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ALLEN-BRADLEY

1391-DES Digital AC Servo Drive

User Manual

Important User Information

Because of the variety of uses for this equipment and because of the differences between this solid-state equipment and electromechanical equipment, the user of and those responsible for applying this equipment must satisfy themselves as to the acceptability of each application and use of the equipment. In no event will Allen-Bradley Company be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The illustrations shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, the Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits or equipment described in this text.

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This information in this manual is organized in numbered chapters. Read each chapter in sequence and perform procedures when you are instructed to do so. Do not proceed to the next chapter until you have completed all procedures.

ATTENTION: Identifies information about practices or circumstances that can lead to personal injury or death, property damage or economic loss.

Attentions help you:

- identify a hazard
- avoid the hazard
- recognize the consequences

IMPORTANT: Identifies information that is especially important for successful application and understanding of the product.

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Chapter 1

Introduction

Manual Objectives

This manual is meant to guide the interface, installation, programming and troubleshooting of a 1391-DES Digital AC Servo Drive. The contents are arranged in order from a general description of the drive to troubleshooting and maintenance. To assure successful installation and operation, the material presented must be thoroughly read and understood before proceeding. Particular attention must be directed to the Attention and Important statements contained within.

Important Information about this Manual
This manual has been prepared primarily to support this product in a single drive application. It is a standard document that is intended to help the user understand the individual operating characteristics and limitations of this equipment including hazards associated with installation, programming and maintenance procedures. Note the following points:

- This equipment has been designed to meet the requirements of a component drive in an integrated drive system.
- While the potential hazards associated with the drive remain the same when used in a system environment, it must be noted that special considerations are to be given to characteristics of other peripheral solid-state control equipment and the cumulative impact on safety.
- Manufacturers and engineering groups responsible for specification or design of electrical control equipment must refer to applicable industry standards and codes for specific safety guidelines and interface requirements.
- In the actual factory environment, the user is responsible to ensure compliance with applicable machine and operator safety codes or regulations which are beyond the scope and purpose of this document.

General Precautions

In addition to the precautions listed throughout this manual, the following statements which are general to the drive must be read and understood.

ATTENTION: Only personnel familiar with the 1391-DES Digital Servo Drive and associated machinery should plan or implement the installation, start-up and subsequent maintenance of the drive. Failure to comply may result in personal injury and/or equipment damage.

ATTENTION: An incorrectly applied or installed drive can result in component damage or a reduction in product life. Wiring or application errors, such as, undersizing the motor, incorrect or inadequate AC supply, or excessive ambient temperatures may result in malfunction of the drive.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this assembly. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference Allen-Bradley publication 8000-4.5.2, Guarding Against Electrostatic Damage or any other applicable ESD Protection Handbook.

Certification Notice: In order to maintain UL listing on Allen-Bradley 1391-DES Digital Servo Drives, the user must provide power from a 1391 Isolation Transformer. Use of any other transformer voids the UL listing.

The user is responsible for providing motor overload protection in accordance with the National Electrical Code (NEC), and any other local codes that may apply.

Drive Description

The 1391-DES Pulse Width Modulated Digital Servo Drive is a digital and programmable single axis, AC servo drive. It has been packaged to require a minimum amount of panel space while containing, as standard, a number of features required by the machine tool and automated equipment industries.

The 1391-DES allows Allen-Bradley 1326 AC servomotors to be operated from 33% to 50% over their rated speed. This can help achieve greater precision, a finer finished product and increased production from existing machinery.

The 1391-DES is generally used with computer aided, closed loop positioning systems such as Allen-Bradley “S” Class or IMC products. These systems control the position and linear or rotary motion of various machine members on an automated machine. To enhance system reliability, the 1391-DES has an encoder output (AQB) that produces four channels of 2048, 1024, 512 or 256 lines and two marker pulses per motor revolution which feeds position information to the position controller.

All components are mounted in an open framed package with a slide-on front cover. The drive is intended to be panel mounted in an enclosure and ventilated with filtered and/or cooled air. An internal fan is included to circulate air over the power heat sink.

The 1391-DES converts a three-phase, 50/60 Hz input, to a variable AC voltage with controlled phase, amplitude and frequency. The output which is proportional to a user supplied analog command, regulates the speed and/or current (torque) of a 1326 permanent magnet AC servomotor. The drive is available in ratings of 15, 22.5 and 45A RMS with all package sizes being identical. A 1391 Transformer, 1326 AC Servomotor and 1326 Cables complete the servo system.

Standard Features

The 1391-DES contains a number of standard features required in a typical automated machine servo system.

- Input protected against transient voltage.
- A power line/DB contactor which opens the AC line to the drive and inserts a shunt regulator resistor across the DC bus whenever the contactor is de-energized.
- An integral circuit breaker which will open all three AC line leads in the event of a short circuit condition in the power circuitry.
- A standard 300V DC power bus supply that includes an integral shunt regulator.
- A shunt regulator resistor to dissipate the energy generated by the motor during regenerative braking.
- Prompted startup procedure to shorten setup time.
- Two line LCD display and programming panel.
- Patented current control implementation.
- Torque feedforward differential input.
- Microprocessor based logic boards that can be quickly removed and easily interchanged for troubleshooting and diagnostics.
- Three drive ratings that are in the same physical package and have identical mounting dimensions.
- True vector control.
- Up to 600 feet (183 meters) between drive and motor.

Options/Modifications

The 1391-DES contains most functions needed in a servo system.

The following are selectable at the user's option:

- Contactor Auxiliary Switch
  Two N.O. (normally open) contacts are mounted on the main power contactor and wired to the power terminal block. These contacts can be used in a motor brake control circuit or as an indicator that the contactor has closed.
- Current or Torque Amplifier Operation
  When the velocity loop is being closed as part of the position control system, the drive can be configured to operate as a current or torque amplifier by selection on the programming panel.
- External Shunt Regulator Resistor
  On 15 and 22.5A drives an internal power resistor that is part of the DC bus voltage shunt regulator can dissipate 162 watts continuous power. Some applications such as an overhauling load have excessive regenerative energy to dissipate. For these applications, an external shunt regulator resistor rated at 386 watts continuous can be supplied for user mounting on 22.5A drives. This is selectable by removing the jumper on TB5 and using an external resistor. The shunt has integral fusing accessible from the outside of 15 and 22.5A drives. The 45A drive has an externally mounted resistor and fuse.

Important: An external shunt regulator resistor is included as standard equipment on 45A units. An additional unit is not required.

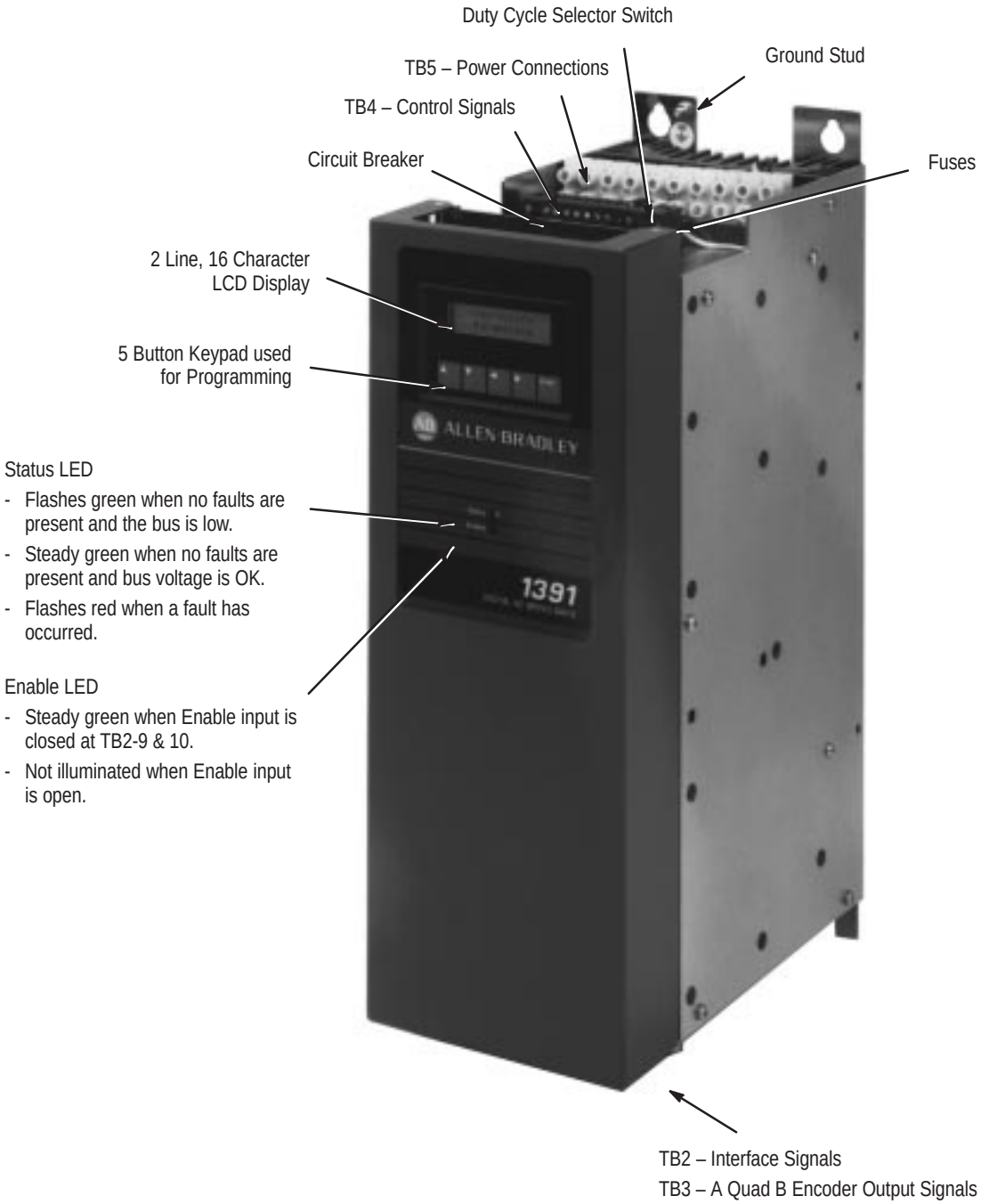
- Tach Output
  A voltage equal to 1.2V DC/1000 RPM is available at TB2.
- Torque or Current Monitor
  A voltage equal to 3.0V DC=100% scaled current is available at TB2.
- Anti-Backlash
  Anti-backlash control can be implemented with several software parameters and an additional instruction manual. Contact your local Allen-Bradley Sales Office for details.
- Linear Accel/Decel
  Linear accel/decel can be set using the CR-APG-001 Control Module. This module provides a manually generated trapezoidal velocity profile for up to four preset speeds.

Important: The 1391-DES contains one accel/decel rate which can be used if accel/decel times will be the same.

Drive Layout

Figure 1.1 provides an exterior view of the 1391-DES AC Servo Drive, showing accessibility of various components.

Figure 1.1
1391-DES Digital AC Servo Drive



End of Chapter

Chapter 2

Specifications

Chapter Objectives

Chapter two contains the electrical and environmental specifications for the 1391-DES. Dimensions are provided in Appendix A.

Drive Specifications

The general specifications of the 1391-DES are provided in the listing below. The specifications are divided when necessary for the various drive ratings.

Specific Drive Ratings	1391-DES15	1391-DES22	1391-DES45
Nominal Bus Voltage	300V DC	300V DC	300V DC
Continuous Current (RMS)	15A	22.5A	45A
Peak Current (RMS)	30A	45A	90A
Continuous Power Output	5.0 kW	7.5 kW	15.0 kW
Peak Power Output	10.0 kW	15.0 kW	30.0 kW
Input Circuit Breaker Rating	17A RMS	26A RMS	38A RMS
Circuit Breaker Interrupt Rating (Symmetrical Amperes)	1300A	1300A	1300A
Unit Weight in lbs. (kg)	22 (9.97)	28 (12.69)	34 (15.40)

All Drive Ratings	
Static Gain (A/RMS)	1.5 x Rated Motor Current / rpm (typical)
Form Factor	1.03 or less
Peak Current Limit Adjust	20 to 300% of Rated Motor Current or 2 x Continuous Rating of Drive (max.), whichever achieves Drive Peak Current Rating first
Drive Efficiency	85% (Minimum at Rated Load)
Power Factor	95% Minimum
Modulation Frequency	2500 Hz ±10%
Drift (Referred to Tach)	0.07 rpm /Degrees C. Maximum
Speed Regulation	0 to 0.05% of Maximum Motor Speed with 95% Load Change
Ambient Temperature	0 to 60° C (32 to 140° F)
Storage Temperature	0 to 65° C (32 to 149° F)
Input Voltage (from Transformer)	Power: 230V AC +10%/–15%, Three-Phase, 50/60 Hz ±3 Hz Control: 36V AC, Single-Phase
Transformer Input Tolerance	+10%, –15%
Relative Humidity	5 to 95% Non-Condensing
Deadband	Zero
Altitude	1000 meters (3300 feet)
Integral Fan Output	50 CFM (Unloaded)
Max. RMS Short Circuit Current	1300A (Symmetrical Amperes)
Certifications	UL Listed - File No. E59272, CSA Certified - File No. LR32334-548,

Specifications are for reference only and are subject to change without notice.

Environmental Specifications

The 1391-DES must be mounted in an enclosure that is clean, dry and ventilated by filtered or cooled air. Enclosures vented with ambient air must have appropriate filtering to protect against contamination caused by oils, coolants, dust, condensation etc. The ambient air temperature must be kept between 0 to 60° C (32 to 140° F) and the humidity between 5 and 95%, non-condensing.

The 1391-DES is equipped with an integral cooling fan. The general flow of air through the unit must be maintained by following the recommended spacing guidelines found in Chapter 7. The 1391-DES can operate at elevations to 3300 feet (1000 meters) without derating, however, the current rating must be derated by 3% for each additional 1000 feet (305 meters) up to 10,000 feet (3050 meters). Consult with your local Allen-Bradley Sales Representative prior to operation over 10,000 feet (3050 meters).

Drive Power Dissipation

The 1391-DES dissipation characteristics are approximated in Table 2.A.

Table 2.A
Drive Power Dissipation

Rated Power Output (%)	**1391-DES15** (watts)	**1391-DES22** (watts)	**1391-DES45** (watts)
20	38	55	104
40	76	110	208
60	114	165	312
80	152	220	416
100	190	275	520

Transformer Power Dissipation

The power dissipation characteristics of the 1391 Isolation Transformer are shown in Table 2.B.

Table 2.B
1391 Isolation Transformer Power Dissipation

Rated Power Output (%)	**1.5kVA** (watts)	**3.5kVA** (watts)	**5.0kVA** (watts)	**10.0kVA** (watts)	**12.5kVA** (watts)	**15.0kVA** (watts)
20	13	35	50	100	125	150
40	25	70	100	200	250	300
60	38	105	150	300	375	450
80	50	140	200	400	500	600
100	60	175	250	500	625	750

Important: Power Dissipation figures shown are for use in calculating cumulative system heat dissipation to ensure ambient temperature inside enclosure does not exceed 60° C (140° F).

Chapter 3

Receiving, Unpacking and Inspection

Chapter Objectives

Chapter 3 provides the information needed to unpack, properly inspect and if necessary, store the 1391-DES and related equipment. The section entitled *Inspection* provides a complete explanation of the 1391-DES catalog numbering system.

Receiving

It is the responsibility of the user to thoroughly inspect the equipment before accepting the shipment from the freight company. Check the item(s) received against the purchase order. If any items are obviously damaged, it is the responsibility of the user not to accept delivery until the freight agent has noted the damage on the freight bill. Should any concealed damage be found during unpacking, it is again the responsibility of the user to notify the freight agent. The shipping container must be left intact and the freight agent should be requested to make a visual inspection of the equipment.

Unpacking

Remove all packing material, wedges, or braces from within and around the drive. Remove all packing material from the cooling fans, heat sink etc.

Important: Before the installation and start-up of the drive, a general inspection of mechanical integrity (i.e. loose parts, wires, connections, packing materials, etc.) must be made.

Inspection

After unpacking, check the item(s) nameplate catalog number against the purchase order. An explanation of the catalog numbering system is included on the following pages as an aid for nameplate interpretation.

Storing

The drive should remain in its shipping container prior to installation. If the equipment is not to be used for a period of time, it must be stored according to the following instructions:

- Store in a clean, dry location.
- Store within an ambient temperature range of 0 to 65° C (32 to 149° F).
- Store within a relative humidity range of 5% to 95%, non-condensing.
- Do not store equipment where it could be exposed to a corrosive atmosphere.
- Do not store equipment in a construction area.

Isolation Transformer

1391 – T 015 D T

First Position	Second Position		Third Position		Fourth Position		Fifth Position	
Bulletin Number	**Type**		**kVA Rating**		**Primary Voltage & Frequency**		**Secondary Voltage**	
	Letter	Description	Number	kVA	Letter	Description	Letter	Description
	T	Transformer Open Core and Coil	015	1.5	D	240/480V AC, Three-Phase, 60 Hz	T	230V AC, three-phase and four 36V AC, single-phase C.T.windings
			035	3.5	E	240/380/415/480V AC, Three-Phase, 50/60 Hz		
			050	5.0	N	208/230/460/575V AC, Three-Phase, 60 Hz		
			100	10.0				
			125	12.5				
			150	15.0				

NEMA Type 1 Transformer Enclosure Kit

1391 – TA2

Bulletin Number	Accessory Module	
	Letter	Description
	TA2	Fits all kVA ratings on 1386, 1388, 1389 and 1391 Isolation Transformers.

External Shunt Regulator Resistor

1391 – MOD – SR22A

First Position	Second Position		Third Position	
Bulletin Number	**Type**		**Description**	
	Code	Description	Code	Description
	MOD	Modification Kit	SR22A	Shunt Regulator Resistor for 22.5A Drive
			SR45A	Shunt Regulator Resistor for 45A Drive [1]

[1] Drive comes equipped with this resistor as standard. Catalog number is provided if spare or replacement is required,

Bulletin 1391-DES Drive

1391 – DES15 – DI – AQB – A

First Position

Bulletin Number

Second Position

Configuration/ Current Rating

Code	Description
DES15	15A Continuous Current
DES22	22.5A Continuous Current
DES45	45A Continuous Current

Third Position

User Interface

Code	Description
DI	Includes Integral Display

Fourth Position

Output Configuration

Code	Description
AQB	Encoder Output – 2048, 1024, 512, 256 selectable pulses/motor revolution

Fifth Position

Options

Letter	Description
A	24V DC M contactor coil voltage instead of 115V AC (available on 22A drives only)
Blank	115V AC M contactor coil voltage

1326AB Servomotor

1326 A B – A 3 E – 11 – A4

First Position

Bulletin Number

Second Position

Type

Letter	Description
A	AC Servomotor PM Type

Third Position

Design

Description
Factory use only

Fourth Position

Series

Description
Sequentially lettered to designate frame diameters.

Code	Description
A	4.25” (108 mm)
B	5.88” (149 mm)
C	7.63” (194 mm)

Fifth Position

Motor Length

Description
Sequentially numbered to indicate stack length within a given frame size.

Sixth Position

Max. Op. Speed [2]

Letter	RPM
B	1600/2000
C	2000/3000
E	3000/4000
G	5000/6000

Seventh Position

Mounting & Shaft Description

Code	Description
11	NEMA Inch Combination Face/Flange with Keyway
21	IEC Metric Flange with Keyway

Eighth Position

Standard Options

Code	Description
A4	72 lb.-in. (8.1 N-m) Holding Brake w/90V DC Coil.
A5	120 lb.-in. (13.6 N-m) Holding Brake w/90V DC Coil.
A7	360 lb.-in. (40.7 N-m) Holding Brake w/90V DC Coil.
K4	72 lb.-in. (8.1 N-m) Holding Brake w/24V DC Coil.
K5	120 lb.-in. (13.6 N-m) Holding Brake w/24V DC Coil.
K7	360 lb.-in. (40.7 N-m) Holding Brake w/24V DC Coil.

[2] Ratings shown indicate the rated speed and speed capability of the motor with the 1391-DES (rated/w 1391-DES).

1326AB Torque Plus Series Servomotor

1326 AB – A 4 30 E – 21 – A4

First Position	Second Position		Third Position		Fourth Position	Fifth Position	Sixth Position		Seventh Position		Eighth Position
Bulletin Number	**Type**		**Voltage**		**Series**	**Motor Length**	**Max. Operating Speed**		**Mounting & Shaft Description**		**Standard Options**
	Letter	Description	Code	Rating	Description	Description	Letter	Rated/1391-DES	Code	Description	
	AB	Ferrite AC Servomotor	A	230V AC	Sequentially lettered to designate frame diameters.	Sequentially numbered to indicate stack length within a given frame size.	B C E G	1600/2000 rpm 2000/3000 rpm 3000/4000 rpm 5000/6000 rpm	21	IEC Metric Flange with Keyway	

Code	Description
4	115 mm
5	166 mm
7	215 mm

Code	Description
A4	72 lb.-in. (8.1 N-m) Holding Brake w/90V DC Coil for 1326AB-A4
A5	120 lb.-in. (13.6 N-m) Holding Brake w/90V DC Coil for 1326AB-A5
A7	360 lb.-in. (40.7 N-m) Holding Brake w/90V DC Coil for 1326AB-A7
K4	72 lb.-in. (8.1 N-m) Holding Brake w/24V DC Coil for 1326AB-A4
K5	120 lb.-in. (13.6 N-m) Holding Brake w/24V DC Coil for 1326AB-A5
K7	360 lb.-in. (40.7 N-m) Holding Brake w/24V DC Coil for 1326AB-A7

Shaft Oil Seal Kit

1326AB – MOD – SS V – A 1

First Position	Second Position		Third Position	Fourth Position		Fifth Position				Sixth Position	
Bulletin Number	**Type**		**Shaft Seal**	**Material**		**Motor Series**				**Motor Mounting [3]**	
	Code	Description		Letter	Description	Letter	Standard	Torque Plus		Number	Description
	MOD	Modification Kit		V	Viton	A B C	Series A Series B Series C	-A4 -A5 -A7	*Use Metric Only*	1 2	Std. Inch Metric

[3] "A" Series motors with brake must use 1326AB-MOD-SSV-A2.

Brake Power Supply Rectifier

1326 – MOD – BPS

Bulletin Number	Type		Description	
	Code	Description	Code	Description
	MOD	Modification Kit	BPS	Single-phase, full-wave, screw mount rectifier. 115V AC input, for use with 90V DC brakes. [4]

[4] Up to 4 brakes per rectifier can be used.

Motor Junction Box Kit [5]

1326AB – MOD – RJAB

First Position	Second Position		Third Position	
Bulletin Number	**Type**		**Description**	
	Code	Description	Code	Description
	MOD	Modification Kit	RJAB	For all AB-A & B Series Motors (A4 & A5 Torque Plus Motors)
			RJBC	For all AB-B4 & Cx Series Motors (A7 Torque Plus Motors)

[5] The motor comes standard with IP65 plug style connectors mounted radially to the motor. This kit allows the connectors to be brought out axially to the motor without further wiring. Kit includes Motor Junction Box and Mounting Hardware.

Feedback Mounting Adapter Kit [6]

1326AB – MOD – M4 – C1

First Position	Second Position		Third Position	Fourth Position	
Bulletin Number	**Type**		**Mounting Adapter Kit for . . .**	**Coupling Size for . . .**	
	Code	Description		Code	Motor Series
	MOD	Modification Kit		C1	A, B, C (A4, A5, A7 Torque Plus)
				Blank	For M22, M23, M24, M25, M26

Code	Description
M4	A-B 845H/T Encoder for AB-A series motor (A4 Torque Plus)
M5	A-B 845H/T Encoder for AB-B series motor (A5 Torque Plus)
M6	A-B 845H/T Encoder for AB-C series motor (A7 Torque Plus)
M22	Type VC/VD 4.25” (108 mm) Resolver for AB-B series motor (A5 Torque Plus)
M23	Type VC/VD 4.25” (108 mm) Resolver for AB-C series motor (A7 Torque Plus)
M24	0.375” (9.5 mm) diameter heavy duty shaft extension adapter
M25	0.625” (15.9 mm) diameter heavy duty shaft extension for type VC/VD 4.25” (108 mm) resolver
M26	Foot mounting kit for M25

[6] All kits contain a feedback device mounting adapter and mounting hardware. M4, M5 and M6 include a motor to encoder coupling. M22 and M23 do not include a coupling since it is included with the resolver feedback device.

Feedback Coupling [7]

1326 – MOD – C1

First Position	Second Position		Third Position	
Bulletin Number	**Type**		**Coupling Size**	
	Code	Description	Code	Size – Motor Shaft to Encoder Shaft
	MOD	Modification Kit	C1	3/8" to 3/8" (9.5 mm to 9.5 mm) – Standard on all 1326AB Motors
			C2	1/4" to 3/8" (6.4 mm to 9.5 mm)

[7] The feedback coupling is included as standard with all Feedback Mounting Adapter Kits.

Resolver Feedback Package

1326AB – MOD – VC 1:1

First Position	Second Position		Third Position	Fourth Position
Bulletin Number	**Type**		**Resolver Feedback Package**	**Gear Ratio Input:Resolver**
	Code	Description		
	MOD	Modification Kit [8]		

Code	Description
VC	4.25" (108 mm) feedback package with cast housing and single or vernier (dual) format with receiver (Harowe 11BRW-300-F-58A or equivalent) type resolver(s) for use with A-B series 8200 CNC and IMC] 120, 121, 123.
VD	4.25" (108 mm) feedback package with cast housing and single or vernier (dual) format with transmitter (Harowe 11BRCX-300-C10/6 or equivalent) type resolver(s) for use with A-B series 8600, MAX and IMC S Class controllers with a REC 4096 Board.

Code	Description
1:1	Single device format – 1 turn of the motor shaft to 1 turn of the resolver.
1:2	Single device format – 1 turn of the motor shaft to 2 turns of the resolver.
1:2.5	Single device format – 1 turn of the motor shaft to 2.5 turns of the resolver.
1:5	Single device format – 1 turn of the motor shaft to 5 turns of the resolver.
255	Absolute master/vernier format – 1:1 input/master, 255:256 master/vernier for IMC 120, 121, 123 only.
256	Absolute master/vernier format – 1:1 input/master, 256:255 master/vernier for 8600 series and MAX, IMC S class controls with a REC 4096 Board.
424	Absolute master/vernier format – 1:1 input/master, 424:425 master/vernier for IMC 120, 121, 123 only.
425	Absolute master/vernier format – 1:1 input/master, 425:424 master/vernier for 8600 series and MAX, IMC S class controls with a REC 4096 Board.
800	Absolute master/vernier format – 1:1 input/master, 800:801 master/vernier for IMC 120, 121, 123 only.
801	Absolute master/vernier format – 1:1 input/master, 801:800 master/vernier for 8600 series controllers (is not applicable for use with MAX and IMC S Class controls)

[8] Kit includes Resolver Feedback Package, mounting hardware and 3/8" to 3/8" (9.5 mm to 9.5 mm) resolver to motor mounting coupling.

Power and Feedback Cables

1326 – C P AB T 15

First Position

Bulletin Number

Code	Description
1326	Standard Cable
1326ES [9]	Extended length cable used with 1391B-ES & 1391-DES Only

Second Position

Type

Code	Description
C	Connector & Cable Assembly
CC	Connector on both ends (for use with 1391C-HB)

Third Position

Function

Letter	Description
P	Power Connection
F	Commutation & Feedback Connection
E	845H/T Encoder
V	All 4.25” (108 mm) Resolver Packages

Fourth Position

Motor Size Used On

Code	Type
AB	Series A & B (except 1326AB-B4)
C	Series C & 1326AB-B4
U	All Series

Fifth Position

Power Track Cable

Letter	Description
T	All Series, used for high flex applications
Blank	Standard Cable

Sixth Position

Cable Length

Code	Description
K	Connector Kit (No Cable)
15	15’ (4.6 m)
30	30’ (9.1 m)
50	50’ (15.2 m)
100	100’ (30.4 m)
150 [9]	150’ (45.7 m)
200 [9]	200’ (61 m)
250 [9]	250’ (76.2 m)
300 [9]	300’ (91.4 m)

[9] The extended length option is only available for 1326-CFUxx, CPABxx and CPCxx cables and can only be used with 1391B-ES and 1391-DES drives.

Blower Mod Kit

1326AB – MOD – G3

First Position

Bulletin Number

Second Position

Type

Code	Description
MOD	Modification Kit

Third Position

Description

Code	Motor Series
G3	Rear mounted blower for C series motors
G4	“Saddle” type blower for C series motors with rear mounted encoders

Planetary Gearbox

1326AB – PG A 05 – LB – 21

First Position

Bulletin Number

Second Position

Type

Code	Description
PG	Straight Planetary Gearbox
RP	Right Angle Planetary Gearbox

Third Position

Used on 1326AB Motor Series

Code	Standard	Torque Plus
A	Series A	-A4 [10]
B	Series B	-A5 [10]
C	Series C	-A7 [10]

Fourth Position

Gear Ratio (Motor Shaft:Output Shaft)

Code	Description
03	3:1
05	5:1
10	10:1
15	15:1
20	20:1
30	30:1
50	50:1
100	100:1

Fifth Position

Options

Code	Description
Blank	No Options
LB	Low Back-lash Option

Sixth Position

Adapter

Code	Description
21	Metric
11	English

[10] Use only -21 (Metric) style adapter gearboxes for -A4, -A5 Torque Plus Motors.

Chapter 4

Description of Operation

Chapter Objectives

Chapter 4 is intended to familiarize the reader with the circuitry of the 1391-DES in terms of function and operation.

General

The intended use of the 1391-DES is to control the speed and torque of an AC servomotor in a closed loop position system. A complete servo system can be configured with a 1391-DES Servo Drive, 1326 AC Servomotor and 1391 Isolation Transformer. Refer to the 1391-DES Block Diagram presented in Figure 4.4 for general layout.

The 1391-DES PWM Servo Drive is made up of the following: 300V DC power supply, power transistor output modules, shunt regulator circuit, logic power supply, microprocessor based logic boards, isolated current sensing, circuit breaker and line contactor.

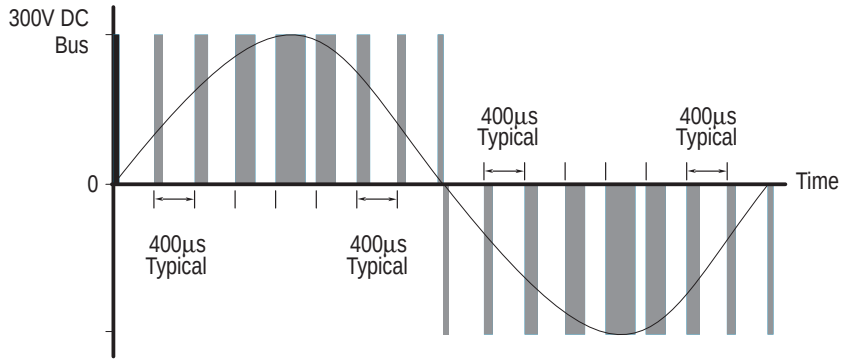
300V DC Power Bus Supply

The drive contains an integral, unregulated, 300V DC nominal, full load power supply. It consists of the power transformer input (230V AC, three-phase, 50 or 60 Hz), a three-phase input bridge rectifier and one power supply filter capacitor (C1).

PWM Operation

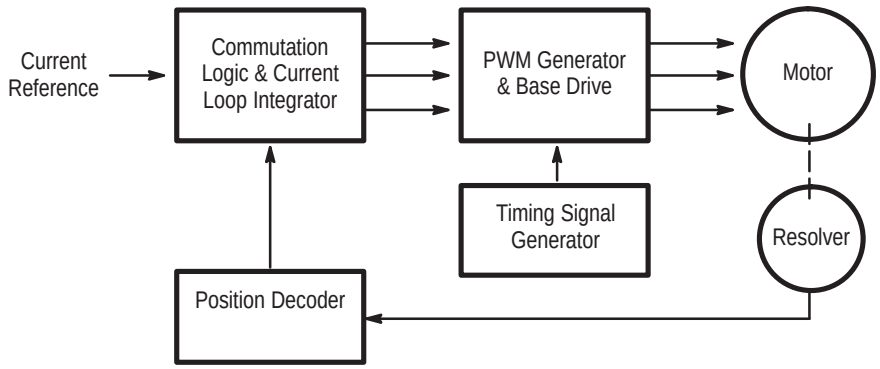
The 1391-DES incorporates a fixed timing wave (V_T) of 2500 Hz. The drive generates a three-phase sine wave by varying the width of the fixed timing pulses (see Figure 4.1). This frequency corresponds to the velocity command. The 0 to 10V DC velocity command is scaled to provide an output frequency (dotted line) that varies from 0 to 200 Hz, depending on the maximum velocity of the motor. This variable frequency output drives a permanent magnet AC servomotor whose speed varies as a function of the frequency.

Figure 4.1
PWM Waveform



The three-phase relationship between the reference signal and the timing wave provide PWM pulses to the power transistor base drive. This base drive switches the power transistors across the 300V DC bus, providing current to the motor windings, thus causing the motor to turn. A resolver attached to the motor provides a signal corresponding to the actual rotor position of the motor. This signal is decoded to a signal representing rotor position and is fed to the commutation logic along with the torque command. In this way, the drive combines the desired position signal and current reference with the decoded resolver signal to produce a reference signal commanding the motor to speed up or slow down. See Figure 4.2.

Figure 4.2
Operation



Shunt Regulator Operation

The 1391-DES shunt regulator provides power dissipation for regenerative conditions when the energy returned to the drive by the motor exceeds that which can be stored in the bus capacitors. The shunt regulator monitors the bus voltage and at a predetermined “ON” point activates the shunt regulator transistor, allowing current to flow through the shunt resistor and dissipating power in the form of heat. A fuse is placed in series with the resistor to protect it against short circuit conditions. When the shunt transistor is activated and power is being dissipated at the resistor, the bus voltage will quickly decrease, turning the transistor off when the voltage reaches the “OFF” point. This cycle repeats, provided the bus voltage continues to increase to the “ON” point. If too much regenerative energy is present, the bus voltage will continue to increase even with the shunt regulator on. At a predetermined bus voltage level, the 1391-DES will determine that an overvoltage condition exists, and trip out on an Overvoltage Fault.

The shunt regulator behavior is further modified by an adjustable duty cycle timer. The timer is used to model the shunt resistor temperature. SW1, a selector switch located on the top of the drive (see Figure 1.1) determines the temperature level and therefore the average power level at which the drive will trip out. When this level is reached, the drive will be forced to trip out on an Overvoltage Fault. This action would be equivalent to turning the shunt regulator off. Refer to Chapter 10 for further shunt regulator information.

Logic Power Supply

The 1391-DES control logic voltage is ±12V DC and +5V DC. The voltages are generated on the Power Driver Board, which receives its 36V AC input from a tertiary winding on the isolation transformer.

Logic Control Boards

The Logic Control Boards are the printed circuit boards that are readily accessible behind the front cover of the drive. They contain all circuits necessary to control the 1391-DES. These circuits include: the velocity and current loop, programming panel, A Quad B Board, fault detection and annunciation circuits, power-up/power-down logic, PWM generation and forward/reverse controlling circuits.

Fault Monitoring and Detection

A number of fault monitor and detection functions exist on the 1391-DES that guard the drive and help to minimize motor and system faults. The occurrence of a fault will cause the drive to trip out. In this condition, the Drive OK (DROK) contact will open and remain open until the fault is cleared. If the DROK contact is wired into the user’s stop circuit, the line/DB contactor (M) will also de-energize. This will place the shunt resistor across the bus causing the motor to dynamic brake to a stop.

These fault conditions are annunciated through the front panel display. The conditions displayed include:

Overtemperature
The drive contains a thermal switch on the heat sink which indirectly senses transistor module temperature. If the temperature rating of the switch is exceeded, the DROK contact opens and the drive is disabled.

Power Fault
A fault related to the power bridge section of the drive will cause the drive to be disabled and open the DROK contact.

Control Voltage Fault
If the control voltage varies more than ±10% of the nominal 12V DC, this fault will occur. When a fault is detected, the DROK contact opens and the drive is disabled.

Resolver Loss Fault
If the resolver wiring is grounded or missing, this fault will occur. When a fault is detected, the DROK contact opens and the drive is disabled.

Overvoltage
The DC power bus voltage is continuously monitored. If it exceeds a preset level of 405V DC, the DROK contact opens and the drive is disabled

Undervoltage
If the DC power bus voltage drops below 50% of its nominal operating value an undervoltage fault occurs. Parameter 130 selects the reaction of the DROK contacts to an undervoltage detection. Two options are possible: 1) DROK opens, but closes when the bus voltage is restored; 2) DROK is not affected by an undervoltage.

Important: Regardless of interaction with the DROK contacts, the transistor bridge is disabled upon an undervoltage condition. This is done to protect the output transistors against voltage transients.

Current Foldback
The drive contains a fixed time versus current overload circuit which monitors the current through each leg of the output bridge. If the overload is sustained for a period, resulting in the drive rating being exceeded, the circuitry will reduce (foldback) the peak output current of the drive. A continuous overload will fold the available peak current down to its continuous rating. This condition will reduce the current limit or torque available to the motor.

Enable LED
The application of an enable signal by the machine position drive will cause the front panel ENABLE LED to illuminate.

Status LED
The status of the power supplies and fault conditions are monitored continuously. If a fault is present, the front panel FAULT/DRIVE READY LED will flash red and the DROK contact will be open. If the drive is operational, this LED will be green.

Microprocessor Control

The 1391-DES is controlled by an 80C196KB microprocessor. Velocity control, sequencing, fault logic, programming and option control is performed by the processor. Current control is analog, as is the input velocity command. The input command is fed through a 14 bit digital to analog converter (13 bits/8192 resolution and a +/– sign bit).

Isolated Current Sensing

The Logic Control Boards receive current feedback from the Isolated Current Sense Board. This circuitry provides the data used for current loop closure.

Integral Circuit Breaker

The DC bus supply, input rectifier and power circuitry are protected against overcurrents by an integral three pole magnetic circuit breaker. This is not designed nor intended to meet NEC branch circuit requirements.

Line/DB Contactor

The three-phase incoming AC line is opened by the contactor whenever the voltage on the contactor coil is removed. This operation in conjunction with the shunt regulator reduces the bus voltage when the contactor is disabled. The Logic Control Board remains energized except when voltage is removed from the incoming isolation transformer.

Important: The 1391-DES contains a definite purpose contactor that is not to be energized/de-energized more than twice an hour on a continuous basis. The life of the contactor may be reduced considerably if the cycle is exceeded. Contact your local Allen-Bradley Sales Representative for additional information.

Power Driver Board

The Power Driver Board contains the circuitry needed to switch the power transistor modules.

A Quad B Board

The A Quad B Board changes the resolver signal from a 1326AB or AD motor into an encoder signal for use by a position controller (such as an IMC S Class or 12x family controller).

Starting and Stopping

ATTENTION: The Enable control circuitry in the 1391-DES includes solid-state components. If hazards due to accidental contact with moving machinery or unintentional flow of liquid, gas or solids exist, an additional hardwired stop circuit may be required. Refer to the codes and standards applicable to your particular system for specific requirements and additional information. A device that removes AC input power when a stop is initiated is an integral part of this drive. Refer to the following individual stop mode explanations.

ATTENTION: The user has the ultimate responsibility to determine which stopping method is best suited to the application and will meet applicable standards for operator safety.

Starting and Stopping must be accomplished by hardwired user supplied elements as shown in Appendix B. Stopping modes for the 1391-DES are outlined below. Refer to the paragraphs that follow for detailed information. The effects described below assume that the 36V AC control voltage has not been de-energized.

Cause	Effect on Motor
De-energize Line/DB Contactor (M) Coil	Dynamic Brake
Speed Command brought to Zero	Regenerative Brake
Open Enable Input	Regenerative Brake
DROK Opens (Fault)	Coast to Stop

Dynamic Braking

When the line/DB contactor (M) is de-energized by the control circuitry, an inherent dynamic braking effect will occur during the DC bus decay, provided the 36V AC logic voltage is not de-energized. The dynamic braking effect depends on the value of the shunt regulator resistor and total load inertia.

Important: Frequent cycling of the line/DB contactor to start/stop the motor will reduce the life of the contactor.

Regenerative Braking

Normal run commands to the drive are performed through the Enable input and any additional customer supplied control circuitry. Refer to Appendix B. With input power applied, a mechanical contact closure (or solid-state contact closure rated +15 to +30V DC, 30 mA) between TB2-9 & 10 will cause the drive to run, provided the line/DB contactor (M) has been energized by the control circuitry. When the Enable input is de-energized, the maximum available reverse torque is applied to the motor in a regenerative stopping mode, which will occur for approximately 450ms.

Coast

An internal drive fault opens the DROK contact. Coasting will only occur if the DROK contact is not wired to the line/DB contactor coil (M) or the Enable input circuits.

Power-Up/Down Sequence

Figure 4.3 describes the various steps involved in the power-up/down sequence of the 1391-DES Drive.

Figure 4.3
Drive Power-Up / Down Sequence

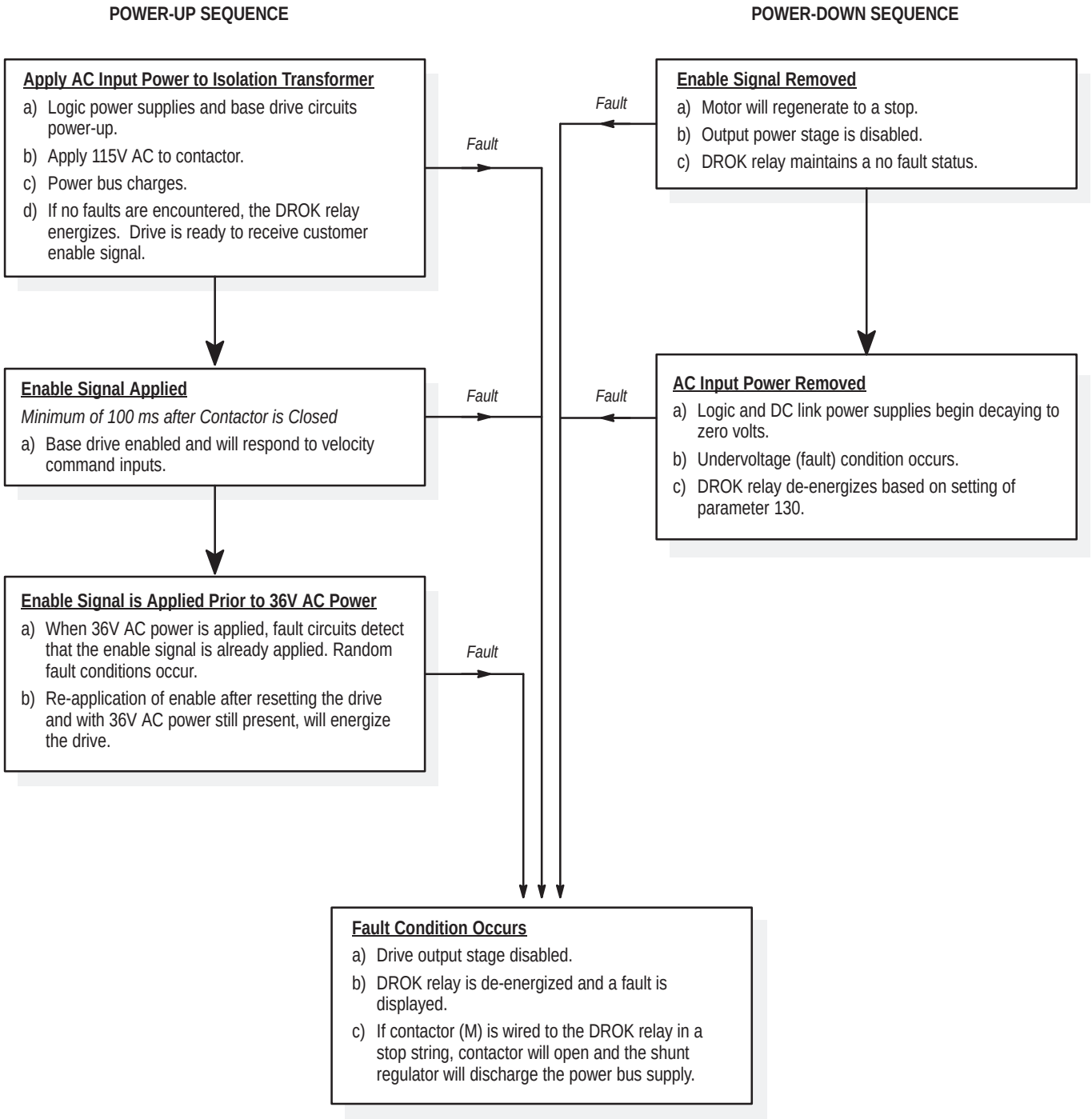
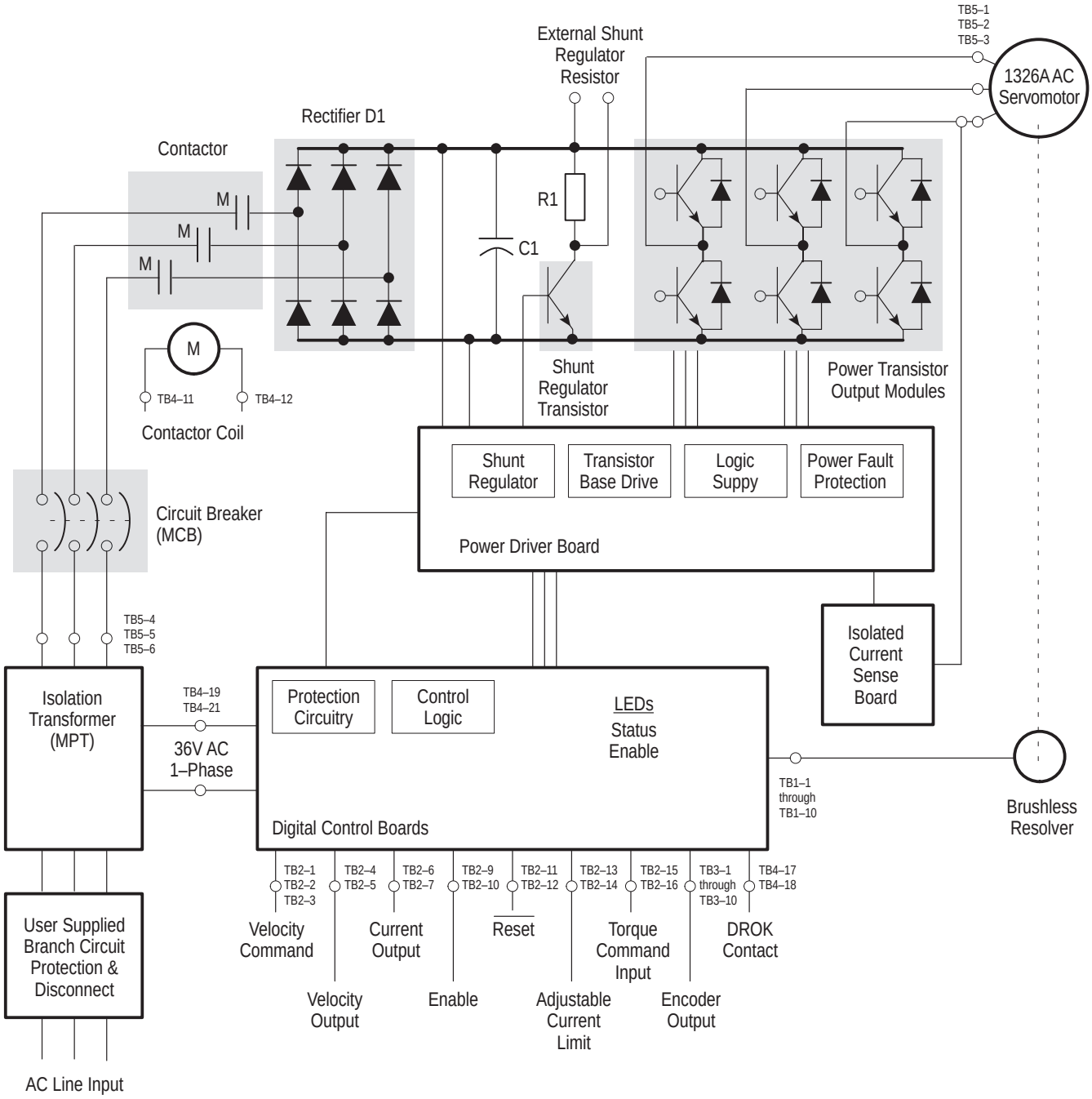


Figure 4.4
1391-DES Block Diagram



Chapter 5

Inputs, Outputs and Switch Settings

Chapter Objectives

Chapter 5 contains descriptions of the various inputs and outputs available on the 1391-DES Digital Servo Drive. Additionally, information for properly setting the drive switches is provided for reference when you perform start-up. For information on shunt regulator adjustments, refer to Chapter 10.

Inputs/Outputs

The following paragraphs provide detailed descriptions of the various inputs and outputs available for the 1391-DES. See Figure 5.2 for terminal block locations.

Terminal Block - TB1

Resolver Signals (TB1, Terminals 1-10)
These terminals are used for connecting the commutation resolver from the motor to the drive. Refer to Appendix B for connection details.

Important: Terminal 1 of TB1 must be connected to chassis ground at the Ground Stud (see Figure 5.2 for Ground Stud location).

Terminal Block - TB2

Please note that there are no connections to TB2-18, 19 & 20.

Velocity Command Input (TB2, Terminals 1, 2)
The drive will accept up to a ±10V DC velocity command signal to achieve maximum motor speed. Voltages lower than ±10V DC can be used by reprogramming parameter 211 (Analog Velocity Gain). The plus (+) and minus (–) reference are at terminals 2 and 1, respectively. Shield must be terminated at one end only. The differential impedance of the velocity command input is 80k ohms (40k ohms for single ended inputs).

Signal Common (TB2, Terminals 3, 5, 7, 8, 12, 17)
Signal input reference point.

Analog Out 1 (Velocity) (TB2, Terminal 4)
A voltage corresponding to the motor velocity and direction of rotation will be present between this terminal and signal common (Terminal 5). +1.2V DC for each 1000 rpm is available. Minimum impedance that can be placed across this output is 10k ohm.

Analog Out 2 (Current) (TB2, Terminal 6)
A voltage corresponding to positive and negative current will be present at this terminal and signal common (Terminal 7). +3V DC equals 100% of the continuous rating of the motor with +6V DC equaling 200%. Minimum impedance that can be placed across this output is 10k ohm.

Enable Input (TB2, Terminals 9, 10)
Normal Run commands to the drive are performed through the Enable input and any additional user supplied run control circuitry. With input power applied and the line contactor energized, a mechanical contact closure (or a solid-state contact closure rated +15 to +30V DC, 30 mA) between TB2-9 & 10 will cause the drive to run. When this input is de-energized, the control will cause a regenerative braking action in the motor.

Reset (TB2, Terminal 11)
Removing the Enable signal and momentarily connecting this terminal to signal common (TB2-12) will reset the drive after a drive fault occurs.

Important: A Reset must not be initiated until the cause is determined and corrected.

Adjustable Current Limit (TB2, Terminal 13, 14)
The current limit of the drive is set to 300% of motor continuous rating or twice the continuous rating of the drive, whichever is lower. Applying a voltage between 0 and +10V DC to terminals 13 & 14 will limit the peak current of the drive. The range of this input is the lower of the following:

- Value set by parameters 156 and 157,
- Twice the continuous rating of the drive.

For each volt applied, 30% reduction of current limit is achieved, based on 300% of motor rating being available. If only 200% current (drive peak) is available, a voltage of less than 3.33 volts will have no effect on current limit. On TB2, pin 14 must be positive with respect to pin 13 for this input to operate. Refer to the following information.

Voltage	Percent of Peak Rating	Voltage	Percent of Peak Rating
10V	10%	4V	180%
9V	30%	3V	210%
8V	60%	2V	240%
7V	90%	1V	270%
6V	120%	0V (open)	300%
5V	150%		

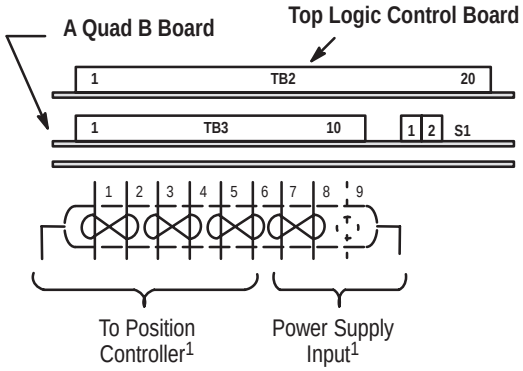
Torque Command Input (TB2, Terminals 15, 16)
Terminals 15 and 16 provide a small amount of input filtering for operating the drive as a torque block (with IMC S Class, MAX, IMC 121 and 123) or velocity feedforward mode. A ±3V DC command equals 100% of the motor current setting (as set by parameter 155).

Terminal Block - TB3 (A Quad B Board)

Figure 5.1 provides interconnect information between the position controller and TB3 on the A Quad B Board.

ATTENTION: To guard against possible damage to the A Quad B Board, assure that wiring between TB3 and the position controller is correct. Refer to Figure 5.1.

Figure 5.1
A Quad B Board Wiring



TB3 Number	Description
1	$\underline{A}$
2	$\overline{A}$ (NOT)
3	$\underline{B}$[2]
4	$\overline{B}$ (NOT)[2]
5	$\underline{Z}$
6	$\overline{Z}$ (NOT)
7	+5V DC (± 5%)
8	Signal Common
9	+8 to +15V DC In
10	No Connection

Important: Note terminal orientation prior to wiring.

1 Recommended Wire – Belden #9728 or equivalent. Maximum distance between the A Quad B Board and the position controller is 40 feet (12.2 meters) using a 5 volt signal. For distances up to 300 feet (91 meters), 18 AWG (0.8 mm^2) wire (Belden 9388 or equivalent) and an 8 to 15V DC power supply must be used.

2 For proper operation when interconnecting to IMC classic products (IMC 110, 12x), the B and B (NOT) signals must be reversed.

3 When interfacing to IMC 121 or 123 controllers, use the 1391-CAQB cable. When interfacing to the integrated packages of the MAX or S Class controls, use the 1391-SAQB or 1391 SAQBK cable.

The A Quad B option operates in the same manner as the Allen-Bradley 845H Line Driver Encoder (26LS31 line driver output). The option requires either a regulated +5V DC at terminal 7 or an unregulated +8 to +15V DC input at terminal 9 (board draws 125mA maximum). The pulse train output is selectable to 256, 512, 1024 or 2048 lines per revolution via the Encoder Output switch, S1 (see page 5-6).

Terminal Block - TB4

Please note that there are no connections to TB4-20 & 22.

Contactor Coil (TB4, Terminals 11, 12)
Connections to the coil of the integral contactor are performed at these terminals. The coil voltage is 115V AC, 50/60 Hz.

Important: Drives with a catalog number of 1391-DESxx-DI-AQB-A will have a 24V DC coil. Drives with a catalog number of 1391-DESxx-DI-AQB-B will have a 240V AC coil.

"M" Contactor Auxiliary Contacts (TB4, Terminals 13, 14, 15, 16)
The auxiliary contacts of the integral contactor are accessed through these terminals. Refer to Table 5.A for contact ratings.

Table 5.A
"M" Contact Ratings (minimum 50 mA at all voltages)

AC Ratings		DC Ratings	
Volts (U_e)	Amperes (I_e)	Volts (U_e)	Amperes (I_e)
12-120	6	28	5.0
220-240	3	110	1.25
380-480	1.5	220	0.62
500-600	1.2	440	0.27
		660	0.20

Drive OK (DROK) Contacts (TB4, Terminals 17, 18)
Application of power to the transformer energizes the logic supply of the drive. When 50% of rated DC Bus voltage is achieved and no drive faults are detected, this relay contact is closed. The contact remains closed until a drive fault occurs or power is removed from the transformer. Contact rating: 115V AC, 1A or 24V DC, 0.3A.

36V AC Logic Supply Voltage (TB4, Terminals 19, 21)
The isolation transformer contains four separate windings. Each winding supplies 36V AC. The 36V AC leads are brought out to terminals 19 and 21 of TB4. See Chapter 10 for transformer details.

Terminal Block - TB5

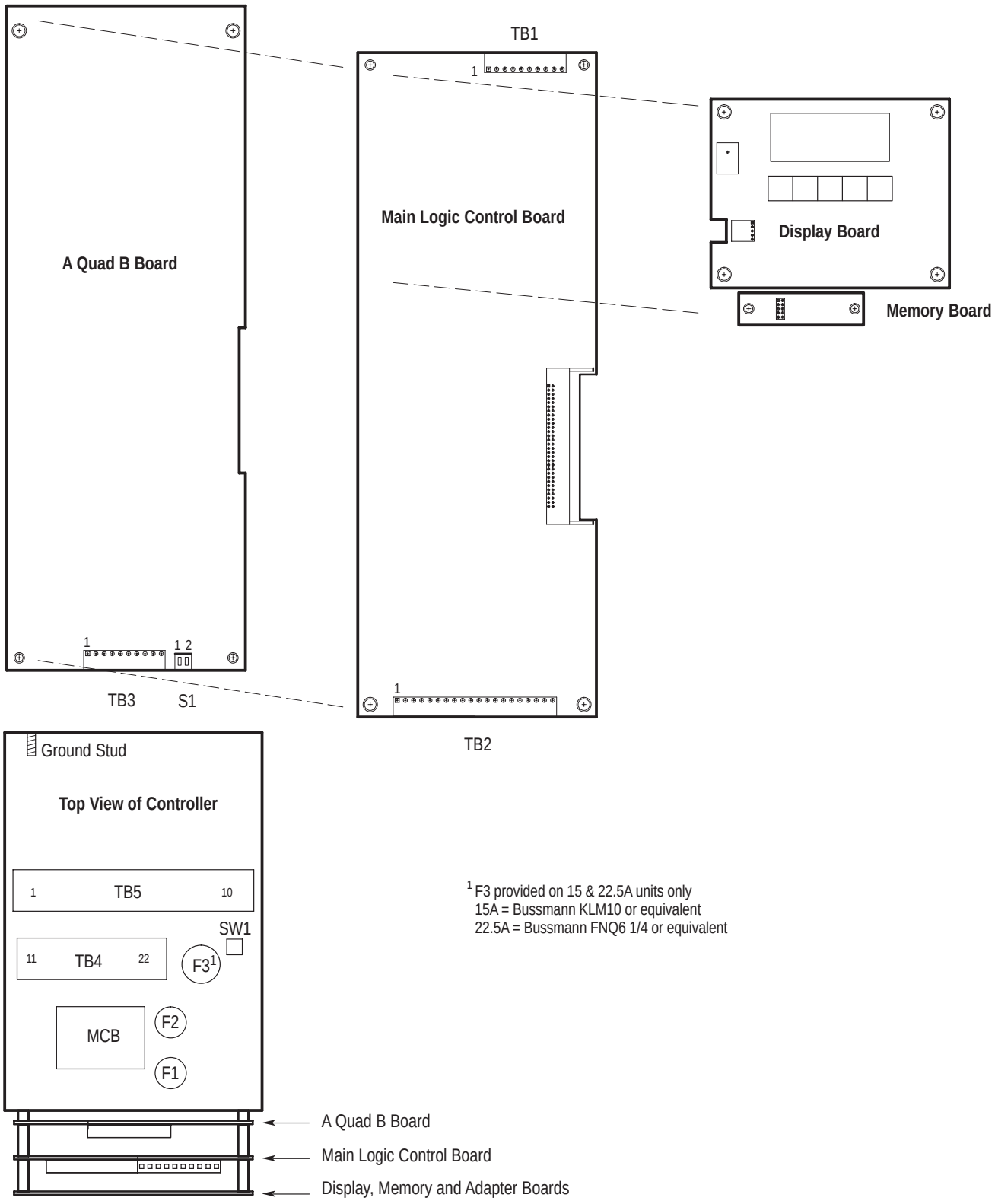
Motor Power Terminals (TB5, Terminals 1, 2, 3)
Motor power is provided at these terminals. Refer to Chapter 7 and Appendix B for connection details.

Input Power Terminals (TB5, Terminals 4, 5, 6)
The drive requires a 230V AC, three-phase, 50 or 60 Hz input supplied by the transformer secondary. Refer to Chapters 7, 10 and Appendix B for wiring and transformer information.

External Shunt Regulator Resistor (TB5, Terminals 8, 9, 10)
The 22.5A drives have provisions to accept an external shunt resistor to supplement the integral unit. This is available for applications that require the dissipation of more regenerative energy to the DC Bus. To use an external shunt resistor, first remove the jumper at terminals 8 and 10 of TB5. Consult your Allen-Bradley sales office for application assistance. Additionally, the bus voltage can be monitored at terminals 9 (+) and 7 (–) of TB5.

The shunt regulator resistor supplied with the 1391-DES45 must be externally mounted and connected to terminals 8 and 9 of TB5 prior to operation. Refer to Chapter 10 and Appendix B for details.

Figure 5.2
Terminal Block, Circuit Board and Switch Locations



[1] F3 provided on 15 & 22.5A units only
15A = Bussmann KLM10 or equivalent
22.5A = Bussmann FNQ6 1/4 or equivalent

Switch Settings

This section provides information on setting the Duty Cycle Selector switch (SW1) and the A Quad B Encoder Output switch (S1). Note that the settings for 1326AP motors are the same as 1326AB motors. Refer to Figure 5.2 for switch locations.

Duty Cycle Selector Switch - SW1

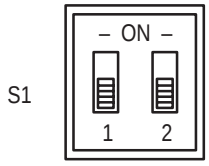
The Duty Cycle Selector Switch (SW1) which is located on top of the drive, modifies the behavior of the shunt regulator. The switch determines the temperature level and therefore the average power level at which the drive will fault. Refer to Chapter 10 for detailed switch setting information.

A Quad B Encoder Output Switch - S1

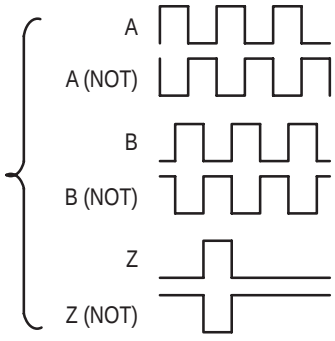
S1 selects the line count that will be output from the A Quad B Board.

ATTENTION: Incorrect setting of S1 can cause erratic and/or improper machine motion which may result in personal injury or equipment damage. Assure that switch S1 has been properly set as shown in Figure 5.3.

Figure 5.3
A Quad B Board Switch (S1) Settings



Line Count/ Revolution	S1-1 Switch Setting	S1-2 Switch Setting
2048	OFF	OFF
1024	ON	OFF
512	OFF	ON
256	ON	ON



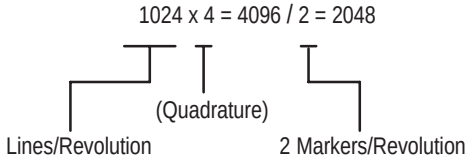
2 Marker Pulses per Revolution

CCW Rotation of Motor Shaft
(similar to Allen-Bradley 845H)

When using the A Quad B option with Allen-Bradley IMC motion controllers, the AMP parameters will be set according to the line count selected. In general, one parameter must be justified when using this device.

Important: For all IMC classic products (IMC 110, 12x) the normal line counts per cycle of the encoder must be divided by two since the drive will see two markers per cycle.

Example (using an IMC 12x Controller)
With switch S1 set to 1024 lines per revolution (S1-2 OFF, S1-1 ON), the lines per cycle of the position feedback device (located in the Feedback Parameters File) must be 2048.



End of Chapter

Chapter 6

Programming

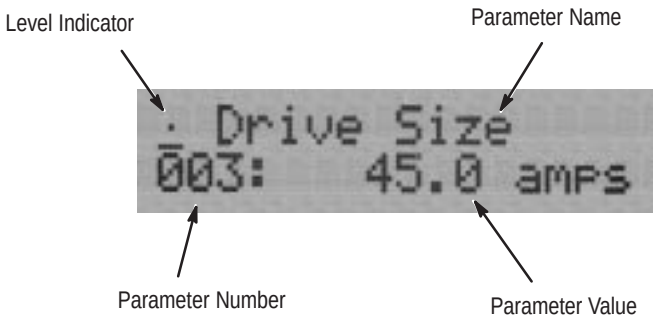
Chapter Objectives

This chapter explains the programming/setup system of the 1391-DES Digital AC Servo Drive. Included is an explanation of the display, general programming procedure and description of the programmable parameters. You will need to read this chapter before performing the start-up procedure provided in Chapter 8.

Display Description

The 1391-DES display is used for programming, as well as status and diagnostic messages. The display consists of a 16 character, 2 line, "Super-Twist" LCD (Liquid Crystal Display) that allows a wide viewing area. The display can be divided into several different sections as shown in Figure 6.1.

Figure 6.1
LCD Display



When power is applied to the 1391-DES the Basic Display (see Figure 6.4) will be shown. The Basic Display alternates (every 2 seconds) between the two displays shown. The alternating display indicates that the drive is functioning normally.

Keypad Description

The 1391-DES display panel utilizes five keys (pushbuttons) which allow the various parameters to be accessed. Once a parameter is accessed, status information of the drive can be viewed. In addition, certain parameters can also be modified.

Each of the keys has several functions depending on the view/modify mode. Refer Figure 6.2 and the paragraphs that follow for a description of the display panel controls.

Figure 6.2
1391-DES Display Panel

Up Arrow Key
This key is used to increase values when modifying parameters. Other uses will be described when applicable.

Down Arrow Key
The Down Arrow key is used to activate modifiable parameters or decrease values. Other uses will be described as required.

Left Arrow Key
This key is used to scroll through parameters or move the cursor when modifying parameters. Other key functions will be described as needed.

Right Arrow Key
The Right Arrow key can be used to scroll through parameters or move the cursor when modifying. Other key functions will be described when required.

Enter Key
The Enter key is used to make a selection or store a changed parameter value in memory. Other key functions will be described as needed.

Parameter Levels

For ease of use, the various parameters of the 1391-DES are numbered and arranged in three different levels. The levels range from viewing simple drive status parameters to more complex setup information. The three levels are as follows:

View Level

The View level allows viewing only of the drive operating conditions (see below). The View level is denoted on the display by a single dot (•) in the upper left corner (see Figure 6.1).

03	Drive Size
19	Final Velocity Command
20	Velocity Feedback
45	Iq (Torque) Current Reference
50	Current Feedback Rated
51	Current Limit
57	Analog Velocity Command
154	Motor Type
253	Display Software Version
254	Drive Software Version

Modify Level

The Modify level allows access to the View level parameters in addition to the system configuration parameters listed below. This level of programming allows parameter modification to some of the View level parameters and the other parameters listed. The Modify level is denoted by two dots (• •) in the upper left corner of the display (see Figure 6.1).

68	Bandwidth Maximum
69	Auto Tune Friction Compensation
128	EEprom Functions
130	Drive OK Mode
131	Language Select
132	Velocity Mode Select
133	Torque Mode Select
144	Clockwise Velocity Limit
145	Counterclockwise Velocity Limit
146	Accel/Decel Ramp
156	Positive Current Limit
157	Negative Current Limit
159	Current Preload
168	Kp Velocity Loop
169	Ki Velocity Loop
170	Feed Forward Gain
171	Static Gain
182	Desired Velocity Bandwidth
183	Velocity Damping Selection
184	Velocity Low Pass Filter Bandwidth
185	Lead/Lag Velocity Feedback Filter Gain
186	Lead/Lag Velocity Feedback Filter Bandwidth
187	Auto Tune Velocity
188	Auto Tune Current Limit
189	Auto Tune Inertia
190	Auto Tune Select
210	A/D Converter Offset
211	Analog Velocity Gain

212 D/A #1 Gain
233 Cable Compensation

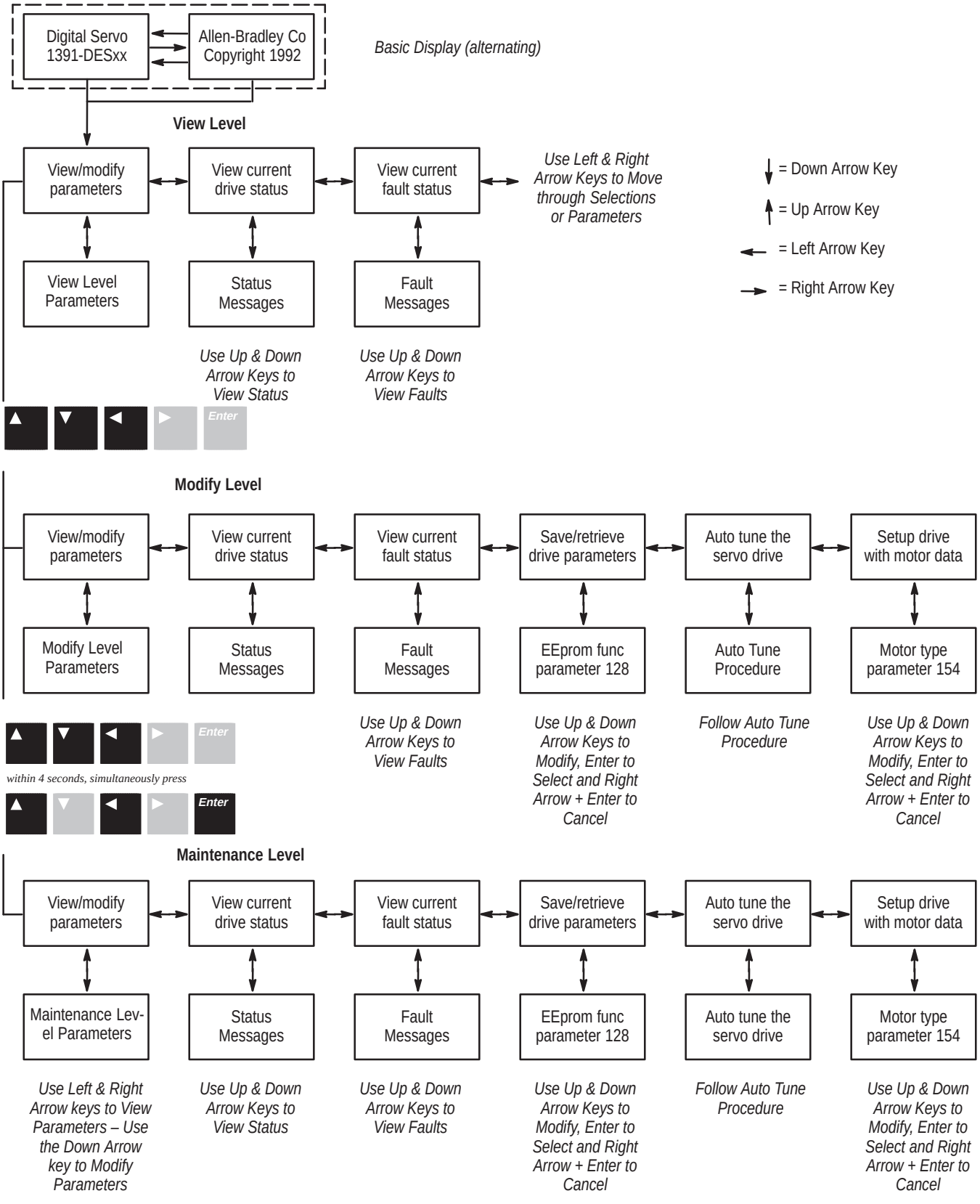
Maintenance Level

The Maintenance level allows access to all of the parameters listed in the View and Modify levels in addition to the parameters listed below. Two squares (⧉) will be present in the upper left corner of the display to denote that this level is active (see Figure 6.1).

04 Adapter Type
05 Logic Command
06 Drive Faults
07 Drive Status
08 Auto Tune Status
17 Velocity Reference Whole
18 Velocity Reference Fraction
21 Filtered Velocity Feedback
22 Average Motor Velocity
23 Resolver Turns
24 Resolver Position Feedback
25 Pre Ramp Velocity
33 Proportional Velocity Error
34 Velocity Loop PI Output
35 Integral Velocity Error
44 External Torque Reference
46 Id (Flux) Current Reference
47 IT Protection Limit
48 Bridge Current Limit
49 Current Feedback Scale
58 D/A #1 Command Value
59 D/A #2 Command Value
129 Units Select
135 Up to Speed Tolerance
136 Drive Address
155 Rated Motor Current
158 Current Rate Limit
172 Velocity Loop Integrator Preset Value
181 Motor Inertia
199 Friction Compensation
200 Friction Hysteresis
201 Friction Bit
213 D/A #2 Gain
222 Id RPM Start
223 Id RPM End
224 Id Percent Limit
234 Transport Compensation
243 Indirect Sink Parameter 1
244 Indirect Source Parameter 1
245 Indirect Sink Parameter 2
246 Indirect Source Parameter 2
251 Access Timeout
252 Drive Init Stats

In addition to the three levels described, each level has additional auxiliary menus. These menus allow quick access to important parameters such as fault status and setup data. Refer to Figure 6.3 for further information.

Figure 6.3
1391-DES Programming Levels

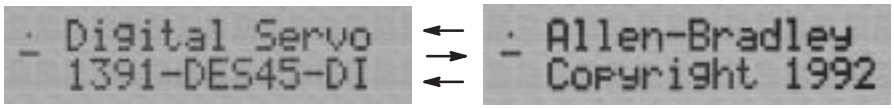


Accessing Parameter Levels

To help guard against access to advanced programming levels by untrained personnel, special key combinations must be pressed to gain access.

When power is first applied to the 1391-DES the Basic Display (see Figure 6.4) will be shown. The Basic Display alternates (every 2 seconds) between the two displays shown. The alternating display indicates that the drive is functioning normally. If for some reason the display does not alternate or is not shown, refer to Chapter 11, *Troubleshooting*.

Figure 6.4
1391-DES Basic Display



The three parameter levels can be accessed by using the key combinations described below. The parameter level can be confirmed by observing the number of dots in the upper left corner of the display.

■ **To Access the View Level**
Press the Down Arrow key once, the View Level will be active.

■ **To Access the Modify Level**
Press the up, down and left arrow keys simultaneously and release.

■ **To Access the Maintenance Level**

a) Press the up, down and left arrow keys simultaneously, then *within 4 seconds . . .*
b) simultaneously press the up, left arrow and Enter keys and release.

within 4 seconds, simultaneously press

■ **To Return to the Basic Display**
Press the Up Arrow and Enter keys simultaneously to return to the Basic Display.

Programming

Important: Programming of most 1391-DES parameters is not required. When power is initially applied to the drive, a prompted start-up procedure will occur (first time only). The display will guide the user through this procedure, which will set all of the main parameters for machine operation. Parameters listed in this chapter are essentially for reference only. Follow the Start-Up Procedure in Chapter 8 before attempting to change any parameters.

Pressing the Down Arrow key from the Basic Display (see Figure 6.4) will cause the “View/Modify parameters” menu to be displayed. Pressing the Down Arrow key a second time allows the View level parameters to be viewed. From this point any of the other levels can be selected using the preceding procedures.

After a level has been selected, the Left and Right Arrow keys will be used to locate the desired parameter.

Parameter Types

Two types of parameters are used in the 1391-DES programming system; Numeric and Selection.

Numeric Parameter
A Numeric parameter contains a numeric value. When this type of parameter is displayed in the Modify or Maintenance levels, pressing the Down Arrow key will cause the cursor to flash. Pressing the right or left arrow keys will then move the cursor one digit to the right or left. The Up and Down Arrow keys can then be used to scroll to the desired value. When the parameter is set to the desired value, press the Enter key. The cursor will stop flashing to indicate that the change has been loaded into memory. To cancel the modification (before pressing Enter), press the Right Arrow and Enter keys simultaneously.

Selection Parameter
When viewing a Selection parameter, multiple choices will be displayed for the parameter. Pressing the Up and Down Arrow keys will scroll through the possible choices. When the desired choice is displayed, press the Enter key to make the selection. To cancel the selection (before pressing Enter), press the Right Arrow and Enter keys simultaneously.

Important: Parameter values or selections will not be stored in EEprom until parameter 128 (EEprom Functions) is accessed, and item 3 (Save) is selected. Parameter 128 can be accessed at any time by pressing the Left and Right Arrow keys simultaneously.

Parameter Descriptions

This section lists and describes the various parameters currently available (software version 2.01). Not all parameters will be available in every parameter level. Refer to the "Parameter Type" classification in each description for further information. In addition to the Parameter Type, each description (when applicable) will also provide Minimum, Maximum and Default Values. Please note that parameter numbers not listed are reserved for future software enhancements.

Important: Parameter names followed by an asterisk (*****) should not be modified. These parameters are provided for information purposes only.

ATTENTION: To guard against personnel injury and/or machine damage caused by improper programming, parameter names followed by an asterisk (*) should only be modified by qualified personnel.

Parameter 00 – Reset Display Faults (Rst Disp Flts)

This parameter clears display faults.

Parameter Type: View/Modify in Maintenance level only

Parameter 03 – Drive Size *

The current drive size in amperes (as read from the drive on power-up) is contained in this parameter.

Parameter Type: View only, all levels

Parameter 04 – Adapter Type *

This parameter is not active at this time.

Parameter Type: View only in Maintenance level

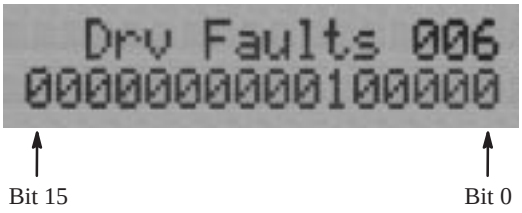
Parameter 05 – Logic Command (Logic Comd) *

This parameter contains a 16 bit, bit encoded, binary word that represents the logic commands from an adapter board. A bit set to "1" indicates that a condition exists. If a "0" is displayed that condition does not exist.

Parameter Type: View only in Maintenance level

Parameter 06 – Drive Faults (Drv Faults) *

Parameter 06 is a 16 bit, binary word that represents the drive faults. A “1” indicates that a fault has occurred. If a “0” is displayed, a fault has not occurred. Refer to the list below for an explanation of the individual bits.



Parameter Type: View only in Maintenance level

bit 0	Not Used
bit 1	Drive Overtemperature
bit 2	Power Up Enable
bit 3	Not Used
bit 4	Control Voltage Fault
bit 5	Resolver Loss
bit 6	Not Used
bit 7	Power Fault
bit 8	Bus Overvoltage
bit 9	Not Used
bit 10	External A/D Conversion Fault
bit 11	Internal A/D Conversion Fault
bit 12	Not Used
bit 13	Not Used
bit 14	EEprom Fault
bit 15	Auto Tune Fault

Parameter 07 – Drive Status (Drv Status) *

A 16 bit, binary word represents the drive status. A “1” indicates that a particular state exists. If a “0” is displayed, that state does not exist. Refer to the list below for an explanation of the individual bits.

Parameter Type: View only in Maintenance level

bit 0	Class 1 Fault
bit 1	At Zero Speed
bit 2	At Speed
bit 3	IT Active
bit 4	EEprom Write Enabled
bit 5	Drive State
bit 6	Drive State
bit 7	Drive State
bit 8	At Current Limit.
bit 9	Not Used
bit 10	Not Used
bit 11	Not Used
bit 12	Not Used
bit 13	Not Used
bit 14	Not Used
bit 15	Not Used.

Parameter 08 – Auto Tune Status (ATn Status) *

A 16 bit, binary word represents the auto tune status. A “1” indicates that a particular state exists. If a “0” is displayed, that state does not exist. Refer to the list below for an explanation of the individual bits.

Parameter Type: View only in Maintenance level

bit 0	Ready
bit 1	Active
bit 2	Enable Drive
bit 3	Not Used
bit 4	Accel
bit 5	Decel
bit 6	Abort
bit 7	Complete
bit 8	Enable Time Limit
bit 9	Execution Time Limit
bit 10	Accel Fault
bit 11	Decel Fault
bit 12	Gain Calculation Fault
bit 13	Gains Updated
bit 14	Not Used
bit 15	Not Used

Parameter 17 – Velocity Reference Whole (Vel Ref Whole) *

This parameter supplies the whole number part of an internal digital velocity reference, when internal digital velocity control has been selected in parameter 132. The data contained in this parameter represents the whole number of the velocity reference.

Parameter Type: View/modify in Maintenance level
Minimum Value: –8000 rpm
Maximum Value: +8000 rpm

Parameter 18 – Velocity Reference Fraction (Vel Ref Fract) *

The fractional part of an external velocity reference when internal digital velocity control has been selected in parameter 132 is contained in this parameter. The data contained represents the low order, fractional part of the internal digital velocity reference.

Parameter Type: View/modify in Maintenance level
Minimum Value: 0 rpm
Maximum Value: 65535 rpm

Parameter 19 – Final Velocity Command (Vel Command) *

Parameter 19 indicates the value of the velocity reference into the velocity PI regulator, after the Velocity Mode Select (parameter 132) and the Velocity Limiter.

Parameter Type: View only, all levels
Minimum Value: –8000 rpm
Maximum Value: +8000 rpm

Parameter 20 – Velocity Feedback (Vel Feedback) *

The unfiltered motor velocity is displayed through this parameter.

Parameter Type:	View only, all levels
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 21 – Filtered Velocity Feedback (Filtrd Vel Fb) *

The filtered velocity feedback which is output by the lead/lag filter is supplied by this parameter. The bandwidth of the filter is specified by parameter 186 and the filter gain is specified by parameter 185.

Parameter Type:	View only in Maintenance level
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 22 – Average Motor Velocity (Average Mtr Vel) *

This parameter supplies the average velocity feedback which is output by the single pole low pass filter. The bandwidth of the filter is specified by parameter 184.

Parameter Type:	View only in Maintenance level
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 23 – Resolver Turns *

The number of resolver electrical turns is supplied by this parameter. When these values reach maximum, the value drops to zero and begins to again count up and down.

Parameter Type:	View only in Maintenance level
Minimum Value:	–32768
Maximum Value:	+32767

Parameter 24 – Resolver Position Feedback (Resolver Posn) *

This parameter supplies the position feedback count. 65,535 represents the counts per 1/2 motor revolution.

Parameter Type:	View only in Maintenance level
Minimum Value:	0
Maximum Value:	65535

Parameter 25 – Pre Ramp Velocity (Pre Ramp Vel) *

This is the velocity before the velocity rate limiter.

Parameter Type:	View only in Maintenance level
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 33 – Proportional Velocity Error (Prop Vel Error) *

This is the error between the Final Velocity Command (parameter 19) and the Filtered Velocity Command (parameter 21).

Parameter Type:	View only in Maintenance level
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 34 – Velocity Loop PI Output (Vel PI Output) *

Indicates the latest output of the velocity PI regulator.

Parameter Type:	View only in Maintenance level
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 35 – Integral Velocity Error (Intg Vel Error) *

The error between the Final Velocity Command (parameter 19) and the Velocity Feedback (parameter 20) is supplied by this parameter.

Parameter Type:	View only in Maintenance level
Minimum Value:	–8000 rpm
Maximum Value:	+8000 rpm

Parameter 44 – External Torque Reference (Ext Torque Ref) *

A digital motor torque reference to the drive is supplied by this parameter from an adapter board (not available at this time). This reference can be selected by setting the Torque Mode (parameter 133).

Parameter Type:	View/modify in Maintenance level
Minimum Value:	–300% rated motor current or 2 times drive rating (whichever is less)
Maximum Value:	+300% rated motor current

Parameter 45 – Iq (Torque) Current Reference (Iq Current Ref) *

This parameter displays the torque producing current reference.

Parameter Type:	View only in all levels
Minimum Value:	–300% rated motor current or 2 times drive rating (whichever is less)
Maximum Value:	+300% rated motor current

Parameter 46 – Id (Flux) Current Reference (Id Current Ref) *

The flux producing current reference is displayed by this parameter.

Parameter Type:	View only in Maintenance level
Minimum Value:	0
Maximum Value:	70% rated motor current

Parameter 47 – IT Protection Limit (IT Protect Lim) *

This parameter displays the amount that the bridge current limit is reduced, based on the output of an analog circuit which models the thermal characteristic of the inverter power transistors.

Parameter Type:	View only in Maintenance level
Minimum Value:	0
Maximum Value:	Drive current rating

Parameter 48 – Bridge Current Limit (Bridge Cur Lim) *

The bridge current limit which is calculated by the drive based on motor current and drive size (parameters 155 & 3) is displayed by this parameter.

Parameter Type:	View only in Maintenance level
Minimum Value:	0 Amperes
Maximum Value:	200% drive rating or 3 times motor rating

Parameter 49 – Current Feedback Scale (Cur Fdbk Scale) *

The current feedback scaling is displayed based on motor current rating and drive size (parameters 155 & 3). See Table 6.A.

Parameter Type: View only in Maintenance level
Minimum Value: 0
Maximum Value: 15

Table 6.A
Typical Current Feedback Scaling

Motor Rated Current			
1391-DES15	**1391-DES22**	**1391-DES45**	**Parameter 49 Value**
15.0	22.5	45.0	15
14.1	21.1	42.2	14
13.1	19.7	39.4	13
12.2	18.3	36.6	12
11.3	16.9	33.8	11
10.3	15.5	30.9	10
9.4	14.0	28.1	9
8.4	12.6	25.3	8
7.5	11.3	22.5	7
6.6	9.8	19.7	6
5.6	8.5	16.9	5
4.7	7.0	14.1	4
3.8	5.7	11.3	3
2.8	4.2	8.4	2
1.9	2.8	5.6	1
0.9	1.4	2.8	0

Parameter 50 – Current Feedback Rated (Cur Fdbk Rated) *

This parameter displays the actual motor current scaling based on current feedback scale and drive size (parameters 49 & 3).

Parameter Type: View only in all levels
Minimum Value: Drive size/16
Maximum Value: Drive size

Parameter 51 – Current Limit *

The real time current limit is displayed by this parameter.

Parameter Type: View only in all levels
Min/Max Value: Whichever is less: 200% drive rating, +/– current limit, 3 times motor current, ext limit or IT limit

Parameter 57 – Analog Velocity Command (Analog Vel Cmd) *

This parameter displays the analog velocity command value.

Parameter Type: View only in all levels
Minimum Value: –7000 rpm
Maximum Value: +7000 rpm

Parameter 58 – D/A #1 Command Value (D/A 1 Cmd Val) *

This parameter displays the actual value input to D/A Converter 1.

Parameter Type: View only in Maintenance level
Minimum Value: –2047
Maximum Value: +2047

Parameter 59 – D/A #2 Command Value (D/A 2 Cmd Val) *

This parameter displays the actual value input to D/A Converter 2.

Parameter Type: View only in Maintenance level
Minimum Value: –2047
Maximum Value: +2047

Parameter 68 – Bandwidth Maximum (Bandwidth Max.) *

After an auto tune, this parameter displays the maximum system bandwidth that can be achieved with the machine mechanics.

Parameter Type: View only in Modify level and Maintenance level
Minimum Value: 0 rads/second
Maximum Value: 250 rads/second

To convert rads/second to Hertz, divide by 6.28.

Parameter 69 – Auto Tune Friction (Auto Tune Friction)*

The system friction as measured by the auto tune cycle is represented through this parameter.

Parameter Type: View only in Modify level and Maintenance level
Minimum Value: 0%
Maximum Value: 100% = rated motor current

Parameter 128 – EEprom Functions (EEprom Func)

This parameter allows the user to initialize, recall or save the parameters stored in the EEprom. Entering the number listed will cause the drive to perform the designated action.

Parameter Type: View/modify in Modify level and Maintenance level

0 Exit – exit EEprom functions
1 Initialize* – load the default parameters into EEprom
2 Recall – load the drive with the current EEprom values
3 Save – save the current drive parameters to EEprom

*Important: initializing the EEprom will convert all parameters to default values – all previous values will be lost.

Parameter 129 – Units Select

Allows selection of “User Units” or “Per Unit Values.”

Important: All values shown in this manual are “User Units.” Changing this parameter is not recommended.

Parameter Type: View/modify in Maintenance level
Default Value: 0 User Units

0 User Units
1 Per Unit

Parameter 130 – Drive OK Mode

This parameter specifies how the Drive OK (DROK) relay is controlled. If the parameter is set to "0," the relay will be opened when a fault occurs. If the parameter is set to "1," the relay will open when a fault occurs and there is not sufficient DC bus voltage.

Parameter Type: View/modify in Modify level and Maintenance level
Default Value: 0 Fault only

0 Fault only
1 Fault and undervoltage

Parameter 131 – Language Select (Language Selct)

This parameter allows selection of available languages.

Parameter Type: View/modify in Modify level and Maintenance level
Default Value: 0 English

0 English

Parameter 132 – Velocity Mode Select (Vel Mode Selct)

Parameter 132 selects the velocity command source(s) within the drive.

Parameter Type: View/modify in Modify level and Maintenance level
Default Value: 0 A/D Input

0 A/D Input – analog reference from the 14 bit A/D converter (parameter 57) which is fed from user input command voltage (typically 0 to ±10V DC).
1 Digital Inp – internal digital reference (parameters 17, 18)
2 A/D+Digt1 – analog and digital reference (parameters 57 + 17, 18)
3 Zero Input – zero velocity reference

Parameter 133 – Torque Select

This parameter selects the torque command source within the drive. When operating the drive in velocity mode, set to Velocity Mode 1. When operating in torque mode, (using S Class, MAX, IMC 121 & 123) set to A/D Torque Block (#4).

Parameter Type: View/modify in Modify level and Maintenance level
Default Value: 0 Vel Mode 1

0 Vel Mode 1 – velocity regulator PI output (parameter 34)
1 Vel Mode 2 – PI output + current preload + external torque reference (parameters 34, 159, 44)
2 Torq Block – Digital torque reference (parameter 44)
3 Vel Mode 3 – PI output + A/D value (3V = 4096) + current preload (parameters 34 + A/D + 159)
4 A/D Tq Blk – current preload + A/D value (159 + A/D)
5 Zero Ref. – zero torque command

Parameter 135 – Up To Speed Tolerance (Up To Spd Tol)

This parameter establishes a band around the velocity command that is used to determine when to update the At Speed bit in parameter 7.

Parameter Type: View/modify in Maintenance level
Minimum Value: 0 rpm
Maximum Value: 7812 rpm
Default Value: 19.5 rpm

Parameter 136 – Drive Address *

This parameter is not active at this time.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	1
Maximum Value:	14
Default Value:	1

Parameter 144 – Clockwise Velocity Limit (CW Vel Limit)

Specifies maximum velocity reference in the clockwise (positive) direction.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0 rpm
Maximum Value:	7000 rpm
Default Value:	Set by “Setup drive with motor data” routine

Parameter 145 – Counterclockwise Velocity Limit (CCW Vel Limit)

The maximum counterclockwise (negative) velocity reference is specified by this parameter.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0
Maximum Value:	7000 rpm
Default Value:	Set by “Setup drive with motor data” routine

Parameter 146 – Accel/Decel Ramp (Acc/Dec Ramp)

This parameter specifies the largest change in the velocity command per velocity loop sample that will be allowed except when an immediate stop causes the velocity limit block to be bypassed.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	5 revs per sec/sec
Maximum Value:	22216 revs per sec/sec
Default Value:	22216 revs per sec/sec

Parameter 154 – Motor Type

The catalog number of the 1326 servomotor currently installed is contained in this parameter.

Important: Changing this parameter doesn’t change any motor related parameters. Motor changes must be made through the “Setup drive with motor data” menu.

Parameter Type:	Can be viewed in all levels – modified in Maintenance level
Default Value:	Set by “Setup drive with motor data” routine

Parameter 155 – Rated Motor Current (Mtr Rated Cur) *

This parameter scales the current feedback in the drive to match the servomotors continuous current rating.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	Drive/motor dependent
Maximum Value:	Drive/motor dependent

Parameter 156 – Positive Current Limit (Pos. Cur Limit)

Parameter 156 specifies the maximum allowable positive motor current that can be commanded. If greater than parameter 48, parameter 48 will then set the limits.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	10% rated motor current
Maximum Value:	300% rated motor current or 2 times drive rating (whichever is less)
Default Value:	Set by “Setup drive with motor data” routine

Parameter 157 – Negative Current Limit (Neg. Cur Limit)

The maximum allowable negative motor current that can be commanded is specified through this parameter. If greater than parameter 48, parameter 48 will then set the limits.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	10% rated motor current
Maximum Value:	300% rated motor current or 2 times drive rating (whichever is less)
Default Value:	Set by “Setup drive with motor data” routine

Parameter 158 – Current Rate Limit (Cur Rate Limit) *

The largest change in the current reference per velocity loop sample that will be allowed is specified through this parameter. Value shown on the display is in amperes/second. Description is based on percentage of motor rating to allow interpretation of value.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	130% rated motor current per second
Maximum Value:	80% rated motor current per millisecond
Default Value:	36% of motor rated current/ms, but will change according to motor selection

Parameter 159 – Current Preload (Cur Preload)

This parameter specifies the amount of preload added to the velocity loop Pl output.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	–200% rated motor current
Maximum Value:	+200% rated motor current
Default Value:	0

Parameter 168 – KP Velocity Loop (Prop Gain kp)

This parameter controls the proportional error gain of the velocity regulator. For example, if KP = 8, then velocity (1000 rpm) error will produce a (rated motor) current torque reference.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0
Maximum Value:	560
Default Value:	100

Parameter 169 – Kl Velocity Loop (Intg Gain ki)

This parameter controls the integral error gain of the velocity regulator. For example, if KI = 8, then velocity (1000 rpm) error for 1 second will produce a (rated motor) current torque reference.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0
Maximum Value:	24000
Default Value:	6667

Parameter 170 – Feed Forward Gain (Feed Frwd Gain)

Controls the feedforward gain of the velocity regulator. Setting this to a value greater than zero reduces the velocity feedback overshoot in response to a step change in the velocity reference. The velocity loop response to a load disturbance is unaffected by the Feed Forward Gain.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0
Maximum Value:	0.39
Default Value:	0

Parameter 171 – Static Gain/Droop

Specifies the velocity regulation tolerance in rpm.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0 rpm
Maximum Value:	15.6 rpm
Default Value:	1 rpm

Parameter 172 – Velocity Loop Integrator Preset (Intg Prest Val)

The velocity loop integrator will be set to the value in this parameter when the drive transitions into the run state.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	–200% rated motor current
Maximum Value:	+200% rated motor current
Default Value:	0

Parameter 181 – Motor Inertia

Displays the time it will take for the selected motor to reach 1000 rpm at 100% of rated torque. This assumes that the motor has 0.2 times the motor inertia connected to it, representing typical system inertia (couplings, etc.)

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0 ms
Maximum Value:	500 ms
Default Value:	Set by “Setup drive with motor data” routine

Parameter 182 – Desired Velocity Bandwidth (Desired Vel BW)

This is associated with the Auto Tune Calculate function and allows the user to enter a desired velocity bandwidth less than or equal to the Maximum Bandwidth (parameter 68) as calculated by the auto tune cycle.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	1 rads/second
Maximum Value:	250 rads/second
Default Value:	200 rads/second – To convert rads/second to Hertz, divide by 6.28.

Parameter 183 – Velocity Damping Selection (Vel Damp Selct)

This parameter is associated with the auto tune function and specifies the velocity damping desired by the user. The auto tuning procedure calculates a new set of Velocity Loop Gains (parameters 168 & 169) and a new Current Rate Limit (parameter 158) when the user initiates the Auto Tune Calculate function. Refer to Figure 8.1 for further information.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0
Maximum Value:	3
Default Value:	0

0 zeta = 0.87
1 zeta = 1.0
2 zeta = 0.7
3 zeta = 1.4

Parameter 184 – Velocity Low Pass Filter Bandwidth (Vel Low Pas BW)

Specifies the single pole low pass velocity feedback filter bandwidth. A value of 30000 disables the filter.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0 rads/second
Maximum Value:	30000 rads/second
Default Value:	30000 rads/second

Parameter 185 – Lead/Lag Velocity Fdbk. Filter Gain (Lead/Lag Gain)

Specifies the gain of the velocity feedback filter. A value of 1.00 disables the filter.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	–10.00 (lag)
Maximum Value:	+10.00 (lead)
Default Value:	1.00

Parameter 186 – Lead/Lag Velocity Fdbk. Filter BW. (Lead/Lag BW)

Specifies the bandwidth of the velocity feedback filter.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0 rads/second
Maximum Value:	2700 rads/second
Default Value:	250 rads/second

Parameter 187 – Auto Tune Velocity (Auto Tune Vel)

This parameter specifies the maximum velocity attained during an auto tune cycle.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	–2000 rpm
Maximum Value:	+2000 rpm
Default Value:	+1000 rpm

Parameter 188 – Auto Tune Current Limit (Auto Tune Cur)

The motor current used while an auto tune cycle is executing is specified with this parameter.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0
Maximum Value:	200% rated motor current in amperes
Default Value:	50% rated motor current in amps

Parameter 189 – Auto Tune Inertia (Auto Tun Inert)

This parameter is calculated during auto tune and is the time that the motor or motor and system takes to reach Auto Tune Velocity (parameter 187) at Auto Tune Current Limit (parameter 188) and back to zero rpm. To determine the inertia of the machine system, use the following formula:

$$J_{system} = \frac{\text{Parameter 189}}{\text{Parameter 181 x 0.83}} \text{ x Motor}_{actual} \text{ (from Motor Data Sheet in lb.-in.-sec}^2\text{)}$$

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	0 ms
Maximum Value:	10000 ms
Default Value:	100 ms

Parameter 190 – Auto Tune Select (Auto Tune Sel)

This parameter initiates an auto tune cycle which measures the Auto Tune Inertia (parameter 189) and Auto Tune Friction (parameter 69) by accelerating the motor up to the Auto Tune Velocity (parameter 187) at the Auto Tune Current Limit (parameter 188). The parameter also calculates the gains based on auto tune information.

Parameter Type:	View/modify in Modify level and Maintenance level

0	Exit
1	Clr Status
2	Systm Tune
3	Calculate

Parameter 199 – Friction Compensation (Friction Comp)

This value represents the machine friction torque as a percentage of the measured friction torque (or parameter 69) as measured by auto tuning. This will be compensated for in the velocity loop.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0% *(No Friction Compensation)*
Maximum Value:	100%
Default Value:	50%

Parameter 200 – Friction Hysteresis (Frictn Hystrs)

This parameter defines the number of bits of velocity command before a switch is made by Friction Bit (parameter 201).

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	2.4 rpm
Default Value:	0.5 rpm

Parameter 201 – Friction Bit (Frictn Bit)

The number of bits surrounding Friction Hysteresis (parameter 200).

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	50
Default Value:	10

Parameter 210 – Analog to Digital Converter Offset (Anlg Vel Offst)

This parameter adds an offset to the A/D converter value to correct for input A/D offset and user input command D/A output offset.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	–61 mV
Maximum Value:	+61 mV
Default Value:	0 mV

Parameter 211 – Analog Velocity Gain (Anlg Vel Gain)

This parameter determines how the A/D converter value is scaled. It is set to the number of motor rpm that is to represent 1 volt of input command.

The desired input velocity command voltage to motor rpm scaling is accomplished with the Analog Velocity Gain parameter (211). The default setting is 500 rpm/volt. Use the following formula if the maximum motor speed (rpm) and maximum velocity command (volts) are known.

$$\frac{\text{Maximum Desired Motor RPM}}{\text{Maximum Velocity Command}} = \frac{\text{RPM}}{\text{Volts}}$$

for example:

$$\frac{\text{3000 RPM Maximum}}{\text{8V DC Maximum Command}} = \frac{\text{375 RPM}}{\text{Volts}}$$

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	–790 rpm per volt
Maximum Value:	+790 rpm per volt
Default Value:	+500 rpm per volt

Parameter 212 – Digital to Analog #1 Gain (D/A 1 Gain)

This parameter scales the D/A #1 Command Value (parameter 58) before it is output to D/A Converter 1.

To change output voltage scaling: Desired Voltage per 1000 rpm x 0.05553.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	gain of –14.6
Maximum Value:	gain of +14.6
Default Value:	gain of +0.067

Parameter 213 – Digital to Analog #2 Gain (D/A 2 Gain)

This parameter scales the D/A #2 Command Value (parameter 59) before it is output to D/A Converter 2.

To change scaling: Desired Voltage /Rated Current x 0.05553.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	gain of –14.6
Maximum Value:	gain of +14.6
Default Value:	gain of +0.167

Parameter 222 – Id RPM Start *

This parameter is associated with the field weakening function.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0 rpm
Maximum Value:	6000 rpm
Default Value:	Set by “Setup drive with motor data” routine

Parameter 223 – Id RPM End *

This parameter is associated with the field weakening function.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0 rpm
Maximum Value:	8000 rpm
Default Value:	Set by “Setup drive with motor data” routine

Parameter 224 – Id Percent Limit (Id Percnt Lim) *

This parameter is associated with the field weakening function.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0 rpm
Maximum Value:	100%
Default Value:	70%

Parameter 233 – Cable Compensation (Cable Comp)

This parameter is set based on the distance between the motor and drive. It optimizes drive for resolver cable length variations based on installation.

Parameter Type:	View/modify in Modify level and Maintenance level
Minimum Value:	5 feet
Maximum Value:	600 feet (183 m)
Default Value:	50 feet (15.2 m)

Parameter 234 – Transport Compensation (Transport Comp) *

This parameter specifies the amount of linear transport lag compensation due to the sample time of the control loops.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	–200
Maximum Value:	+200
Default Value:	81

Parameter 243 – Indirect Sink Parameter 1 (Indirect Sink1) *

This parameter specifies the sink parameter for Indirect Link 1. Parameters 243 and 244 define a link between two other parameters. The value of the parameter specified by parameter 244 is written to the parameter specified by parameter 243 once every velocity loop update.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	245
Default Value:	59

Parameter 244 – Indirect Source Parameter 1 (Indirect Sorc1) *

This parameter specifies the source parameter for Indirect Link 1.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	254
Default Value:	20

Parameter 245 – Indirect Sink Parameter 2 (Indirect Sink2) *

This parameter specifies the sink parameter for Indirect 2. Parameters 245 and 246 define a link between two other parameters. The value of the parameter specified by parameter 246 is written to the parameter specified by parameter 245 once every velocity loop update.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	254
Default Value:	59

Parameter 246 – Indirect Source Parameter 2 (Indirect Sorc2) *

This parameter specifies the source parameter for Indirect Link 2.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	254
Default Value:	45

Parameter 251 – Access Timeout

This parameter specifies the length of time in minutes that the display will spend unattended before going back to the View level from a higher level. A value of zero disables this function.

Parameter Type:	View/modify in Maintenance level
Minimum Value:	0
Maximum Value:	32767
Default Value:	0

Parameter 252 – Drive Initialization Status (Drv Init Stats)

This parameter specifies if the drive has gone through an out-of-the-box start-up procedure (defined in Chapter 8).

Parameter Type: View/modify in Maintenance level
Default Value: 1 No

1 No – has not been setup
0 Yes – has been setup

Parameter 253 – Display Software Version (Display SW Ver) *

This parameter displays the current display software version number.

Parameter Type: View only in all levels

Parameter 254 – Drive Software Version (Drive SW Ver.) *

This parameter displays the current drive software version number.

Parameter Type: View only in all levels

Chapter 7

Installation

Chapter Objectives

Chapter 7 provides the information needed to help properly mount and wire the 1391-DES Servo Drive for operation. Since most start-up difficulties are the result of incorrect wiring, every precaution must be taken to assure that the wiring is done as instructed. **All items must be read and thoroughly understood before the actual installation begins.**

ATTENTION: The following information is merely a guide for proper installation. The National Electrical Code and any other governing regional or local code will overrule this information. The Allen-Bradley Company cannot assume responsibility for the compliance or the noncompliance to any code, national, local or otherwise for the proper installation of this drive or associated equipment. A hazard of personal injury and/or equipment damage exists if codes are ignored during installation.

Mounting

Mounting dimensions for the 1391-DES Servo Drive can be found in Appendix A. Chapter 2 provides information on power dissipation and environmental specifications. The drive must be located on a flat, rigid, vertical surface and must not be subjected to shock, vibration, moisture, oil mist, dust, corrosive vapors, etc. or temperatures that exceed 60° C (140° F) ambient.

Drives can be mounted adjacent to each other with a minimum clearance of 0.312” (7.9 mm) between units and/or surrounding cabinetry and non-current carrying surfaces. However, it is recommended that a space of approximately 1.0” (25.4 mm) be left between adjacent units to allow easy access and removal of the front cover. To allow for proper airflow, a minimum clearance of 3.0” (76.2 mm) is required along the top and bottom of the unit and any adjacent components.

The transformer that supplies 230V AC, three-phase and 36V AC to each servo drive must have 3” (76.2 mm) of clearance around it and any adjacent components. This will allow for proper airflow and wiring access. The transformer can be mounted in either a horizontal or vertical position.

ATTENTION: The installation of the drive must be planned such that all cutting, drilling, tapping and welding can be accomplished with the drive removed from the enclosure. The drive is of the open type construction and any metal debris must be kept from falling into it. Metal debris or other foreign matter may become lodged in the circuitry resulting in component damage.

Wiring Recommendations

General Information

The information supplied in this manual on wire sizes, practices, layouts, system configurations and grounding/shielding techniques for the 1391-DES Servo Drive are presented as guidelines. Due to the diversity of applications and systems, no single method of wiring is completely applicable.

Important: This information represents common PWM servo system wiring configurations, size and practices that have proven satisfactory in a majority of applications. The National Electrical Code, local electrical codes, special operating temperatures, duty cycles or system configurations will take precedence over the values and methods listed. Refer to Chapter 5 for detailed descriptions of input and output terminations before beginning the task of wiring.

Wire Sizes

Unless noted, the wire sizes in this manual are recommended minimums and assume type MTW wire (machine tool wire, 75° C, minimum) per NFPA 79. Since ambient conditions vary widely, on certain applications, a derating factor has to be taken into account. Also, wiring to drives or motors exceeding 50 feet (15.2 meters) in length (total includes to and from device) may cause excessive voltage drops. Consult the National Electrical (or local) Code for factors on ambient conditions, length etc. or the Allen-Bradley Sales Representative in your area for further information.

Shielding

Reasonable care must be taken when connecting and routing power and signal wiring on a machine or system. Radiated noise from nearby relays (relay coils should have surge suppressors), transformers, other electronic drives, etc. may be induced into the velocity command signal lines causing undesired movement of the servomotor.

To help alleviate the problem, machine power and signal lines must be routed separately. The 1391-DES power and signal lines must be shielded, twisted and routed in separate ferrous metal conduit or harnesses spaced at least 12” (304.8 mm) apart. Power leads are defined here as the transformer primary and secondary leads, motor leads and any 115V AC or above control wiring for relays, fans, thermal protectors etc. Signal wiring is defined as velocity command, resolver feedback, enable lines and low level logic signal lines.

Feedback, command signal and other shields must be insulated from each other and connected at a common machine or system earth ground in a “star” fashion (i.e. all shields connected to a single earth ground point). This helps to minimize radiated and induced noise problems and ground loops. Refer to the paragraph entitled “Grounding” and Appendix B.

Open ended shields (resolver feedback cable at the resolver and velocity command cable at the servo drive) must be insulated so that they do not accidentally cause ground loops.

EMI Shielding

The 1391-DES has an inverter carrier frequency of 2500 Hz. Therefore, the system may induce noise into sensitive equipment lines adjacent to it.

ATTENTION: This drive can produce electromagnetic radiation that may cause industrial or radio controlled equipment to operate erratically and cause possible injury to personnel.

The 1391-DES system is designed to be interconnected with Allen-Bradley EMI shielded motor cables only. Do Not substitute cables. The EMI shield of the motor cable only, must be grounded at both ends to function properly.

Important: The thermal switch and brake wires are routed near motor power and can pickup PWM radiation. Isolation from control devices may be required.

Grounding

All equipment and components of a machine or process system shall have their chassis connected to a common earth ground point. This ground system provides a low impedance path that helps minimize shock hazards to personnel and damage to equipment caused by short circuits, transient overvoltages and accidental connection of energized conductors to the equipment chassis.

Grounding requirements, conventions and definitions are contained in the National Electrical Code. Local codes will usually dictate what particular rules and regulations are to be followed concerning system safety grounds. See Appendix B.

Wiring

ATTENTION: The National Electrical Code (NEC) and local codes outline provisions for safely installing electrical equipment. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnect devices. Failure to do so may result in personal injury and/or equipment damage.

The Interconnect Drawing presented in Appendix B provides typical interconnection wiring for the 1391-DES AC Servo Drive. Typical control logic circuitry (starting and stopping), motor interconnections and grounding techniques are shown.

Please note that the drive circuit breaker (MCB) is not designed or intended to meet branch circuit protection requirements. The circuit breaker protects the DC bus supply, input rectifier and power circuitry against overcurrents.

Motor Wiring

The motor wiring size is determined by the continuous and overload current requirements (RMS Duty Cycle), NEC and local codes. In general, motors operated from the following drives would not require wire sizes larger than those accepted by TB5, but codes must be followed. In addition, the motor leads must be twisted throughout their entire length to minimize radiated electrical noise. Allen-Bradley 1326 cables (or equivalent type) must be used. The maximum motor wire sizes that the 1391-DES drive will accept are shown in Table 7.A.

Table 7.A
Maximum Motor Wire Sizes – TB5

Drive Catalog Number	Max. Wire Size Accepted
1391-DES15	#8 AWG (6 mm^2) – MTW
1391-DES22	#8 AWG (6 mm^2) – MTW
1391-DES45	#8 AWG (6 mm^2) – MTW

Motor Feedback Wiring

Connections to the integral commutation resolver must be made using an Allen-Bradley 1326-CFUxx shielded cable.

ATTENTION: To guard against hazard of personal injury or damage to equipment, the interconnections to the motor and resolver must be made exactly as shown in Appendix B. Failure to do so could cause loss of motor control and/or severe oscillation of the motor shaft.

Encoder (A Quad B Board) Wiring

Recommended Wire – Belden #9728 or equivalent. Maximum distance between the A Quad B Board and the position controller is 40 feet (12.2 meters) using a 5 volt signal. For distances up to 300 feet (91 meters), 18 AWG wire (0.75 mm^2), such as Belden #9388 (or equivalent) and an 8 to 15V DC power supply must be used.

For proper operation when interconnecting to IMC products, the B and B (NOT) signals must be reversed.

Applications that interface the 1391-DES with an IMC Classic Controller (IMC 110, 120, 121, 123) require a relay to sequence the encoder power supply during a drive shutdown.

Without this power supply relay, erroneous counts could be received by the IMC Classic Controller when AC power is cycled to the drive, but not the controller. When power is removed to the drive, the AQB Board will not have control voltage. However, the board will still receive the encoder voltage (+5V DC or +8-15V DC) from the IMC Classic Controller. As the drive power is cycled, it will briefly output a stream of encoder pulses which will be interpreted as movement of the servomotor by the IMC Classic Controller.

It is recommended that a normally open (N.O.) contact from an external relay be wired in series with the encoder voltage going to the drive from the IMC Classic Controller. The relay coil must be wired into the control circuit. When power is not applied to the drive, a Quadrature Fault will occur in the controller, forcing a re-homing and calibration of the controller.

Transformer Wiring

The transformer secondary (230V AC, three-phase) connection to the drive is phase insensitive and is shown in Appendix B. The maximum wire size TB5 will accept is 8 AWG (6 mm^2). Refer to Chapter 10 for the transformer wiring diagrams.

The minimum recommended wire sizes for the transformer secondary are shown in Table 7.B.

Table 7.B
Minimum Transformer Wire Sizes – AWG (mm^2)

	kVA					
Input Voltage	**1.5**	**3.5**	**5.0**	**10.0**	**12.5**	**15.0**
208V AC	#12 (2.5)	#12 (2.5)	#12 (2.5)	#8 (6)	#8 (6)	#6 (10)
240V AC	#12 (2.5)	#12 (2.5)	#12 (2.5)	#8 (6)	#8 (6)	#8 (6)
380V AC	#12 (2.5)	#12 (2.5)	#12 (2.5)	#10 (4)	#10 (4)	#8 (6)
415V AC	#12 (2.5)	#12 (2.5)	#12 (2.5)	#12 (2.5)	#10 (4)	#10 (4)
480V AC	#12 (2.5)	#12 (2.5)	#12 (2.5)	#12 (2.5)	#10 (4)	#10 (4)
575V AC	#12 (2.5)	#12 (2.5)	#12 (2.5)	#12 (2.5)	#12 (2.5)	#10 (4)

Important: The transformer primary requires protection by means of a customer supplied branch circuit disconnect device. Refer to Appendix B.

Fusing (Transformer Primary)

Time delay fusing similar to Bussman Fusetron FRS Series or equivalent must be used if the primary circuit is fused. Circuit breakers must provide protection equivalent to fuses.

Fuse ratings shown in Table 7.C are the highest ratings allowed in a 25° C (77° F) ambient temperature. Higher electrical enclosure ambient temperatures will require fuses with higher current ratings. Consult fuse manufacturer's derating data. Fuses larger than those listed below may result in transformer damage.

Table 7.C
Fuse Current Rating – Amperes

	kVA					
Primary Voltage	**1.5**	**3.5**	**5.0**	**10.0**	**12.5**	**15.0**
208V AC	8	17.5	20	40	50	60
240V AC	7	15	20	35	45	50
380V AC	4.5	9	12	25	30	35
415V AC	4	8	12	20	25	30
480V AC	3.5	7	10	17.5	25	30
575V AC	3	6	8	15	20	25

External Shunt Regulator Resistor

The external Shunt Regulator Resistor and fuse for the 45A 1391-DES must be connected to TB5-8 and TB5-9 as described in Chapter 10.

22.5A drives must be converted for use with an external shunt resistor and fuse. Refer to Chapter 10 and Appendix B for detailed instructions.

Interface Connections

Refer to Chapter 5 and Appendix B for connection information.

Chapter 8

Start-Up

Chapter Objectives

Chapter 8 provides the steps needed to help properly start-up the 1391-DES Digital AC Servo Drive. Included in the procedure are typical adjustments and voltage checks to assure proper operation. The information contained in Chapters 5, 6 and 7 must be read and understood before proceeding.

Start-Up Procedure

The following procedure provides the required steps to start-up the 1391-DES AC Servo Drive in velocity and position mode.

ATTENTION: Power must be applied to the drive to perform many of the adjustments specified in the following paragraphs. Voltages behind the front panel are at incoming line potential. To avoid injury to personnel and/or damage to equipment, only qualified service personnel should perform the following start-up procedures. Thoroughly read and understand the following procedure before beginning the Start-Up Procedure. If an event does not occur while performing this start-up, Do Not Proceed. Remove Power by opening the branch circuit disconnect device and correct the malfunction before continuing.

ATTENTION: This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltage on the capacitors has been discharged before attempting to service, repair or remove this unit.

Voltage at terminals 9 (+) and 7 (–) of TB5 must be “0.00” as measured with a standard digital voltmeter or multimeter.

Only qualified personnel familiar with solid-state control equipment and safety procedures in publication NFPA 70E should attempt this procedure.

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1. Assure that all power to the drive branch circuit is off. Most start-up difficulties are the result of wiring errors. Therefore, prior to applying power to the first device in the branch circuit, primary of the transformer or system, check all of the system interconnection wiring.

2. Check terminal block connections as described in Chapter 5 and Appendix B.

3. Set switches S1 (A Quad B Board) and SW1 (top of drive) as explained in *Switch Settings* in Chapter 5

4. Assure that the drive circuit breaker (MCB), contactor (M) and Enable input are OFF (de-energized).

5. Apply power to the input transformer primary, but Do Not Enable the drive or energize the contactor (M). The Enable LED should be Off.

6. Using a voltmeter, verify that the voltages listed below are present at the locations shown. The tolerance for all voltages is ±10%. Clear faults before replacing any blown fuses. Refer to Chapter 11 for test point locations.

Location	Voltage
TB5-4 to TB5-5	230V AC
TB5-4 to TB5-6	230V AC
TB5-5 to TB5-6	230V AC
TB4-21 to TB4-19	36V AC
TP13 to TP12	+12V DC
TP14 to TP12	–12V DC

7. Remove all power to the transformer.

8. The wires connected to terminals 9 and 10 of TB2 must be marked and removed to allow for local operation of the enable circuit. Connect a suitable temporary switch between these terminals and insulate the switch connections.

9. Once control connections are made:

   a) Open the enable switch – the ENABLE LED will be Off.

   b) Apply power to the transformer primary.

   c) Place the circuit breaker (MCB) to the On position.

   d) Energize the contactor (M). The STATUS LED should illuminate to a steady green.

   Important: If power is applied while the drive is enabled, the STATUS LED will flash red and disable the drive. The drive may be reset by removing the Enable signal and momentarily grounding the Reset terminal (TB2-11). An alternate method would be to remove and reapply the branch circuit or drive power (36V) with the Enable input removed.

10. The drive will now prompt you through a start-up procedure. Read the following important points before continuing.

    - From time to time the drive will display the message "*EEprom Fnction in progress*." This message alerts the user that an EEprom function is in progress and that operation will return to normal momentarily. If the message "*drive can't be running for EE*" is displayed, verify that the drive is disabled.
    - If the drive faults during start-up (i.e. feedback miswired, etc.) the procedure will be continued from the point where you left off, after the cause of the fault has been resolved.
    - To stop the start-up procedure at any time and restart from this step: press the first 4 keys on the keypad (Up, Down, Left and Right Arrow keys) simultaneously and release.
    - To cancel the procedure and return to the Basic Display at any time: disable the drive and simultaneously press the last 4 keys of the keypad (Down, Left, Right and Enter keys) and release.
    - If you wish to repeat the start-up procedure: access the Maintenance programming level by pressing the Up, Down and Left Arrow keys, simultaneously – then within 4 seconds – press the Up, Left and Enter keys. Access parameter 252 and enter a value of 1, press Enter. Then press the Left or Right Arrow keys to access parameter 128. Select "Save" to save the parameters to EEprom, press Enter. Cycle all power and proceed.

11. The display will now read, "*START UP PROCEDURE*" – press the Enter key to continue.

    Display: "*setup drive with motor data.*" Press Enter to continue. If a custom motor is being used, consult Allen-Bradley for special instructions before proceeding.

    The drive will now allow you to select the catalog number of the motor being used. Use the Up and Down Arrow keys to select the appropriate motor catalog number – press Enter to select.

    Torque Plus catalog numbers will not be displayed. Use the following cross reference to select a motor catalog number.

Torque Plus Catalog Number	Use this Catalog Number	Torque Plus Catalog Number	Use this Catalog Number
1326AB-A410G-21	1326AB-A1G	1326AB-A520E-21	1326AB-B2E
1326AB-A420E-21	1326AB-A2E	1326AB-A530E-21	1326AB-B3E
1326AB-A430E-21	1326AB-A3E	1326AB-A740B-21	1326AB-C4B
1326AB-A515E-21	1326AB-B2E		

    The drive will respond by displaying "*writing data to servo drive.*"

12. The display will show "*execute motor rotation test.*" This test assures that the motor cables have been connected correctly – press Enter to continue.

ATTENTION: In the following steps, reverse rotation or uncontrolled rotation at high speed can occur. Be prepared to remove drive power by opening (MCB) or the branch circuit disconnect device if this occurs. This movement may be due to a wiring error or system component malfunction and must be corrected before proceeding. Damage to machine system components can occur due to uncontrolled machine movements.

13. The drive will display the message "*DANGER, MOTOR MAY RUNAWAY!!*" Be prepared to open MCB on the drive if the motor does not run correctly (under this condition the motor current limit is set to 25% of rated current to minimize motor speed) – press Enter to continue.

14. The display will now read "*enable to strt rotation test*."

    Energize the contactor (M) and enable the drive.

    A correctly wired drive will rotate the motor clockwise at 30 rpm for 5 seconds – stop for 2 seconds – then rotate the motor counterclockwise for 5 seconds – then stop.

    If the motor runs away or does not rotate, verify all power and resolver wiring.

15. The display will now read "*disable drive to continue*." Disable the drive by opening the Enable input, leaving the contactor energized.

    Display: "*press enter to exit motor test*" – press Enter.

16. The display will now read "*zero analog velocity offset*" – press Enter.

    In this mode the drive will automatically adjust out any offset, while the motor remains at zero speed. When the display reads: "*enable to strt zero vel offset,*" apply the Enable input to the drive.

    The display will now read "*jumper analog velocity inputs*." Jumper TB2-1 to TB2-2. This applies zero volts to the velocity inputs. Press Enter to continue.

    The display will now read "*now zeroing velocity offset*." The drive can take up to 60 seconds to zero the offset. If zeroing was successful, the display will show "*velocity zero complete*." Remove the jumper and press Enter.

    Important: If for some reason the offset cannot be adjusted, the message "*cannot zero velocity offset*" will be displayed. If this occurs, verify that the jumper connections are correct and continue on with the procedure. After completion, do a manual zero speed adjustment as explained in step 32.

    The display will now read "*disable drive to continue*" – Remove enable, leaving the contactor (M) energized.

17. The display will now read "*enter parameter information*" – press the Enter key to continue.

    The drive will allow you to enter a value for the Analog Velocity Gain.

    The desired input velocity command voltage to motor rpm scaling is accomplished with the Analog Velocity Gain parameter (211). The default setting is 500 rpm/volt. Use the following formula if the maximum motor speed (rpm) and maximum velocity command (volts) are known.

$$\frac{\text{Maximum Desired Motor RPM}}{\text{Maximum Velocity Command}} = \frac{\text{RPM}}{\text{Volts}}$$

    for example:

$$\frac{\text{3000 RPM Maximum}}{\text{8V DC Maximum Command}} = \frac{\text{375 RPM}}{\text{Volts}}$$

    Enter the desired value followed by the Enter key.

18. The drive will prompt for CW and CCW velocity limits (parameters 144 and 145, Clockwise/Counterclockwise Velocity Limits). Enter the maximum speed limit of the motor plus 10% at maximum velocity command. If the maximum command voltage exceeds the normal maximum level, these values will limit the speed of the motor. If unknown, leave setting at the default value.

    Important: Factory default values are set +10% over the maximum rated speed of the motor as shown in Table 9.A.

    Press the Enter key to continue.

19. The drive will prompt for the resolver cable length being used, (parameter 233, Cable Compensation). Use the Up or Down Arrow key to select the cable length value closest to the length of the feedback cable being used.

    When the desired value is displayed, press the Enter key to make the selection.

20. To continue with this start-up procedure, go to step 22.

Auto Tune Procedure

21. This step only needs to be performed when repeating the auto tune cycle. Access the Modify programming level (from the View level) by pressing the Up, Down and Left Arrow keys simultaneously. Press the Down Arrow key and use the Left or Right Arrow keys to select "*autotune the servo drive.*" Press the Down Arrow key.

22. Display: "*autotune the servo drive*" – press Enter to continue.

    Assure that the drive Enable input is de-energized and the contactor (M) is energized. The drive will display the message "*drive not ready to tune*" if this has not been done.

    The drive will prompt you for Auto Tune Current Limit. This current is used for auto tuning only. The default value displayed is sufficient, however, a different value of up to 100% of motor rating can be entered if desired. Press the Enter key to accept the value.

23. The drive will prompt you for Auto Tune Velocity. This velocity is used for auto tune only. To accept the default value, press Enter. If clockwise motor rotation (looking at the motor shaft) is desired, this parameter value should be positive. If counterclockwise rotation is desired, set this parameter value negative.

ATTENTION: A portion of the following auto tune cycle will cause the motor to accelerate to a desired velocity and decelerate to zero velocity. Be prepared for this movement and take precautions to guard against personnel injury or machine damage. Depending on the inertia of the system, several revolutions of the motor may occur. Axis movement must take place for the drive to complete the auto tune cycle.

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24. The drive will display the message "*DANGER ## MTR REVS POSSIBLE*." This means that the motor may make ## revolutions during auto tune, causing machine movement.

    Important: If the number of motor revolutions displayed is acceptable, press Enter and proceed to step 25. If the number of motor revolutions displayed could cause damage to your equipment, Do Not Continue! – Press The Up Arrow Key to end the auto tune procedure.

    Repeat the auto tune procedure by returning to step 21. During the procedure the value for Auto Tune Current Limit can be increased, or the Auto Tune Velocity can be decreased. Either value will lower the number of motor revolutions. For example, twice the current will halve the number of revolutions to do auto tune.

25. The display will now read "*enable drive to execute autotune*."

    Important: When you enable the drive the motor will ramp up to the auto tune velocity and back to zero again.

    The display will now read "*disable drv to continue*" – Disable the drive.

26. The drive will display the Bandwidth Max. parameter (68). The value displayed is the maximum bandwidth, in rads/sec. your system can achieve. Record this value for future reference and press Enter.

    Bandwidth Maximum = _____ rads/sec.

    (rads/sec. can be converted to Hertz (Hz) by dividing by 6.28)

27. The drive will display the Desired Velocity BW (182). Enter any value of bandwidth up to the value of Bandwidth Max. from above. Values greater than Bandwidth Max. will be ignored. Press Enter.

28. The auto tune and startup procedure is now complete. Press Enter. Now press the Up Arrow and Enter keys simultaneously to return to the Basic Display – values have now been stored in EEprom.

    If it is desired to repeat the auto tune procedure, return to step 21.

    Important: Do Not initialize the EEprom unless you wish to return all parameters to their default state.

    Remove power. Reconnect user command wiring (if previously disconnected), apply power and check operation. If motor rotation is incorrect, reverse the Velocity Command Input leads at TB2-1 & 2.

29. If the drive is to be run in torque control (with S Class, IMC 123 Controllers etc.) set parameter 133, (Torque Select) to "*A/D Torque Block*."

30. Enter the Maintenance programming level by pressing the up, down and left arrow keys simultaneously – then *within 4 seconds*– simultaneously press the up, left arrow and Enter keys.

    Access parameters 155 (Rated Motor Current) and 181 (Motor Inertia) – enter the appropriate values shown below.

Motor Catalog Number	Parameter 155 Value	Parameter 181 Value
1326AB-A410G-21 (1326AB-A1G)	7.1 A	21 ms
1326AB-A420E-21 (1326AB-A2E)	7.0 A	22 ms
1326AB-A430E-21 (1326AB-A3E)	9.5 A	22 ms
1326AB-A515E-21 (1326AB-B2E)	15.2 A	62 ms
1326AB-A520E-21 (1326AB-B2E)	19.2 A	62 ms
1326AB-A530E-21 (1326AB-B3E)	28.4 A	62 ms
1326AB-A740B-21 (1326AB-C4B)	38.2A	73ms

31. Access parameter 128 (EEprom Functions) and select "Save," followed by the Enter key. This will load the parameter values into memory.

    If further tuning is not required, record parameter settings in Appendix E. Proceed to step 39.

Manual Tuning Procedure

If manual tuning of certain parameters is required, the following procedure can be followed after all of the previous steps have been performed. Parameters referenced in the following steps are located in the Modify programming level. This level can be reached from the View level by pressing the Up, Down and Left Arrow keys, simultaneously.

32. Zero Speed Adjust

    a) Remove all power from the drive.

    b) Install a jumper between TB2-1 & 2 or leave the velocity command wiring in place if the system offset adjust is being performed.

    c) Apply power, energize the contactor (M) and enable the drive.

    d) Access the Offset parameter (210, Modify level) and increase or decrease the value until the motor shaft does not rotate.

    e) Perform step 36.

    f) De-energize the Enable input, remove power and reconnect all wiring, if applicable.

33. Analog Velocity Gain

    a) Apply power to the drive.

    b) Energize the contactor (M), but Do Not Enable the drive.

    c) Access the Analog Velocity Gain parameter (211, Modify level).

    d) The drive will allow you to enter a value for the Analog Velocity Gain.

    The desired input velocity voltage to motor rpm scaling is accomplished with the Analog Velocity Gain parameter (211). The default setting is 500 rpm/volt. Use the following formula if the maximum motor speed (rpm) and maximum velocity command (volts) are known.

$$\frac{\text{Maximum Desired Motor RPM}}{\text{Maximum Velocity Command}} = \frac{\text{RPM}}{\text{Volts}}$$

for example:

$$\frac{\text{3000 RPM Maximum}}{\text{8V DC Maximum Command}} = \frac{\text{375 RPM}}{\text{Volts}}$$

    Enter the desired value followed by the Enter key.

    e) Perform step 36.

    f) Remove power and reconnect all wiring, if applicable.

34. Clockwise/Counterclockwise Velocity Limits

    a) Apply power to the drive.

    b) Energize the contactor (M), but Do Not Enable the drive.

    c) Access parameters 144 and 145 (Clockwise/Counterclockwise Velocity Limits) to enter the maximum speed limit of the motor at maximum velocity command. If the maximum command voltage exceeds the normal maximum level, these values will limit the speed of the motor.

    d) Perform step 36.

    e) Remove power and reconnect all wiring, if applicable.

35. Current Limit Adjustment

    a) Apply power to the drive.

    b) Energize the contactor (M), but Do Not Enable the drive.

    c) Access parameters 156 and 157 (Positive and Negative Current Limits) to enter the desired positive and negative current limits.

    d) Perform step 36.

    e) Remove power and reconnect all wiring, if applicable.

36. Saving Current Parameters to EEprom

    If this step was just performed, proceed to the *System Compensation Procedure* or step 39.

    a) Access parameter 128 (EEprom Functions) and select "Save," followed by the Enter key. This will load the parameter values into memory.

       If no additional changes are required, press the Up Arrow key and Enter keys simultaneously to show the Basic Display.

System Compensation Procedure

The auto tune feature of the 1391-DES drive should provide sufficient system velocity loop compensation for the majority of applications. Additional tuning is usually not required. However, the following manual procedure for system velocity loop compensation can be followed, if desired.

37. Enable the drive and monitor the velocity feedback signal at terminals 5 (common) and 4 of TB2 with an oscilloscope or chart recorder. Default scaling is 1.2V/krpm.

ATTENTION: If an oscilloscope (or chart recorder) is used during Start-Up or Troubleshooting, it must be properly grounded. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. Always connect the oscilloscope chassis to earth ground.

When using an oscilloscope (or chart recorder) it is recommended that the test probe ground be connected to TB2-5.

38. Adjust parameter 168 (Kp Velocity Loop) and observe the velocity response (at TB2-4) profile at various levels of step input speed commands. The "Underdamped" response curve in Figure 8.1 with a single velocity overshoot of 20-30% on accel and decel is optimal on a point to point positioning or velocity controlled system. The "Critically Damped" curve is desirable on a contouring or metal removing system.

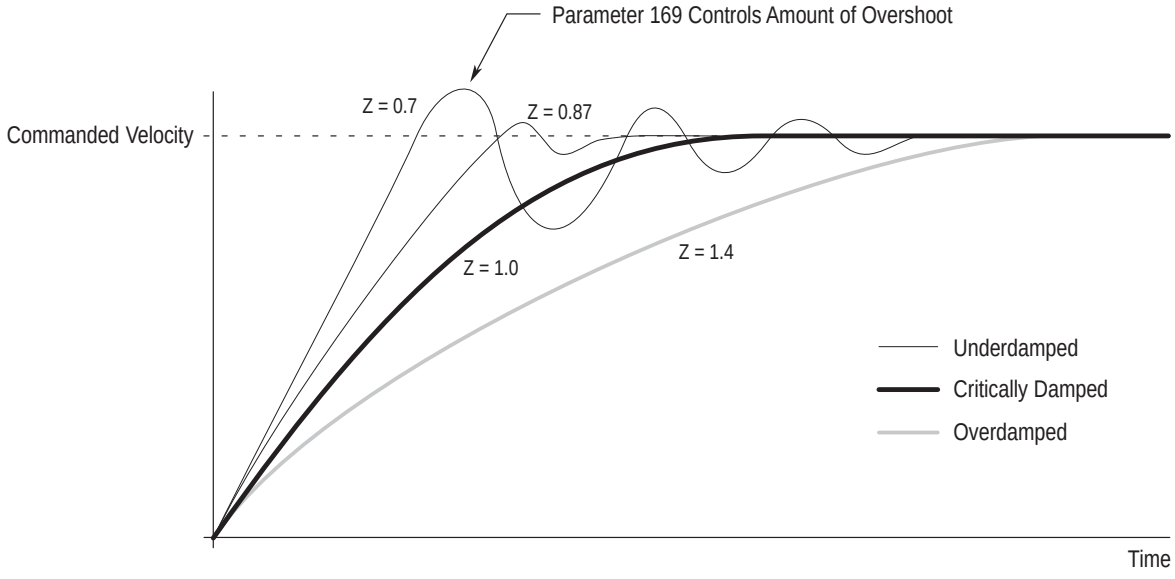
    Parameter 169 (Ki Velocity Loop) should be adjusted so that the motor achieves the commanded speed or final position as quickly as possible with little or no overshoot. In addition to the dynamic response, the motor shaft should not oscillate or exhibit any erratic motion at zero speed.

39. Remove power with the branch circuit disconnect.

40. Remove the local Enable switch and reconnect external wiring.

41. Apply power and check system operation.

Figure 8.1
Velocity Response Profiles



Linear Accel/Decel Control Module

The following information explains manual controller operation with the Linear Accel/Decel Control Module (CR-APG-001). This module provides adjustable acceleration/deceleration control for the 1391-DES. Up to four remote or local preset speeds are available.

Important: The 1391-DES Accel/Decel Ramp parameter (146) locally controls the velocity command per time rate. The default value is set to a maximum of 22216 revs per sec/sec. This parameter must be kept at maximum to allow the Linear Accel/Decel Control Module to set the accel/decel rate within the minimum/maximum values.

1. Perform the Start-Up Procedure presented earlier in this chapter.

2. Remove all system power.

3. Install and interconnect the Linear Accel/Decel Control Module as shown in Figure 8.2. Refer to Figure 8.3 for dimension information.

4. Set all of the Speed pots (SPD 1-SPD 4 or remote pots) to the maximum clockwise position (speed minimum). Set the front panel Accel and Decel pots to the maximum counterclockwise position (minimum accel/decel time).

   Important: All potentiometers on the module are 15 turn, bi-directional. The Local Speed pots are setup such that counterclockwise rotation will increase output and clockwise rotation will decrease output. Counterclockwise rotation of the Accel/Decel pots will decrease time, while clockwise rotation will increase time.

5. Apply 115V AC to terminals 1 & 2 of J3. Using a voltmeter, verify that this voltage is present. Also verify that +10V DC is present between terminals 9 (+) and 2 (–) of J1. The “ON/OFF” LED located on the front of the module will be illuminated.

6. Select Remote or Local speed control.

   To select Remote Speed

   a) Connect an external, 1k ohm, 1/2 watt speed potentiometer as shown in Figure 8.2.

   b) Energize the R/L 1 input (terminals 3 & 4 of J2) with either 24V DC or 115V AC.

   c) Energize the speed select input, SEL 1 (terminals 1 & 2 of J2) with the same voltage used in the previous step. The front panel “R/L 1” LED will illuminate.

   d) Repeat steps *a* through *c* for any of the other three preset speeds.

   Important: If more than one speed is selected at the same time, the resulting speed for the velocity profile will not be predictable.

To select Local Speed

a) Energize the speed select input, SEL 1 (terminals 1 & 2 of J2) with either 24V DC or 115V AC. The front panel “SEL 1” LED will illuminate.

b) Repeat the above step for any of the other three preset speeds.

Important: If more than one speed is selected at the same time, the resulting speed for the velocity profile will not be predictable.

Important: In the following steps, the local speed control (SPD 1) will be used. If your application utilizes remote speed pots, the remote pot should be substituted for SPD 1.

7. Connect a voltmeter between terminals 11 (+) and 10 (–) of J1. While monitoring the meter, turn the speed pot (SPD 1 or remote) counterclockwise until the output voltage is approximately +10V DC. Toggle the FWD/REV switch. The voltage measured should change in polarity.

   If the polarity does not change, recheck the wiring and connections of the FWD/REV relay and switch.

   Important: Changing direction with the speed input follows the accel/decel times set on the module.

8. Move the meter leads to drive terminals 1 (–) & 2 (+) of TB2. The meter should indicate a voltage of approximately +10V DC.

9. Rotate the Accel and Decel pots (located on the module front panel) approximately 7 turns.

10. De-energize the SEL 1 input (terminals 1 & 2 of J2) and note the time needed for the meter voltage to reach zero (minimum) volts. Energize the SEL 1 input and note the time needed for the voltage to reach +10V DC (maximum).

11. Adjust the Accel/Decel pots for desired ramp times (approximate range is 0.25 to 6.5 seconds) by repeating step 10. The final ramp time will be set during final system calibration. Rotate the speed pot fully clockwise for minimum speed. Remove the SEL1 input.

ATTENTION: To protect against rapid accel/decel commands from the module and possible machine damage or personal injury, the “Bypass” input (terminals 19 & 20 of J2) must not be energized. Applying 24V DC or 115V AC to this input will remove the Accel/Decel pot settings from the circuit, causing the output to immediately ramp to +10V DC or zero volts.

12. The output of the module is controlled by the “Deadman” input at terminals 10 & 11 of J1. Applying 24V DC or 115V AC to this input will cause the module to operate. The front panel “Dedman” LED will be off. When this input is de-energized, the module output will be connected to logic ground, thus disabling output. At this point the “Dedman” LED will illuminate.

    Energize the “Deadman” input with 24V DC or 115V AC.

ATTENTION: During subsequent steps, the servomotor may begin to rotate and cause incorrect machine movement when the drive is enabled. Be prepared to remove drive power by opening (MCB) or the branch circuit disconnect device if this occurs. This movement may be due to a wiring error or system component malfunction and must be corrected before proceeding with this procedure. Damage to machine system components can occur due to uncontrolled machine movements.

---

13. Apply power to the drive and module. Initiate a Start command by selecting speed input, SEL1. Command a speed through the speed pot, SPD 1 that represents approximately 10% of maximum speed (i.e. 1V DC).

    The motor should rotate slowly under control (following the speed pot). If the motor is uncontrollable or rotates incorrectly, de-energize SEL 1. Remove all power and check wiring.

    If the application requires reverse direction, use the FWD/REV toggle switch to check operation in the reverse direction.

14. With a zero velocity command from the module, use the drive parameter 210 (Analog to Digital Converter Offset) to set zero motor speed. Refer to Chapter 6 for more information on this parameter.

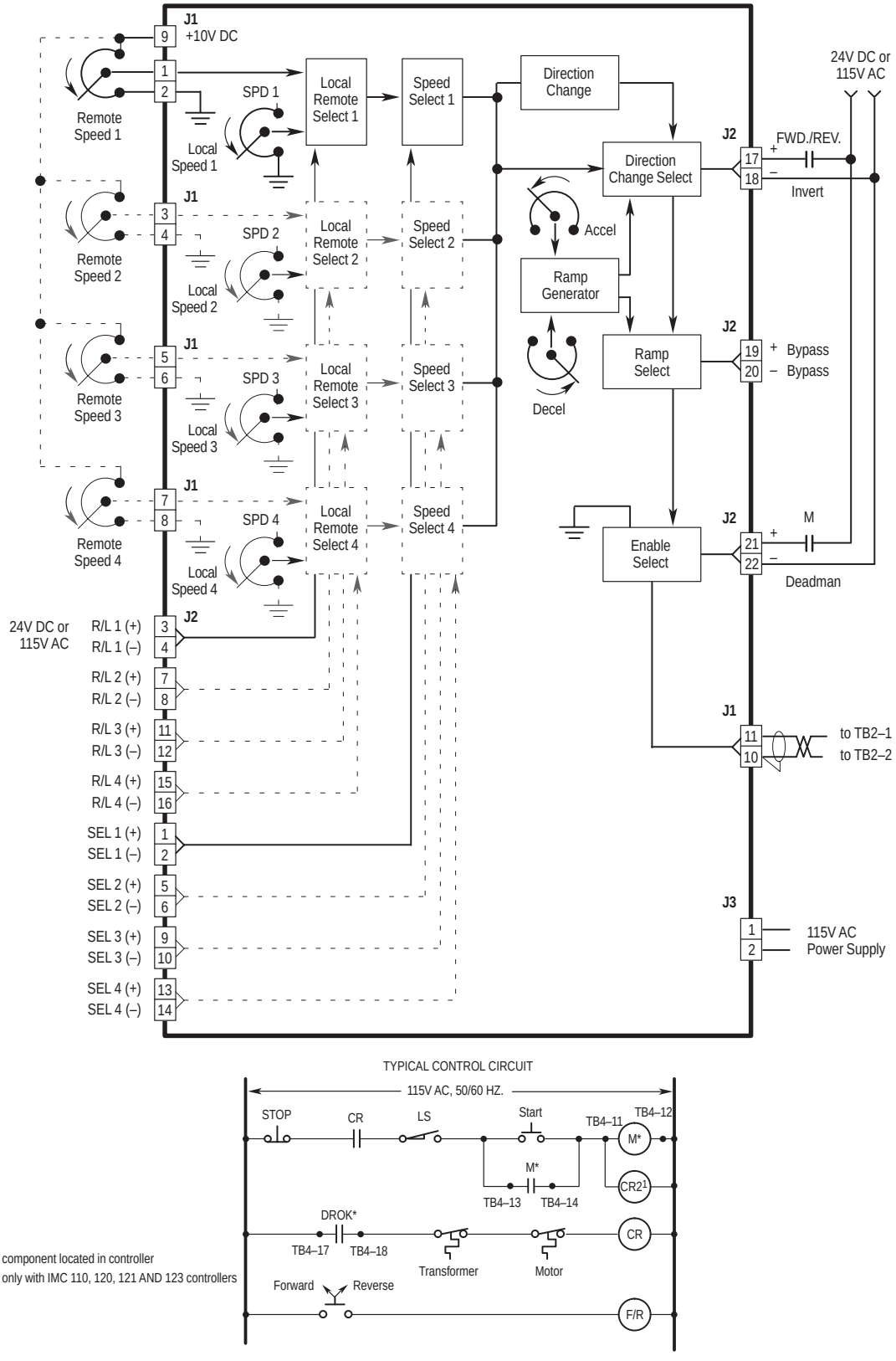
    Important: The motor may begin to move slowly after a period of time (several minutes) even though parameter 210 is set to zero.

15. Rotate the speed pot (SPD 1) fully counterclockwise. Adjust the Analog Velocity Gain parameter (211) if necessary to give the desired motor speed.

16. Check the accel/decel rate settings at speeds selected for the application. Refer to steps 10 & 11.

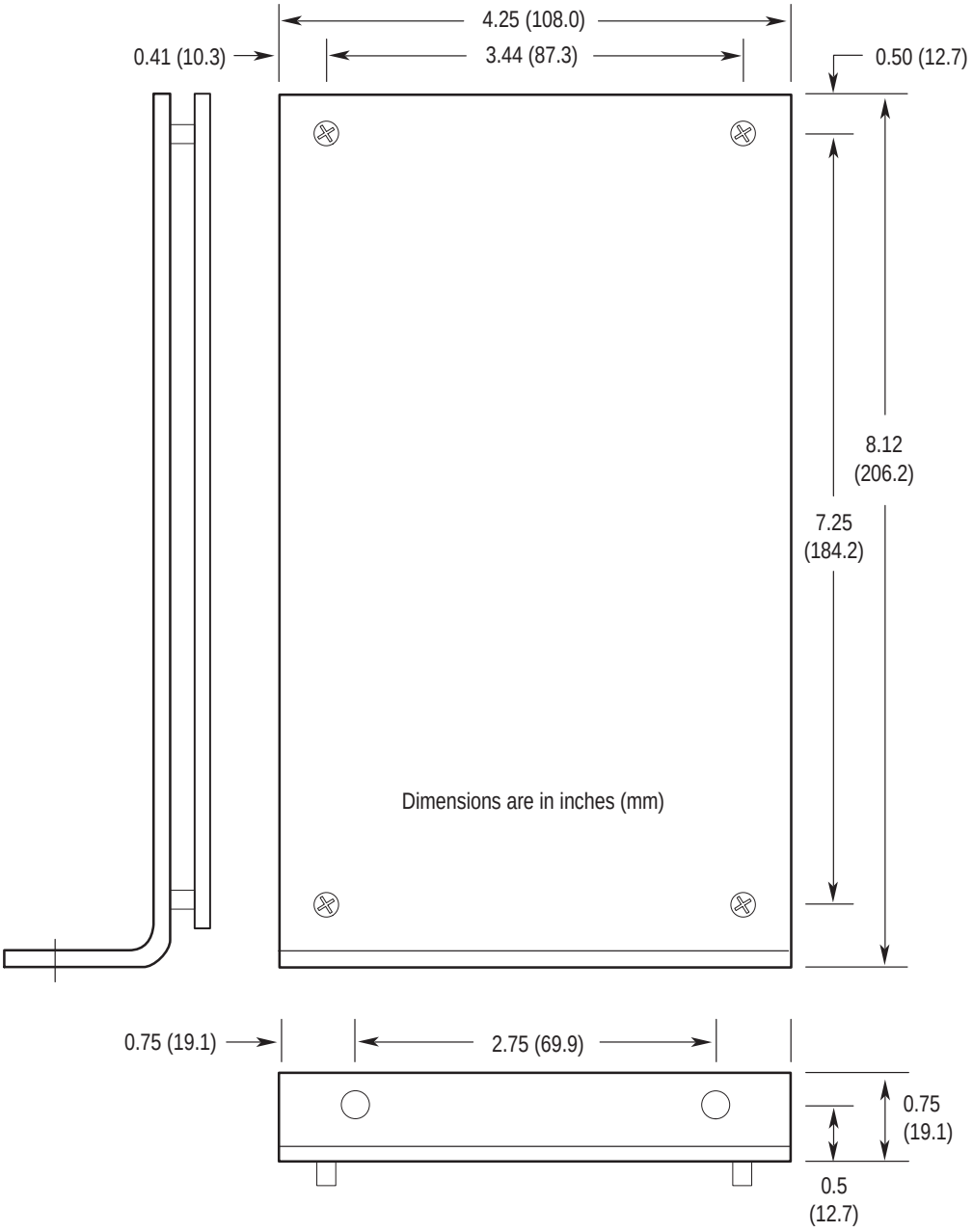
17. If applicable, repeat steps 6-16 for any of the other three preset speeds

Figure 8.2
Linear Accel/Decel Control Module Wiring



* Indicates component located in controller
[1] Required only with IMC 110, 120, 121 AND 123 controllers

Figure 8.3
Linear Accel/Decel Control Module Dimensions



End of Chapter

Chapter 9

1326 AC Servomotors

Chapter Objectives

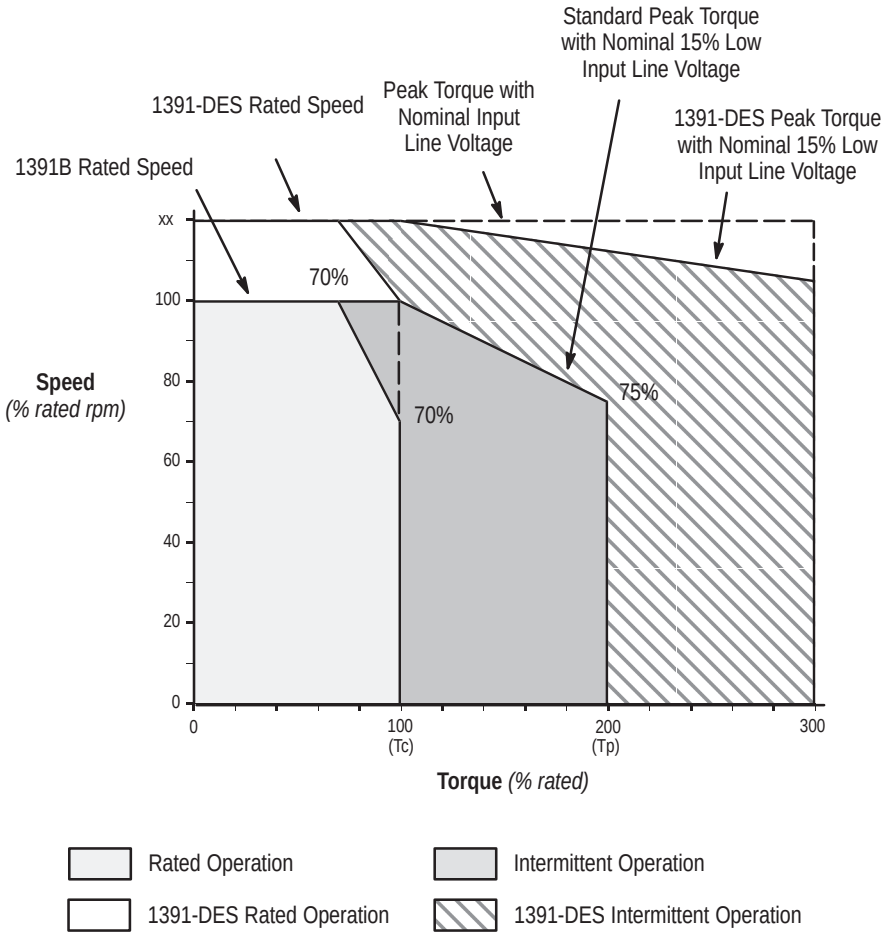
Chapter 9 describes the operation of a standard 1326 AC Servomotor with the enhanced capabilities of a Bulletin 1391-DES Digital AC Servo Drive. Refer to the *1326 AC Servomotor Product Data* for further information on Allen-Bradley AC Servomotors.

Introduction

The 1391-DES provides additional energy to the 1326 motor, allowing it to operate at higher speeds without a reduction of torque.

In general, the 1326 motor will follow the speed–torque curve shown in Figure 9.1

Figure 9.1
Typical Bulletin 1326 Speed–Torque Curve



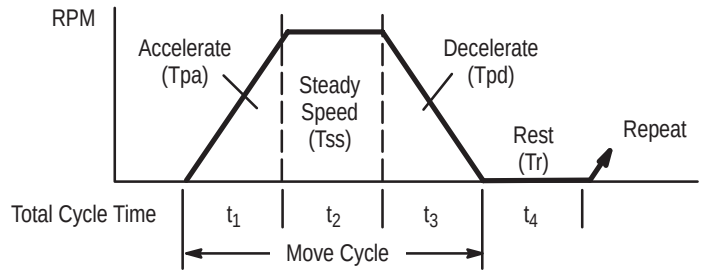
Tc – rated torque of motor with windings at rated temperature and an ambient of 40°C. The drive is operating in a rated ambient of 60°C.

Tp – the peak torque that can be produced by the motor/drive combination with both at rated temperature and the motor in a 40°C ambient and the drive in a 60°C ambient. Higher peak torques are permissible where RMS torque is less than or equal to the rated torque (Tc). 1391-DES operation is shown in the outer envelope and will show higher speed and 300% torque capability.

Rated Speed – the operating speed of the drive and motor combination at which a minimum of 70% of continuous rated torque (Tc) can be developed. This point is defined with the motor at 25°C and drive operating in a 60°C ambient.

Rated Operation Area – boundary of speed-torque curve where the motor and drive combination may operate on a servo basis without exceeding the RMS rating of either.

Duty Cycle Profile



$$Trms = \sqrt{\frac{Tpa^2 \times t_1 + Tss^2 \times t_2 + Tpd^2 \times t_3 + Tr^2 \times t_4}{t_1 + t_2 + t_3 + t_4}}$$

where:

Trms	The motors RMS or average torque over the duty cycle. (Expressed in lb.-in. or lb.-ft. The same units must be used throughout the formula.)
Tpa	Motor peak torque to accelerate to maximum speed. (Expressed in lb.-in. or lb.-ft. The same units must be used throughout the formula.)
Tss	Motor torque present at the motor shaft during constant speed segment. (Expressed in lb.-in. or lb.-ft. The same units must be used throughout the formula.)
Tpd	Motor peak torque to decelerate to zero speed. (Expressed in lb.-in. or lb.-ft. The same units must be used throughout the formula.)
Tr	Torque when motor is at zero speed.
t_1, t_2, t_3, t_4	Time for each portion of the duty cycle in seconds.

Intermittent Operation Area – Boundary of speed-torque curve where the motor and drive combination may operate in acceleration-deceleration mode without exceeding peak rating of either, provided that the duty cycle RMS continuous torque limit is not exceeded.

Table 9.A provides a comparison of the resultant speed obtained from standard 1326 servomotors using 1391 and 1391-DES Servo Drives. Table 9.B provides performance data for the 1326AB Torque Plus Series Motors.

Table 9.A
1391/1391-DES Speed Comparison [1, 2]

Continuous Stall Torque *(lb.-in./N-m)*	Peak Stall Torque *(lb.-in./N-m)*	Mtr. Rated Speed *(rpm)*	1391-DES Speed *(rpm)*	Motor Catalog Number	Servo Amplifier Catalog Number	Amperes at Continuous Stall Torque	Rotor Inertia *(lb.-in.-s^2/kg-m^2)*	Rated/DES Output *(kW)*
16/1.8	48/5.4	5000	6000	1326AB-A1G	1391-DES15	4.5	0.004/0.0005	0.7/0.9
32/3.6	96/10.84	3000	4000	1326AB-A2E	1391-DES15	5.2	0.007/0.0008	0.8/1.1
48/5.4	144/16.3	3000	4000	1326AB-A3E	1391-DES15	7.8	0.010/0.001	1.2/1.6
93.3/10.53	170.7/19.3	3000	4000	1326AB-B2E	1391-DES15	15.0	0.05/0.006	2.28/3.0
102/11.5	279/31.5	3000	4000	1326AB-B2E	1391-DES22	16.8	0.05/0.006	2.5/3.3
140/15.8	280/31.6	3000	4000	1326AB-B3E	1391-DES22	22.5	0.08/0.009	3.5/4.7
153/17.3	459/51.9	3000	4000	1326AB-B3E	1391-DES45	24.6	0.08/0.009	3.8/5.1
210/23.7	569/64.3	3000	4000	1326AB-C2E	1391-DES45	33.2	0.14/0.015	5.2/6.9
310/35.0	568/64.1	3000	4000	1326AB-C3E	1391-DES45	49.1	0.22/0.024	7.5/10.0
420/47.4	811/91.7	2000	3000	1326AB-C4C	1391-DES45	46.6	0.29/0.032	7.0/9.3 [3]
420/47.4	989/111.8	1600	2000	1326AB-C4B	1391-DES45	38.2	0.29/0.032	5.6/7.5

1 All ratings are for 40° C motor ambient,110° C case and 60° C amplifier ambient. For extended ratings at lower ambients contact Allen-Bradley.

2 The motor contains two thermal switches wired in series that will open on an overtemperature condition. They are set to open at 150° C (typical) and close at 90-100° C (typical). Contacts are rated for 1A at 115V AC, 1A at 24V DC.

3 –10% line voltage maximum.

Table 9.B
Torque Plus Performance Data and Selection List [1, 2]

Continuous Stall Torque *(lb.-in./N-m)*	Peak Stall Torque *(lb.-in./N-m)*	Rated Speed *(rpm)*	Rotor Inertia *(lb.-in.-s^2/kg-m^2)*	Motor Catalog Number	Servo Drive Catalog Number	Amperes at Continuous Torque	Rated Output *(kW)*
24/2.7	72/8.1	6000	0.004/0.0005	1326AB-A410G	1391-DESAA15	7.1	1.2
40/4.5	120/13.6	4000	0.007/0.0008	1326AB-A420E	1391-DESAA15	7.0	1.3
58/6.6	174/19.7	4000	0.010/0.001	1326AB-A430G	1391-DESAA15	9.5	1.9
92/10.4	181.5/20.5	4000	0.038/0.0043	1326AB-A515E	1391-DESAA15	15.2	3.0
92/10.4	272.4/30.8	4000	0.038/0.0043	1326AB-A515E	1391-DESAA22	15.2	3.0
106/11.98	248/28.0	4000	0.050/0.006	1326AB-A520E	1391-DESAA22	21.0	3.5
165/18.6	489/55.2	4000	0.080/0.009	1326AB-A530E	1391-DESAA45	29.5	5.5
500/56.5	1178/133	2000	0.29/0.32	1326AB-A740B	1391-DESAA45	38.2	8.3

1 All ratings are for 40° C motor ambient, 110° C case and 60° C amplifier ambient. For extended ratings at lower ambients contact Allen-Bradley.

2 The motor contains two thermal switches wired in series that will open on an overtemperature condition. They are set to open at 150° C (typical) and close at 90-100° C (typical). Contacts are rated for 1A at 115V AC, 1A at 24V DC.

Motor Options/Accessories

For detailed motor option/accessory information, refer to the individual instruction sheets shipped with the option/accessory.

End of Chapter

Chapter 10

Transformers and Shunt Regulators

Chapter Objectives

Chapter 10 provides general information about the 1391 Isolation Transformer. In addition, shunt regulator information is also provided.

1391 Transformers

The 1391-DES must operate from an isolation transformer having a three-phase, 230V AC output and a single-phase, 36V AC output.

Transformers supplied with the 1391-DES can provide power for up to four drives. Standard three-phase input voltages for the 60 Hz units are available. The kVA values specified are the continuous outputs of the units in a 60° C ambient.

Important: The maximum rating that can be connected to the 1391-DES is 15 kVA.

Important: The 1391-DES drive uses a 36V AC transformer tap to provide power to the Logic Control Board. It is recommended that a 1391 Isolation Transformer be used. Contact your local Allen-Bradley Sales Representative if a transformer of a different type must be used. Refer to Figure 10.1 and Appendix B for connection information.

60 Hz Transformers

Two 60 Hz transformers are available and have input ratings of:

1. 240/480V AC , three-phase
2. 208/230/460/575V AC, three-phase

50/60 Hz Transformers

The 50/60 Hz transformer that is available has an input rating of 240/380/415/480V AC, three-phase.

NEMA Type 1 Enclosure

Dimensions for the NEMA Type 1 enclosures are shown in Appendix A.

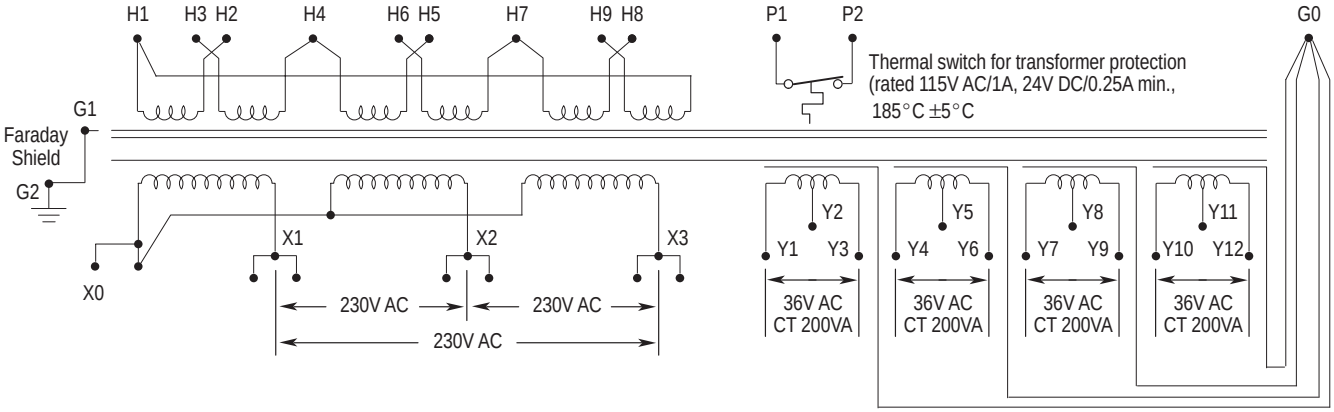
Important: The NEMA Type 1 enclosure is shipped as a kit for customer assembly.

If other input voltages or special enclosures are required, consult your local Allen-Bradley Sales Representative. Refer to Figure 10.1 for connection information and Appendix A for dimensions.

Figure 10.1
1391 Transformer Wiring Diagrams [1]

1391–TxxxDT (60 Hz.)

Primary Voltage	Connect	Lines On
240V AC	H1 to H3 to H8 H2 to H4 to H6 H5 to H7 to H9	H1 H4 H7
480V AC	H2 to H3 H5 to H6 H8 to H9	H1 H4 H7

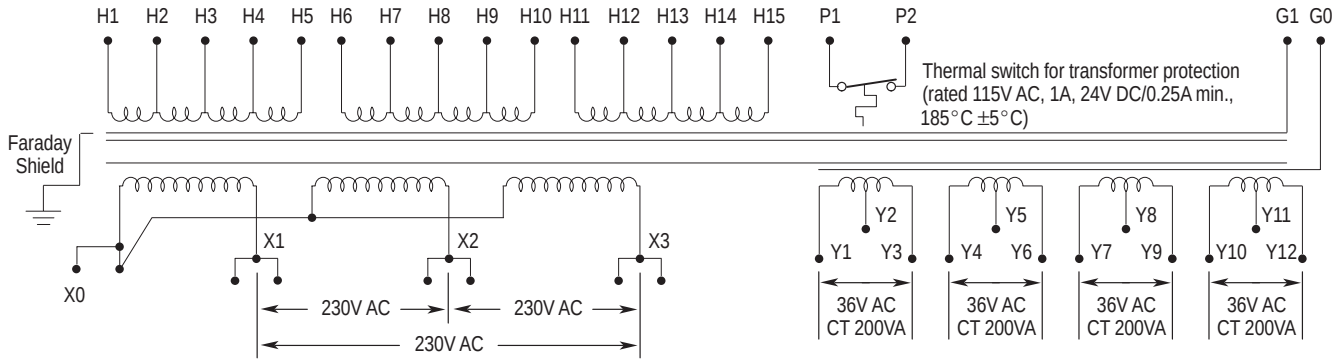


1391–TxxxET (50/60 Hz.)

Primary Voltage	Connect	Lines On
240V AC	H2 to H6 H7 to H11 H12 to H1	H1 H6 H11
380V AC	H3 to H6 H8 to H11 H13 to H1	
415V AC	H4 to H6 H9 to H11 H14 to H1	
480V AC	H5 to H6 H10 to H11 H15 to H1	

1391–TxxxNT (60 Hz.)

Primary Voltage	Connect	Lines On
208V AC	H2 to H6 H7 to H11 H12 to H1	H1 H6 H11
240V AC	H3 to H6 H8 to H11 H13 to H1	
480V AC	H4 to H6 H9 to H11 H14 to H1	
575V AC	H5 to H6 H10 to H11 H15 to H1	



[1] The Y2, Y5,Y8 and Y11 center taps are available but not used with the 1391-DES.

Shunt Regulator Operation

Refer to Chapter 4 for an explanation of the shunt regulator circuitry. The nominal data for the shunt regulator is as follows:.

Overvoltage Trip Point	= 405V DC±2.5%
DC Bus Shunt "ON" Point	= 386.4V DC
DC Bus Shunt "OFF" Point	= 366.9V DC
Nominal DC Bus Voltage	= 300V DC
DC Bus Undervoltage Detect	= 145V DC±20%

The shunt regulator behavior is modified by an adjustable duty cycle timer. The timer is used to model the shunt resistor temperature. A selector switch (SW1) determines the temperature level and therefore the average power level at which the drive will fault. When this level is reached, the drive will be forced to fault on an overvoltage. This action would be equivalent to turning the shunt regulator off.

The Duty Cycle Selector Switch is located on top of the drive near terminal Block, TB5 (see Figure 1.1). The switch has 16 positions designated "0 to F," with "0" being the lowest value and "F" the highest. The higher the setting, the higher the average power seen by the shunt resistor. The Duty Cycle Selector Switch settings for various drive/shunt combinations are shown in Tables 10.A and B.

Important: Accurate operation of the Duty Cycle Timer is dependent on the shunt resistor value. Do Not substitute alternate values.

Important: Setting SW1 higher than the rating of the shunt resistor may cause a blown fuse, resulting in repeated overvoltage faults. This will occur until the fuse is replaced and/or the switch is set correctly (see Table 10.B).

Table 10.A provides the required Duty Cycle Selector Switch settings and resistor power trip points for factory supplied configurations. An optional external resistor assembly (catalog number 1391-MOD-SR22A) is available for the 22.5A 1391-DES.

Table 10.A
Maximum Switch Settings and Trip Points for Factory Supplied Configurations

Configuration	SW1 Switch Setting	Nominal Trip Point
1391-DES15 w/ standard 16 ohm internal resistor	B*	164w, ±10%
1391-DES22 w/ standard 12 ohm internal resistor	B*	162w, ±10%
1391-DES22 w/ 9 ohm external resistor (1391-MOD-SR22A)	F	386w, ±10%
1391-DES45 w/ standard 5 ohm external resistor	D*	715w, ±10%

* Denotes SW1 setting at time of shipment. User must reconfigure drive when using optional 1391-MOD-SR22A.

ATTENTION: The designated settings for the factory supplied configurations must be used or damage to the drive may result.

Table 10.B shows the nominal resistor power trip levels in watts for the various switch settings. When shunt requirements exceed the selector setting, the excess power will cause the bus voltage to rise, resulting in an overvoltage fault condition and loss of braking.

Table 10.B
Nominal Power Trip Level Reference Data (continuous watts, ±10%)*

SW1 Switch Setting	**15A** W/ Int. 16 Ohm Resistor	**22.5A** W/ Int. 12 Ohm Resistor	**22.5A** W/ Ext. 9 Ohm Resistor	**45A** W/ Ext. 5 Ohm Resistor
0	67	73	98	215
1	71	77	103	227
2	75	82	109	241
3	80	86	115	256
4	85	92	122	274
5	91	98	130	294
6	99	105	139	317
7	107	113	150	344
8	118	122	163	378
9	130	133	177	417
A	145	146	195	466
B	164*	162*	216	527
C	189	183	243	607
D	223	208	277	715*
E	272	242	323	872
F	347	290	386*	1115

* Denotes the maximum allowable settings for factory supplied configurations.

ATTENTION: To guard against personal injury and/or equipment damage from an overheated resistor, the designated duty cycle settings for factory supplied shunt resistor configurations must not be exceeded. Check the Duty Cycle Selector Switch (SW1) to ensure that it is set properly before operation.

ATTENTION: When using a customer supplied external shunt resistor assembly, the Duty Cycle Selector Switch (SW1) must be set to an appropriate level for that resistor assembly. Consult the resistor manufacturer for the appropriate derating guidelines. Failure to comply could result in personal injury and/or equipment damage from an overheated resistor.

Frequent overvoltage trips and blown fuse on high inertia systems during regenerative states (deceleration) may be an indication that an external shunt resistor having increased power dissipation capacity is required. Based on the data supplied, Allen-Bradley will specify a shunt resistor with the proper resistance value for the drive being used.

Shunt Regulator Installation

External Shunt Resistors

The 1391-DES is designed to allow the use of an external shunt resistor on the 22.5 and 45A units. To use an external shunt resistor with the 22.5A units, the user must reconfigure the drive at terminal block TB5.

The following steps provide the information needed to properly convert 22.5A drives for use with an external shunt resistor and fuse. Refer to the resistor and fuse mounting dimensions provided in Appendix A and the Interconnect Diagram in Appendix B, as required. A minimum wire size of 12 AWG (2.5 mm^2) must be used when connecting an external resistor.

ATTENTION: To guard against an electrical shock hazard, ensure that all power to the drive has been removed prior to performing the following procedure and the bus voltage at terminal 9 (+) and 7 (–) of TB5 measures 0.00 volts.

---

1. Remove and discard the jumper present between terminals 8 and 10 of TB5. This disconnects the internal shunt resistor and fuse from the shunt regulator circuit.

ATTENTION: When using an external shunt resistor assembly with the 22.5A 1391-DES, ensure that the internal resistor assembly has been disconnected per the above instructions. Personal injury and/or equipment damage could result from an overheated resistor if the internal resistor is not disconnected.

---

2. Connect one end of the new external shunt fuse to terminal 9 of TB5. Connect the other end of the fuse to one end of the shunt resistor.

   Important: The external shunt resistor must have a fuse in series with the shunt resistor. Refer to the paragraph entitled “Shunt Fusing” for more information.

3. Connect the remaining end of the shunt resistor to terminal 8 of TB5.

4. Using Table 10.B, set the Duty Cycle Selector Switch to the appropriate setting for the resistor being used.

5. Install the appropriate shunt fuse in its holder.

ATTENTION: Proper derating must be applied to the manufacturers nominal resistor power ratings when using these in external shunt configurations. Consult the resistor manufacturer for recommended derating. Failure to comply could result in personal injury and/or equipment damage from an overheated resistor.

Shunt Fusing

Shunt regulator fusing is provided with all of the 1391-DES drives. The fuse is in series with the resistor and used to protect the resistor against short circuits. The shunt fuse is located on top of the drive near the circuit breaker for 15 and 22.5A drives. External resistors for 22.5A and 45A drives are supplied with a fuse which must be mounted external to the drive (see Appendix A for mounting dimensions). Refer to Table 10.C for further shunt fuse information.

Table 10.C
Shunt Fuse Information

Drive Rating	Fuse Location	Fuse Type
15A	Top Panel	Bussmann KLM-10 or equivalent
22.5A	Top Panel	Bussmann FNM-6.25 or equivalent
22.5A	External	Bussmann KTK-15 or equivalent
45A	External	Bussmann KLM-20 or equivalent

Important: Repeated overvoltage tripping can be an indication that the shunt fuse has malfunctioned.

Chapter 11

Troubleshooting

Chapter Objectives

Chapter 11 provides information to guide the user in troubleshooting the 1391-DES. Included in the chapter are board and drive substitution procedures, fault indications, general system faults and test point descriptions.

System Troubleshooting

Most drive faults are annunciated by fault messages on the front panel display. Many system malfunctions manifest themselves through a drive fault. The troubleshooting information provided will take advantage of the fault messages and list a number of potential system problems related to each. In addition, a number of common system and motor malfunctions are described.

ATTENTION: This product contains stored energy devices. To avoid hazard of electrical shock, verify that all voltage on the capacitors has been discharged before attempting to service, repair or remove this unit.

Voltage at terminals 9 (+) and 7 (–) of TB5 must be “0.00” as measured with a standard digital voltmeter or multimeter.

Only qualified personnel familiar with solid-state control equipment and safety procedures in publication NFPA 70E should attempt this procedure.

ATTENTION: Do not attempt to defeat or override the drive fault circuits. The cause of a fault indication must be determined and corrected before attempting operation. Failure to correct a drive or system malfunction may result in personal injury and/or equipment damage due to uncontrolled machine system operation.

ATTENTION: If an oscilloscope (or chart recorder) is used for troubleshooting, it must be properly grounded. The oscilloscope chassis may be at a potentially fatal voltage if not properly grounded. Always connect the oscilloscope chassis to earth ground.

The majority of faults cause the DROK contact to operate. The use of fault messages may aid in identifying drive and motor malfunctions. If a drive fault occurs, the fault detection circuitry can be reset by removing and reapplying power to the transformer supplying the servo drive or connecting the Reset input (TB2-11) to ground (TB2-12) with the enable removed.

This material along with the diagnostic/troubleshooting information included with the position controller, will help identify most common system malfunctions to an assembly level. The position controller is considered to be a; computer numerical control (such as an Allen-Bradley 9/240), programmable controller (IMC 120, 121, 123) or stand-alone control (S Class, MAX), controlling a closed loop position or velocity system.

Substituting or interchanging complete servo drives or major board assemblies is a common technique used in troubleshooting closed loop position systems. The 1391-DES has been designed to facilitate this technique. The procedures provided must be followed when substituting or interchanging drives or board assemblies. Refer to Figure 11.1 for board and connector locations.

ATTENTION: This drive contains ESD (Electrostatic Discharge) sensitive parts and assemblies. Static control precautions are required when installing, testing, servicing or repairing this drive. Component damage may result if ESD control procedures are not followed. If you are not familiar with static control procedures, reference A-B publication 8000-4.5.2, *Guarding Against Electrostatic Damage* or any other applicable ESD protection handbook.

Drive Substitution

1. Remove all power to the drive branch circuit.
2. Remove connectors TB1, TB2 and TB3.
3. Label and remove the motor leads and three-phase input at TB4. Also remove the drive ground wire.
4. Remove the Memory Board. Refer to Figure 11.1 and the following page for further information.
5. Remove the drive and insert replacement unit.
6. Reconnect the ground wire, motor leads, three-phase input and signal connectors previously removed.
7. Replace the Memory Board previously removed.
8. Apply power to the system and check for proper operation – tuning should not be required.

Display Board Substitution

1. Remove all power to the drive branch circuit.
2. Remove the front cover from the drive.
3. Loosen the 4 thumb screws and remove the cable between the Display and Logic Control Boards. Remove the Display Board.
4. Install the new Display Board. Reconnect cable.
5. Apply power to the system and check for proper operation – tuning is not be required.

Memory Board Substitution

1. Remove all power to the drive branch circuit.
2. Remove the front cover from the drive.
3. Remove the Memory Board by squeezing the nylon latches.
4. Install the new Memory Board.
5. Apply power to the system – tuning will be required.

Logic Control Board Substitution

1. Remove all power to the drive branch circuit.
2. Remove the front cover from the drive. Label and remove the ribbon cables and signal connectors (TB1 and TB2) from the Logic Control Board.
3. Remove the Memory and Display Boards.
4. Insert the replacement Logic Control Board.
5. Replace the Memory and Display Boards and reconnect the signal connectors/cables previously removed.
6. Apply power to the system and check for proper operation – tuning should not be required.

A Quad B Board Substitution

1. Remove all power to the drive branch circuit.
2. Remove the front cover from the drive. Label and remove the ribbon cables and signal connectors (TB1, TB2 and TB3) from the A Quad B and Logic Control Boards.
3. Remove the Display and Logic Control Boards.
4. Remove the A Quad B Board.
5. Install the new A Quad B Board to the Logic Control Board with the 8 thumb screws.
6. Install the Logic Control Board (w/AQB Board) verifying that the connectors between the boards mate. Tighten the 8 screws.
7. Install the Display Board and cable.
8. Reconnect the signal connectors/cables previously removed.
9. Apply power to the system and check for proper operation – tuning should not be required.

LED Indications

The 1391-DES has two LEDs visible from the front of the drive. The top LED, labeled “STATUS,” flashes green when no faults are detected by the drive and a bus undervoltage condition exists. The LED will be a steady green when no faults exist and bus voltage is present. If a fault is detected, the LED will turn red and flash.

The lower green LED, labeled “ENABLE,” will be lit when the drive is enabled (on and in control of the servomotor). An enable signal must be applied to terminals TB2-9 & 10 for the LED to be lit. Refer to Table 11.A for further information.

Table 11.A
LED Fault Diagnostics

Enable	The application of an Enable signal by the machine position controller will cause the ENABLE LED to illuminate.	Enable LED is NOT Illuminated 1. The position controller has not enabled the drive. 2. The Enable wiring to the drive is open. 3. The position controller Enable relay/switch has malfunctioned. 4. The position controller has detected a machine system malfunction that will not allow the drives to be Enabled. 5. Power has not been applied to input transformer. 6. The logic supply (±12V DC) circuits have malfunctioned (fuse blown etc.) or the AC input at TB4-19, 21 is incorrectly wired or missing. Enable LED is Illuminated, but drive does not Enable 1. A drive malfunction has occurred but is not annunciated by the LED indicators. Check the status of the Drive OK output (DROK) relay. 2. A component malfunction exists in the Enable circuit. 3. The circuit breaker (MCB) is tripped. 4. The power contactor has not been energized or has malfunctioned. 5. Motor cables removed. <u>The drive logic supplies are not operational</u> 1. The logic supply fuses are blown 2. Logic supply AC voltage is missing 3. A drive malfunction has occurred but is not annunciated by the LED indicators (check the status of the Drive OK contacts).
Status	Status LED is flashing red.	1. System fault has occurred. 2. Power was applied while the drive was enabled. Remove enable and reapply power.
	This LED is green until a system fault occurs. The LED will flash green when bus voltage is not present (DROK open). If the DC Power Bus drops below a preset level the DROK contact will open if parameter 130 is set to 1.	1. The power contactor (M) has not energized or has dropped out. 2. The input line voltage is low. 3. The shunt regulator circuit has malfunctioned and is placing the shunt resistor across the power bus. 4. The power bus capacitor has malfunctioned. 5. The circuit breaker (MCB) has tripped. 6. The three-phase input line is open. 7. Transformer is supplying the wrong line voltage or has malfunctioned.

Troubleshooting Tables

Table 11.B provides a listing and description of the faults shown through the front panel display. Also included are possible solutions to the faults. Table 11.C provides a listing of common system malfunctions and their possible causes. Table 11.D lists servomotor malfunctions and their possible causes. Table 11.E provides a listing and description of the available test points. Refer to Figure 11.1 for board, connector and test point locations.

Fault Codes

Parameter 06 is a 16 bit, binary word that represents the drive faults. A "1" indicates that a fault has occurred. If a "0" is displayed, a fault has not occurred. Refer to the following table for an explanation of the individual codes.

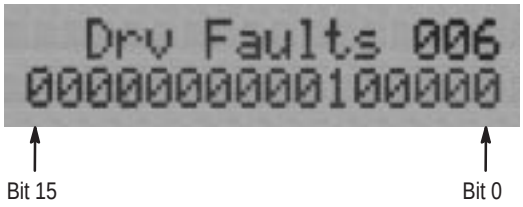


Table 11.B
Fault Descriptions and Diagnostics

Fault/Message	Fault Description	Potential Cause
"*No Active Faults*"	None	All circuits are functional.
Drive Overtemperature "*amp overtemp*" (Bit 1)	The drive contains a thermal switch on the heat sink which senses the power transistor temperature. If the temperature is exceeded the LED will illuminate.	The logic supply (±12V DC, +5V DC) circuits have malfunctioned (fuse blown etc.) or the AC input at TB4-19, 20, 21 is incorrectly wired. The heat sink thermal overload has tripped. One or more of the following may have occurred: 1. The cabinet ambient temperature is above rating. 2. The machine duty cycle requires an RMS current exceeding the continuous rating of the drive. 3. The integral fan is not functioning. 4. The airflow access to the drive is limited or blocked.
Control Voltage Fault "*cntrl voltage*" (Bit 4)	A fault will occur if the logic supply rises or drops 10% from its nominal value.	1. The input line voltage is out of tolerance. 2. The transformer auxiliary logic supply winding is open. 3. The logic supply (±12V DC, +5V DC) circuits have malfunctioned (fuse blown etc.) or the AC input at TB4-19, 20, 21 is incorrectly wired.
Resolver Loss "*resolver loss*" (Bit 5)	The resolver wiring is open or shorted or missing.	1. Open or short circuit on resolver wiring. 2. Incorrect resolver wiring.
Power Fault "*power fault*" (Bit 7)	The current through the power output transistors is monitored. If the current exceeds a fixed level (greater than 300% of drive rating) the LED will illuminate.	1. The current through any one of the power transistors has exceeded 300% of the drive's current rating. 2. Malfunctioning power transistor. 3. Shorted Lead. 4. Motor malfunction.

Table 11.B
Fault Descriptions and Diagnostics *(Continued)*

Fault/Message	Fault Description	Potential Cause
Overvoltage "*bus overvoltage*" (Bit 8)	The DC Power Bus is continuously monitored. If it exceeds a preset level a fault is sensed and the power supply is disabled.	The power bus voltage has exceeded 405V DC. 1. Power Driver Board is malfunctioning and incorrectly sensing the bus voltage. 2. A vertical axis with insufficient counterbalancing is overdriving the servomotor and causing excessive energy to be returned to the power supply bus. 3. The system inertia is too high causing excessive energy to be returned to the power supply bus. 4. Input line voltage exceeds the maximum drive input voltage rating. 5. The position controller acceleration / deceleration rate is incorrectly set. 6. The shunt regulator or transistor has malfunctioned. 7. Shunt regulator fuse has blown. 8. Shunt regulator resistor not connected to drive.
External A/D Conversion Fault "*ext A/D fault*" (Bit 10)	Component malfunction of input A/D converter.	Component on Logic Control Board has malfunctioned – replace Logic Control Board.
Internal A/D Conversion Fault "*int A/D fault*" (Bit 11)	Component malfunction of input A/D converter.	Component on Logic Control Board has malfunctioned – replace Logic Control Board.
EEPROM Fault "*EEprom fault*" (Bit 14)	Problem reading or writing to EEprom.	1. Re-initialize EEprom (parameter 128). 2. Malfunctioning EEprom – replace Memory Board.
Auto Tune Fault "*auto tune flt*" (Bit 15)	Auto tune cycle time has exceeded 2 seconds.	1. Auto tune current limit should be increased to speed up the auto tune cycle. 2. Auto tune velocity should be decreased to speed up auto tune cycle. 3. Motor is disconnected or not able to turn. 4. Motor power/resolver continuity disconnected or miswired.
	Enable has not been applied within 60 seconds during auto tune,	1. Enable not applied.

Table 11.C
General System Troubleshooting

Condition	Possible Cause
Axis or System runs uncontrollably	1. The velocity feedback, position feedback device or velocity command signal wiring is incorrect or open. 2. An internal drive malfunction exists. 3. Set in torque mode incorrectly.
Axis or System is unstable	1. Parameters 168, 169 and 170 are set too high. 2. Position Loop Gain or Position Controller accel/decel rate is improperly set. 3. Improper grounding or shielding techniques are causing noise to be transmitted into the position feedback or velocity command lines, causing erratic axis movement. 4. Parameter 154 is incorrectly set (servomotor is not matched to drive).
Desired motor acceleration / deceleration cannot be obtained	1. Parameters 156/157 are set too low. 2. Parameter 154 is incorrectly set (servomotor is not matched to drive). 3. The system inertia is excessive. 4. The system friction torque is excessive. 5. Available drive current is insufficient to supply the correct accel/decel rate. 6. Accel/Decel Ramp (parameter 146) incorrect. 7. Velocity limit (parameters 144, 145) incorrect. 8. Analog Velocity Gain (parameter 211) incorrect.
Motor does not respond to a Velocity Command	1. The drive has a malfunction 2. The drive is not enabled. 3. The contactor (M) is not energized. 4. Power transformer is supplying the incorrect voltage or none at all. 5. The motor wiring is open. 6. The motor or transformer thermal overload has tripped. 7. The motor has malfunctioned. 8. The coupling between motor and machine has malfunctioned. 9. The feedback circuit (motor to drive) is open. 10. Velocity Mode Select (parameter 132) set incorrectly. 11. Torque Select (parameter 133) set incorrectly. 12. Velocity limits (parameters 144, 145) set incorrectly.
Presence of noise on Command or resolver signal wires	1. 50/60 Hz line frequency may be present. 2. 100/120 Hz from a single phase logic supply may be present. 3. 180 or 360 Hz from other adjustable speed drives may be present. 4. Variable frequency (varies with motor speed) may be velocity feedback ripple or a disturbance caused by gear teeth or ballscrew balls etc. The frequency may be a multiple of the motor power transmission components or ballscrew speeds. 5. Recommended grounding per Appendix B has not been followed.
Position controller faults on excess encoder counts during power-up.	1. AQB Board outputs a series of encoder pulses during power-up. An intermittent connection or removal of TB3 while powered up will cause this series of pulses to repeat.

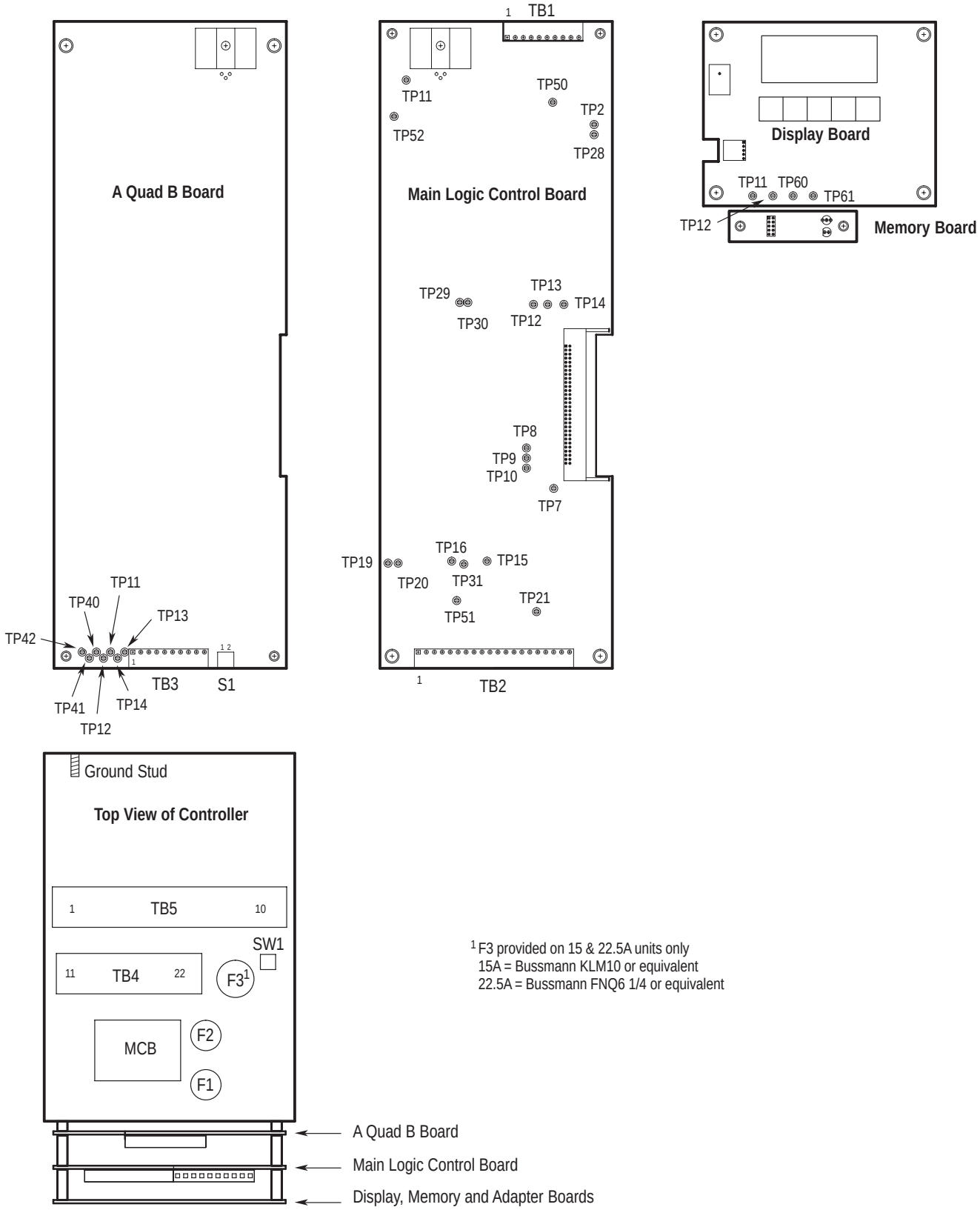
Table 11.D
General Servomotor Troubleshooting

Condition	Possible Cause
No Rotation	1. The motor connections are loose or open. 2. Foreign matter is lodged in the motor. 3. The motor load is excessive. 4. The bearings are worn. 5. The motor brake is engaged (if supplied).
Overheating	1. The rotor is partially demagnetized causing excessive motor current. 2. Motor voltage is exceeding the maximum value. 3. The duty cycle is excessive.
Abnormal Noise	1. Loose parts are present in the motor. 2. Through bolts are loose. 3. The bearings are worn. 4. Parameters 168, 169 and 170 are set too high.
Erratic Operation - Motor locks into position, runs without control or with reduced torque	1. Phases A & B, A & C or B & C reversed 2. Sine, Cosine or Rotor leads reversed 3. Sine, Cosine, Rotor lead sets reversed 4. Combinations of 1, 2, 3

Table 11.E
Test Point Descriptions

Test Point	Description	
TP2	Resolver:	8.000 kHz sine wave 3.0V RMS
TP7	Triangle:	Triangle oscillator 2.5kHz , 5.5 volts peak
TP8	PWM B:	Phase B transistor turn on signal
TP9	PWM A:	Phase A transistor turn on signal
TP10	PWM C:	Phase C transistor turn on signal
TP11	+5V DC	
TP12	Signal Common	
TP13	+12V DC	
TP14	–12V DC	
TP15, 16	IALPHA and IBETA:	Sinusoidally varying DC level representing the current command to the current loop scaled for 2.5V peak = rated motor current
TP17	IT Ref:	Voltage representing current reduction amount
TP19	Buffered Output:	Velocity input
TP20	Buffered Output:	Torque input
TP21	Ext Current Limit:	Indicates the external current limit command (3V = rated)
TP28	Signal Common	
TP29, 30	IA, IB Feedback	Buffered motor current feedback signals scaled for 2.5 volts peak = rated motor current
TP31	Signal Common	
TP50	ABS Rotor:	Signal used to detect resolver loss. Nominal value = 2.596V. Trip point is approximately 0.8V.
TP51	9V Ref:	Signal feeding output d/a's reference
TP52	Microprocessor Reset:	Momentarily ground to reset microprocessor
TP40	Sine (wt):	4.0 kHz 2.0 Vrms sine wave used for A Quad B
TP41	Sine (wt) Sine (theta):	2.0 Vrms modulated waveform used for A Quad B
TP42	Sine (wt) Cosine (theta):	2.0 Vrms modulated waveform used for A Quad B
TP60	Display Reset:	Ground to reset display microprocessor
TP61	Test Result:	Indicates a pass or fail result from a self test initialization

Figure 11.1
1391-DES Test Point Locations



[1] F3 provided on 15 & 22.5A units only
15A = Bussmann KLM10 or equivalent
22.5A = Bussmann FNQ6 1/4 or equivalent

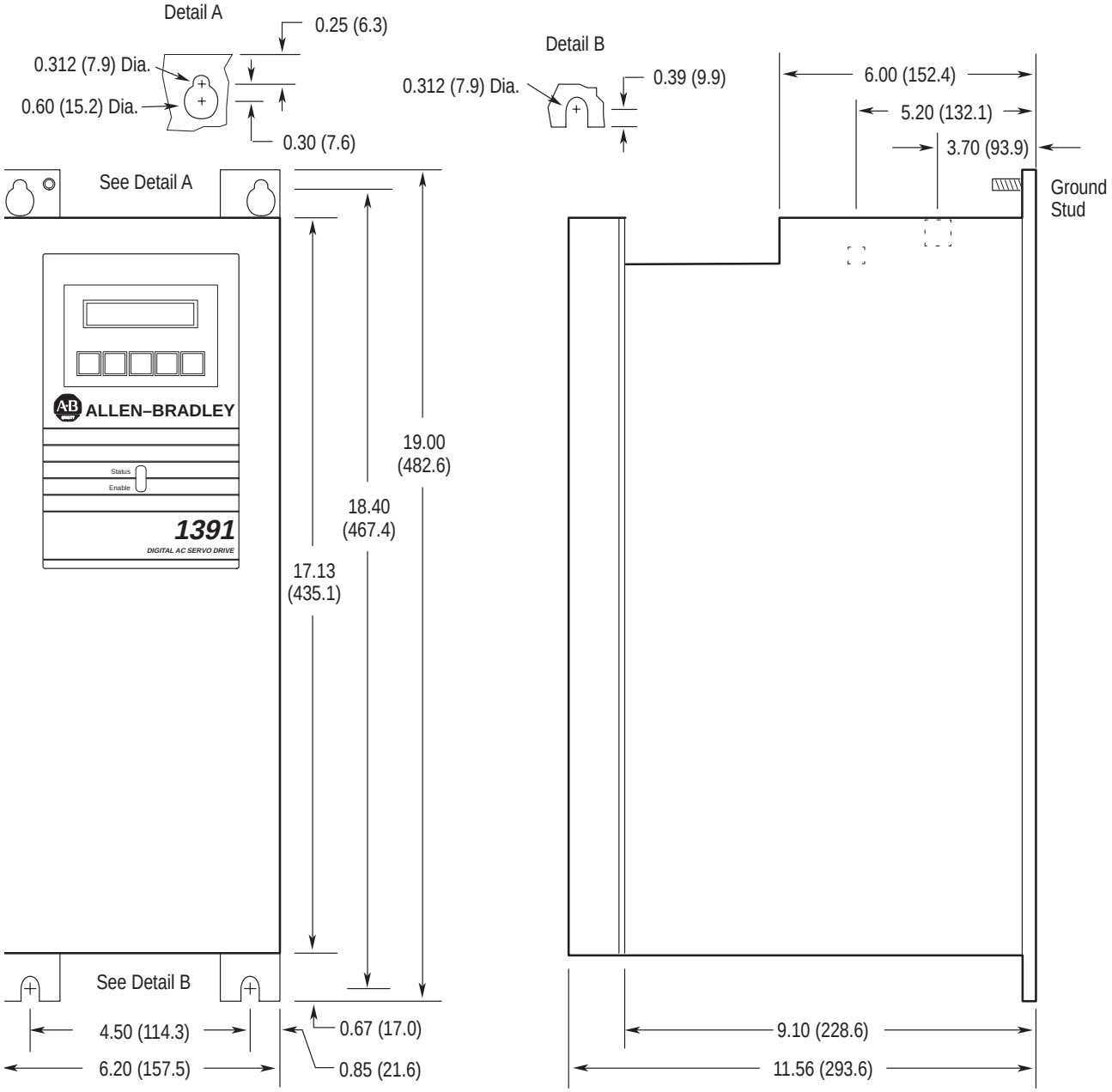
End of Chapter

Appendix

A

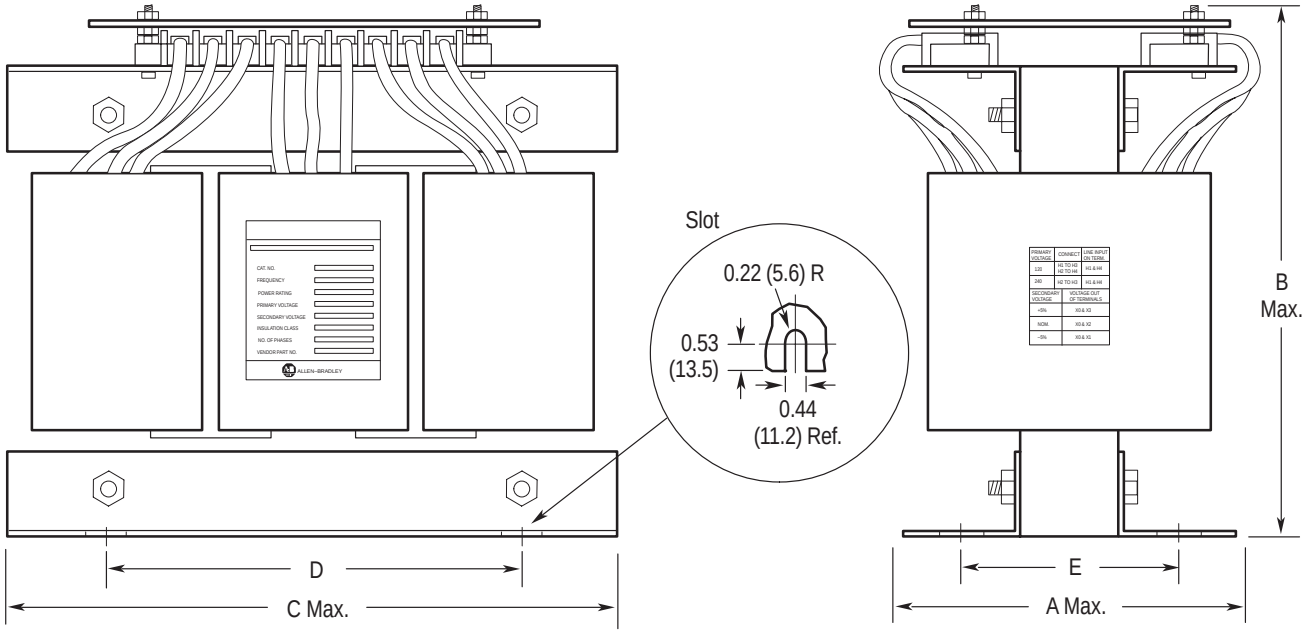
Dimensions

Figure A.1
1391-DES Dimensions
Dimensions are in inches and (millimeters)



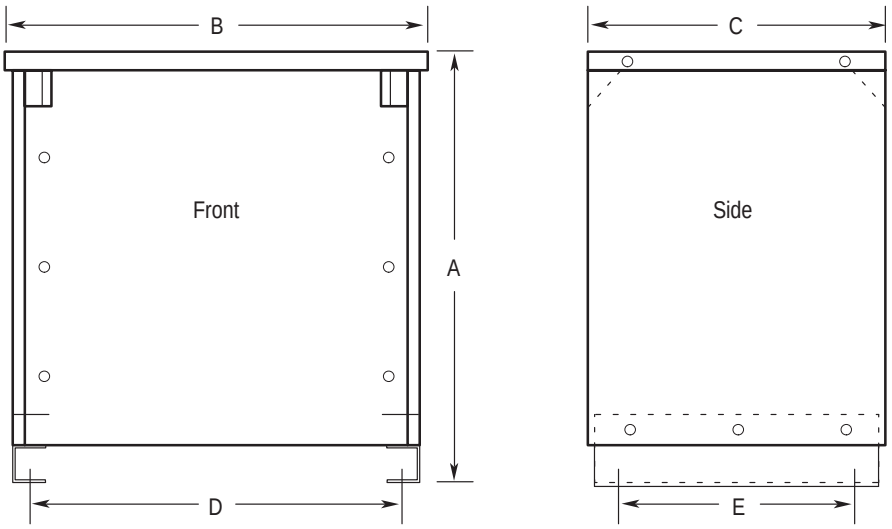
Notes: 1. Mounting slots and keyholes will accept 1/4–20 (7 mm) hardware.
2. A minimum spacing of 0.312" (7.9 mm) is required between adjacent controllers 1" (25.4 mm) is recommended.

Figure A.2
1391 Isolation Transformer Dimensions
Dimensions are in inches and (millimeters)



Catalog Number	kVA	A	B	C	D	E	Weight
1391-T015DT	1.5	9.00 (228)	10.00 (254)	13.00 (330)	5.00 (127)	3.10 (79)	27 (12.2)
1391-T015ET/NT		9.00 (228)	10.00 (254)	13.00 (330)	5.00 (127)	3.50 (89)	40 (18.2)
1391-T035DT	3.5	11.00 (279)	11.00 (279)	14.00 (356)	6.00 (152)	4.50 (114)	60 (27.2)
1391-T035ET/NT		11.00 (279)	11.00 (279)	14.00 (356)	6.00 (152)	4.50 (114)	85 (38.6)
1391-T050DT	5.0	11.00 (279)	11.00 (279)	14.00 (356)	6.00 (152)	5.25 (133)	75 (34.0)
1391-T050ET/NT		11.00 (279)	11.00 (279)	14.00 (356)	6.00 (152)	6.00 (152)	100 (45.4)
1391-T100DT	10.0	12.00 (305)	12.50 (317)	16.00 (406)	8.00 (203)	5.85 (149)	112 (50.8)
1391-T100ET/NT		12.00 (305)	12.50 (317)	16.00 (406)	8.00 (203)	5.85 (149)	140 (63.6)
1391-T125DT	12.5	12.00 (305)	12.50 (317)	16.00 (406)	8.00 (203)	5.63 (143)	126 (57.1)
1391-T125ET/NT		12.00 (305)	12.50 (317)	16.00 (406)	8.00 (203)	5.63 (143)	160 (72.7)
1391-T150DT	15.0	13.00 (330)	14.00 (356)	17.50 (444)	9.50 (241)	6.00 (152)	150 (68.0)
1391-T150ET/NT		13.00 (330)	14.00 (356)	17.50 (444)	9.50 (241)	6.00 (152)	200 (90.9)

Figure A.3
NEMA Type 1 Enclosure Dimensions
Dimensions are in inches and (millimeters)

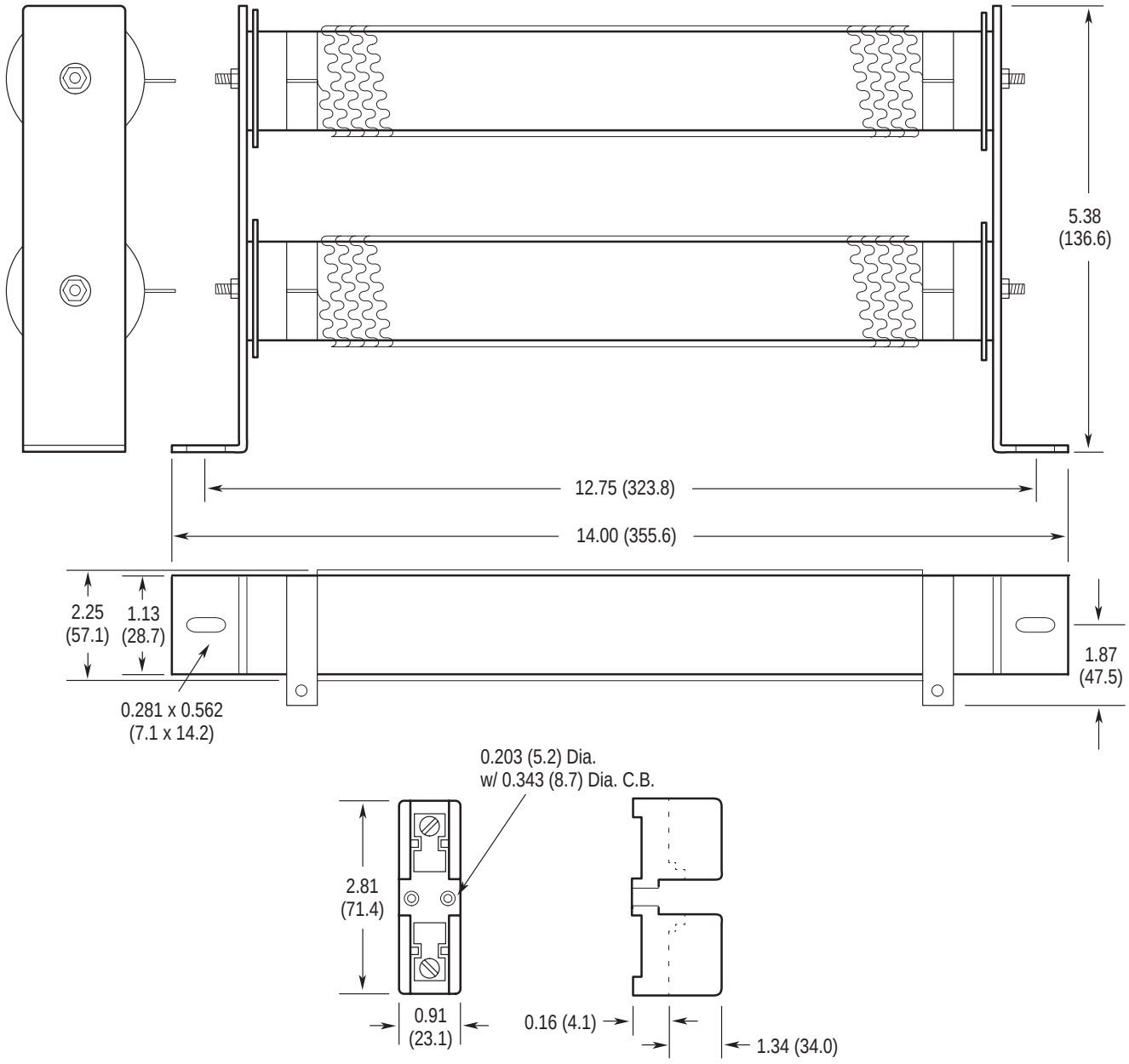


The following items are included with the NEMA Type 1 Enclosure.

Qty.	Description
2	Steel Mounting Channels
4	3/8-16 x 1.0 HHCS Screw
4	3/8-16 x 1.5 HHCS Screw
8	3/8 Flat Washer
8	3/8 Split Lock Washer
8	3/8-16 Hex Nuts

Catalog Number	kVA	A	B	C	D	E	Weight
1391-TA2	All	17.00 (432)	19.00 (483)	14.50 (368)	16.50 (419)	12.00 (305)	35.5 (16.1)

Figure A.4
External Shunt Resistor and Fuse Dimensions
Dimensions are in inches and (millimeters)



Appendix **B**

Interconnect Drawings

Objectives

Appendix B provides typical interconnection diagrams that illustrate the wiring between the 1391-DES and various other Allen-Bradley position control products. Due to the numerous electrical circuit designs possible, these diagrams are provided for reference only. The diagrams provided include:

- 1391-DES interconnect drawing showing the inputs, outputs and recommended control circuitry.
- 1391-DES / IMC 110 Interconnect Drawing
- 1391-DES / IMC 120 Interconnect Drawing
- 1391-DES / IMC 121, 123 and 123CR Interconnect Drawing
- 1391-DES / MAX CONTROL Interconnect Drawing
- 1391-DES / S (20x) Class Interconnect Drawing
- 1391-DES / S (21x) Class Interconnect Drawing
- 1391-DES / IMC-201 Interconnect Drawing
- 1391-DES / 9/Series Interconnect Drawing

1391-DES Interconnect Drawing

The 1391-DES Interconnect Drawing is presented on pages B-2 and B-3. Refer to the "Notes" listed below when using this drawing.

Notes:

1) Power Wiring unless Noted:

15A	12 AWG (2.5 mm^2) min. 75 degrees C min.
22.5A	10 AWG (4 mm^2) min. 75 degrees C min.
45A	8 AWG (6 mm^2) min. 75 degrees C min.

2) Signal Wiring: 18 AWG (0.75 mm^2) min.

3) Allen-Bradley Supplied Cable:

8 AWG (6 mm^2) Motor	126473
12 AWG (2.5 mm^2) Motor	126474
Resolver	116190

4) Customer Supplied Resolver Cable:
Belden 9873 or equivalent, 20 AWG (0.5 mm^2), 30 pf/ft (97.5 pf/m) max. capacitance between conductors.

5) Terminate shield on source end only.

6) Do not make connections to unused pins on the resolver connector.

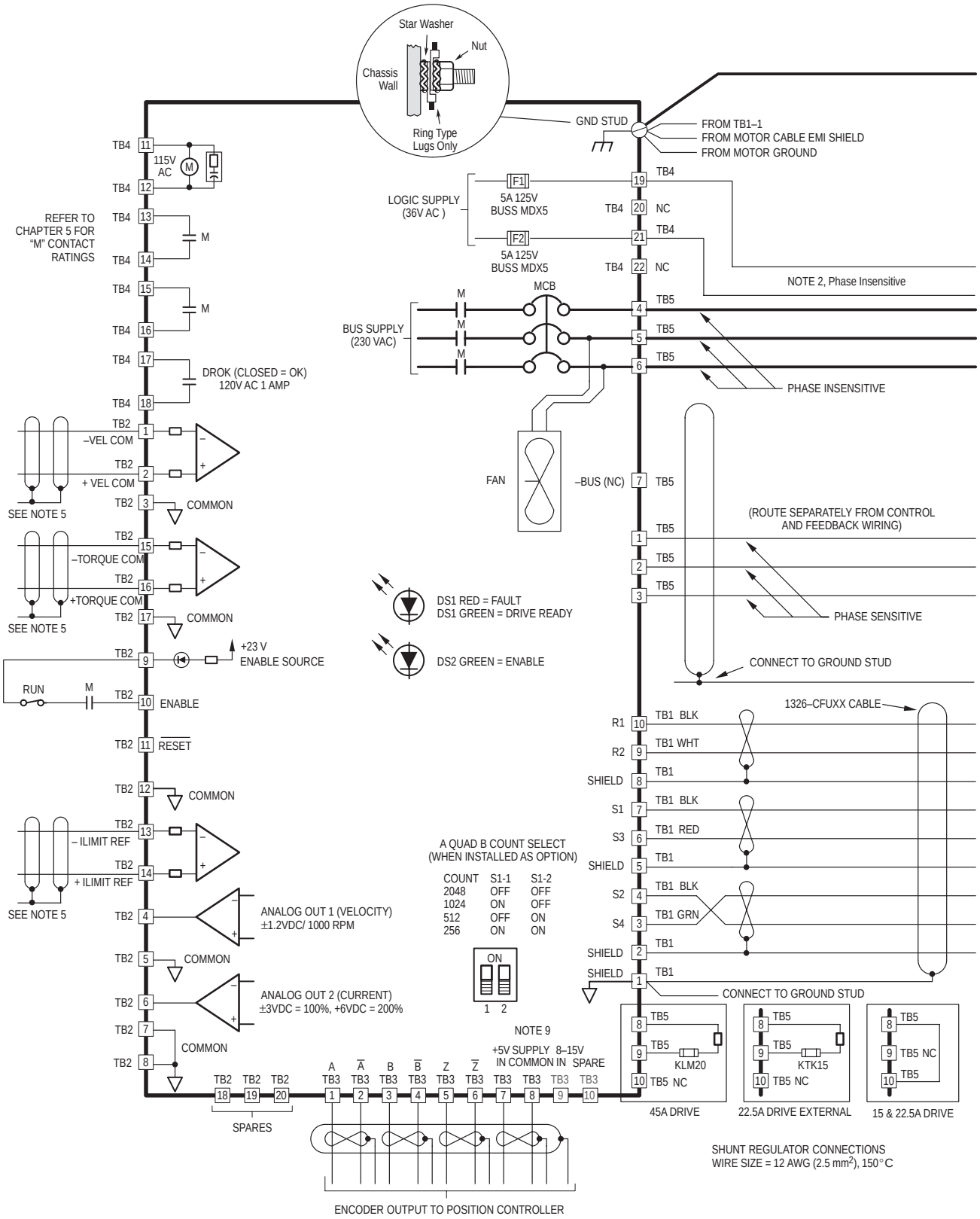
7) F3 provided on 15 & 22.5A units only. 15A=KLM-10, 22.5A=FNQ 6 1/4.

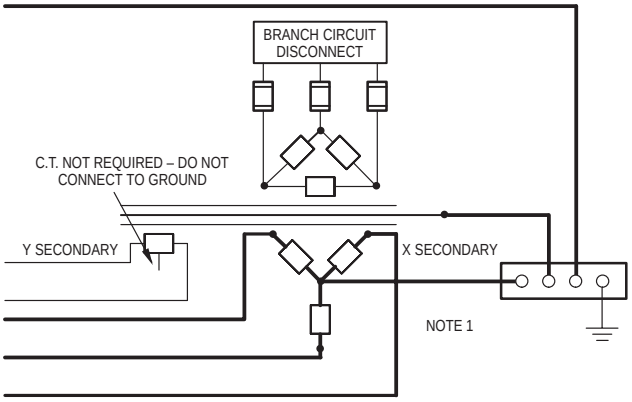
8) Parameter 130 must be set to zero in this configuration.

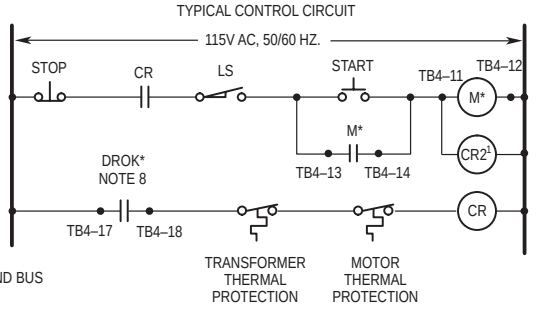
9) Apply either +5V DC to TB3-7 or 8-15V DC to TB3-9 (do not apply both).

10) NC = No connection.

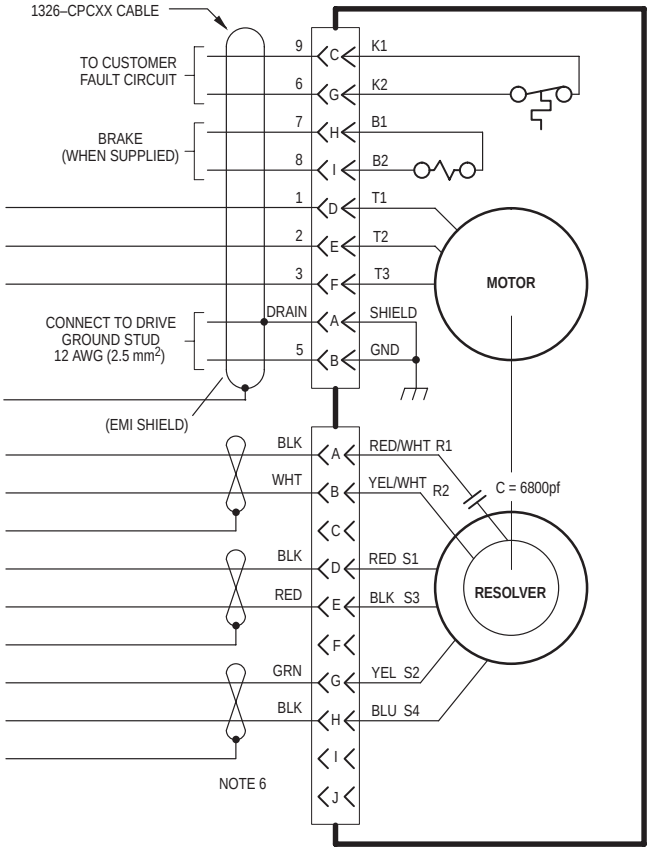
Figure B.1
1391-DES Interconnect Drawing



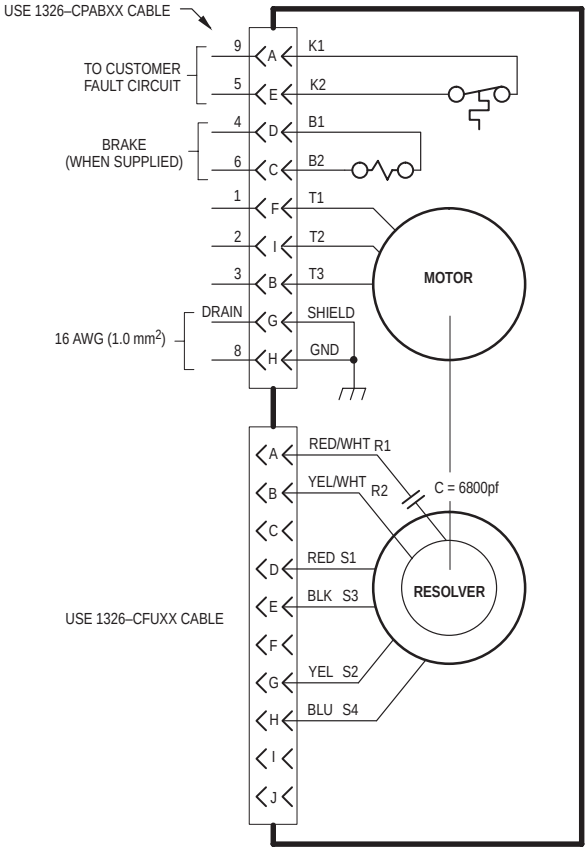




* INDICATES COMPONENT LOCATED IN CONTROLLER
[1]REQUIRED ONLY WITH IMC 110, 120, 121, AND 123 CONTROLLERS

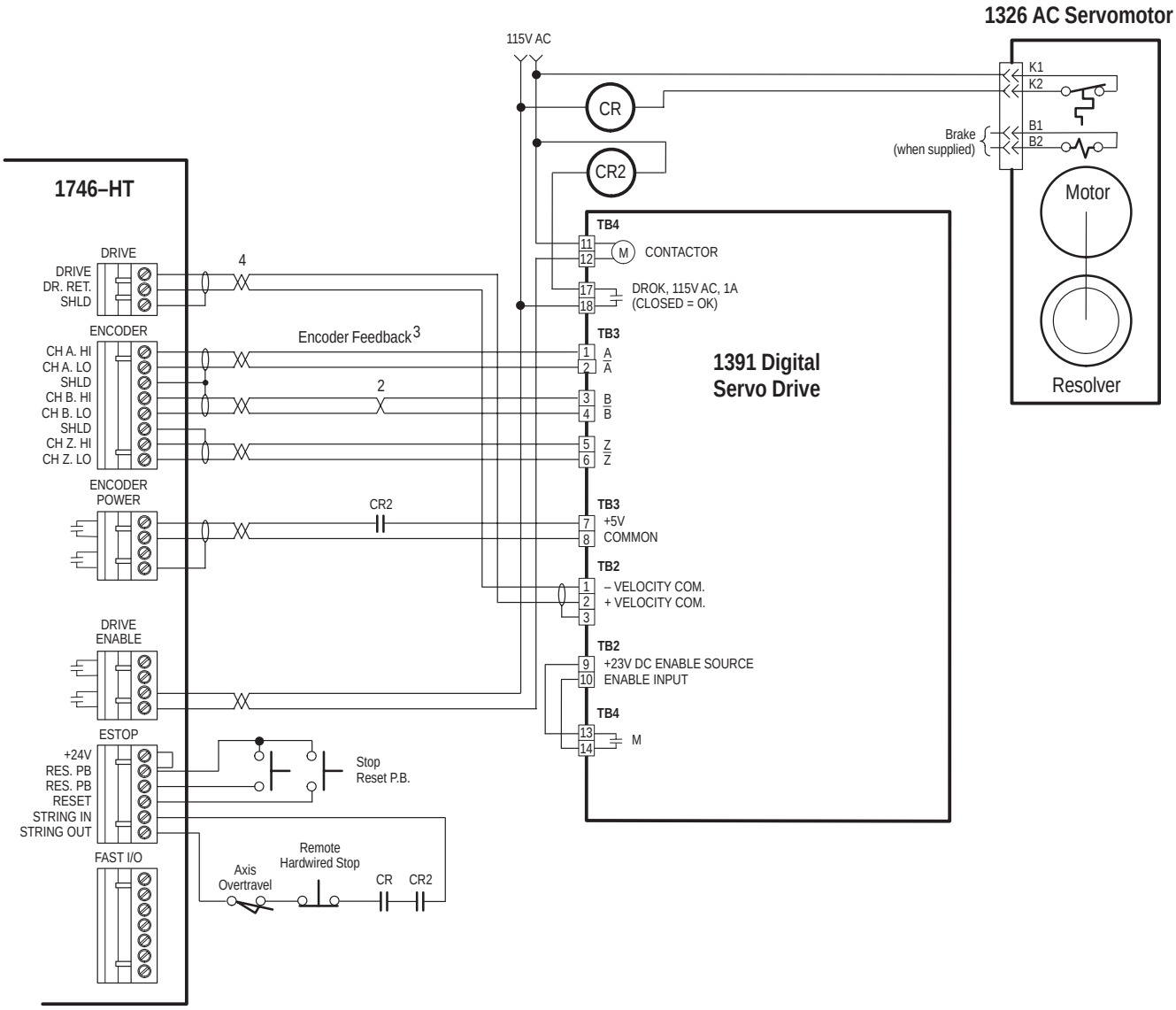


1326AB–CXX AND 1326AB–B4X



1326AB–BXX AND 1326AB–AXX

Figure B.2
Typical IMC 110 Interconnect Diagram [1]



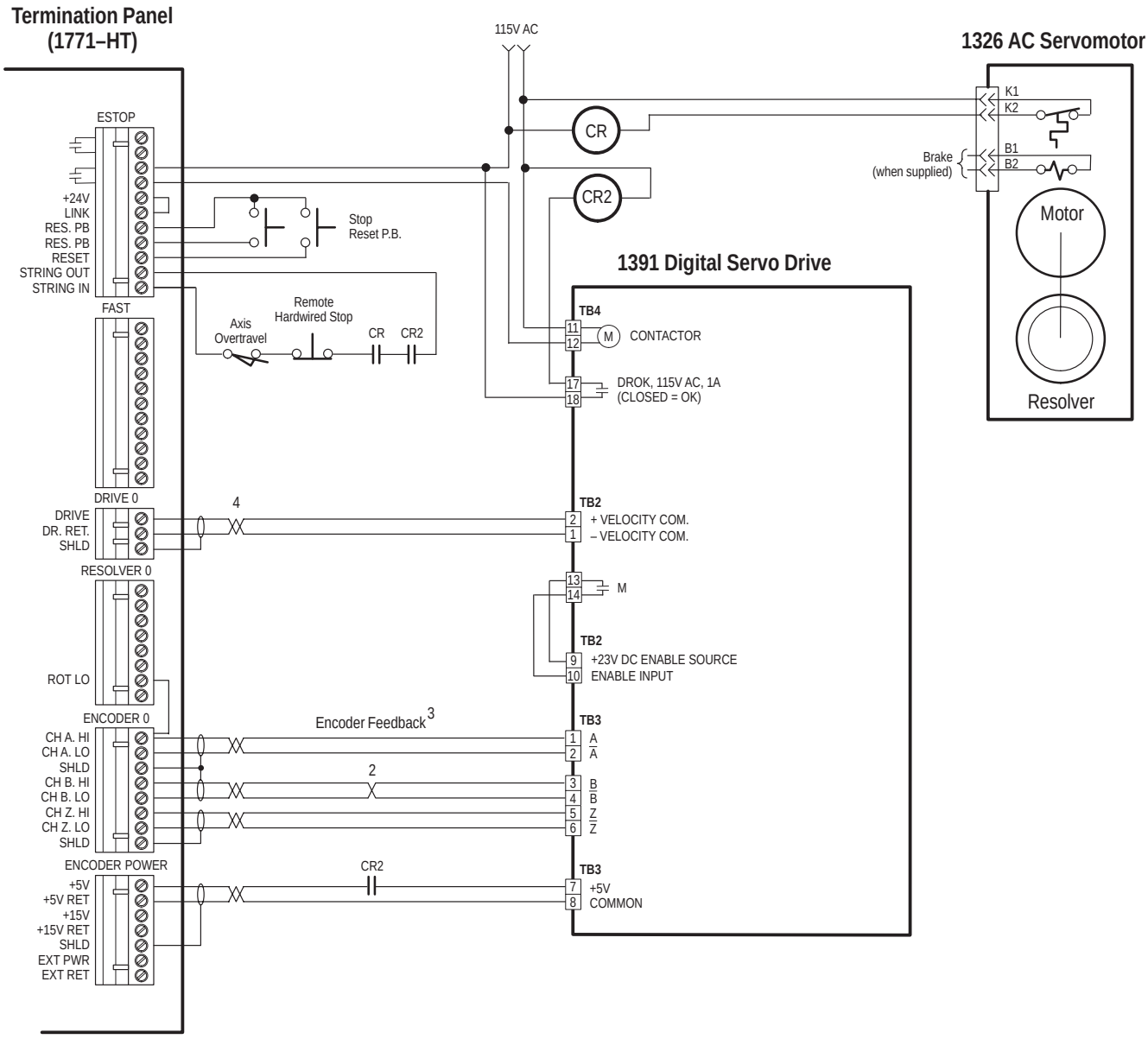
1 Refer to the 1391-DES Interconnect Drawing for further details.

2 B and B (NOT) are interchanged.

3 Use Belden brand #9504 or equivalent twisted pair, shielded cable, 40 feet (12.2 meters) maximum. Shields grounded at controller only.

4 Use Belden brand #8760 or equivalent shielded cable.

Figure B.3
Typical IMC 120 Interconnect Diagram [1]



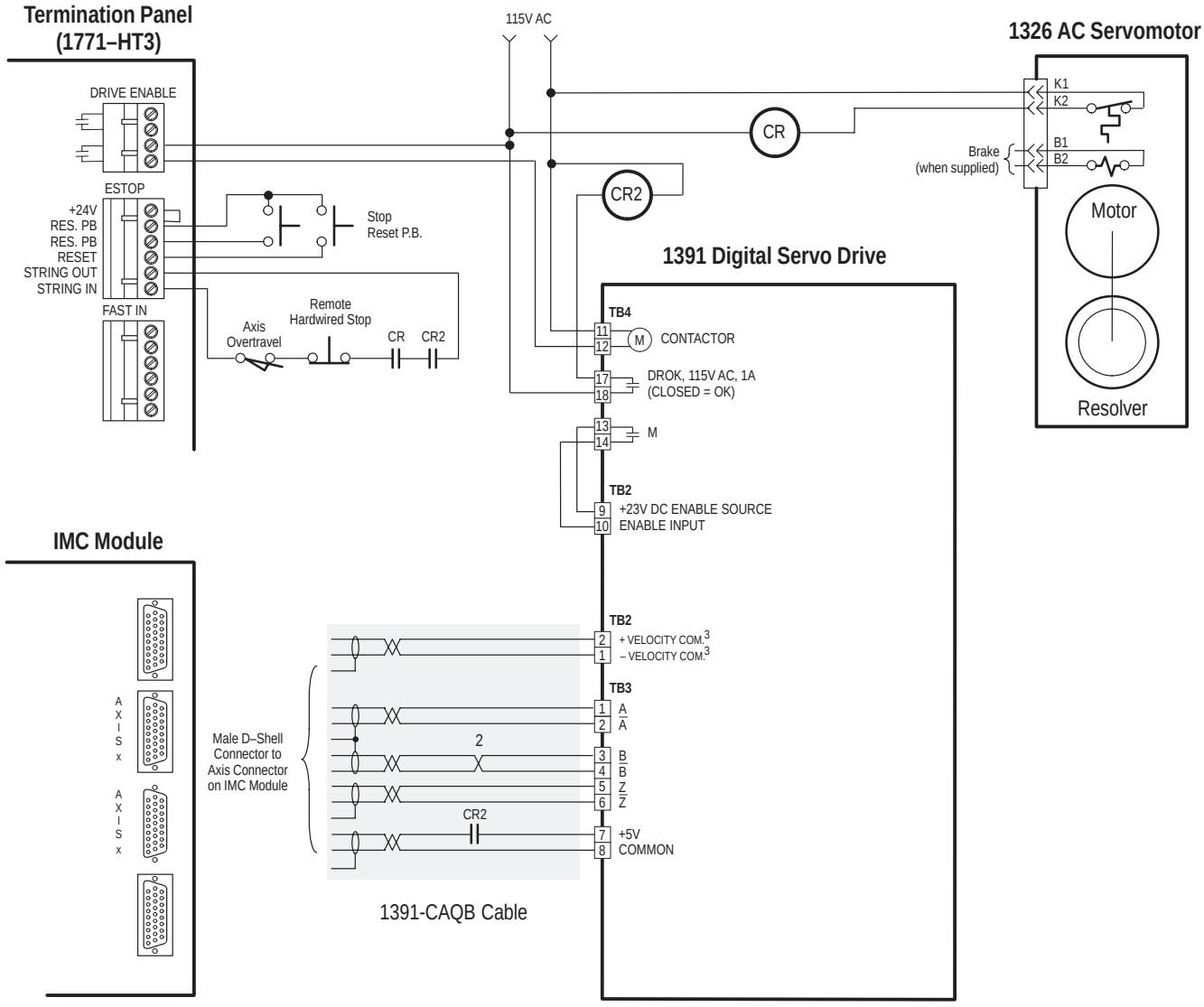
1 Refer to the 1391-DES Interconnect Drawing for further details.

2 B and B (NOT) are interchanged.

3 Use Belden brand #9504 or equivalent twisted pair, shielded cable, 40 feet (12.2 meters) maximum. Shields grounded at controller only.

4 Use Belden brand #8760 or equivalent shielded cable.

Figure B.4
Typical IMC 121, 123 and 123CR Interconnect Diagram [1]

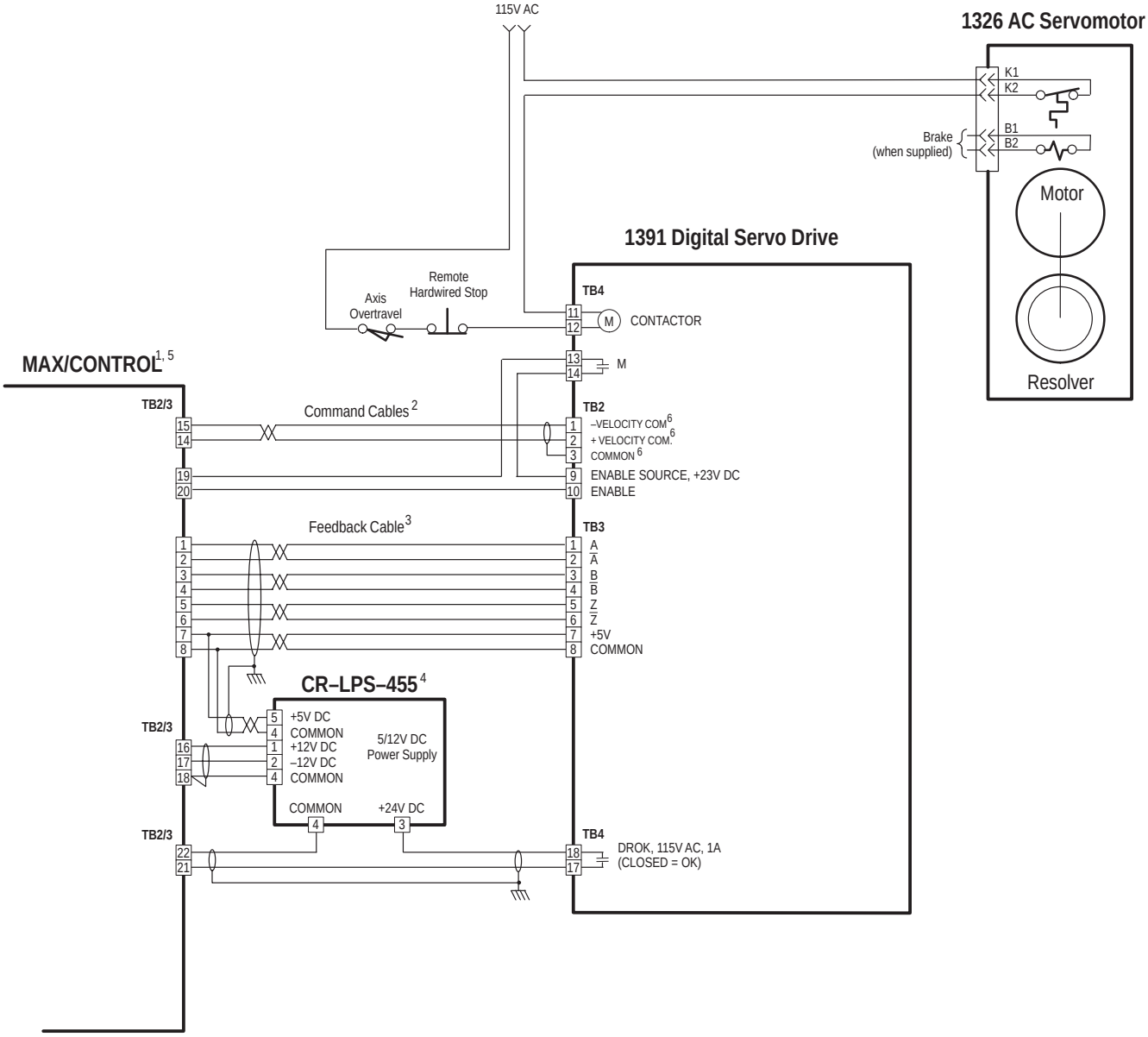


1 Refer to the 1391-DES Interconnect Drawing for further details.

2 B and B (NOT) are interchanged.

3 If the drive is to be operated as a torque block from an IMC 121 or 123, command wires should be connected to TB2-15, 16 & 17.

Figure B.5
Typical MAX/CONTROL Interconnect Diagram



1 Refer to the MAX/CONTROL Installation and Setup Manual (999-051) and the 1391-DES Interconnect Drawing for further details.

2 Use Belden brand #8760 or equivalent shielded cable.

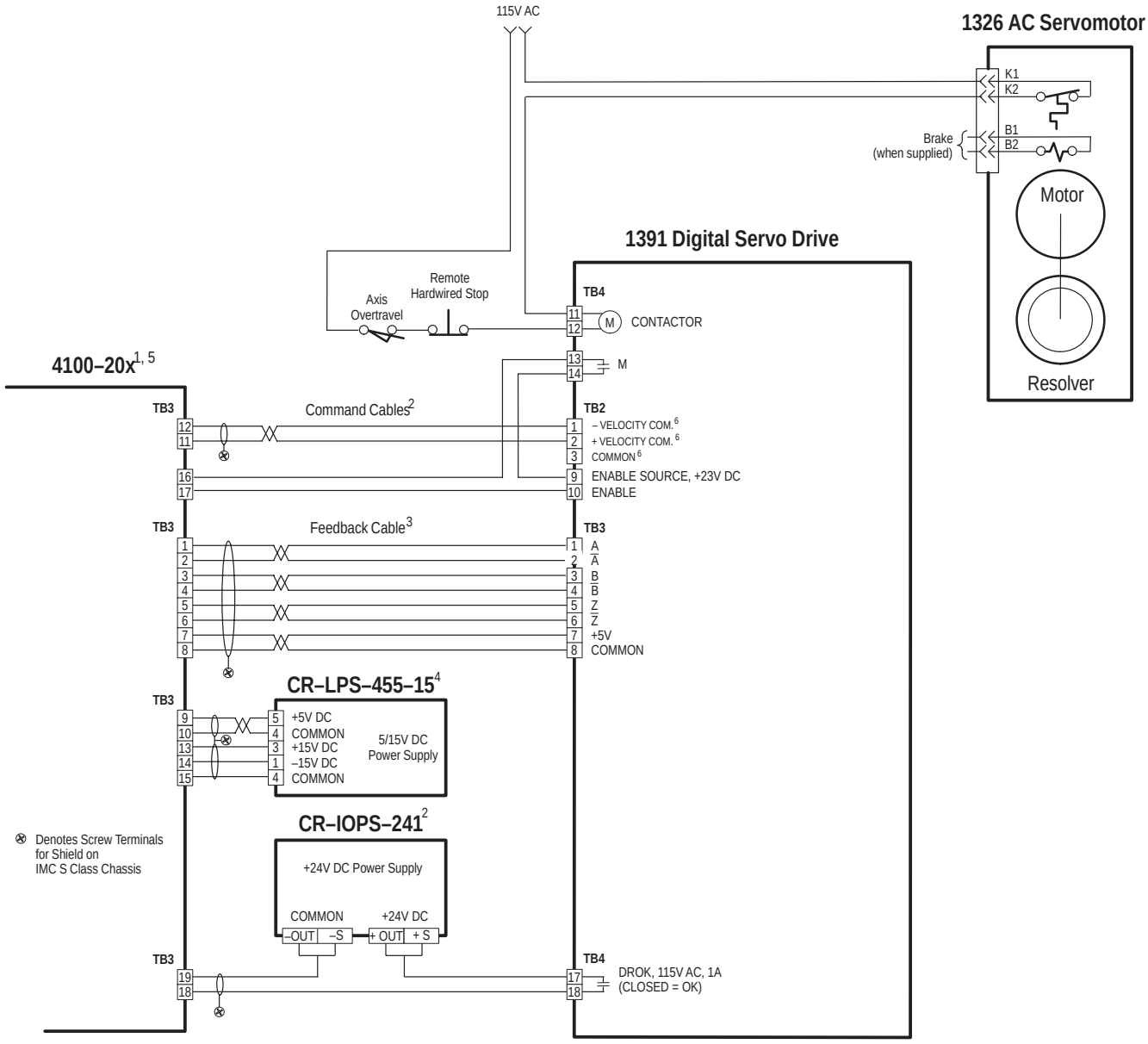
3 Use Belden brand #9504 or equivalent twisted pair, shielded cable, 40 feet (12.2 meters) maximum. Shields grounded at controller only.

4 Use Belden brand #9533 or equivalent shielded cable.

5 X-axis connections are shown – Y-axis connections (TB3) are identical.

6 If the drive is to be operated as a torque block, command wires should be connected to 1391-DES TB2-15, 16 & 17.

Figure B.6
Typical IMC-S/20x Interconnect Diagram



1 Refer to the IMC-S/20x Installation and Setup Manual (999-105) and the 1391-DES Interconnect Drawing for further details.

2 Use Belden brand #8760 or equivalent shielded cable.

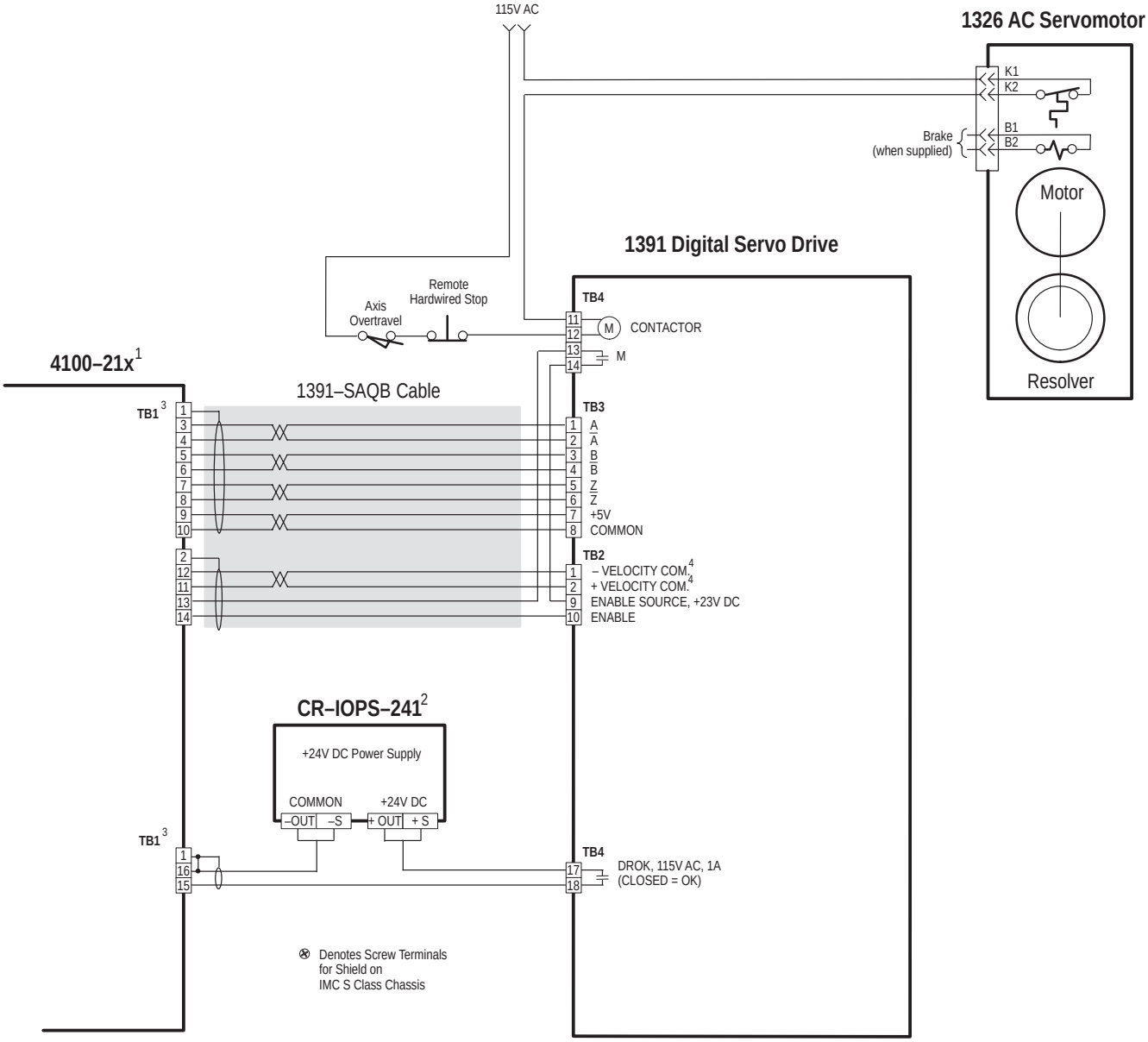
3 Use Belden brand #9504 or equivalent twisted pair, shielded cable, 40 feet (12.2 meters) maximum. Shields grounded at controller only.

4 Use Belden brand #9533 or equivalent shielded cable.

5 Axis 0 (TB3) connections are shown – Axis 1, 2, 3 connections are identical (use TB5 for Axis 1, TB4 for Axis 2, and TB6 for Axis 3).

6 If the drive is to be operated as a torque block, command wires should be connected to 1391-DES TB2-15, 16 & 17.

Figure B.7
Typical IMC-S/21x Interconnect Diagram



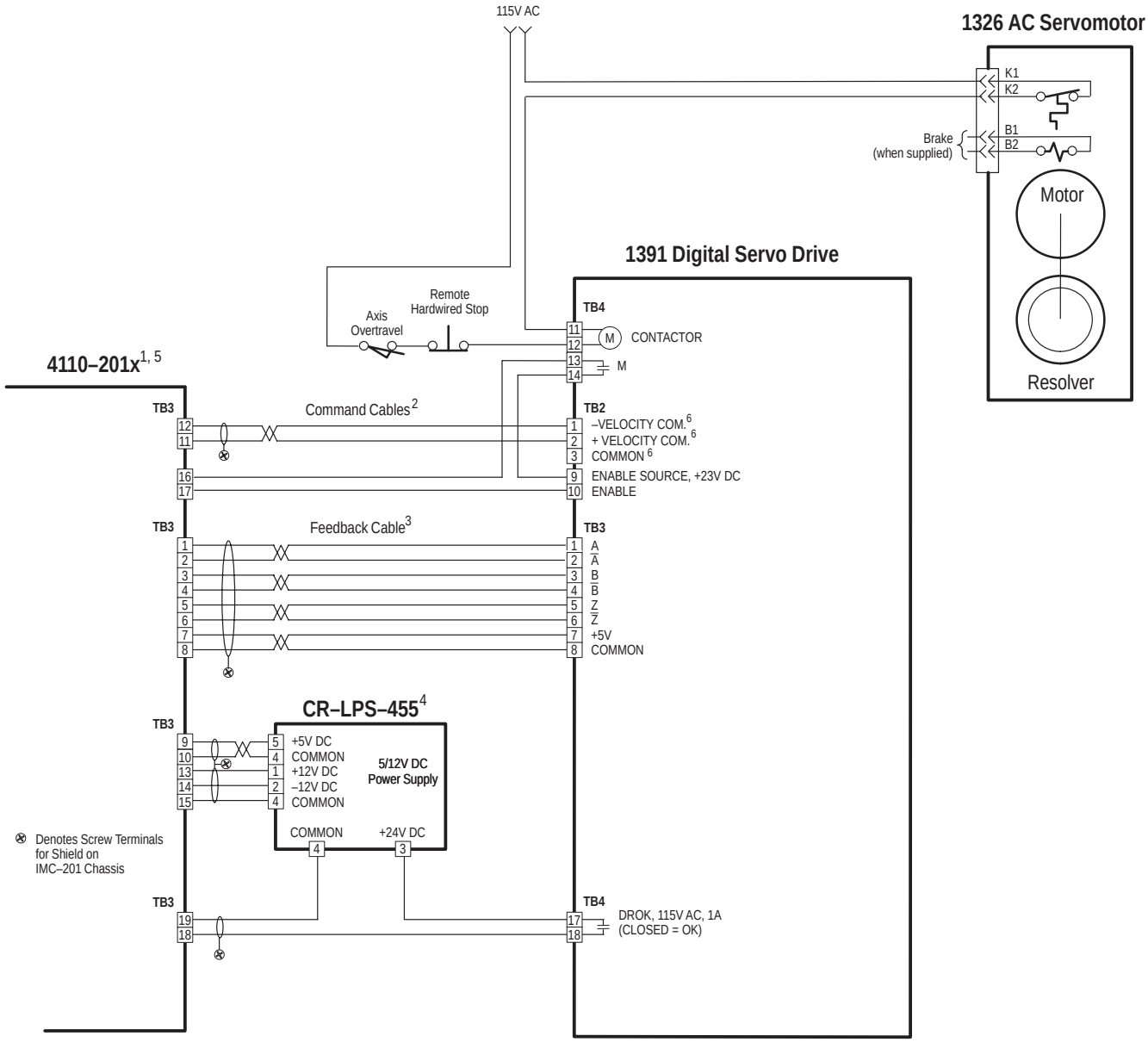
1 Refer to the IMC-S/21x Installation and Setup Manual (999-103) and the 1391-DES Interconnect Drawing for further details.

2 Use Belden brand #8760 or equivalent shielded cable.

3 Axis 0 connections (TB1) are shown – Axis 1, 2, 3 connections are identical (use TB3 for Axis 1, TB4 for Axis 2 and TB5 for Axis 3).

4 If the drive is to be operated as a torque block, command wires should be connected to 1391-DES TB2-15, 16 & 17.

Figure B.8
Typical IMC-201 Interconnect Diagram



1 Refer to the IMC-201 Installation and Setup Manual (999-108) and the 1391-DES Interconnect Drawing for further details.

2 Use Belden brand #8760 or equivalent shielded cable.

3 Use Belden brand #9504 or equivalent twisted pair, shielded cable, 40 feet (12.2 meters) maximum. Shields grounded at controller only.

4 Use Belden brand #9533 or equivalent shielded cable.

5 X Axis (TB3) connections are shown – secondary feedback (TB5) connections are identical to the TB3 connections.

6 If the drive is to be operated as a torque block, command wires should be connected to 1391-DES TB2-15, 16 & 17.

Figure B.9
9/ Series Interconnect Diagram

For detailed 9/Series interconnect information, please refer to the following publications:

Controller	Publication
9/240	9/240 Integration Manual, publication 8520-4.1
9/230, 9/260, 290	9/230, 9/260 or 9/290 Integration Manual, publication 8520-6.2

End of Appendix

Appendix C

Cable Information

Cable Wiring Information

Pin-outs and interconnect information for the various 1326 cables are provided in this section.

1326-CFUxx Commutation Cable

			Servo Control Connection	
Wire Color	Gauge (AWG)	Connector Pin	1389-AAxx Terminal #	1391-AAxx Terminal #
Black	#20	A	TB2-1	TB1-10
White	#20	B	TB2-2	TB1-9
Shield - Drain	#20	N/C	TB2-3	TB1-8
Black	#20	D	TB2-4	TB1-7
Red	#20	E	TB2-5	TB1-6
Shield - Drain	#20	N/C	TB2-6	TB1-5
Black	#20	H	TB2-7	TB1-4
Green	#20	G	TB2-8	TB1-3
Shield - Drain	#20	N/C	TB2-9	TB1-2
Braided Shield	#36	N/C	TB2-10	TB1-1 to Ground Stud

1326-CPABxx Motor Power Cable

				Servo Control Connection	
Wire Number	Wire Color	Gauge (AWG)	Connector Pin	1389-AAxx Terminal #	1391-AAxx Terminal #
1	Black	12	F	TB3-1	TB5-1
2	Black	12	I	TB3-2	TB5-2
3	Black	12	B	TB3-3	TB5-3
4	Black	16	D	Brake Power	Brake Power
5	Black	16	E	Thermal Switch	Thermal Switch
6	Black	16	C	Brake Power	Brake Power
7	Drain Wire	16	G	Power Ground	Power Ground
8	Black	16	H	Power Ground	Power Ground
9	Black	16	A	Thermal Switch	Thermal Switch
Mylar Shield	Mylar Shield	16	N/C	Ground Stud	Ground Stud

1326-CPCxx Motor Power Cable

Wire Number	Wire Color	Gauge (AWG)	Connector Pin	Servo Control Connection 1389-AAxx Terminal #	Servo Control Connection 1391-AAxx Terminal #
1	Black	8	D	TB3-1	TB5-1
2	Black	8	E	TB3-2	TB5-2
3	Black	8	F	TB3-3	TB5-3
4	Drain Wire	12	A	Power Ground	Power Ground
5	Black	12	B	Power Ground	Power Ground
6	Black	16	G	Thermal Switch	Thermal Switch
7	Black	16	H	Brake Power	Brake Power
8	Black	16	I	Brake Power	Brake Power
9	Black	16	C	Thermal Switch	Thermal Switch
Mylar Shield	Mylar Shield	16	No Conn.	Ground Stud	Ground Stud

1326-CVUxx Master/Vernier Resolver Cable

Master/ Vernier	Pair	Wire Color	Gauge (AWG)	Connector Pin	Description
Master	1	White	22	A	Rotor 1
		Black	22	B	Rotor 2
	2	Red	22	D	Stator 1
		Black	22	F	Stator 3
	3	Orange	22	E	Stator 2
		Black	22	G	Stator 4
Vernier	4	Blue	22	J	Rotor 1
		Black	22	K	Rotor 2
	5	Green	22	N	Stator 2
		Black	22	R	Stator 4
	6	Violet	22	M	Stator 1
		Black	22	P	Stator 3

Pairs 1, 2 and 3 are used with single device format resolvers (i.e. 1:1, 1:2, 1:2.5 and 1:5).

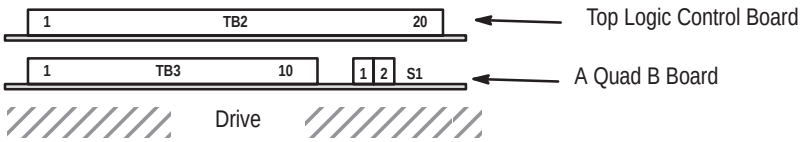
1326-CEUxx Encoder Feedback Cable

Pair	Wire Color	Gauge (AWG)	Connector Pin
1	Black	22	H
	White	22	A
2	Black	22	F
	Red	22	D
3	Black	22	J
	Orange	22	C
4	Black	22	I
	Blue	22	B
5	Black	22	F
	Green	22	E

1391-CAQB A Quad B Cable

The 1391-CAQB cable allows the user to connect directly from an IMC 121, 123, 123CR or 9/Series controller to the 1391-DES drive. The 1391-CAQB cable is 15 ft. (4.5 m) long and has a D-shell connector on one end and loose leads on the other.

The 1391-CAQB Cable also carries the drive command voltage, which is connected to TB2-1 and TB2-2.



IMPORTANT: Note terminal orientation prior to wiring

Cable			Connection	
Wire Number	**Wire Color**	**Signal**	**Terminal**	**Location**
3	Black	A	TB3-1	AQB
12	Red	A (NOT)	TB3-2	Board
21	Shield	Common	No Connection	
4	Black	B	TB3-4	AQB
13	White	B (NOT)	TB3-3	Board
22	Shield	Common	No Connection	
5	Black	Z	TB3-5	AQB
14	Green	Z (NOT)	TB3-6	Board
23	Shield	Common	No Connection	
7	Black	+5V DC	TB3-7	AQB
16	Blue	Common	TB3-8	Board
24	Shield	Shield	No Connection	
9	Black	Drive	TB2-2	Logic
18	Yellow	Drive Ret.	TB2-1	Control
26	Shield	Shield	No connection	Board

1391-SAQB and 1391-SAQBK Cables

1391-SAQB and 1391-SAQBK cables allow the user to connect the 1391-DES directly to an integrated, standalone MAX or S Class Motion Controller. The 1391-SAQB cable is 3 ft. (1 m) long and has connectors on both ends. The 1391-SAQBK is 15 ft. (4.5 m) long and has a controller connector on one end and loose leads on the other.

End of Appendix

Appendix D

Block Diagrams

Objectives

Appendix D provides detailed software and hardware block diagrams for the 1391 Digital AC Servo Drive. You may use these to gain a better understanding of the 1391-DES software system.

Figure E.1
1391-DES Software Block Diagram – Part 1

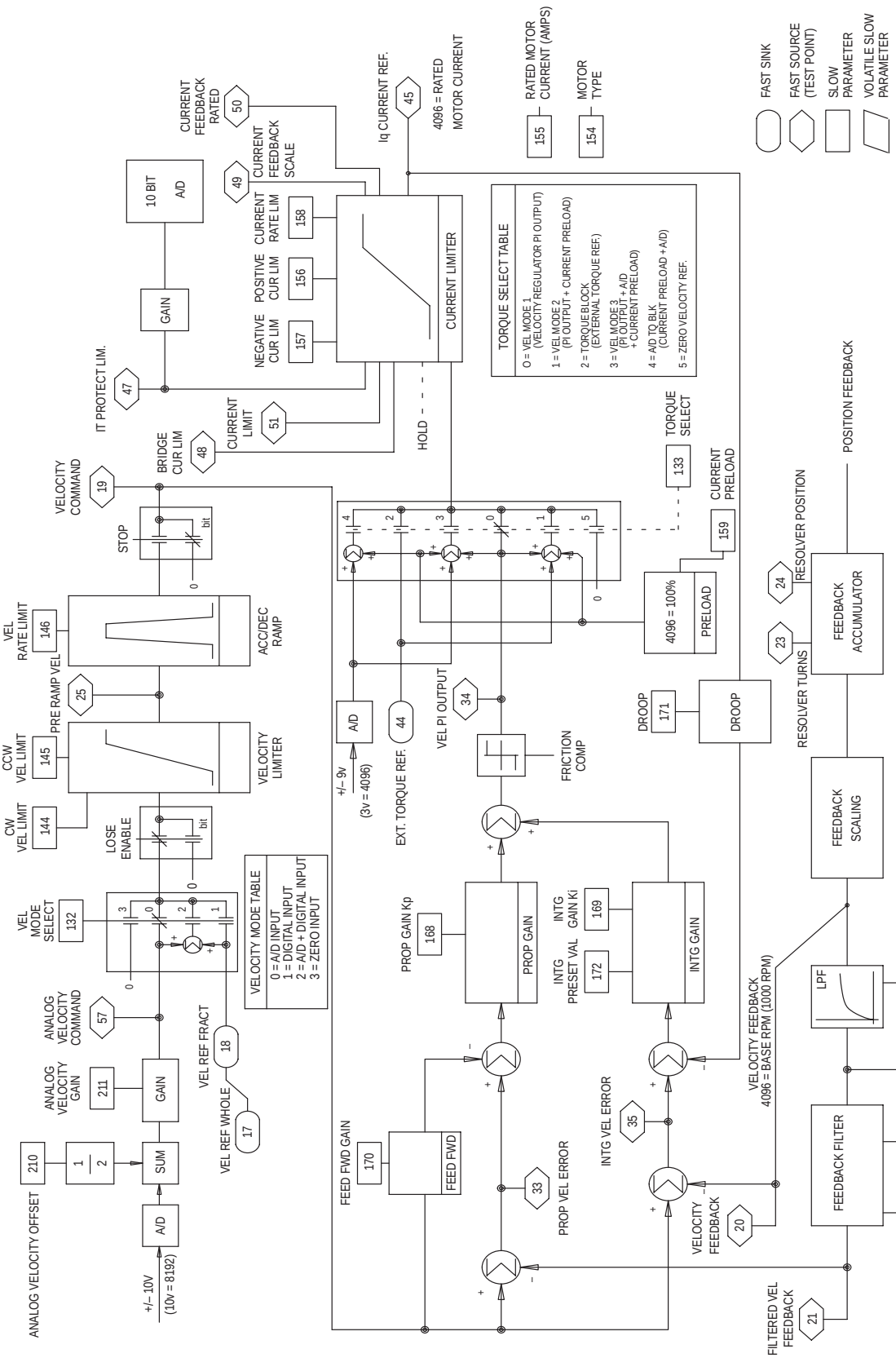


Figure E.1
1391-DES Software Block Diagram – Part 2

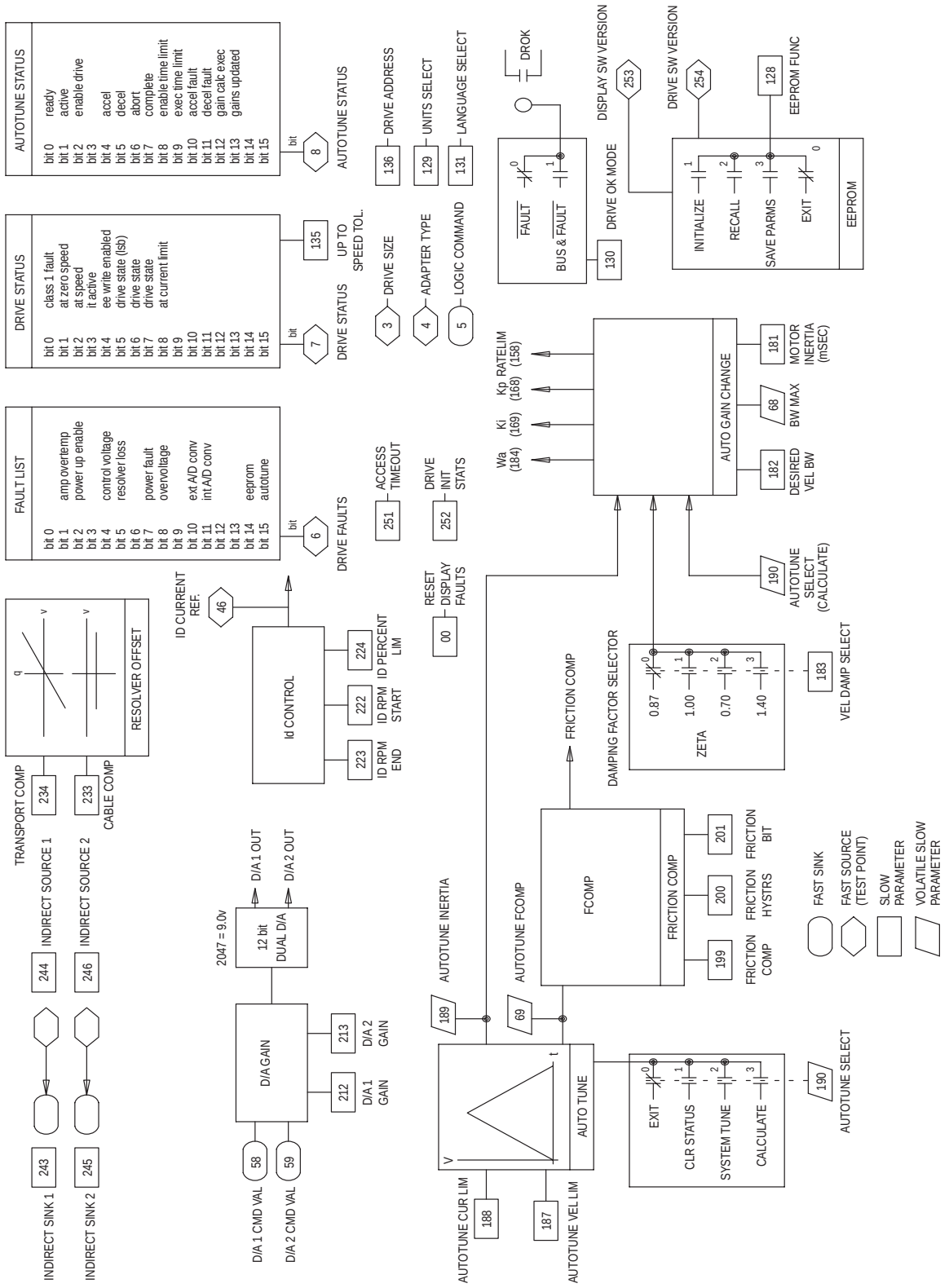
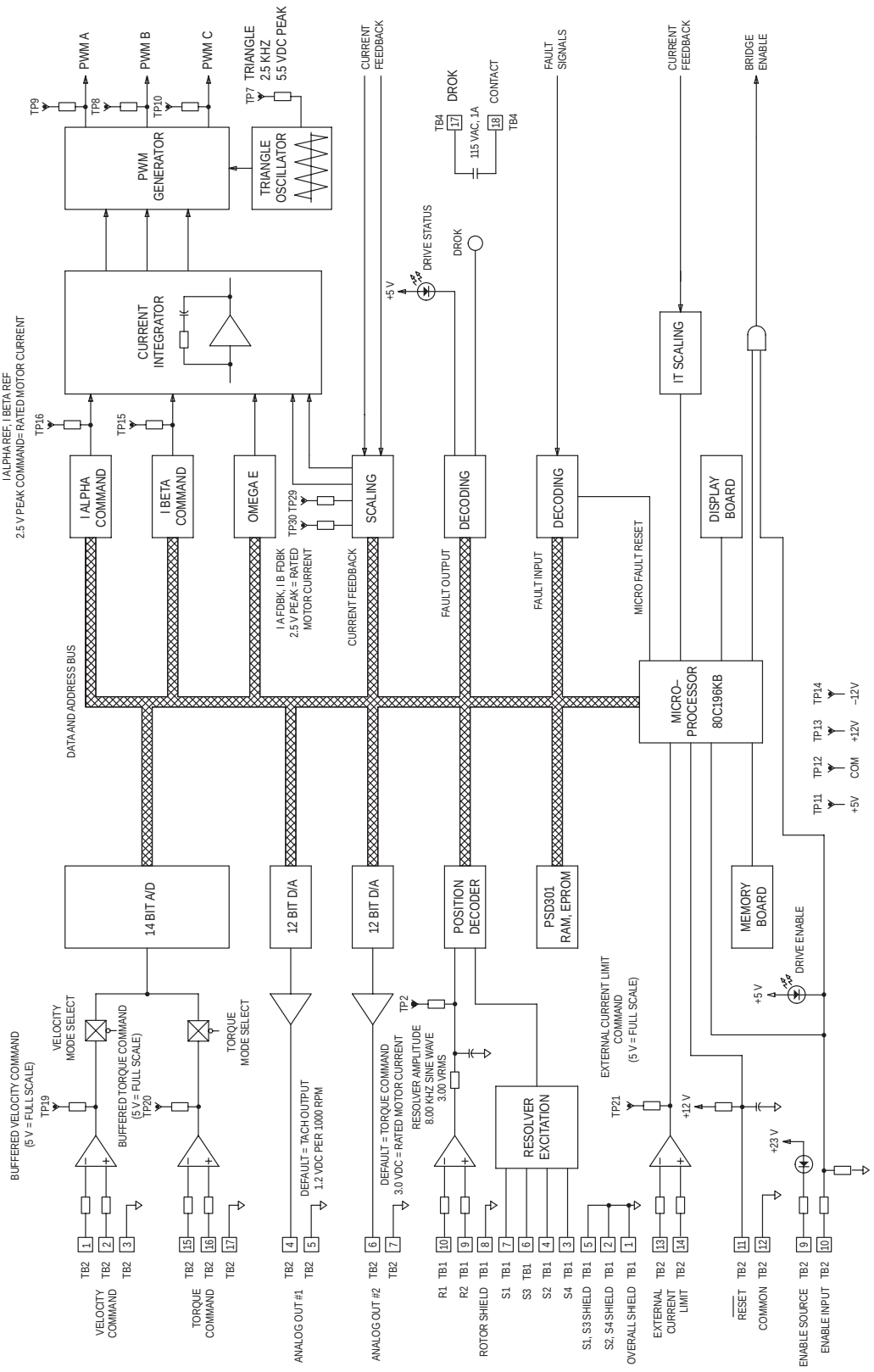


Figure E.2
1391-DES Logic Control Board Block Diagram



Appendix E

Parameter Record

Introduction

The following list can be used to record final parameter values for reference at a later date. It is recommended that any changes made to the parameter values be recorded after loading them into EEprom.

Important: Initializing the EEprom will convert all values to the defaults listed and delete any previous values. Parameters with a " * " in the Actual column should not be changed unless you have consulted Allen-Bradley.

Machine Designation _____

Axis Designation _____

Date _____

Name _____

General Information _____

_____

_____

_____

View Level

Parameter	Description	Default	Actual
03	Drive Size	–	*
19	Final Velocity Command	–	*
20	Velocity Feedback	–	*
45	Iq (Torque) Current Reference	–	*
50	Current Feedback Rated	–	*
51	Current Limit	–	*
57	Analog Velocity Command	–	*
154	Motor Type	–	_____
253	Display Software Version	–	*
254	Drive Software Version	–	*

Modify Level

Parameter	Description	Default	Actual
68	Bandwidth Maximum	–	*
69	Auto Tune Friction	–	*
128	EEprom Functions	–	
130	Drive OK Mode	0 Fault Only	
131	Language Select	0 English	
132	Velocity Mode Select	0 A/D Input	
133	Torque Mode Select	0 Velocity Mode 1	
144	Clockwise Velocity Limit	–	
145	Counterclockwise Velocity Limit	–	
146	Accel/Decel Ramp	22216 rads/sec.	
156	Positive Current Limit	–	
157	Negative Current Limit	–	
159	Current Preload	0	
168	Kp Velocity Loop	100	
169	Ki Velocity Loop	6667	
170	Feed Forward Gain	0	
171	Static Gain	1 rpm	
182	Desired Velocity Bandwidth	200 rads/sec.	
183	Velocity Damping Selection	0 zeta=0.87	
184	Velocity Low Pass Filter Bandwidth	30000 rads/sec.	
185	Lead/Lag Vel. Fdbk. Filter Gain	1.00	
186	Lead/Lag Vel. Fdbk. Filter Bandwidth	250 rads/sec.	
187	Auto Tune Velocity	+1000 rpm	
188	Auto Tune Current Limit	50%	
189	Auto Tune Inertia	100 ms	
190	Auto Tune Select	–	
210	A/D Converter Offset	0 mV	
211	Analog Velocity Gain	+500 rpm/volt	
212	D/A #1 Gain	+0.07	
233	Cable Compensation	50 ft.	

Maintenance Level

Parameter	Description	Default	Actual
04	Adapter Type	–	*
05	Logic Command	–	*
06	Drive Faults	–	*
07	Drive Status	–	*
08	Auto Tune Status	–	*
17	Velocity Reference Whole	–	*
18	Velocity Reference Fraction	–	*
21	Filtered Velocity Feedback	–	*
22	Average Motor Velocity	–	*
23	Resolver Turns	–	*
24	Resolver Position Feedback	–	*
25	Pre Ramp Velocity	–	*
33	Proportional Velocity Error	–	*
34	Velocity Loop PI Output	–	*
35	Integral Velocity Error	–	*
44	External Torque Reference	–	*
46	Id (Flux) Current Reference	–	*
47	IT Protection Limit	–	*
48	Bridge Current Limit	–	*
49	Current Feedback Scale	–	*
58	D/A #1 Command Value	–	*
59	D/A #2 Command Value	–	*
129	Units Select	0 User Units	*
135	Up to Speed Tolerance	19.5 rpm	_____
136	Drive Address	1	*
155	Rated Motor Current	–	*
158	Current Rate Limit	–	*
172	Velocity Loop Integrator Preset Value	0	_____
181	Motor Inertia	–	_____
199	Friction Compensation	50%	_____
200	Friction Hysteresis	0.5 rpm	_____
201	Friction Bit	10	_____
213	D/A #2 Gain	00.167	_____
222	Id RPM Start	–	*
223	Id RPM End	–	*
224	Id Percent Limit	70%	*
234	Transport Compensation	81	*
243	Indirect Sink Parameter 1	59	*
244	Indirect Source Parameter 1	20	*
245	Indirect Sink Parameter 2	59	*
246	Indirect Source Parameter 2	45	*
251	Access Timeout	0	_____
252	Drive Init Stats	1 No	_____

End of Appendix

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