 bit counters as opposed to the 24 bit counter in the DSP6001). The DIR0, DIR1 and OH1 commands will result in a "Command Error."

8. Optional Equipment

8.1 I/O CARD 1 AND I/O CARD 2

Specifications:

I/O Analog input:

16 bit convertor +/-10 VDC (0.3 mV resolution)

Accuracy 0.1% of range (I/O card range is 10 volts. 0.1 % of 10 volts = 0.010 volts or 10 mV)

I/O Analog output:

16 bit convertor +/-10 VDC (0.3 mV resolution)

Accuracy 0.1% of range (I/O card range is 10 volts. 0.1 % of 10 volts = 0.010 volts or 10 mV)

Digital Outputs:

Open collector type 30 volts/20 mA (100 ohm internal protection resistor)

Digital Inputs:

Internally pulled to 5 volts DC using a 10K resistor

Refer to *Appendix C* for detailed I/O circuitry

8.1.1 I/O Card Installation

1. Turn off the device. Remove the two Philips pan head screws at each side of the cover of DSP7000 as shown in *Figure 8–1 DSP7000 Top Cover*, and then remove the cover.

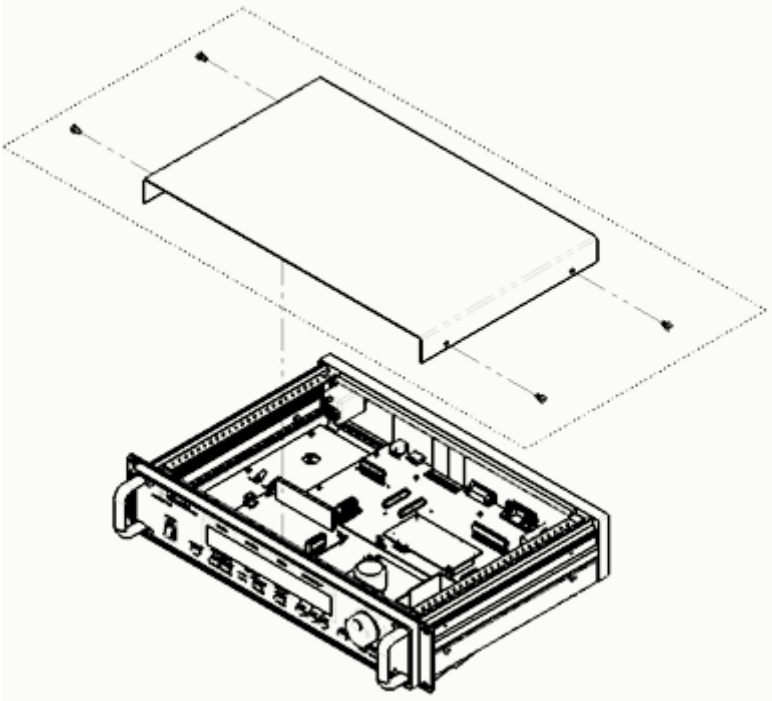


Figure 8–1 DSP7000 Top Cover

2. Remove the two Phillips pan head screws from the back panel covering the I/O Card 1 slot and remove the panel.
3. Plug I/O card 1 into the female header of main board as shown in *Figure 8–2 I/O Card Installation.* Ensure the component side of the IO card is on the left.

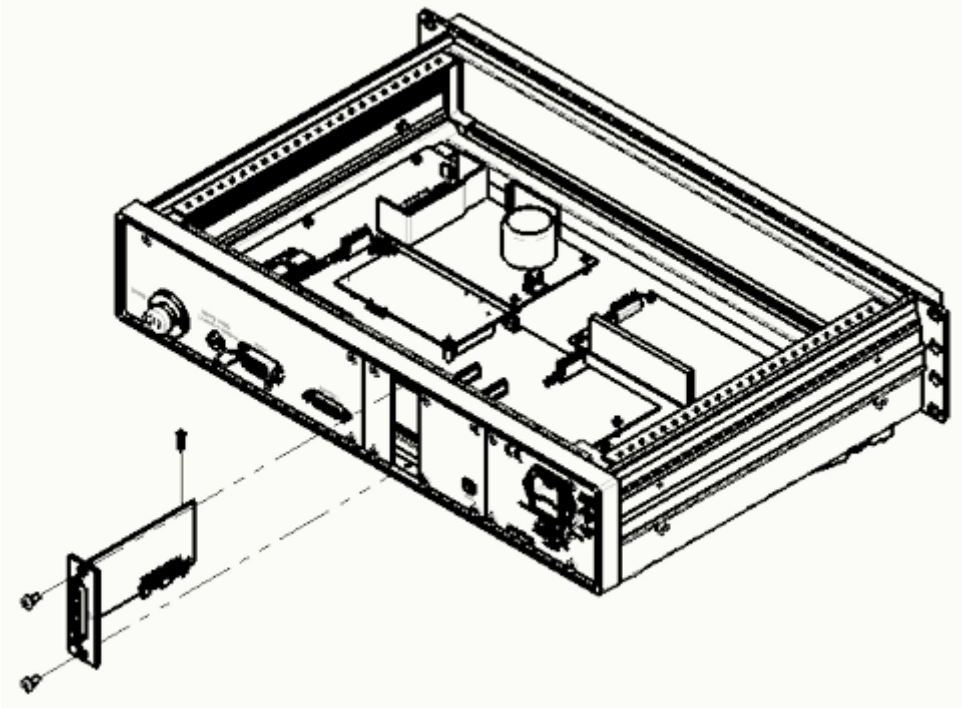


Figure 8–2 IO Card Installation

4. Mount one socket head cap screw onto the main board. Use two Philips pan head screws to secure I/O card 1 into the rear panel of the DSP7000.
5. Replace the top cover of the DSP7000 and secure with four Philips pan head screws.

Note: To install I/O Card 2 follow the instructions above using the slot on the back panel to the left of I/O Card 1.

8.1.2 I/O Card Interface

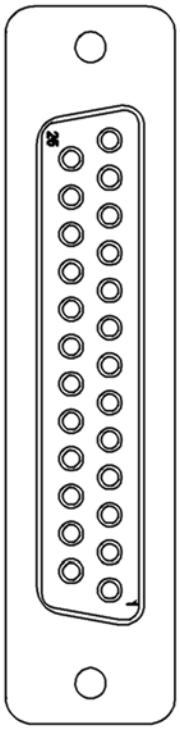


Figure 8–3 I/O Card Interface

Pin	Signal Name	Input/ Output	Level	Intended Use	Secondary Use	Notes
1	DAC 1	Output	+/ - 10VDC	Analog Torque output	User DAC 1	16 bit D/A convertor
2	DAC 2	Output	+/ - 10VDC	Analog Speed output	User DAC 2	16 bit D/A convertor
3	AIN1+	Input	+/ - 10VDC	Analog input for a Tachometer	Analog input for user	16 bit A/D convertor
4	AIN2+	Input	+/ - 10VDC	Analog input for user	---	16 bit A/D convertor
5	5 Volts	Output	+ 5 VDC	Supply external sensor	---	* Referenced to PIN18, 200mA max, internally fused at 500mA

Pin	Signal Name	Input/ Output	Level	Intended Use	Secondary Use	Notes
6	External Alarm	Input	OPEN or 5 Volts Common	External contact opening will put the DSP7000 in an alarm condition	If not used as external alarm, the user can use as another digital input. (DIN3)	10K internal pullup resistor to 5 Volts, Switch to PIN19
7	DI1	Input	OPEN or 5 Volts Common	The user can use as digital input	---	10K internal pullup resistor to 5 Volts, Switch to PIN20
8	DI2	Input	OPEN or 5 Volts Common	The user can use as digital input	---	10K internal pullup resistor to 5 Volts, Switch to PIN21
9	DOUT1	Output	OPEN collector	Open collector, less than 20 mA, can be used to switch on a optocoupler or small relay.	---	If inductive loads are used, clamp with a diode.
10	Alarm Relay1 NO	Bidirectional	N/A	Relay output, to shut down user equipment if DSP7000 is in an alarm condition	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT
11	Alarm Relay1 NC	Bidirectional	N/A	Relay output, to shut down user equipment if DSP7000 is in an alarm condition	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT
12	Relay2 NO	Bidirectional	N/A	Relay output, to turn motor power on or off (Controlled by MTEST)	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT
13	Relay2 NC	Bidirectional	N/A	Relay output, to turn motor power on or off (Controlled by MTEST)	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT
14	DAC 1 common	N/A	Bidirectional	Analog common for torque output	---	Signal return for PIN 1

Pin	Signal Name	Input/ Output	Level	Intended Use	Secondary Use	Notes
15	DAC 2 common	N/A	Bidirectional	Analog common for speed output	---	Signal return for PIN 2
16	AIN1-	Input	Bidirectional	Analog tachometer input common	User DAC 1 common	Signal return for PIN 3
17	AIN2-	Input	Bidirectional	Analog user input common	User DAC 2 common	Signal return for PIN 4
18	5 Volts Common	N/A	0 VDC	Supply external sensor common	---	---
19	5 Volts Common	N/A	0 VDC	External alarm common	DIN3 common	Switch closer to PIN 6
20	5 Volts Common	N/A	0 VDC	DIN1 common	---	Switch closer to PIN 7
21	5 Volts Common	N/A	0 VDC	DIN2 common	---	Switch closer to PIN 8
22	DOUT2	Output	OPEN or 8 Volts	Open collector, less than 20 mA, can be used to switch on a optocoupler or small relay.	---	If inductive loads are used, clamp with a diode.
23	Alarm Relay1 Common	Bidirectional	N/A	Relay output, to shut down user equipment if DSP7000 is in an alarm condition	General purpose user relay	Recommended used as a pilot relay. 24 VDC, 1 amp max.
24	5 Volts Common	N/A	0 VDC	Spare	---	---
25	Alarm Relay2 Common	Bidirectional	N/A	Relay output, to turn motor power on or off (Controlled by MTEST)	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT

8.1.3 I/O Card Configuration

1. Press SHIFT.
2. Press SETUP button.
3. Select I/O. The display should appear as follows:

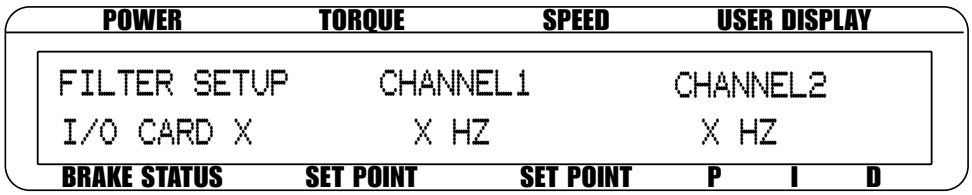


Figure 8–4 Filter Channel Setup Menu

4. Press TORQUE UNITS button until the desired filter for channel 1 is reached.
5. Press SCALE P button until the desired filter for channel 2 is reached.
6. Press SHIFT. The display should appear as follows:

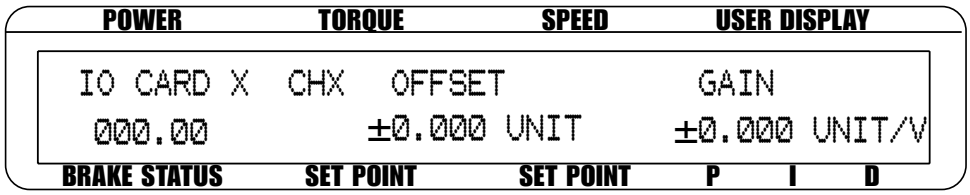


Figure 8-5 Offset and Gain Setup Menu

7. Press TORQUE UNITS button and use ◀ and ▶ buttons and the Decrease/Increase dial to set the offset for channel 1.
8. Press SCALE P button and use ◀ and ▶ buttons and the Decrease/Increase dial to set the gain for channel 1.
9. Press SHIFT.
10. Press TORQUE UNITS button and use ◀ and ▶ buttons and the Decrease/Increase dial to set the offset for channel 2.
11. Press SCALE P button and use ◀ and ▶ buttons and the Decrease/Increase dial to set the gain for channel 2.
12. Press SHIFT. The display should appear as follows:

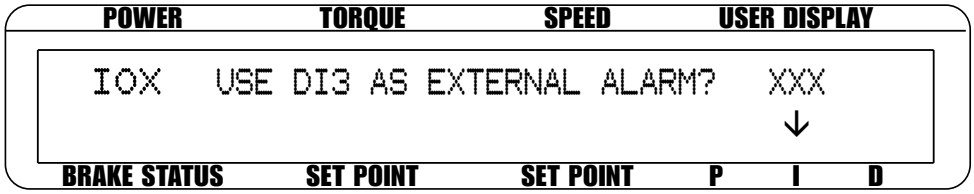


Figure 8–6 External Alarm Setup

13. Press SCALE I button to select yes or no.
14. Press SHIFT. The display should appear as follows:

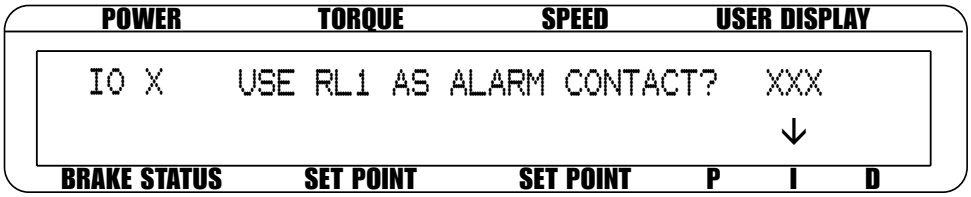


Figure 8–7 Alarm Contact Setup

15. Press SCALE I button to select yes or no.
16. Press SHIFT. The display should appear as follows:

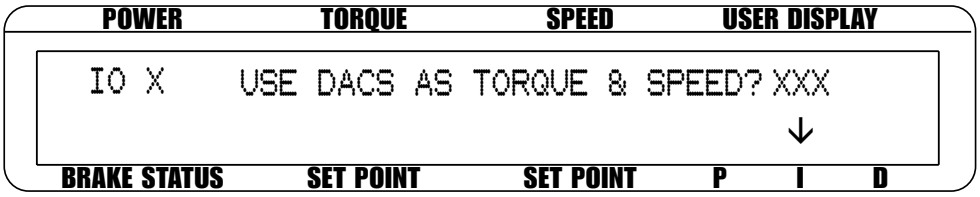


Figure 8–8 Torque/Speed Setup

17. Press SCALE I button to select yes.
18. Press SHIFT. The display should appear as follows:

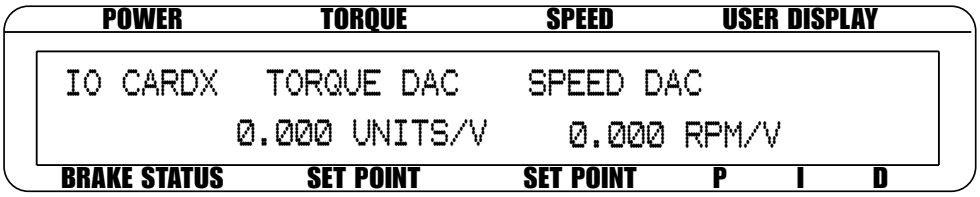


Figure 8–9 Torque/Speed DAC Setup Menu

19. Press TORQUE UNITS button and use ◀ and ▶ buttons and the Decrease/Increase dial to set the desired Torque DAC vlaue.
20. Press MAX SPEED button and use ◀ and ▶ buttons and the Decrease/Increase dial to set the desired Speed DAC value.
21. Press SHIFT 2 times to complete configuration and return to the main menu.

8.1.3.1 Torque DAC Scale Factor

Torque DAC Scale Factor is scaled in displayed torque units/volt.

Example:

If the displayed torque units are set to oz·in. and the Torque DAC scale is set to 1 unit/volt, then 1 oz·in. will result in 1 volt at the torque output.

8.1.3.2 Speed DAC Scale Factor

Speed DAC Scale Factor is scaled in rpm/volt.

Example:

If the Speed DAC scale is set to 1000 rpm/volt, then 1000 rpm will result in 1 volt at the speed output.

8.1.3.3 I/O Card A/D Input Signal Range

The input signals of the I/O card are from -10V to +10V.

8.1.3.4 I/O Card DAC Output Signal Range

The output singals of the DAC is from -10V to +10V.

8.1.4 I/O Card 1/Card 2 Command Set

Command Code I/O Card 1	Command Code I/O Card 2	Function	Explanation
IO1AI,#	IO2AI,#	Read to IO card Analog input Analog Channel 1 is available when not assigned as the TACH input.	Read the value of the AD channel of the IO card. Scale factor unit per volt will be applied to reading. # 1 = Channel 1 2 = Channel 2 Returns a float and <cr>< lf>
IO1AO,#,xx.xxx	IO2AO,#,xx.xxx	Write to IO card analog output Analog outputs are available when not assigned to speed and torque.	Write the value to the DA channel of the IO card. Volts is assumed. # 1 = Channel 1 2 = Channel 2 xx.xx floating point voltage value 3 decimal places +10.000 to -10.000
IO1RL,#,&	IO2RL,#,&	Write to IO card Relay output Relay output 1 is available when not assigned to the alarm output.	Write the value to the relay. # 1 = Relay 1 2 = Relay 2 & 0 = Relay off 1 = Relay on
IO1DO,#,&	IO2DO,#,&	Write to IO card Digital output Open collector NPN	Write the value to the relay. # 1 = Output line 1 2 = Output line 2 & 0 = transistor off 1 = transistor on

Command Code I/O Card 1	Command Code I/O Card 2	Function	Explanation
IO1DI,#	IO2DI,#	Read to IO card Digital input DIN3 is available if not being used for external alarm	Read a value of the Digital input # 1 = Input line 1 2 = Input line 2 3 = Input line 3 Returns a 0 or 1 and <cr>< lf>
AF11,# AF12,#	AF21,# AF22,#	Set up I/O card Filter	0=NONE 1=2 Hz 2=5 Hz 3=10 Hz 4=20 Hz 5=50 Hz 6=100 Hz
IO1AIO,#	IO2AIO,#	Set up the offset of channel 1 of analog input	# 1=Channel 1 2=Channel 2
IO1AIG,#	IO2AIG,#	Set up the gain of channel 1 of anolog input	# 1=Channel 1 2=Channel 2

8.2 GPIB INTERFACE

8.2.1 GPIB Card Installation

1. Remove the two Philips pan head screws at each side of the cover of DSP7000 as shown in *Figure 8–1 DSP7000 Top Cover*, and then remove the cover.
2. Remove the four Phillips pan head screws from the back panel covering the GPIB Card slot and remove the panel.
3. Plug the GPIB card into the female header of the main board as shown in *Figure 8–9 GPIB Card Installation*. Ensure the component side of the GPIB card is on the left.

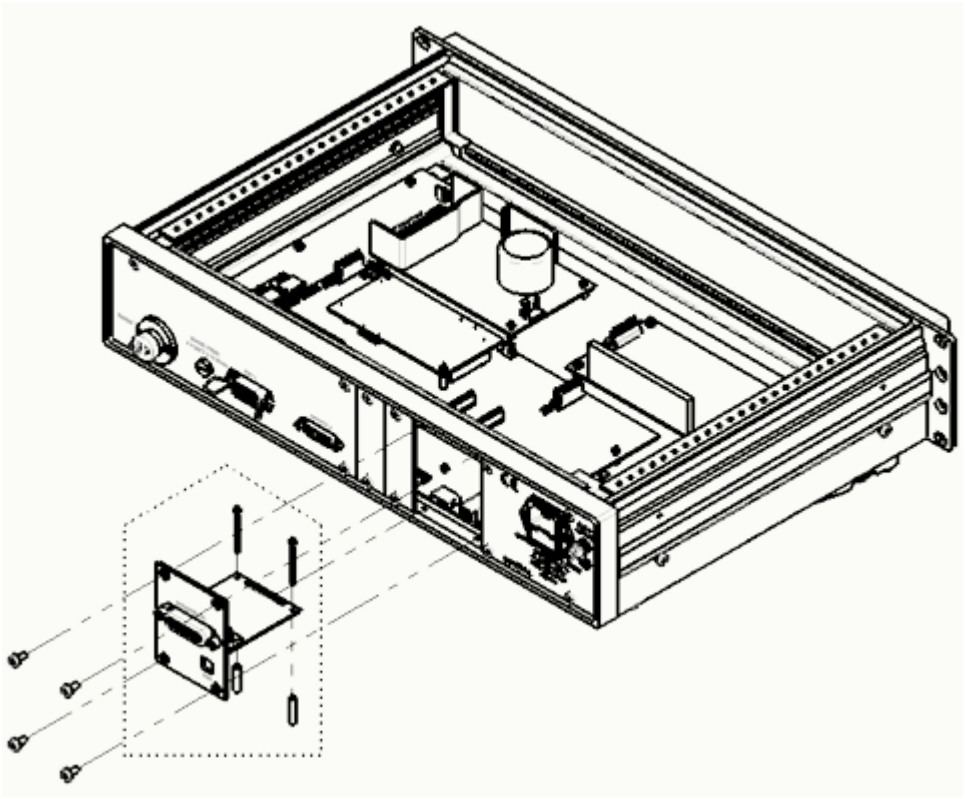


Figure 8–10 GPIB Card Installation

4. Mount the two standoffs and the two socket head cap screws onto the main board. Use four Philips pan head screws to secure the GPIB card into the rear panel of the DSP7000.
5. Replace the top cover of the DSP7000 and secure with four Philips pan head screws.

8.2.2 About the GPIB Interface

(General Purpose Interface Bus)

Magtrol instruments use the GPIB (IEEE-488 Standard) for computer-to-instrument interfacing because:

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

Note: The GPIB interface is not standard on most computers. An interface card and driver software must be installed. An IEEE-488 cable must also be installed between the computer and the DSP7000. Magtrol recommends National Instruments Corporation hardware and software.

8.2.3 Installing the GPIB (IEEE-488) Connector Cable

CAUTION: MAKE SURE BOTH THE COMPUTER AND DSP7000 ARE TURNED OFF BEFORE INSTALLING THE GPIB CONNECTOR CABLE.

1. Connect one end of a high-quality, double-shielded cable to the DSP7000 GPIB port.
2. Connect the other end to the USB port in your PC

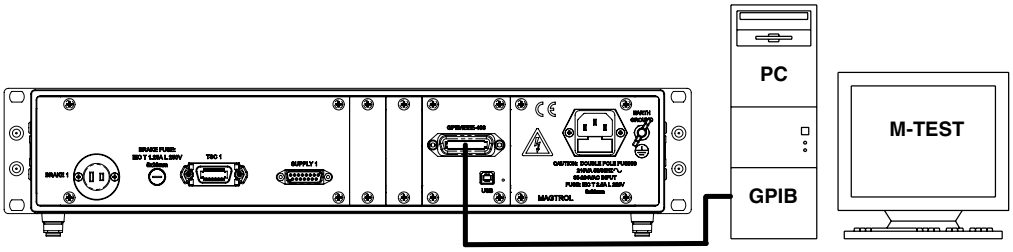


Figure 8–11 GPIB Installation

8.2.4 Changing the GPIB Primary Address

Each instrument serviced by the GPIB has its own Primary Address code, which enables the computer to obtain readings from the instrument. The factory default of the setting on the DSP7000 is 09.

Some PC interfaces can access from one to fifteen 4-bit primary addresses. Other interfaces can access as many as thirty-one 5-bit primary addresses. The DSP7000 uses the 4-bit format. For setup, follow the steps below.

1. Press the SHIFT button.
2. Press the SETUP button.
3. Press SCALE P button to select system. The display should appear as follows:

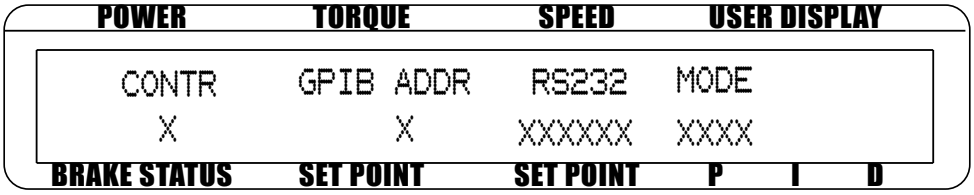


Figure 8–12 Setup Menu Display

4. Press TORQUE UNITS until the desired primary address is reached (range 0-15).
5. Press SHIFT 2 times to exit and return to main menu.

8.3 RS232 INTERFACE

The DSP7000 is equipped with an RS-232 (serial) interface that communicates with the host computer through a DB-9 interface connector. The connector pin-out consists of 2-TX, 3-RX and 5-GND.

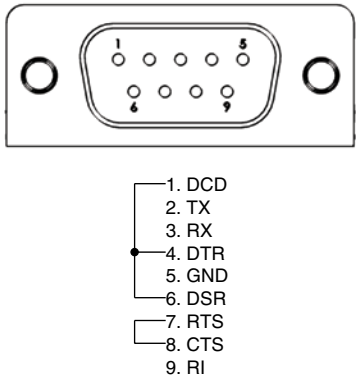


Figure 8–13 RS-232 Interface

8.3.1 RS-232 INSTALLATION

1. Remove the two Philips pan head screws at each side of the cover of DSP7000 as shown in *Figure 8–1 DSP7000 Top Cover*, and then remove the cover.
2. Remove the four Phillips pan head screws from the back panel covering the RS-232 Card slot and remove the panel.
3. Plug the RS232 card into the female header of main board as shown in Figure 8–14 RS-232 Card Installation. Ensure the component side of the RS-232 card is in left.

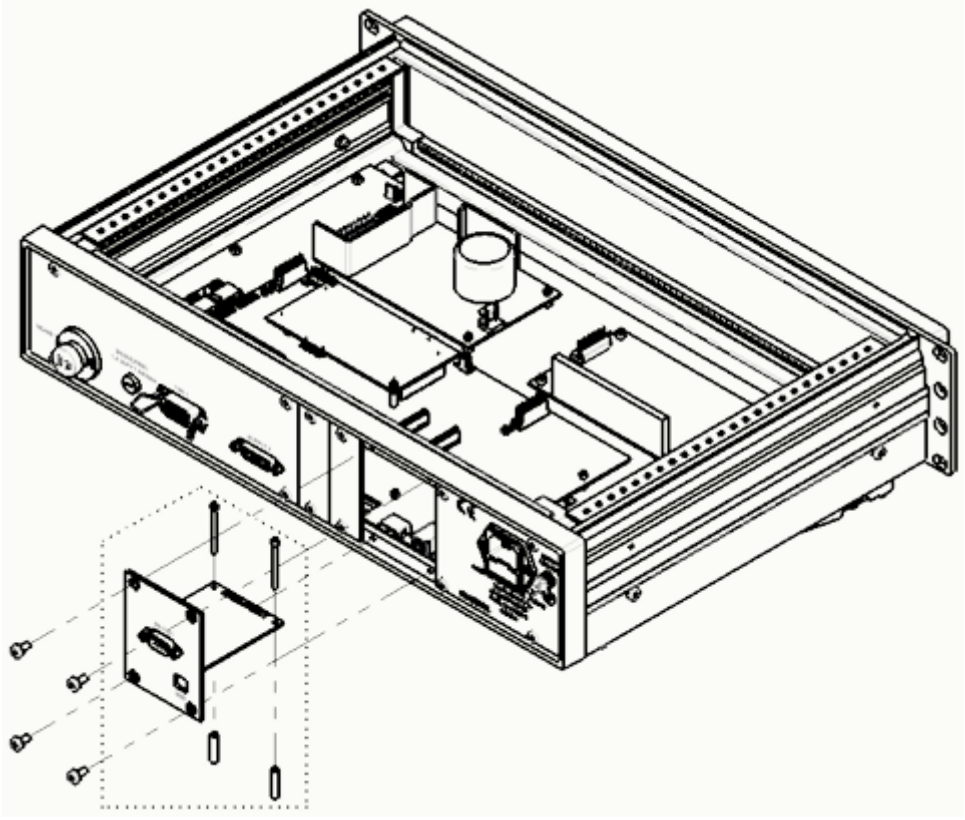


Figure 8–14 RS-232 Card Installation

4. Mount the two standoffs and the two socket head cap screws onto the main board. Use four Philips pan head screws to secure the RS-232 card into the rear panel of the DSP7000.
5. Replace the top cover of the DSP7000 and secure with four Philips pan head screws.

8.3.2 CONNECTION

The RS-232 connection includes null modem wiring internal to the unit. To install, use a straight through pin-to-pin connector cable, which can be purchased from your local electronics store.

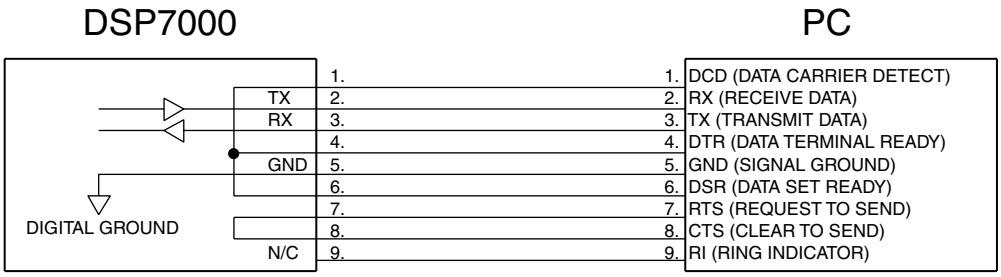


Figure 8–15 Straight Through Pin-to-Pin Cable Connection

8.3.3 COMMUNICATION PARAMETERS

- No parity
- 8 data bits
- 1 stop bit
- No protocol

8.3.4 BAUD RATE

There are eight different baud rates to choose from including 300, 600, 1200, 2400, 4800, 9600, 19200 and 115200. To set up the desired baud rate, follow the instructions below.

1. Press SHIFT and release.
2. Press the SETUP button. The display will appear as shown in *Figure 3–5 Setup Menu.*
3. Press SCALE P button to select system.
3. Press MAX SPEED button until the desired baud rate is reached.
4. Press SHIFT 2 times to exit and return to main menu.

8.4 CHECKING THE DSP7000-TO-PC CONNECTION

8.4.1 GPIB COMMUNICATION CHECK

1. Launch the application Measurement and Automation Explorer in PC desktop.

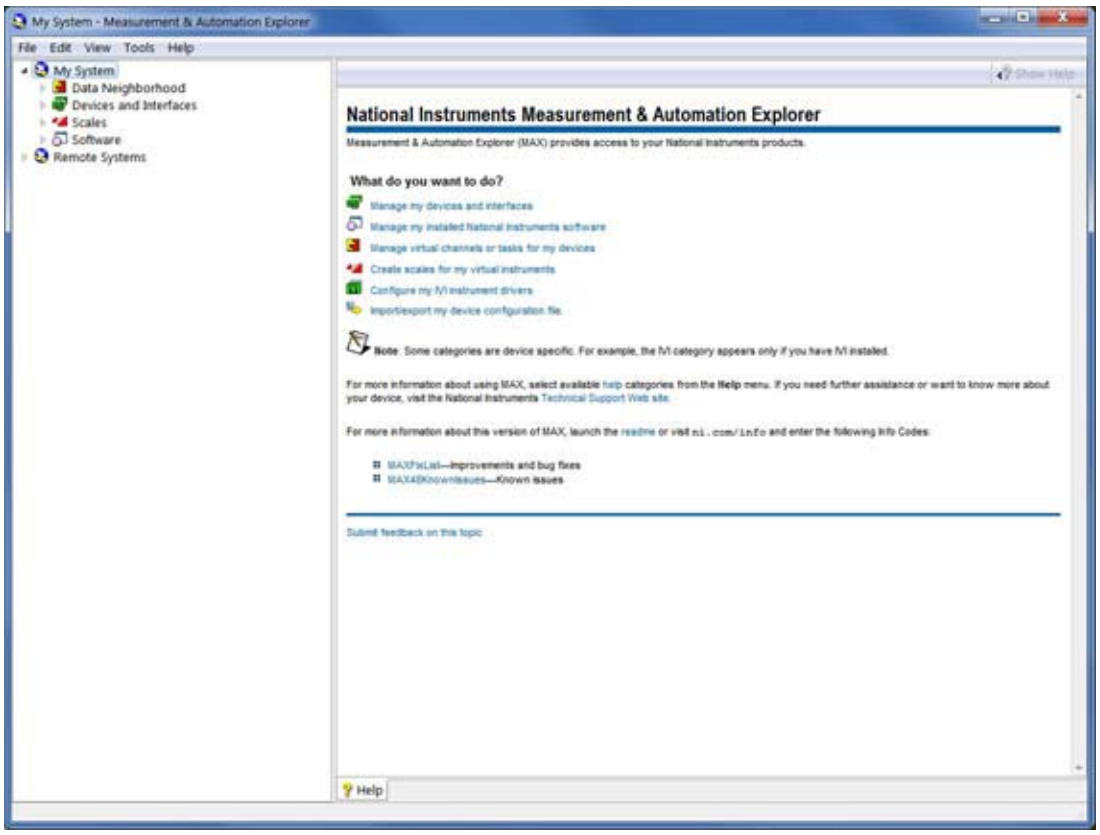


Figure 8–16 Measurement and Automation Explorer Window

2. Double click on Devices and Interfaces in the left column. The submenu will display.
3. Double click on GPIB (PCI-GPIB) in the Devices and Interfaces submenu. Ensure the primary GPIB address is set correctly. Also, make sure the primary address is set correctly for the DSP7000.

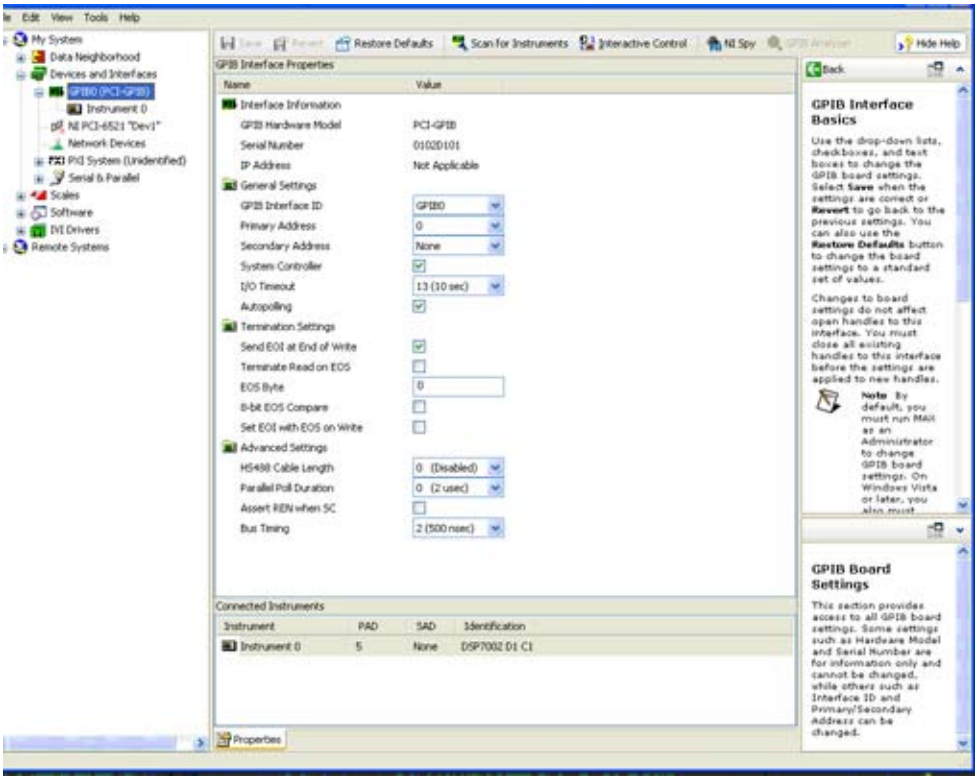


Figure 8–17 GPIB (PIC_GPIB) Window

4. Click the Scan for Instruments tab. The new connection will show in the Connected Instruments window.
5. Double click on Instruments 0 in the Connected Instruments window.

OPERATION

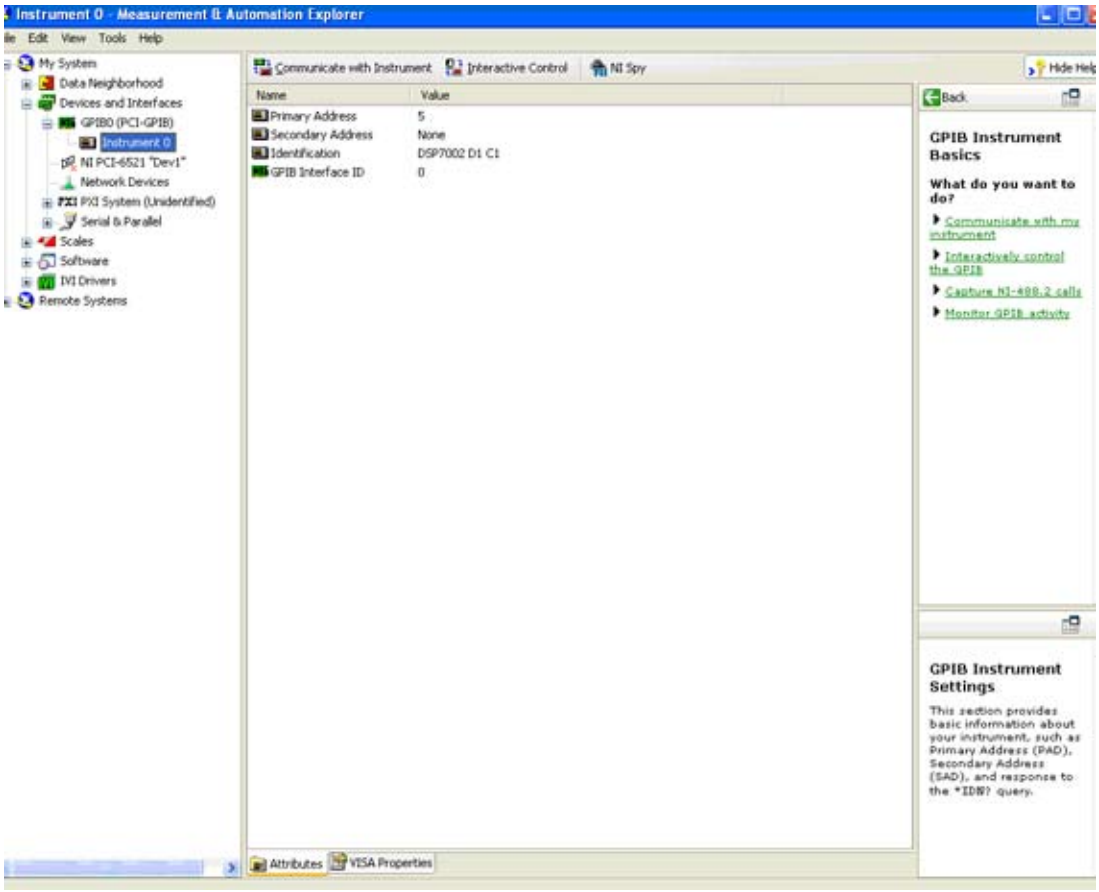


Figure 8–18 Connected Instruments Window

6. Click the Communication with Instrument tab, the following screen will show:

Figure 8–19 Communication with Instrument Window

OPERATION

7. Click Query. The response DSP700x xx xx will display in the String Received window.

Figure 8–20 Query Window

8.4.2 RS232 Communication Check

Note: If you have already installed the Tera Term Application on your desktop, skip to step 10.

1. Run TeraTerm-4.70.exe found on the Magtrol Manual CD at *programs\DSP7000 Drivers\Tera Term* to launch the intall wizard. Click the NEXT button to begin installation.

Figrue 8–21 Tera Term Setup Window

OPERATION

2. Click on the option “I accept the agreement”, then click NEXT.

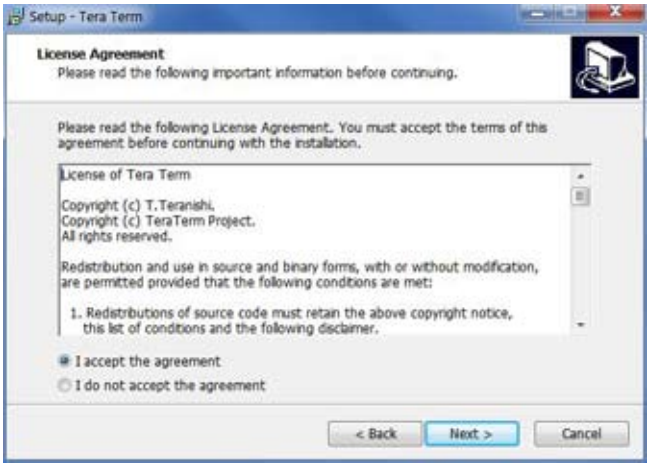


Figure 8–22 Tera Term Licence Agreement Window

3. Select the default install folder click NEXT.

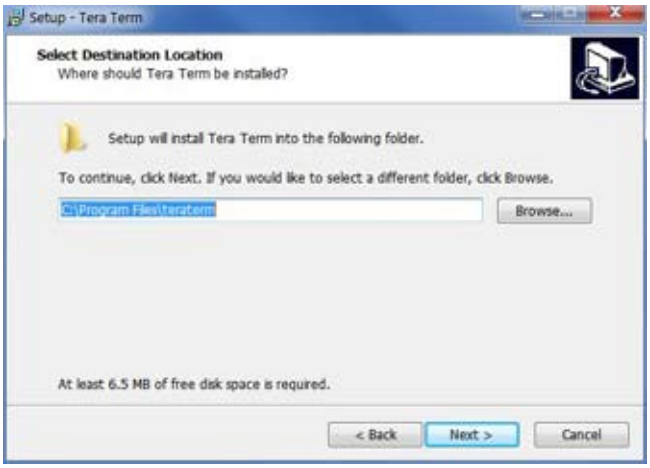


Figure 8–23 Tera Term Destination Location Window

4. Uncheck all boxes except for “Tera Term & Macro” option, then click NEXT.

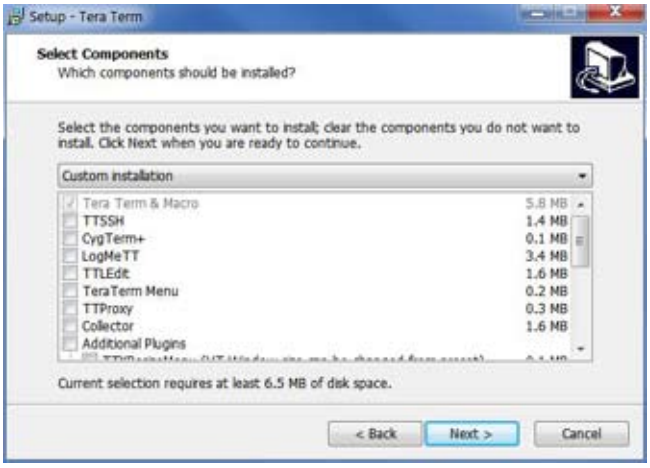


Figure 8–24 Tera Term Select Components Window

5. Click “YES” to continue to install the application.
6. Select “English”, then click NEXT.

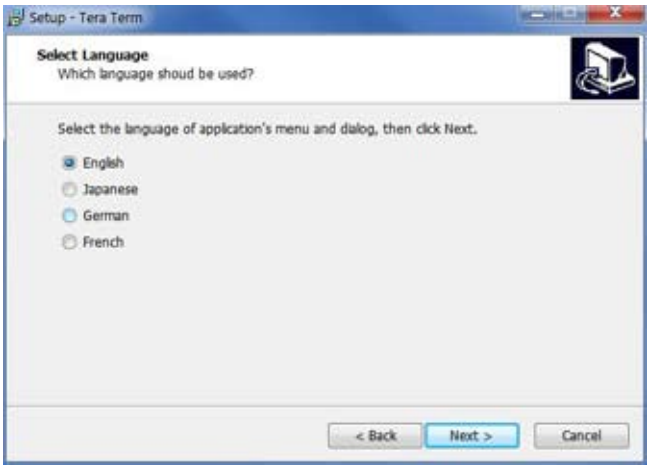


Figure 8–25 Tera Term Language Selection Window

7. Select the Start Menu folder, then click NEXT.

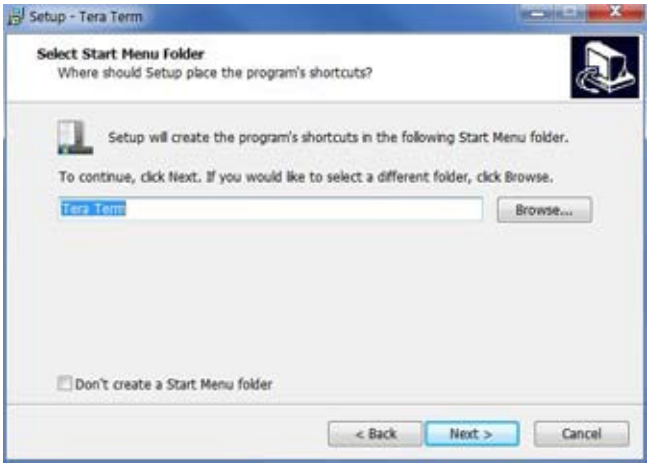


Figure 8–26 Tera Term Start Menu Folder Window

8. Click NEXT.

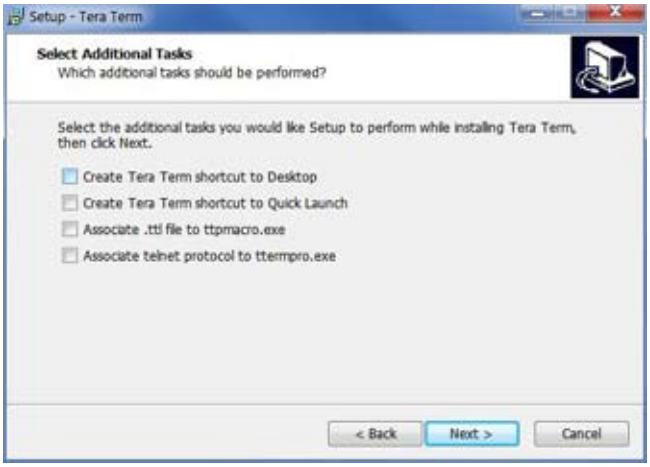


Figure 8–27 Tera Term Additional Tasks Window

9. Click the FINISH button.

10. Go to the Start Menu on your PC desktop. Launch the Tera Term Application.

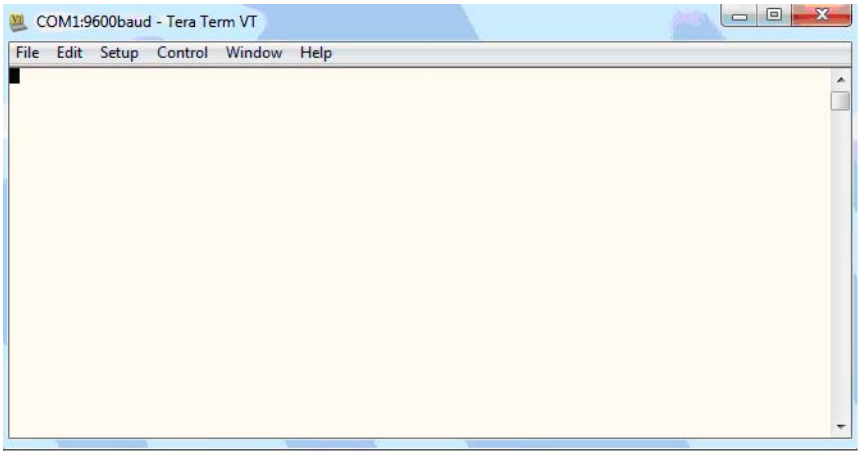


Figure 8–28 Tera Term Window

11. Go to the Setup menu. Click on Terminal. Configure the selections as follows, and then close this screen.

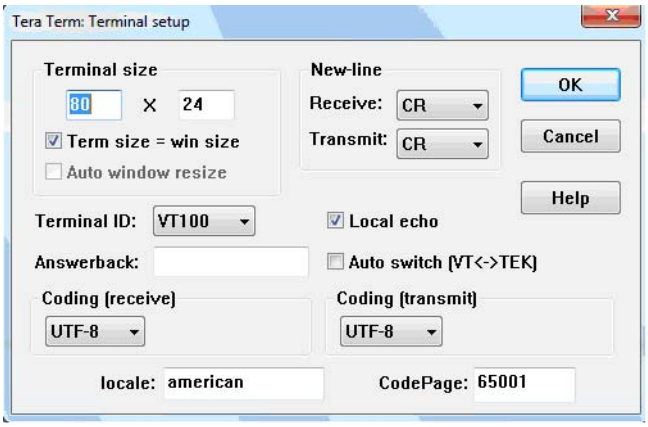


Figure 8–29 Terminal Setup Window

12. Return to the Setup menu. Click on Serial Port. Configure the selections as follows, and then close this screen. Please note that the baud rate setting should be the same as the DSP7000 setting.

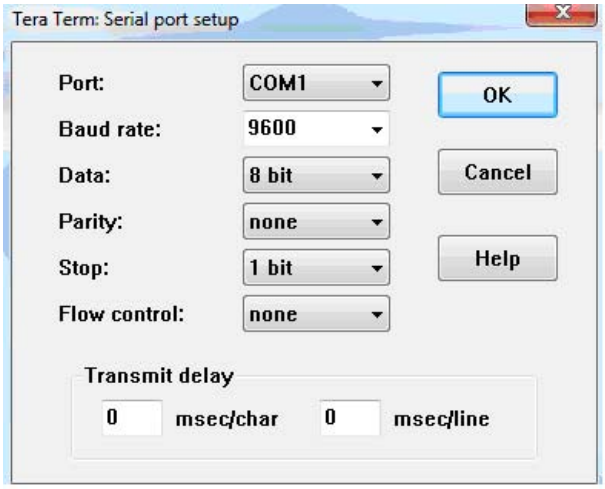


Figure 8–30 Serial Port Setup Window

13. Input a command, such as *IDN? plus CR + LF. The response DSP700x xx xx should display.

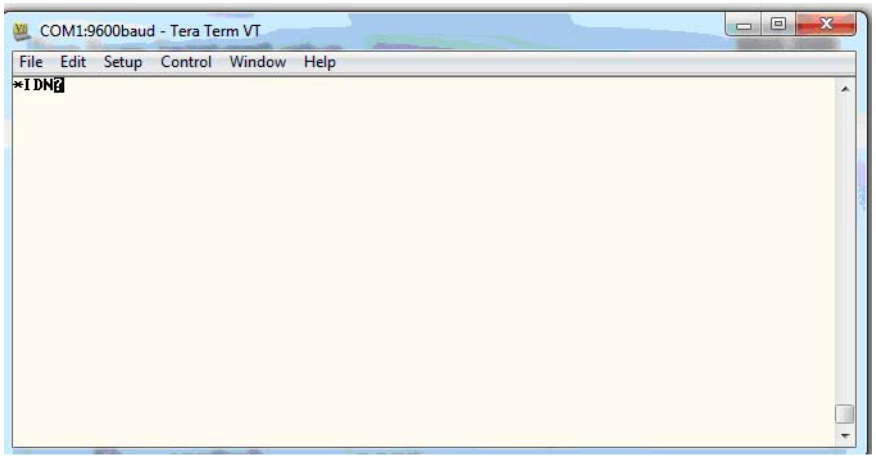


Figure 8–31 Tera Term Window with a Command

9. Calibration

9.1 CLOSED-BOX CALIBRATION

The DSP7000 features closed-box calibration. The advantage of closed-box calibration is that the user does not have to disassemble the case or make mechanical adjustments.

9.2 CALIBRATION SCHEDULE

Calibrate the DSP7000:

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

9.3 BASIC CALIBRATION PROCESS

The basic calibration process consists of procedures which must be performed in the following order: (Depending on your hardware configuration some steps may not apply)

1. Initial Calibration Procedure (re initializes unit to default values)
2. TSC1 A/D Offset and Gain
3. TSC1 D/A Offset and Gain
4. TSC2 A/D Offset and Gain
5. TSC2 D/A Offset and Gain
6. IO Card 1 Channel 1 A/D Offset and Gain
7. IO Card 1 Channel 2 A/D Offset and Gain
8. IO Card 1 Channel 1 D/A Offset and Gain
9. IO Card 1 Channel 2 D/A Offset and Gain
10. IO Card 2 Channel 1 A/D Offset and Gain
11. IO Card 2 Channel 2 A/D Offset and Gain
12. IO Card 2 Channel 1 D/A Offset and Gain
13. IO Card 2 Channel 2 D/A Offset and Gain
14. Speed Check
15. Decimal Point Check

Items needed for calibrating the DSP7000:

- External voltage reference of 0 to 10 volts DC
- Digital multimeter (DMM)

Both instruments should have a VDC accuracy of 0.05% or better.

9.3.1 Initial Calibration Procedure

1. Allow the DSP7000 to stabilize in an environment with:
   - An ambient temperature of 18°C to 25°C.
   - Relative humidity less than 80%.
   - Power Resistor 25 ohms 50W.

2. Turn on the DSP7000.
3. Allow the DSP7000 to warm up for at least 30 minutes.

9.3.2 Calibration of Analog to Digital Converters

1. A/D Offset and Gain on any of the 6 analog inputs.
   - TSC1 (low gain and high gain)
   - TSC2 (low gain and high gain)
   - IO Card 1 Channel 1
   - IO Card 1 Channel 2
   - IO Card 2 Channel 1
   - IO Card 2 Channel 2

2. Connect the external voltage reference common to the input connector.
   - TSC1 = Pin 13 of the TSC1 connector
   - TSC2 = Pin 13 of the TSC2 connector
   - IO Card 1 Channel 1 = Pin 16 of the IO Card 1 connector
   - IO Card 1 Channel 2 = Pin 17 of the IO Card 1 connector
   - IO Card 2 Channel 1 = Pin 16 of the IO Card 2 connector
   - IO Card 2 Channel 2 = Pin 17 of the IO Card 2 connector

3. Connect the external voltage reference high to the input connector.
   - TSC1 = Pin 14 of the TSC1 connector
   - TSC2 = Pin 14 of the TSC2 connector
   - IO Card 1 Channel 1 = Pin 3 of the IO Card 1 connector
   - IO Card 1 Channel 2 = Pin 4 of the IO Card 1 connector
   - IO Card 2 Channel 1 = Pin 3 of the IO Card 2 connector
   - IO Card 2 Channel 2 = Pin 4 of the IO Card 2 connector

4. Send the DSP7000 the MODE2 command. This command puts the unit into engineering mode. After completing calibration, send the DSP7000 the MODE0 command.

NOTE: The appropriate DIN command needs to be sent to choose between HD (2 Volt) and WB/PB (10 Volt) calibration to activate internal multiplexer.

5. Send the DSP7000 the CALAD# command. This chooses the A/D to be calibrated. Where # represents the A/D being calibrated.

   0 = TSC1 (HD 2.0 volts)

   1 = TSC1 (WB/PB 10.0 volts)

   2 = TSC2 (HD 2.0 volts)

   3 = TSC2 (WBPB 10.0 volts)

   4 = IO Card 1 Channel 1

   5 = IO Card 1 Channel 2

6 = IO Card 2 Channel 1
7 = IO Card 2 Channel 2

6. If the hard ware is not available the unit will respond "NOT INSTALLED." If the hardware is available the unit will respond "ZERO TO A/D#."
7. Apply +0.000 VDC and send the DSP7000 the ZEROAD# command. This command makes the DSP take a reading and save it as its offset value for that particular channel. The unit will respond "FS TO A/D#."
8. Apply approximately +2.000 VDC for HD (# = 0 or 2) or approximately +10.000 VDC for all others.
9. Send the DSP7000 the FSAD#,xx.xxx command where xx.xxx represents the voltage applied. This command makes the DSP take a reading calculate the gain and save it as its gain value for that particular channel.
10. The unit will respond "CAL COMP AD#."

NOTE: On units with Firmware Revisions Y0 and later a negative calibration can be performed for greater accuracy

11. Apply approximately -2.000 VDC for HD (# = 0 or 2) or approximately -10.000 VDC for all others.
12. Send the DSP7000 the FSAN#,xx.xxx command where xx.xxx represents the voltage applied. This command makes the DSP take a reading calculate the gain and save it as its gain value for that particular channel.
13. The unit will respond "CAL COMP AD#."

9.3.3 Calibration of Digital to Analog Converters

Note: A calibration load of about 25 ohms (at least 50 watts) is required to calibrate the current outputs.

1. D/A Offset and Gain on any of the 6 analog outputs.
   - TSC1 (Current and Voltage) Current from the brake connector, Voltage from the SUPPLY1 connector
   - TSC 2 (Current and Voltage) Current from the brake connector, Voltage from the SUPPLY2 connector
   - IO Card 1 Channel 1 (Commonly used as Analog Torque out)
   - IO Card 1 Channel 2 (Commonly used as Analog Speed out)
   - IO Card 2 Channel 1
   - IO Card 2 Channel 2

2. If calibrating a Current output connect the voltmeter common BRAKE- connector (larger of the two pins).
3. If calibrating a Voltage output connect the voltmeter common to output connector.
   - TSC1 = Pin 14 of the SUPPLY1 connector
   - TSC2 = Pin 14 of the SUPPLY2 connector

- IO Card 1 Channel 1 = Pin 14 of the IO Card 1 connector
- IO Card 1 Channel 2 = Pin 15 of the IO Card 1 connector
- IO Card 2 Channel 1 = Pin 14 of the IO Card 2 connector
- IO Card 2 Channel 2 = Pin 15 of the IO Card 2 connector

4. If calibrating a Current output connect the voltmeter positive to the load resistor and the other end of the load resistor to the BRAKE+ connector (smaller of the two pins).
5. If calibrating a Voltage output connect the Voltmeter high to the input connector.
   - TSC1 = Pin 7 of the SUPPLY1 connector
   - TSC2 = Pin 7 of the SUPPLY2 connector
   - IO Card 1 Channel 1 = Pin 1 of the IO Card 1 connector
   - IO Card 1 Channel 2 = Pin 2 of the IO Card 1 connector
   - IO Card 2 Channel 1 = Pin 1 of the IO Card 2 connector
   - IO Card 2 Channel 2 = Pin 2 of the IO Card 2 connector
6. Send the DSP7000 the MODE2 command. This command puts the unit into engineering mode.
7. Send the DSP7000 the CALDAC# command. This chooses the D/A to be calibrated. Where # represents the DAC being calibrated. This tells the DAC to output zero.
   0 = TSC1 (Current) BRAKE1
   1 = TSC1 (Volts) SUPPLY1
   2 = TSC2 (Current) BRAKE2
   3 = TSC2 (Volts) SUPPLY2
   4 = IO Card 1 Channel 1
   5 = IO Card 1 Channel 2
   6 = IO Card 2 Channel 1
   7 = IO Card 2 Channel 2
8. If the hardware is not available the unit will respond “NOT INSTALLED.” If the hardware is available the unit will respond “READ ZERO.”
9. User will read the meter and send the DSP7000 the ZDAC#,xx.xxx command where xx.xxx represents the voltage (or current) read. This command makes the DSP take a reading and save it as its offset value for that particular channel. This offset is immediately applied.
10. The hardware will respond “ZERO OK?”
11. If the meter reading is zero the user responds “ZERO OK#.” The unit will respond “READ FS.” If the meter reading is not zero the user must return to step 7.
12. User will read the meter and send the DSP7000 the FSDAC#,xx.xxx command where xx.xxx represents the voltage (or current) read. This command makes the DSP take a reading, calculate the gain and save it for that particular channel. This offset is immediately applied.
13. The hardware will respond “FS OK?”
14. If the meter reading is FS the user responds “FS OK#.” The unit will respond “CAL COMP DA #.” If the meter reading is not zero the user must return to step 10.

9.3.4 CALIBRATION FREQUENCY

NOTE: On units with Firmware Revision R1 and later speed calibration can be performed for greater accuracy

NOTE: A high-precision square wave signal generator or frequency counter is required to calibrate frequency gain.

1. Frequency gain on TSC1 and TSC2.
   - TSC1 speed from pin 10 of the TSC1 connector
   - TSC2 speed from pin 10 of the TSC2 connector
2. Send the command CALS# to the unit via USB/GPIB/RS232.
3. The response will be FRQ#=XXXXXX.XX.
4. Apply a square wave of 50 kHz to 99 kHz frequency to the input (this can vary from 50 kHz to 99 kHz but must be measured accurately).
5. Send the command FRQ#=XXXXXX.XX (where XXXXXX.XX is your meter reading).
6. The response will be CAL COMPLETE FRQ#.

10. Theory

10.1 HOW THE PID LOOP WORKS

The following diagram demonstrates the correlation between the variables in the PID Loop.

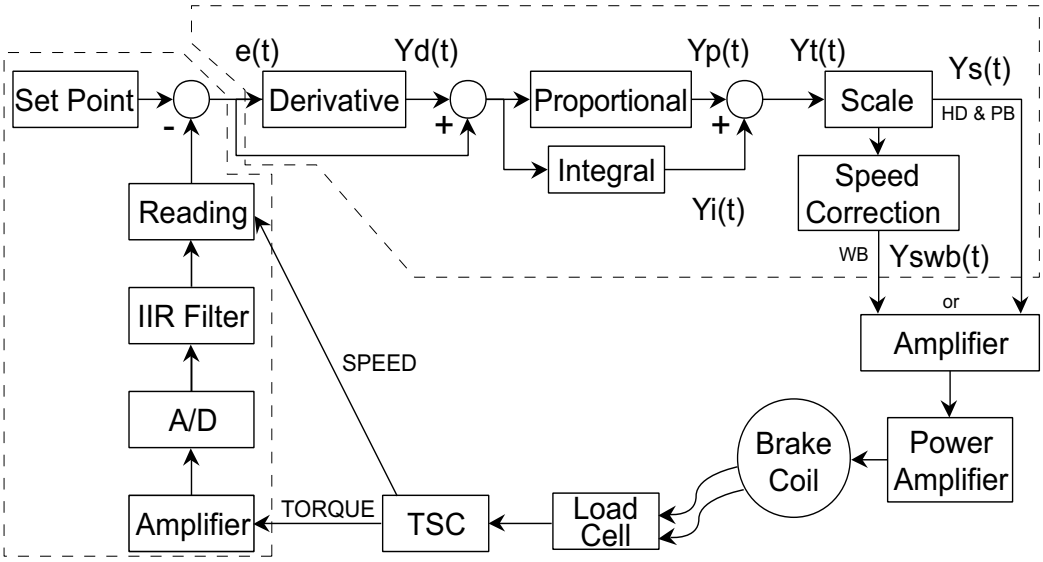


Figure 10–1 System Block Diagram

10.1.1 Scale Factors for Hysteresis, Eddy-Current and Powder Brake Dynamometers

TORQUE: TSC1 & TSC2 Ys(t) = Yt(t) / 1.90775 * 2 (HB brake)
Ys(t) = Yt(t) / 1.0908 * 2 (all others)

SPEED: TSC1 & TSC2 Ys(t) = Yt(t) * 5599.19 / MAX SPEED

10.1.2 Speed Correction for WB (Eddy-Current Brake) Dynamometer

The WB Dynamometer follows the same scaling as the HYST and PB with the addition of one calculation for both torque and speed. This calculation is due to the fact that for a given current the torque changes with speed. This is referred to as speed correction.

Yswb(t) = (Ys(t) + Ys(t) / speed correction factor) / 2

The speed correction factor is calculated on each entry into the PID loop equations.

Speed Correction Factor = - 0.0001 * x * 2 + 0.0203 * x + 0.005 limited to 0.051 to 1

where x = RPM / NOMINAL SPEED * 100

NOMINAL SPEED is set by the user and obtained from the data sheets for the dynamometer or brake.

10.1.3 EQUATIONS

Where Skp, Ski and Skd are system coefficients…

Yd(t) = (e(t) - e(t-3) + 3 * (e(t-1) - e(t-2))) * (10/Skd) * D%

Yp(t) = (e(t) + Yd(t)) * (10/Skp) * P%

Yi(t) = Yi(t-1) + (e(t) + Yd(t)) * (10/Ski) * I%

Yt(t) = Yp(t) + Yi(t)

Ys(t) = Scale * Yt(t)

10.2 ADDITIONAL SCALE FACTOR

The Additional Scale Factor is a multiplier of the P, I or D term. Due to the fact there are so many different dynamometer types and motor combinations, this multiplier is needed to extend the range of the PID. The letters represent the following:

A	=	0.001	F	=	0.5
B	=	0.005	G	=	1
C	=	0.01	H	=	5
D	=	0.05	I	=	10
E	=	0.1			

In using the multiplier, the user can input PID numbers from 0.001 (.001 x 1%) to 990 (10.0 x 99%) with good resolution.

10.2.1 HOW TO SET ADDITIONAL SCALE FACTOR

Before following the setup instructions, the values that must be set will need to determined. This will depend on which testing instrument has been chosen for the configuration. For appropriate settings, refer to the guide provided in *Appendix D: Additional Scale Factor Table*. Once the proper settings have been determined, proceed with the following instructions for setup.

10.2.1.1 Setting Additional Scale Factor for P (Proportional Gain)

1. Press SHIFT then the P button. Use the dial to change value (A, B, C, D, E, F, G, H and I).
2. Once the letter is chosen, press SHIFT to return to the main menu.

10.2.1.2 Setting Additional Scale Factor for I (Integral)

1. Press SHIFT then the I button. Use the dial to change value (A, B, C, D, E, F, G, H and I).
2. Once the letter is chosen, press SHIFT to return to the main menu.

10.2.1.3 Setting Additional Scale Factor for D (Derivative)

1. Press SHIFT then the D button. Use the dial to change value (A, B, C, D, E, F, G, H and I).
2. Once the letter is chosen, press SHIFT to return to the main menu.

10.3 FILTER PARAMETERS

The Digital Filters of the DSP7000 are used to remove undesired noise from the TSC inputs. This noise could be conducted from an undesired measured signal such as mechanical vibration or other electrical sources.

The input to the A/D converter internal to the DSP7000 has a traditional analog filter that is comprised of the following characteristics:

- -3db Point: 3.8 KHz
- A/D Sample Rate: 7812.5 Hz
- 16 Acquired and Averaged Samples: Average applied to filter at a rate of 488.28125 Hz
- Filter Cutoff Frequencies: 3 Hz, 10 Hz, 25 Hz, 50 Hz
- Filter Output: Equivalent to second order Butterworth analog filter
- Transposed Direct Form II Architecture: The diagram below shows this architecture.

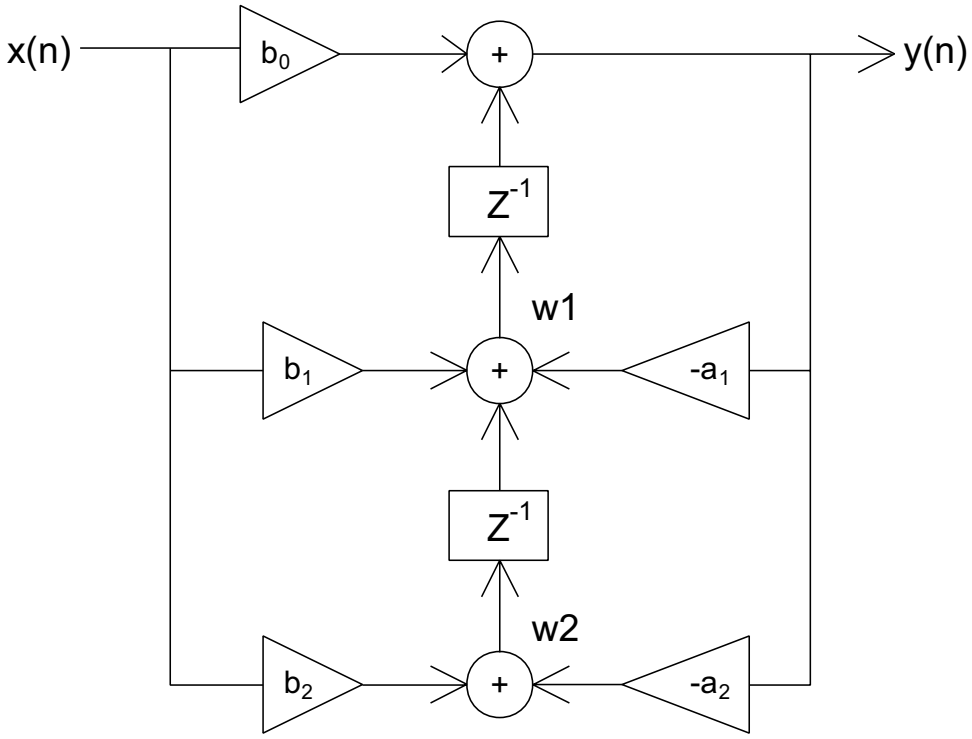


Figure 10–2 Transposed Direct Form II Architecture

With a Digital Filter, the DSP7000 is able to solve the following equations:

$y(n) = b_0 * x(n) + w1$

$w1 = b_1 * x(n) + a1 * y(n) + w2$

$w1 = b_2 * x(n) + a2 * y(n)$

The equations are applicable to each channel, occurring every 2.48 milliseconds.

11. Troubleshooting

Problem	Reason	Solution
Display indicates I/O ERROR.	Command does not match the unit's programmed set of instructions.	Use correct command and format.
Speed command sent, but Controller does not respond.	Communication occurred but the Controller is not loading the motor.	Adjust PID values.
Mechanical power reads much higher or lower than expected	Torque units are incorrect.	Set torque input units to match the specifications on dynamometer nameplate.
No GPIB communication.	Setup error and/or hardware fault.	Check: • GPIB address of Controller. • GPIB cable - should be functioning and attached to Controller and computer interface card.
No RS-232 communication.	Setup error and/or hardware fault.	Check: • Baud rate of Controller. • Pinout of serial cable. • Cable attachment to Controller and serial interface port of computer.
Dynamometer shaft does not turn smoothly when BRAKE is OFF.	Salient poles were set up on the rotor by having brake current applied with no shaft rotation.	Start the motor and bring up to speed. Press BRAKE button ON. Adjust output current up to a value at least 25% of the maximum torque rating of the dynamometer in use (if possible). Reduce output current to 0.
Dynamometer loads too quickly causing motor to stall.	Input units are improperly set up.	Set torque input units to match specifications on dynamometer nameplate.
Speed not reading correctly.	Speed encoder is improperly set up.	Set speed encoder bits to match specifications on dynamometer nameplate.

If you require additional assistance, please contact Magtrol Customer Service at 1-716-668-5555.

Appendix A: Inertia Correction

A.1 INERTIAL EFFECT ON MOTOR TEST DATA

A major advantage of the DSP7000 is its ability to obtain full motor performance data (free run to locked rotor) by continuous load application with an absorption dynamometer. Data acquisition is fast, resulting in minimal motor I^2R 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 or stored energy of the system. Unless inertial torque is excluded, motor performance will vary in proportion to the rate of acceleration or deceleration.

This type of error can produce problematic test results. For example, during rapid deceleration, system inertia can produce apparent efficiency greater than 1.0. This error may occur if output power is divided by input power without extracting the stored energy in the system.

Since "inertial effect" is only a factor when speed is changing, and because inertial torque is proportional to the rate of change, inertial value may be expressed as a unit of torque *per* change in rpm *in a given period of time*. With the DSP7000, properly adjusted PID values yield constant change in rpm so that the inertial torque can be expressed as a constant.

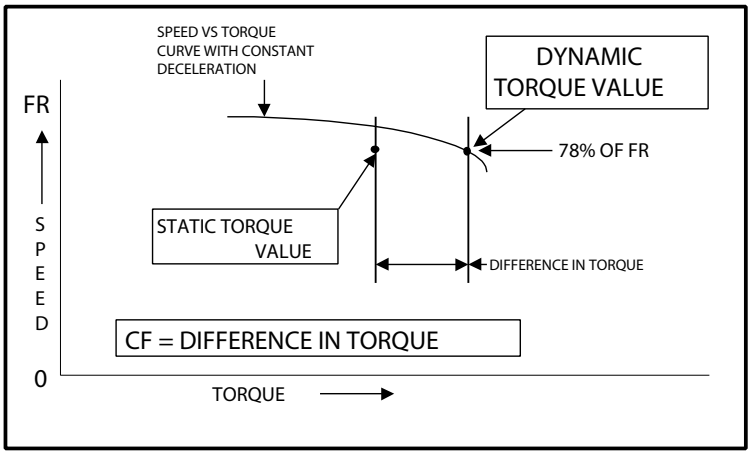
A.2 PROCEDURE FOR INERTIA CORRECTION

1. Determine the torque Correction Factor (CF) as follows:
   - Adjust the PID loop properly
   - Establish a torque value equal to the inertial torque.
2. Use the "Program Down" command (PD#) to ramp to 75% of the free-run speed.
3. Select a data point on the performance curve where speed will be approximately 78% of the free-run speed. Let this represent the dynamic speed-torque value.
4. Immediately program your DSP7000 (Ndddd) to a speed equal to the dynamic speed value. When the speed stabilizes, use this as the *static torque value*.

CF = Dynamic Torque - Static Torque

To correct your data, subtract the CF from each torque point obtained during the ramp.

Example:



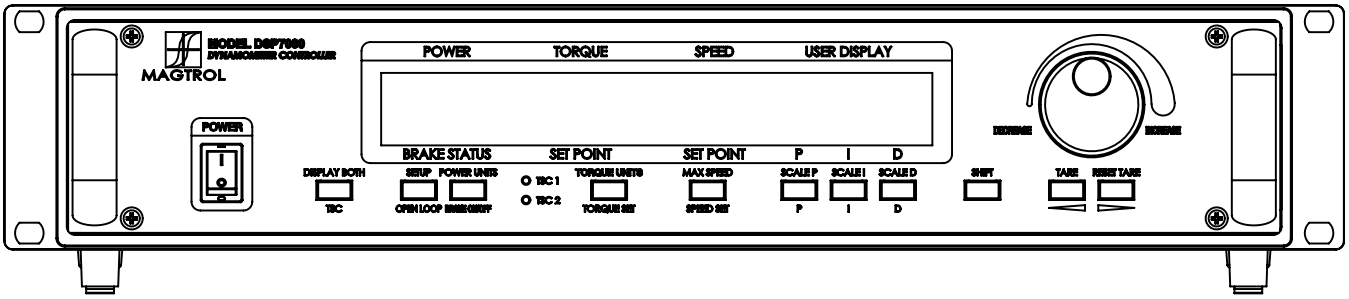
A.2.1 KEY CONDITIONS

- **Select appropriate value**. The test point selection of 78% is typical for an induction motor. Use a value in the linear portion of the motor curve where there is a substantial torque change with speed.
- **Acquire data rapidly**. Rapid data acquisition is necessary so that motor heating does not degrade performance by adding a false difference between the static and dynamic torque values.
- **Use a regulated power source**. The input line voltage must be stable for the time necessary to perform the test. Torque varies by the square of the change in line voltage.
- **Obtain new CF value for various deceleration/ acceleration rates**. The CF is only valid for its specific ramp rate. To calculate other CF rates, use the following equation:

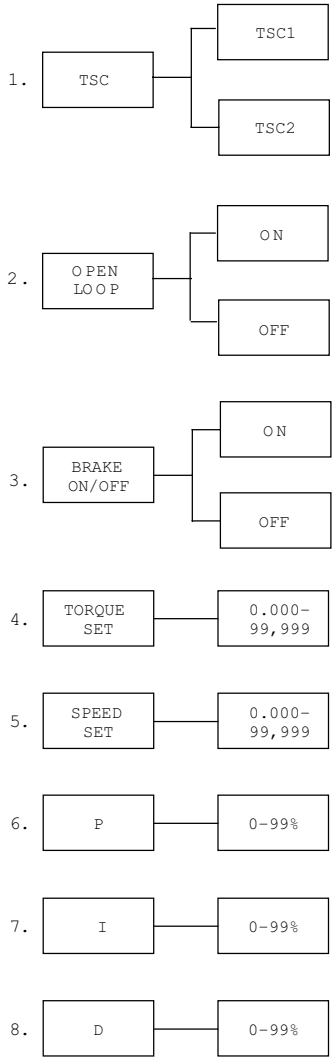
  $CF_{new} = (CF_{old} / \text{ramp rate}) \times \text{new ramp rate}$

Appendix B: Front Panel/Display Menu Flow Charts

The following flow charts are a reference for navigating through the key functions of the DSP7000 Dynamometer Controller. For step-by-step setup instructions, refer to the corresponding chapters in this manual.



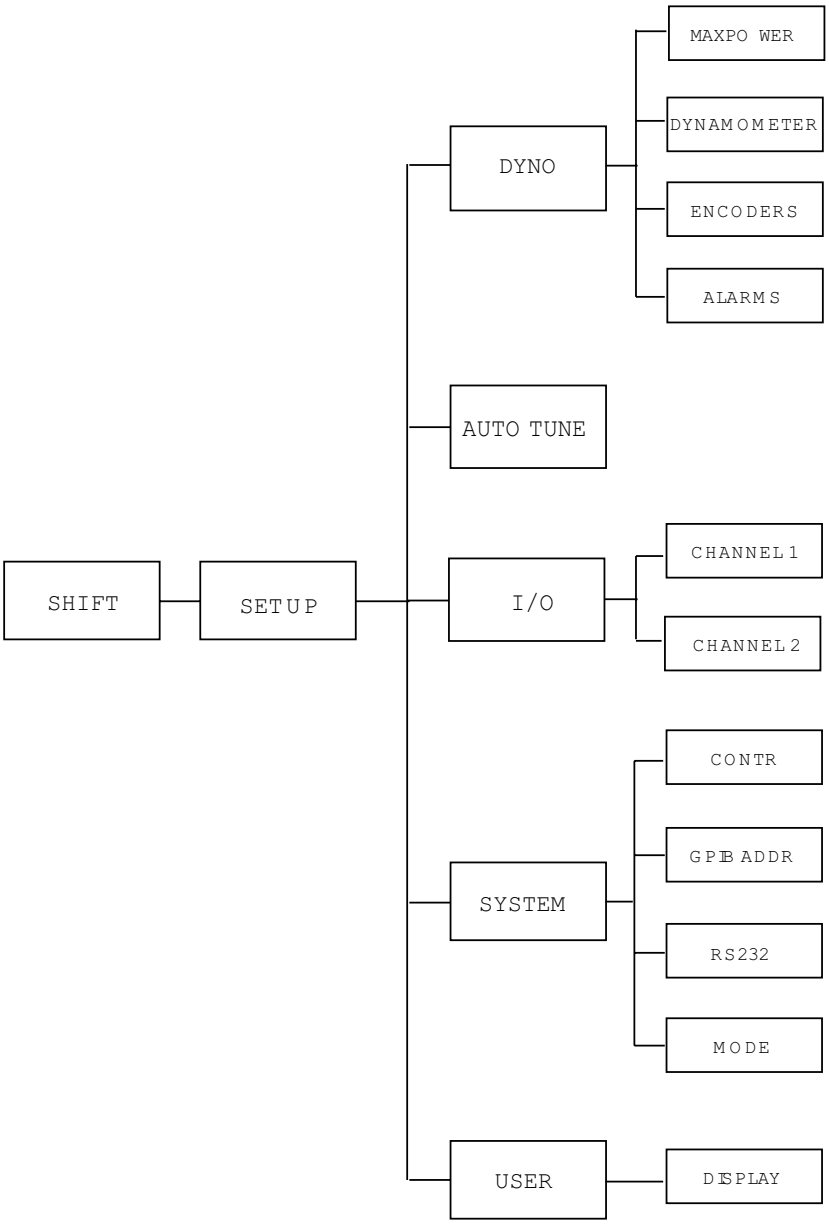
B.1 PRIMARY KEY FUNCTIONS



B.2 SECONDARY KEY FUNCTIONS

B.2.1 DISPLAY BOTH

B.2.2 SETUP

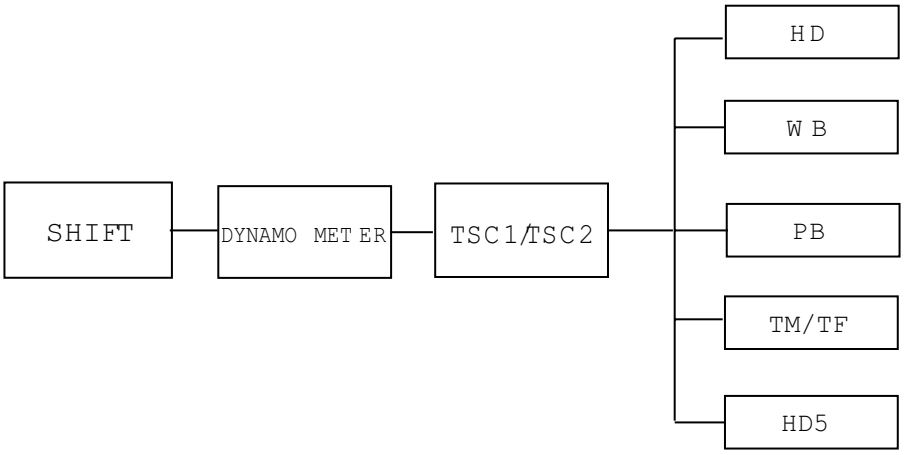


Note: Refer to the flow charts on the following pages for a more detailed breakdown of Dyno, Autotune, I/O, System and User. All flow charts will be a continuation of B.2.2 beginning at SHIFT*.

B.2.2.1 Dyno

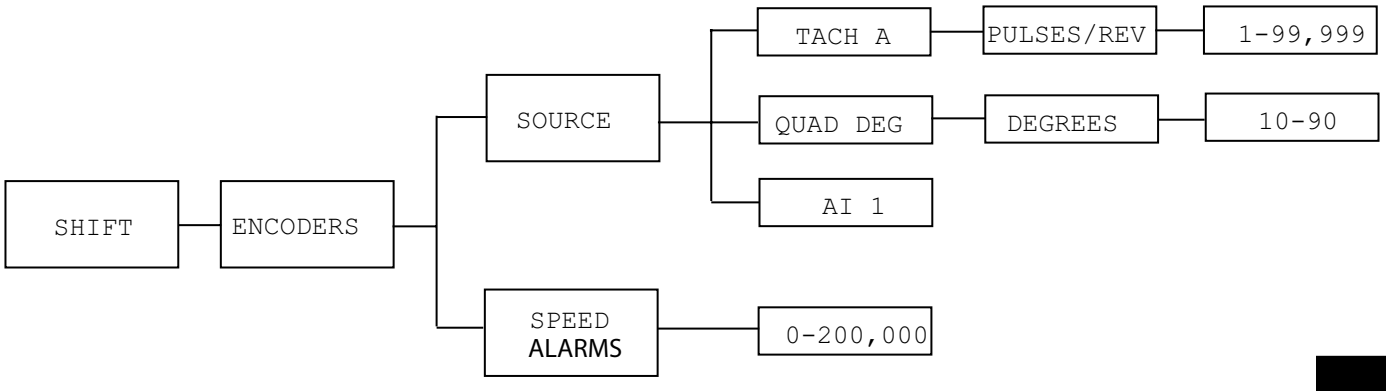
B.2.2.1.1 Max Power

B.2.2.1.2 Dynamometer

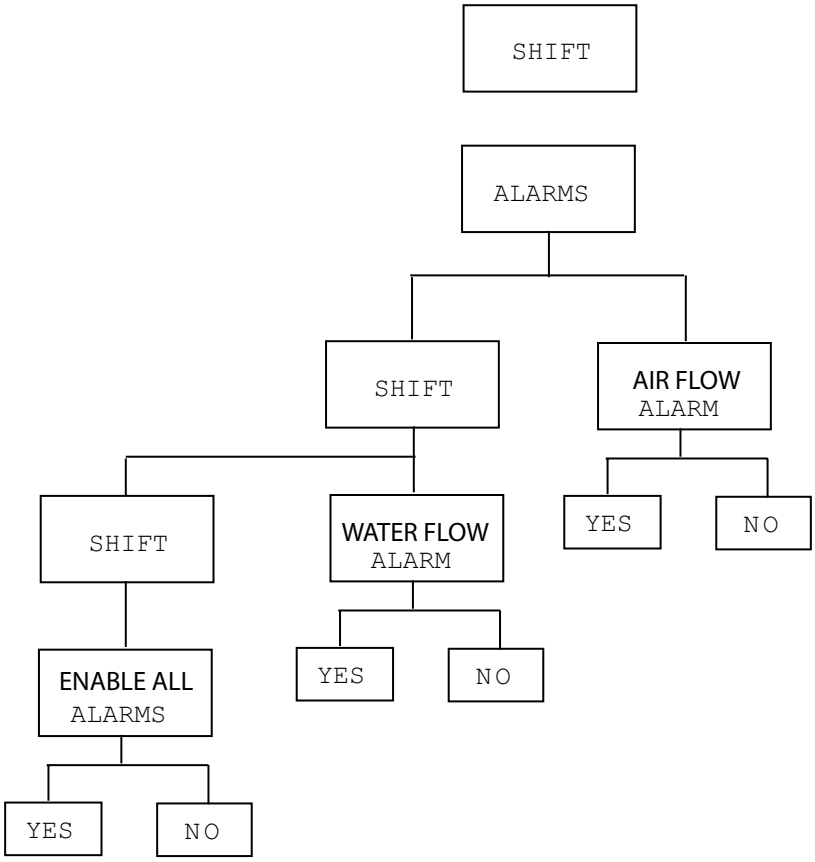


Note: Refer to flow charts B.3.1.1 through B.3.1.5 for a more detailed breakdown based on test instrument selection. All flow charts will be a continuation of B.2.2.1.2 beginning at SHIFT*.

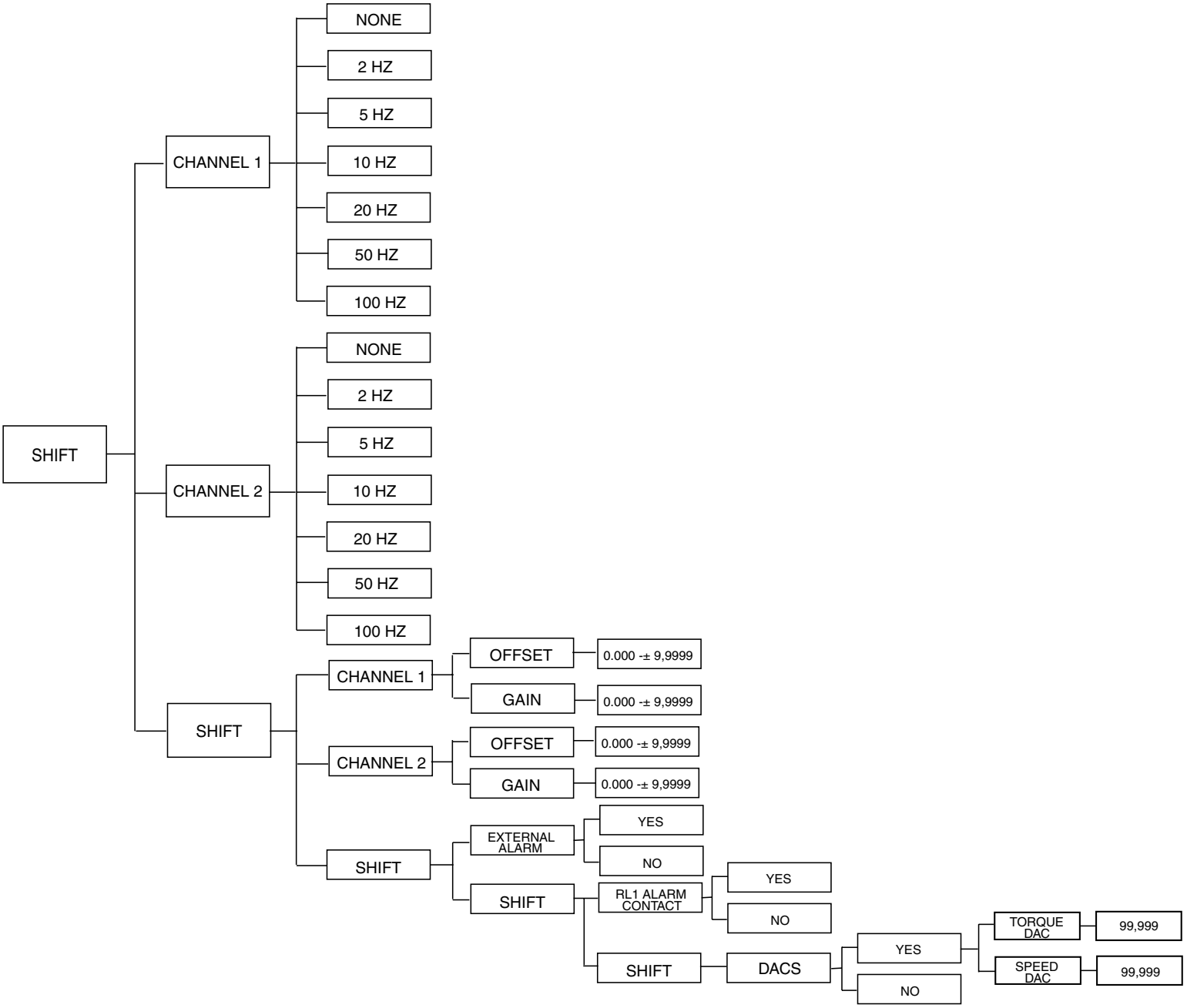
B.2.2.1.3 Encoders



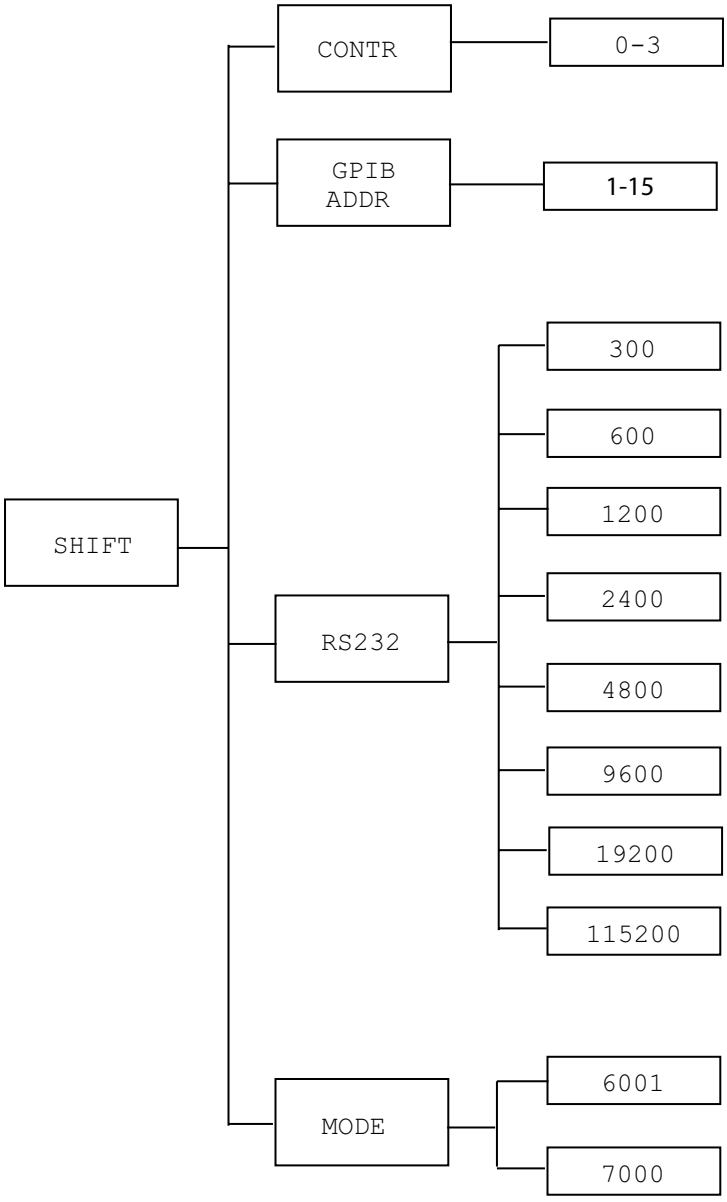
B.2.2.1.4 Alarms



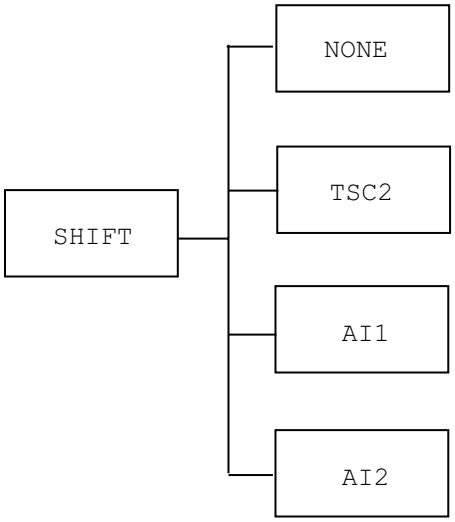
B.2.2.2 I/O


SHIFT
CHANNEL 1
NONE
2 HZ
5 HZ
10 HZ
20 HZ
50 HZ
100 HZ
CHANNEL 2
NONE
2 HZ
5 HZ
10 HZ
20 HZ
50 HZ
100 HZ
SHIFT
CHANNEL 1
OFFSET
0.000 -± 9,9999
GAIN
0.000 -± 9,9999
CHANNEL 2
OFFSET
0.000 -± 9,9999
GAIN
0.000 -± 9,9999
SHIFT
EXTERNAL ALARM
YES
NO
SHIFT
RL1 ALARM CONTACT
YES
NO
SHIFT
DACS
YES
NO
TORQUE DAC
99,999
SPEED DAC
99,999

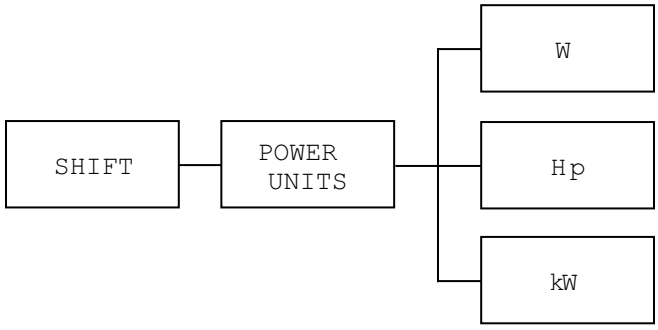
B.2.2.3 System


SHIFT
CONTR
0-3
GPIB ADDR
1-15
RS232
300
600
1200
2400
4800
9600
19200
115200
MODE
6001
7000

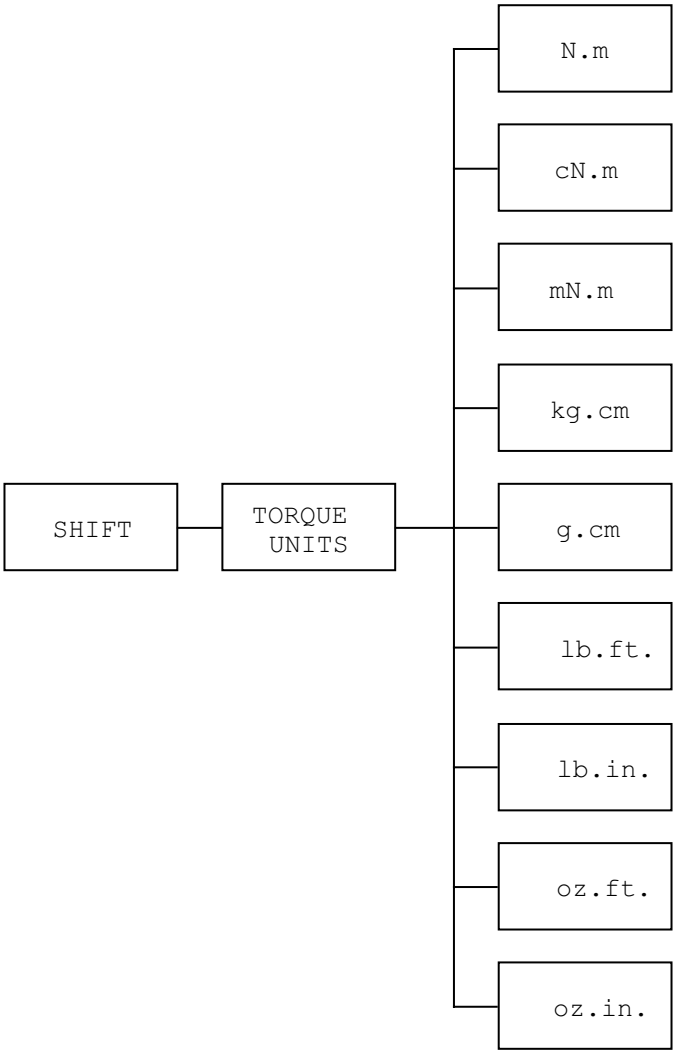
B.2.2.4 Display



B.2.3 POWER UNITS

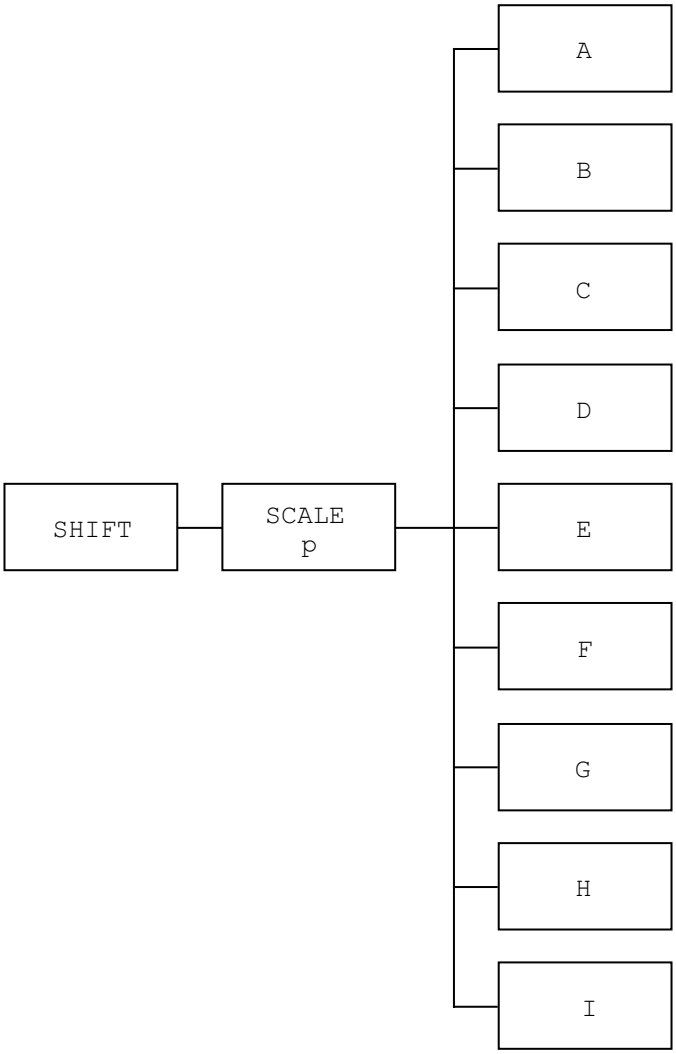


B.2.4 TORQUE UNITS

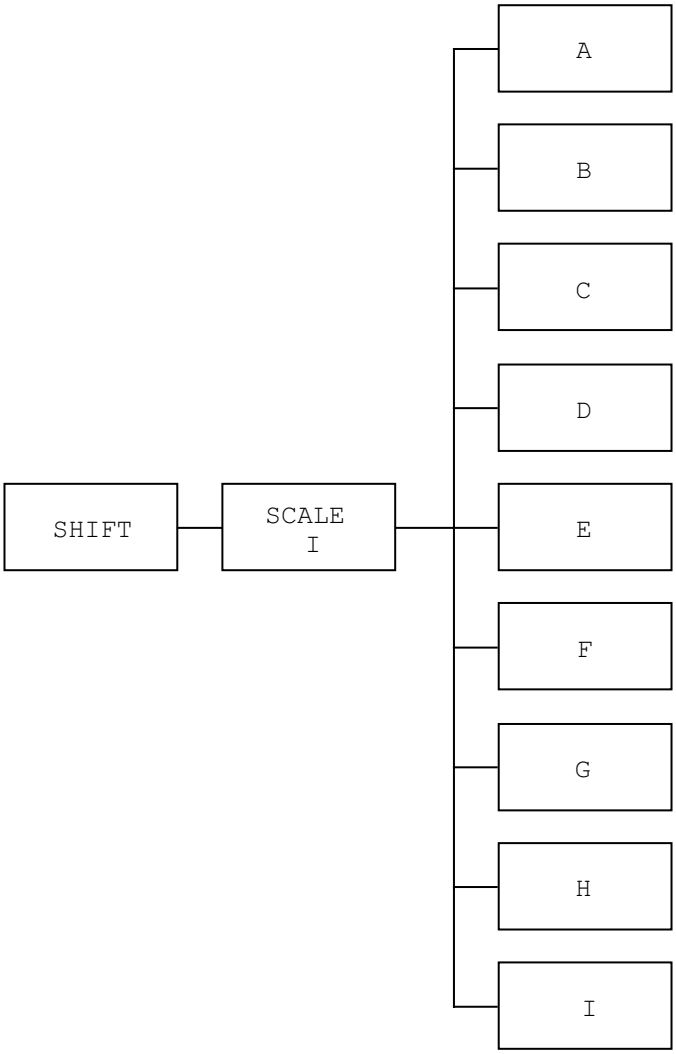


B.2.5 MAX SPEED

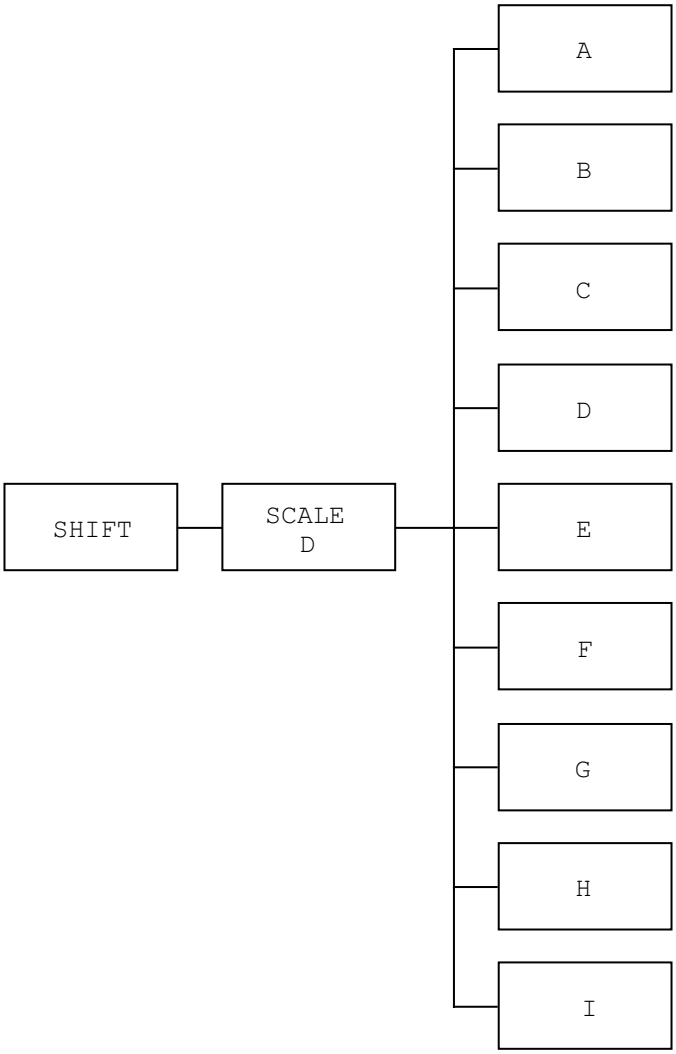
B.2.6 SCALE P



B.2.7 SCALE I



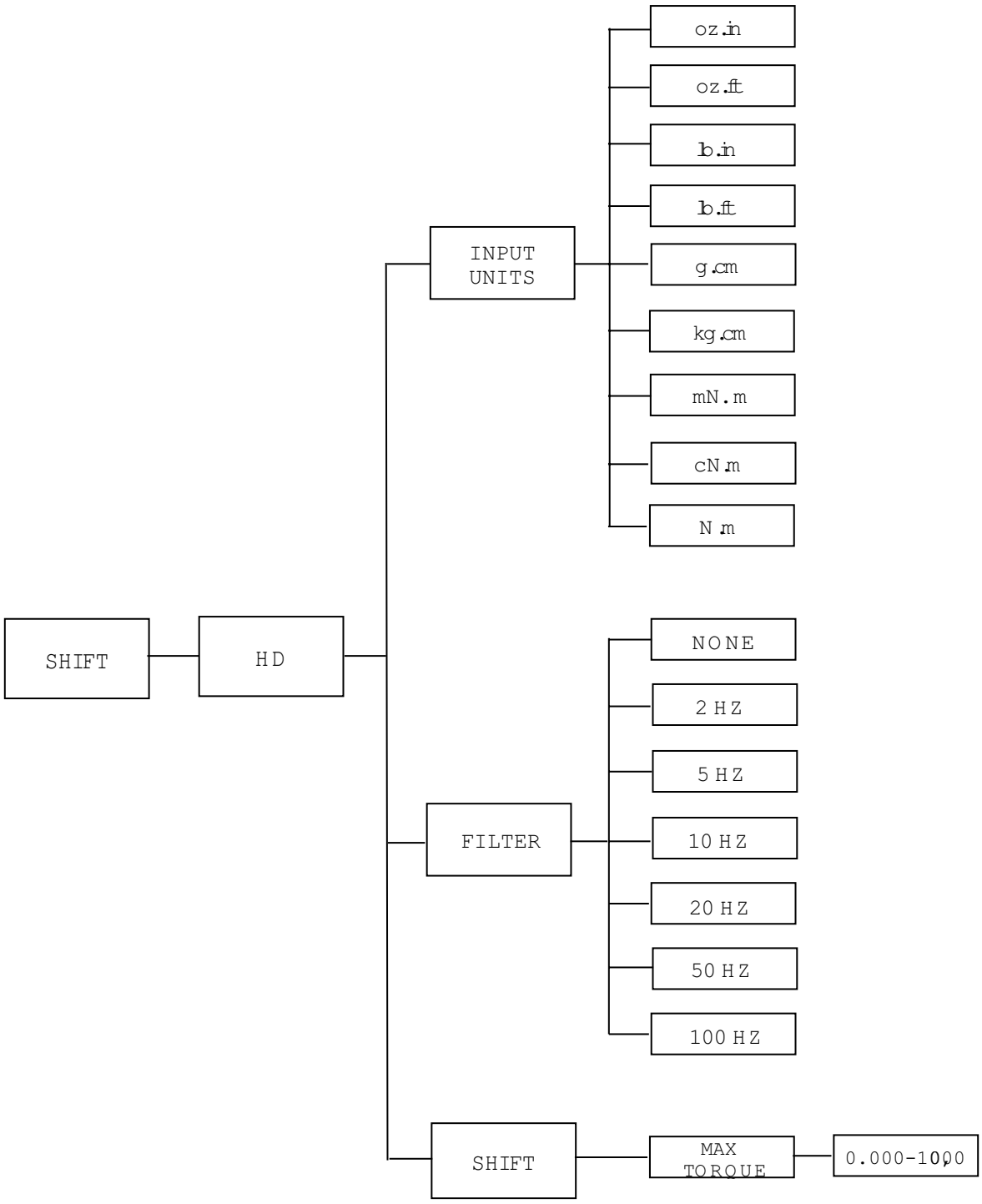
B.2.8 SCALE D



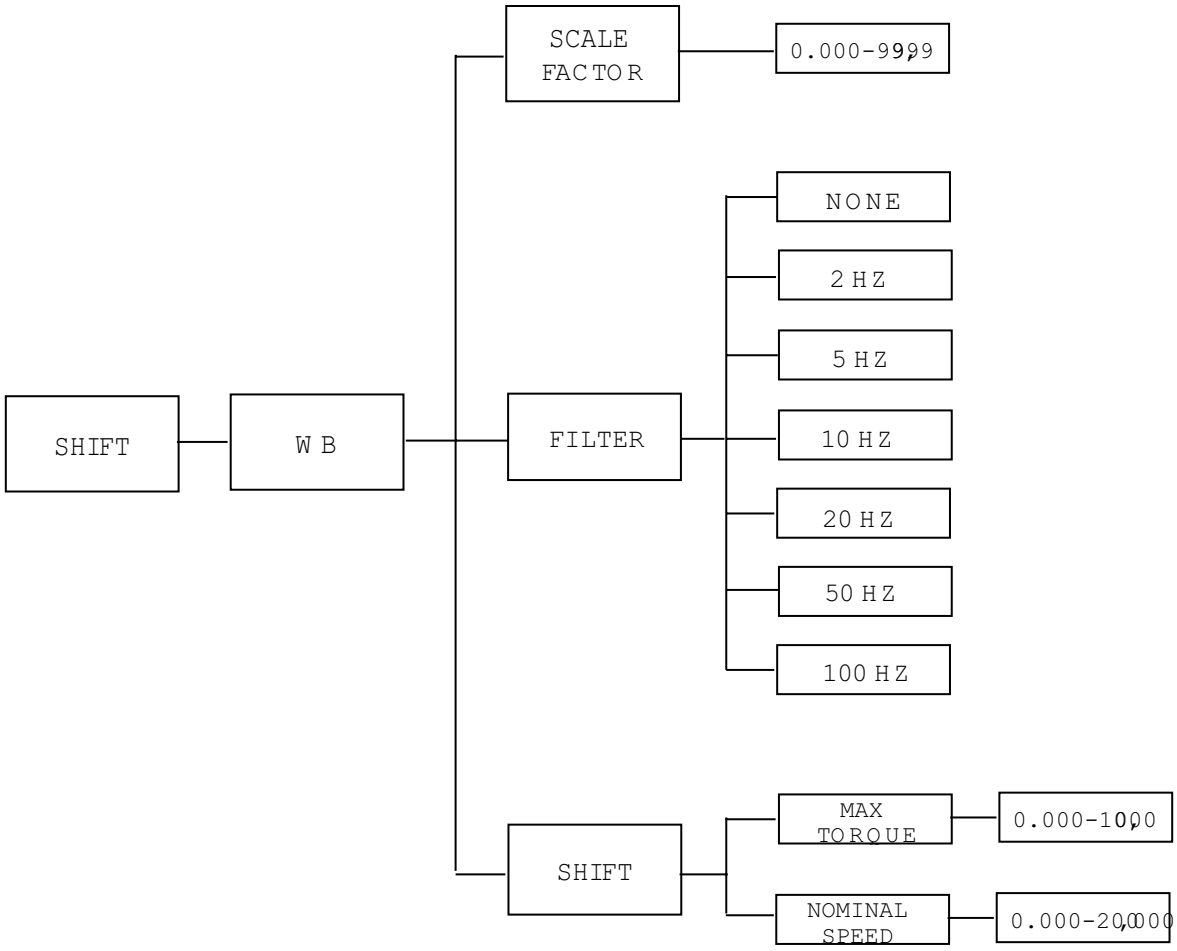
B.3 TEST INSTRUMENT SETUP

Note: All flow charts will be a continuation of C.2.2.1.2 beginning at SHIFT*.

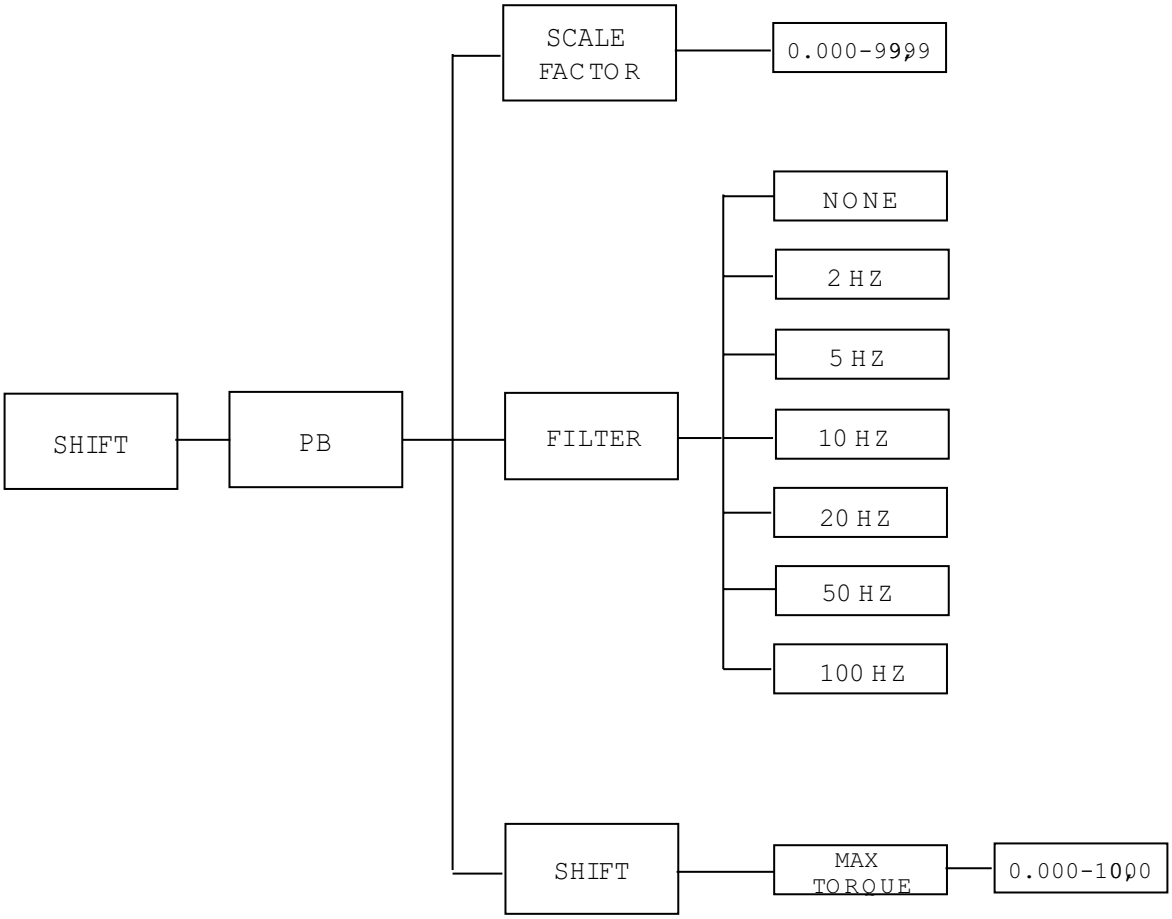
B.3.1 HYSTERESIS DYNAMOMETER SETUP MENU



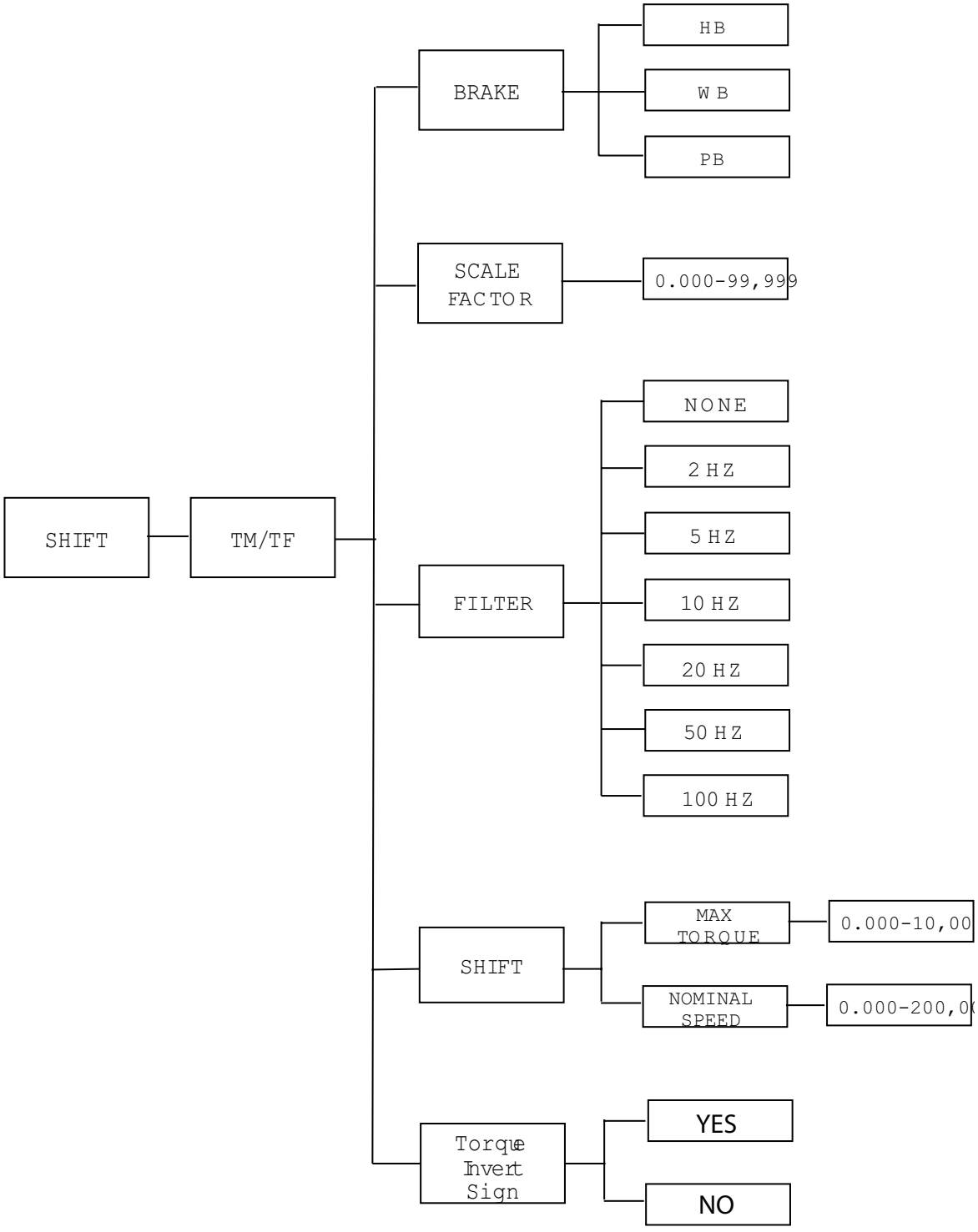
B.3.2 EDDY-CURENNT DYNAMOMETER SETUP MENU


SHIFT
W B
SCALE FACTOR
0.000-9999
FILTER
NONE
2 HZ
5 HZ
10 HZ
20 HZ
50 HZ
100 HZ
SHIFT
MAX TORQUE
0.000-1000
NOMINAL SPEED
0.000-20,000

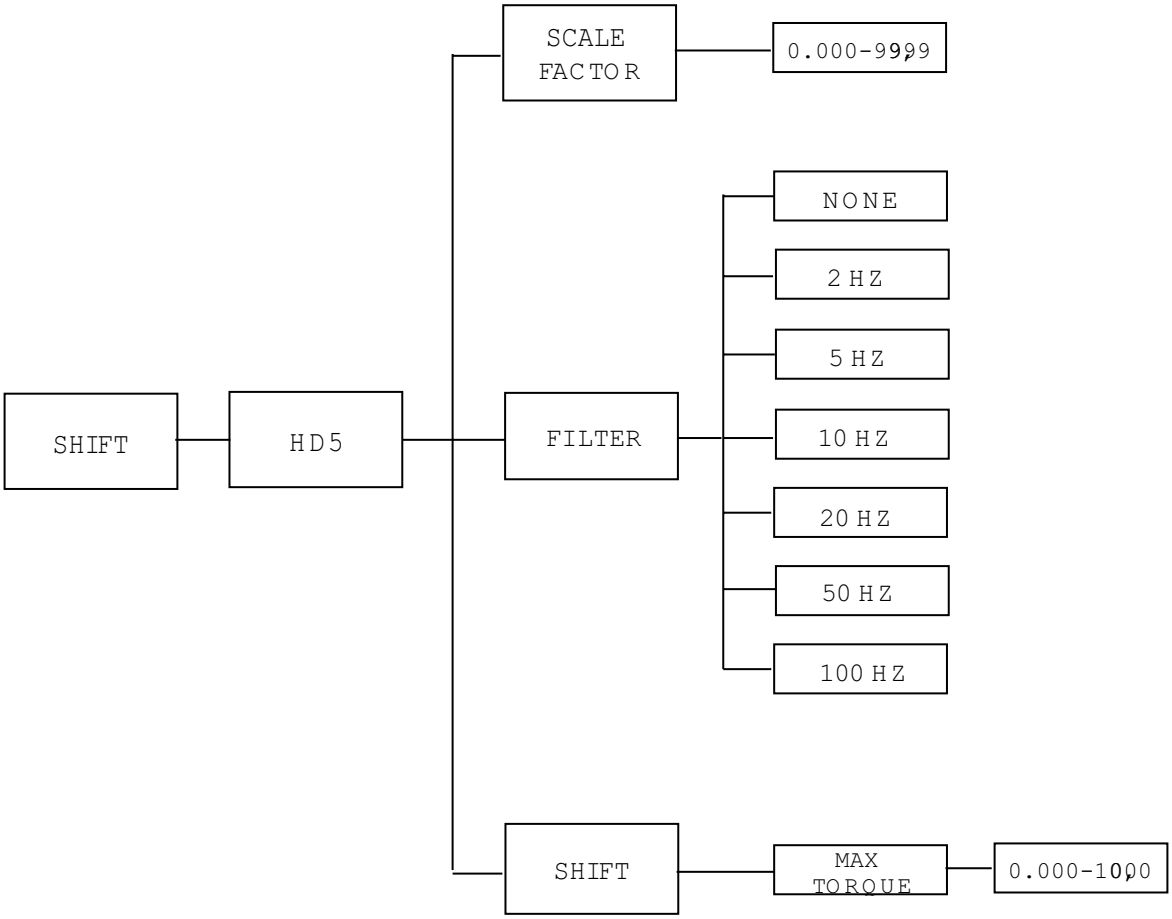
B.3.3 POWDER BRAKE DYNAMOMETER SETUP MENU



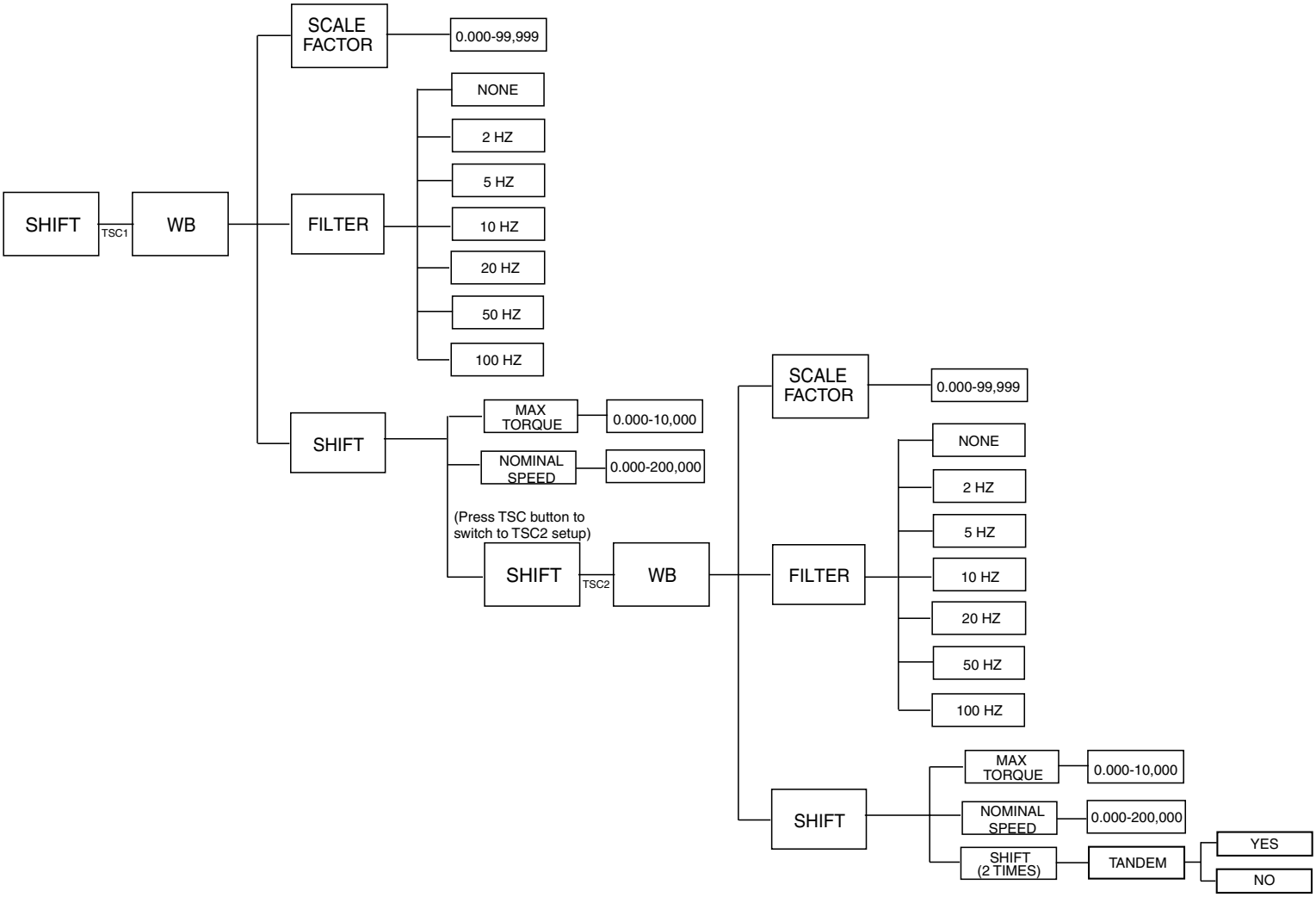
B.3.4 TORQUE TRANSDUCER/TORQUE FLANGE SENSOR SETUP MENU



B.3.5 HD5 SETUP MENU

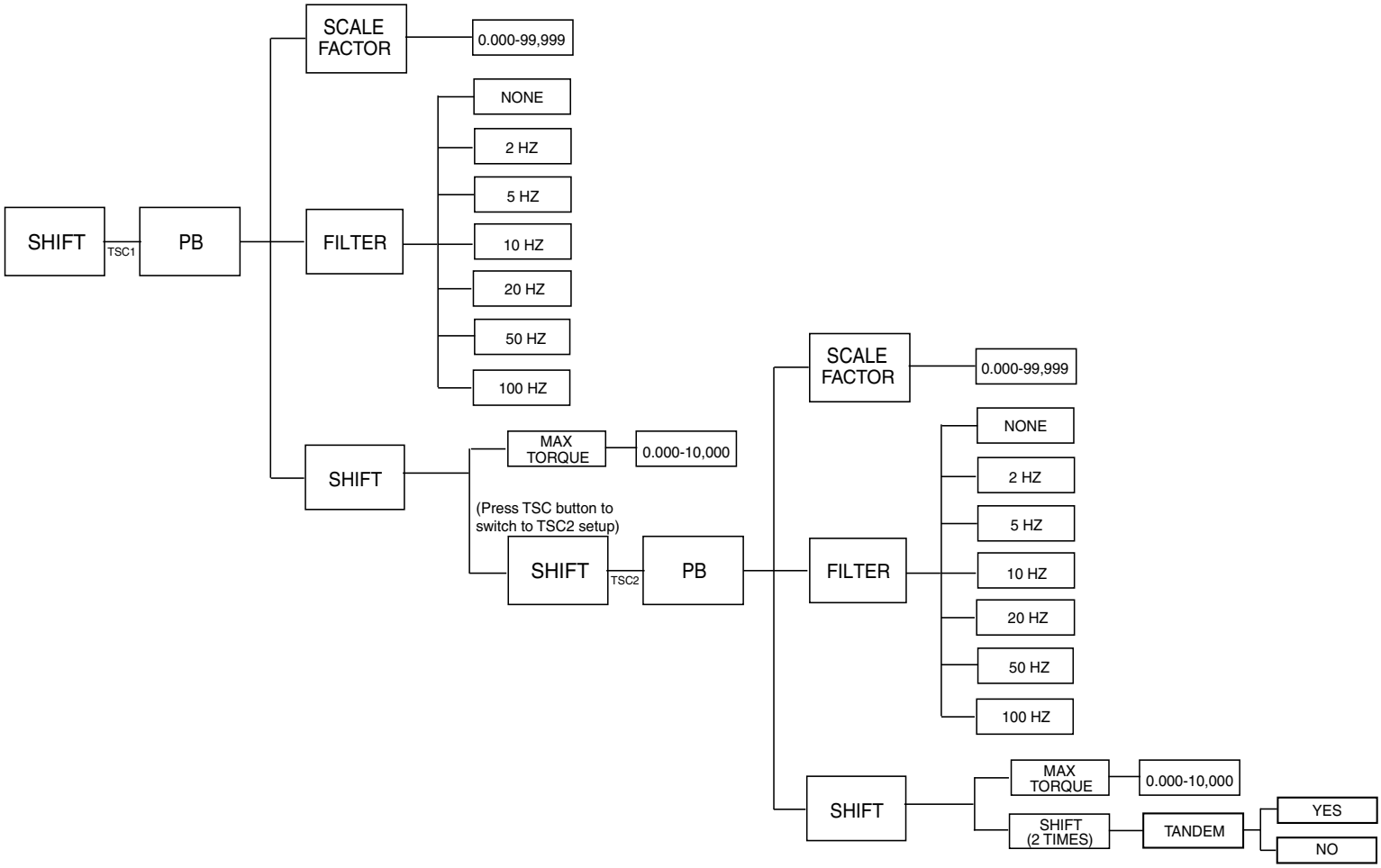


B.3.6 EDDY-CURRENT DYNAMOMETER WITH EDDY-CURRENT DYNAMOMETER (TANDEM SETUP)

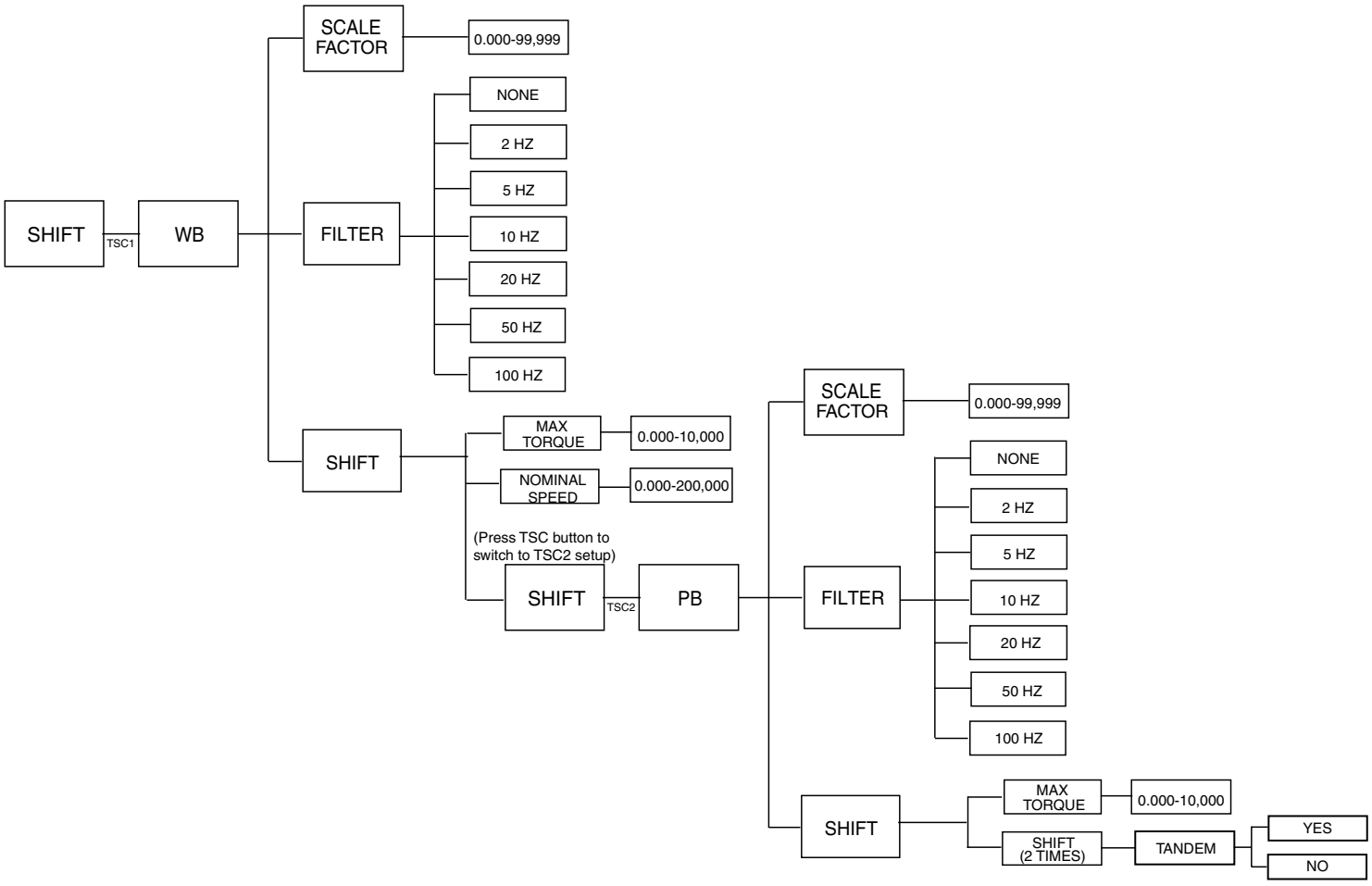


APPENDICES

B.3.6 Powder Brake Dynamometer with Powder Brake Dynamometer (Tandem Setup)

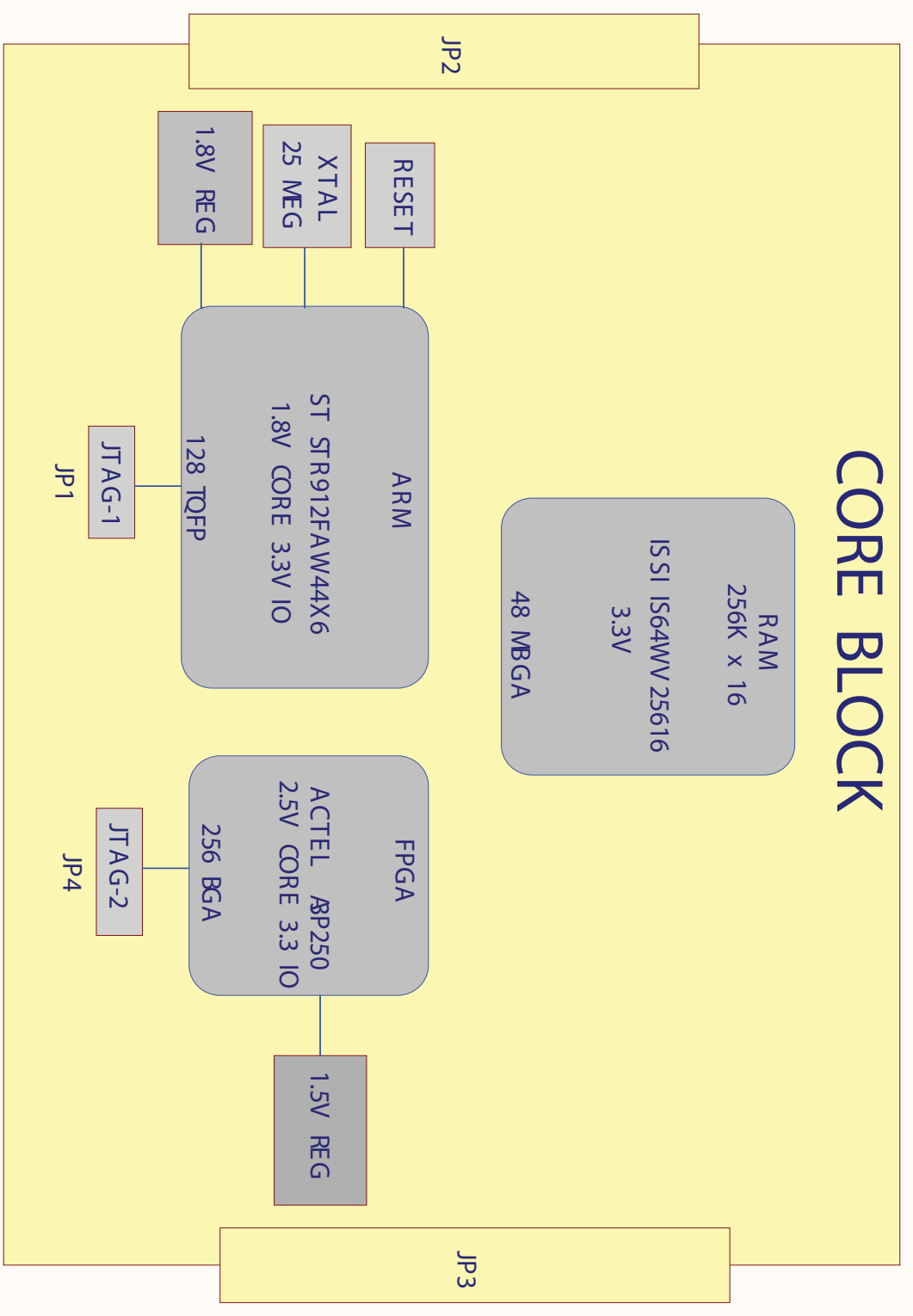


B.3.7 EDDY-CURRENT DYNAMOMETER WITH POWDER BRAKE DYNAMOMETER (TANDEM SETUP)

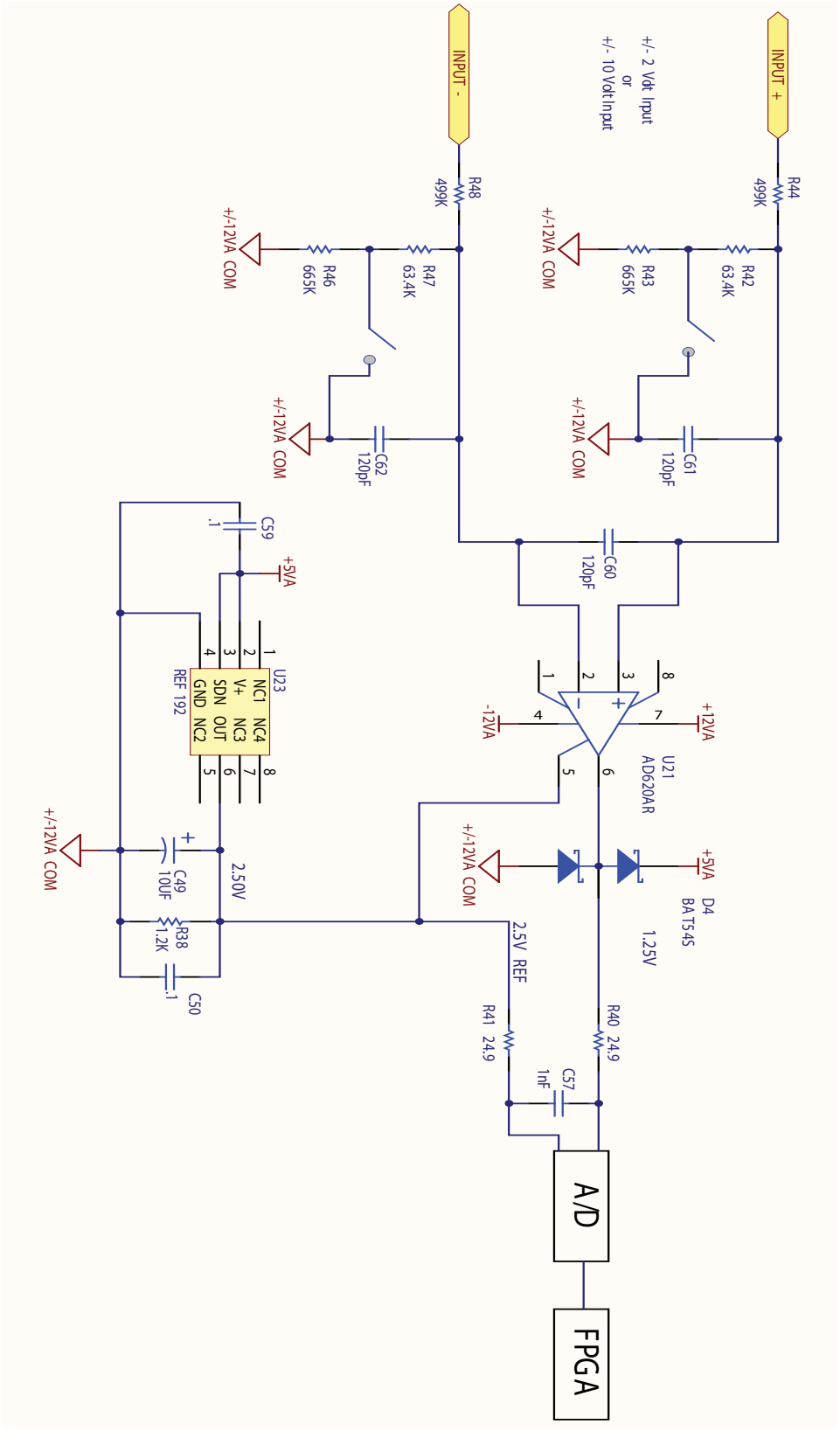


Appendix C: Schematics

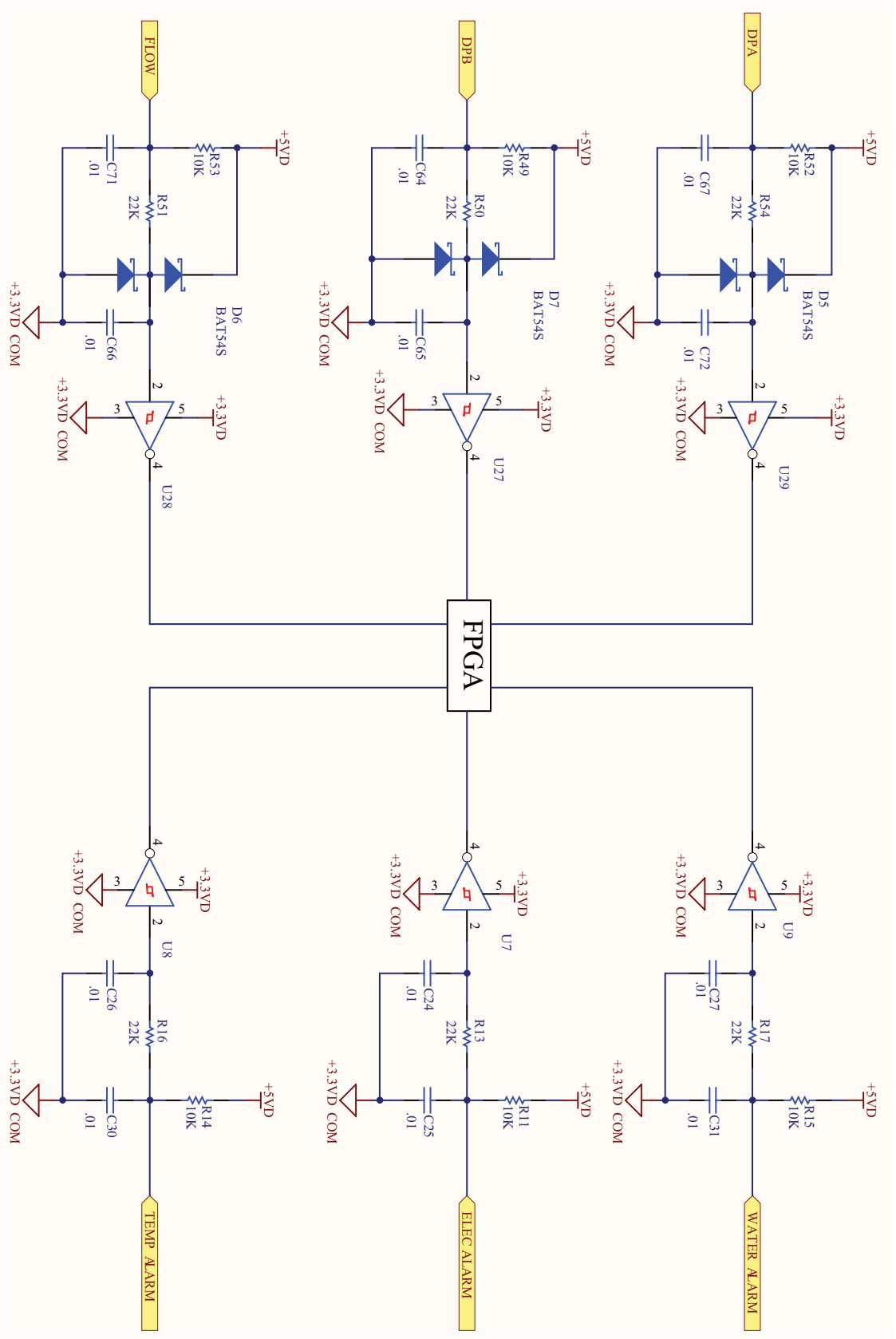
C.1 DSP7000 CORE BLOCK



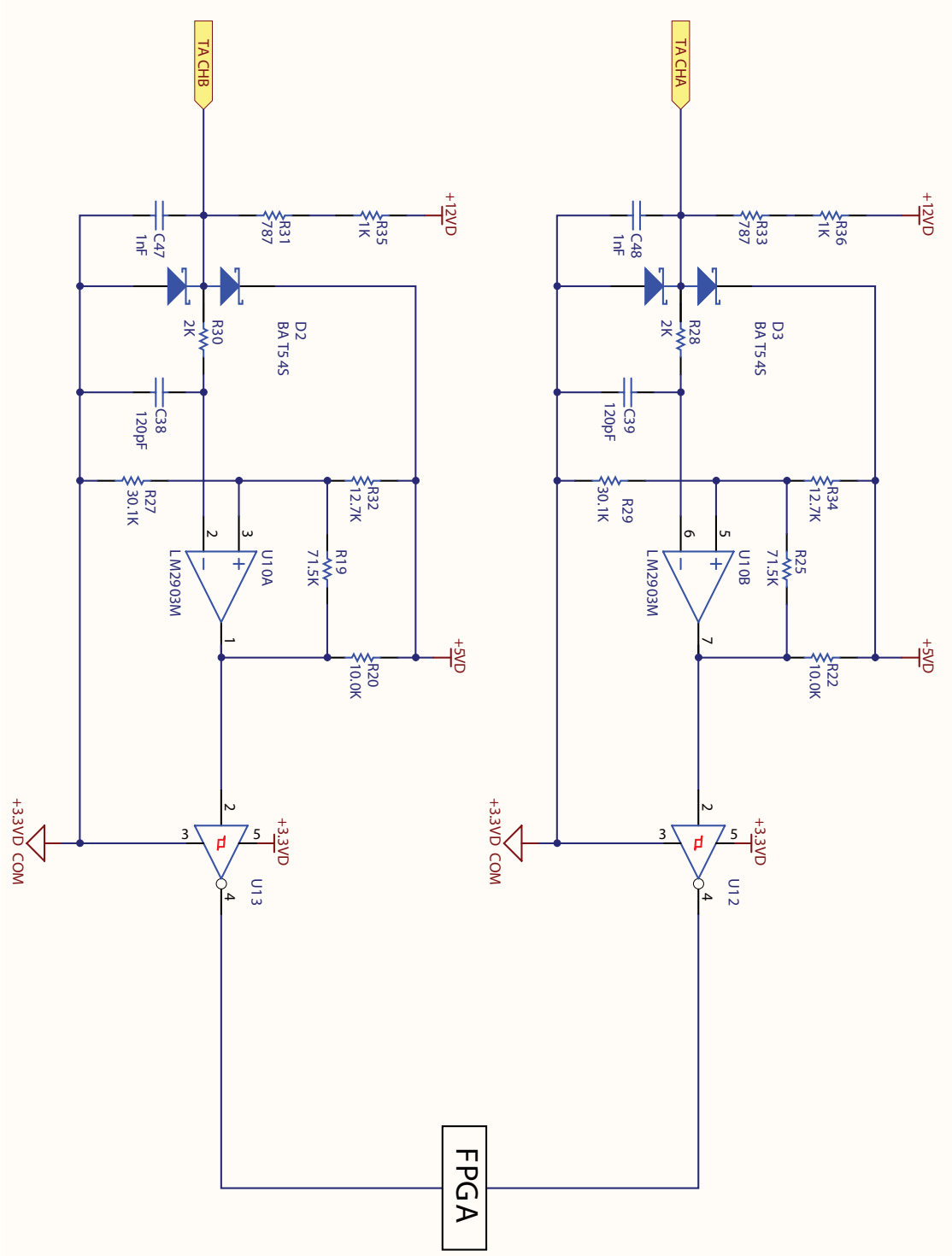
C.2 DSP7000 ANALOG INPUTS



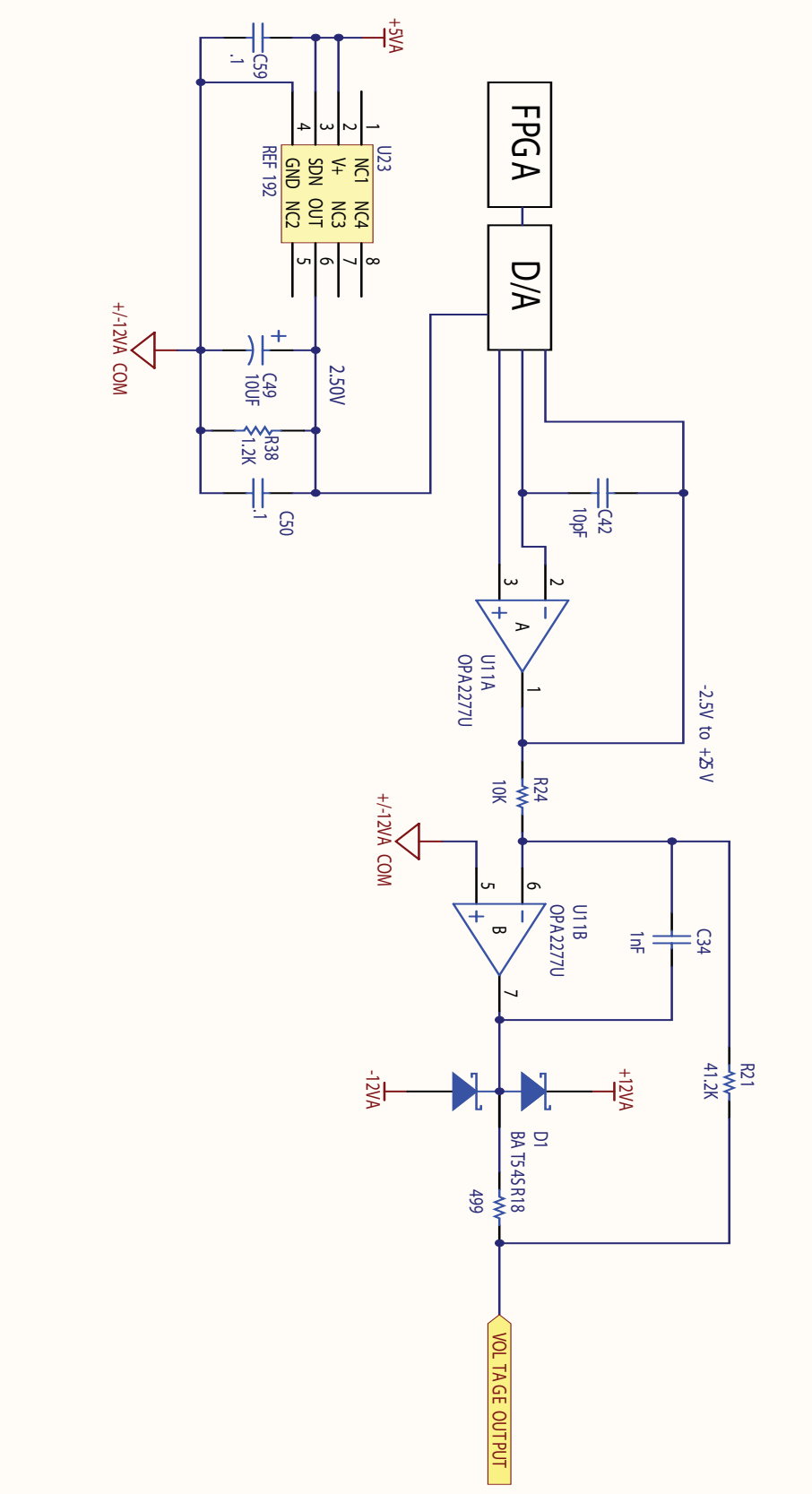
C.3 DSP7000 DIGITAL INPUTS



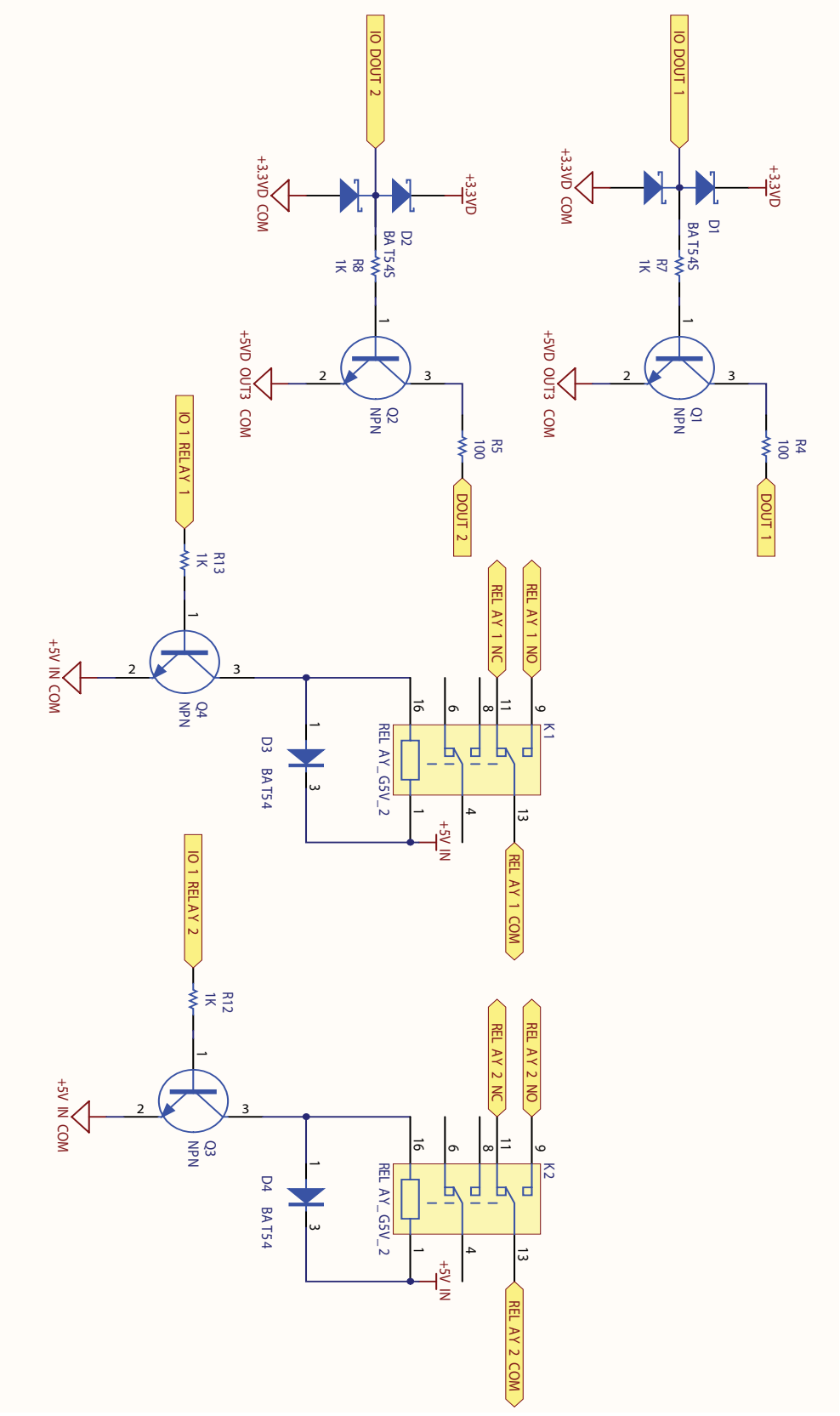
C.4 DSP7000 ENCODER IN



C.5 DSP7000 ANALOG OUTPUT



C.6 DSP7000 DIGITAL OUTPUT



APPENDICES

Appendix D: Additional Scale Factor Table

The Additional Scale Factor Table is the same as the M-TEST Defaults file, which contains default values for all parameters used in the testing of Magtrol Dynamometers and Torque Transducers. The M-TEST Defaults file is subject to change as ratings on Magtrol's Motor Test Equipment change but the most recent version of this file can always be accessed from our Web site at www.magtrol.com/support/downloads.htm#mtestdefaults. Simply click the link if you are connected to the Internet or type the web address into your browser.

The file is saved in a tab delimited text format and can be accessed by Microsoft® Excel or LabVIEW™ programs, including M-TEST. If you need this information to configure your DSP7000 but do not have M-TEST 4.0 or 5.0, the text file can be imported into any spreadsheet or database program and the default values can be manually programed into the DSP7000 via the front panel menu system. Be sure to check the file frequently to make sure you have the most current data. Please feel free to contact our sales department at 1-716-668-5555, if you should have any questions or concerns.

RETURNING MAGTROL EQUIPMENT FOR REPAIR AND/OR CALIBRATION

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

Returning Equipment to Magtrol, Inc. (United States)

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

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

Returning Equipment to Magtrol SA (Switzerland)

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

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

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