

# DSP7010 SERIES DYNAMOMETER CONTROLLER

## USER MANUAL



**DSPM Industria**<sup>®</sup>  
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## TRADEMARKS

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## 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 : \_\_\_\_\_

## SAFETY PRECAUTIONS

**WARNING**

WARNING! IN ORDER TO MINIMIZE RISKS, IT IS OF UTMOST IMPORTANCE TO RESPECT THE CURRENT SAFETY STANDARDS WHEN PLANNING, CONFIGURING AND OPERATING THE DSP7010 SERIES DYNAMOMETER CONTROLLER.

---

**CAUTION**

CAUTION! OPERATE THE DSP7010 SERIES DYNAMOMETER CONTROLLER WITH GREAT CAUTION! THE DSP7010 MAY BE IRREVERSIBLY DAMAGED IF IMPACTED MECHANICALLY (FALL), CHEMICALLY (ACIDS) OR THERMALLY (HOT AIR, VAPOR).

---

1. Make sure that all Magtrol electronic products are earth-grounded, to guarantee personal safety and proper operation.
2. Check line voltage before operating electronic equipment.
3. Make sure that all rotating parts are equipped with appropriate safety guards.
4. Periodically check all connections and attachments.
5. Always wear protective glasses when working close to rotating elements.
6. Never wear a necktie or baggy clothes when standing close to rotating elements.
7. Never stand too close or bend over the rotating drive chain.

### QUALIFIED PERSONNEL

Persons in charge of installing and operating the DSP7010 Series Dynamometer Controller must have read and understood this user manual, paying extra close attention to all safety-related information.

The DSP7010 Series Dynamometer Controller is a high-precision product integrating the most recent measurement techniques. The DSP7010 can give rise to residual dangers if used and manipulated in a non-compliant way by unqualified personnel.

This DSP7010 must be handled by qualified personnel according to the technical requirements and the above-mentioned safety instructions. This is also true when using dynamometer accessories.





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# PREFACE

## PURPOSE OF THIS MANUAL

This manual contains all the information required for the setup, connection and general use of Magtrol's DSP7010 Dynamometer Controller. To achieve maximum capability and ensure proper use, please read this manual in its entirety before operating the unit. Keep the manual in a safe place for quick reference whenever a question should arise.

## WHO SHOULD USE THIS MANUAL

This is written for operators who are going to use the DSP7010 Series 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 DSP7010 Series 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 DSP7010 Series 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 built-in alarm feature, providing the user with information on how each alarm operates with instructions for setup and use.
- Chapter 6: **MANUALLY CONTROLLED OPERATION** – How to run a test when the DSP7010 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 DSP7010 is used with a PC. Includes information on data format, programming, and command set.
- Chapter 8: **I/O** – Information on the optional I/O cards, and GPIB Interface.
- Chapter 9: **APPLICATIONS**
- Chapter 10: **CALIBRATION** – Provides recommended calibration schedules along with step-by-step instructions for the calibration procedure.
- Chapter 11: **THEORY**
- Chapter 12: **TROUBLESHOOTING** – Solutions to common problems encountered during setup and testing.
- Appendix A: **INERTIA CORRECTION** – Describes the inertial effect on motor test data and provides 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..

## SEMANTICS

In this manual, different terminologies may be used to speak about the «DSP7010 Series Dynamometer Controller». The primary purpose is to make this user manual useful and easy to read.

Different terminology used: «DSP7010», «controller».



## CONVENTIONS USED IN THIS MANUAL

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



**NOTICE**

Indicates information considered important but not hazard related.

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 function of the product.



**CAUTION**

INDICATES A HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN MINOR OR MODERATE INJURY.

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



**WARNING**

INDICATES A HAZARDOUS SITUATION THAT, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY.

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 PARTY MAY BE AT RISK. THE READER MUST ABSOLUTELY TAKE NOTE OF THE ACCOMPANYING TEXT, AND ACT UPON IT, BEFORE PROCEEDING FURTHER.



**DANGER**

INDICATES A HAZARDOUS SITUATION THAT, IF NOT AVOIDED, WILL RESULT IN DEATH OR SERIOUS INJURY. THE SIGNAL WORD «DANGER» IS TO BE LIMITED TO THE MOST EXTREME SITUATIONS.

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 PARTY MAY BE AT RISK. THE READER MUST ABSOLUTELY TAKE NOTE OF THE ACCOMPANYING TEXT, AND ACT UPON IT, BEFORE PROCEEDING FURTHER.

The safety symbol may subsequently vary depending on the source of the hazard. Below are examples:



Various safety pictograms according to ISO 7010



# 1. INTRODUCTION

## 1.1 UNPACKING THE DSP7010

### 1.1.1 PACKING

Your DSP7010 was packaged carefully for shipping.

Inspect the contents for any evidence of damage in shipping. In the event of shipping damage, immediately notify the carrier and Magtrol's Customer Service Department.

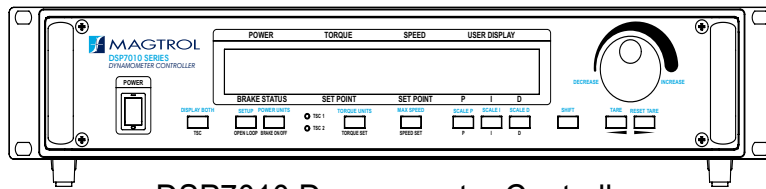


**NOTICE**

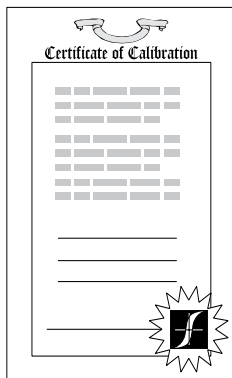
Save all shipping cartons and packaging material for reuse when returning the instrument for calibration or servicing.

### 1.1.2 PARTS LIST

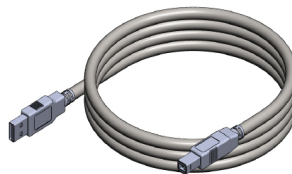
Make sure the carton contains all the following:



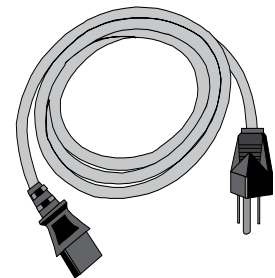
DSP7010 Dynamometer Controller



Calibration Certificate



USB Type B Cable



Power Cable

Fig.1-1 DSP7010 parts list

## 1.2 NEW FEATURES OF THE DSP7010

Magtrol's new DSP7010 Series Dynamometer Controller is an upgraded version of the DSP7000, 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 DSP7010 both controls the dynamometer and provides digital readouts on the front panel. New features of the DSP7010 include:

- EMC hardening for better performance in high noise environments.
- IO and GPIB included as standard equipment.
- Cosine ramp removed.
- Analog Tach input removed.
- Quadrature RPM measurement removed.
- DIN3 removed.
- RS-232 Removed.

## 1.3 DATASHEET

# DSP7010 SERIES DYNAMOMETER CONTROLLER

## FEATURES

- **DSP7011 Single Channel:** Low cost and easy to use
- **DSP7012 Dual Channel:** Enables the support of two testing instruments with independent or tandem configurations and two fully independent control loops
- **Alarm System:** For power, speed, torque, temperature, air flow, water flow, electrical overload and external inputs
- **High Speed Data Acquisition:** Up to 488 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 1A
- **Selectable Torque Units:** Imperial and Metric 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:** 482.6 mm (19") with handles
- **Command Compatible:** Compatible with the DSP7000
- **USB:** Standard
- **GPIB:** Standard
- **Position Measurement:** Two quadrature decoders
- **I/O accessible programmatically (LabVIEW™, Visual C)**



Fig.1 : DSP7010 Series Programmable Controller

## DESCRIPTION

Magtrol's DSP7010 Series 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 DSP7010 can provide complete PC control via the USB or IEEE-488 interface. With up to 488 readings per second, the DSP7010 is ideally suited for both the test lab and the production line.

## APPLICATIONS

In the laboratory, the DSP7010's high sample rate provides superior resolution for data acquisition and curve plotting. This allows capturing more usable motor test data during switching, breakdown and other transitional areas of the motor test curve. For production and incoming inspection, the DSP7010 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.

## 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 DSP7010 Controller, Magtrol M-TEST 7 Software provides control of any Magtrol Dynamometer and runs test sequences in a manner best suited to 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 feedback is 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 $\pm 0.01\%$ of range ( $\pm 0.2$ mV) (used on all HD Series other than HD5 Series) 10 volt range $\pm 0.01\%$ of range ( $\pm 1$ mV) (used on all except HD Series)

### DIMENSIONS

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

### ELECTRICAL CHARACTERISTICS

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

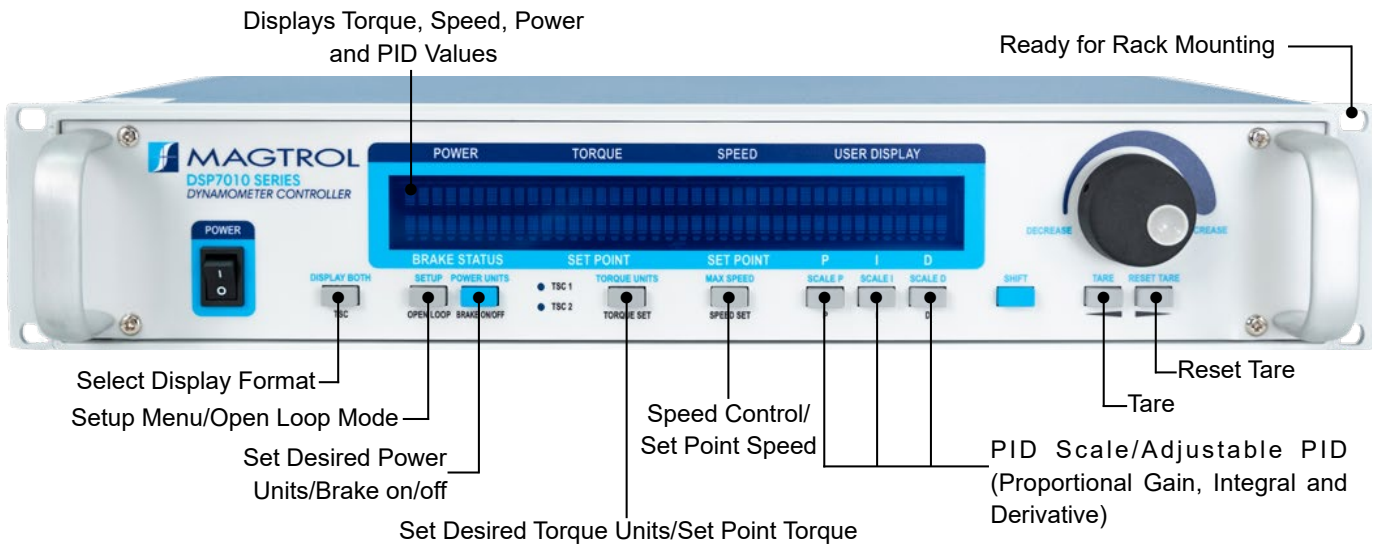
### ENVIRONMENT

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

I/O

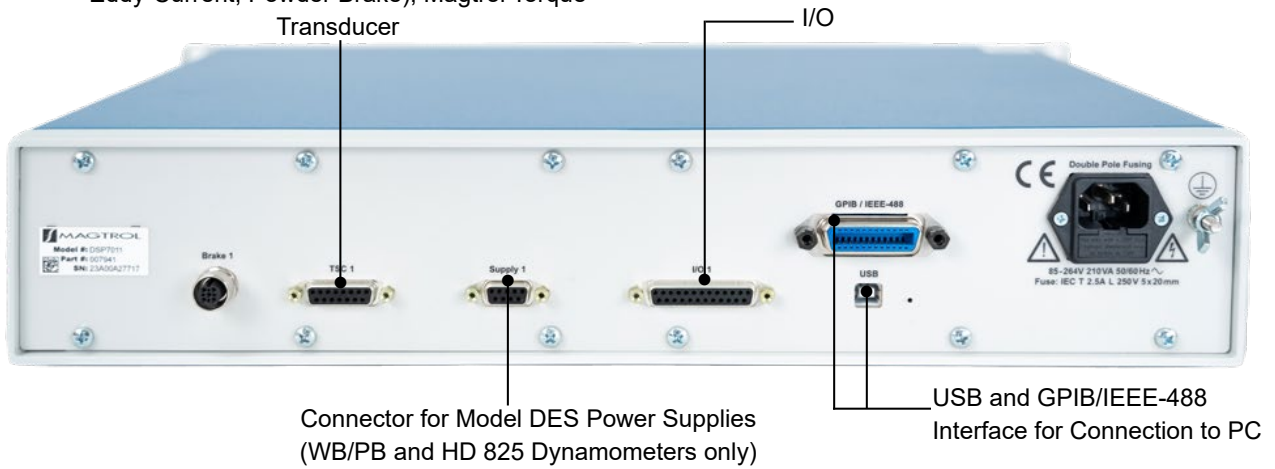
- Torque/Speed Analog Outputs: For interface with a data acquisition system
- External alarm input
- Alarm relay contacts
- 2 Relays per channel
- 2 Digital inputs per channel
- 2 Digital outputs per channel
- 2 Analog inputs per channel
- 2 Analog outputs per channel
- All I/O data can be accessed by LabVIEW™

FRONT PANEL



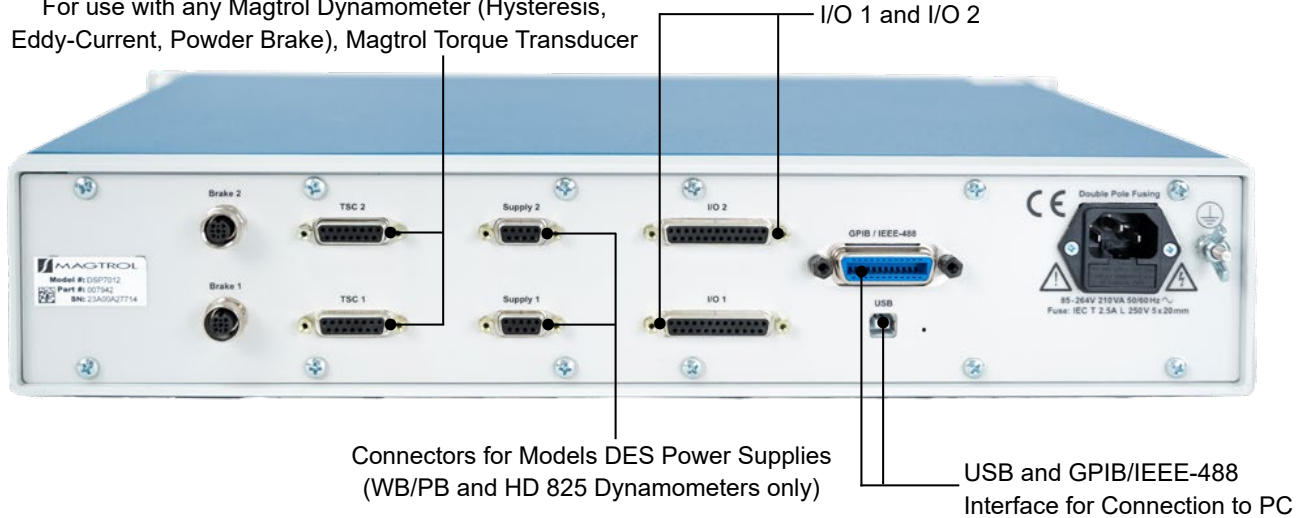
**REAR PANELS**

For use with any Magtrol Dynamometer (Hysteresis, Eddy-Current, Powder Brake), Magtrol Torque Transducer



**DSP7011 REAR PANEL**

For use with any Magtrol Dynamometer (Hysteresis, Eddy-Current, Powder Brake), Magtrol Torque Transducer

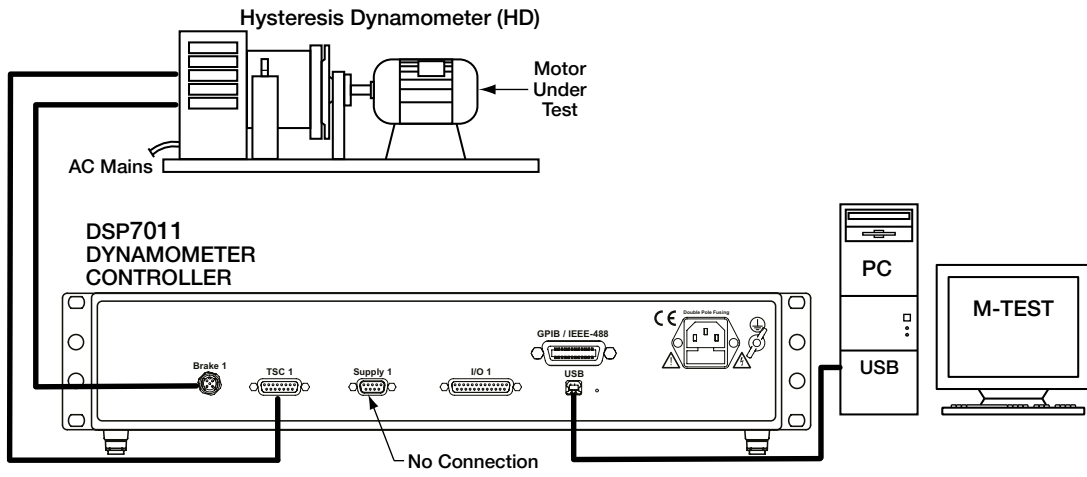


**DSP7012 REAR PANEL**

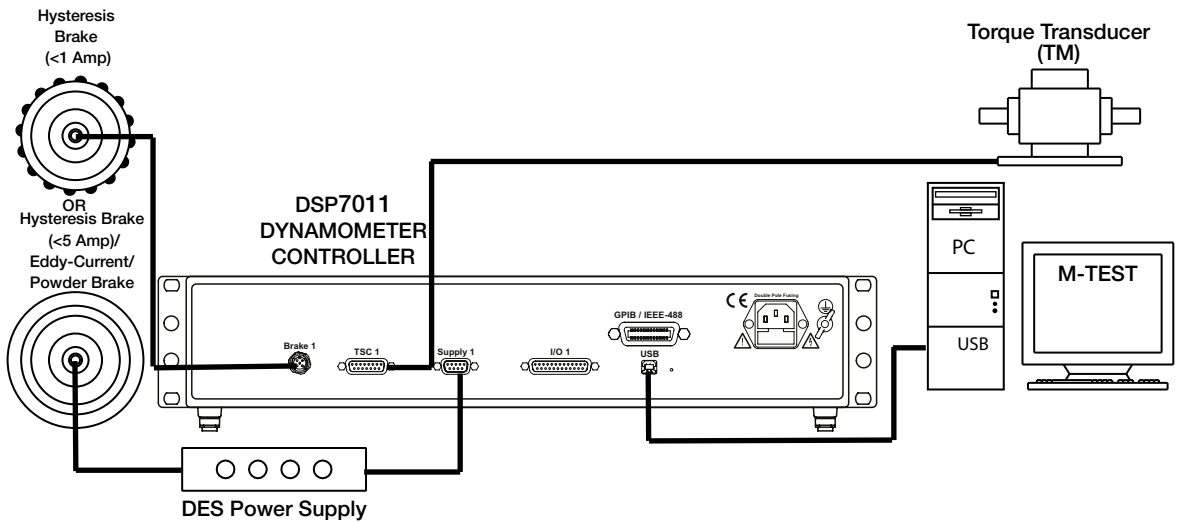
The USB Driver required for communication between the PC and DSP7010 is available for download at Magtrol's website:  
[www.magtrol.com/support/downloads.html](http://www.magtrol.com/support/downloads.html)



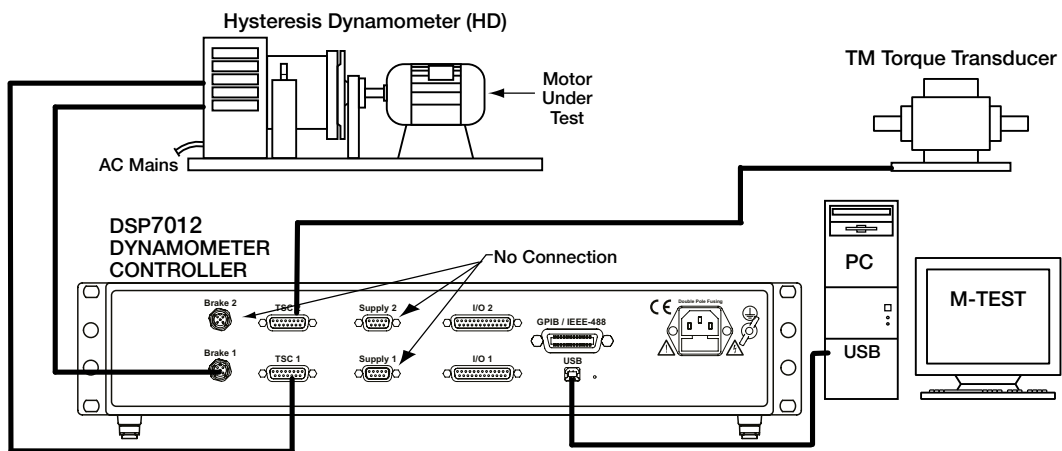
**SYSTEM CONFIGURATIONS**



**DSP7011 CONNECTED TO HYSTERESIS DYNAMOMETER**

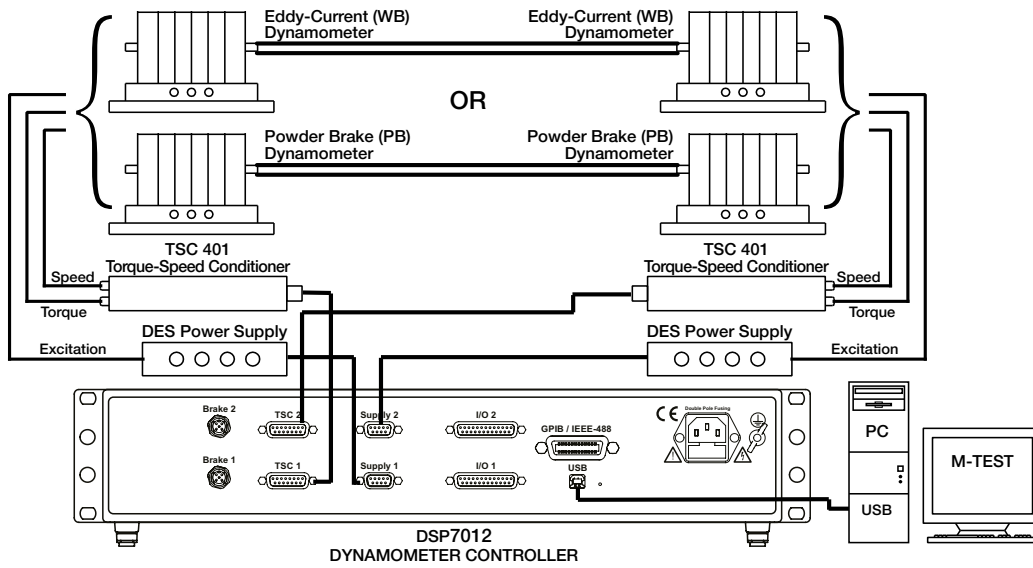


**DSP7011 CONNECTED TO A HYSTERESIS OR EDDY-CURRENT/POWDER BRAKE WITH IN-LINE TORQUE TRANSDUCER**

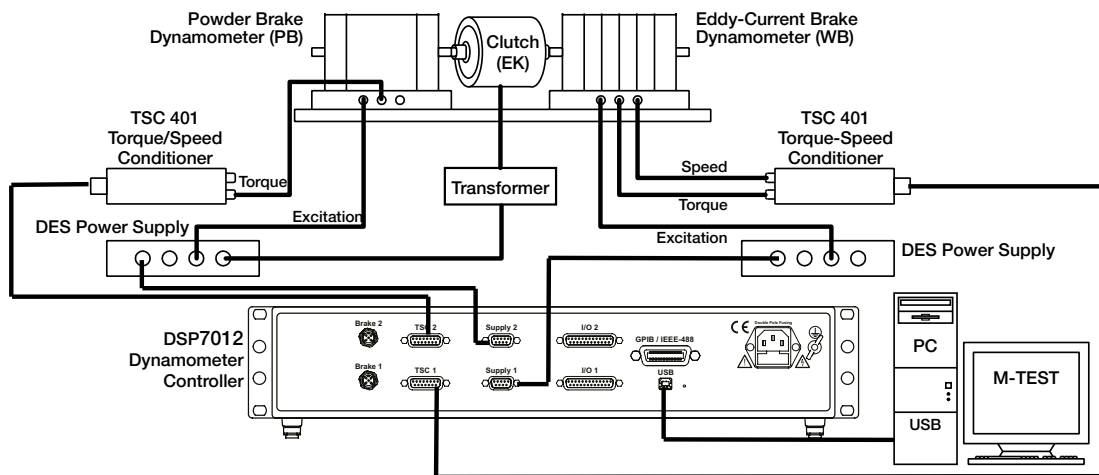


**DSP7012 CONNECTED TO HYSTERESIS DYNAMOMETER WITH IN-LINE TORQUE TRANSDUCER**

**SYSTEM CONFIGURATIONS**

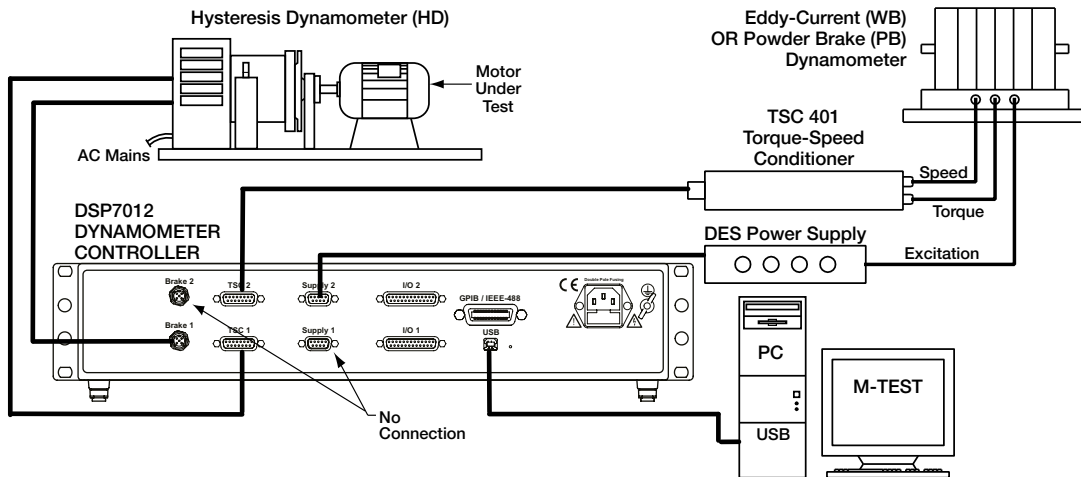


**DSP7012 CONNECTED TO 2 EDDY-CURRENT OR 2 POWDER BRAKE DYNAMOMETERS (TANDEM SETUP)**

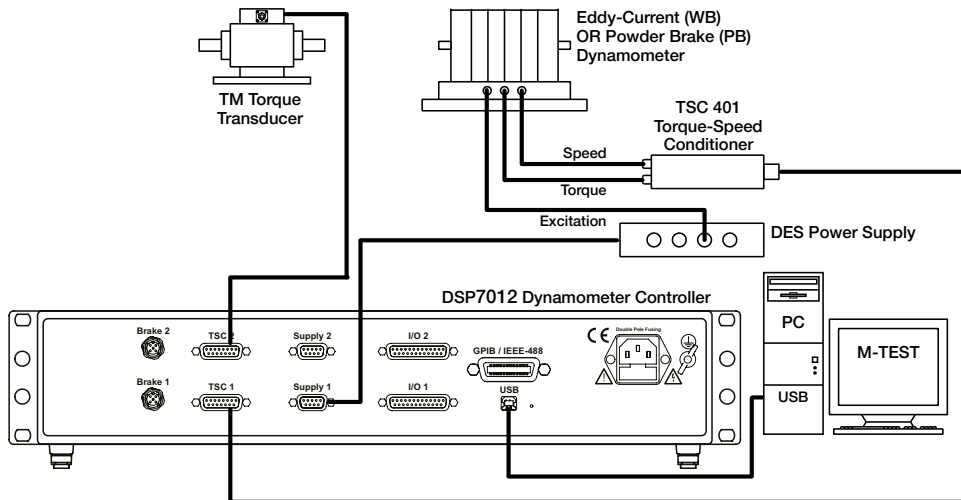


**DSP7012 CONNECTED TO EDDY-CURRENT AND POWDER BRAKE DYNAMOMETER (TANDEM SETUP)**

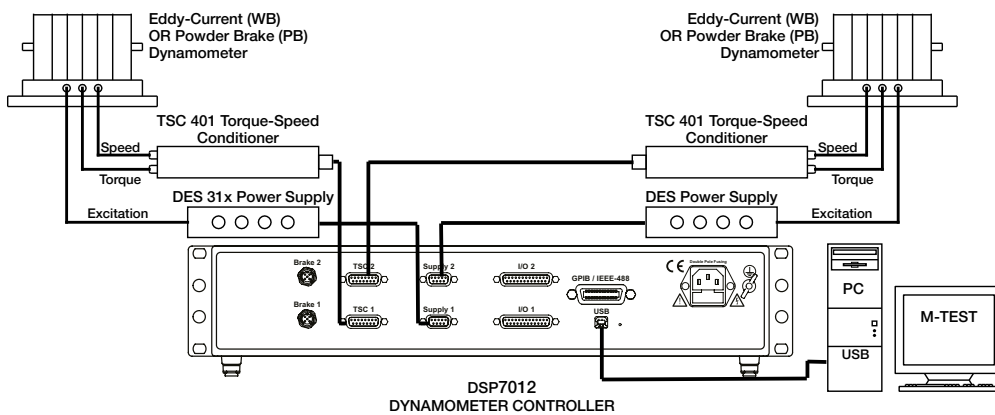
### SYSTEM CONFIGURATIONS



**DSP7012 CONNECTED TO HYSTERESIS DYNAMOMETER AND EDDY-CURRENT OR POWDER BRAKE DYNAMOMETER**



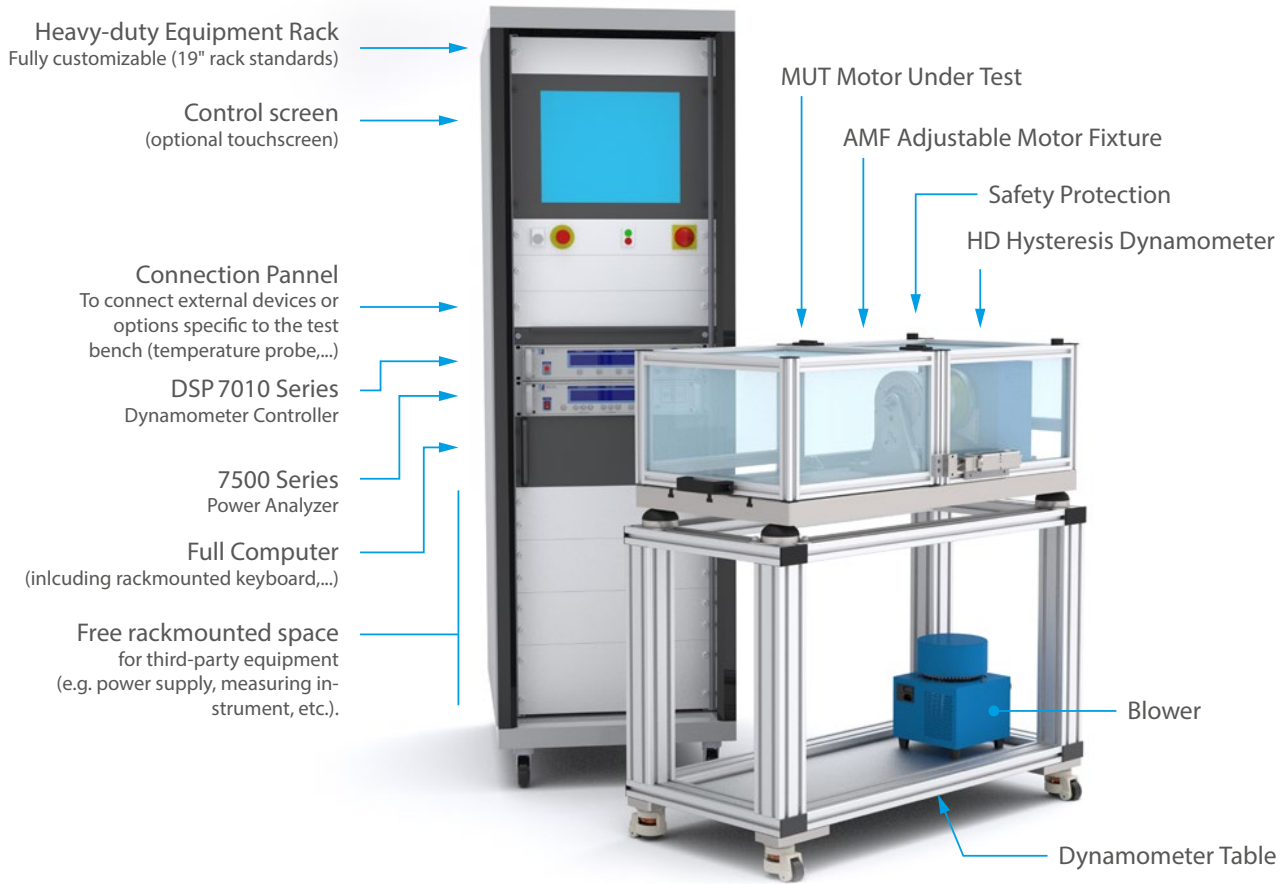
**DSP7012 CONNECTED TO EDDY-CURRENT OR POWDER BRAKE DYNAMOMETER (WB/PB) WITH IN-LINE TORQUE TRANSDUCER**



**DSP7012 CONNECTED TO 2 EDDY-CURRENT OR POWDER BRAKE DYNAMOMETERS (INDEPENDENT SETUP)**

## 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.



## ORDERING INFORMATION

DSP7011	High-Speed Programmable Dynamometer Controller - single channel
DSP7012	High-Speed Programmable Dynamometer Controller - dual channel

### 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
	Hysteresis Brakes	HB/MHB/LB/AHB/ BHB/CHB 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	Current-Regulated Power Supply	5212
	Power Amplifier (required for HD-825 Dynamometer only)	5242
	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-USB-HS+ Interface Cable	73M044
	GPIB Cable, 1 meter	88M047
	GPIB Cable, 2 meters	88M048
	Torque Transducer Connector Cable	ER 113/01



## 2. CONTROLS

### 2.1 FRONT PANEL

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

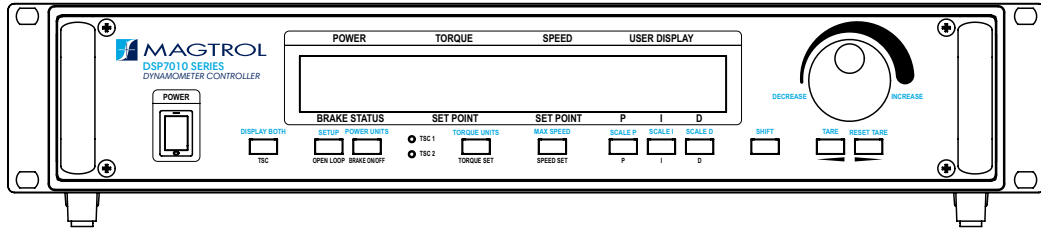


Fig.2-1 Font Panel

### 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



**NOTICE**

The TSC/DISPLAY BOTH button has no function on the DSP7010 Dynamometer Controller.

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

## 2.2.1 ENABLING SECONDARY FUNCTIONS

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

1. Press [SHIFT]. The word "SHIFT" will appear on the display:

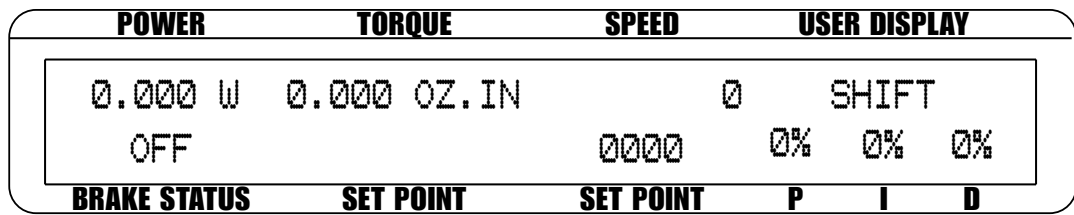


Fig.2-2 Secondary Function Menu

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



**NOTICE**

[SHIFT] is disabled while the brake status is ON.

## 2.2.2 ENABLING THE SAVE FUNCTION

To save all current programmed settings:

1. Press [SHIFT] two times. "SAVING" will appear on the display, as shown in Figure 2-3 Saving Function Menu.

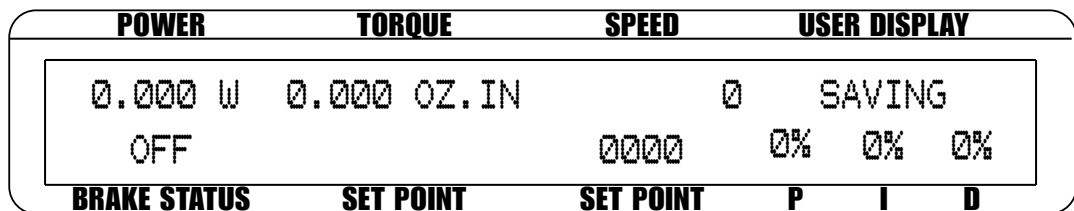


Fig.2-3 Saving Function Menu

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 then desired control button.	Enables the function written in blue above control button.
	Press this button twice.	Saves current configuration of unit to non-volatile memory.
INCREASE / DECREASE DIAL	Turn clockwise or counterclockwise.	Increases or decreases the selected parameter.



### 2.2.3.2 DOUBLE-FUNCTION BUTTONS

BUTTON	TO USE	FUNCTION
DISPLAY BOTH	Press [SHIFT] then press this button.	Displays both TSC1 and TSC2 measurements.
TSC	Press this button.	Switches between TSC1 and TSC2 setup.
SETUP	Press [SHIFT] then press this button.	Displays setup menu for dynamometer, I/O, system, and user.
OPEN LOOP	Press this button.	Enables Open Loop mode (if brake is off).
POWER UNITS	Press [SHIFT] 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] 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] 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] then press this button.	Set Coarse P-Scale Factor.
P	Press this button.	Set Fine P-Scale Factor.
SCALE I	Press [SHIFT] then press this button.	Set Coarse I-Scale Factor.
I	Press this button.	Set Fine I-Scale Factor.
SCALE D	Press [SHIFT] then press this button.	Set Coarse D-Scale Factor.
D	Press this button.	Set Fine D-Scale Factor.
TARE	Press [SHIFT] then press this button.	Tare the torque to eliminate any offset.
LEFT ◀	Press this button.	Move the cursor left when setting a numeric value.
RESET TARE	Press [SHIFT] then press this button.	Reset the torque offset.
RIGHT ▶	Press this button.	Move the cursor right when setting a numeric value

## 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 DSP7010 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].
3. Select SYSTEM.
4. Press [BRAKE ON/OFF] until desired brightness is reached.
5. Press [SHIFT] twice to return to the main menu.



#### NOTICE

Try to use the lowest setting possible as display segments may burn-in over 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-volatile memory.
RAMP DU	Decrease motor speed and then increase motor speed.
POWER UNITS	Power unit of measurement

## 2.4 REAR PANEL

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

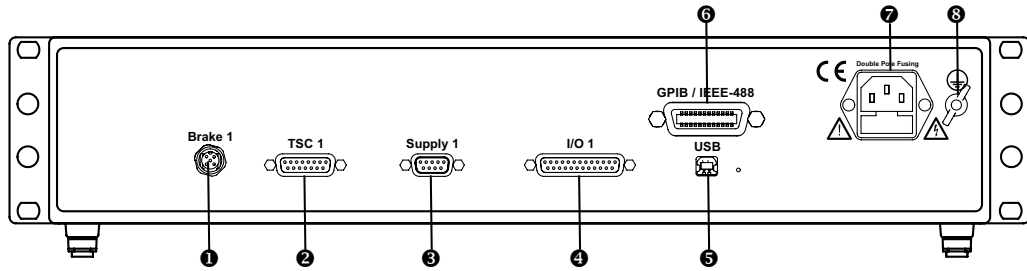


Fig.2-4 DSP7011 Rear Panel

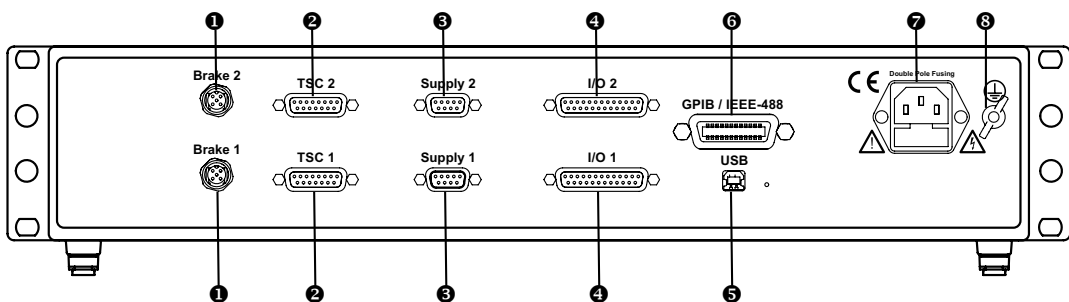


Fig.2-5 DSP7012 Rear Panel

### 2.4.1 REAR PANEL INPUTS AND OUTPUTS

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

PIN 1 and PIN 4 connected at the PCB "+ 48 Volts"  
 PIN 2 and PIN 3 connected at the PCB "Transistor"

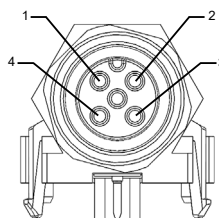
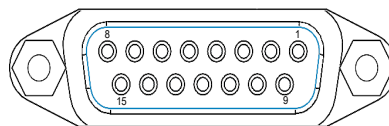


Fig.2-6 Dynamometer Brake Output

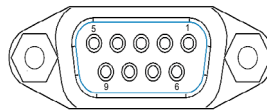
❷ TSC 1/TSC 2 - Connect torque signal cable here.



- |                |                   |
|----------------|-------------------|
| 1. FLOW/CLUTCH | 8. NC             |
| 2. TACH. B     | 9. +5 VOLT COMMON |
| 3. +24 VDC     | 10. D.P.A.        |
| 4. +24 VDC COM | 11. TACH A        |
| 5. -24 VDC COM | 12. NC            |
| 6. -24 VDC     | 13. D.P.B.        |
| 7. +5.0 VDC    | 14. TORQUE COMMON |
|                | 15. TORQUE SIGNAL |

Fig.2-7 TSC 1/TSC 2 Connector

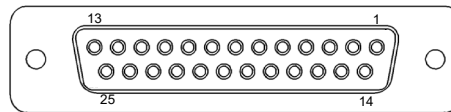
③ SUPPLY 1/SUPPLY 2 - Connect WB/PB DES Supply for TSC 1/TSC 2 here.



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

Fig.2-8 Supply 1/Supply 2 Connector

④ I/O 1 and I/O 2 - Connect I/O cable here.



- |                                          |                           |
|------------------------------------------|---------------------------|
| 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.                                       | 18. 5 Volts Common        |
| 6. External Alarm                        | 19. External Alarm Common |
| 7. DI1                                   | 20. 5 Volts Common        |
| 8. DI2                                   | 21. 5 Volts Common        |
| 9. DOUT1                                 | 22. DOUT2                 |
| 10. Relay1 NO                            | 23. Relay1 Common         |
| 11. Relay1 NC                            | 24. 5 Volts Common        |
| 12. Relay2 NO                            | 25. Relay2 Common         |
| 13. Relay2 NC                            |                           |

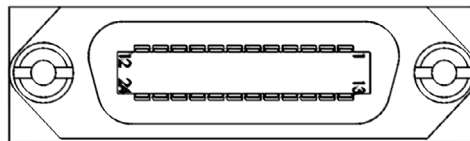
Fig.2-9 I/O 1 and I/O 2 Connector

⑤ USB - Connect PC USB cable here.



Fig.2-10 USB Connector

⑥ GPIB/IEEE-488 - Connect GPIB cable here.



- |            |                   |
|------------|-------------------|
| 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 |

Fig.2-11 GPIB Connector

⑦ POWER - Attach power cord here.

⑧ EARTH GROUND - Attach earth ground here.

### 3. INSTALLATION/CONFIGURATION



**NOTICE** Before installing the DSP7010, you should become familiar with the front and rear panels, as outlined in *Chapter 2–Controls*.

#### 3.1 POWERING UP THE DSP7010



**WARNING** TO REDUCE THE RISK OF ELECTRIC SHOCK, MAKE SURE THE DSP7010 IS EARTH GROUNDED BEFORE STARTING!

##### 3.1.1 SELF-TEST

After turning on the power on to the DSP7010, the display will show the message “SERIAL KEY PAD REV X.X” while the DSP7010 is downloading its program.

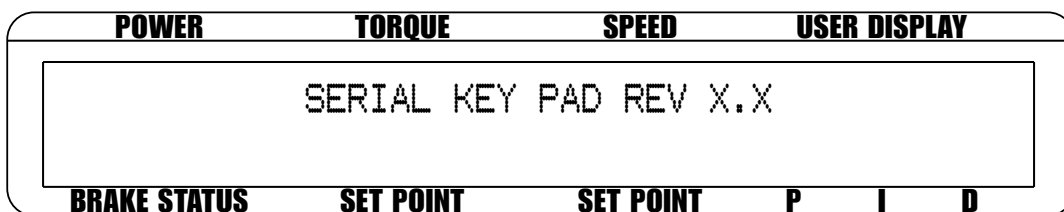


Fig.3-1 Program Download Display

When the program download is complete, the message “MAGTROL DSP701X, FW REV:XX, FPGA REV:XX” appears.



Fig.3-2 Revision Display

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

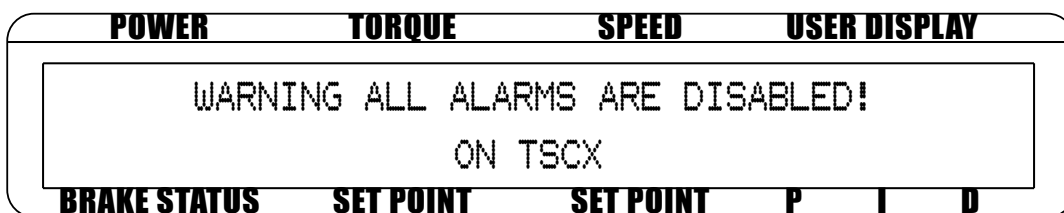


Fig.3-3 Alarm Warning Display

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

### 3.1.2 MAIN MENU

When the DSP7010 is completely powered up and ready for use, the main menu will appear on the display.

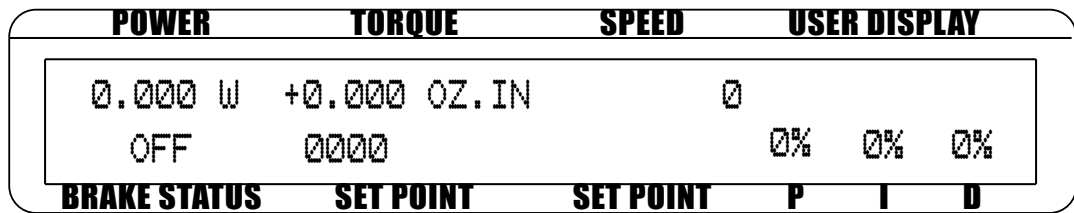


Fig.3-4 Main Menu

## 3.2 INSTRUMENTATION SETUP (TORQUE)

The DSP7010 can support a combination of up to two testing instruments with independent or tandem configurations.



**NOTICE**

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 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 DSP7010 can support the following instruments:

HD-xxx-6,7,8
WB
PB
TM/TS/TF/TS
HD-xxx-5

### 3.2.1 DYNAMOMETER CONFIGURATION MENU

To reach the dynamometer configuration menu:

1. Turn on DSP7010 power. See Section 3.1 – Powering Up the DSP7010.
2. Press [SHIFT]. The word “SHIFT” will appear in the display.
3. Press the [SETUP] button. The display should appear as follows:

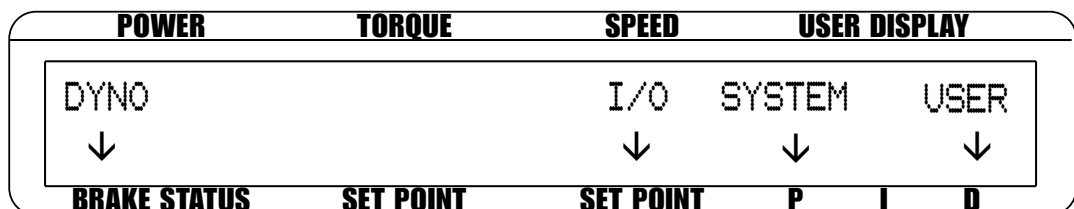


Fig.3-5 Setup Menu

- Select DYNO. The display should appear as follows:

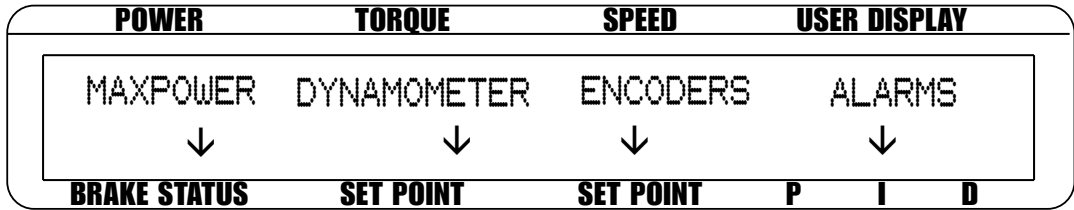


Fig.3-6 Dynamometer Setup Menu

- Select DYNAMOMETER. The display should appear as follows:

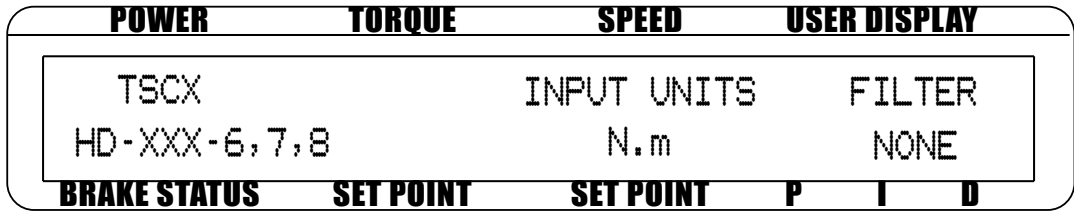


Fig.3-7 Dynamometer Configuration Menu

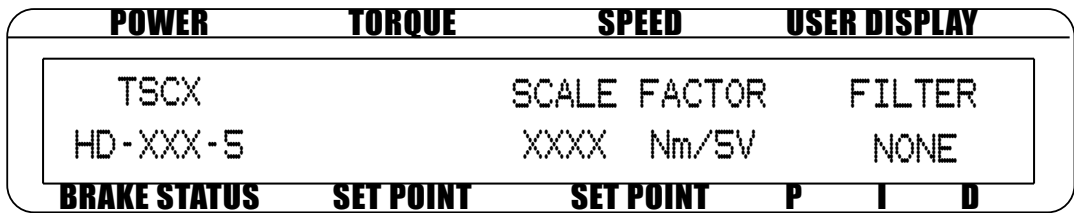


Fig.3-8 Dynamometer Configuration Menu for HD5, WB, PB, TM/TS/TF

- Pressing [POWER UNITS] allows selection of the preferred testing device (HD, WB, PB, TM/TS/TF, or HD5) for TSC1. Pressing [MAX SPEED] 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.

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



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

### 3.2.2 HYSTERESIS DYNAMOMETER SETUP

#### 3.2.2.1 HARDWARE CONNECTION

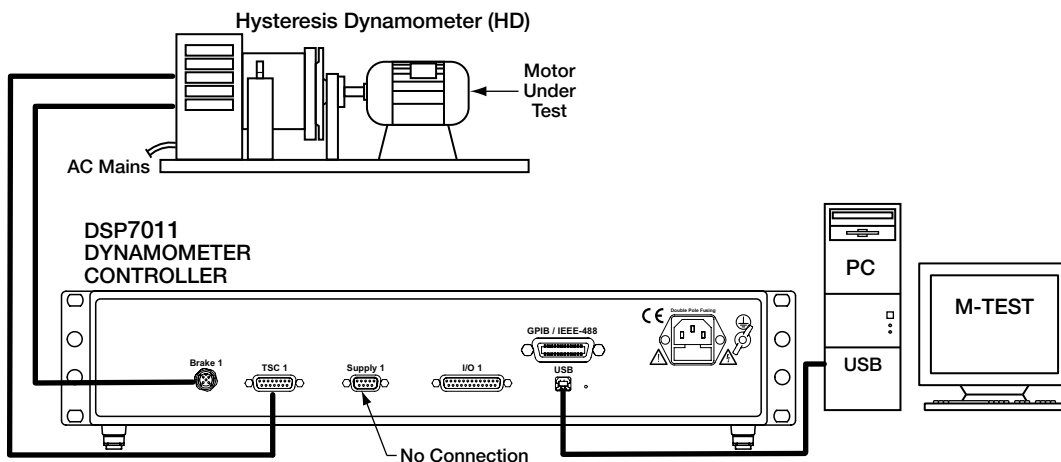


Fig.3-9 Hysteresis Dynamometer Setup

#### 3.2.2.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010 and proceed to the dynamometer configuration menu. See Section 3.2.1 – Dynamometer Configuration Menu.
2. Press [POWER UNITS] until HD or HD5 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:

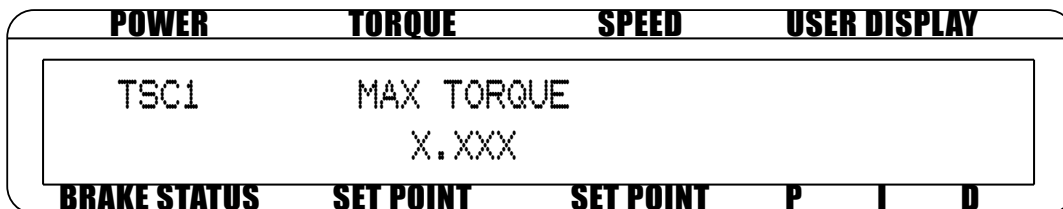


Fig.3-10 Hysteresis Setup Menu

6. Press [TORQUE UNITS]. Use ◀ and ▶ and the 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

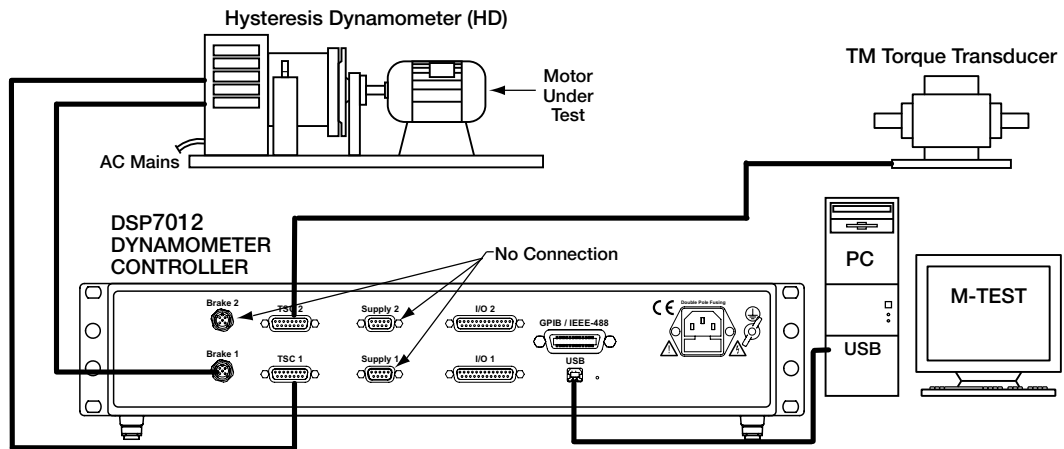


Fig.3-11 Hysteresis Dynamometer with Torque Transducer Setup

#### 3.2.3.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010. 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/TS/TF is reached for TSC2.
3. Press [TORQUE UNITS] until HB is reached.
4. Press [MAX SPEED]. Use ◀ and ▶ and the 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:

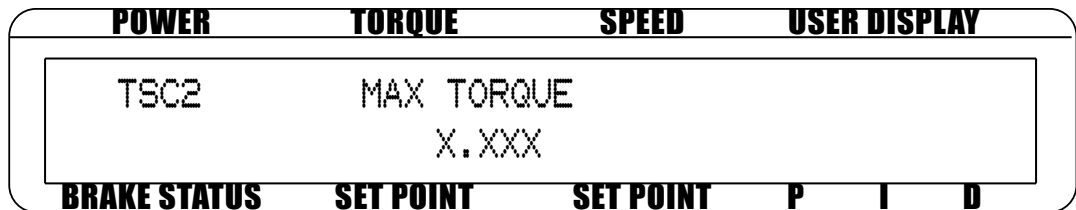


Fig.3-12 Torque Transducer Setup Menu

7. Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the 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

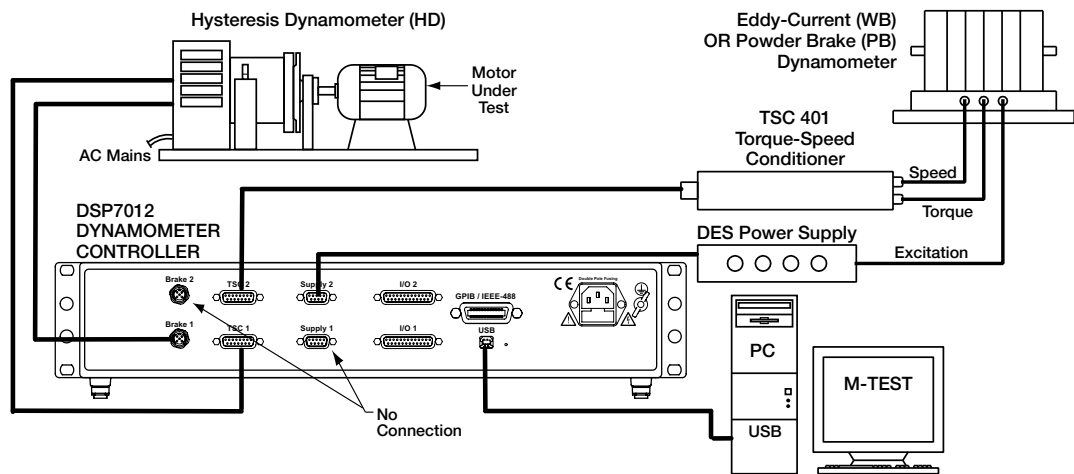


Fig.3-13 Hysteresis Dynamometer with Eddy-Current or Powder Brake Setup

#### 3.2.4.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010. 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 WB or PB is reached.
3. Press [MAX SPEED]. Use ◀ and ▶ and the dial to set desired scale factor for TSC2.
4. Press [SCALE I] to add a filter if desired.
5. If using an Eddy Current Dynamometer, press [SHIFT]. The display should appear as follows:

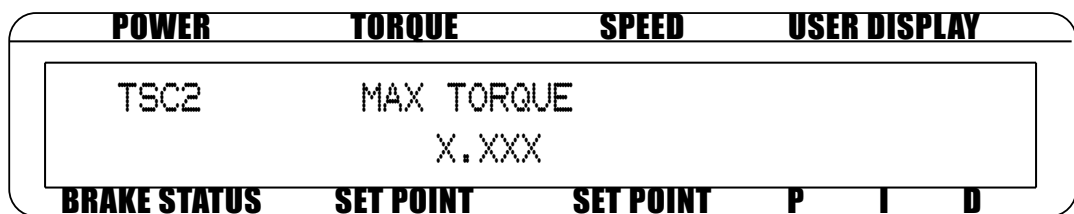


Fig.3-14 TSC2 Eddy-Current Setup Menu

Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the dial to set desired nominal speed. Press [SHIFT] 4 times to complete the initial setup and return to the main menu.

6. If using a Powder Brake Dynamometer, press [SHIFT]. The display should appear as follows:

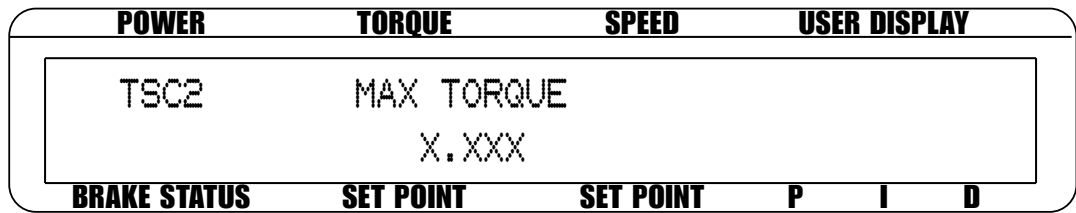


Fig.3-15 TSC2 Powder Brake Setup Menu

Press [TORQUE UNITS]. Use ◀ and ▶ and the 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

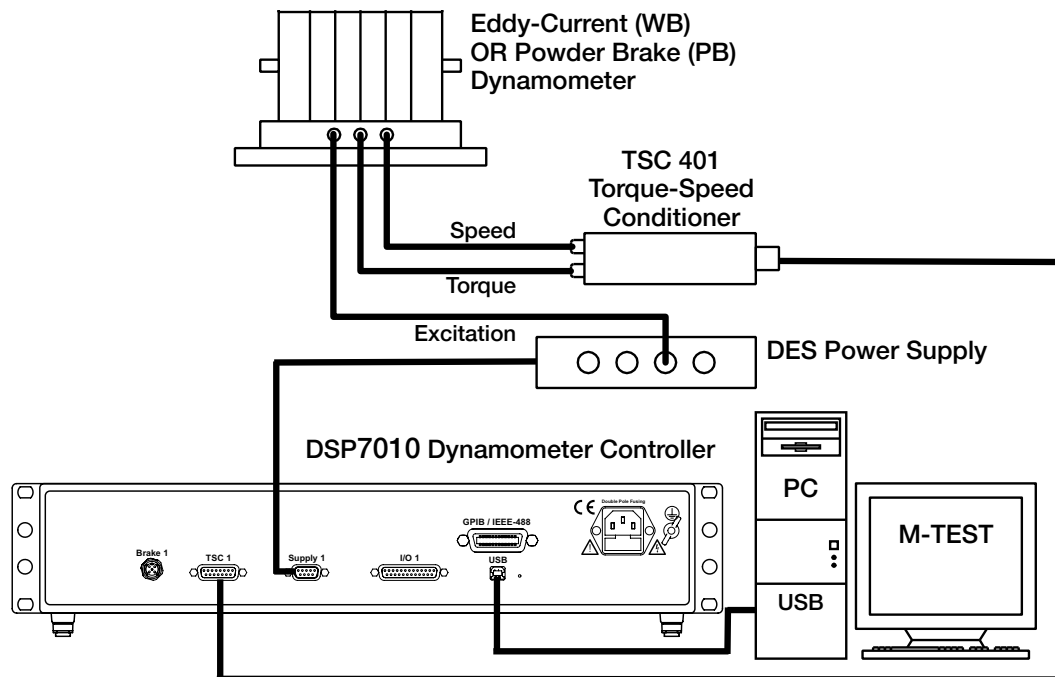


Fig.3-16 Eddy-Current or Powder Brake Dynamometer Setup

### 3.2.5.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010 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]. Use ◀ and ▶ and the dial to set desired scale factor. Press [SCALE I] to add a filter if desired.
4. If using an Eddy Current Dynamometer, press [SHIFT]. The display should appear as follows:

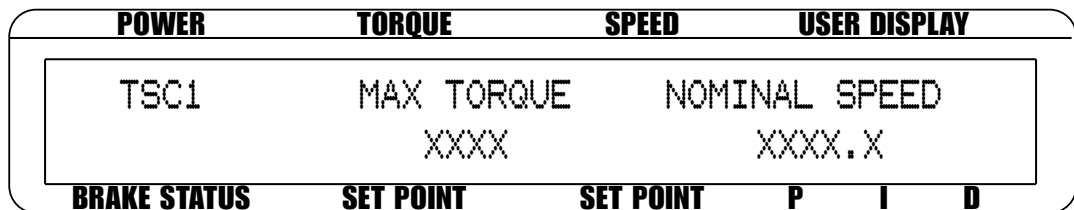


Fig.3-17 TSC1 Eddy-Current Setup Menu

Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the dial to set desired nominal speed. Press [SHIFT] 3 times to complete the initial setup and return to the main menu.

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

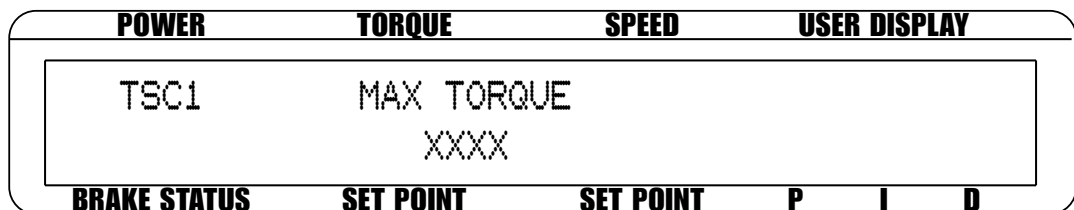


Fig.3-18 TSC1 Powder Brake Setup Menu

Press [TORQUE UNITS]. Use ◀ and ▶ and the 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

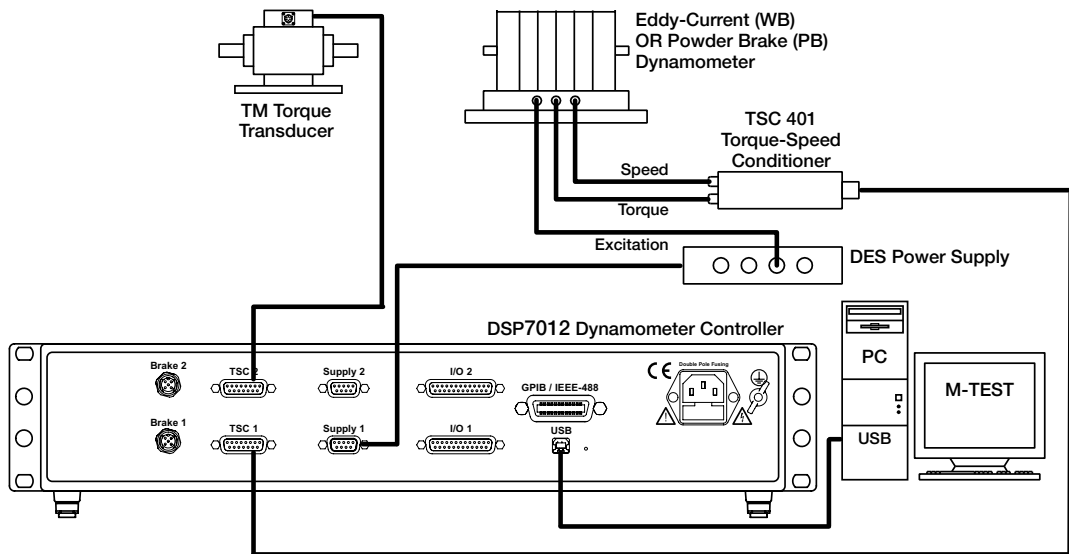


Fig.3-19 Eddy-Current or Powder Brake Dynamometer with Torque Transducer Setup

#### 3.2.6.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010. Set up TSC1 as described in section 3.2.5 Eddy-Current or Powder Brake 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/TS/TF is reached.
3. Press [TORQUE UNITS] until WB or PB is reached.
4. Press [MAX SPEED]. Use ◀ and ▶ and the 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:

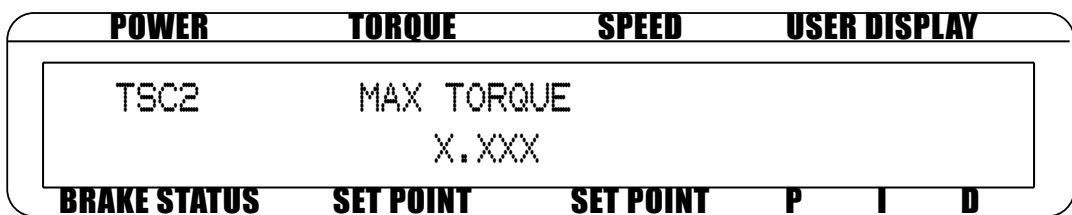


Fig.3-20 TSC2 torque transducer setup menu.



**NOTICE**

Nominal Speed will appear in the display if WB is selected as the brake.

Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the 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

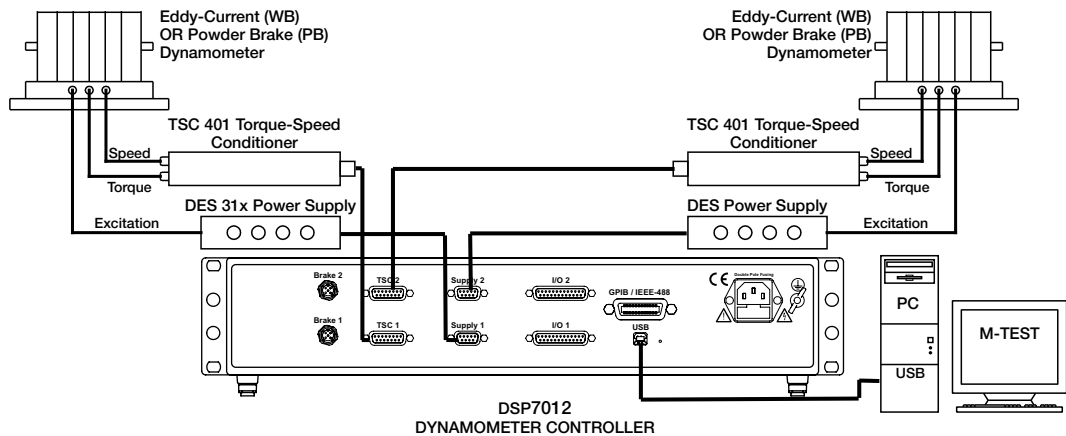


Fig.3-21 Two Eddy-Current/Powder Brake Dynamometers (Independent Setup)

#### 3.2.7.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010. Set up TSC1 as described in section 3.2.5 Eddy-Current or Powder Brake 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 WB or PB is reached.
3. Press [MAX SPEED]. Use ◀ and ▶ and the dial to set desired scale factor for TSC2.
4. Press [SCALE I] to add a filter if desired.
5. If using an Eddy Current Dynamometer, press [SHIFT]. The display should appear as shown in Figure 3-13 TSC2 Eddy-Current Setup Menu. Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the dial to set desired nominal speed. Press [SHIFT] 2 times to return to the setup menu. The display will appear as follows:

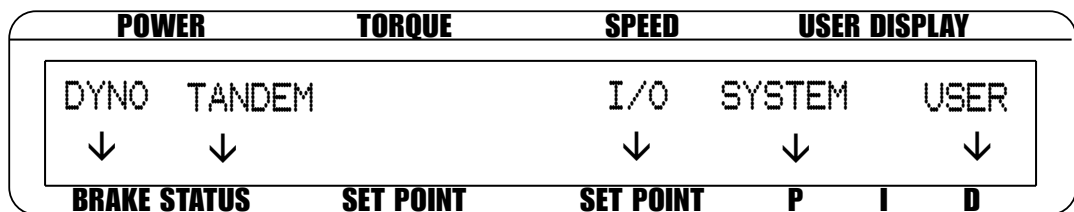


Fig.3-22 Tandem Setup Menu

6. If using a Powder Brake Dynamometer, press [SHIFT]. The display should appear as shown in Figure 3-14 TSC2 Powder Brake Setup Menu. Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SHIFT] 2 times to return to the setup menu. See Figure 3-21 Tandem Setup Menu.
7. Press [POWER UNITS] to select tandem.

8. The menu will appear as follows:

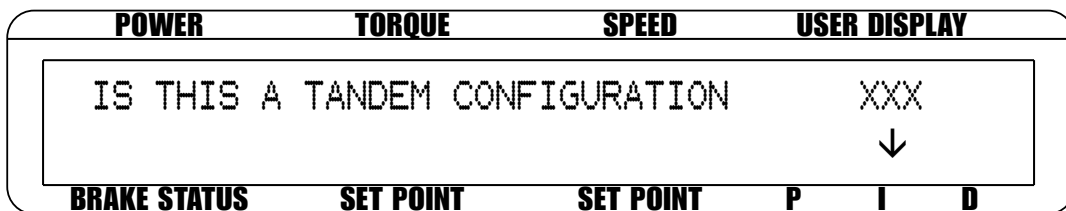


Fig.3-23 Tandem Configuration Menu

9. Press [SCALE I] button until the menu says “NO”.

10. 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

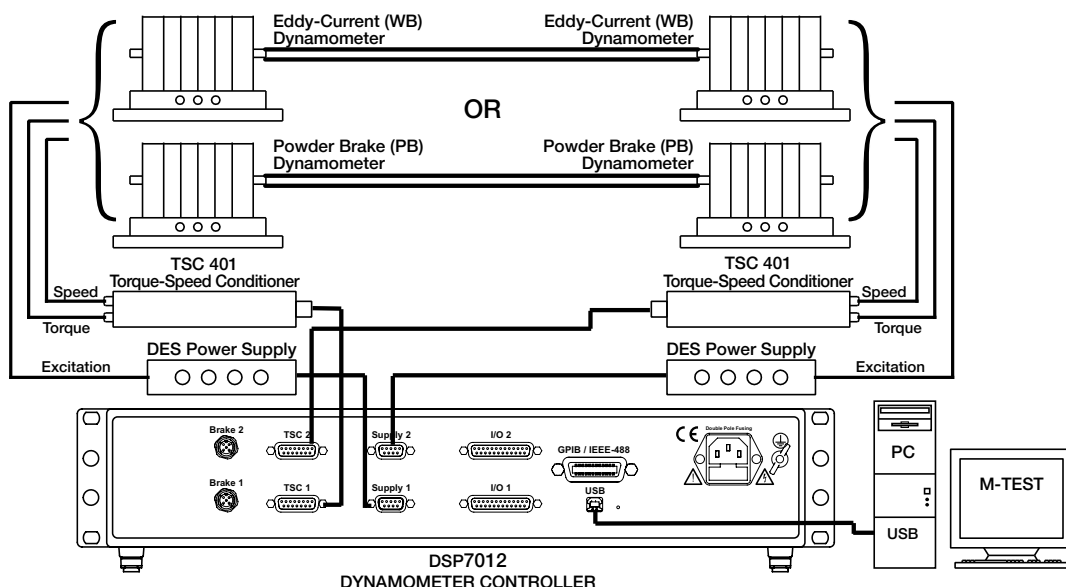


Fig.3-24 Two Eddy-Current/Powder Brake Dynamometers (Tandem Setup)



**NOTICE** This tandem configuration is only applicable to a WB-WB or PB-PB combination.

### 3.2.8.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010. Set up TSC1 as described in section 3.2.5 Eddy-Current or Powder Brake 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 WB or PB is reached.
3. Press [MAX SPEED]. Use ◀ and ▶ and the dial to set desired scale factor for TSC2.
4. Press [SCALE I] to add a filter if desired.
5. If using an Eddy Current Dynamometer, press [SHIFT]. The display should appear as shown in Figure 3-13 TSC2 Eddy-Current Setup Menu. Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the dial to set desired nominal speed. Press [SHIFT] 2 times to return to the setup menu. See Figure 3-21 Tandem Setup Menu.
6. If using a Powder Brake Dynamometer, press [SHIFT]. The display should appear as shown in Figure 3-14 TSC2 Powder Brake Setup Menu. Press [TORQUE UNITS]. Use ◀ and ▶ and the dial to set desired max torque. Press [SHIFT] 2 times to return to the setup menu. See Figure 3-21 Tandem Setup Menu.
7. Press [POWER UNITS] to select tandem. See Figure 3-22 Tandem Configuration Menu.
8. Press [SCALE I] button until the menu says “YES”.
9. 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

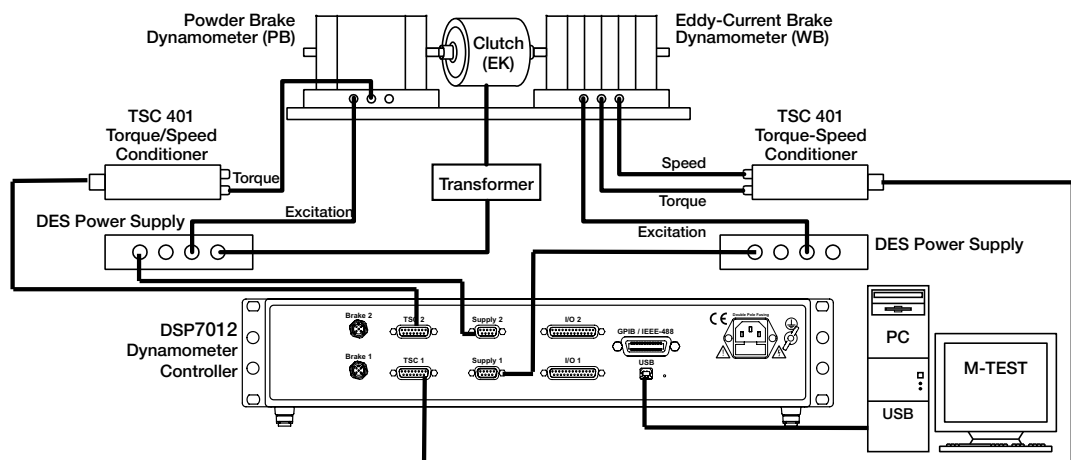


Fig.3-25 Eddy-Current Dynamometer with Powder Brake Dynamometer (Tandem Setup)



### 3.2.9.2 SOFTWARE CONFIGURAION

1. Turn on the DSP7010 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]. Use ◀ and ▶ and the 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]. Use ◀ and ▶ and the dial to set desired max torque. Press [SCALE P]. Use ◀ and ▶ and the 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]. Use ◀ and ▶ and the 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]. Use ◀ and ▶ and the 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.
15. Press [SCALE I] button until the menu says “YES”.
16. Press [SHIFT] once to reach the Maximum Speed Excited Menu as shown below:

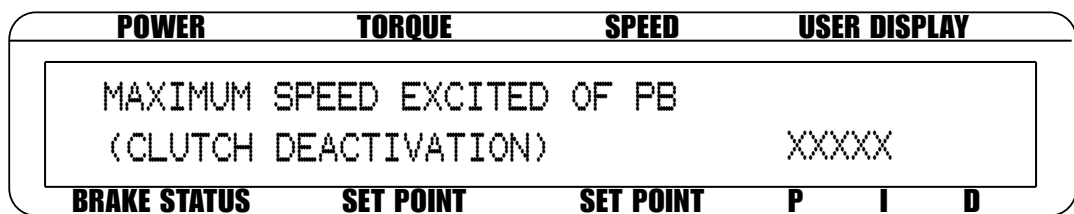


Fig.3-26 Maximum Speed Excited Menu

17. Press [SCALE P]. Use ◀ and ▶ and the dial to set maximum speed excited of PB.
18. Press [SHIFT] 3 times to complete initial setup and return to the main menu.



**NOTICE**

The TSC key is disabled in tandem configuration.

### 3.2.10 IN-LINE TORQUE TRANSDUCER WITH BRAKE

#### 3.2.10.1 HARDWARE CONFIGURATION

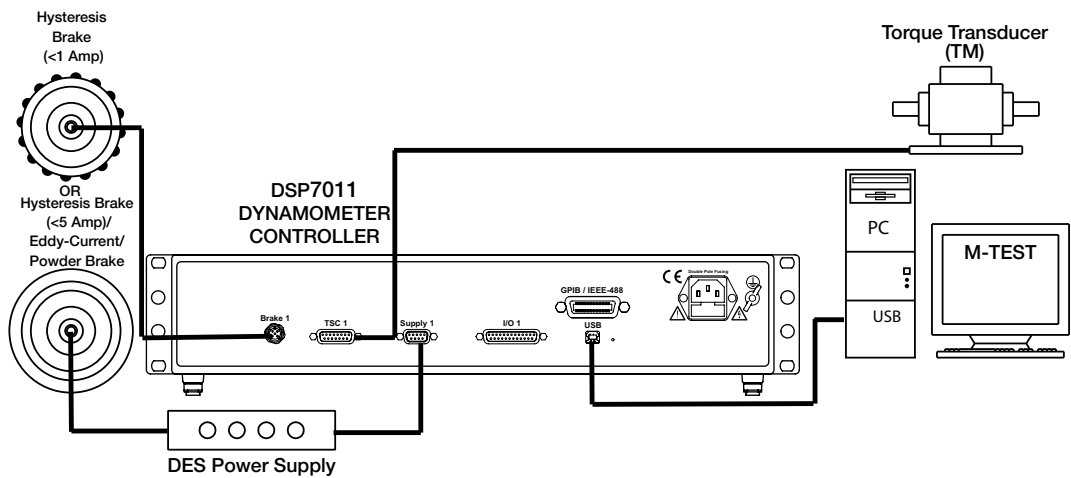


Fig.3-27 In-Line Torque Transducer with Brake

#### 3.2.10.2 SOFTWARE CONFIGURATION

1. Turn on the DSP7010 and proceed to the dynamometer configuration menu. See Section 3.2.1 – Dynamometer Configuration Menu.
2. Press [POWER UNITS] until TM/TS/TF is reached.
3. Press [TORQUE UNITS] until the desired brake is selected.
4. Press [MAX SPEED]. Use ◀ and ▶ and the 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:

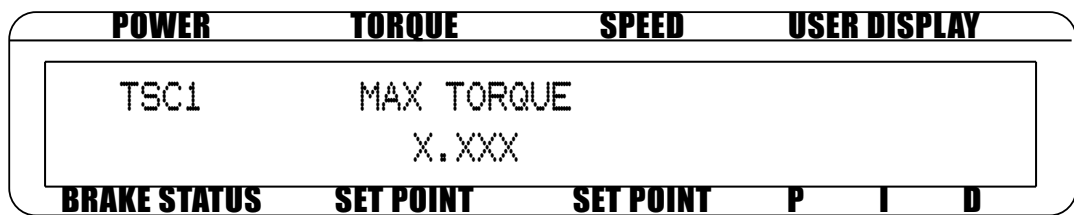


Fig.3-28 TSC1 Setup Menu



**NOTICE** Nominal Speed will appear in the display if WB is selected as the brake.

7. Press [TORQUE UNITS]. Use ◀ and ▶ and the 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

**NOTICE**

Filter setup should take place after hardware installation and 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].
3. Select DYNO.
4. Select DYNAMOMETER.
5. Press [SCALE I] 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 ENCODER AND SPEED ALARM SETUP

**NOTICE**

The calculated speed is made available to the control loop at a rate of 488 samples per second and to the display at a slower rate of about 4 samples per second.

Tach A is intended 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 99,999 PPR.

### 3.4.1 HOW TO SET PPR (PULSE PER REVOLUTION)

1. Starting from the main menu, press [SHIFT].
2. Press [SETUP].
3. Select DYNO.
4. Select ENCODER
5. Select [TORQUE UNITS]
6. Use ◀ and ▶ and the dial to set the desired PPR.

**RPM vs PPR**  
**Keeping input frequency to the DSP7010**  
**less than 200,000 Hz**

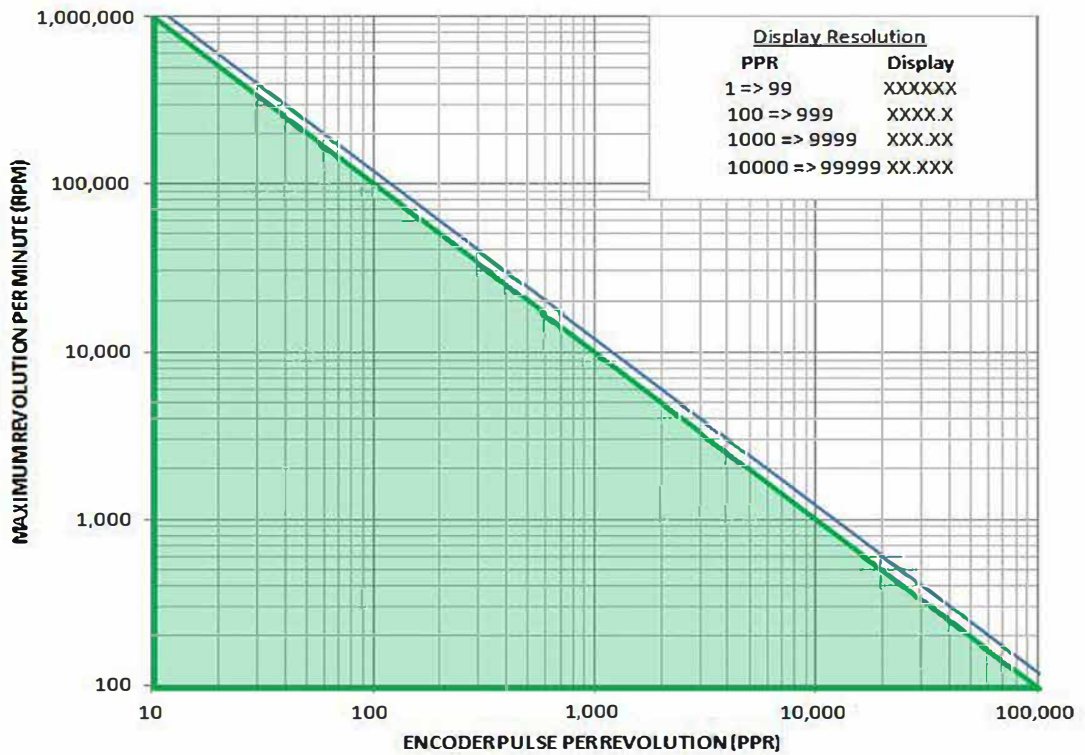


Fig.3-29 RPM vs PPR Chart

Figure 3-29 provides a guide for allowable maximum RPMs when using an encoder with a given PPR. These combinations keep the input frequency within the allowable limits for the DSP7010.

**3.4.2 SPEED ALARM**

1. From the main menu, follow the instrumentation setup instructions. See Section 3.4 - Instrumentation Setup (Speed).
2. Press [SCALE P]. Use ◀ and ▶ and the dial to set the Speed Alarm.
3. Press [SCALE P]. Use ◀ and ▶ and the dial to set the Speed Alarm.
4. 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:

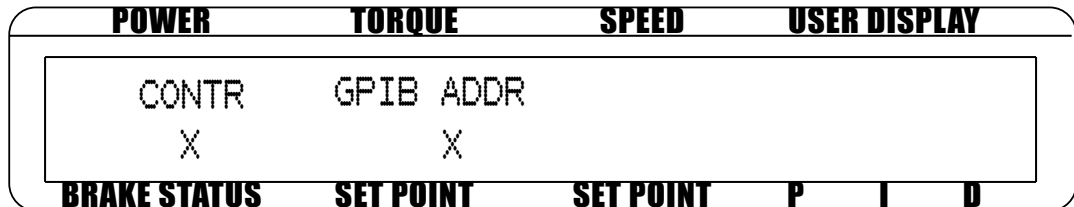


Fig.3-30 System Setup Menu

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.



## 4. PID SETTINGS

### 4.1 ABOUT THE PID LOOP

The DSP7010 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 gain
D	=	derivative gain

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 gain 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 GAIN)

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

#### 4.1.3 D (DERIVATIVE GAIN)

With derivative gain, the controller output is responsive to the rate of change of measurement. Derivative gain can compensate for a fast-changing measurement.

## 4.2 SETTING PID VALUES

### 4.2.1 HOW TO SET P (PROPORTIONAL GAIN) VALUE

1. Starting at the main menu, press [P].
2. Use the dial until the desired percentage is reached (ranges from 0-99).

### 4.2.2 HOW TO SET I (INTEGRAL GAIN) VALUE

1. Starting at the main menu, press [I].
2. Use the dial until the desired percentage is reached (ranges from 0-99).

### 4.2.3 HOW TO SET D (DERIVATIVE GAIN) VALUE

1. Starting at the main menu, press [D].
2. Use the dial until the desired percentage is reached (ranges from 0-99).

**NOTICE**

To extend the range of the PID settings see section 11.2.

## 4.3 SETTING THE CORRECT PID'S FOR YOUR MOTOR



**NOTICE**

Each type of motor will have its 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 [OPEN LOOP]. The display will appear as follows:

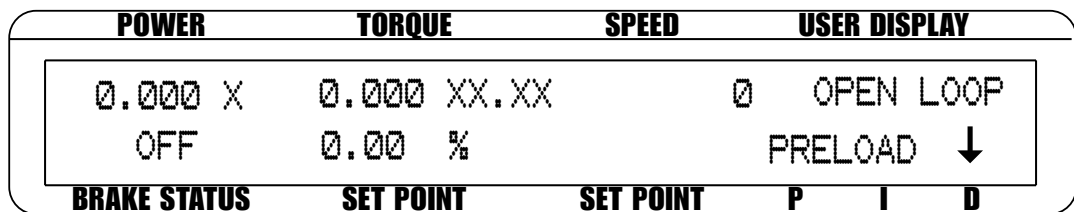


Fig.4-1

2. Set the percent excitation to zero using the 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 [OPEN LOOP].

### 4.3.2 SETTING THE PID FOR TORQUE CONTROL

1. With the motor and brake OFF, set the desired Torque Set Point by pressing [TORQUE SET]. Use ◀ and ▶ and the dial to set the value.
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.



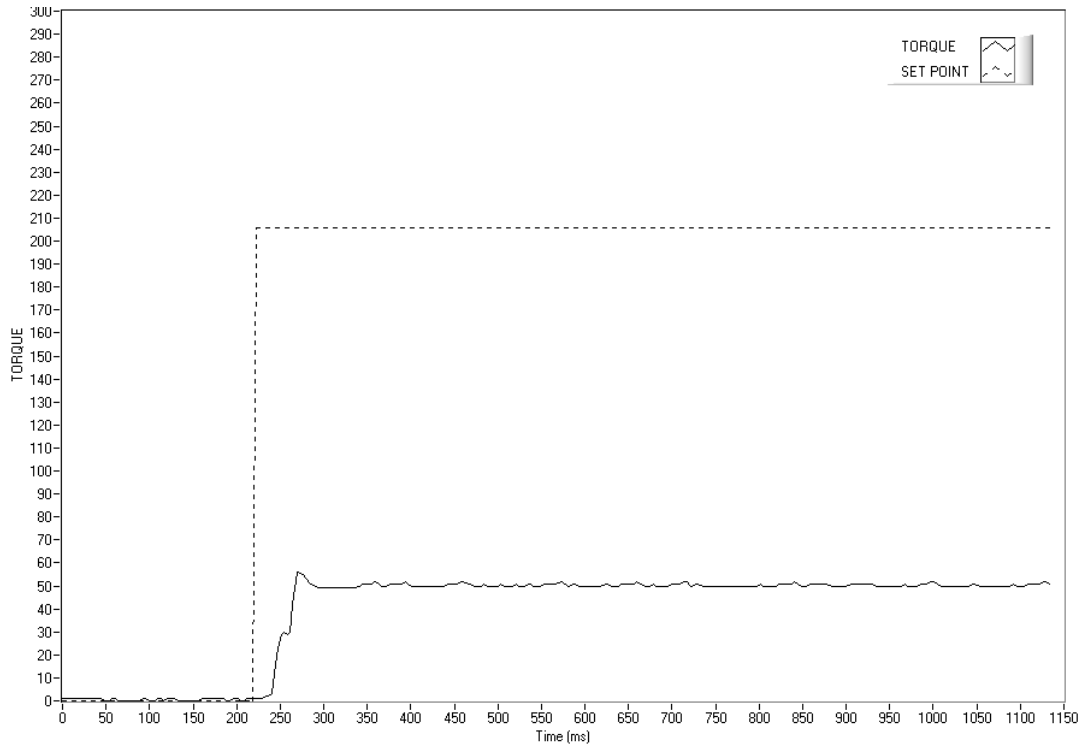


Fig.4-2 Initial P Setting for Torque Control at 25%

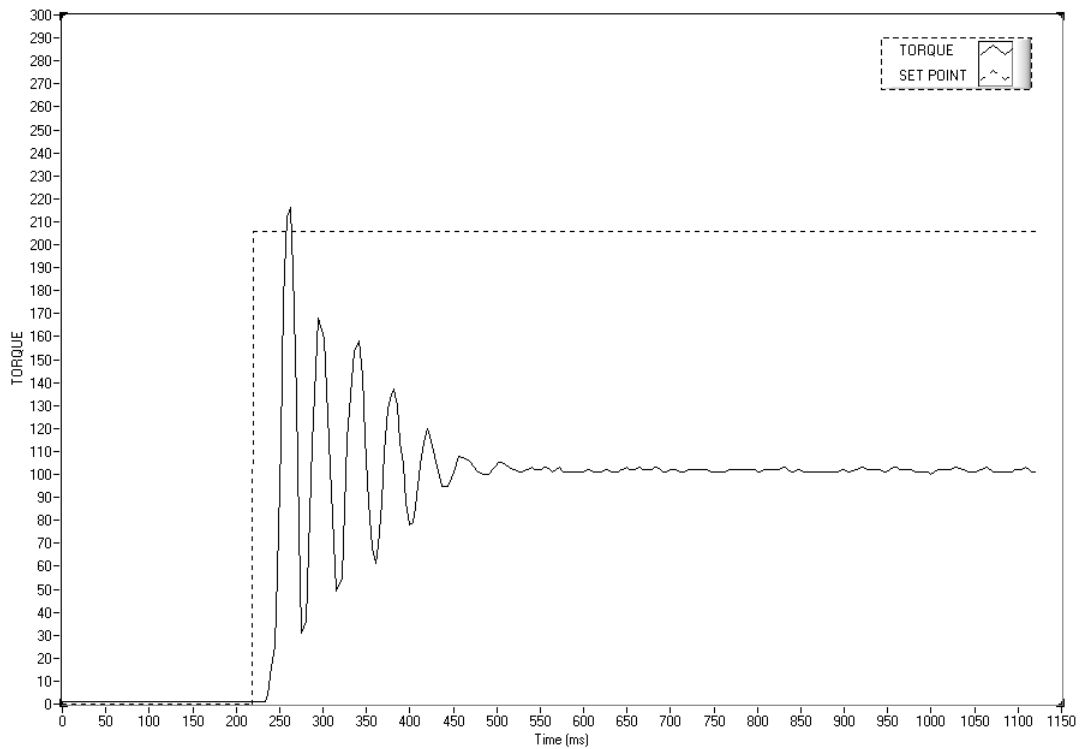


Fig.4-3 Figure 4-3 High Initial P Setting for Torque Control

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

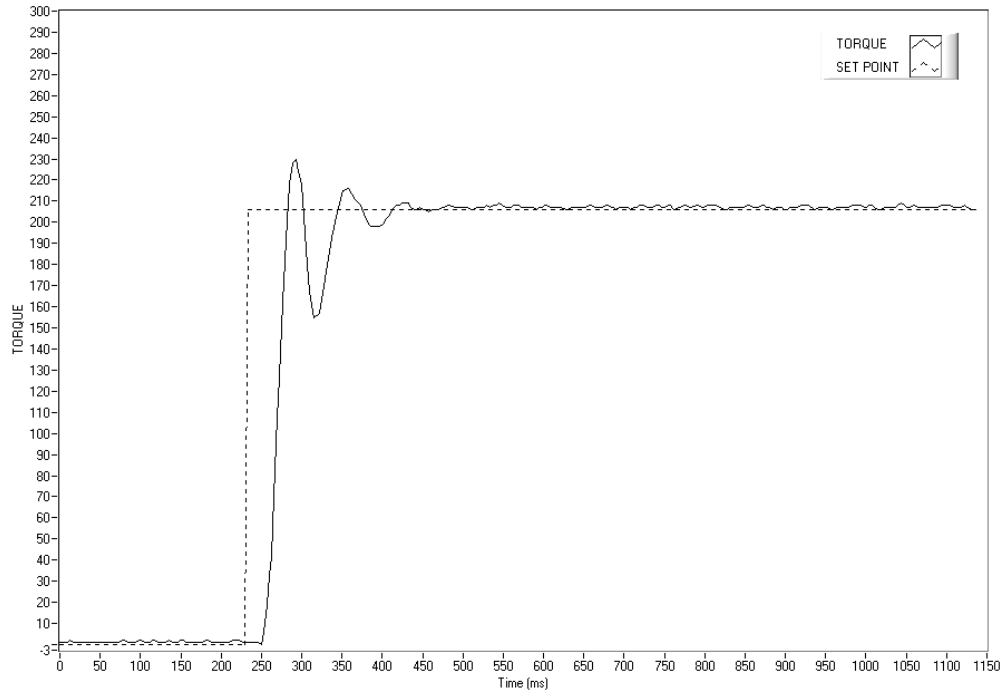


Fig.4-4 Initial I Setting for Torque Control

If there is too much overshoot, increase the D term in 1% increments and repeat #8.

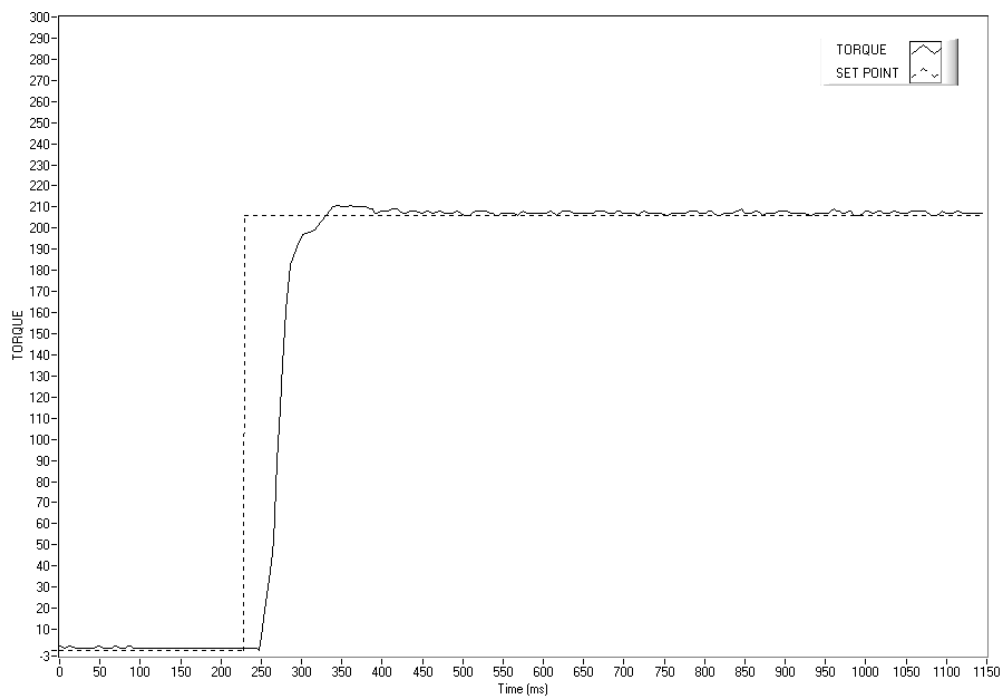


Fig.4-5 Initial D Setting for Torque Control

### 4.3.3 SETTING THE PID FOR SPEED CONTROL

1. With the motor and brake OFF, set the desired Speed Set Point by pressing [SPEED SET]. Use ◀ and ▶ and the dial to set the value.
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.

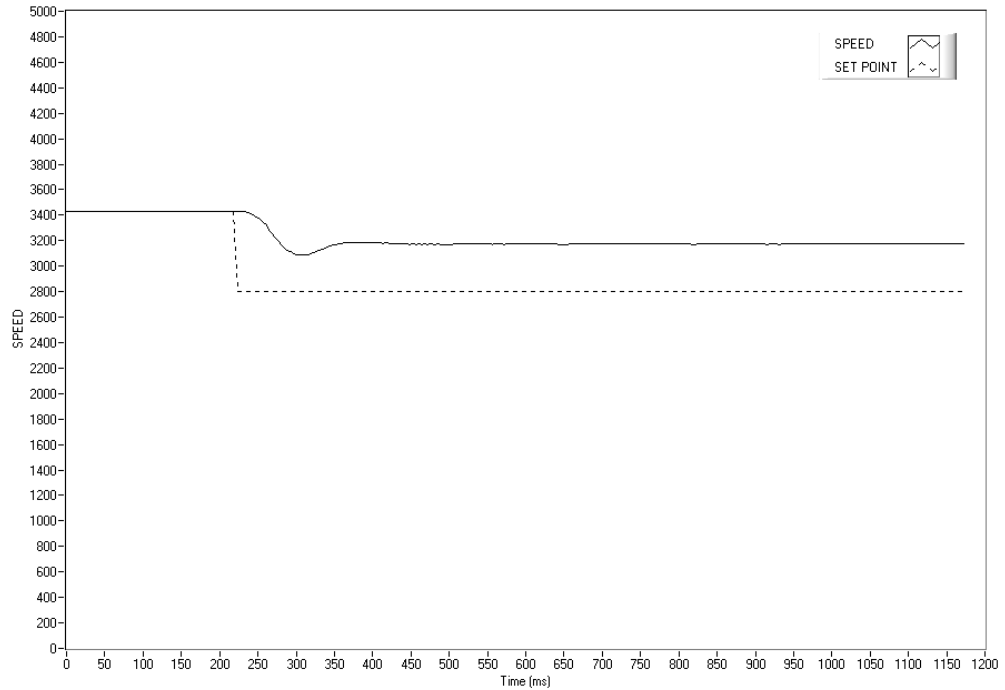


Fig.4-6 Initial P Setting for Speed Control at 25%

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

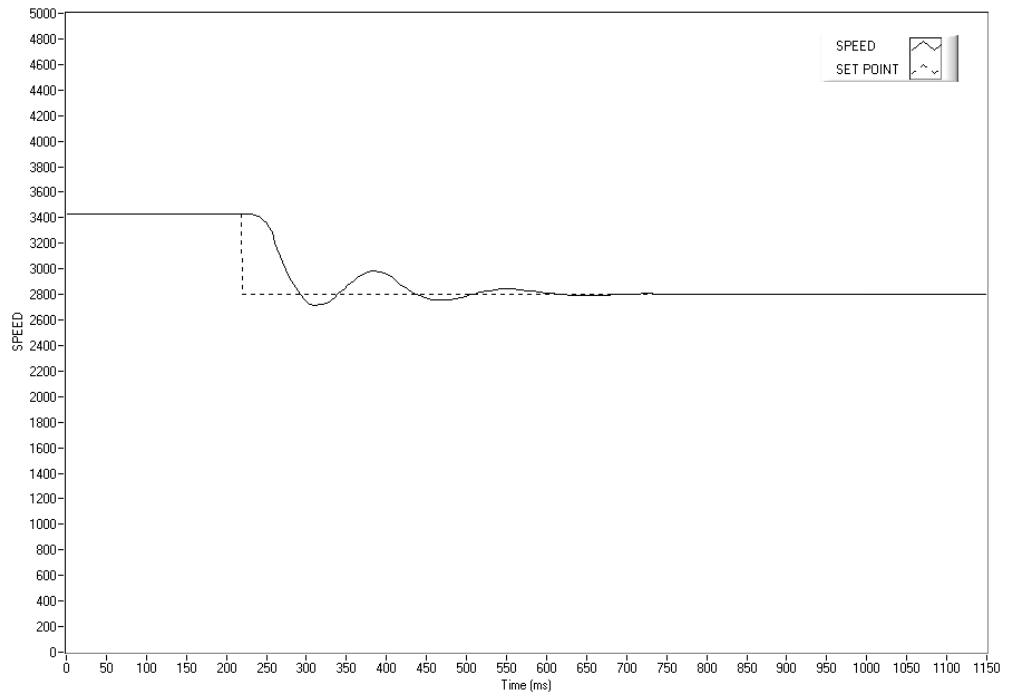


Fig.4-7 Initial I Setting for Speed Control

If there is too much overshoot, increase the D term in 1% increments and repeat #8.

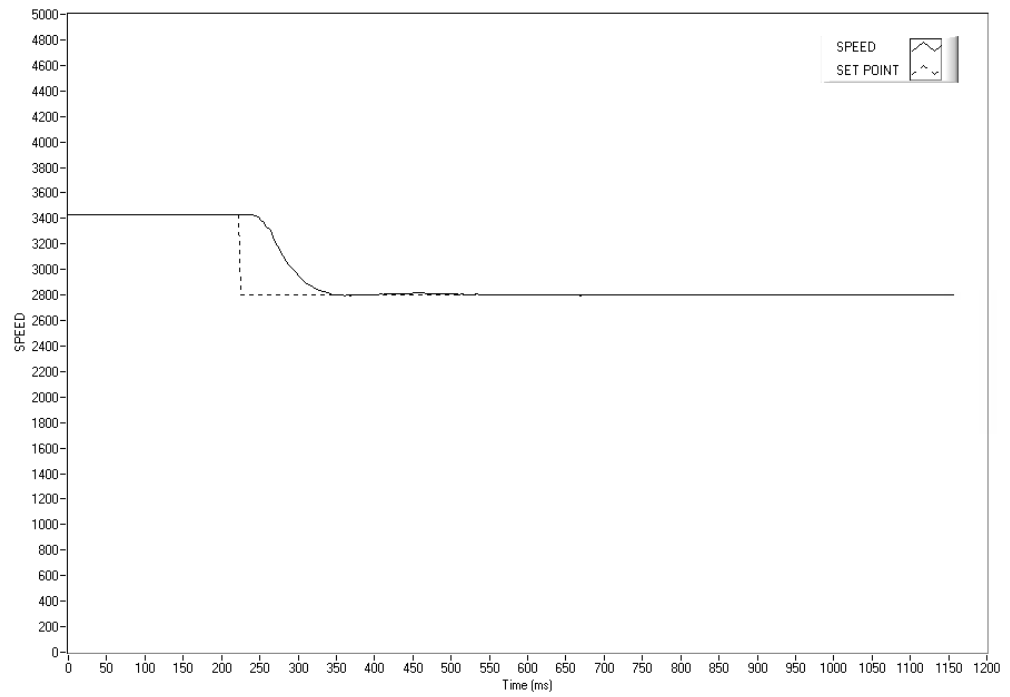


Fig.4-8 Initial D Setting for Speed Control

### 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.

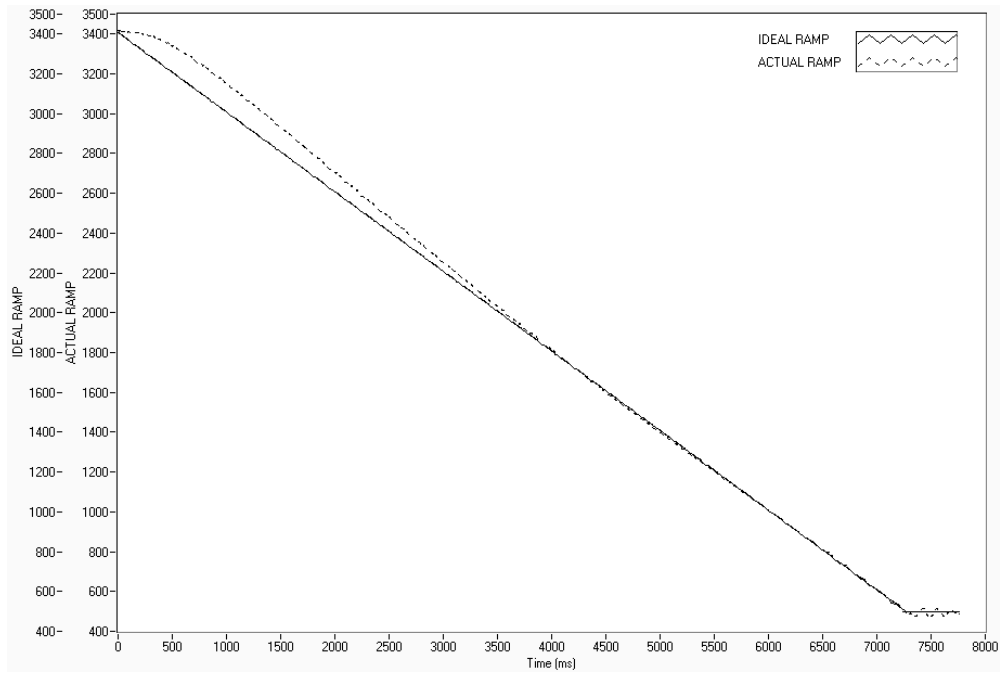


Fig.4-9 Ramp Down Low I

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

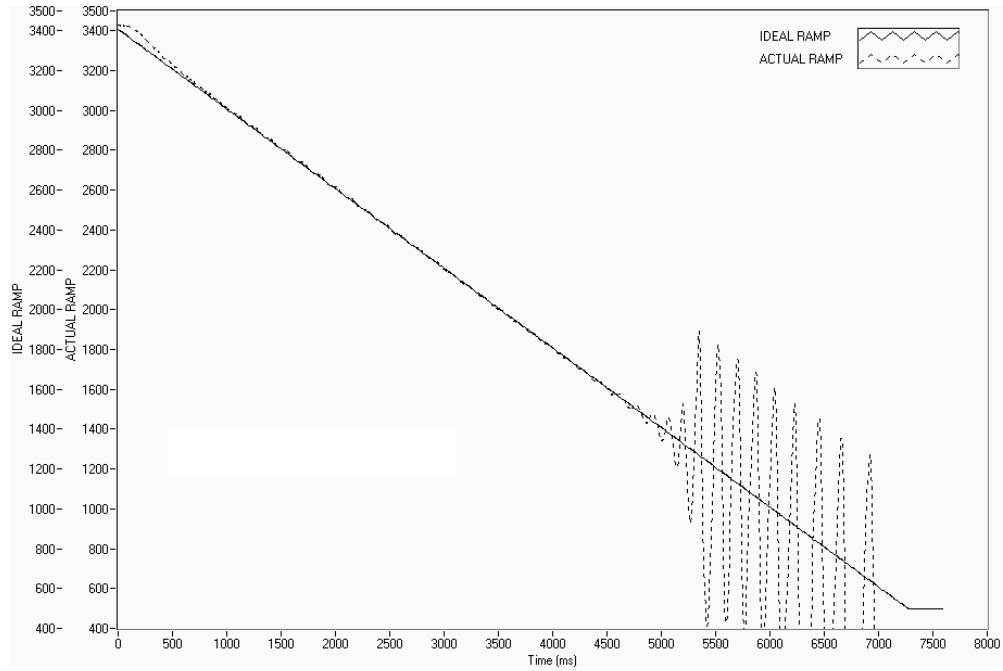


Fig.4-10 Ramp Down High I

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.

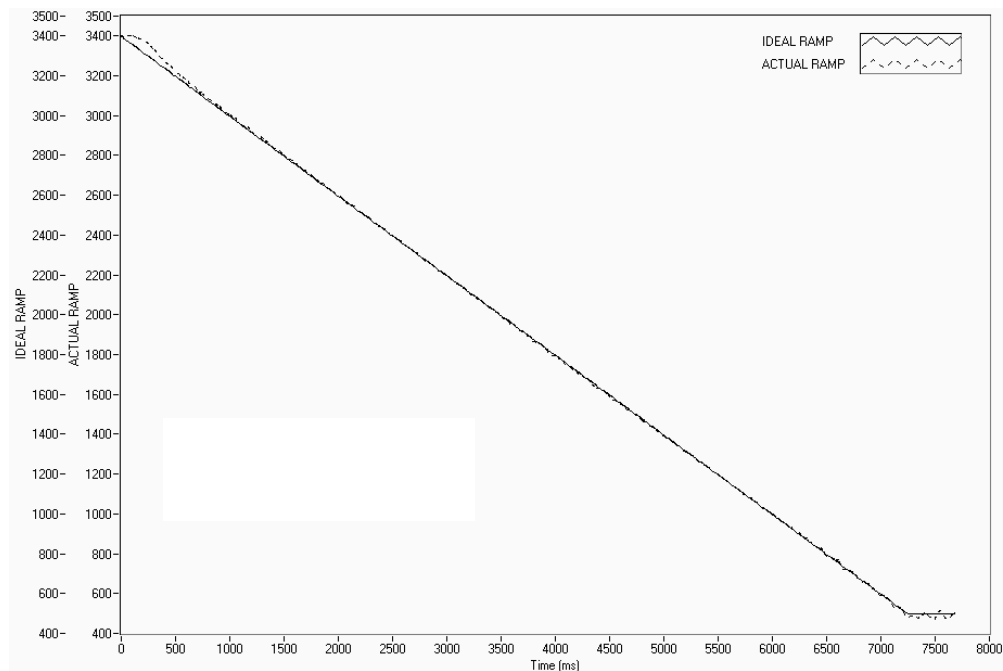


Fig.4-11 Ramp Down Dynamic I

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

The DSP7010 has a built-in alarm system, designed to alert 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 Power Supply. There are also power, speed, torque, air flow, water flow, and external input alarms, which can be enabled by the user. Instructions on how to set up and activate these alarms are included in this chapter.

#### 5.1.1 ALARM RELAY

One of the two relays on the IO 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

The relay has normally open and normally closed contacts. When not in an alarm state, the relay is energized as shown in *Figure 5-1*.

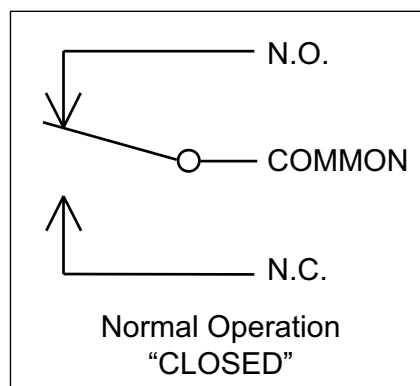


Fig.5-1 Normal Condition "Energized Relay"

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

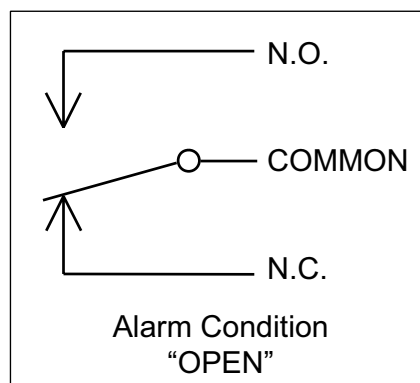


Fig.5-2 Alarm Condition "De-Energized Relay"

The relay contacts are made accessible on the IO connector. See Figure 2-10 I/O Interface.

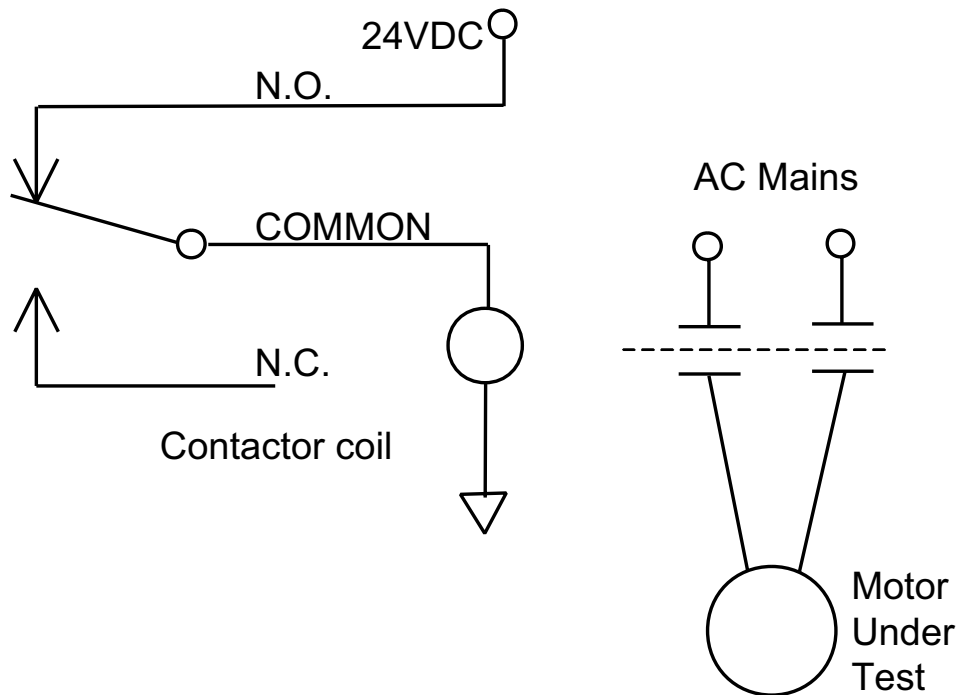


Fig.5-3 Typical Application

## 5.1.2 ALARM OPERATION

The DSP7010 gives the user the ability to enable or disable the alarms in the unit. Alarms are defaulted to OFF and must first be enabled by the user.

### 5.1.2.1 HOW TO ENABLE/DISABLE ALARMS

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

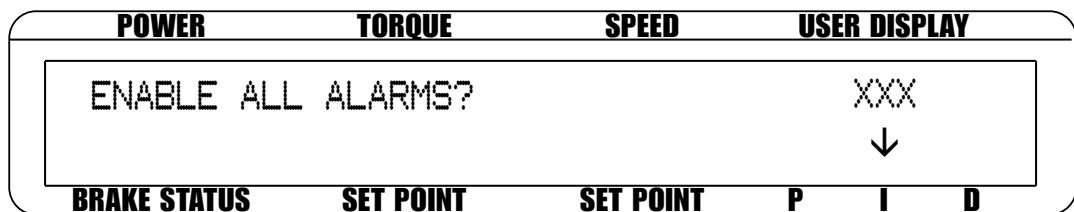


Fig.5-4 Alarm Enable/Disable Menu

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



#### NOTICE

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



### 5.1.3 ALARM PRIORITY

If two or more alarms are activated at once, the highest priority alarm will be displayed. The priority order is as follows.

PRIORITY	ALARM	AVAILABILITY HYSTERESIS DYNAMOMETER	AVAILABILITY EDDY-CURRENT/ POWDER BRAKE DYNAMOMETER
1	Temperature	N/A	✓
2	Electrical	N/A	✓
3	External	✓	✓
4	Air Flow	✓	N/A
5	Water Flow	N/A	✓
6	Clutch	N/A	✓ (Tandem)
7	Maximum Torque	✓	✓
8	Maximum Speed	✓	✓
9	Power	✓	✓

## 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].
3. Select DYNO.
4. Select MAXPOWER. The display should appear as follows:

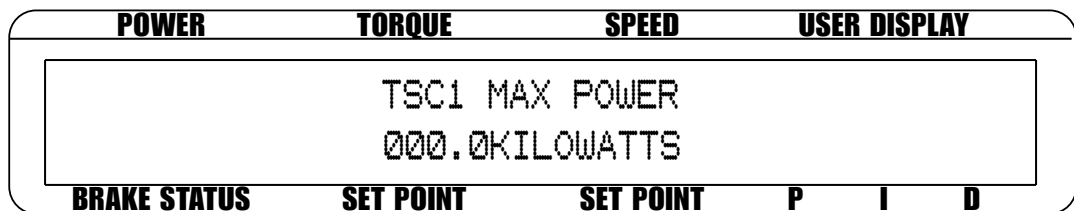


Fig.5-5 Max Power Menu

5. Press [TORQUE UNITS]. Use ◀ and ▶ and the 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] 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).

POWER	TORQUE	SPEED	USER DISPLAY		
-OL-	0.000 OZ.IN	0			
OFF		0000	0%	0%	0%
<b>BRAKE STATUS</b>	<b>SET POINT</b>	<b>SET POINT</b>	<b>P</b>	<b>I</b>	<b>D</b>

Fig.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.

POWER	TORQUE	SPEED	USER DISPLAY		
			*** POWER ALARM TSCX ***		
	TORQUE=XXX.XX XX		RPM=X XXXX		
<b>BRAKE STATUS</b>	<b>SET POINT</b>	<b>SET POINT</b>	<b>P</b>	<b>I</b>	<b>D</b>

Fig.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

- Starting from main menu, press [SHIFT].
- Press [SETUP] button.
- Select TANDEM.
- PRESS [SCALE] to select "YES" and then press [SHIFT].

POWER	TORQUE	SPEED	USER DISPLAY		
GLOBAL	POWER	TORQUE	ALARMS		
	XXX.XXXkW	XXX.XX Nm			
<b>BRAKE STATUS</b>	<b>SET POINT</b>	<b>SET POINT</b>	<b>P</b>	<b>I</b>	<b>D</b>

Fig.5-8 Global Power Alarm Setup



**NOTICE** Global power alarm is only enabled when operating in a WB/WB or PB/PB dyno tandem configuration.

5. Press [TORQUE UNITS]. Use ◀ and ▶ and the 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.

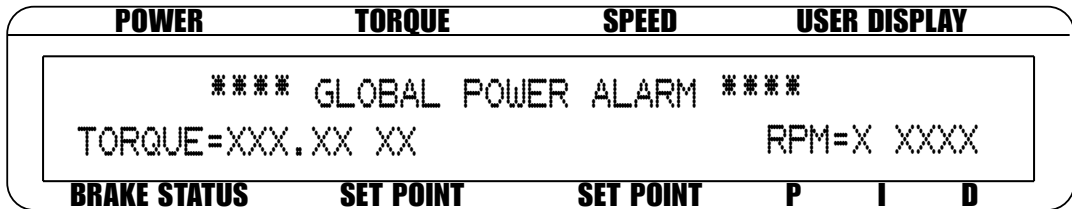


Fig.5-9 Global Power Alarm Display

### 5.3.3 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].
3. Select DYNO.
4. Select ENCODERS. The display should appear as follows:

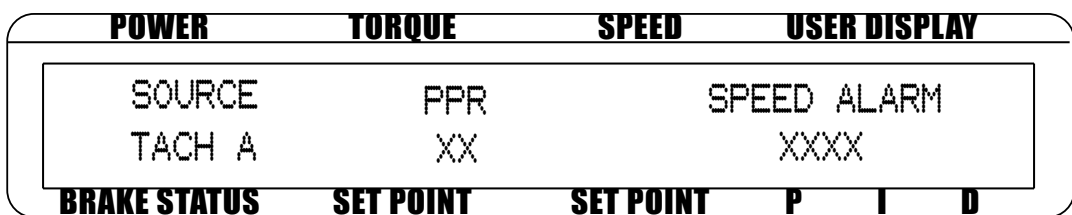


Fig.5-10 Speed Alarm Setup Menu

5. Press [SCALE P]. Use ◀ and ▶ and the 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).

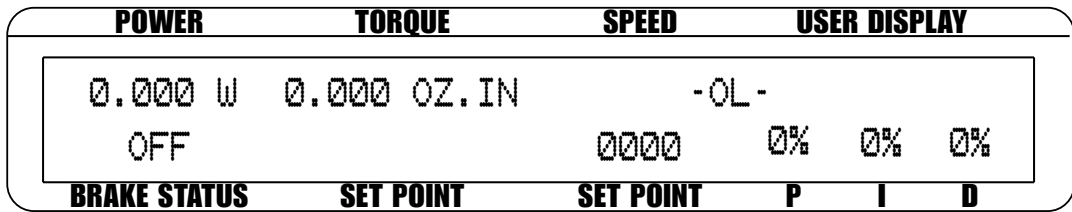


Fig.5-11 -OL-Speed Alarm Display

- 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.

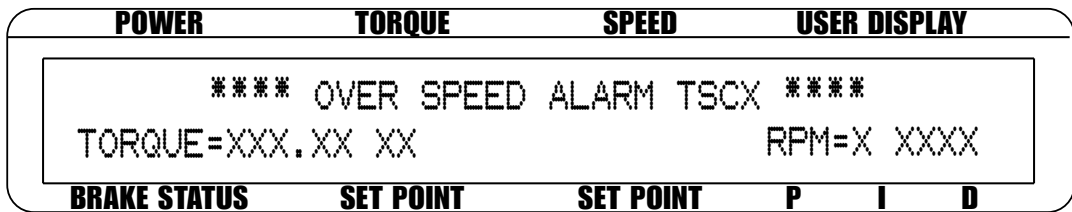


Fig.5-12 Over Speed Alarm Message Display

### 5.4.3 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

- Starting from main menu, press [SHIFT].
- Press [SETUP].
- Select DYNO.
- Select DYNAMOMETER.
- Press [SHIFT]. The display should appear as follows:

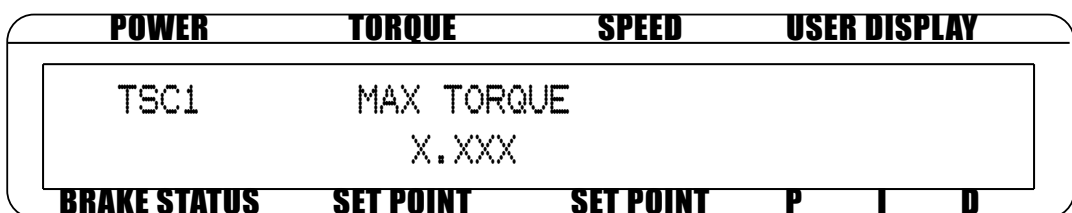


Fig.5-13 Torque alarm Setup Menu

6. Press [TORQUE UNITS]. Use ◀ and ▶ and the 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.

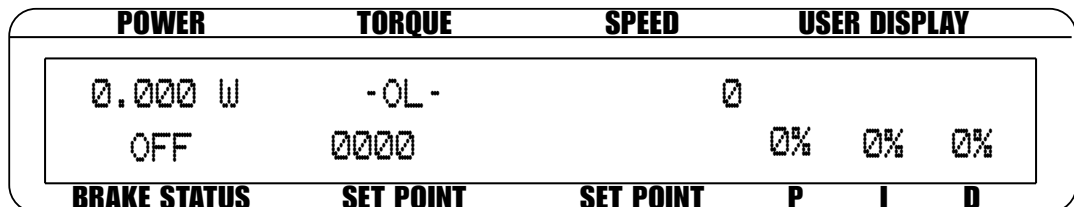


Fig.5-14 -OL-Torque Alarm Disply

- 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.

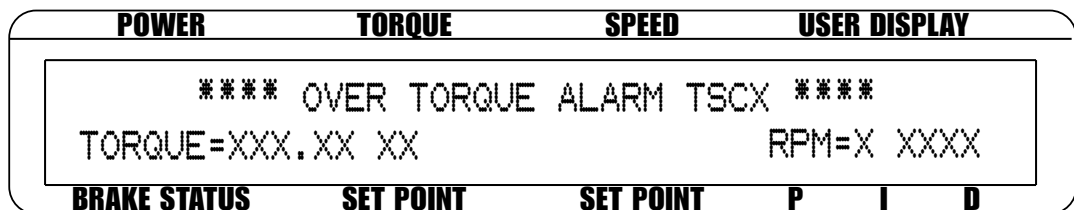


Fig.5-15 Over Torque Alarm Message Display

### 5.5.3 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].
3. Select TANDEM.
4. Press [SCALE I] to select "YES" and then press [SHIFT].

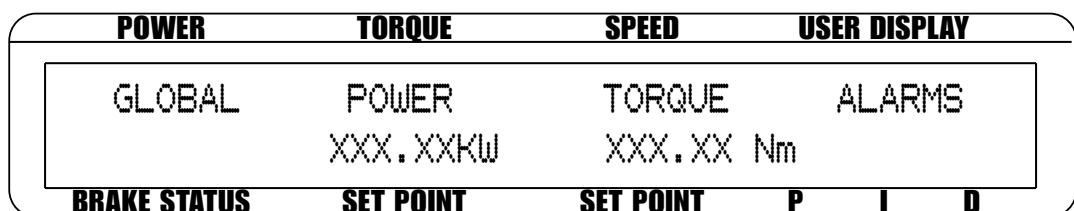


Fig.5-16 Global Torque Alarm Setup

**NOTICE**

Global torque alarm is only enabled when operating in a WB/WB or PB/PB dyno tandem configuration.

5. Press [MAX SPEED]. Use ◀ and ▶ and the 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 5-16) 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 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 to "OFF"

### 5.7.1 INSTRUCTIONS FOR AIR FLOW ALARM SETUP

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

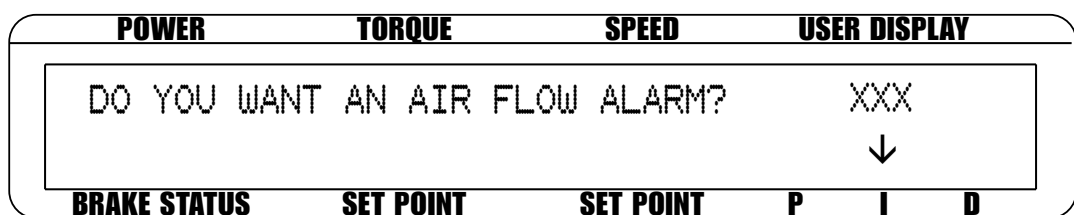


Fig.5-17 Air Flow Alarm Setup Display

### 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.

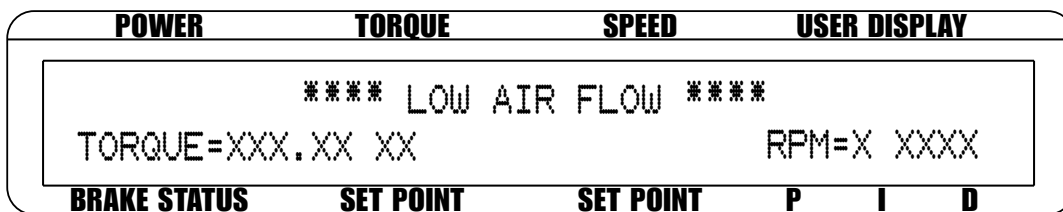


Fig.5-18 Air Flow Alarm Message Display

### 5.7.3 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 to "OFF"
- 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].
3. Select DYNO.
4. Select ALARMS.
5. Press [SHIFT]. The display should appear as follows:

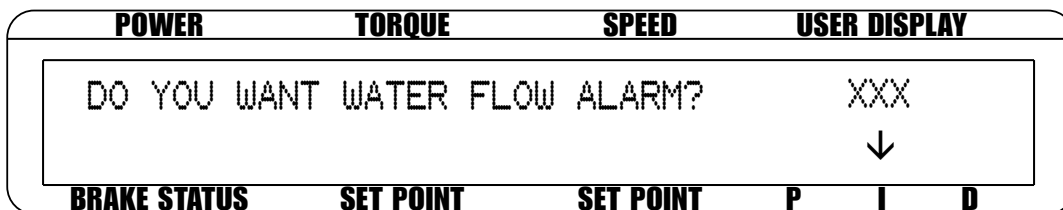


Fig.5-19 Water Flow Alarm Setup Display

6. Press [SCALE I] 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.

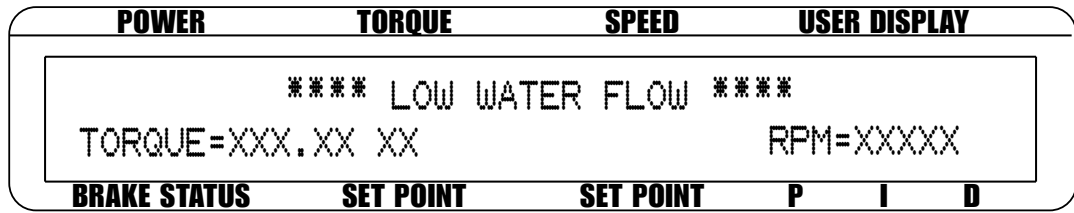


Fig.5-20 Water Flow Alarm Message Display

### 5.8.3 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

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

### 5.9.1 INSTRUCTIONS FOR EXTERNAL ALARM SETUP

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

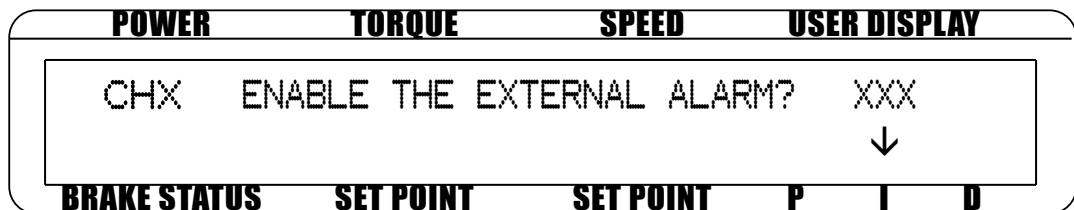


Fig.5-21 External Alarm Setup Display

5. Press [SCALE I] to select YES.
6. 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 not tied to 5 volts common, 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

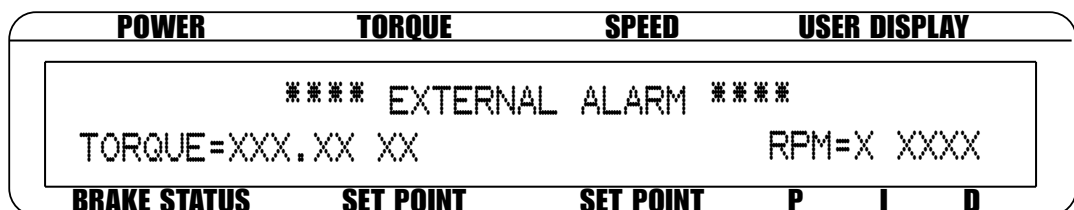


Fig.5-22 External Alarm Message Display



### 5.9.3 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

- Used to indicate a dynamometer’s thermal switch opening due to overheating
- 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.

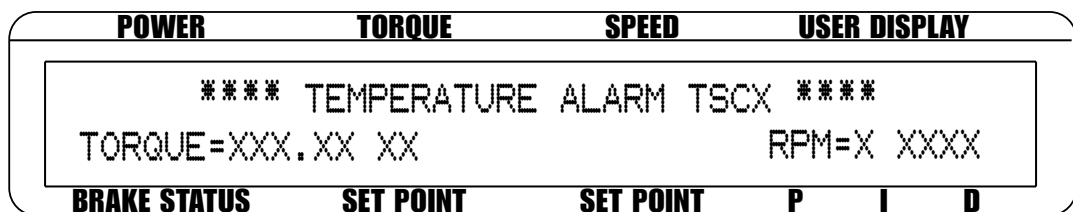


Fig.5-23 Temperature Alarm Message Display

### 5.10.3 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.

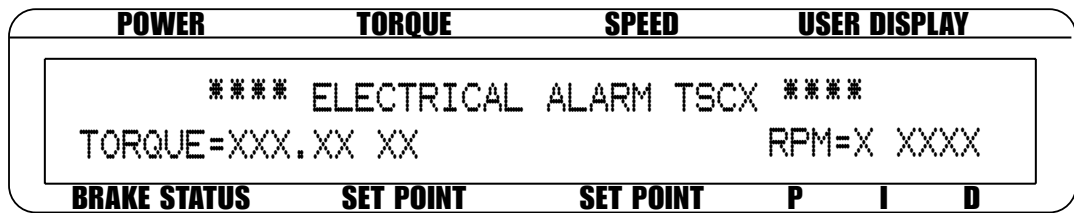


Fig.5-24 Electrical Alarm Message Display

### 5.11.3 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 TANDEM ONLY)

- Used to detect a good clutch closure
- Only available for use with WB / PB tandem dynamometers
- Default – not always active, user needs to set up

In a WB/PB tandem setup, the clutch feedback signal will be monitored. If enabled, the signal is checked and if the clutch is open when there is zero RPM the clutch control signal will be toggled two more times. If the clutch is still open then the system goes into alarm.

### 5.12.1 INSTRUCTIONS FOR CLUTCH ALARM SETUP

1. Starting from main menu, press [SHIFT].
2. Press [SETUP].
3. Select DYNO.
4. Select ALARM.
5. Press [SCALE I] to select YES.
6. Press [SHIFT] 5 times to complete Clutch Alarm setup and return to the main menu.

### 5.12.2 CLUTCH ALARM ACTION

When there is a clutch alarm, the display will flash “CLUTCH FAILURE” (as indicated in Figure 5-25).

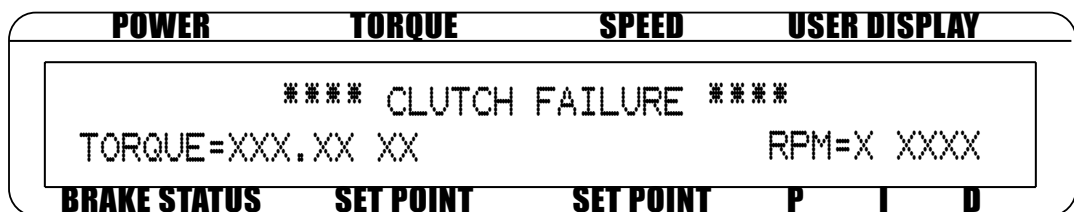


Fig.5-25 Clutch Alarm Message Display

### 5.12.3 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



**NOTICE** Each type of motor will have its own optimum PID setting at different load points.

## 6.1 HOW TO SET DESIRED POWER UNITS

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

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

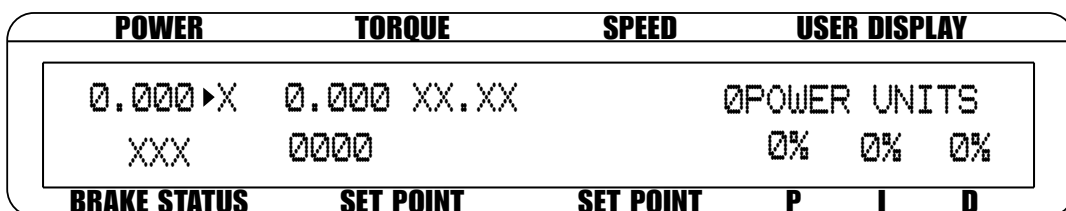


Fig.6-1 Power Units Menu

4. Use ◀ and ▶ 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]. The display should appear as follows:

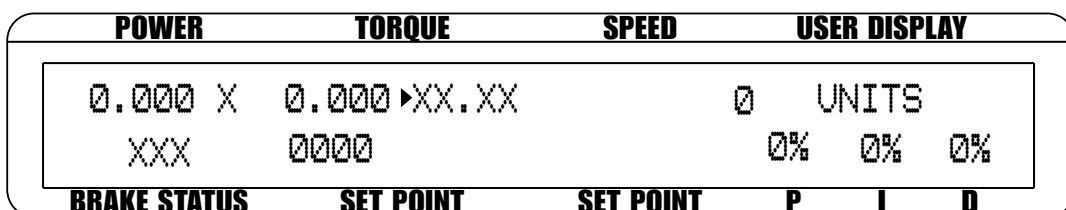


Fig.6-2 Torque Units Menu

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

### 6.3 HOW TO SET TORQUE CONTROL

1. Use [BRAKE ON/OFF] to turn the brake OFF.
2. Press [TORQUE SET]. The display should appear as follows:

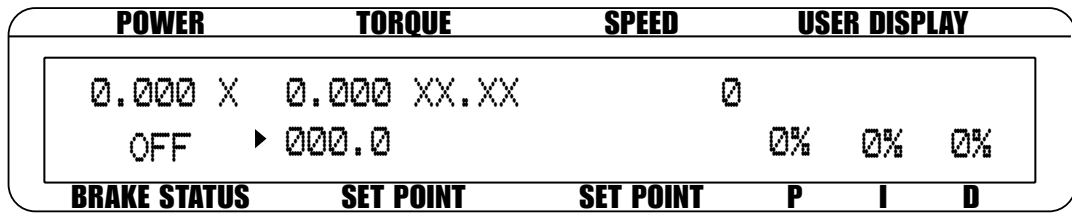


Fig.6-3 Torque Control Menu

3. Use ◀ and ▶ and the dial to adjust the set point to zero.



**NOTICE** PID values should be set at this time. See Section 4.3 – Setting the Correct PIDs for Your Motor.

4. Start the motor under test.
5. Use [BRAKE ON/OFF] to turn the brake ON.
6. Press [TORQUE SET] and adjust the set point to the desired load.
7. 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.



**NOTICE** 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.)



**WARNING** 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.

## 6.4 HOW TO SET SPEED CONTROL



**NOTICE**

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. Use [BRAKE ON/OFF] to turn the brake OFF.
2. Press [SHIFT].
3. Press [MAX SPEED]. The display should appear as follows:

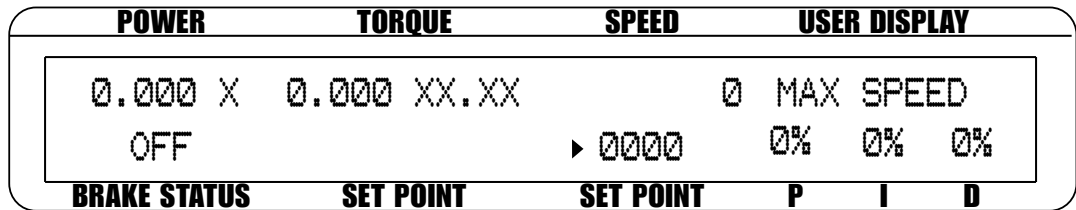


Fig.6-4 Max Speed Menu

4. Use ◀ and ▶ and the dial to set a value equal to or slightly greater than the free-run speed of the motor under test.
5. Press [SHIFT] to exit the MAX SPEED function.
6. Press [SPEED SET].
7. Use ◀ and ▶ and the dial to set a speed equal to the max speed.



**NOTICE**

PID values should be set at this time. See Section 4.3 – Setting the Correct PIDs for Your Motor.

8. Start the motor under test.
9. Use [BRAKE ON/OFF] to turn the brake ON.
10. Press [SPEED SET] to 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.



**NOTICE**

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. Use [BRAKE ON/OFF] to turn the brake OFF.
2. Press [OPEN LOOP]. The open loop control menu should appear. See *Figure 4-1 Open Loop Control Menu*.
3. Use ◀ and ▶ and the dial to set a value of current equal to the percent of full-scale output.
4. 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*.)
5. Use [BRAKE ON/OFF] 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.)
6. Start the motor under test.
7. To exit the Open Loop Control mode and return to the main menu, use [BRAKE ON/OFF] to turn the brake OFF and press [OPEN LOOP].

### 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. Use [BRAKE ON/OFF] to turn the brake OFF.
2. Press [OPEN LOOP]. The open loop control menu should appear. See *Figure 4-1 Open Loop Control Menu*.
3. Use ◀ and ▶ and the dial to set the preload value of current equal to the percent of full-scale output.
4. Enable or disable PRELOAD function by pressing [SCALE D].
5. If the preload function is enabled, "\*" indicator will be displayed as shown in *Figure 6-5 Preload function enabled*.

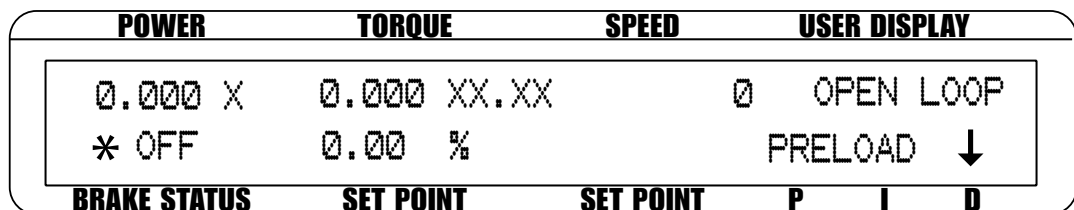


Fig.6-5 Preload Function Enabled

6. After the preload function has been enabled, and the preload value has been set, the set point of the open loop will be initialized to 0.00 % and preload settings is saved to non-volatile memory.
7. If [SCALE D] 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].
2. Press [TARE].
3. "\*" indicator will be displayed as in *Figure 6-6 Tare function enabled*.

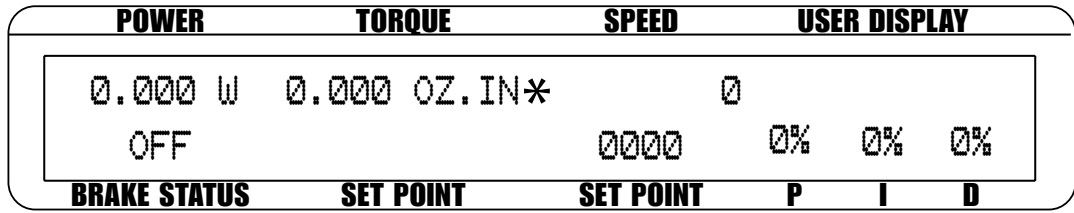


Fig.6-6 Tare Function Enabled



**NOTICE**

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].
2. Press [RESET TARE].
3. "\*" indicator will disappear.

## 6.8 HOW TO SET THE TM/TS/TF INVERT FLAG

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

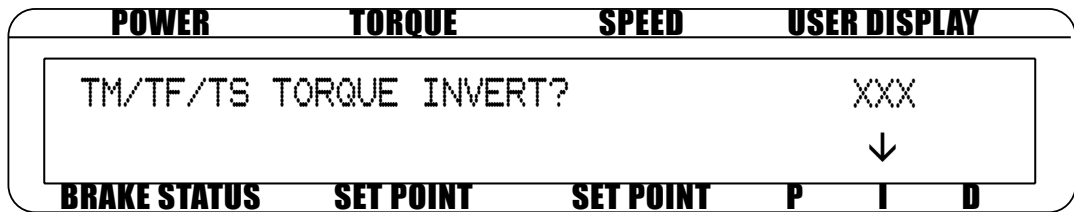


Fig.6-7 Torque Invert Flag Screen

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





## 7. COMPUTER CONTROLLED OPERATION

The DSP7010 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 DSP7010 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 DSP7010. The USB driver must be installed for the DSP7010 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/](http://www.magtrol.com/software-downloads/). Scroll down to DSP7010 USB Drivers.

1. Choose either the 32-bit or 64-bit version depending on your operating system.
2. You will be asked for some basic information about yourself. Complete the fields and press continue.
3. On the next screen press download.
4. Save the file when asked.
5. A self-installing MSI file will be located in your downloads folder by default.
6. Double-click DSP7010.drivers.x64.msi for 64-bit operating systems 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 DSP7010 to the computer.
9. Checking device manager, you should now see the DSP7010 showing as a COM port.

### 7.2 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 still used in many applications.
- 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.

**NOTICE**

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 DSP7010. A USB to GPIB option is also available. Magtrol recommends National Instruments Corporation hardware and software.

**NOTICE**

Make sure that the DSP7010 and its host computer are communicating before acquiring data.

1. Make sure the primary GPIB address is set correctly for the DSP7010 (default is address 9).
2. Set the input variable to 16 characters (14 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.

**NOTICE**

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

## 7.2.1 INSTALLING THE GPIB CONNECTOR CABLE

**WARNING**

**MAKE SURE BOTH THE COMPUTER AND DSP7010 ARE TURNED OFF BEFORE INSTALLING THE GPIB CONNECTOR CABLE.**

1. Connect one end of a high-quality, double-shielded cable to the DSP7010 GPIB port.
2. Connect the other end to the GPIB port in your PC

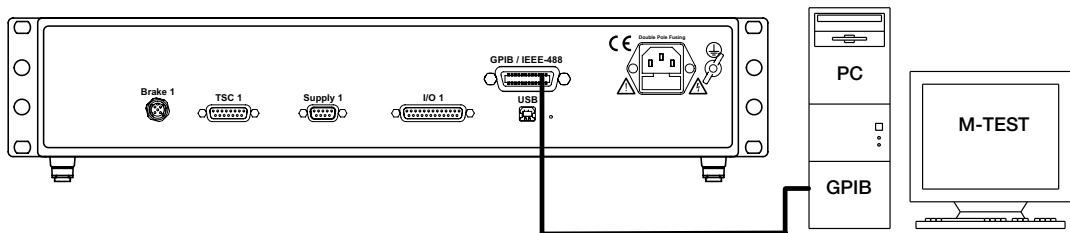


Fig.7-8 GPIB Installation

## 7.2.2 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 DSP7010 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 DSP7010 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:

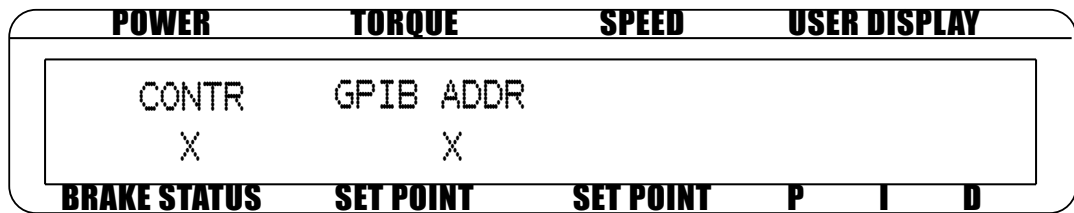


Fig.7-9 Setup Menu Display

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.

## 7.3 DATA FORMAT

### 7.3.1 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:

SddddddTddd.R(cr)(lf)

Or

SddddddTddd.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).

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.)



**NOTICE**

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



**NOTICE**

The (cr) and (lf) characters may not display depending on your setup.

**EXAMPLE**

If a motor is running at 1725 RPM clockwise, with the dynamometer loading the motor to 22.6 oz.in., the DSP7010 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.

## 7.4 PROGRAMMING

### 7.4.1 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 DSP7010 uses the GPIB standard termination characters Carriage Return (CR) and Line Feed (LF). Provide them in that order.

#### 7.4.1.1 CODES FOR CR - LF

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

### 7.4.2 TIMEOUT

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



#### NOTICE

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

## 7.5 DSP7010 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.



#### NOTICE

If a command is not recognized the return string will read "COMAND ERROR"

### 7.5.1 ALARM COMMANDS

COMMAND	FUNCTION	EXPLANATION
ALA#,X	<b>Air Flow Alarm</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Disable 1 = Enable	Enable or disable the air flow alarm for the selected channel
ALC,#	<b>Clutch Alarm</b> 0 = Disable 1 = Enable	Enable or disable the clutch alarm <b>NOTE: Intended for use with WB/PB tandem configurations only</b>
ALE#,X	<b>External Alarm</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Disable 1 = Enable	Enable or disable the external alarm for the selected channel
ALL#,X	<b>System Alarm</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Disable 1 = Enable	Enable or disable all alarms for the selected channel
ALP#,X	<b>Power Alarm</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the maximum power for the power alarm in kW (default 1kW) for the selected channel Range: 0.0 to 99,999.0
ALS#,X	<b>Speed Alarm</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the maximum speed for the speed alarm in RPM (default 4000 RPM) for the selected channel Range: 0.0 to 199,999.0
ALT#,X	<b>Torque Alarm</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the maximum torque for the torque alarm in user-selected units (default 1 unit) for the selected channel Range: 0.0 to 10,000.0
ALW#,X	<b>Water Flow Alarm</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Disable 1 = Enable	Enable or disable the water flow alarm for the selected channel
ALR#,X	<b>Alarm Relay</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Disable 1 = Enable	Enable or disable the alarm relay function for the selected channel
CLR	<b>Clear</b>	Clear alarm status for all alarms on all channels <b>NOTE: Equivalent to clearing the alarm using the front panel</b>
GP,X	<b>Global Power</b> X = float	Set the maximum global power in kilowatts, enabling the global power alarm Range: 0.0 to 99,999.0 <b>NOTE: For WB/WB &amp; PB/PB tandem configurations</b>
GT,X	<b>Global Torque</b> X = float	Set the maximum global torque in N·m, enabling the global torque alarm Range: 0.0 to 99,999.0 <b>NOTE: For WB/WB &amp; PB/PB tandem configurations</b>

### 7.5.2 COMMUNICATION COMMANDS

COMMAND	FUNCTION	EXPLANATION
*IDN?	<b>Device Information</b>	Read the device model, firmware revision, and FPGA revision
OB#	<b>Output Binary</b> # = [Null   1]	Read the values specified by the COB command Null = send all packets of data 1 = send only the last packet of data
OD#	<b>Output Data</b> #: 1 = Channel 1 2 = Channel 2	Read Speed, Torque, and Direction data from the selected channel SxxxxxTxxxxxD D: L = left; counter-clockwise (CCW) R = right; clockwise (CW) A = alarm condition
OP#	<b>Output Position</b> #: 1 = Channel 1 2 = Channel 2	Read the raw quadrature position counter value for the selected channel, which is used to calculate the angle position
OR#	<b>Output RPM</b> #: 1 = Channel 1 2 = Channel 2	Read Speed (Display RPM), Torque, and Direction data from the selected channel. This is an alternate to the OD command
SP#	<b>Set Point</b> #: 1 = Channel 1 2 = Channel 2	If in Torque Control Mode, read the Torque Set Point and current Torque value for the selected channel. If in Speed Control Mode, read the Speed Set Point and the current Speed value for the selected channel.
STAT#	<b>Status</b> # = [Null   1]	STAT returns status bits in binary STAT1 returns ASCII status bits 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

### 7.5.3 RAMP COMMANDS

COMMAND	FUNCTION	EXPLANATION
DPL#,X	<b>Dynamic Scale – P Coefficient</b> #: 1 = Channel 1 2 = Channel 2 X = float	Sets the coefficient to multiply the Proportional gain factor, P, and enables dynamic scaling
DIL#,X	<b>Dynamic Scale – I Coefficient</b> #: 1 = Channel 1 2 = Channel 2 X = float	Sets the coefficient to multiply the Integral gain factor, I
DS#,X	<b>Dynamic Scale</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Disable 1 = Enable	Enable or disable dynamic scaling for the selected channel
PD#,0,X	<b>Program Down</b> #: 1 = Channel 1 2 = Channel 2 X = float	Perform a linear RPM ramp down to the RPM set with the S# command on the selected channel, starting from the current RPM, at a rate of X, in RPM/s
PU#,0,X	<b>Program Up</b> #: 1 = Channel 1 2 = Channel 2 X = float	Perform a linear RPM ramp up to free-run on the selected channel, starting from the RPM set with the S# command, at a rate of X, in RPM/s
PDU#,0,X	<b>Program Down Up</b> #: 1 = Channel 1 2 = Channel 2 X = float	Perform a linear RPM ramp down to the RPM set with the S# command on the selected channel, starting from the current RPM, followed by a ramp up to free-run, at a rate of X, in RPM/s
PR#	<b>Program Reset</b> #: 1 = Channel 1 2 = Channel 2	Reset the ramp function on the selected channel, halting it if in progress. Set the speed set point to the maximum speed setting and turn the brake OFF
S#,X	<b>Set Ramp</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the start or stop speed, in RPM, for the ramp functions (PD, PDU, PU) Range: 0.0 to 199,999.0

### 7.5.4 SETUP COMMANDS

COMMAND	FUNCTION	EXPLANATION																																																																																										
COB,0,1[,#]	<b>Configure Output Binary</b> # = Optional list of desired data Ex: COB,0,1,14,15,16,17	Configures the DSP7010 to package the desired data																																																																																										
		<table border="1"> <thead> <tr> <th>#</th> <th>DATA DESCRIPTION</th> <th>DATA TYPE</th> </tr> </thead> <tbody> <tr><td>0</td><td>Time Stamp - High (Upper 32 bits)</td><td>Integer</td></tr> <tr><td>1</td><td>Time Stamp - Low (Lower 32 bits)</td><td>Integer</td></tr> <tr><td>2</td><td>Channel 1 - Speed (Average DeltaT)</td><td>Float</td></tr> <tr><td>3</td><td>Channel 1 - Torque</td><td>Float</td></tr> <tr><td>4</td><td>Channel 1 - Set Speed</td><td>Float</td></tr> <tr><td>5</td><td>Channel 1 - Set Torque</td><td>Float</td></tr> <tr><td>6</td><td>Channel 2 - Speed (Average DeltaT)</td><td>Float</td></tr> <tr><td>7</td><td>Channel 2 - Torque</td><td>Float</td></tr> <tr><td>8</td><td>Channel 2 - Set Speed</td><td>Float</td></tr> <tr><td>9</td><td>Channel 2 - Set Torque</td><td>Float</td></tr> <tr><td>10</td><td>IO Card 1 Analog Input 1</td><td>Float</td></tr> <tr><td>11</td><td>IO Card 1 Analog Input 2</td><td>Float</td></tr> <tr><td>12</td><td>IO Card 2 Analog Input 1</td><td>Float</td></tr> <tr><td>13</td><td>IO Card 2 Analog Input 2</td><td>Float</td></tr> <tr><td>14</td><td>Undefined</td><td>None</td></tr> <tr><td>15</td><td>Undefined</td><td>None</td></tr> <tr><td>16</td><td>Undefined</td><td>None</td></tr> <tr><td>17</td><td>Undefined</td><td>None</td></tr> <tr><td>18</td><td>Channel 1 - Select Digital Inputs DPA DPB Electrical Alarm Water Alarm Temperature Alarm Air Flow Alarm External Alarm Digital Input 1 Digital Input 2</td><td>Bit-field Integer</td></tr> <tr><td>19</td><td>Channel 2 - Select Digital Inputs DPA DPB Electrical Alarm Water Alarm Temperature Alarm Air Flow Alarm External Alarm Digital Input 1 Digital Input 2</td><td>Bit-field Integer</td></tr> <tr><td>20</td><td>Channel 1 - Filter Output</td><td>Float</td></tr> <tr><td>21</td><td>Channel 2 - Filter Output</td><td>Float</td></tr> <tr><td>22</td><td>Channel 1 - Quadrature Position</td><td>Integer</td></tr> <tr><td>23</td><td>Channel 1 - Quadrature Time Stamp</td><td>Integer</td></tr> <tr><td>24</td><td>Channel 2 - Quadrature Position</td><td>Integer</td></tr> <tr><td>25</td><td>Channel 2 - Quadrature Time Stamp</td><td>Integer</td></tr> <tr><td>26</td><td>Channel 1 - Display Speed</td><td>Float</td></tr> <tr><td>27</td><td>Channel 2 - Display Speed</td><td>Float</td></tr> <tr><td>28-35</td><td>Undefined</td><td>None</td></tr> </tbody> </table>	#	DATA DESCRIPTION	DATA TYPE	0	Time Stamp - High (Upper 32 bits)	Integer	1	Time Stamp - Low (Lower 32 bits)	Integer	2	Channel 1 - Speed (Average DeltaT)	Float	3	Channel 1 - Torque	Float	4	Channel 1 - Set Speed	Float	5	Channel 1 - Set Torque	Float	6	Channel 2 - Speed (Average DeltaT)	Float	7	Channel 2 - Torque	Float	8	Channel 2 - Set Speed	Float	9	Channel 2 - Set Torque	Float	10	IO Card 1 Analog Input 1	Float	11	IO Card 1 Analog Input 2	Float	12	IO Card 2 Analog Input 1	Float	13	IO Card 2 Analog Input 2	Float	14	Undefined	None	15	Undefined	None	16	Undefined	None	17	Undefined	None	18	Channel 1 - Select Digital Inputs DPA DPB Electrical Alarm Water Alarm Temperature Alarm Air Flow Alarm External Alarm Digital Input 1 Digital Input 2	Bit-field Integer	19	Channel 2 - Select Digital Inputs DPA DPB Electrical Alarm Water Alarm Temperature Alarm Air Flow Alarm External Alarm Digital Input 1 Digital Input 2	Bit-field Integer	20	Channel 1 - Filter Output	Float	21	Channel 2 - Filter Output	Float	22	Channel 1 - Quadrature Position	Integer	23	Channel 1 - Quadrature Time Stamp	Integer	24	Channel 2 - Quadrature Position	Integer	25	Channel 2 - Quadrature Time Stamp	Integer	26	Channel 1 - Display Speed	Float	27	Channel 2 - Display Speed	Float	28-35	Undefined	None
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COMMAND	FUNCTION	EXPLANATION
AF#,X	<b>Digital Filter</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = None 1 = 2 Hz 2 = 5 Hz 3 = 10 Hz 4 = 20 Hz 5 = 50 Hz 6 = 100 Hz	Set the digital filter of the selected channel's torque input to the specified frequency
BT#,X	<b>Brake Type</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = HD 1 = WB 2 = PB	Set the brake type for the selected channel
DIN#,X	<b>Dynamometer Input</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = HD 1 = WB 2 = PB 3 = TM/TS/TF 4 = HD-5	Specify the instrument connected to the selected channel
M#	<b>Front Panel Control</b> 0 = Disable 1 = Enable	Enable or disable the front panel controls <b>NOTE: The BRAKE ON/OFF key will always function</b>
NS#,X	<b>Nominal Speed</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set nominal speed for WB dynamometer on selected channel Range: 0.0 to 100,000
R#	<b>Reset</b> #: 1 = Channel 1 2 = Channel 2	Reset the selected channel to the power-on defaults, cancel any previous commands, turn the brake OFF, and turn manual control ON
SFT,#	<b>Set Flag Tandem</b> #: 0 = Disable 1 = Enable	Enable or disable the tandem function "indicate that we want to treat as a tandem"
TMV#,X	<b>TM Invert</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Normal 1 = Invert	Invert the TM/TS/TF torque reading
TSC,#	<b>Torque Speed Conditioner</b> #: 1 = Channel 1 2 = Channel 2 3 = Both	Display Torque Speed Conditioner information for selected channel on the front panel
TSF#,X	<b>Torque Scale Factor</b> #: 1 = Channel 1 2 = Channel 2 X = float (0.0 to 99,999.0)	Set the scale factor, X, for the Torque Speed Conditioner of the selected channel
UI#,X	<b>Input Units</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = oz-in [default] 1 = oz-ft 2 = lb-in 3 = lb-ft 4 = g-cm 5 = kg-cm 6 = mN-m 7 = cN-m 8 = N-m	Specify the units of the torque signal coming from the dynamometer attached to the selected channel. For the correct torque calculations to be displayed in HP or Watts, the correct units must be specified

COMMAND	FUNCTION	EXPLANATION
UR#,X	<b>Readout Units</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = oz·in [default] 1 = oz·ft 2 = lb·in 3 = lb·ft 4 = g·cm 5 = kg·cm 6 = mN·m 7 = cN·m 8 = N·m	Sets the units to display the torque signal for the specified channel
UE#,X	<b>Encoder Units</b> #: 1 = Channel 1 2 = Channel 2 X = Integer	Specify the pulses-per-revolution (PPR) rating, X, of the rotary encoder in the dynamometer attached to the selected channel

### 7.5.5 SPEED COMMANDS

COMMAND	FUNCTION	EXPLANATION
CO,X	<b>Clutch Operation</b> X = float	Set the maximum excited speed of a PB dynamometer operating in tandem with a WB dynamometer. The clutch will open at the specified speed in RPM
F#,X	<b>Max Speed</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the maximum speed, X, for the selected channel in RPM. Use this command before using the Speed Mode or Ramp Function
N#[,X]	<b>Speed Settings</b> #: 1 = Channel 1 2 = Channel 2 X = Optional float	Reset speed set point to maximum speed, set speed mode OFF, and set brake OFF for the selected channel. Optionally, set the speed point to the specified value, X, and set the brake ON in order to load the Motor Under Test to a specific speed value
NPS#,X	<b>Speed Proportional Scale</b> #: 1 = Channel 1 2 = Channel 2 X = [A B C D E F G H I]	Set the coarse gain factor for the proportional gain coefficient of the PID control loop
NIS#,X	<b>Speed Integral Scale</b> #: 1 = Channel 1 2 = Channel 2 X = [A B C D E F G H I]	Set the coarse gain factor for the integral gain coefficient of the PID control loop
NDS#,X	<b>Speed Derivative Scale</b> #: 1 = Channel 1 2 = Channel 2 X = [A B C D E F G H I]	Set the coarse gain factor for the derivative gain coefficient of the PID control loop
NP#,X	<b>Speed Proportional</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the fine gain factor for the proportional gain coefficient of the PID control loop Range: 0.0 to 99.0
NI#,X	<b>Speed Integral</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the fine gain factor for the integral gain coefficient of the PID control loop Range: 0.0 to 99.0
ND#,X	<b>Speed Derivative</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the fine gain factor for the derivative gain coefficient of the PID control loop Range: 0.0 to 99.0

### 7.5.6 TORQUE COMMANDS

COMMAND	FUNCTION	EXPLANATION
Q#[,X]	<b>Torque Settings</b> #: 1 = Channel 1 2 = Channel 2 X = Optional float	Reset torque set point to 0.0, set torque mode OFF, and set brake OFF for the selected channel. Optionally, set the torque set point to the specified value, X, and set the brake ON
QPS#,X	<b>Torque Proportional Scale</b> #: 1 = Channel 1 2 = Channel 2 X = [A B C D E F G H I]	Set the coarse gain factor for the proportional gain coefficient of the PID control loop
QIS#,X	<b>Torque Integral Scale</b> #: 1 = Channel 1 2 = Channel 2 X = [A B C D E F G H I]	Set the coarse gain factor for the integral gain coefficient of the PID control loop
QDS#,X	<b>Torque Derivative Scale</b> #: 1 = Channel 1 2 = Channel 2 X = [A B C D E F G H I]	Set the coarse gain factor for the derivative gain coefficient of the PID control loop
QP#,X	<b>Torque Proportional</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the fine gain factor for the proportional gain coefficient of the PID control loop Range: 0.0 to 99.0
QI#,X	<b>Torque Integral</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the fine gain factor for the integral gain coefficient of the PID control loop Range: 0.0 to 99.0
QD#,X	<b>Torque Derivative</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set the fine gain factor for the derivative gain coefficient of the PID control loop Range: 0.0 to 99.0
TS#	<b>Tare Set</b> #: 1 = Channel 1 2 = Channel 2	Tare the torque on the selected channel, removing any offset, up to 10% of the full scale
TR#	<b>Tare Reset</b> #: 1 = Channel 1 2 = Channel 2	Reset the torque offset tare on the selected channel

### 7.5.7 MISCELLANEOUS COMMANDS

COMMAND	FUNCTION	EXPLANATION
FRZ#,X	<b>Freeze</b> #: 1 = Channel 1 2 = Channel 2 X: 0 = Unpaused 1 = Paused	Pause the PID loop from responding to changes in the torque or speed of the Motor Under Test
I#[,X]	<b>Output Current</b> #: 1 = Channel 1 2 = Channel 2 X = Optional float	Reset the open loop set point for the selected channel. Optionally, if a value is specified, set the open loop percentage where 99.99% = 1A Range: 0.0 to 99.99
IO#,X	<b>Offset Current</b> #: 1 = Channel 1 2 = Channel 2 X = float	Set an offset of the brake current output of the selected channel by the specified percentage where 99.99% = 1A Range: 0.0 to 99.99 <b>NOTE: Sums the % to the output of the DAC</b>
QR#	<b>Quadrature Reset</b> #: 1 = Channel 1 2 = Channel 2	Reset the quadrature position counter of the selected channel to 0
RT	<b>Reset Timer</b>	Reset the internal timer to 0 <b>NOTE: Timer used for OB command</b>

COMMAND	FUNCTION	EXPLANATION
SAVE[,#]	<b>Save Settings</b> #: 0 = Channel 1 1 = Channel 2 2 = IO 1 3 = IO 2	Saves the present settings configuration of optionally specified channel to non-volatile memory. SAVE (alone) Will save channel 1 and channel 1 IO If channel 2 is attached Will save channel 2 and channel 2 IO
SERIAL?	<b>Serial</b>	Read the serial number of the unit

### 7.5.8 IO COMMANDS

COMMAND	FUNCTION	EXPLANATION
AF#&,X	<b>Digital Filter</b> #: 1 = Channel 1 2 = Channel 2 &: 1 = Analog Input 1 2 = Analog Input 2 X: 0 = None 1 = 2 Hz 2 = 5 Hz 3 = 10 Hz 4 = 20 Hz 5 = 50 Hz 6 = 100 Hz	Set the digital filter of the selected channel's analog input to the specified frequency
CD#	<b>Coast Down</b> #: 1 = Channel 1 2 = Channel 2	Prime the selected channel for a coast down test, initiated with the IOxDO command
IO#AI,X	<b>IO Analog Input</b> #: 1 = Channel 1 2 = Channel 2 X: 1 = Analog Input 1 2 = Analog Input 2	Reads the specified analog input as a voltage ranging from ±10V from the selected channel
IO#AO,&,X	<b>IO Analog Output</b> #: 1 = Channel 1 2 = Channel 2 &: 1 = Analog Output 1 2 = Analog Output 2 X = float	Set the output voltage of the specified analog output to ±10.000V on the selected channel <b>NOTE: Analog outputs are only available when not assigned to Speed &amp; Torque</b>
IO#DI,&	<b>IO Digital Input</b> #: 1 = Channel 1 2 = Channel 2 &: 1 = Digital Input 1 2 = Digital Input 2	Read the specified digital input from the selected channel
IO#DO,&,X	<b>IO Digital Output</b> #: 1 = Channel 1 2 = Channel 2 &: 1 = Digital Output 1 2 = Digital Output 2 X: 0 = Reset 1 = Set	Set or reset the specified digital output on the selected channel <b>NOTE: Output is NPN open-collector</b>
IO#RL,&,X	<b>IO Relay</b> #: 1 = Channel 1 2 = Channel 2 &: 1 = Relay 1 2 = Relay 2 X: 0 = Reset 1 = Set	Set or reset the specified relay on the selected channel <b>NOTE: Relay 1 is not available when assigned the alarm output</b>

# 8. I/O

## 8.1 I/O 1 AND I/O 2

### 8.1.1 SPECIFICATIONS

I/O Analog input:

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

Accuracy 0.05% of range (I/O card range is 10 volts. 0.05 % of 10 volts = 0.005 volts or 5 mV)

I/O Analog output:

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

Accuracy 0.05% of range (I/O card range is 10 volts. 0.05 % of 10 volts = 0.005 volts or 5 mV)

Digital Outputs:

Open collector type 24 volts / 15 mA (internal fused protection)

Digital Inputs:

Internally pulled to 5 volts DC using a resistor

Refer to Appendix C for detailed I/O circuitry

### 8.1.2 I/O INTERFACE

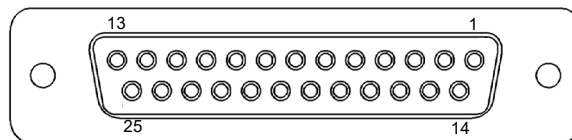


Fig.8-1 I/O Card Interface

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 user	---	16 bit A/D convertor
4	AIN2+	Input	+/- 10VDC	Analog input for user	---	16 bit A/D convertor
6	External Alarm	Input	OPEN or 5 Volts Common	External contact opening will put the DSP7010 in an alarm condition	---	2.2K internal pullup resistor to 5 Volts, Switch to PIN19
7	DI1	Input	OPEN or 5 Volts Common	The user can use as digital input	---	2.2K internal pullup resistor to 5 Volts, Switch to PIN20

PIN	SIGNAL NAME	INPUT/ OUTPUT	LEVEL	INTENDED USE	SECONDARY USE	NOTES
8	DI2	Input	OPEN or 5 Volts Common	The user can use as digital input	---	2.2K internal pullup resistor to 5 Volts, Switch to PIN21
9	DOUT1	Output	OPEN collector	Open collector, less than 40 mA, can be used to switch on an optocoupler or small relay.	---	If inductive loads are used, clamp with a diode
10	Relay1 NO	Bidirectional	N/A	Relay output, to shut down user equipment if DSP7010 is in an alarm condition	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT
11	Relay1 NC	Bidirectional	N/A	Relay output, to shut down user equipment if DSP7010 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	User DAC 1 common	Signal return for PIN 1
15	DAC 2 common	N/A	Bidirectional	Analog common for speed output	User DAC 2 common	Signal return for PIN 2
16	AIN1-	Input	Bidirectional	Analog common for AIN 1	---	Signal return for PIN 3
17	AIN2-	Input	Bidirectional	Analog common for AIN 2	---	Signal return for PIN 4
18	5 Volts Common	N/A	0 VDC	Spare common	---	---
19	5 Volts Common	N/A	0 VDC	External alarm common	---	Switch closure to PIN 6
20	5 Volts Common	N/A	0 VDC	DIN1 common	---	Switch closure to PIN 7
21	5 Volts Common	N/A	0 VDC	DIN2 common	---	Switch closure to PIN 8
22	DOUT2	Output	OPEN collector	Open collector, less than 40 mA, can be used to switch on a optocoupler or small relay	---	If inductive loads are used, clamp with a diode
23	Relay1 Common	Bidirectional	N/A	Relay output, to shut down user equipment if DSP7010 is in an alarm condition	General purpose user relay	Recommended used as a pilot relay. LOW VOLTAGE, LOW CURRENT
24	5 Volts Common	N/A	0 VDC	Spare common	---	---
25	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 CONFIGURATION

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

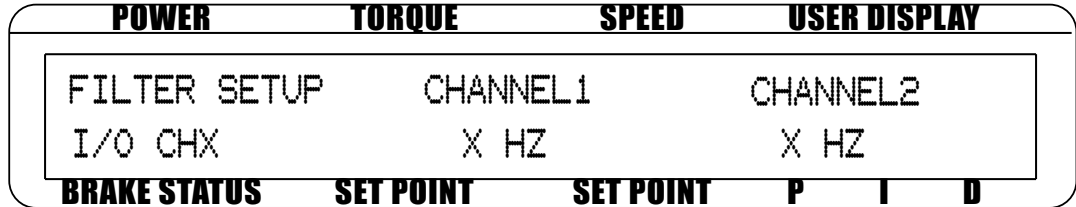


Fig.8-2 Filter Channel Setup Menu

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:

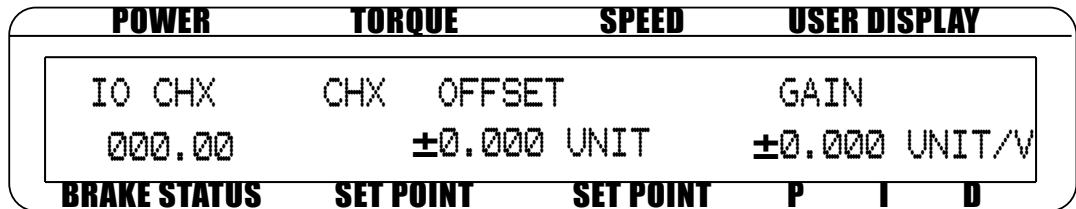


Fig.8-3 Offset and Gain Setup Menu

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

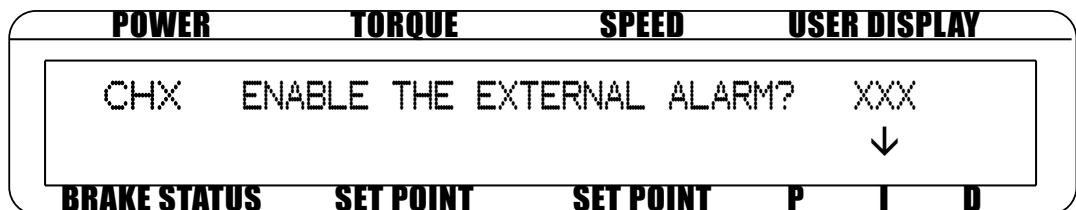


Fig.8-4 External Alarm Setup

13. Press [SCALE I] button to select yes or no.

14. Press [SHIFT]. The display should appear as follows:

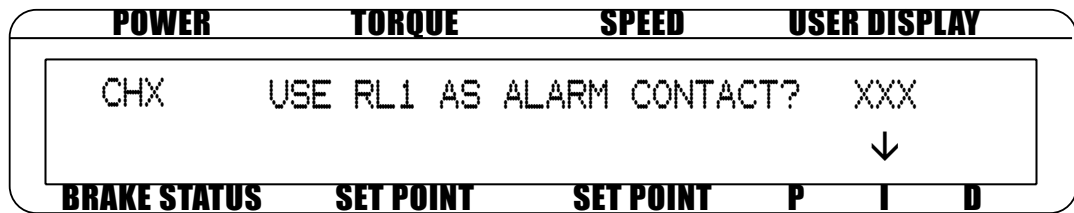


Fig.8-5 Alarm Contact Setup

15. Press [SCALE I] button to select yes or no.

16. Press [SHIFT]. The display should appear as follows:

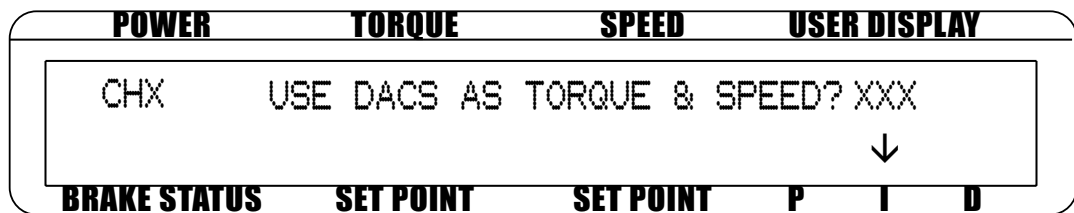


Fig.8-6 Torque/Speed Setup

17. Press [SCALE I] button to select yes.

18. Press [SHIFT]. The display should appear as follows:

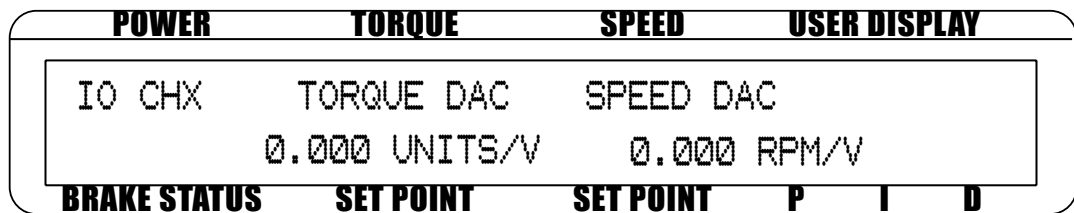


Fig.8-7 Torque/Speed DAC Setup Menu

19. Press [TORQUE UNITS]. Use ◀ and ▶ buttons and the dial to set the desired Torque DAC value.

20. Press [MAX SPEED]. Use ◀ and ▶ buttons and the 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 A/D INPUT SIGNAL RANGE

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



### 8.1.3.4 I/O DAC OUTPUT SIGNAL RANGE

The analog output signals of the DAC are from -10V to +10V.

## 8.2 CHECKING THE DSP7010-TO-PC CONNECTION

### 8.2.1 GPIB COMMUNICATION CHECK

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

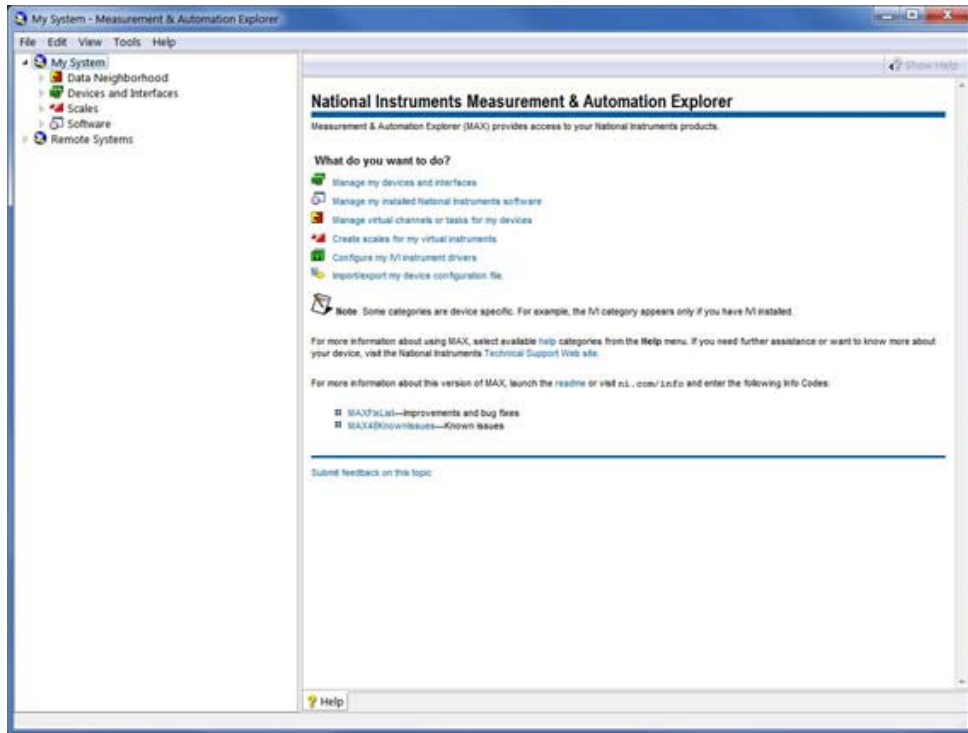


Fig.8-8 Measurement and Automation Explorer Window

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 DSP7010.

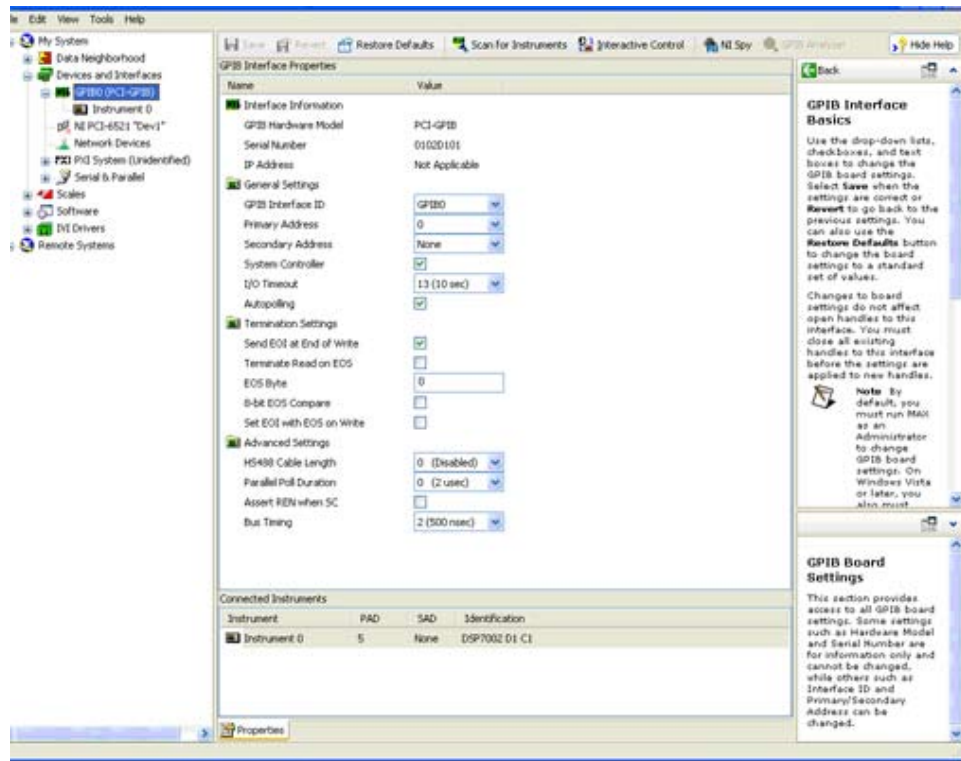


Fig.8-9 GPIB (PIC\_GPIB) Window

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.

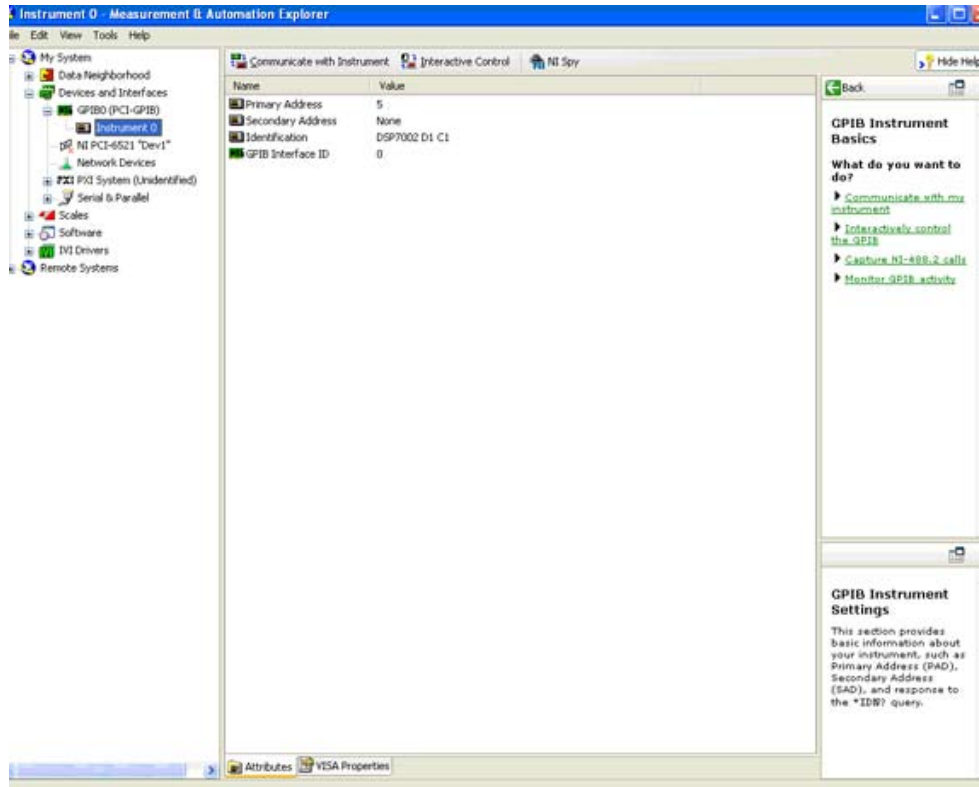


Fig.8-10 Connected Instruments Window

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



Fig.8-11 Communicaton with Instrument Window

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



Fig.8-12 Query Window

## 8.2.2 USB COMMUNICATION CHECK



### NOTICE

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

- Download and run TeraTerm.exe which can be found at <https://www.magtrol.com/software-downloads/> under the section 'DSP7010 USB Drivers' to launch the install wizard. Click the NEXT button to begin installation.



Fig.8-13 Tera Term Setup Window

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

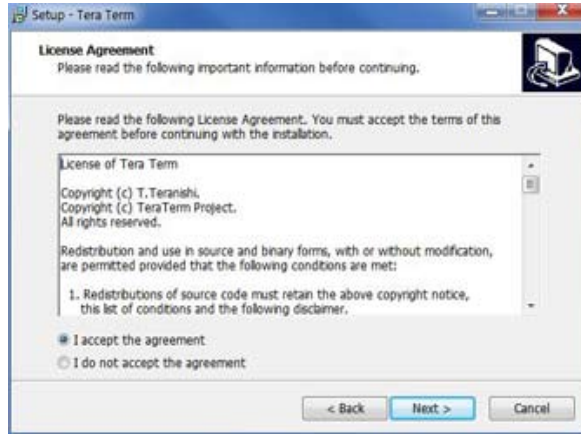


Fig.8-14 Tera Term License Agreement Window

3. Select the default install folder click NEXT.

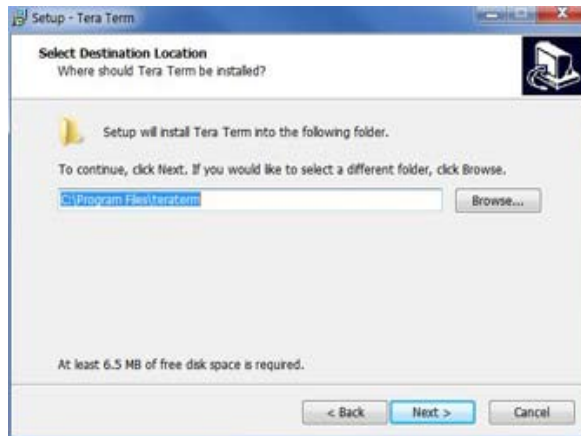


Fig.8-15 Tera Term Destination Location Window

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

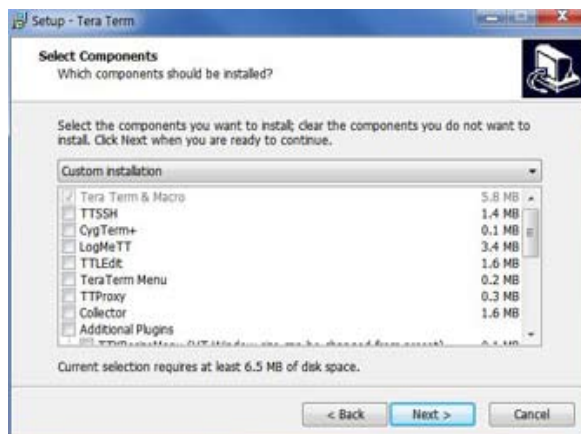


Fig.8-16 Tera Term Select Components Window

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



Fig.8-17 Tera Term Language Selection Window

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

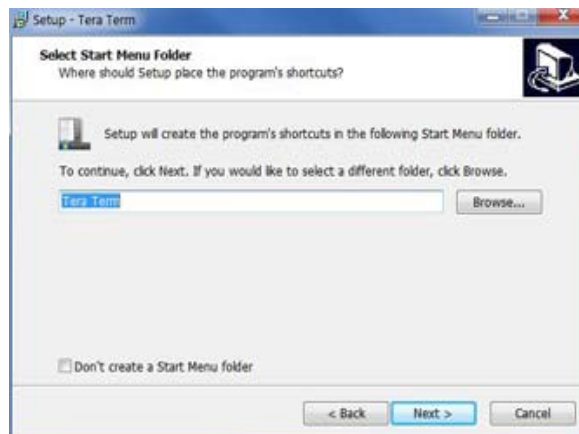


Fig.8-18 Tera Term Start Menu Folder Window

8. Click NEXT.

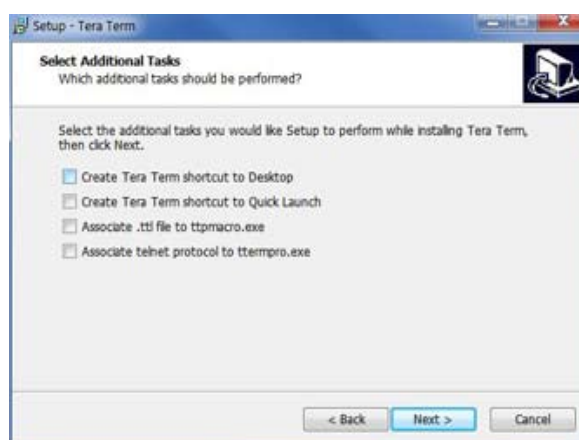


Fig.8-19 Tera Term Additional Tasks Window

9. Click the FINISH button.

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

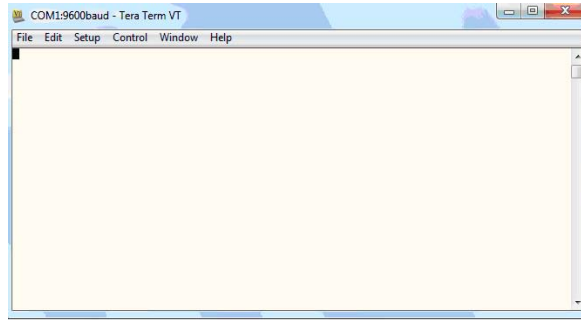


Fig.8-20 Tera Term Window

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

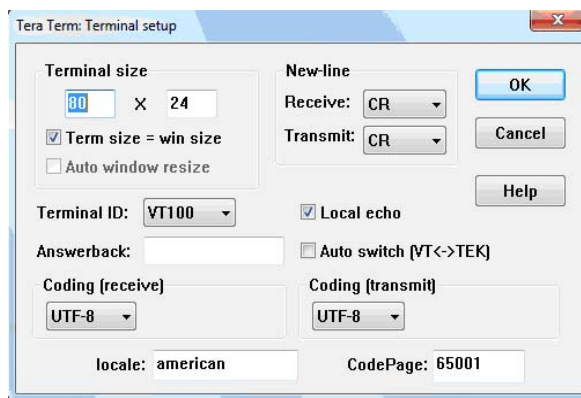


Fig.8-21 Terminal Setup Window

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 DSP7010 setting.

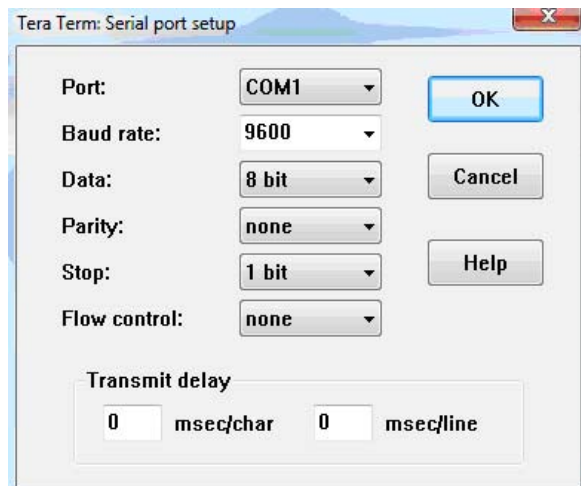


Fig.8-22 Serial Port Setup Window

13. Input a command, such as \*IDN? plus CR + LF. The response DSP701x xx xx should display.

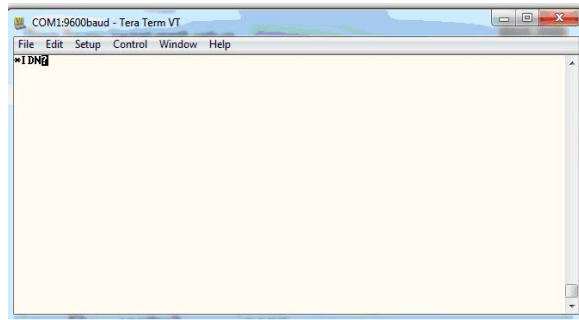


Fig.8-23 Tera Term Window with Command



## 9. APPLICATIONS

### 9.1 ANALOG SET POINT MODE (ASPM)

The Analog Set Point Mode (ASPM) on the DSP7011 is a special setup that allows a set point to be inputted to the system by way of one of the analog inputs. This mode is only available in the DSP7011.

#### 9.1.1 CONDITIONS FOR USE

- DSP7011 with AIN 2 available
- MTEST cannot be used in ASPM mode
- ASPM mode can only be entered and exited using the front panel keypad  
[SHIFT] → [SETUP] → Select I/O → 7x [SHIFT] until "IO1 AD2 USE ANALOG SET POINT" → Select YES/NO
- Only the data reading commands are still available (OD, OB, etc...)
- Can be used with WB/PB/HD-xxx-5/TM,TS,TF (not on a HD-xxx-6,-7,-8,-9)
- While BRAKE is ON, no switching modes is allowed (Torque to Speed, Speed to Torque)
- Front panel BRAKE ON/OFF is disabled
- Front panel PID settings are available in ASPM
- Front Panel Torque, Speed and Open Loop settings are NOT available in ASPM. Offset, if desired, must be implemented prior to entering ASPM
- All setup required has to be done before entering ASPM

#### 9.1.2 SPEED MODE

- Enter the Max Speed value by pressing [SHIFT] + [MAX SPEED]
- Select Speed Mode by pressing [SPEED SET] before switching the brake ON
- Set point 5V = MAX SPEED Value
- Set point 0V = 0 RPM → Loss of input = 0 RPM = Locked Rotor!

#### 9.1.3 TORQUE MODE

- Torque Scale Factor = 5V Set point
- Select Torque Mode by pressing [TORQUE SET] before switching the brake ON
- Set point 5V = Scale Factor value
- Set point 0V = 0 Nm → Loss of input = 0 torque

#### 9.1.4 OPEN LOOP MODE

- 100% excitation = 5V Set point
- Select Open Loop Mode by pressing [OPEN LOOP] before switching brake ON
- Set point 5V = 100% excitation
- Set point 0V = 0% → Loss of input = 0%

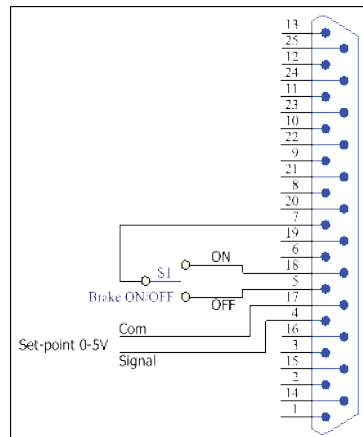


Fig.9-1 Analog Set Point Mode Diagram

## 9.2 COAST TEST

The coast test is a special application that counts the number of revolutions of the rotor shaft that the MUT takes to reach 0 RPM after the motor contactor is turned off. . More specifically, it is a measure of how well the motor under test's internal brake is operating.

A quadrature encoder must be attached to the motor to do this test. It could be a quadrature encoder in a dynamometer or a stand-alone encoder such as the EMA series encoder. Pay attention to the inertia of the connected encoder and take this into account in your readings.

- First, with the motor running, the system is primed by selecting the channel for a coast down test with the CD1 or CD2 command.
- Second, we send the command to turn off the motor using IO1DO1,0 or IO2DO1,0to control a pilot relay to a contactor. (See Appendix for Digital output circuitry)

The CD1 command sets the system up to reset the quadrature count precisely when the command is issued to turn off the motor. The angle the motor traveled can then be read with the OP1 command or by reading the quadrature count and calculating the angle.

# 10. CALIBRATION

## 10.1 CLOSED-BOX CALIBRATION

The DSP7010 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.

## 10.2 CALIBRATION SCHEDULE

Calibrate the DSP7010:

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

## 10.3 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 DSP7010:

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

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

### 10.3.1 INITIAL CALIBRATION PROCEDURE

1. Allow the DSP7010 to stabilize in an environment with:
  - 1a. An ambient temperature of 18°C to 25°C.
  - 1b. Relative humidity less than 80%.
  - 1c. Power Resistor 25 ohms 50W.
2. Turn on the DSP7010.
3. Allow the DSP7010 to warm up for at least 30 minutes.

### 10.3.2 CALIBRATION OF ANALOG TO DIGITAL CONVERTERS

1. A/D Offset and Gain on any of the 6 analog inputs.
  - 1a. TSC1 (low gain and high gain)
  - 1b. TSC2 (low gain and high gain)
  - 1c. IO 1 Channel 1
  - 1d. IO 1 Channel 2
  - 1e. IO 2 Channel 1
  - 1f. IO 2 Channel 2
2. Connect the external voltage reference common to the input connector.
  - 2a. TSC1 = Pin 14 of the TSC1 connector
  - 2b. TSC2 = Pin 14 of the TSC2 connector
  - 2c. IO 1 Channel 1 = Pin 16 of the IO Card 1 connector
  - 2d. IO 1 Channel 2 = Pin 17 of the IO Card 1 connector
  - 2e. IO 2 Channel 1 = Pin 16 of the IO Card 2 connector
  - 2f. IO 2 Channel 2 = Pin 17 of the IO Card 2 connector
3. Connect the external voltage reference high to the input connector.
  - 3a. TSC1 = Pin 15 of the TSC1 connector
  - 3b. TSC2 = Pin 15 of the TSC2 connector
  - 3c. IO 1 Channel 1 = Pin 3 of the IO Card 1 connector
  - 3d. IO 1 Channel 2 = Pin 4 of the IO Card 1 connector
  - 3e. IO 2 Channel 1 = Pin 3 of the IO Card 2 connector
  - 3f. IO 2 Channel 2 = Pin 4 of the IO Card 2 connector
4. Send the DSP7010 the MODE2 command. This command puts the unit into engineering mode. After completing calibration, send the DSP7010 the MODE0 command.

**NOTICE**

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 DSP7010 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 1 Channel 1
  - 5 = IO 1 Channel 2
  - 6 = IO 2 Channel 1
  - 7 = IO 2 Channel 2
6. If the hardware 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 DSP7010 the ZEROAD# command. This command makes the DSP take a reading and save it as its offset value for that 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 DSP7010 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 channel.
10. The unit will respond "CAL COMP AD#."
11. Apply approximately -2.000 VDC for HD (# = 0 or 2) or approximately -10.000 VDC for all others.
12. Send the DSP7010 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 channel.
13. The unit will respond "CAL COMP AD#."

### 10.3.3 CALIBRATION OF DIGITAL TO ANALOG CONVERTERS



#### NOTICE

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.
  - 1a. TSC1 (Current and Voltage) Current from the brake connector, Voltage from the SUPPLY1 connector
  - 1b. TSC 2 (Current and Voltage) Current from the brake connector, Voltage from the SUPPLY2 connector
  - 1c. IO 1 Channel 1 (Commonly used as Analog Torque out)
  - 1d. IO 1 Channel 2 (Commonly used as Analog Speed out)
  - 1e. IO 2 Channel 1
  - 1f. IO 2 Channel 2
2. If calibrating a Current output connect the voltmeter common to the BRAKE-Pins (Pins 2 and 3).
3. If calibrating a Voltage output connect the voltmeter common to output connector.
  - 3a. TSC1 = Pin 6 of the SUPPLY1 connector
  - 3b. TSC2 = Pin 6 of the SUPPLY2 connector

- 3c. IO 1 Channel 1 = Pin 14 of the IO Card 1 connector
- 3d. IO 1 Channel 2 = Pin 15 of the IO Card 1 connector
- 3e. IO 2 Channel 1 = Pin 14 of the IO Card 2 connector
- 3f. IO 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+Pins (Pins 1 and 4).
5. If calibrating a Voltage output connect the Voltmeter high to the input connector.
  - 5a. TSC1 = Pin 1 of the SUPPLY1 connector
  - 5b. TSC2 = Pin 1 of the SUPPLY2 connector
  - 5c. IO 1 Channel 1 = Pin 1 of the IO Card 1 connector
  - 5d. IO 1 Channel 2 = Pin 2 of the IO Card 1 connector
  - 5e. IO 2 Channel 1 = Pin 1 of the IO Card 2 connector
  - 5f. IO 2 Channel 2 = Pin 2 of the IO Card 2 connector
6. Send the DSP7010 the MODE2 command. This command puts the unit into engineering mode.
7. Send the DSP7010 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 = TSC 1 (Current) BRAKE1
  - 1 = TSC 1 (Volts) SUPPLY1
  - 2 = TSC2 (Current) BRAKE2
  - 3 = TSC2 (Volts) SUPPLY2
  - 4 = IO 1 Channel 1
  - 5 = IO 1 Channel 2
  - 6 = IO 2 Channel 1
  - 7 = IO 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 DSP7010 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 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 DSP7010 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 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.

### 10.3.4 CALIBRTION FREQUENCY

**NOTICE**

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

1. Frequency gain on TSC1 and TSC2.
  - 1a. Input frequency on pin 11 of the TSC1 connector (common pin 9)
  - 1b. Input frequency on pin 11 of the TSC2 connector (common pin 9)
2. Send the command CALS# to the unit via USB/GPIB
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#.





# 11. THEORY

## 11.1 HOW THE PID LOOP WORKS

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

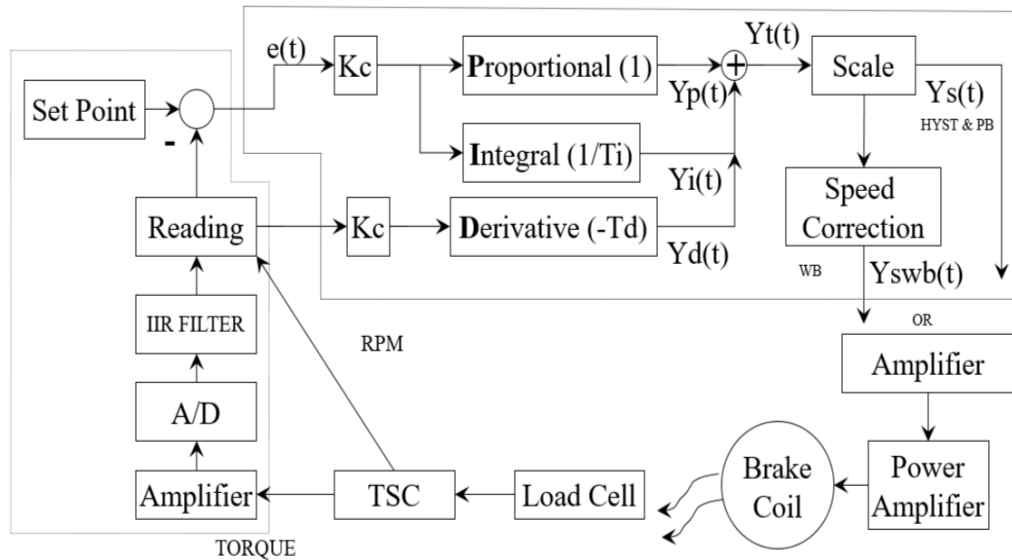


Fig.11-1 System Block Diagram

### 11.1.1 SCALE FACTORS FOR HYSTERESIS, EDDY-CURRENT, AND POWDER BRAKE DYNAMOMETERS



TORQUE: TSC1 & TSC2  $Y_s(t) = Y_t(t) / 1.97 * 2$  (HB brake)

$Y_s(t) = Y_t(t) / 0.995 * 2$  (all others)

SPEED: TSC1 & TSC2  $Y_s(t) = Y_t(t) * 4998.4 / \text{MAX SPEED}$

### 11.1.2 SPEED CORRECTION FOR WE (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 because for a given current the torque changes with speed. This is referred to as speed correction.

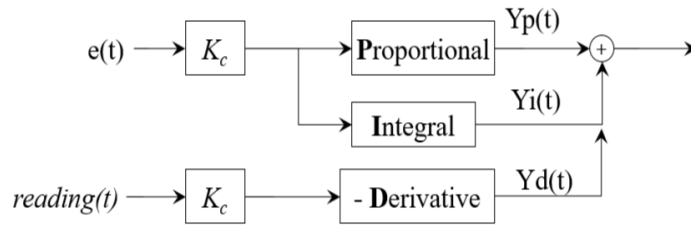
$$Y_{swb}(t) = (Y_s(t) + Y_s(t) / \text{speed correction factor}) / 2$$

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

$$\text{Speed Correction Factor} = -0.0001 * x * x + 0.0203 * x + 0.005 \text{ limited to } 0.051 \text{ to } 1 \text{ where } x = \text{RPM} / \text{NOMINAL SPEED} * 100$$

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

### 11.1.3 EQUATIONS



$$Y(t) = K_c(e(t) + \frac{1}{T_i} \int e(t)dt - T_d \frac{dreading(t)}{dt})$$

$$Y_p(t) = e(t)K_c$$

$$Y_i(t) = Y_i(t-1) + \frac{K_c * \Delta t}{T_i} \left[ \frac{(e(t) + e(t-1))}{2} \right]$$

$$Y_d(t) = -T_d * K_c \left[ \frac{reading(t) - reading(t-1)}{\Delta t} \right]$$

$$Y(t) = Y_p(t) + Y_i(t) + Y_d(t)$$

## 11.2 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

B = 0.005

C = 0.01

D = 0.05

E = 0.1

F = 0.5

G = 1

H = 5

I = 10

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.

### 11.2.1 HOW TO SET ADDITIONAL SCALE FACTOR

Before following the setup instructions, the values that must be set will need to be determined. This will depend on which testing instrument has been chosen for the configuration.

#### 11.2.1.1 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.

#### 11.2.1.2 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.

### 11.2.2 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.

### 11.3 FILTER PARAMETERS

The Digital Filters of the DSP7010 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 DSP7010 has a traditional analog filter that is comprised of the following characteristics:

- 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.

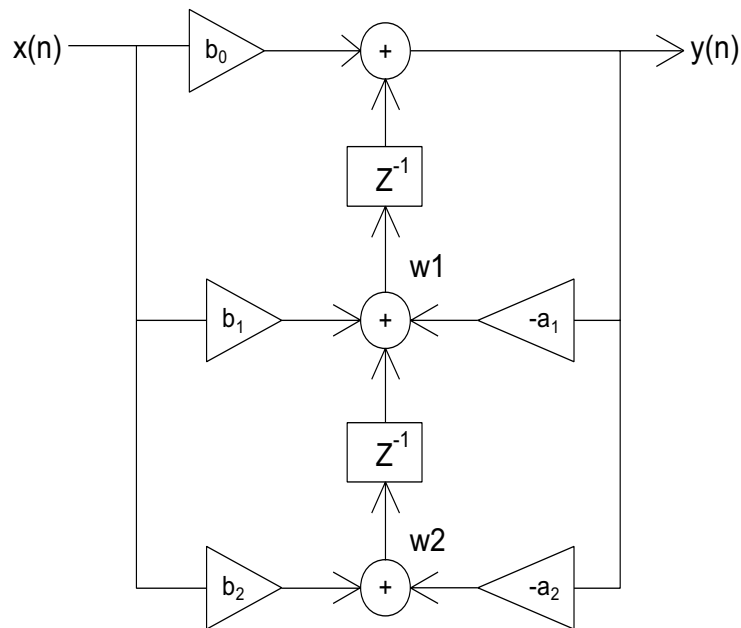


Fig.11-2 Transposed Direct Form II Architecture

With a Digital Filter, the DSP7010 can solve the following equations:

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

$$w1 = b1 * x(n) + a1 * y(n) + w2$$

$$w2 = b2 * x(n) + a2 * y(n)$$

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



## 12. TROUBLESHOOTING

PROBLEM	REASON	SOLUTION
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: <ul style="list-style-type: none"> <li>• GPIB address of Controller.</li> <li>• GPIB cable - should be functioning and attached to Controller and computer interface card.</li> </ul>
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 PPR to match specifications on dynamometer nameplate.



# APPENDIX A. INERTIA CORRECTION

## A.1 INERTIAL EFFECT ON MOTOR TEST DATA

A major advantage of the DSP7010 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<sup>2</sup>R 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 DSP7010, properly adjusted PID values yield constant change in RPM so that the inertial torque can be expressed as a constant.

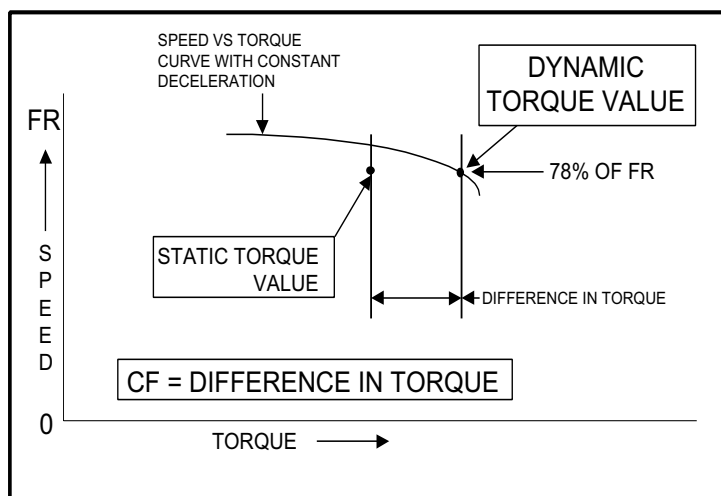
## A.2 PROCEDURE FOR INERTIA CORRECTION

1. Determine the torque Correction Factor (CF) as follows:
  - 1a. Adjust the PID loop properly
  - 1b. 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 DSP7010 (Nddddd) to a speed equal to the dynamic speed value. When the speed stabilizes, use this as the static torque value.

$$CF = \text{Dynamic Torque} - \text{Static Torque}$$

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

Example:



## A.2.1 KEY CONDITIONS

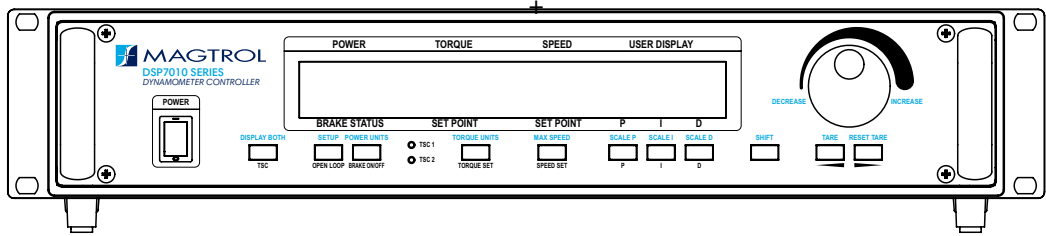
- **Select appropriate value.** The test point selection of 78% is typical for an induction motor. Use a value in the linear portion of the motor curve where there is a substantial torque change with speed.
- **Acquire data rapidly.** Rapid data acquisition is necessary so that motor heating does not 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:

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

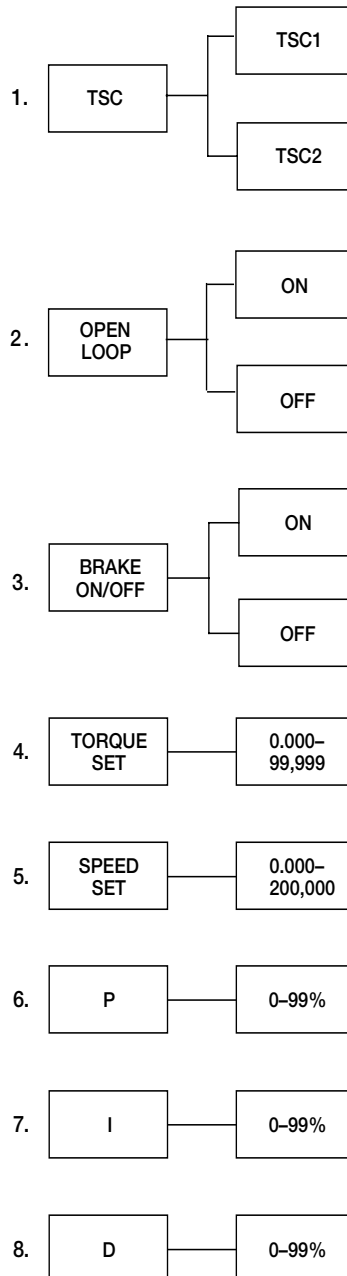


# APPENDIX B. FRONT PANEL/DISPLAY MENU FLOW CHARTS

The following flow charts are a reference for navigating through the key functions of the DSP7010 Dynamometer Controller. For step-by-step setup instructions, refer to the corresponding chapters in this manual.

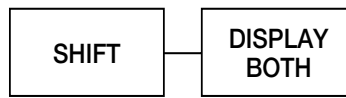


## B.1 PRIMARY FUNCTIONS

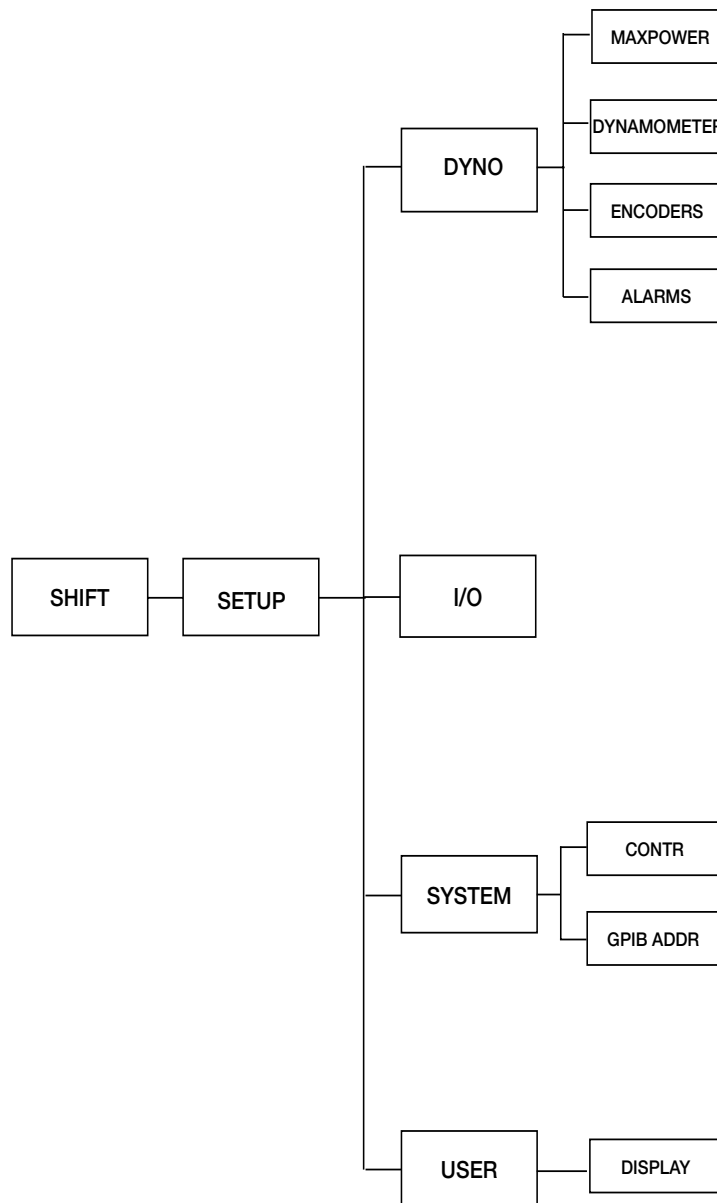


## B.2 SECONDARY KEY FUNCTIONS

### B.2.1 DISPLAY BOTH



### B.2.2 SETUP

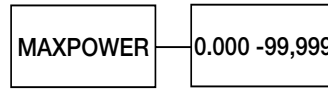


**NOTICE**

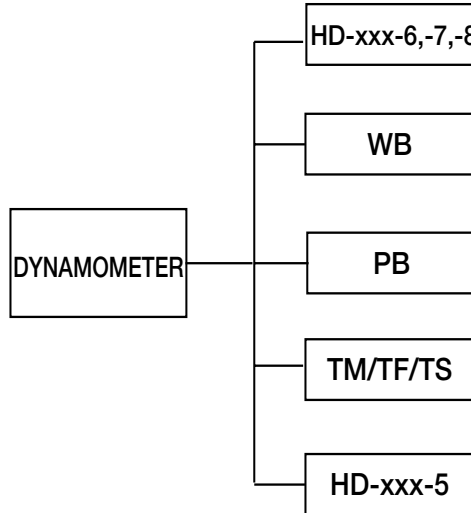
Refer to the flow charts on the following pages for a more detailed breakdown of Dyno, I/O, System and User. All flow charts will be a continuation of B.2.2 beginning at SHIFT\*.

1.3.2.1 B.2.2.1 DYNAMOMETER

Max Power



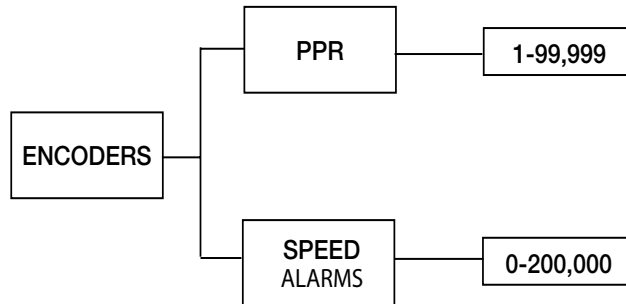
Dynamometer



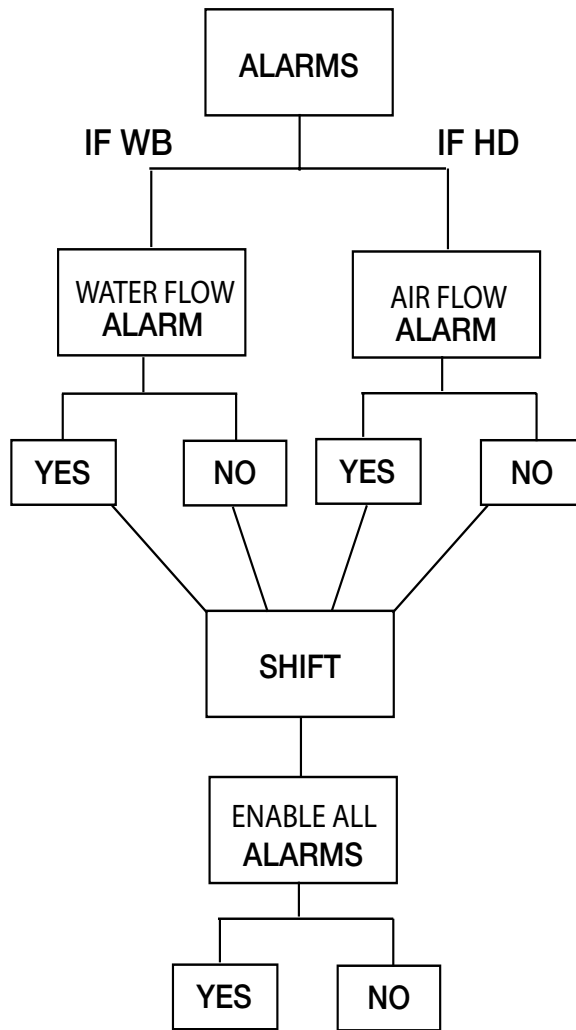
**NOTICE**

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\*.

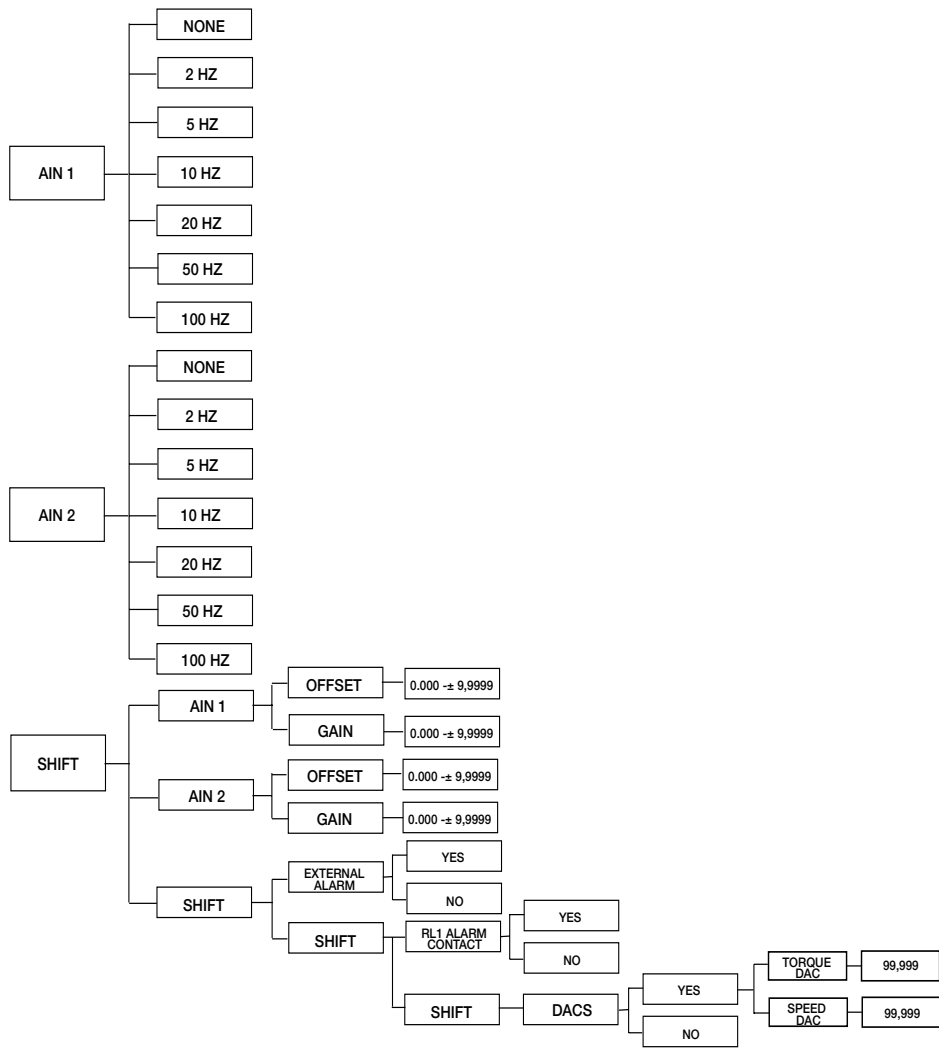
Encoders



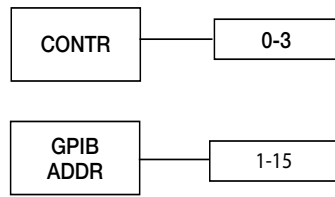
Alarms



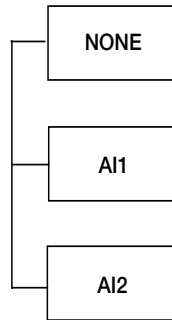
1.3.2.2 B2.2.2 IO



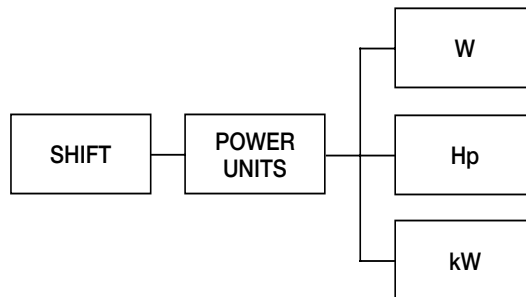
1.3.2.3 B.2.2.3 SYSTEM



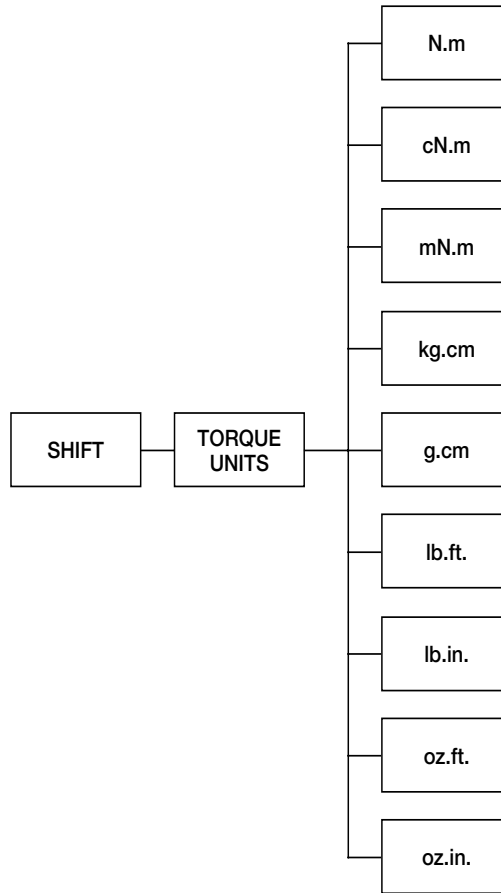
1.3.2.4 B.2.2.4 DISPLAY



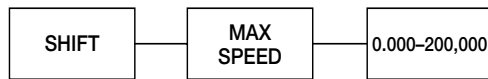
B.2.3 POWER UNITS



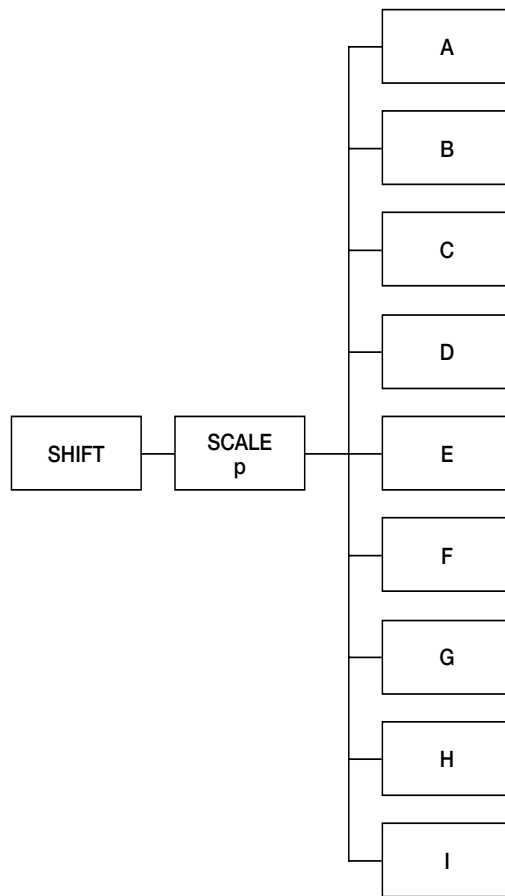
### B.2.4 TORQUE UNITS



### B.2.5 MAX SPEED

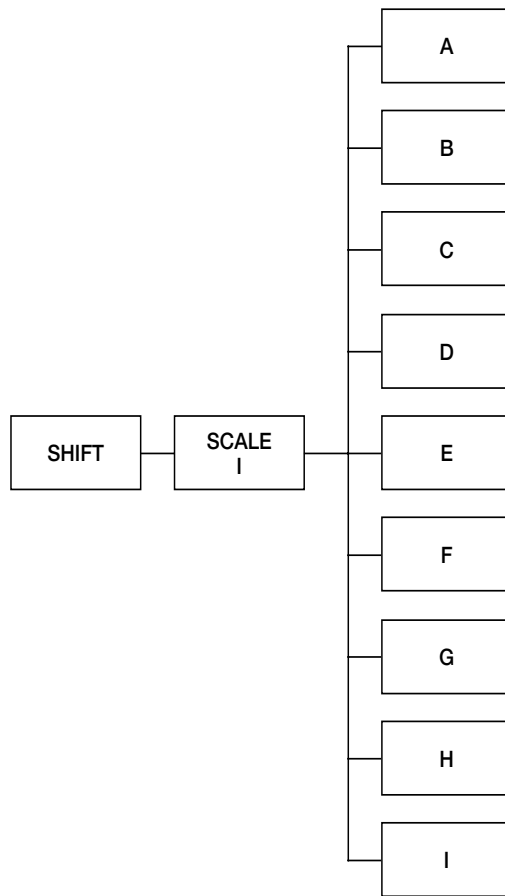


### B.2.6 SCALE P

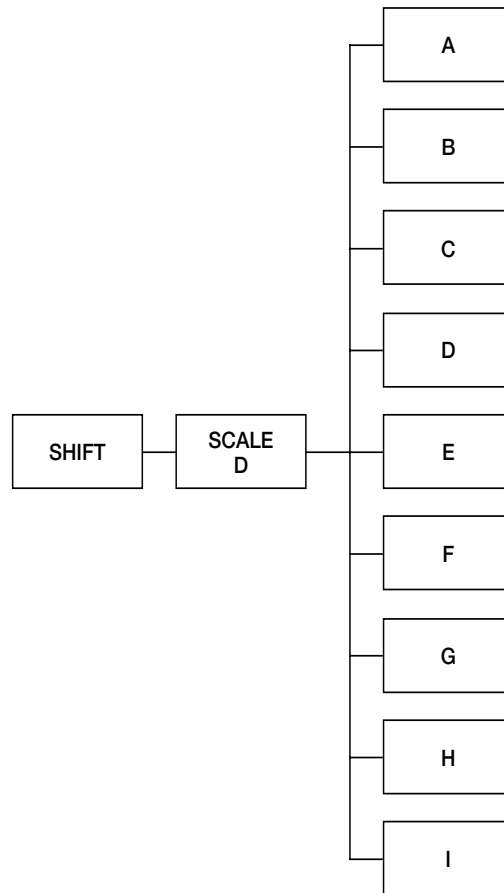




### B.2.7 SCALE I



## B.2.8 SCALE D



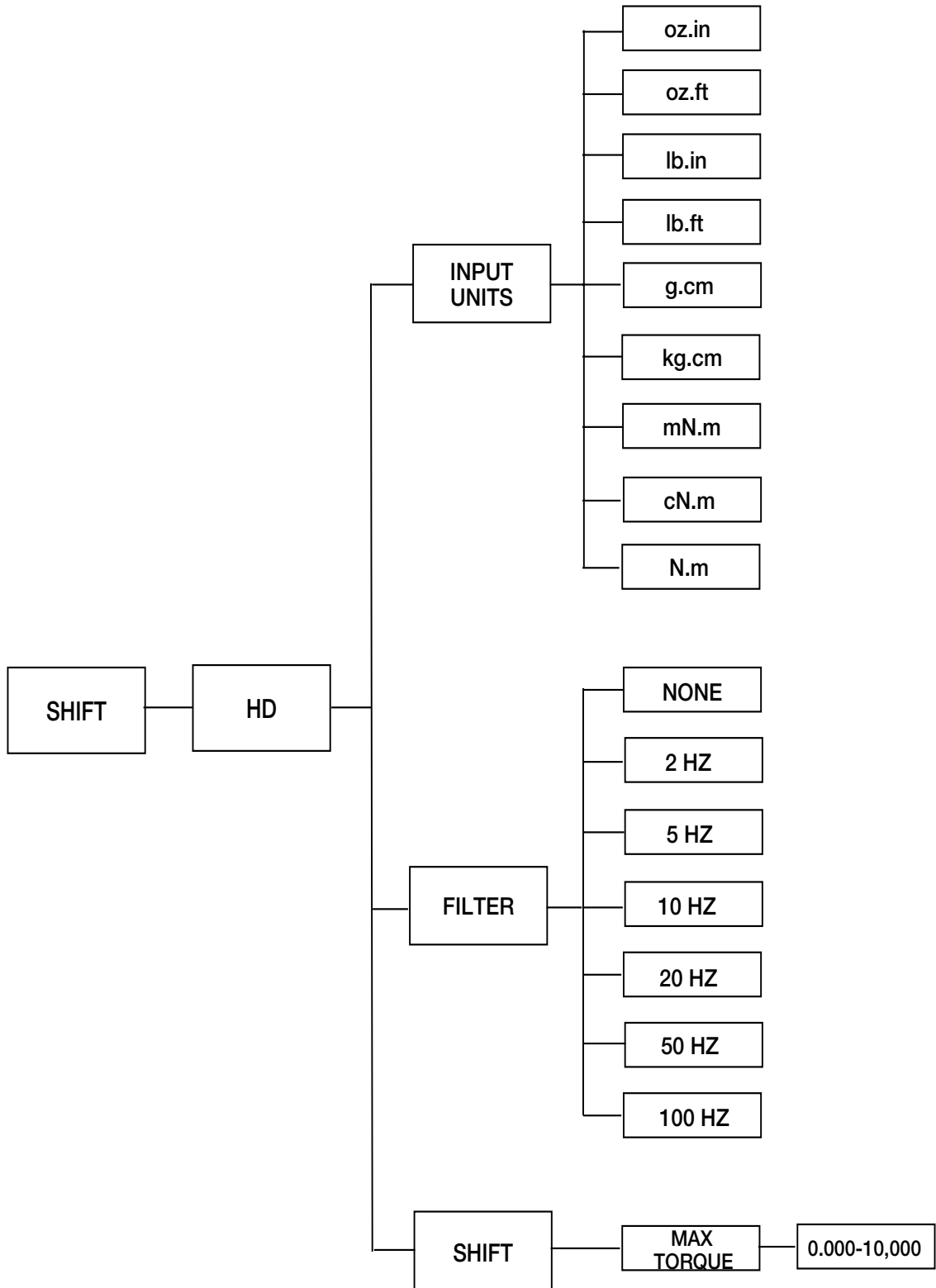
## B.3 TEST INSTRUMENT SETUP



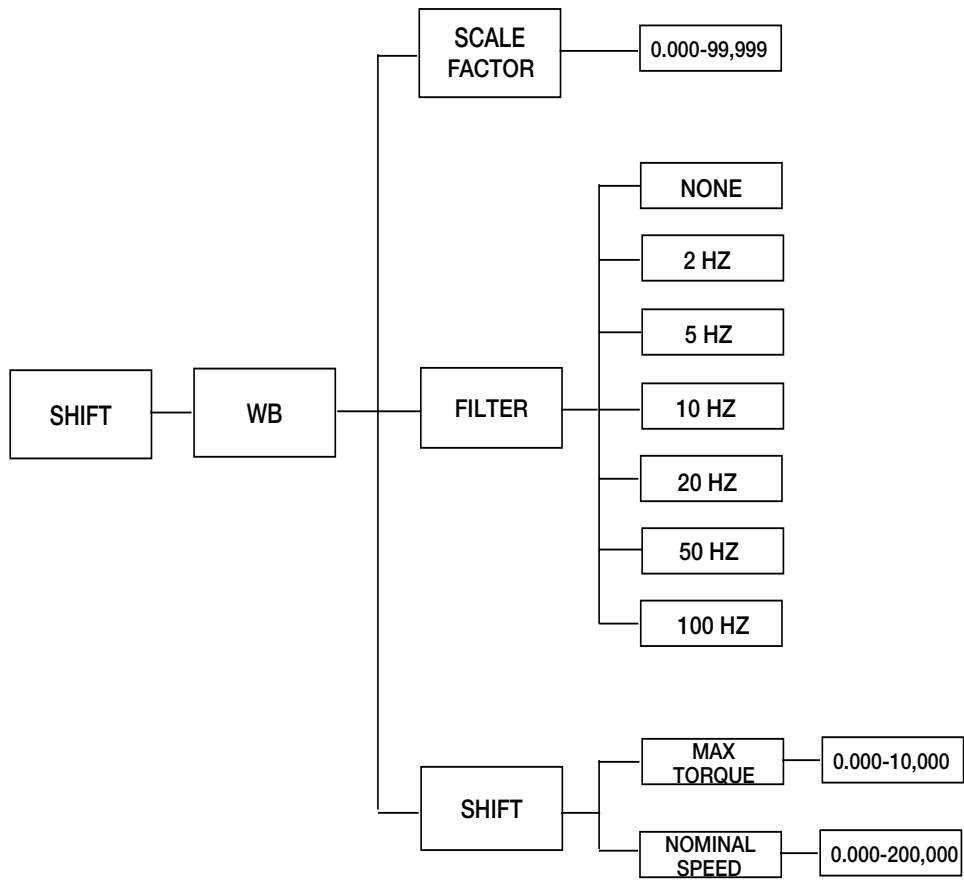
**NOTICE**

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

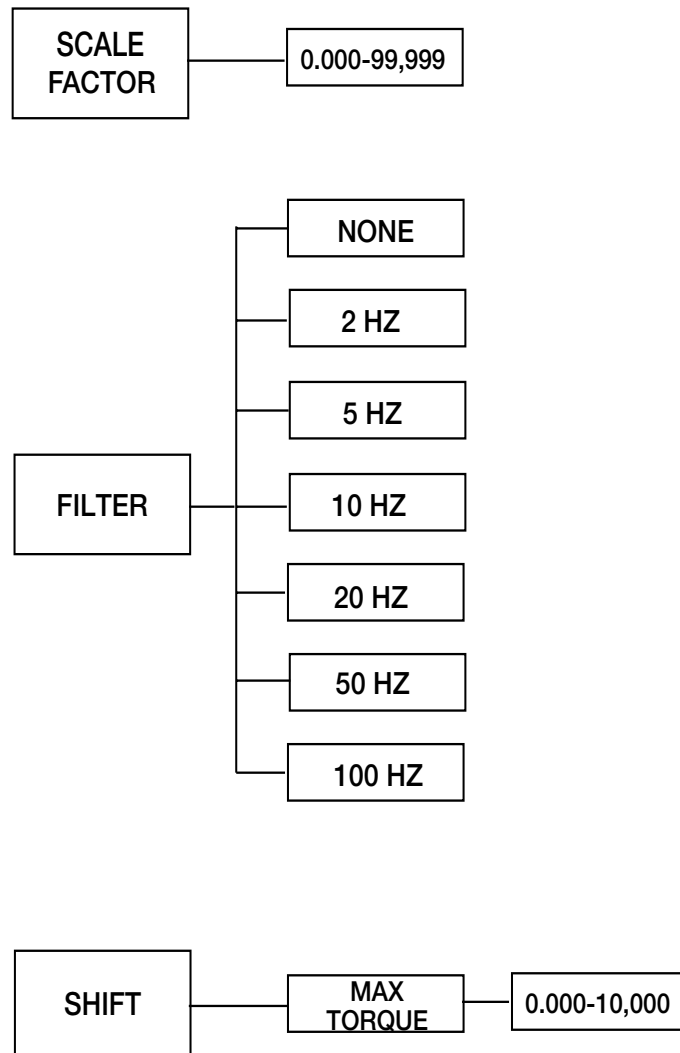
### B.3.1 HD-XXX-6,7,8 DYNAMOMETER SETUP MENU

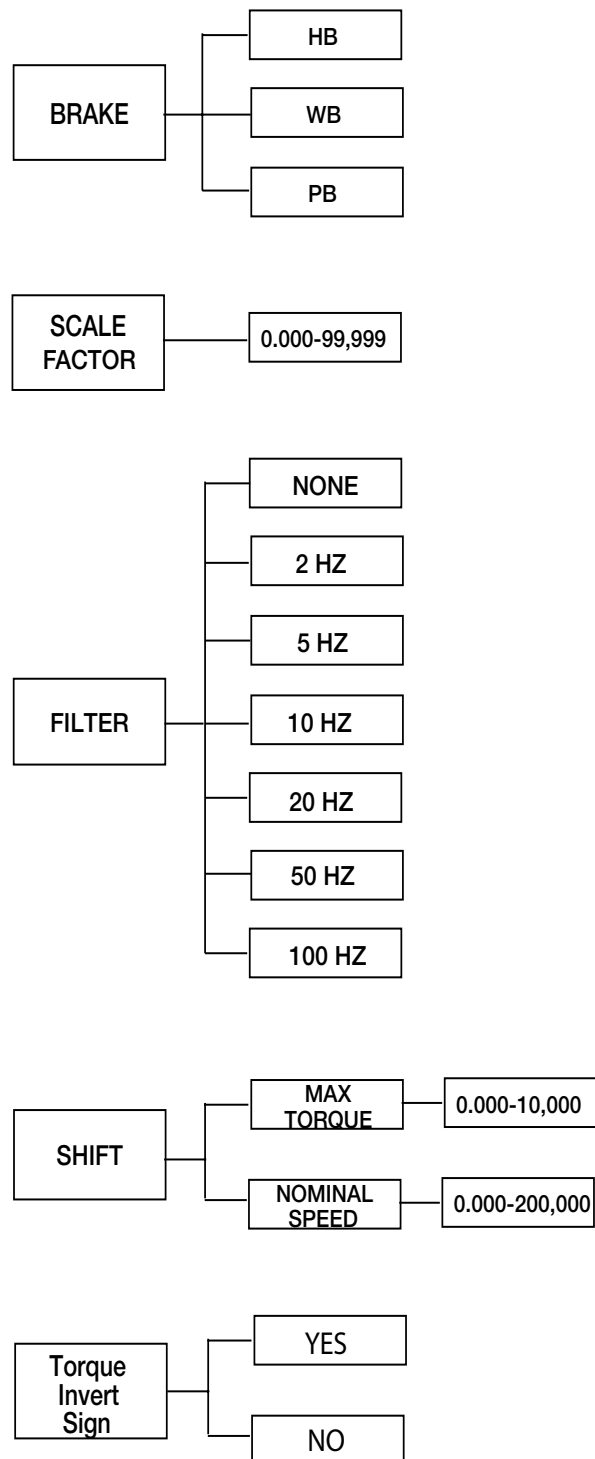


### B.3.2 EDDY-CURRENT DYNAMOMETER SETUP MENU

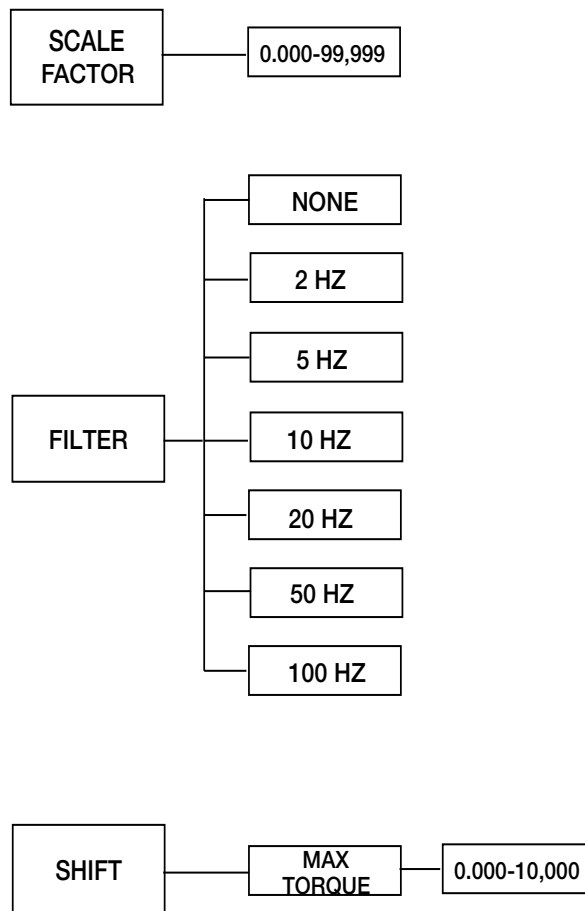


### B.3.3 POWDER BRAKE DYNAMOMETER SETUP MENU

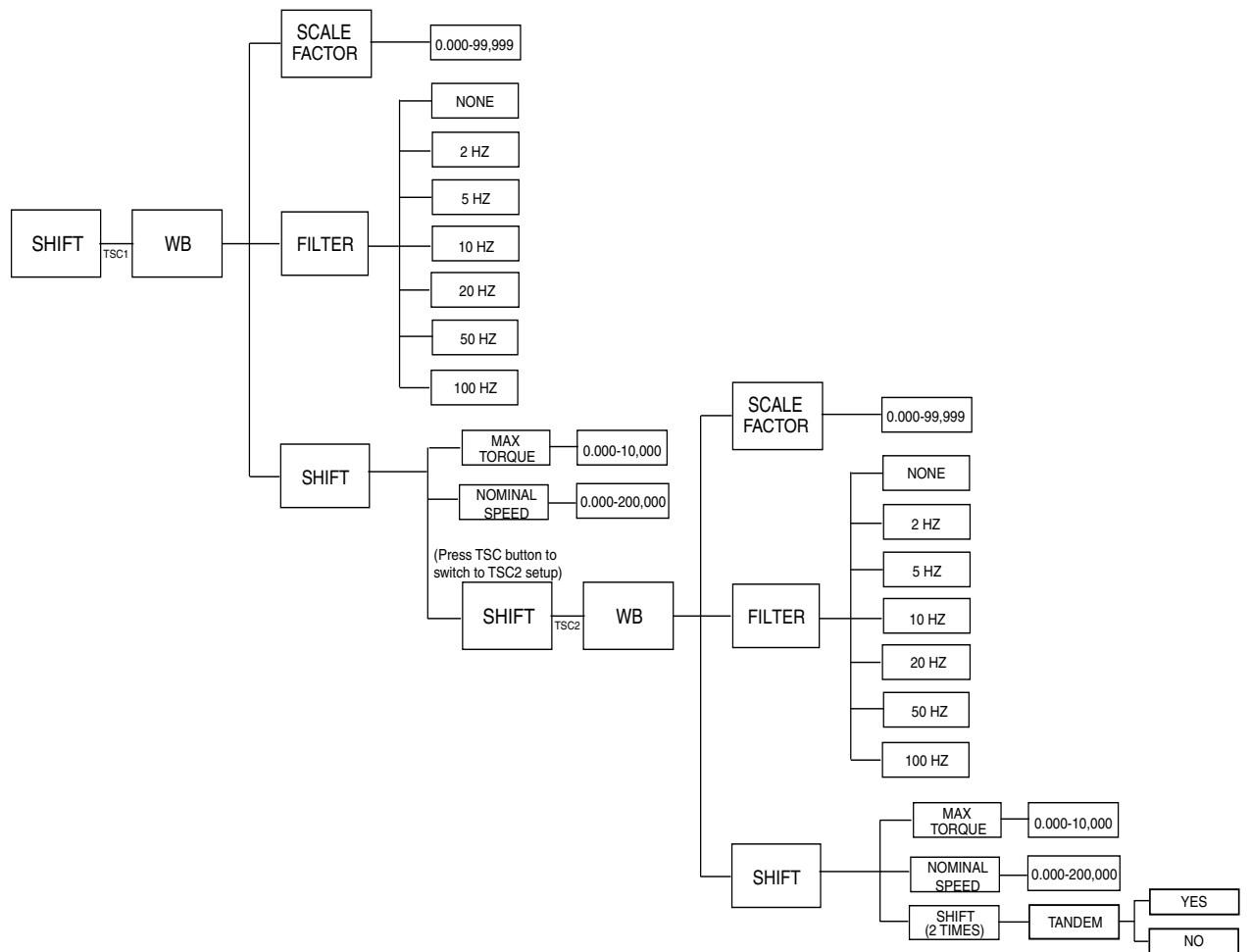


**B.3.4 TORQUE TRANSDUCER/TORQUE FLANGE SENSOR SETUP MENU**

### B.3.5 HD-XXX-5 SETUP MENU

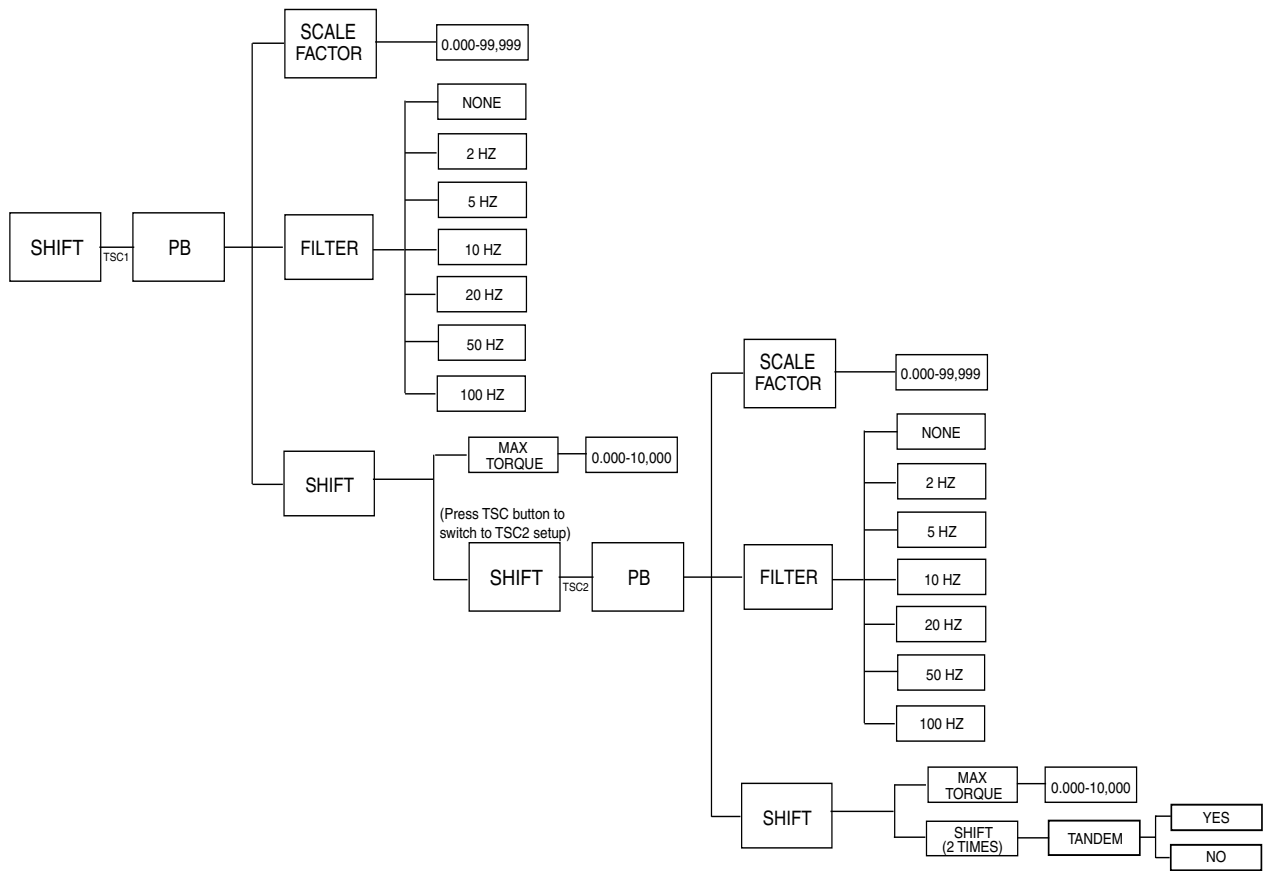


**B.3.6 EDDY-CURRENT DYNAMOMETER WITH EDDY-CURRENT DYNAMOMETER (TANDEM SETUP)**

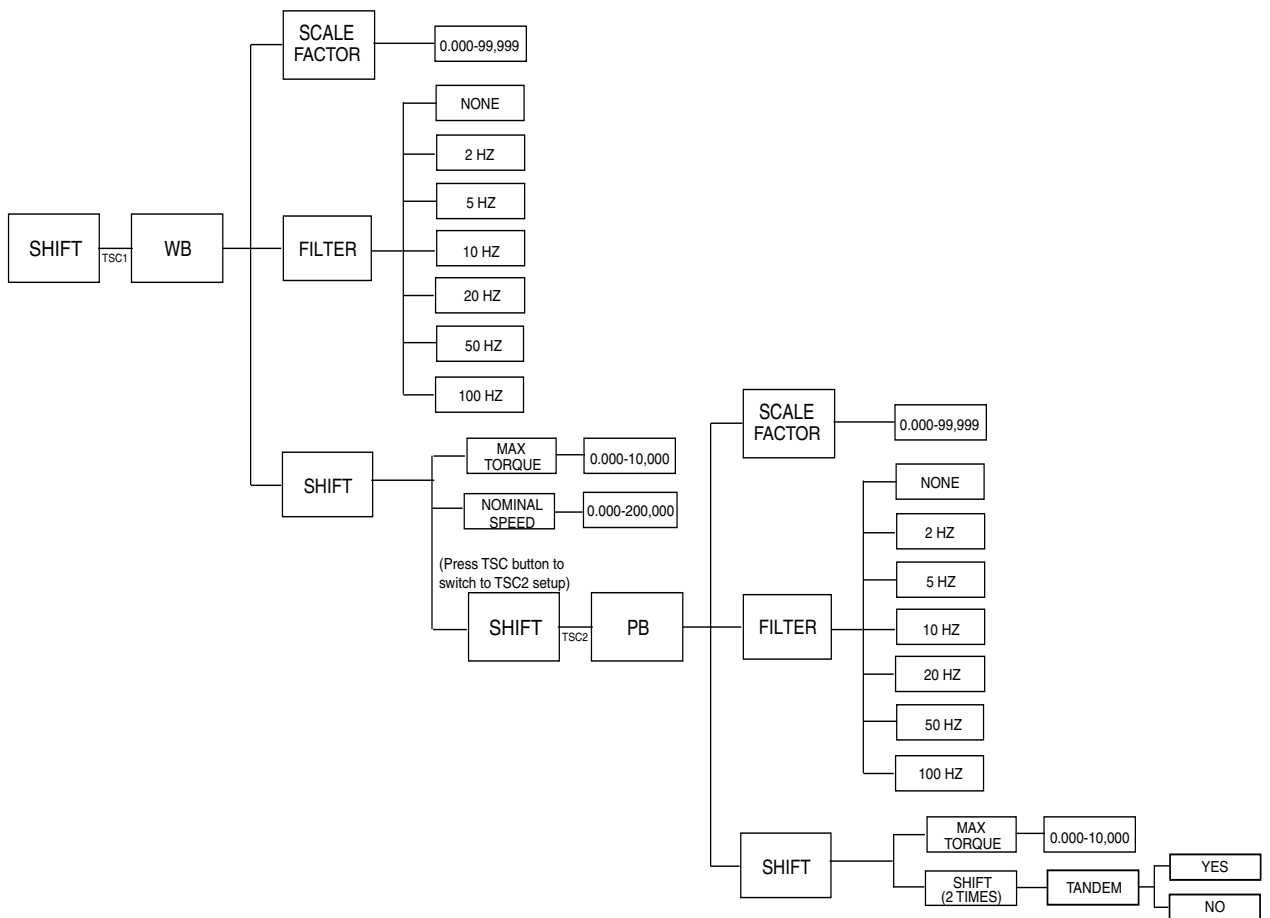




**B.3.7 POWDER BRAKE DYNAMOMETER WITH POWDER BRAKE DYNAMOMETER (TANDEM SETUP)**

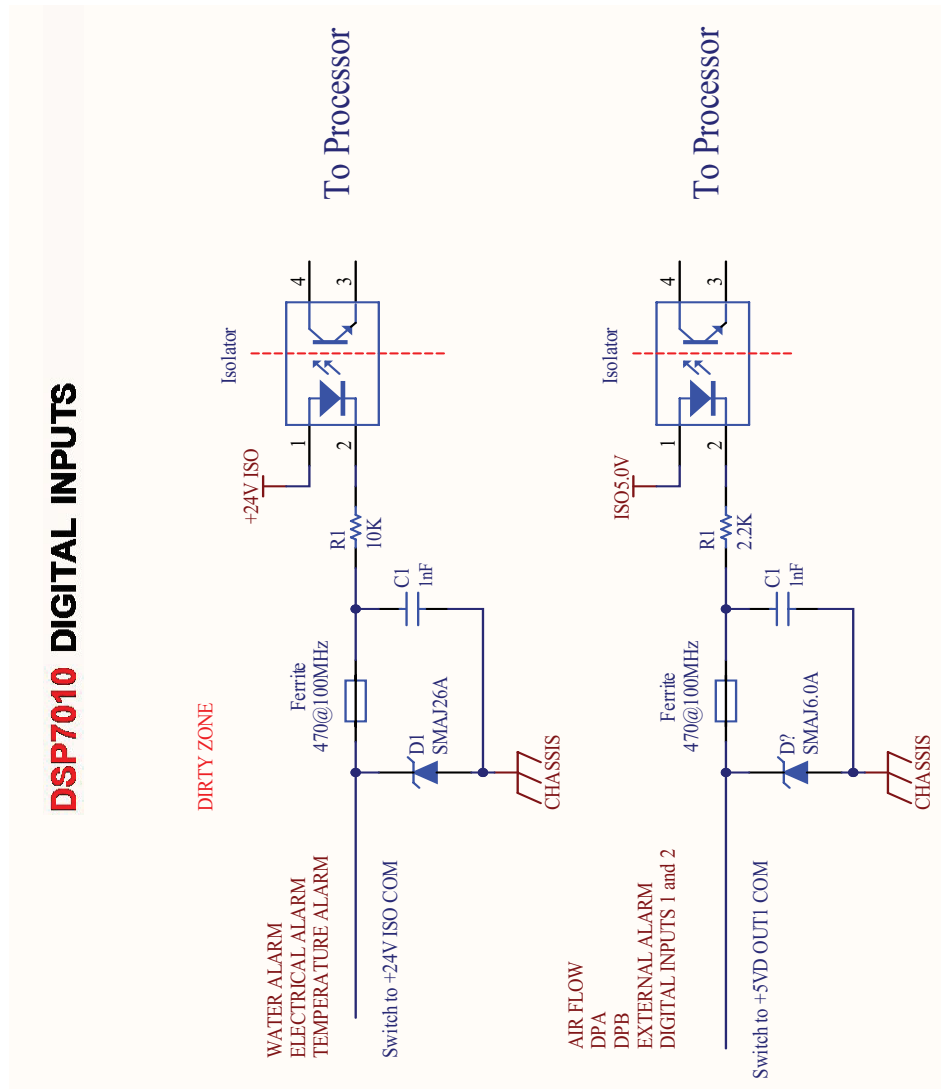


**B.3.8 EDDY-CURRENT DYNAMOMETER WITH POWDER BRAKE DYNAMOMETER (TANDEM SETUP)**

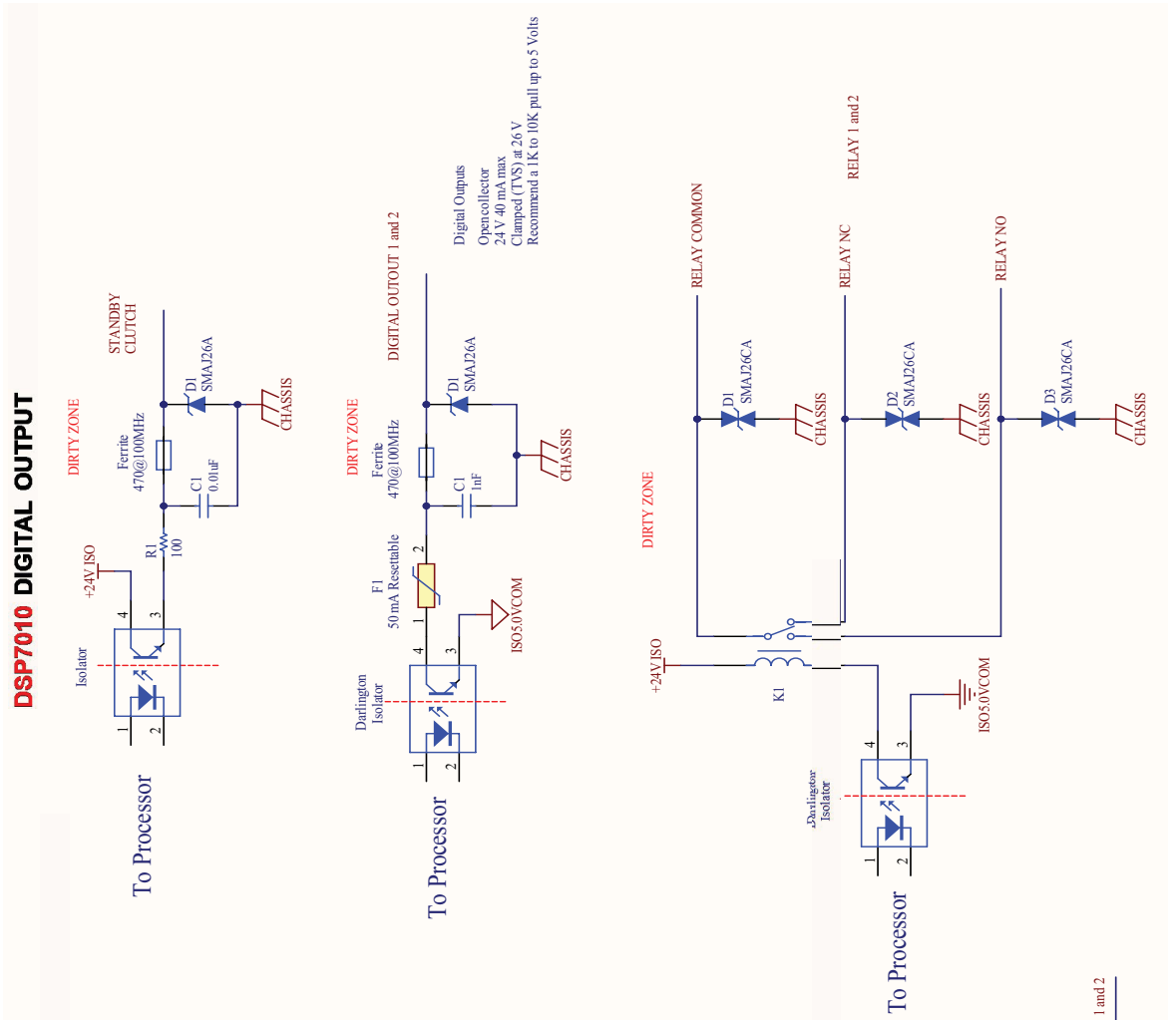


# APPENDIX C. SCHEMATICS

## C.1 DIGITAL INPUT

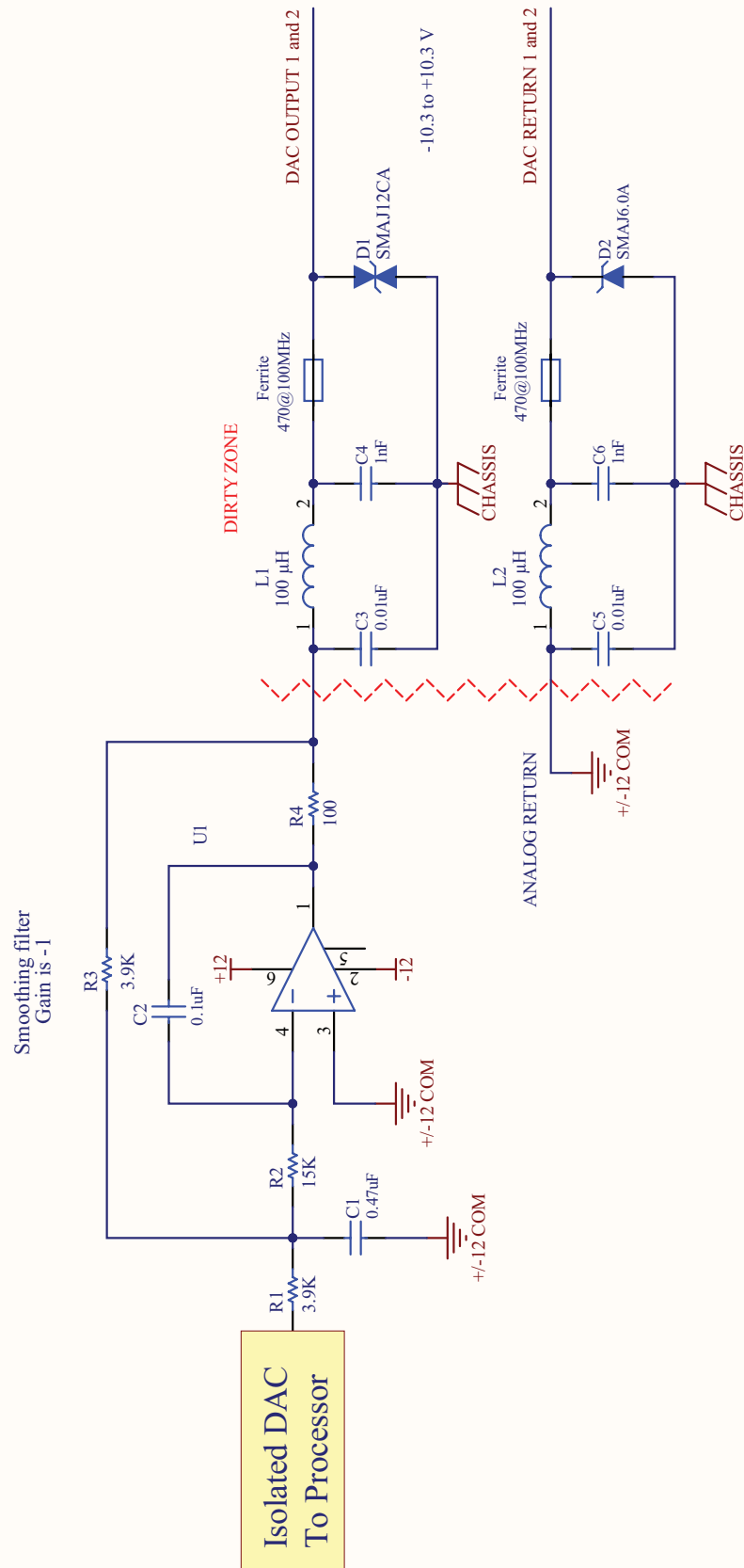


## C.2 DIGITAL OUTPUT

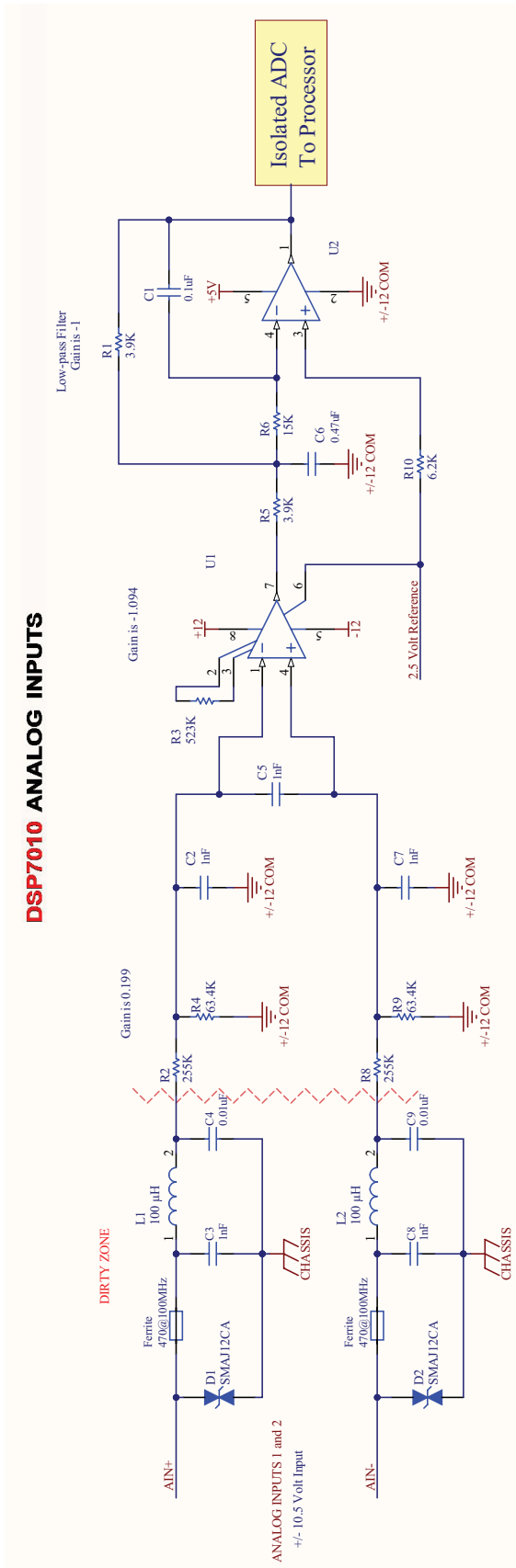


### C.3 ANALOG OUTPUT

#### DSP7010 ANALOG OUTPUT

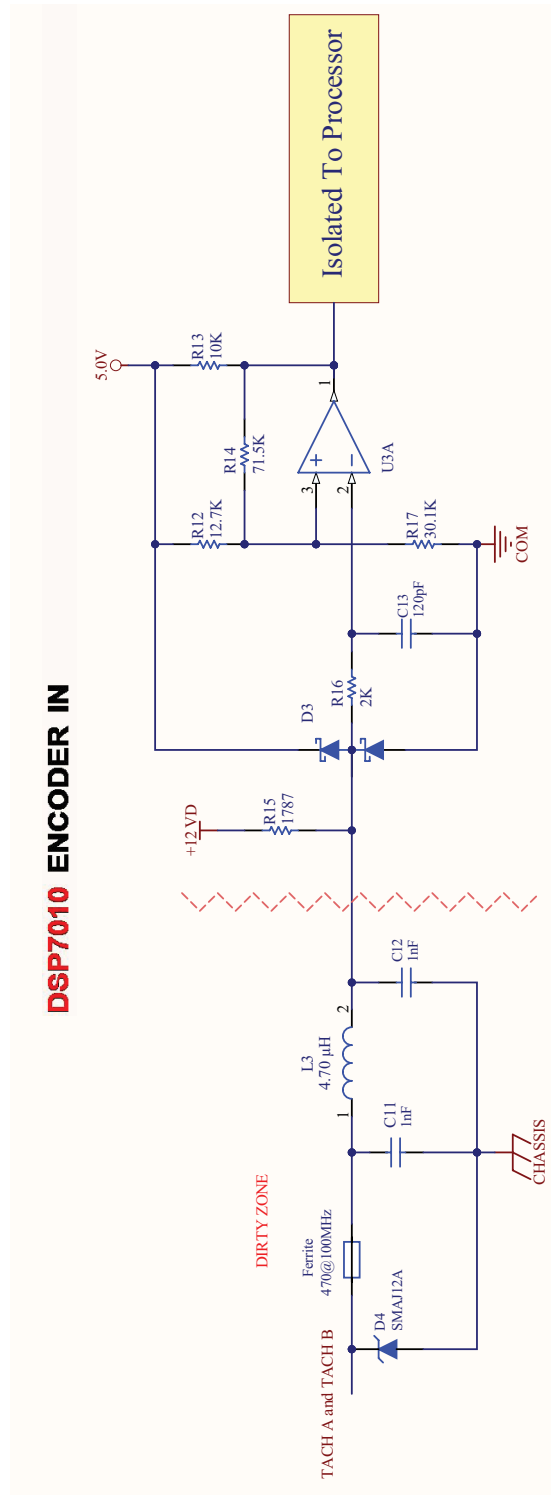


## C.4 ANALOG INPUTS



# C.5 ENCODER IN

## DSP7010 ENCODER IN







# SERVICE INFORMATION

## RETURNING MAGTROL EQUIPMENT FOR REPAIR AND/OR CALIBRATION

When returning equipment to MAGTROL INC. (United States) or MAGTROL S.A. (Switzerland) for repair and/or calibration, a completed **Return Material Authorization (RMA) form is required.**



## REVISIONS TO THIS MANUAL

The contents of this manual are subject to change without prior notice. The latest updated versions of our manuals are available and downloadable at any time on Magtrol's website [www.magtrol.com](http://www.magtrol.com) in the « SUPPORT » section.

To ensure that you have the latest version, compare the issue date (on the back of this manual) with the last updated document available on our website.

The table of revisions below lists the significant updates that have been made.

### REVISION DATES

DATE	EDITION	CHANGES	SECTION(S)
03/15/23	1st Edition	Release	All

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