ServoWire Drives

Installation and Operation Manual
SAC-SW01g

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ORMEC Systems Corp.

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G-Series Servomotors are recognized under the Component Program of Underwriters Laboratories Inc., and are distinguished by the UL trademark symbols shown below.

CE Mark

G-Series Servomotors carry the CE Mark, as shown below.

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Chapter 1
Welcome

1 Welcome

This manual provides information about ORMEC's ServoWire Servodrives and G-Series, DE-Series, DA-Series and DB-Series Servomotors--- providing both technical descriptions and information required for their installation, operation and maintenance.

The manual is divided into the following chapters:

Chapter 1	**Welcome** introduces you to this manual and how it is organized.
Chapter 2	**General Description** gives an overview of the ServoWire Drive product family.
Chapter 3	**Installation** provides instructions on how to install your ServoWire Drives. It also provides a complete hardware description of the ServoWire Drives.
Chapter 4	**Operation** documents the power up and initial configuration approach for the ServoWire Drive.
Chapter 5	**Getting Started** provides detailed instructions on how to run your ServoWire Drive system for the first time.
Chapter 6	**Specifications** provides a detailed list of performance specifications for ServoWire Drives and G-Series and DE/DA/DB-Series brushless servomotors.
Chapter 7	**Maintenance and Troubleshooting** documents the various status and alarm indicators.
Appendixes	**Appendixes** contain a detailed drawing set **.**

Chapter 2
General Description

2 General Description

This manual covers ServoWire Drives, which operate with ORMEC's motion controllers and control a wide variety of AC Servomotors, including G-Series and D/DE Series Servomotors.

2.1 ServoWire Drive Capabilities and Features

- **ServoWire Interface:** The IEEE 1394 ServoWire interface to the controller simplifies panel wiring and reduces cabling cost.
- **Simple Setup:** The drive's axis ID is programmed via a pushbutton on the top of the drive; all other drive configuration settings are set by the user's application software using the ServoWire interface, eliminating drive jumpers, address switches, and potentiometers.
- **All Digital:** High speed DSP-controlled current loops for precise torque mode and velocity mode operation.
- **Standard Line Voltage Input:** ServoWire Drives can be operated directly on commercial power lines which supply at either 115 (+15%, -20%) or 230 (+15%, -20%) VAC for the main power as well as the control power.
- **Fault Detection and Protection:** Detection and protection against:

Motor short	Encoder open wire detection
Peak & RMS drive current limit	Hall sensor phasing error
Peak & RMS motor current limit	Motor over temperature
Missing phase detection (SW225, SW235, & SW260 only)	

- **Diagnostics:** A 2-digit 7-segment display shows servodrive ID number, enabled status and alarm status. Individual LEDs display high speed sensor status, hardware travel limits, motor over temperature, and bus power.
- **Variety of Commutation Options:** ServoWire Drives can be configured via MotionDesk for sinusoidal or trapezoidal commutation for AC brushless motors, as well as for DC motor operation to control DC motors, voice coils and other single phase actuators.
- **Soft Start:** Circuitry is provided to reduce Servodrive in-rush current.

- **Torque Mode Operation:** When combined with DSP based velocity and position loops in ORMEC motion controllers, torque mode operation allows extremely high load inertia to motor inertia ratios.
- **Velocity Mode Operation:** Velocity mode operation allows for fast and precise velocity control.
- **Wide Current Loop Bandwidth:** For high positioning accuracy and response.
- **Velocity and Torque Monitor:** High quality velocity monitor and torque monitor signals are provided to simplify system testing.
- **Small Package:** ServoWire Drives have a small footprint to conserve panel space.
- **Shunt Regulation:** All Models except SAC-SW203 and SAC-SW205 have shunt regulation circuitry. If an application requires regenerative operation, regenerative discharge resistors can be mounted external to the servodrive.

2.1.1 ServoWire Drive Model Number Description

SAC-SW2##/E$O_1O_2\ O_3O_4$

Current
= continuous rated current, amps (03, 05, 10, 17, 20, 25, 35, 60)

Motor Feedback
E = encoder feedback (required option)

Options O_1, O_2, O_3, O_4

P	=	pacer encoder or other auxiliary encoder
D	=	delay counter
A	=	support for absolute encoder
N	=	no Phoenix connectors

NOTE: After the /E, only the desired options in the ServoWire Drive model number are specified.

2.2 G-Series Servomotor Capabilities and Features

- **Wide Power Range:** Output power ratings from 0.20 to 13 HP.
- **Wide Torque Range:** Continuous stall torques from 5 to 640 in-lb.
- **Low to High Speed:** Maximum motor speeds from 1700 to 7,000 RPM.
- **High Torque-to-Inertia Ratios:** Motors with high Torque-to-Inertia ratios deliver a higher percentage of rated power to the load in applications that require high acceleration and deceleration rates.
- **English and Metric Frames:** All motors are available with metric mounting flanges; some models are also available with NEMA frames.
- **Durable Construction:** Service life is maximized by the brushless motor construction, high thermal efficiency frame and rugged sealed bearings. Standard IP-65 motor sealing permits operation in harsh industrial environments.
- **Industrial Internal Position Transducer:** The standard rugged internal position encoder measures 8,000 precise increments of position, or counts, per revolution. Optional motor encoders provide 6,000, 8192, 12,000, 16,384, or 24,000 counts per revolution.
- **Low Torque Ripple:** Sinusoidal construction combined with precise sinusoidal electronic commutation provide low motor output torque ripple.

- **Fail-Safe Brake:** An optional fail-safe brake is available integral to the motor.

2.2.1 G-Series Servomotor Model Number Description

MAC-G###*WV/FTO*$_1$

	Torque		
###	=	Continuous Stall Torque (in-lb)	
	Winding Identifier		
W	=	A	(high speed)
	=	B	(medium speed)
	Input Voltage		
V	=	1	(115 VAC input power)
	=	2	(230 VAC input power)
	=	4[1]	(230 VAC input power)
	Feedback Type		
F	=	1[2]	(1500 linecount encoder – 6000 cts/rev)
	=	2	(2000 linecount encoder – 8000 cts/rev)
	=	3	(3000 linecount encoder – 8192 cts/rev)
	=	B[2]	(2048 linecount encoder – 12000 cts/rev)
	=	C[2]	(4092 linecount encoder – 16384 cts/rev)
	=	6	(6000 linecount encoder – 24000 cts/rev)
	Mounting Flange Type		
T	=	M	(metric frame dimensions)
	=	E	(NEMA frame dimensions)
	Fail-Safe Brake *(specified only if option is desired)*		
O_1	=	B	(fail-safe brake with 24 VDC coil)

[1] 460 VAC motor operated at 230 VAC.
[2] Not available for some servomotors. Refer to **Table 30** for motor-encoder compatibility.

2.3 DE/DA/DB Series Capabilities and Features

- **Wide Power Range:** Output power ratings from 0.13 to 15 HP.
- **Wide Torque Range:** Continuous stall torques from 2.8 to 665 in-lb.
- **High Speed:** Maximum motor speeds from 2,000 to 4,500 RPM.
- **High Torque-to-Inertia Ratios:** Motors with high Torque-to-Inertia ratios deliver a higher percentage of rated power to the load in applications which require high acceleration and deceleration rates.
- **Durable Construction:** Service life is maximized by the brushless motor construction, high thermal efficiency frame and rugged sealed bearings. Standard IP-65 motor sealing with optional IP-67 sealing permits motor operation in harsh industrial environments.
- **Industrial Internal Position Transducer:** The rugged internal position transducer measures 4096 to 32,768 (depending on selected motor) precise increments of position, or counts, per revolution.
- **Low Torque Ripple:** Sinusoidal construction combined with precise sinusoidal electronic commutation provide low motor output torque ripple.
- **Fail-Safe Brake:** An optional fail-safe brake is available integral to the motor.
- **Multi-Revolution Absolute Encoder:** An optional multi-revolution absolute encoder is available, which allows a servomotor to "remember" it's position through power cycles.

2.3.1 DE/DA/DB Series Servomotor Model Number Description

MAC-DA###$M_1/O_1O_2O_3$ **MAC-DB**###$M_1/O_1O_2O_3$ **MAC-DE**###$M_1V_1/O_1O_2O_3$

Torque
= Continuous Stall Torque (in-lb)

Motor Identifier
M_1 = A – U (motor matching reference letter)

Input Voltage (MAC-DE only)
V_1 = 1 (115 VAC input power)
= 2 (230 VAC input power)

Feedback Type
O_1 = I (incremental encoder)
= A (Multi-rev absolute encoder)[3]

Sealing *(specified only if option is desired)*
O_2 = V (shaft oil seal)

Fail-Safe Brake *(specified only if option is desired)*
O_3 = B (fail-safe brake with 24 VDC coil)

[3] A ServoWire Drive with absolute encoder support option is required for the battery backup and reset capabilities.

Chapter 3
Installation

3 Installation

3.1 Receiving and Inspection

ORMEC Servodrives, Servomotors, and their associated accessories are put through rigorous tests at the factory before shipment. After unpacking, however, check for damage, which may have been sustained in transit. The bolts and screws should all be tight, and motor output shafts should rotate freely by hand. Check the Servodrives and any accessories for bent or broken components or any other physical damage before installation.

3.2 ServoWire Drive Panel and Environment Considerations

ServoWire Drives are designed for panel mounting, with the panel in turn mounted in a metallic enclosure (supplied by the machine builder). For optimal EMC (ElectroMagnetic Compatibility) shielding, the enclosure should have continuous ground continuity maintained between all metal panels.

For high quality servo performance, proper wiring, grounding and shielding techniques must be considered. Refer to the "Shielding and Grounding Electrical Panels" Application Note, which is available in the Orion Installation & Operation Manual, as well as from ORMEC's site on the World Wide Web at http://www.ormec.com.

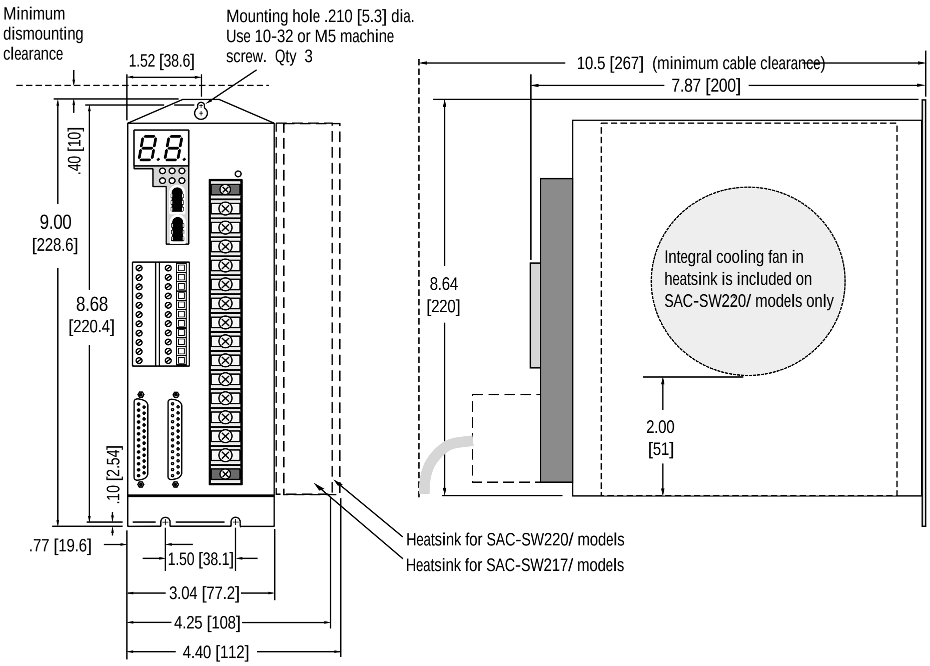
The servodrive environment should be maintained as follows:

- Ambient operating temperature should be at or below 50^{o}C.
- If the electrical panel is subjected to vibration, mount the units on shock absorbing material.
- Avoid use in corrosive atmospheres which may cause damage over time.
- Select a location with minimum exposure to oil, water, hot air, high humidity, excessive dust, or metallic particles.
- The proper mounting orientation for the Servodrive is vertical on a panel using the mounting holes holes (3 with SW203 through SW220, 4 with SW225 through SW260) on the base plate.
- Allow sufficient clearance around Servodrives for airflow, and provide proper ventilation. Section 3.3 shows the minimum clearance between drives.

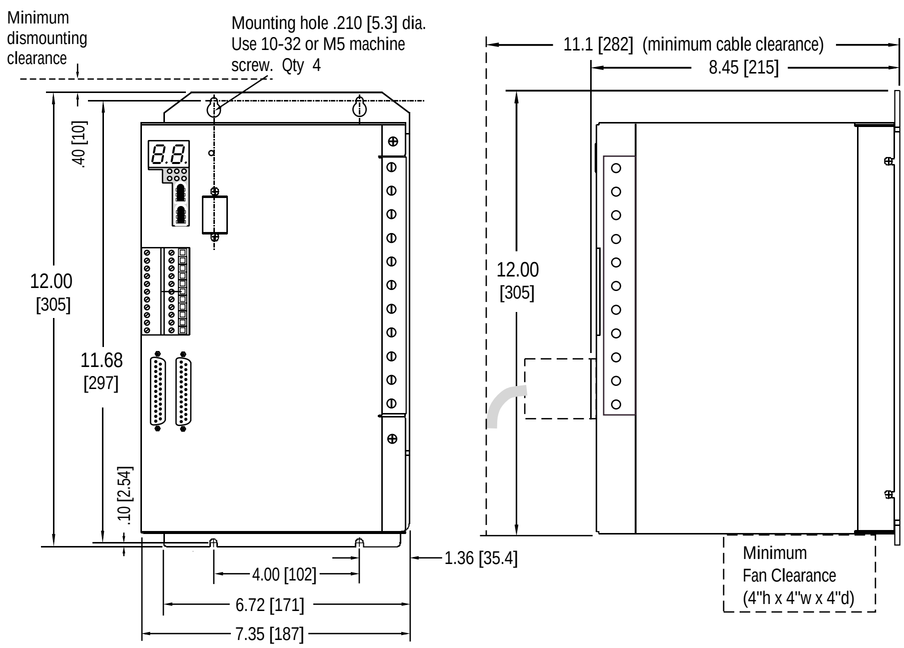
- External regenerative discharge resistors should be mounted in an enclosure separate from the ServoWire Drive enclosure, if possible. Regenerative discharge resistors can become extremely hot, so proper ventilation must be provided.

3.3 ServoWire Drives Outline Drawings

Mounting Information for SAC-SW203, SW205, SW210, SW217 & SW220



Mounting Information for SAC-SW225, SW235 & SW260



All dimensions are in inches [mm].

Figure 1, *ServoWire Drives Outline Drawings*

Additional clearance above, below and to the sides of the ServoWire Drives is also required for heat dissipation:

SAC-SW203, SAC-SW205 and SAC-SW210
Add 2” (51 mm) clearance top and bottom.
Add 1” (25 mm) clearance each side.

SAC-SW217
Add 2” (51 mm) clearance top and bottom.
Add 1.2” (31 mm) clearance each side.

SAC-SW220
Add 2” (51 mm) clearance top and bottom.
Add 1” left-side, 2” (51 mm) right-side clearance.

SAC-SW225, SAC-SW235 and SAC-SW260
Add 2” (51 mm) clearance.
Add 4” (102 mm) clearance bottom.
Add 1” (25 mm) clearance each side.

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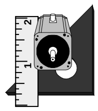
3.4 MotionDesk Software Configuration

The following drive settings are configured in MotionDesk:

- **Motor Model Number**
- **Continuous Stall Current**
- **Peak Current**
- **Motor Torque** (Peak, Continuous, Rated)
- **Maximum Speed** of motor
- **Resistance** measured phase-to-phase
- **Inductance** measured phase-to-phase
- **Inertia** of rotor
- **Number of Poles** of motor
- **Hall Offset** in degrees
- **Maximum Drive Input Voltage** based on motor’s rating
- **Commutation Type**: (Sine-Brushless/Trap-Brushless/DC-Brush)
- **Commutation Feedback Type**:
  Incremental encoder with separate U,V,W hall inputs -or-
  Incremental encoder with encoded U,V,W hall information -or-
  Absolute encoder
- **Feedback Resolution** (Counts per revolution)
- **Thermal Switch** in motor is present/not present
- **Thermal Time Constant** of motor.

- **Motor Over Temperature Handling** (Ignore/Error/Drive Alarm)
- **Hardware Travel Limit Inputs** (Enable/Disable)
- **Input Voltage for Drive** (115/230)
- **Pullup Resistors for ASEN, BSEN, CSEN:**
  20 KΩ (10 mA at 24 VDC) for NPN sensor -or-
  2.38 KΩ (2.1 mA at 24 VDC) for NPN sensor -or-
  No pullup resistor for PNP sensor
- **ASEN & BSEN gating** (Enable/Disable)
- **ASEN,BSEN,CSEN, ENCZ trigger** (Rising/Falling/High/Low)
- **ZOUT & Delay Counter** (primary or auxiliary axis)
- **Regen Resistor Resistance** (Ohms)
- **Regen Resistor Rated Power** (Watts)

These settings are stored as part of your project (.mtd) file, and are downloaded to the Orion controller when you synchronize. They take effect when your program runs MotionBASIC statement MP.CONFIG.



The MotionDesk icon, shown at the left, will be displayed in this manual wherever one of these drive parameters is discussed, to indicate that the functionality of the drive will depend on the MotionDesk setting.

The above parameters are entered in the following MotionDesk screens:

Project Navigator
- **Axis Settings**
  - **ServoWire Axis Module**
    - **ServoWire Drive Properties:** Pullup Resistors for ASEN,BSEN,CSEN; Regen Resistor Resistance; Regen Resistor Rated Power; ZOUT & Delay Counter source
    - **Axis Selection:** Motor Model Number; Input Voltage for Drive; Motor Over Temperature Fault
    - **Motion:** Hardware Travel Limit Inputs
    - **Axis Input:** ASEN & BSEN gating; ASEN,BSEN,CSEN,ENCZ trigger
    - **User-defined Motor Editor:** Continuous Stall Current; Peak Current; Motor Torque; Maximum Speed; Resistance; Inductance; Inertia; Number of Poles; Hall Offset; Maximum Motor Voltage; Commutation Type; Commutation Feedback Type; Feedback Resolution; Thermal Switch status; Thermal Time Constant

3.5 ServoWire Drives Power Considerations

3.5.1 Supply Power

ServoWire Drives can be operated, through line filters or an isolation transformer, on commercial power lines, which supply either 115 (+15%, -20%) or 230 (+15%, -20%) VAC, 50/60 Hz. Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 240 V maximum.

To prevent power line accidents due to grounding error, contact error, or to protect the system from a fire, circuit breakers or fuses must be installed according to the number and size (current capacity) of ServoWire Drives used. Slow-blow circuit breakers or fuses should be used because the servodrives draw substantial inrush current at power up.

3.5.2 Shielding, Power Line Filtering & Noise Suppression

The Servodrive uses high voltage switching power transistors in the main DC Bus circuit. When these transistors are switched, the $^{di}/_{dt}$ or $^{dv}/_{dt}$ switching noise may sometimes prove objectionable depending on the wiring and/or grounding method. The Servodrive also utilizes a microprocessor, which can be susceptible to power line interference caused either by the output switching transistors or other equipment on the power line, such as welders, electrical discharge machines, induction heating equipment, etc. Careful layout of wiring and power line filtering will help prevent noise interference. Recommendations with respect to wiring and grounding are described later in this section. Further information is available in the "Shielding & Grounding Electrical Panels" Application Note, which is available in the ORION Installation & Operation Manual, as well as ORMEC's Web Site (http://www.ormec.com).

It is recommended that line filters be installed to eliminate electro-magnetic interference coming into the system from the power line, as well as block switching noise from being transmitted back out to the power line from the Servodrives.

3.5.3 Sizing Fuses, Line Filters, and Transformers

To determine current requirements for fuses, line filters and transformers for main power, use the following conservative formulas:

$$\textbf{Required Power} \text{ (in KVA)} = \frac{1.1 * \textbf{Rated Power of Motor} \text{ (in Watts)}}{1000}$$

$$\textbf{Required Current} \text{ (in Amps)} = \frac{1.1 * \textbf{RatedPower of Motor} \text{ (in Watts)}}{\textbf{Incoming Line Voltage} \text{ (in Volts AC)}}$$

where **Rated Power of Motor** can be found in Chapter 6, Specifications.

In cases where the motor is substantially over-sized for an application, consider substituting the actual power required by the application into the above formulas, instead of the motor's rated power.

3.5.4 Power Dissipation

Use the following table to determine cabinet cooling requirements:

Dissipated Power (Watts)		
Control Power	Main Power	**External** Regen Resistor (if used)

	Max	Typical		
SAC-SW203	45	20	70	—
SAC-SW205	45	20	120	—
SAC-SW210	45	20	240	1500 max.
SAC-SW217	45	20	400	2100 max.
SAC-SW220	55	30	480	2100 max.
SAC-SW225	56	31	650	3200 max.
SAC-SW235	56	31	900	4000 max.
SAC-SW260	56	31	1550	4800 max.

Table 1*, Power Dissipation*

Main power dissipation in shown in the table for the rated output power of the drive. The actual dissipated main power may be lower, depending on the motor and/or application requirements. To more closely estimate main power dissipation, use the conservative formula: 0.1*(rated power of the motor). In cases where the motor is substantially oversized for the application, use 0.1*(the power required by the application).

Power dissipated in the regen resistor is dependent on the regen resistor connected to the drive, as well as the application requirements. The table shows the rated capability of the regen transistor in the ServoWire Drive.

3.5.5 Line Filters

Once the incoming power service is determined, the appropriate main power line filter can be selected from the following chart. In the case of a system using multiple ServoWire Drives, only one line filter is required per cabinet.

ServoWire Drive	Main Power Input Voltage	Total Continuous Current	Main Power Line Filter
SAC-SW203 SAC-SW205	Single phase	Up to 15 Amps	SAC-LF215U
		Up to 30 Amps	SAC-LF230U
SAC-SW210 SAC-SW217 SAC-SW220 SAC-SW225 SAC-SW235 SAC-SW260	Three-phase	Up to 30 Amps	SAC-LF30C
		30 – 55 Amps	SAC-LF55C
		55 – 100 Amps	SAC-LF100C

Table 2*, Line Filter Recommendations*

The following methods are recommended for proper installation of line filters:

1) The filter must be mounted on the same panel as, and as close as possible to the ServoWire Drive(s).
2) Paint or other panel covering material should be removed before mounting the filter.
3) All SAC-LF___C line filter ground connections should be tied to earth ground with a single wire (preferably braid), and **the filter must be grounded before connecting the ServoWire Drives.**

4) Line filters should not be touched for a minimum of 10 seconds after removal of the supply power.
5) Separate the input and output leads by a minimum of 10 inches (250 mm). Do not bundle them or run them in the same duct or wireway.

Do not bundle the ground lead with the filter output lines or other signal lines, and do not run them in the same duct.

3.6 ServoWire Drive Connections

This section describes the ServoWire Drive connections at TB1a, TB1b, TB2, and J1, J2, J3, J4. Signal descriptions are given in **Table 3** through **Table 8**. The remainder of Section 3.6 shows additional wiring information. Detailed electrical specs are in Section 6.1, ServoWire Drive Specifications. Part numbers for these and mating connectors are in Section 6.1.7 (page 64).

TB1a	
AS	ASEN
BS	BSEN
CS	CSEN
Sh	Shield
V+	V+S
V+	V+S
V-	V-S
V-	V-S
LR	HTLR
LF	HTLF
DL	DELAY

TB1b	
A1	AOUT1
A2	AOUT2
⏚	AGND
Sh	Shield
Z	ZOUT
O11 7	OUT1
O2	OUT2
O3	OUT3
O4	OUT4
O5	OUT5
O6	OUT6

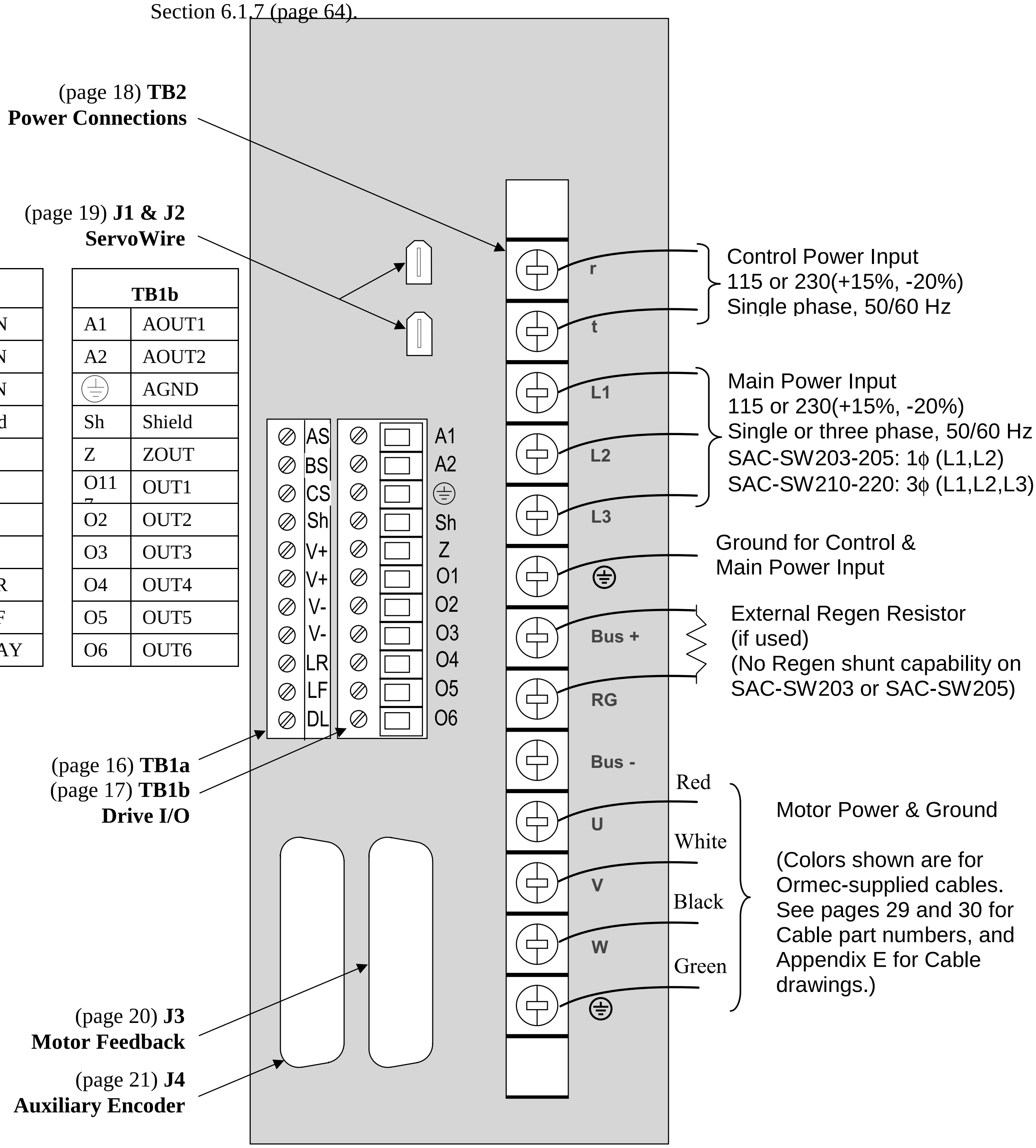
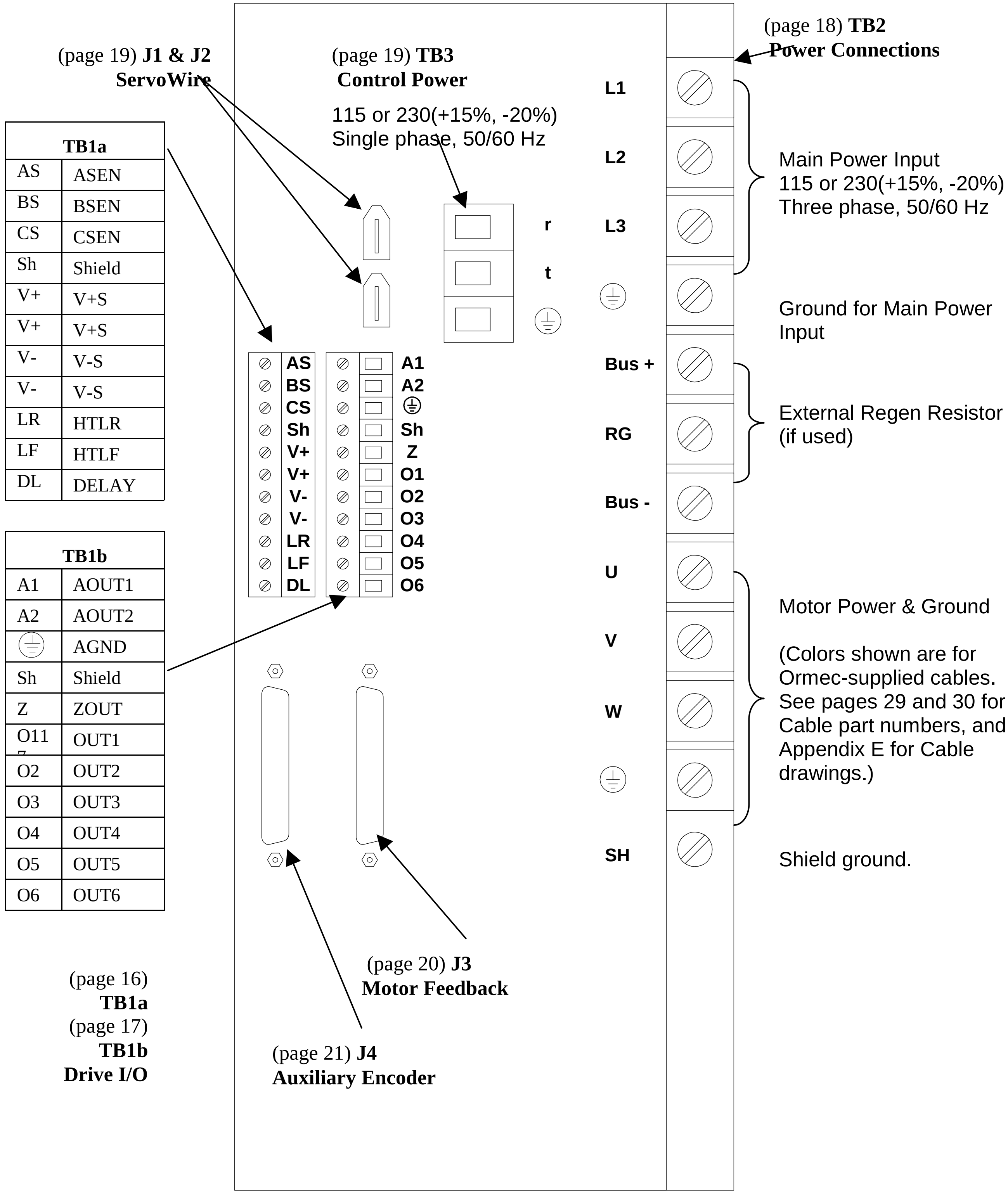


***Figure 2**, ServoWire Drive Connections Overview (SW203 – SW220)*



TB1a	
AS	ASEN
BS	BSEN
CS	CSEN
Sh	Shield
V+	V+S
V+	V+S
V-	V-S
V-	V-S
LR	HTLR
LF	HTLF
DL	DELAY

TB1b	
A1	AOUT1
A2	AOUT2
⏚	AGND
Sh	Shield
Z	ZOUT
O117	OUT1
O2	OUT2
O3	OUT3
O4	OUT4
O5	OUT5
O6	OUT6

***Figure 3**, ServoWire Drive Connections Overview(SW225 – SW260)*

3.6.1 Drive I/O (TB1a – left side of Phoenix block) Connections

Refer to the ServoWire Drive Connector Part Numbers section (page 64) of the Specifications chapter for further information.

Pin	Signal	Function	Description
AS BS CS	ASEN BSEN CSEN	High Speed Sensor Inputs	MotionDesk software-configurable for: • **2.38KΩ** pullup resistor for NPN sensor (10 mA @ 24VDC) • **20KΩ** pullup resistor for NPN sensor (1.2 mA @ 24VDC) • **No** pullup resistor for PNP sensor *See **Figure 5** (page 24) for a simplified schematic.* **V+S** and **V-S** must be connected to a DC Power Supply (5 – 24 VDC) in order to use these inputs.
Sh	Shield	Cable shield connection	Connect the cable shield at one end only.
V+ V+ V- V-	V+S V+S V-S V-S	I/O Power Supply Input Common for I/O Power	Inputs for 5-24 VDC power supply used for: • High Speed Sensor inputs ASEN, BSEN, CSEN • Hardware Travel Limits HTLF', HTLR' • Outputs OUT1'-OUT6', ENCZ' and DELAY'.
LR LF	HTLR' HTLF'	Reverse Travel Limit Input Forward Travel Limit Input	MotionDesk software-configurable for: • **Disabled:** leave unwired (no connection); otherwise a MotionBASIC configuration error (1617) will occur. • **Enabled**: limits should normally sink current to V-S. An open contact indicates an overtravel limit, causing MotionBASIC Error 1615 (HTLR') or 1614 (HTLF'). See **Figure 6** (page 25) for a simplified schematic. **V+S** and **V-S** must be connected to a DC Power Supply (5 – 24 VDC) in order to use these inputs.
DL	DELAY'	Delay Counter Output	*This output is available only if the optional Delay Counter Output (/D) is purchased for the ServoWire Drive.* Active low output; pulled up internally to V+S. MotionDesk software-configurable to output the delay counter signal (DELAY@) for either the motor axis (default) or optional auxiliary encoder axis. See **Figure 7** (page 26) for a simplified schematic. **V+S** and **V-S** must be connected to a DC Power Supply (5 – 24 VDC) in order to use this output.

***Table 3**, Drive I/O (TB1a- left side) Connections*

3.6.2 Drive I/O (TB1b – right side of Phoenix block) Connections

Refer to the ServoWire Drive Connector Part Numbers section (page 64) of the Specifications chapter for further information.

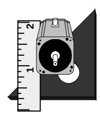
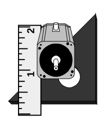
Pin	Signal	Function	Description
A1	AOUT1	Torque Monitor	±10 VDC analog signal. 3 VDC = rated torque.
A2	AOUT2	Velocity Monitor 	±10 VDC analog signal. The scaling depends on the maximum speed of the motor: Max speed 5000 rpm or higher: 1 VDC = 1000 rpm. Max speed between 2000-4999 rpm: 2 VDC = 1000 rpm. Max speed 1999 rpm or lower: 5 VDC = 1000 rpm. The maximum speed is determined by the MotionDesk software setting for Machine Limitations: Speed Limit (MotionBASIC variable MTR.SPD.LIM@). This normally defaults to the maximum speed printed on the side of the motor, but for G-Series motors rated for 460 VAC (MAC-Gxxxx**4**), but operated at 230 VAC, it is limited to <u>half</u> of the maximum speed printed on the side of the motor.
⏚	AGND	Analog Ground	Analog ground for AOUT1 & AOUT2.
Sh	Shield	Cable Shield	Connect the cable shield at one end only.
Z	ZOUT’	Encoder Reference Output 	Active low output; pulled up internally to V+S. See **Figure 7** (page 26) for a simplified schematic. **V+S** and **V-S** must be connected to a DC Power Supply (5 – 24 VDC) in order to use this output. If the ServoWire Drive includes the auxiliary encoder option (/P), ZOUT’ is MotionDesk software-configurable to output either the ENCZ input signal from the motor axis or the AUX ENCZ input signal from the auxiliary encoder axis.
O1 O2 O3 O4 O5 O6	OUT1’ OUT2’ OUT3’ OUT4’ OUT5’ OUT6’	PLS1 for motor axis PLS2 for motor axis PLS3 for motor axis PLS1 for optional pacer axis PLS2 for optional pacer axis PLS3 for optional pacer axis	Active low output; pulled up internally to V+S. See **Figure 7** (page 26) for a simplified schematic. **V+S** and **V-S** must be connected to a DC Power Supply (5 – 24 VDC) in order to use these outputs. *OUT4’, OUT5’ and OUT6’ are only available for use if the auxiliary encoder option (/P) is purchased on the ServoWire Drive.*

Table 4 *Drive I/O (TB1b – right side) Connections*

3.6.3 Power Terminal Block (TB2)

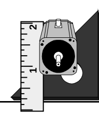
Terminal	**Function**	**Description**
r, t	Input Control Power (SW203 – SW220 only, for SW225 – SW260 see **Table 6**)	Single phase 115 (-20%) to 230 (+15%) VAC, 50/60 Hz control logic input power. Generally, once the ServoWire Drives in a network (on a single ServoWire Axis Module) have control power applied, it is best to leave their control power on continuously, while any of the drives is torque-producing. If one of the ServoWire Drives on a network loses control power, it will not adversely affect the other drives on the network. However, if control power is re-applied to that drive, all other ServoWire Drives on that network will respond with a drive alarm ***E1,*** and disable torque at their motors.
L1, L2, L3 – or – **L1, L2**	Input Main Bus Power 	**(SAC-SW210, 217, 220, 225, 235, 260):** Three phase 115 (+15%, -20%) or 230 (+15%, -20%) VAC, 50/60 Hz**.** **(SAC-SW203, 205):** Single phase 115 (+15%, -20%) to 230 (+15%, -20%) VAC, 50/60 Hz. The input voltage should match the MotionDesk software setting, to ensure proper operation of low bus voltage faults and inrush current limiting.
⏚	Ground	Ground for input power. **Must be connected to input power ground.**
Bus + **Bus -**	DC Bus Power +	**Nominal bus voltage: 325 VDC for 230 VAC input** **163 VDC for 115 VAC input** These terminals can be used for connecting bus power between servodrives. (SW225 – SW260 only) If an external regen resistor is used (SAC-SW210, 217, 220, 225, 235, 260 only), it is connected between **Bus +** and **RG.** See Section 3.6.11, External Regen Resistor Wiring (RG) (page 26).
RG	Regen Resistor	If an external regen resistor is used (SAC-SW210, 217, 220, 225, 235, 260 only), it is connected between **Bus +** and **RG.** See Section 3.6.11, External Regen Resistor Wiring (RG) (page 26).

Table 5, Power Connections (TB2) Description (continued on next page)

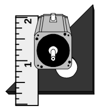
Terminal	Function	Description
U,V,W	Motor Power 	Single or Three-phase power to the motor. See: • G-Series Servomotor Connections (page 32) • DE/DA/DB-Series Servomotor Connections (page 34). • DC Servomotor Connections (page 35). The motor type must match the MotionDesk software setting, to ensure proper operation.
⏚	Ground	Ground connection for motor frame ground
SH	Shield Ground	Connection for motor shield ground (SW225 – SW260 only)

Table 5, *Power Connections (TB2) Description (continued from previous page)*

3.6.4 Control Power Terminal Block (TB3) (SW225 – SW260)

Terminal	Function	Description
r, t	Input Control Power	Single phase 115 (-20%) to 230 (+15%) VAC, 50/60 Hz control logic input power. Generally, once the ServoWire Drives in a network (on a single ServoWire Axis Module) have control power applied, it is best to leave their control power on continuously, while any of the drives is torque-producing. If one of the ServoWire Drives on a network loses control power, it will not adversely affect the other drives on the network. However, if control power is re-applied to that drive, all other ServoWire Drives on that network will respond with a drive alarm ***E1,*** and disable torque at their motors.
⏚	Ground	Ground for control logic input power. **Must be connected to input power ground.**

Table 6, *Control Power Connections (TB3) Description (SW225 – SW260)*

3.6.5 ServoWire Connectors (J1 & J2)

The ServoWire connector has 6 pins: 2 for power and 4 for communications. The connectors are available only as an integral part of a IEEE 1394 or ServoWire cable.

There is no ‘in’ or ‘out’ distinction between the J1 and J2 connectors. Each ServoWire network can be thought of as a bus.

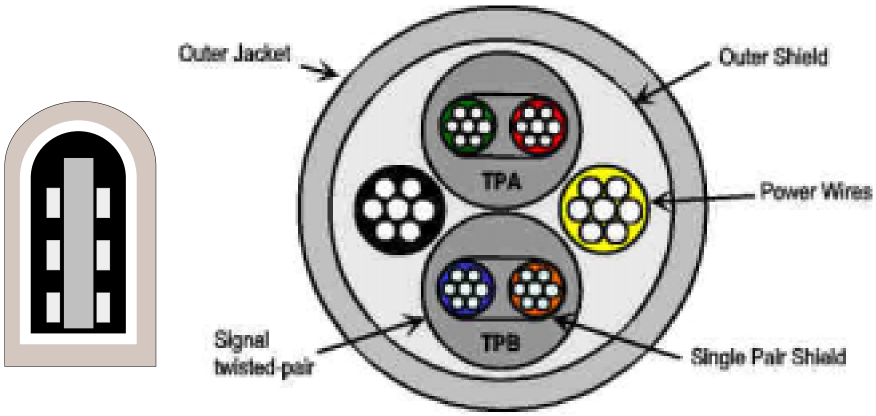


***Figure 4**, ServoWire Connector (J1 & J2) and Cable*

The following rules apply to connecting a ServoWire network:

- No loops are allowed.
- Only one ServoWire Axis Module per network.
- No more than 8 ServoWire Drives per network.
- The ServoWire Axis Module in the Orion Controller has the additional restriction of no more than 8 axes connected to it. For example, if the MotionDesk project has a pacer axis defined for a ServoWire Drive (with the /P option), that counts as 2 axes. So the number of ServoWire Drives that can be connected to that ServoWire Axis Module is reduced to a maximum of 7.

3.6.6 Motor Feedback Connector (J3)

Refer to the ServoWire Drive Connector Part Numbers section (page 64) of the Specifications chapter for further information.

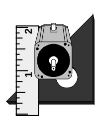
Pin	Signal	Description
1 2	ENCA ENCA'	Differential input, quadrature feedback channel A from the motor encoder.
3 4	ENCB ENCB'	Differential input, quadrature feedback channel B from the motor encoder.
5 6	ENCZ ENCZ'	Differential input, "once per revolution" marker signal from the motor encoder.
7 8 9 10 11 12	U U' V V' W W'	Differential or single-ended input, commutation feedback channels U, V and W from the motor encoder. The U, V and W (pins 7, 9 & 11) inputs are intended for use with single ended commutation feedback. If the feedback signals are open collector outputs, external biasing hardware may be required. The U', V' and W' (pins 8, 10 & 12) inputs are internally biased and no connection or external circuitry is required for use with single ended feedback. Refer to Appendix B-3 for futher information.
13,24,25	ENC PWR1	+5.3 VDC power supply output for the motor encoder (450 mA max). This power is derived from the input control power at TB2 pins **r,t**. For ServoWire Drives with the Absolute Encoder option (/A), this output power will be switched off during absolute encoder resets, and momentarily cycled off/on for absolute encoder reads.
16,17,18	DGND	Common for the +5.3 VDC supply (ENC PWR1).
19 20	TEMP' TEMP RET 	Motor Over Temperature input. MotionDesk Axis Configurator settings determine the usage of this input. **Normally closed Contact** wired to the ServoWire Drive: • Open contact causes drive alarm ***F4***. (immediately disables motor torque). • Open contact causes MotionBASIC Error 1628. • Open contact is ignored. No alarm or error occurs. **No Sensor exists at motor**. Leave TEMP & TEMP RET unconnected. • Contact is normally open. (This setting will cause a MotionBASIC configuration error 1629 if there is a closed contact). See Section 4.7 (page 53) for a detailed explanation & schematic.
21	SHIELD	Motor encoder shield termination point
22 23	BAT+ BAT–	(Optional) Absolute encoder (3 VDC) backup power output. *Available only if Absolute Encoder option /A is present on the ServoWire Drive.*
14	ABS RESET	(Optional) Absolute encoder reset signal. *Available only if Absolute Encoder option /A is present on the ServoWire Drive.*
15	No Connection	

***Table 7**, Motor Feedback Connector (J3) Descriptions (also see cable drawings in Appendix E)*

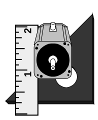
3.6.7 Auxiliary Encoder Connector (J4) (optional)

Refer to the ServoWire Drive Connector Part Numbers section (page 64) of the Specifications chapter for further information.

Pin	Signal	Description
1 14	AUX ENCA AUX ENCA'	Differential input, quadrature feedback channel A from the pacer encoder.
2 15	AUX ENCB AUX ENCB'	Differential input, quadrature feedback channel B from the pacer encoder.
3 16	AUX ENCZ AUX ENCZ'	Differential input, "once per revolution" marker signal from the pacer encoder.
5,6,18	ENC PWR2	+5.3 VDC power supply output for the pacer encoder (450 mA max). This power is derived from the input control power at TB2 pins **r,t**.
7,19,20	DGND	Common for the +5.3 VDC supply (ENC PWR2).
9	SHIELD	Pacer encoder shield termination point
4,8,10, 11,12,13,1 7,21,22,23 ,24,25	No Connection	

Table 8*, Auxiliary Encoder Connector (J4) Pin Descriptions (also see cable drawing p E-10)*

3.6.8 High Speed Sensor Inputs (ASEN, BSEN, CSEN)



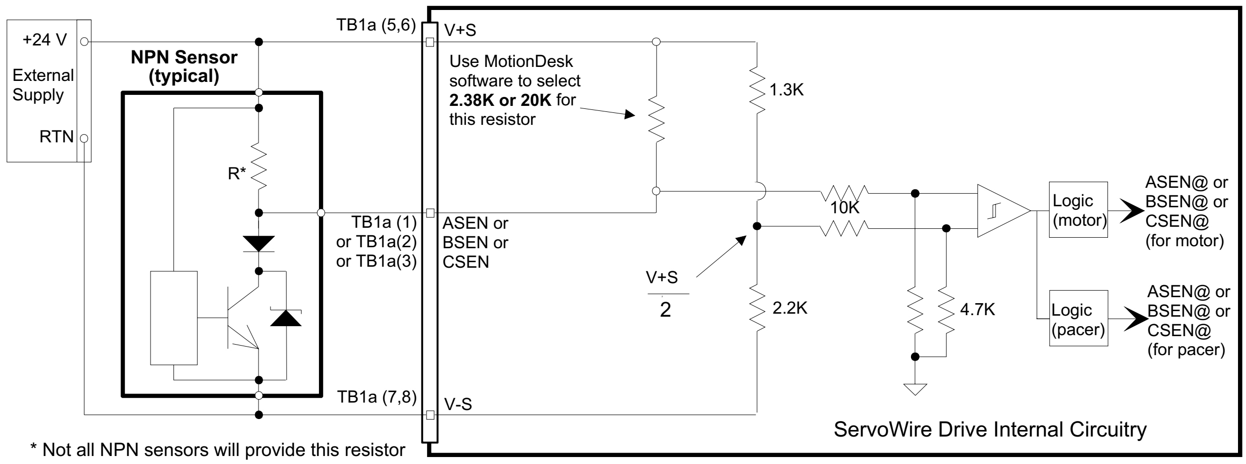
High speed sensor inputs ASEN, BSEN and CSEN are individually configurable in MotionDesk software for:

- NPN sensor: **2.38K** pullup resistor (10 mA @24 VDC)
- NPN sensor: **20K** pullup resistor (1.2 mA @24 VDC)
- PNP sensor: pullup resistor **removed** from circuit.

Figure 5 on the following page shows sensor wiring for types NPN (top) and PNP (bottom).

NPN type sensor example:

For ASEN@, BSEN@, or CSEN@ =true for sensor transistor ON (sinking current), set SENS.MODE@="F" or "L"
For ASEN@, BSEN@ or CSEN@ = true for sensor transistor OFF (floating), set SENS.MODE@="R" or "H"



PNP type sensor example:

For ASEN@, BSEN@ or CSEN@ = true when sensor transistor is ON (sourcing current), set SENS.MODE@="R" or "H"
For ASEN@, BSEN@ or CSEN@ = true when sensor transistor is OFF (floating), set SENS.MODE@="F" or "L"

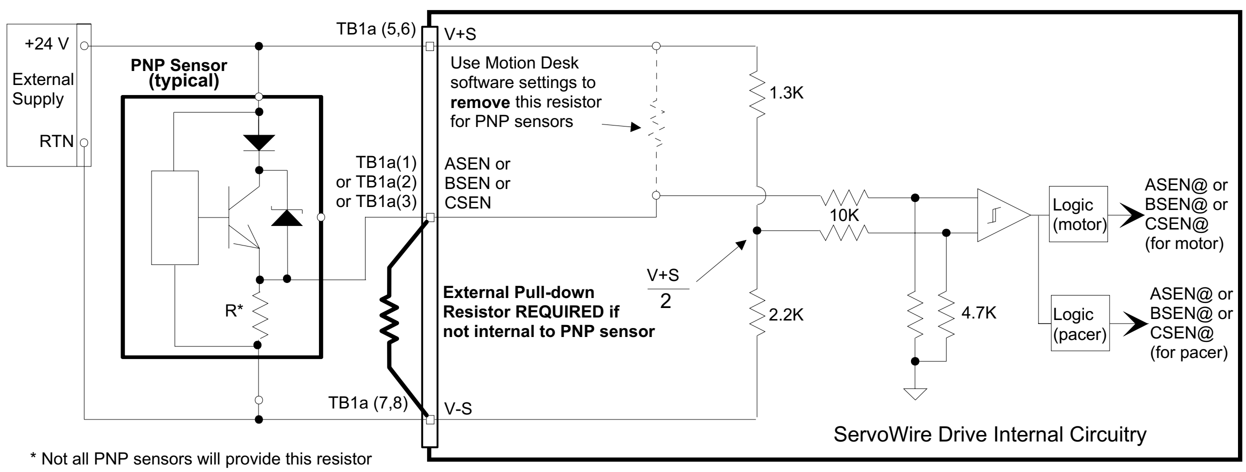


Figure 5, *Schematic of ASEN, BSEN, CSEN wiring for NPN and PNP sensors*

3.6.8 High Speed Sensor Inputs (ASEN, BSEN, CSEN) (continued)

NOTE: ASEN, BSEN and CSEN wiring should be shielded twisted pair cable, with a foil shield. The DC Power Supply V-S connection should be connected to the same ground as the ServoWire Drive frame ground (TB2 pin ⏚).

MotionDesk software and/or MotionBASIC variables ASEN.MODE@, BSEN.MODE@, CSEN.MODE@ are used to configure ASEN, BSEN, CSEN for edge- or level-sensitive triggering. **Using level-sensitive (high or low) triggering increases the susceptibility of your sensor inputs to noise.**

ASEN and BSEN inputs can be gated (masked) by ServoWire Drive outputs OUT1 and OUT2 (or OUT4 and 5 for an auxiliary [pacer] axis). This configuration is done using MotionDesk software and/or MotionBASIC variable SENS.MODE@.

3.6.9 Hardware Travel Limit Inputs (HTLR', HTLF')

Figure 6 shows a simplified schematic of the Hardware Travel Limits, TB1a pins LR and LF.

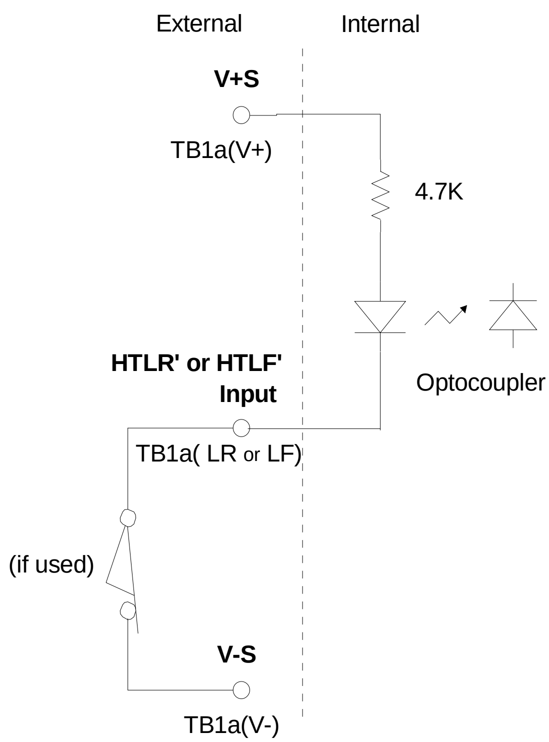


***Figure 6**, Schematic of HTLR' and HTLF' Inputs*

3.6.10 Discrete Outputs (ZOUT, OUT1-OUT6, DELAY')

Figure 7 shows a simplified schematic of the discrete outputs ZOUT', OUT1', OUT2', OUT3', OUT4', OUT5', OUT6', and optional DELAY'.

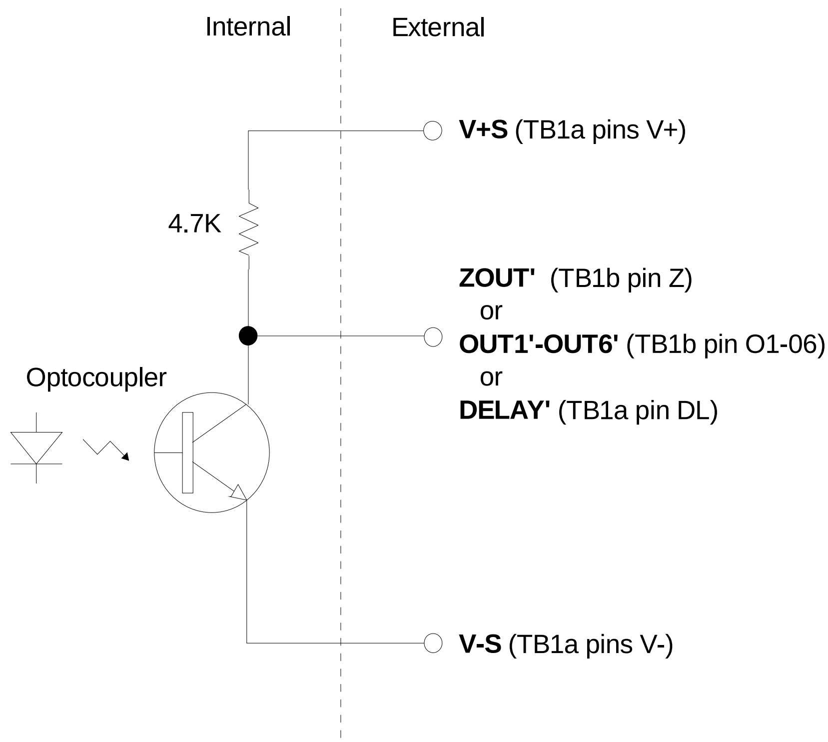


Figure 7, *Schematic of Discrete Outputs ZOUT', OUT1'-OUT6', DELAY'*

3.6.11 External Regen Resistor Wiring (RG)

Regenerative (regen) shunt circuitry, for use with external regen resistors, is provided on ServoWire Drive models SAC-SW210, SAC-SW217, SAC-SW220, SAC-SW225, SAC-SW235, and SAC-SW260. Regen resistors are connected between the **Bus +** and **RG** terminals on TB2 (refer to **Figure 8**).

The following methods are recommended for proper installation of regen resistors:

1. **Regen resistors can become very hot as part of normal operation and should be mounted in a ventilated, "touch safe" enclosure.** ORMEC SAC-SWRR/0700, SAC-SWRR/0845, SAC-SWRR/0846, and SAC-SWRR/1700 regen resistors are supplied with enclosures. Mounting enclosures for the SAC-SWRR/0055 and SAC-SWRR/0095 regen resistors are not included and must be supplied by the user.
2. Regen resistor wiring should have heat resistant, non-combustible insulation.
3. Regen resistor, and other system, wiring should be routed so that it is not in contact with the regen resistors.

4. **Switching voltages exceeding 400 VDC maybe present on the Bus+ and RG terminals (and across the regen resistor).** Use appropriate high voltage safety and noise suppression wiring methods.
5. Mounting and wiring practices should be in accordance with NEC (National Electric Code) or UL (Underwriters Laboratories) specifications and in compliance with local ordinances.

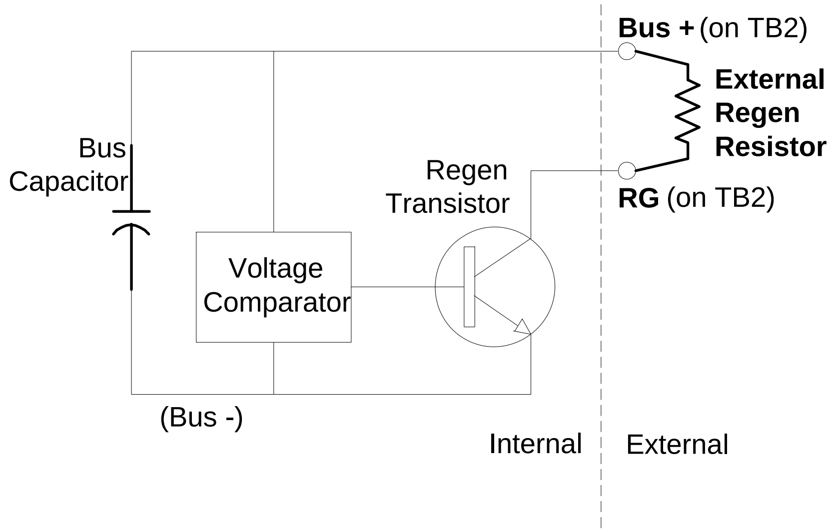


Figure 8*, Regen Resistor Connection*

For information on how the shunt circuitry operates, as well as information on sizing regen resistors, see Section 4.6, Regenerative Loads (page 46).

3.6.12 Bus Sharing Wiring (SW225 – SW260)

DC Bus sharing is supported on ServoWire Drive models ***SAC-SW225, SAC-SW235, and SAC-SW260 only***. To configure these drives for bus sharing, the **Bus +** and **Bus –** terminals are connected as shown in **Figure 9**. Drives should be connected so that the highest power drives are in the center of the bus-sharing chain. Bus wiring between drives should be less than 12 inches in length to minimize oscillatory effects. As long as the total system regenerative load can be dissipated, there is no limit to the number of drives that can share the DC bus.

For information on how the bus sharing operates, see Section 4.6.5, Bus Sharing.

The following methods are recommended for proper configuration of bus sharing:

1. Wiring should have heat resistant, non-combustible insulation, rated at 600V or more.
2. **Switching voltages exceeding 400 VDC maybe present on the Bus+ and BUS- terminals.** Use appropriate high voltage safety and noise suppression wiring methods.
3. Mounting and wiring practices should be in accordance with NEC (National Electric Code) or UL (Underwriters Laboratories) specifications and in compliance with local ordinances.
4. If an external regen resistor is to be used in conjunction with bus sharing, it should be connected to the largest servodrive in the bus-shared network. **No more than one regen resistor may be used in any bus sharing configuration**. See 3.6.11 for more information on regen resistor installation.

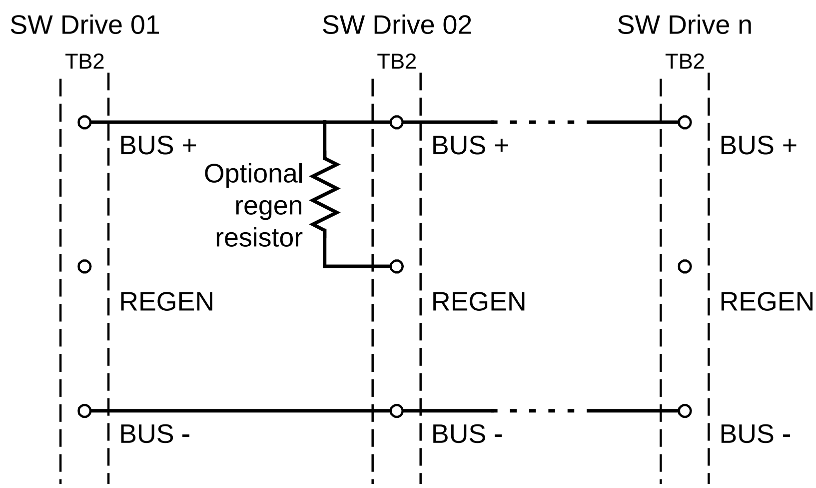


***Figure 9**, Bus Sharing Connections*

3.7 ServoWire Drive ID

Each ServoWire Drive has a Drive ID which is shown in the ID/Status LED display on the front of the drive. ServoWire Drives are shipped from the factory with Drive ID set to 1.

The Drive ID is important because it establishes the axis ID of the motor being controlled by the ServoWire Drive, as well as the axis ID of the optional auxiliary encoder. These axis IDs are used by the MotionBASIC program.

The axis ID of the motor being controlled by the ServoWire Drive (connector J3) **is equal to the Drive ID**.

For ServoWire Drives with the /P pacer option, if the auxiliary axis (connector J4) is used, its a**xis ID is one <u>less</u> than the Drive ID.** (If the pacer option is purchased on the ServoWire Drive, but not used by the MotionDesk project, no axis ID is reserved for it).

For example:

- A ServoWire Drive SAC-SW205/E that has Drive ID 3 controls a motor with axis ID 3.
- A ServoWire Drive SAC-SW205/EP that has Drive ID 3 controls a motor with axis ID 3, and also processes feedback for an auxiliary encoder with axis ID 2.

A recessed push-button on the top of the ServoWire Drive will increase the Drive ID by 1 each time it is pushed, up to a maximum value of 32. After 32, it will roll over back to 1, and continue increasing again from there. This functionality is available after each power-up, before torque has been enabled at the motor.

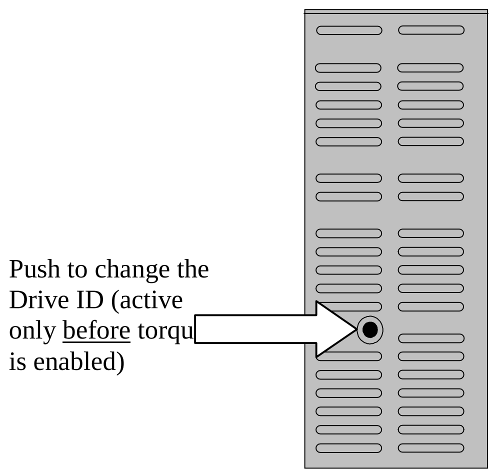


Figure 10*, Top View of ServoWire Drive showing Drive ID Pushbutton*

3.8 Servomotor Installation

3.8.1 Motor Use and Environment

A standard G-Series or DE/DA/DB-Series Servomotor (IP65) is designed for use as described below:

- Either horizontal or vertical mounting orientation
- Indoors, clean and dry
- Free from corrosive and/or explosive gases or liquids
- If the location is subject to excessive water or oil, protect the motor with a cover. The motor can withstand a small amount of splashed water or oil.
- Accessible for inspection and cleaning
- Face mounting: the structural integrity of the mounting can be critical to obtaining the maximum performance from your Servomotor application.
- DE/DA/DB-Series Servomotors: Ambient Temperature: 0^{o}C to $+40^{o}$C.
- G-Series Servomotors: Rated Torques/Currents are for 25^{o}C; for ambient temperatures above 25^{o}C, use the formula given below in **Figure 11**. Note that $^{\circ}C_{Max}$ is 100^{o}C for all G-Series Servomotors except models G006, G011, G015, and

G019; for these motors, $°C_{Max}$ is 85°C. The motor current is derated by the same factor as the torque.

$$Torque_{Derated} = Torque_{Rated} * \frac{(°C_{Max} - °C_{Ambient})}{(°C_{Max} - 25°C)}$$

***Figure 11**, G-Series Torque Derating for High Ambient Temperature*

3.8.2 Recommended Servomotor Wiring Methods

1) When the motor is mounted to the machine and grounded through the machine frame, $^{dv}/_{dt}$ current flows from the ServoWire Drive through the floating capacity of the motor. To prevent the noise effects from this current, and also for safety, the motor housing (terminal D of the motor connector) should be connected to the frame of the ServoWire Drive (TB2 pin), which should be directly grounded to the control panel frame using braided copper wire.
2) When motor wiring is contained in metal conduits, the conduits and boxes must be grounded. Use wires of 12 AWG or heavier for grounding to the case (preferably flat woven silver-plated copper braid).
3) If possible, route motor feedback and motor power cables in separate conduits or ductwork, separated by a minimum of 10 inches (25 cm).

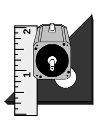
3.8.3 Motors with Integral Fail-Safe Brakes

NOTE: **The integral fail-safe brakes supplied on DA/DB/DE-Series and G-Series motors are intended for holding purposes (preventing the movement of a stopped motor) only and should not be used for braking a motor in motion. Using an integral fail-safe brake to stop a motor in motion may result in damage to the motor-brake unit.** An external brake should be used for fail-safe stopping a motor in motion.

Motors with brakes require special cables; see **Table 11** (page 33) for G-Series cable part numbers; see **Table 13** (page 35) for DE/DA/DB-Series cable part numbers. Drawings for these cables are shown in Appendix E.

Figure 12 shows the recommended safety and fault interlock wiring for motors with fail-safe brakes. ***MotionBASIC 5.1.0 (or later) and ServoWire Drive firmware version 1.1.0 (or later)*** must be used for proper operation of the circuitry indicated in **Figure 12**.

- When the main power contactor opens, the brake engages.



- When OUT6' is asserted, the brake disengages. Through the MotionDesk Axis Configurator, OUT6' can be configured to automatically control when the brake engages and disengages. OUT6' can also be turned on and off to disengage and engage the brake under the control of a MotionBASIC application program. Refer to the MotionDesk and MotionBASIC Help manuals for further information.

Use a separate +24 VDC power supply for coil power! The ORION power supply and the supply used for the ServoWire Drive I/O should **not** be used for switching inductive loads.

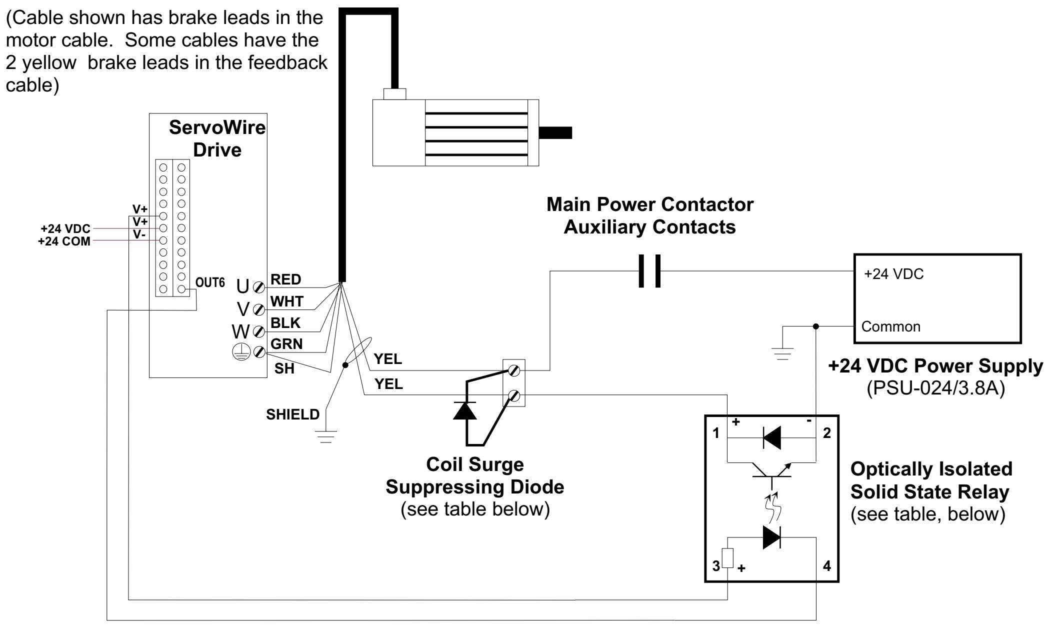


__Figure 12__, Fail-Safe Brake Interlock Circuit, MB 5.1.0 (or later) & SW Drive firmware 1.1.0 (or later)

	Ormec P/N	**Manufacturer, P/N**
Optically-Isolated Solid State Relay	MIO-DC60S-3	Opto-22, DC60S-3
Coil Surge Suppressing Diode	SEM029	Motorola, MUR410

__Table 9__, Additional Components for use with Fail-Safe Brakes

3.8.4 G-Series Servomotor Connections

For G-Series motors without brakes, refer to the appropriate cable drawing(s) in Appendix E. The motor and encoder cable part numbers and page numbers are shown in **Table 10** (motors without brakes) and **Table 11** (motors with brakes).

MAC-G Motors Without Brakes	Motor Power Cable	Motor Encoder Cable
G005, G010, G006, G011, G015,G019 with ServoWire drives SW203 – SW220	CBL-GMSW1 (p E-3)	
G016, G030, G040, G055, G080, G115 with ServoWire drives SW203 – SW220	CBL-GMSW2 (p E-4)	CBL-GMSW (1-50 ft: p E-1) (51-150 ft: p E-2)
G080 & G115A2 with ServoWire drives SW225 & SW235	CBL-GMSWT2 (p E-5)	
G130 & G210 with ServoWire drives SW210 – SW220	CBL-GMSW3 (p E-6)	
G130A2 with ServoWire drive SW225	CBL-GMSWT3 (p E-8)	CBL-GMSW (1-50 ft: p E-1) (51-150 ft: p E-2)
G210, G280A4 & G360A4 with ServoWire drives SW225 – SW235	CBL-GMSWT5 (p E-8)	
G280A2 & G360A2 with ServoWire drives SW235 & SW260	CBL-GMSWT6 (p E-8)	
G640A2 with ServoWire drive SW260	CBL-GMSWT9 (p E-8)	

Table 10, *Cable Drawings for G-Series Motors* ***Without*** *Brakes*

For G005, G006, G010, G011, G015, G019 motors, the brake leads are in the combined power/feedback cable.

For G016, G030, G040, G055, G080, and G115 motors, the brake leads are in the motor power cable.

For G130, G210, G280, G400 and G640 motors, the brake leads are in the motor feedback cable.

<table>
<tr><th>MAC-G Motors With Brakes</th><th>Motor Power Cable</th><th>Motor Encoder Cable</th></tr>
<tr><td>G005, G010, G006, G011, G015,G019
with ServoWire drives SW203 – SW220</td><td colspan="2">CBL-GMSWB1 (p E-3)</td></tr>
<tr><td>G016, G030, G040, G055, G080, G115
with ServoWire drives SW203 – SW220</td><td>CBL-GMSWB2 (p E-11)</td><td rowspan="2">CBL-GMSW
(1-50 ft: p E-1)
(51-150 ft: p E-2)</td></tr>
<tr><td>G080 & G115A2
with ServoWire drives SW225 & SW235</td><td>CBL-GMSWBT2 (p E-12)</td></tr>
<tr><td>G130 & G210
with ServoWire drives SW210 – SW220</td><td>CBL-GMSW3 (p E-6)</td><td rowspan="5">CBL-GMSWB
(1-50 ft: p E-9)
(51-150 ft: p E-10)</td></tr>
<tr><td>G130A2
with ServoWire drive SW225</td><td>CBL-GMSWT3 (p E-8)</td></tr>
<tr><td>G210, G280A4 & G360A4
with ServoWire drives SW225 – SW235</td><td>CBL-GMSWT5 (p E-8)</td></tr>
<tr><td>G280A2 & G360A2
with ServoWire drives SW235 & SW260</td><td>CBL-GMSWT6 (p E-8)</td></tr>
<tr><td>G640A2
with ServoWire drive SW260</td><td>CBL-GMSWT9 (p E-8)</td></tr>
</table>

Table 11*, Cable Drawings for G-Series Motors* ***With*** *Brakes*

3.8.5 DE/DA/DB-Series Servomotor Connections

For DE/DA/DB-Series motors without brakes, refer to the appropriate cable drawing(s) in Appendix E. The motor and encoder cable part numbers are shown in **Table 12** (motors without brakes) and **Table 13** (motors with brakes).

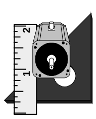
MAC-D_ Motors Without Brakes	Motor Power Cable	Motor Encoder Cable
DE003, DE006, DE008, DE011, DE021, DE042 with ServoWire drives SW203 - SW220	CBL-DEMSW1 (p E-14)	CBL-DMSW (1-50 ft: p E-15) (51-150 ft: p E-16)
DA030, DA055, DB025, DB055, DB080 with ServoWire drives SW210 - SW220	CBL-DMSW1 (p E-17)	
DA055 with ServoWire drive SW225	CBL-DMSWT1 (p E-18)	
DA090, DA110, DB200 with ServoWire drives SW225 - SW260	CBL-DMSWT2 (p E-18)	
DA140 & DB300 with ServoWire drives SW235 - SW260	CBL-DMSWT3 (p E-18)	
DB100 with ServoWire drive SW220	CBL-DMSW4 (p E-17)	
DB100 with ServoWire drive SW225	CBL-DMSWT4 (p E-18)	
DB330 with ServoWire drive SW260	CBL-DMSWT5 (p E-18)	
DB465 & DB700 with ServoWire drives SW235 - SW260	CBL-DMSWT6 (p E-18)	

Table 12*, Cable Drawings for DE/DA/DB-Series Motors* ***Without*** *Brakes*

MAC-D_ Motors With Brakes	Motor Power Cable	Motor Encoder Cable
DE003, DE006, DE008, DE011, DE021, DE042 with ServoWire drives SW203 - SW220	CBL-DEMSWB1 (p E-14)	CBL-DMSW (1-50 ft: p E-15) (51-150 ft: p E-16)
DA030, DA055, DB025, DB055, DB080 with ServoWire drives SW210 - SW220	CBL-DMSWB1 (p E-19)	
DA055 with ServoWire drive SW225	CBL-DMSWBT1 (p E-20)	
DA090, DA110, DB200 with ServoWire drives SW225 - SW260	CBL-DMSWBT2 (p E-20)	
DA140 & DB300 with ServoWire drives SW235 - SW260	CBL-DMSWBT3 (p E-20)	
DB100 with ServoWire drive SW220	CBL-DMSWB4 (p E-19)	CBL-DMSW (1-50 ft: p E-15) (51-150 ft: p E-16)
DB100 with ServoWire drive SW225	CBL-DMSWBT4 (p E-20)	
DB330 with ServoWire drive SW260	CBL-DMSWT5 (p E-18) & CBL-DMACB (p E-21)	
DB465 & DB700 with ServoWire drives SW235 - SW260	CBL-DMSWT6 (p E-18) & CBL-DMACB (p E-21)	

***Table 13**, Cable Drawings for DE/DA/DB-Series Motors **With** Brakes*

3.8.6 DC Servomotor Connections



For DC motors, voice coils and other actuators requiring single phase current output can be connected to pins U and V on the High Power Terminal Block (TB2). The MotionDesk Custom Motor editor can be used to configure the Drive for use with a DC motor or single phase actuator, as well as for configuring the Low Bus Voltage alarm trip point.

3.8.7 Coupling the Servomotor to the Load

Good alignment of motor and the driven machine is essential to prevent vibration, increase bearing and coupling life, and to prevent shaft and bearing failures.

With a direct drive application a torsionally rigid flexible coupling should be used. Timing belts and gearboxes are also commonly used in servo applications. Shaft loading should be kept to a minimum. The allowable shaft bearing loading is listed in the Specifications Section.

In either case, it is preferable to attach the coupling or pulley to the shaft with a clamping arrangement rather than transmit torque through the keyway, because of the reversing shock torques, which the Servomotor can generate. A number of mechanical approaches afford this type of attachment including tapered hubs, split hubs, ringfeder devices, etc.

Further information is available in Ormec Tech Note #27 - Coupling High Performance Servos to Mechanical Loads, which is available in Appendix F of this manual.

Chapter 4
Operation

4 Operation

4.1 Power On and Off Sequencing

Appendix A shows the recommended interlock approaches for both single and multiple axes. Note its features:xyz

1) ESTOP interlocks

a) The recommended E-Stop switch is a maintained-contact red mushroom head push-button, which must be manually pulled out (reset) after it has been pressed (asserted). It should be powered by 115 or 230 VAC, and must conduct current for the Servomotor to provide output torque.

c) The E-Stop Reset should be a momentary contact pushbutton. It must be asserted after all power is applied and the E-Stop switch is closed. It must be closed long enough for the Orion Controller NO FAULT (NF) relay to "pull-in", so that the main power contactor coil circuit is energized.

e) If the E-Stop switch is pressed (asserted), the main circuit power is disconnected, and torque is prevented at the motor(s).

2) ServoWire Drive faults

a) If any fault condition occurs within a ServoWire Drive, the main circuit power is disconnected because the Orion Controller NO FAULT relay opens. In this case, the ServoWire Drive ID/Status display will indicate the fault code.

To reset a High Bus Voltage Fault, the main input power must be disabled long enough to discharge the power capacitors. This will be indicated by the BUS POWER LED on the ServoWire Drive no longer being illuminated.

To reset a Motor Over Temperature Fault, the motor must be sufficiently cool. All other fault conditions can be cleared via software reset (AFAULT@, FAULT@).

Not only must any alarm condition, including E-Stop, be cleared before motor power can be restored, but the E-Stop Reset push-button must then be depressed long enough for all the relays to pull-up again.

4.2 ServoWire Drive Status Indications

The servodrive status indication consists of a 2-digit 7-segment LED display (ID/Status) and several individual LEDs: 3 yellow LEDs indicating sensor inputs, 3 red LEDs indicating motor overtemperature and hardware travel limit conditions, and a yellow LED indicating bus power.

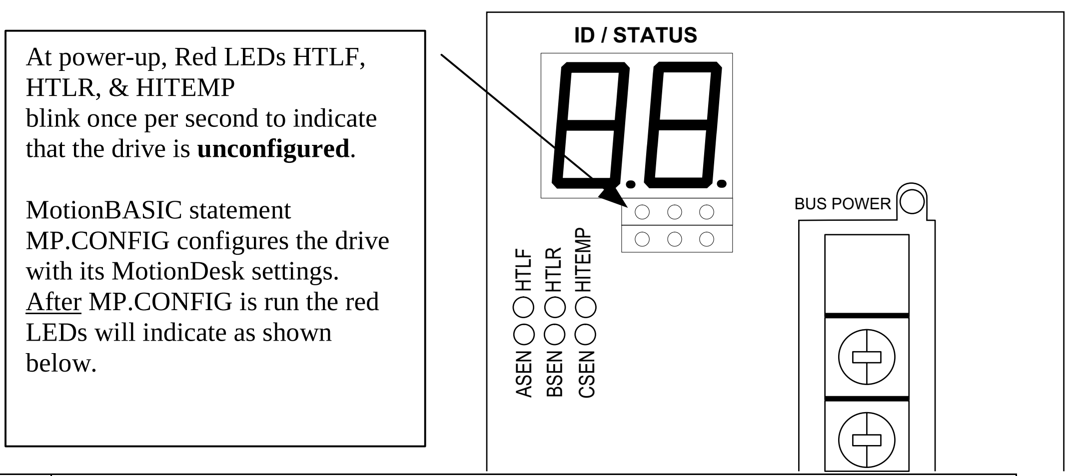
If an alarm condition (except for auxiliary encoder open wire ***F2***) is present on the ServoWire Drive, the output transistors are disabled, and an appropriate error code is displayed on the ID/Status display. The control power should be maintained in case of a Servodrive fault, so that the status indicators can indicate the unit's status until the cause of the fault is determined.

If any wiring changes are necessary, turn off the control and main power circuits and wait for the BUS POWER LED to go completely off to avoid possible electrical shock.

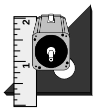
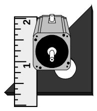
Notes:
1) After the conditions causing a servodrive fault have been corrected, reset the drive fault using MotionBASIC Ormec variable AFAULT@.
2) If the fault is due to the motor or drive being over temperature, the servodrive will not reset until the component has cooled down.

Figure 13, *ServoWire Drive LED Indications*

4.2.1 Individual LED Status Indicators and Descriptions



LED Label	Color	Illuminated when…
BUS POWER	Yellow	Main DC Bus Power is on.
HTLF	Red	One of the following error conditions exists: • A Forward Travel Limit error exists (MotionBASIC Error 1614): The HTLF input (TB1a pin LF) is not sinking current, and Hardware Travel Limits have not been disabled in software. – or –

		• A configuration error exists (MotionBASIC Error 1617): The Hardware Travel Limits have been disabled in software, but the HTLF input (TB1a pin LF) is wired and sinking current.
HTLR 	Red	One of the following error conditions exists: • A Reverse Travel Limit condition exists (MotionBASIC Error 1615): The HTLR input (TB1a pin LR) is not sinking current, and Hardware Travel Limits have not been disabled in software. – or – • A configuration error exists (MotionBASIC Error 1617): The Hardware Travel Limits have been disabled in software, but the HTLR input (TB1a pin LR) is wired and sinking current.
HITEMP 	Red	The thermal contact in the motor (J3 pins 19 & 20) is in one of these states: • The thermal contact is wired and closed, but it is configured in MotionDesk as not existing. – or- • The thermal contact is open, indicating an over temperature condition. Depending on MotionDesk software settings, there may also be an alarm **F4** on the ServoWire Drive, MotionBASIC Error 1628, or neither. In the case of a drive alarm, torque will also be disabled at the motor.
ASEN	Yellow	Illuminated to indicate low voltage at the ASEN sensor input (TB1a pin AS)
BSEN	Yellow	Illuminated to indicate low voltage at the BSEN sensor input (TB1a pin BS)
CSEN	Yellow	Illuminated to indicate low voltage at the CSEN sensor input (TB1a pin CS)

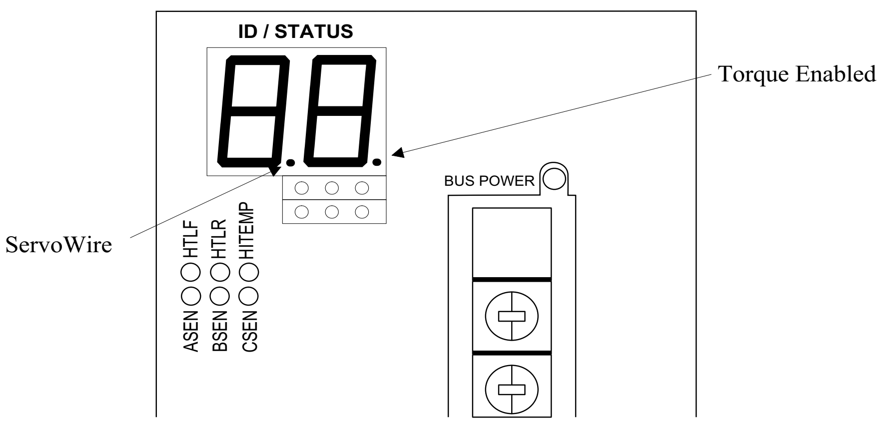


***Table 14**, ServoWire Drive LED Status Indications*

***Figure 14**, ServoWire Drive ID/Status Indications*

4.2.2 ServoWire Communications (Middle Dot of ID/Status Display)

Slow Flash: (on for 1 second, off for 1 second) indicates that the drive is functional, but there is no ServoWire communications.

Rapid Flash: (on for ½ second, off for ½ second) indicates that ServoWire communications is functioning normally.

Solid On or Off: indicates a drive failure that is recoverable only by cycling control power. This should be reported to the Ormec Customer Service Dept.

4.2.3 Torque Enabled (Right Dot of ID/Status Display)

Off: indicates that torque is not enabled at the motor.
On: indicates that torque is enabled at the motor.

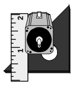
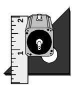
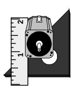
4.2.4 Axis ID and Alarm ID

When no drive alarms exist, the ID/Status will display the Drive ID, e.g. 1, 2, etc. When a drive alarm exists, the ID/Status display will alternate between the Drive ID and the alarm code (shown on the next page in **Table 15**, ServoWire Drive Alarm Codes). There is a more detailed table of alarm codes which shows cause-and-effect for many of these alarms in Section 7.1, ServoWire Drive Troubleshooting Guide (page 99).

A Drive ID that is flashing alone (no alarm code) indicates two ServoWire Drives with duplicate axis IDs on the same Orion Controller. The duplicate axis ID may belong to a pacer axis (ID = one less than the displayed Drive ID).

With one exception (alarm ***F2***, Auxiliary Encoder Open Wire), all drive alarms cause torque to be disabled at the motor.

Drive alarms ***90 – 99*** and ***9A-9F*** may require cycling control power to clear the alarm. All other alarms can be cleared by setting ALARM@=0 (after the cause of the alarm has been cleared).

Alarm Code[1]	alarm@	Condition	Description
90-99 9A-9F	144-159	Internal Drive Error	Should be reported to Ormec Customer Service Internal error ***98*** indicates that the manufacturing calibration of the drive has not been done.
A0	160	Drive RMS Over Current	The actual RMS current has exceeded the drive's rated continuous current longer than the allowed time (2 seconds at peak current).
 ***A1***	161	Peak Over Current	The peak current rating for the drive or motor was exceeded. The motor's peak current rating is a MotionDesk setting.
A2	162	Power Module Fault	The Power Module's self-protection has detected a short circuit, over current, over temperature or control supply under voltage.
A3	163	Low Bus Voltage	The bus voltage is below 90 VDC (usually due to disabled main power).
 ***A4***	164	High Bus Voltage	The bus voltage is excessive. The trip point depends on the rated voltage of the motor, a MotionDesk software setting: • Motor rated for 115 VAC: trip point = 237 VDC • Motor rated for 230 VAC or above: trip point = 425 VDC
 ***A5***	165	Drive/Project Mismatch	MotionBASIC detected that the drive hardware does not match MotionDesk project settings. Either: • The size of the drive (current rating) doesn't match the drive selected in the MotionDesk project settings. – or – • The drive does not have the auxiliary encoder option (/P), but the MotionDesk project has an axis defined for it. – or – • The drive does not have the absolute encoder option (/A), but the MotionDesk project expects it.
A6	166	Drive Not Configured	An attempt was made to enable torque before the drive's setup parameters have been configured (MP.CONFIG must be run each time the drive's control power cycles on).
A7	167	Illegal While Drive Enabled	An attempt was made to configure a drive parameter while the drive was enabled.
A8	168	Invalid Commutation Position	An invalid commutation position was detected, possibly due to a discharged absolute encoder (see ServoWire Drive Troubleshooting Guide, Alarm Code ***A8***), or an encoder failure.
A9	169	Phase Loss	MotionBASIC detected the loss of a main power phase or a soft-start error.
AA	170	No Bus Voltage	No bus voltage was detected.
AB	171	Soft Start Error	An overtemperature condition was detected in the drive powerblock, or a failure of the inrush current resistor.
E0	224	ServoWire Protocol Incompatibility	The ServoWire communications protocol in the drive is not compatible with the one in MotionBASIC.
E1	225	ServoWire Timeout	Isochronous communications (i.e. torque commands) from the ServoWire Axis Module were lost (The ServoWire dot will indicate if communications has been re-established).

[1] *Also see Section 7.1, ServoWire Drive Troubleshooting*

Table 15, *ServoWire Drive Alarm Codes (continued on next page)*

Alarm Code[1]	alarm@	Condition	Description
F0	240	Motor RMS Over Current	The motor's rating for continuous current has been exceeded by the actual RMS current for longer than allowed by the thermal time constant of the motor. (MotionDesk software setting)
F1	241	Motor Encoder Open Wire	At least one motor encoder feedback channel (ENCA, ENCA', ENCB, ENCB') is not connected properly. (J3 pins 1,2,3,4)
F2	242	Auxiliary Encoder Open Wire	At least one channel (AUXENCA, AUX ENCA', AUXENCB, AUXENCB') is not connected properly. (J4 pins 1,2,3,4)
F3	243	Invalid Hall State	The hall track feedback from the motor is improperly wired. This fault can also occur if the feedback type in MotionDesk has been improperly identified.
F4	244	Motor Over Temperature	Open contact at J3 pins 19-20. See Section 4.7, page 53.

[1] *Also see Section 7.1, ServoWire Drive Troubleshooting*

Table 15*, ServoWire Drive Alarm Codes (continued from previous page)*

4.3 ServoWire Drive Commutation Modes

By default, ServoWire Drives are configured to control permanent magent brushless DC servomotors using sine-wave commutation. The Drive can be configured for trapezoidal commutation using the TRAP.MODE@ MotionBASIC variable (TRAP.MODE@ =TRUE). This can be useful when integrating third-party motors or when controlling motors other an DC brushless servomotors.

4.4 Commutation Feedback Signals

Commutation position signals are illustrated in **Figure 15**.

The U, V and W signals are "on" for 180^o spaced 120^o apart and allow the Drive to determine motor position for commanding current. These signals are used to determine rotor position whenever the Drive is operating in trapezoidal commutation mode.

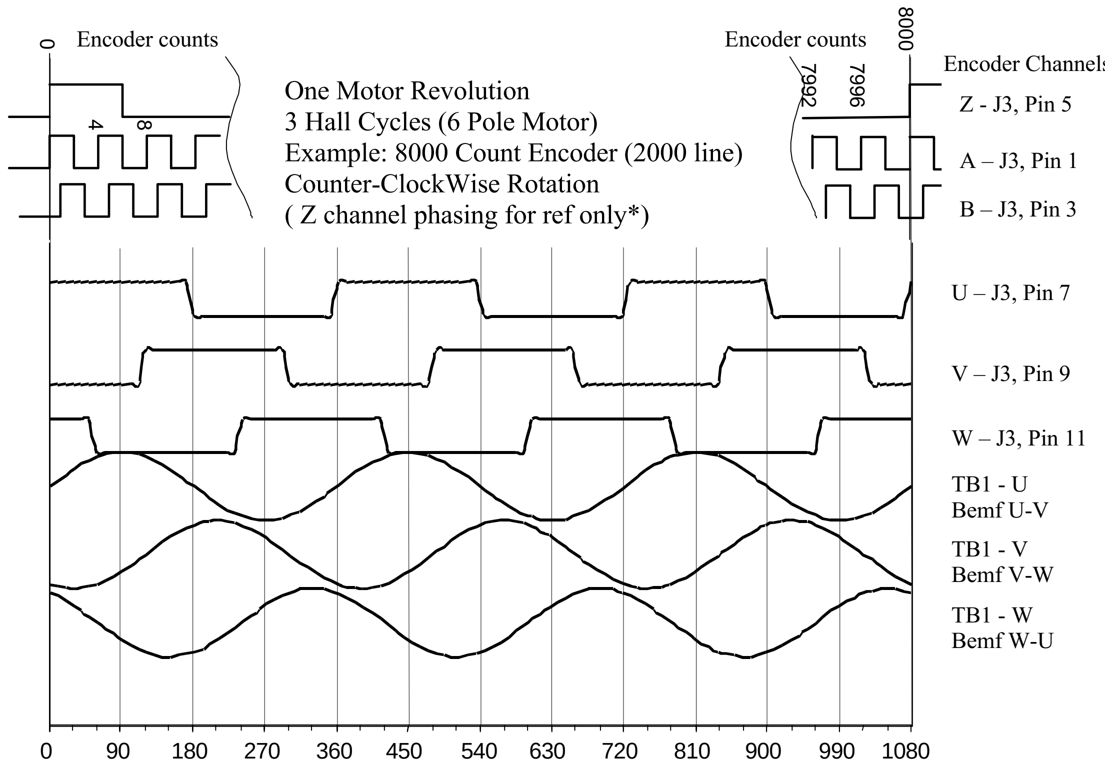


Figure 15*, Hall signals and Motor Back EMF waveforms*

If the the motor's back emf and commutation signals are not directly in phase, the Hall Offset parameter in MotionDesk can be used to compensate for the offset.

The state of the commutation signals can be displayed using the HALL@ MotionBASIC variable and **Table 16**. To verify that the commutation feedback is correct, REPEAT PRINT HALL@(*{axis~}*), rotate the motor shaft clockwise or counter-clockwise and confirm that the HALL@ value proceeds through the sequence indicated in **Table 16**. Refer to the MotionBASIC Help HALL@ variable section for further details.

Counter-Clockwise Rotation		Clockwise Rotation	
W, V, U	**HALL@**	**W, V, U**	**HALL@**
101	5	100	4
001	1	110	6
011	3	010	2
010	2	011	3
110	6	001	1
100	4	101	5
Note: Clockwise and Counter-Clockwise shaft rotation refers to rotation when viewing the end of the motor shaft			

***Table 16**, HALL@ Sequence*

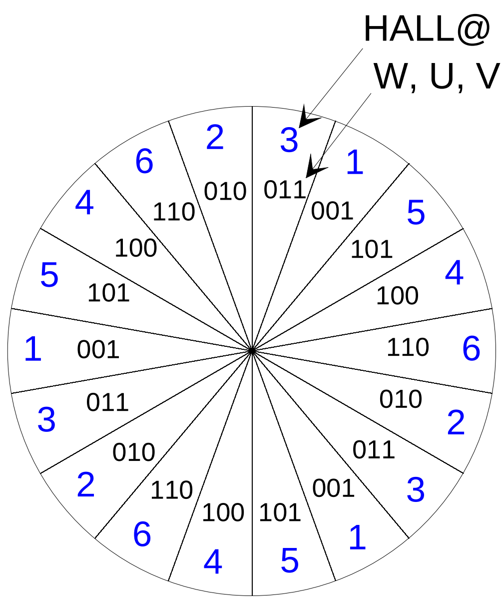


***Figure 16**, Valid Hall States (6 Pole Motor Example diagram)*

4.5 Quadrature Feedback Signals

Quadrature position signals for "Forward" and "Reverse" travel are illustrated in **Figure 17**.

Channel A and Channel B are phase quadrature signals, which allow the Servodrive and associated digital positioning electronics to determine both travel distance and direction. Programmable motion controllers, such as ORMEC's, typically decode each transition of both encoder channels, yielding a resolution of four times the linecount specification per revolution e.g. A position encoder with 4096 linecount, when decoded by an ORMEC Controller yields a positioning resolution of 16,384 cts/rev.

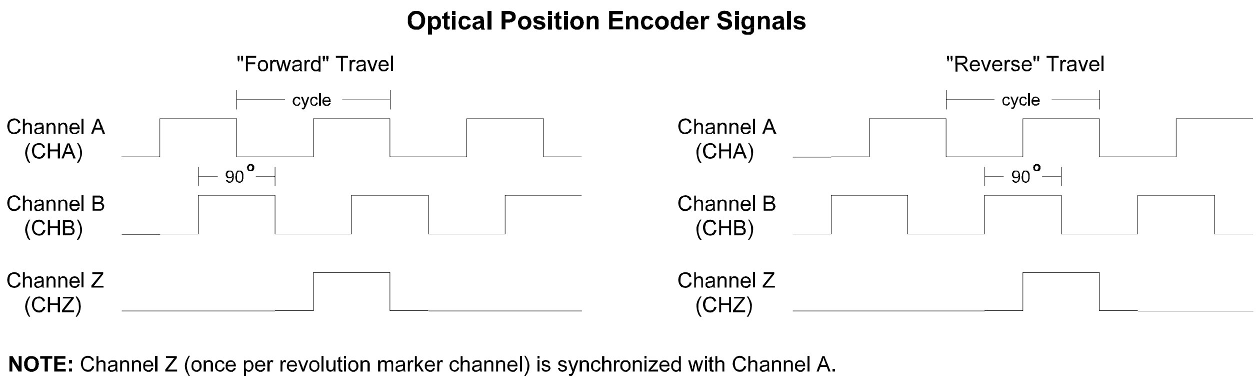


Figure 17*, Quadrature Encoder Channel Description*

4.6 Regenerative Loads

Regenerative loading occurs when the direction of power flow is from the machine to the motor: the motor is acting as a generator. Another way of describing this is that the load torque is acting in a direction to 'help' the motor to move in the commanded direction of motion. This can occur for a variety of reasons including:

1) Decelerating the machine faster than it would coast, especially from high speeds and with large inertial loads;
2) Using the motor to act as a brake on an unwind stand for a roll of material, where the tension in the web causes the motor to brake while moving forward; and
3) Using the motor to lower a vertical load that is not counterbalanced.

In many cases, this extra energy is dissipated by machine friction, or stored temporarily in the drive's power capacitors. However, if the amount of regenerative energy is excessive, it must be shunted to an external regenerative resistor, in order to prevent a high bus voltage condition. For assistance determining if your application has a regenerative load component, contact your ORMEC Sales and Applications Engineer.

4.6.1 Shunt Regulator

ServoWire Drive models SAC-SW210, SAC-SW217, SAC-SW220, SAC-SW225, SAC-SW235 and SAC-SW260 have shunt regulator circuitry for dissipating excessive regenerative voltage.

The shunt regulator consists of a voltage comparator and a switching transistor. When the voltage comparator detects excess bus voltage, it turns on the shunt regulator transistor, dissipating energy from the servodrive capacitors to the external regen resistor. The on-time duty cycle is controlled by the ServoWire Drive, so that the average current is appropriate for the regen resistor specified in the MotionDesk project software setting.

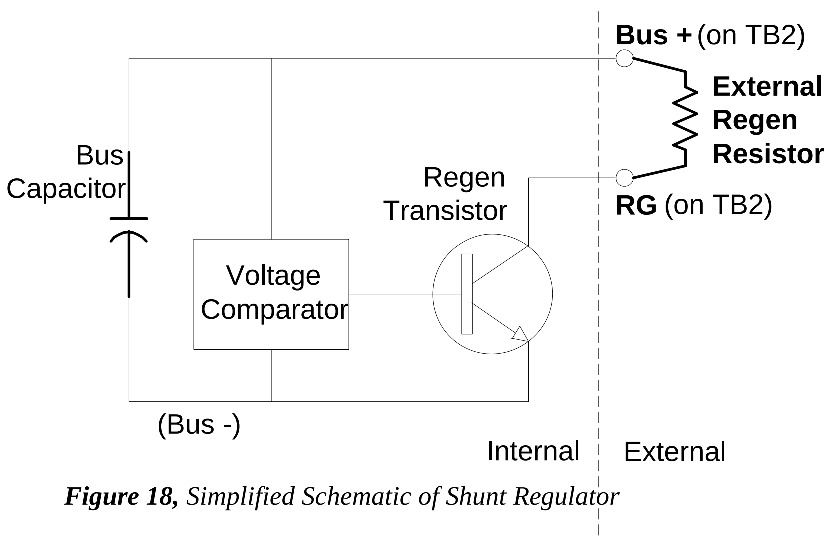


Figure 18, *Simplified Schematic of Shunt Regulator*

4.6.2 Sizing a Regen Resistor: Application-specific Formulas

Regardless of the type of application, the value of interest is **Average Regenerative Power**.

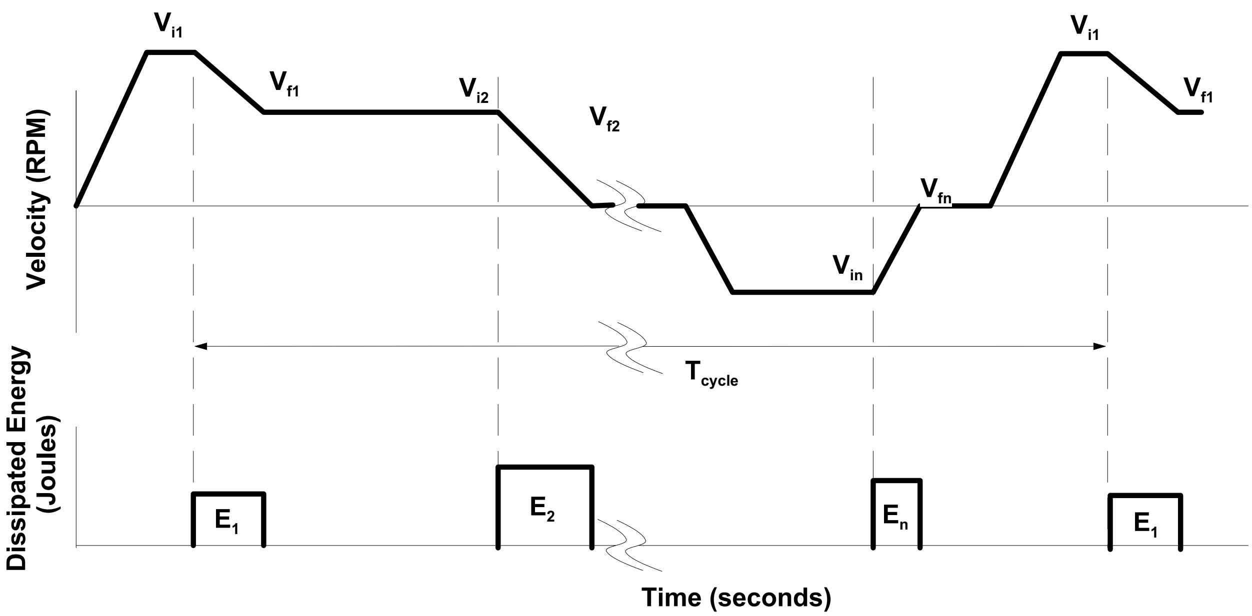


***Figure 19**, Regeneration During Deceleration*

4.6.2.1 Sizing a Regen Resistor: Regeneration Due To Decleration

Regeneration during a motor's deceleration is due to the decreasing kinetic energy of the rotating inertia. Not all of this energy will make it back to the DC bus; some or all of it may be absorbed by machine friction and motor losses. In the case of sizing regen resistors, neglecting frictional losses is a conservative approach to sizing a regen resistor.

Each deceleration in a cycle results in a loss of kinetic energy at the motor. Depending on frictional losses, some or all of this energy may make it back to the drive as **Regenerative Energy**. Rotational kinetic energy at any velocity can be calculated with the general equation $E = \frac{1}{2} I\omega^2$. Applying the appropriate units conversions:

$$E_{regen} = \tfrac{1}{2} I \cdot (V_i^{\,2} - V_f^2) \cdot (0.00124) \qquad \textit{(Equation 1)}$$

where: E_{regen} is the loss of kinetic energy during a deceleration (Joules)
I is the total system inertia (motor + load) (in-lb-sec^2)
V_i is the initial speed of the motor before deceleration (RPM)
V_f is the final speed of the motor after deceleration (RPM)
(0.00124) is a units conversion: $\frac{(2\pi rad/rev)^2 \cdot (4.448 N/lb)(25.4 mm/in)}{(60 sec/min)^2 (1000 mm/m)}$

Average Regenerative Power for the total cycle can be calculated as:

$$P_{avg} = \frac{E_1 + E_2 + \cdots + E_n}{T_{cycle}} \qquad \textit{(Equation 2)}$$

where P_{avg} is the average dissipated power over the entire cycle (Watts)
E_1 is the energy dissipated by the 1st decel in the cycle (Joules)
E_2 is the energy dissipated by the 2nd decel in the cycle (Joules) …

E_n is the energy dissipated by the Nth decel in the cycle (Joules)
N is the number of decelerations in the cycle
T_{cycle} is the total repetitive cycle time (seconds)

4.6.2.2 Sizing a Regen Resistor: Regeneration Due To Web Tension (motor acting as brake)

The regeneration in a tensioned-web application is due to the web tension pulling the braking motor along in the same direction that it is moving.

Average Regenerative Power is calculated with the general formula: $P = T\omega$. Applying the appropriate units conversions:

$$P_{avg} = (0.0118) * T \cdot V \qquad \textit{(Equation 3)}$$

where P_{avg} is the continuous regenerated power (Watts)
T is the torque at the motor due to web tension (in-lb)
V is the velocity of the motor shaft (RPM)
(0.0118) is a conversion: $\frac{(2\pi rad/rev)(25.4mm/in)(4.448N/lb)}{(60\,sec/min)(1000mm/m)}$

4.6.2.3 Sizing a Regen Resistor: Regeneration Due to Vertical Load

In an application where the motor is supporting the weight of an uncounterbalanced load, regeneration may occur when the load is being lowered. This is due to gravity 'helping' the motor lower the load.

Instantaneous Regenerative Power can be calculated with the formula $P = T\omega$. Applying the appropriate units conversions:

$P_{instant} = (0.0118) * T * V$ *(Equation 4)*

where $P_{instant}$ is the instantaneous regenerated power (Watts)
T is the torque at the motor due to load weight (in-lb)
V is the speed of the motor during downward motion (RPM)
(0.0118) is a conversion: $\frac{(2\pi rad/rev)(25.4mm/in)(4.448N/lb)}{(60\,sec/min)(1000mm/m)}$

Average Regenerative Power for the total cycle can be calculated as:

$$P_{avg} = \frac{P_1 \cdot T_1 + P_2 \cdot T_2 + \cdots + P_n \cdot T_n}{T_{cycle}} \qquad \textit{(Equation 5)}$$

where P_{avg} is the average dissipated power over the entire cycle (Watts)
P_1 is the power dissipated by the cycle's 1st downward move (Joules)
T_1 is the time spent in the cycle's 1^{st} downward move (seconds)

P_2 is the power dissipated by the cycle's 2nd downward move (Joules)
T_2 is the time spent in the cycle's 2^{nd} downward move (seconds)
…
P_n is the energy dissipated by the cycle's Nth downward move(Joules)
T_n is the time spent in the cycles Nth downward move (seconds)
N is the total number of downward moves in the cycle
T_{cycle} is the total repetitive cycle time (seconds)

4.6.3 Sizing a Regen Resistor: Use Average Regenerative Power

Once Average Regenerative Power has been determined using one of the methods in section 4.6.2, the sizing of the resistor is nearly complete.

The wattage of the regenerative resistor should be greater than or equal to the application's calculated Average Regenerative Power.

The next section shows the minimum resistance requirements, as well additional limitations on the regen power that can be shunted, based on the ServoWire Drive's shunt transistor.

4.6.4 Sizing a Regen Resistor: Regen Transistor and Resistor Limitations

The amount of energy that can be dissipated by an external regen resistor may be limited by the current capability of the switching transistor.

Table 17 below shows the rated maximum continuous current of the ServoWire Drive's regen transistor circuitry, as well as the minimum resistance for any external regen resistor.

NOTE: **Do not use a lower resistance than shown in the table below! Too low a resistance may result in peak currents that are too high for the regen transistor, and could result in damage to the transistor.**

		Regen Transistor		
ServoWire Drive	**Regen Resistor**[1]	Peak Current[2]	Maximum Continuous Current	Bus Capacitance
SAC-SW203 SAC-SW205	Regen Transistor not available.			540 µF
SAC-SW210	50 Ω	8.5 A	3.75 A	1,170 µF
SAC-SW217 SAC-SW220	35 Ω	12 A	5 A	1,410 µF
SAC-SW225	7.8 Ω	50 A	27 A	3,360 µF
SAC-SW235	7.8 Ω	50 A	30 A	3,360 µF
SAC-SW260	5.0 Ω	75 A	41 A	3,360 µF

1 Minimum resistance.

2 Calculated using minimum resistance.

Table 17*, Regen Resistor Selection Requirements*

The amount of energy that can be dissipated by a regen resistor may also be limited by the resistors own current and power ratings. The peak current that will be seen by the resistor is shown in **Table 18**. This current is limited by the regen resistor's resistance value, so if a higher resistance is used, the peak current will be lower.

The average current that will be seen by the resistor is limited by the ServoWire Drive using an on-off duty cycle. This limits the average current so that neither the wattage of the resistor (a MotionDesk software setting) nor the continuous current of the regen transistor is exceeded on a continuous basis.

Regen Resistor	Resistance	Wattage	Peak Current
SAC-SWRR/0055	50 Ω	55 W	8.5 A
SAC-SWRR/0095	40 Ω	95 W	11 A
SAC-SWRR/0700	54 Ω	700 W	7.9 A
SAC-SWRR/0845	40 Ω	845 W	11 A
SAC-SWRR/0846	10 Ω	846 W	43 A
SAC-SWRR/1700	6.5 Ω	1,700 W	65 A

***Table 18**, Standard Regen Resistor Specifications*

The voltage seen by the resistor will range between the Turn-On level and the High-Bus level, as shown below in **Table 19**.

Nominal Input Voltage (VAC)	Nominal Bus Voltage (VDC)	Turn On Regen Transistor (VDC)	High Bus Voltage Alarm (VDC)
230	325	395	425

***Table 19**, Regen Transistor Turn-On and other Bus Voltage Levels*

4.6.5 Bus Sharing

The extra energy generated by regenerative loads can also be dissipated through bus sharing. In a shared-bus configuration, the bus capacitors are all connected in parallel, magnifying the total bus capacitance by the number of drives present (see **Figure 20**). Also, the regenerative energy generated by one drive can be used to reduce the input power requirements of any other active drives on the shared bus. However, if the amount of regenerative energy available is excessive, it must be still be shunted to an external regenerative resistor, in order to prevent a high bus voltage condition. For assistance in determining how to use bus sharing in your application, contact your ORMEC Sales and Applications Engineer.

4.6.5.1 Bus Sharing Limitations

Bus sharing is supported by ServoWire Drive models ***SAC-SW225, SAC-SW235, and SAC-SW260 only***, and is subject to the following restrictions:

Drives that are sharing the DC bus must also be connected to a main input power source and a control input power source.

Main input power should be applied to all shared-bus drives within 0.1 seconds to prevent possible damage to internal drive control circuits.

Bus wiring between drives should be less than 12 inches in length to minimize oscillatory effects.

Only one regen resistor may be used in a bus sharing network. That regen resistor must be sized to handle the regenerative power produced by all of the drives in a shared bus configuration. See Section 4.6, Regenerative Loads for more information on sizing regen resistors.

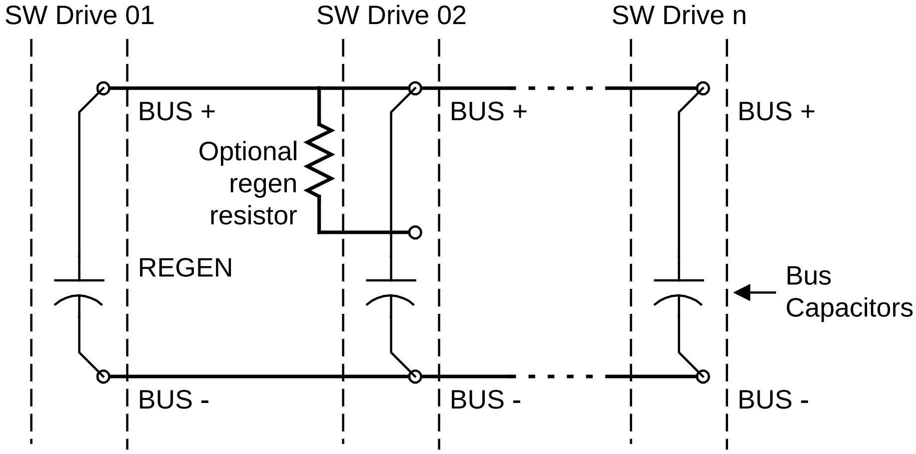


Figure 20*, Shared Bus Capacitors*

4.6.6 Shunt Regulator Overload

If regenerated voltage is excessive, a High Bus Voltage fault (***A4***) may occur. A High Bus Voltage fault will not reset until the voltage level has dropped to an acceptable level. This will occur faster if you disable main power.

If High Bus Voltage faults recur, one of the following actions may resolve the problem:

- Increase the wattage of the external regenerative discharge resistor.
  For this change to be effective, you must also change the MotionDesk software settings for the ServoWire Drive:
  Regen Resistor Power.
- Reduce the commanded current limit for the Controller.
- Reduce the commanded deceleration.
- Decrease the maximum motor speed.
- Reduce the inertial load seen by the motor, either by removing part of the load, or by increasing the gear ratio (motor-to-load).

4.7 Servomotor Temperature Protection

The thermostat contact wiring is part of the Motor Feedback Cable (J3 connector on the ServoWire Drive). When the thermal contact opens, the behavior of the ServoWire drive will depend on the ServoWire Drive's software configuration in MotionDesk:

MotionDesk Configurations		
Thermal Switch Exists on Motor	**Motor OverTemp Handling**	**Behavior of ServoWire Drive**
No		A closed contact will cause MotionBASIC Configuration Error 1629. The red HITEMP LED will be lit.
Yes	Ignore	An open contact will not cause any error or alarm. The red HITEMP LED will be lit. The status of the thermal contact can be monitored with MotionBASIC variable OVER.TEMP@.
Yes	Generate Motion Error	An open contact will cause MotionBASIC Error 1628. No drive alarm will occur. It is up to the application's error handler to respond to the over temperature condition. The red HITEMP LED will also be lit. The status of the thermal contact can be monitored with MotionBASIC variable OVER.TEMP@.
Yes	Generate Drive Alarm	An open contact will cause the red HITEMP LED to be lit. If the drive torque is enabled, a drive alarm ***F4*** will immediately disable torque to the motor. The status of the thermal contact can be monitored with MotionBASIC variable OVER.TEMP@.

Table 20, *Motor Over-Temperature Input (HITEMP – J3 pins 19-20)*

G-Series Servomotors have embedded thermostats, which open when the motor winding temperature exceeds 155ºC.

DE/DA/DB-Series Servomotors do not have embedded thermostats.

4.8 ServoWire Loop Update Rate

One of the big benefits of a ServoWire system is the ability to trade off axis count per Axis Module (price) against loop update rate (performance), allowing users to select the price-performance configuration which is right for them. Users requiring high performance can configure their systems with fewer axes per Axis Module and a higher loop update rate. Conversely, Users with lower performance requirements can configure their systems with more axes per Axis Module and a lower loop update rate.

The sustainable loop update rate (LOOP.RATE@) for the axes on a ServoWire Axis Module is determined by the number of axes (both motors and pacer encoders) connected to that Axis Module and the motion calculation requirements for those axes. Motion calculations include trajectory calculations, loop closure, modulo position functionality, programmable limit switch output control, etc. The more motion features (calculations) used by an axis, the greater burden this puts on the Axis Module DSP and lower the sustainable loop rate. Also, the more axes connected to an Axis Module, the more repetitions of the motion calculations must be made each loop update and the lower the sustainable loop rate. The overall system loop rate in a ServoWire system is determined by the ServoWire Axis Module (ORN-SW-AM/_) with the lowest loop rate. For this reason, balancing the axis count and motion calculation requirements between the ServoWire Axis Modules in a system has a direct impact on the overall system loop rate.

Table 21 indicates the range of loop rates which can be expected for a ServoWire Axis Module (ORN-SW-AM) connected to the corresponding number of axes and for an analog ORION DSP Axis Module (ORN-DSP-A_). The "No Features" numbers reflect the sustainable loop update rate performing the minimum calculations required for time based motion. The "All Features" number reflects the sustainable loop update rate performing a combination of the most calculation intensive motions and features. These numbers were determined based on having at least 10% loop update free-time as a margin of safety, so we believe that they are conservative. The range has been presented because it is likely that an actual system will be operating at some point in between the two extremes, which is application dependent.

Various commands impact the maximum loop rate differently. The following is a list of axis and motion related commands/variables and their in order of their relative impact on loop rate.

Most negative impact on loop rate

- Enabling Programmable Limit Switches (PLS's)
- MOVE FOR, GEAR FOR, GEAR AT, HALT, CAM, PROFILE, DSP Counter functions and Alarms
- Clearing sensors, reading POS.xSEN@, Software Travel Limits (STL's)
- MOVE AT, DSP variable reading/writing (POS.ACT@, POS.CMD@, etc.), MP.CONFIG, MODE@

Least negative impact on loop rate.

Loop rates for 10% min free loop time	ServoWire Axes							Analog Axes
	8	**7**	**6**	**5**	**4**	**3**	**2**	**2**
All Features	1400	1500	1700	2100	2600	3500	4800	4900
No Features	1700	2000	2200	2700	3300	4300	5000	5000

***Table 21**, ServoWire Loop Update Rates*

Chapter 5
Getting Started

5 Getting Started

5.1 Test Run

Before doing a test run, check the following points listed in this section. Correct any problems before proceeding.

5.1.1 Servomotor Check

Before test run, check the following.

- Motor mounting and grounding are correct.
- Bolts and nuts are tight.
- For motors with oil seals (IP67), the seals are not damaged and are properly lubricated.
- Motor Power and Feedback Cables are properly attached.

5.1.2 ServoWire Drive Check

- The control and main power voltage should be 115 (+15%, -20%) or 230 (+15%, -20%) VAC, 50/60 Hz. **The absolute maximum is 265 VAC.**
- The main power voltage depends on the servomotor: **MAC-G005A1, G006A1, G010A1, G010B1, G011A1, G015A1, DE003A1, DE-006B1 and DE008C1 servomotors are rated for 115 VAC – not 230 VAC.**
- **CHECK POWER BEFORE APPLYING IT TO THE SERVODRIVE.**
- Check that feedback connector(s) J3 (and J4 if used) is/are firmly seated.
- Check that Power terminal block connections (r,t,L1,L2,L3, ⏚, BUS+,RG,BUS-,U,V,W, and ⏚) are tight.
- Motor wiring is correct.
- The main power interlock circuit disables main power under a ServoWire drive alarm condition.

5.1.3 Preparation for Test Run

During test run, the driven machine should not be attached to the Servomotor. If it is necessary to start with the driven machine connected to the motor, proceed with great care.

- After checking items above, turn on the control power.
- Enable the main power circuit and measure main DC Bus voltage.
- The front of the ServoWire Drive provides several status indications, described in Section 4.2, ServoWire Drive Status Indications (page 38).

Chapter 6
Specifications

6 Specifications

Ormec products covered by this manual:

ServoWire Drives				
SAC-SW203	SAC-SW205	SAC-SW210	SAC-SW217	SAC-SW220
SAC-SW225	SAC-SW235	SAC-SW260		

G-Series Servomotors	**DE/DA/DB-Series Servomotors**
MAC-G005A1	DE003A1, DE003A2
MAC-G006A1, G006A2	DE006B1, DE006B2
MAC-G010A1, G010B1	DE008C1
MAC-G011A1, G011A2, G011B2	DE011C2
MAC-G015A1, G015A2, G015B2	DE021D2
MAC-G016A2, G016B2	DE042E2
MAC-G019A1, G019A2, G019B2	DA030F
MAC-G030A2, G030B2	DA055G
MAC-G040A2, G040B2	DA090H
MAC-G055A2, G055A4	DA110J
MAC-G080A2, G080A4	DA140K
MAC-G115A2, G115A4	DB025L
MAC-G130A2, G130A4	DB055M
MAC-G210A2, G210A4	DB080N
MAC-G280A2, G280A4	DB100P
MAC-G360A2, G360A4	DB200Q
MAC-G640A2	DB300R
	DB330S
	DB465T
	DB700U

6.1 ServoWire Drive Specifications

6.1.1 ServoWire Drive Environmental Specifications

Operating Temperature:	0 to +50°C
Storage Temperature:	-20 to +70 °C
Operating and Storage Humidity	10 to 90%, non-condensing

***Table 22**, ServoWire Drive Environmental Specifications*

6.1.2 ServoWire Drive Mechanical Specifications

Mounting Method: Also see outline drawings in **Figure 1** (page 9).	Vertical panel mounting, three 10-32 (M5) screws.			
Dimensions:				
SAC-SW203, SAC-SW205 and SAC-SW210				
Height: add 2” (51 mm) clearance top and bottom	9.38	inches	(238	mm)
Width: add 1” (25 mm) clearance each side	3.04	inches	(76	mm)
Depth: includes clearance for attached cables	10.5	inches	(267	mm)
Weight: SAC-SW203 & SAC-SW205	3.8	lbs	(1.7	kg)
SAC-SW210	4.2	lbs	(1.9	kg)
SAC-SW217				
Height: add 2” (51 mm) clearance top and bottom	9.38	inches	(238	mm)
Width: add 1.2” (31 mm) clearance each side	4.25	inches	(97	mm)
Depth: includes clearance for attached cables	10.5	inches	(267	mm)
Weight:	5.9	lbs	(2.7	kg)
SAC-SW220				
Height: add 2” (51 mm) clearance top and bottom	9.38	inches	(238	mm)
Width: add 1” left-side, 2” (51 mm) right-side clearance	4.4	inches	(112	mm)
Depth: includes allowance for attached cables	10.5	inches	(267	mm)
Weight:	6.7	lbs	(3.1	kg)
SAC-SW225, SAC-SW235 and SAC-SW260				
Height: add 2” (51 mm) top, 4” (102 mm) bottom clearance	12.00	inches	(305	mm)
Width: add 1” (25 mm) clearance each side	7.35	inches	(187	mm)
Depth: includes allowance for attached cables	11.1	inches	(282	mm)
Weight:	17.8	lbs	(8.1	kg)

***Table 23**, ServoWire Drive Mechanical Specifications*

6.1.3 ServoWire Drives General Electrical Specifications

Incoming Main Power Line Voltage - **TB2** pins **L1, L2, L3**	
WARNING: Use the servomotor's voltage rating to determine the maximum input voltage for the servodrive. MAC-G005A1, MAC-G006A1, MAC-G010A1, MAC-DE003A1, MAC-DE006B1, and MAC-DE008C1 are rated for 115 VAC, not 230 VAC!	
SAC-SW203, SAC-SW205:	Single Phase, 50/60 Hz 115 (+15%, -20%) or 230 (+15%, -20%) VAC
SAC-SW210, SAC-SW217, SAC-SW220, SAC-SW235, SAC-SW260:	Three Phase, 50/60 Hz 115 (+15%, -20%) or 230 (+15%, -20%) VAC
Incoming Control Power Line Voltage - **TB2** pins **r, t**	Single Phase, 50/60 Hz 115 (-20%) to 230 (+15%) VAC
Main DC Bus Voltage **– TB2** pins **BUS+, BUS-**	
115 VAC nominal input power:	163 VDC nominal level
230 VAC nominal input power:	325 VDC nominal level
Shunt Regulator Activation DC Bus Voltage:	
115 VAC motors:	207 VDC
230 VAC motors:	395 VDC
High Bus Voltage Fault Activation DC Bus Voltage:	
115 VAC motors:	237 VDC
230 VAC motors:	425 VDC
Low Bus Voltage Fault Activation DC Bus Voltage:	
115 VAC nominal input power:	94 VDC
230 VAC nominal input power:	205 VDC

Table 24*, ServoWire Drive General Electrical Specifications*

6.1.4 ServoWire Drive Output (**TB2** pins **U, V, W**) Specifications

	Single Phase 115 VAC Input			Single Phase 230 VAC Input		
Drive Model	**Rated Output Power** (KVA)	**Cont Current** (Amps RMS/∅)	**Peak Current 2 sec** (Amps RMS/∅)	**Rated Output Power** (KVA)	**Cont Current** (Amps RMS/∅)	**Peak Current 2 sec** (Amps RMS/∅)
SAC-SW203	0.29	2.5	4.4	0.59	2.5	4.2
SAC-SW205	0.49	4.2	7.4	0.98	4.1	7.1
SAC-SW210	0.58	5.1	8.8	1.17	4.9	8.5
SAC-SW217	0.98	8.6	14.8	1.97	8.2	14.3
SAC-SW220	1.09	9.5	16.5	2.19	9.1	15.8
SAC-SW225 **SAC-SW235** **SAC-SW260**	Not Available			Not Available		

Table 25, *ServoWire Drive Output (**TB2** pins **U, V, W**) Specifications for Single Phase Input Power*

	Three Phase 230 VAC Input		
Drive Model	**Rated Output Power** (KVA)	**Cont Current** (Amps RMS/∅)	**Peak Current 2 sec** (Amps RMS/∅)
SAC-SW203	Not Available		
SAC-SW205			
SAC-SW210	1.95	8.2	14.2
SAC-SW217	3.32	13.9	24.1
SAC-SW220	3.91	16.3	28.3
SAC-SW225	5.98	25.0	50.0
SAC-SW235	8.37	35.0	70.0
SAC-SW260	15	60.0	120.0

Table 26, *ServoWire Drive Output (**TB2** pins, **U ,V, W**) Specifications for Three Phase Input Power*

6.1.5 ServoWire Drive I/O Specification (TB1a & TB1b)

V+S, V-S **TB1a pins V+, V-**	**I/O Power Supply**
Externally supplied voltage used by: - High speed Sensor Inputs ASEN, BSEN, CSEN - Travel Limit Inputs HTLF', HTLR', - Discrete Outputs ENCZ', DELAY', OUT1'-OUT6'	
Max voltage between V+S and V-S	±27 VDC maximum

ASEN, BSEN, CSEN **TB1a pins AS, BS, CS**	**High Speed Sensor Inputs**
Input Current depends on software configuration:	
NPN-type sensor with 2.38K pull-up resistor selected in drive: NPN-type sensor with 20K pull-up resistor selected in drive: PNP-type sensor: current depends on pulldown resistance in sensor (or external pull-down)	10 mA @ 24 VDC 1.2 mA @ 24 VDC
Max. voltage	V+S
Minimum acceptance time	1 microsecond
Turn-on voltage V_{IN} > 0.5 * (V+S) + 0.4 VDC V_{IN} < 0.5 * (V+S) + 0.1 VDC	Receiver Output High Low

HTLR', HTLF' **TB1a pins LR,LF**	**Optically-coupled Digital Inputs**
Should be normally sinking current to prevent an overtravel limit condition.	
Current to turn on	0.7 mA minimum 7.0 mA maximum
Voltage max.	5V + V+S maximum

DELAY' **TB1a pin DL**	**Optically-coupled Digital Output**
max. sink current	40 mA
low level voltage high level voltage	0.4 VDC max (I_{OL} = 16 mA) 0.7 VDC max (I_{OL} = 40 mA) V+S VDC
absolute maximum	30 VDC

***Table 27**, ServoWire Drive I/O Specifications (TB1a & TB1b) (continued on next page)*

ZOUT', OUT1'-OUT6' **(pins Z, O1-O6**	**Optically-coupled Digital Outputs**
max. sink current	33 mA
low level voltage high level voltage	0.7 VDC maximum (Ic = 33 mA) V+S - 0.5 VDC
absolute maximum	27 VDC

AOUT1, AOUT2 & AGND **(pins A1, A2 & ⏚)**	**Analog Outputs & Analog Ground**
Voltage output range	+/- 10 VDC
Current Output	5 mA maximum
Load Resistance	2K ohms minimum
AOUT1: Torque Monitor Scaling: 3 VDC = Rated Torque (Rated Torque value depends on MotionDesk software settings for motor & drive rated current). AOUT2: Velocity Monitor Scaling depends on MtrSpdLim (MotionDesk software setting): 1999 rpm or below: 5 VDC = 1000 rpm 2000 rpm to 4999 rpm: 2 VDC = 1000 rpm 5000 rpm or above: 1 VDC = 1000 rpm	

Table 27*, ServoWire Drive I/O Specifications (TB1a & TB1b) (continued from previous page)*

6.1.6 ServoWire Drive Motor Encoder Interface Specifications

ENCA, ENCA', ENCB, ENCB' **(pins 1, 2, 3, 4)**	**Differntial Digital Inputs** **Appendix B-1, B-3**
Common Mode Input	-15 VDC to +15 VDC max.
Absolute Max. Input Voltage	+/-25 VDC
Maximum Encoder Counts per Electrical Cycle	32,768 (after 4x decode)
Maximum Encoder Data Rate:	2 MHz
Quadrature Specification	90^{o} +/-45^{o}
Differential Turn On Voltage $V_{ID} > 0.7$ V $-0.7 \text{ V} > V_{ID} > 0.7$ V $V_{ID} < -0.7$ V *Where V_{ID} = (ENCx) – (ENCx')*	<u>Receiver Output</u> H ? L

ENCZ, ENCZ', U, U', V, V', W, W' (pins 5, 6, 7, 8, 9, 10 , 11, 12)		**Differential or Single-Ended Digital Input Appendix B-1, B-3**
Common Mode Input		-12 VDC to +12 VDC max.
Absolute Max. Input Voltage		+/-25 VDC
Differential Turn On Voltage $V_{ID} > 0.2$ V $-0.2 \text{ V} > V_{ID} > 0.2$ V $V_{ID} < -0.2$ V *Where V_{ID} = (ENCx) – (ENCx')*		Receiver Output H ? L

END PWR1, DGND (pins 13, 16, 17, 18, 24, 25)	**Encoder Power Supply Appendix B-1**
+5 VDC	5.3 VDC, +/-5% 450 mA max.

TEMP', TEMP RET (pins 19, 20)	**Optically-isolated Digital Input Appendix B-1, B-4**
Should be normally sinking current to prevent an overtemperature condition.	
Current to turn on	2.5 mA
Voltage max.	+12 VDC maximum

BAT+, BAT- (optional) (pins 22, 23)		**Abs. Edr. Backup Power Supply Appendix B-1, B-4**
Shelf Life		10 years
Working Life[4]		6 years
Capacity		525.6 mA hours
Output Voltage	3.0 to 3.1 VDC 2.75[5] VDC 2.5[3] VDC	when new with 10% of life-remaining with 1% of life-remaining
The absolute encoder battery is a lithium battery used to power optional absolute encoders on MAC-DA, MAC-DB and MAC-DE servomotors. This batter is only provided on ServoWire Drives with the absolute encoder option.		

[4] Refers to the amount of battery life based on having the ServoWire Drive control power turned off 24 hours per day, 365 days per year. The absolute encoder battery is not used when a ServoWire Drive has control power.

[5] This is below the minimum voltage required for the absolute encoder backup power (2.8 VDC).

ABS RESET (optional) (pin 14)	**Optically-coupled Digital Output Appendix B-1, B-4**
Max. Sink Current	15 mA
Absolute Maximum	30 VDC

***Table 28**, ServoWire Drive Motor Encoder Interface Specifications (J3)*

6.1.7 ServoWire Drive Connector Part Numbers

		Mating Connector[6]			**Drive Connector**
Label	**Signal**	**Description**	**Manufacturer & Part Number**	**Ormec P/N**	**Manufacturer & Part Number**
TB1a	Drive I/O	11 pos TB plug (left)	Phoenix 1792100[7]	CON651[7]	Phoenix 1762787 (receptacle for 2 plugs)
TB1b		11 pos TB plug (right)	Phoenix 1779505[7]	CON652[7]	
J3	Motor Feedback	25 pin male D-sub	Amp 207464-1 (conn.) Amp 745254-6 (pin) Amp 206478-3 (shell) Amp 90406-1 (tool)	CON638 CON640 CON641	Kycon Drive with /P option: K42-B25P/S-C4N (2 D-subs per conn.) Drive w/o /P option: K22L-B255N
J4[8]	Auxiliary Encoder	25 pin female D-sub	Amp 207463-1 (conn.) Amp 745253-6 (socket) Amp 206478-3 (shell) Amp 90406-1 (tool)	CON650 CON649 CON641	
J1/J2	ServoWire	6 pin IEEE 1394	Available only as integral part of IEEE1394 (ServoWire) cable		Molex 53462-0611

***Table 29**, ServoWire Drive Connector Part Numbers*

[6] The mating 11-position terminal block plugs for TB1a and TB1b are provided as part of the ServoWire Drive. The mating D-sub connectors for J3 and J4 are not provided as part of the ServoWire Drive.

[7] The Ormec part number is for a connector with 2-letter signal names printed on the connector. The Phoenix part number is for the standard unlabelled connector.

[8] There is no J4 connector unless the Auxiliary Encoder option (/P) has been purchased on the drive.

6.2 MAC-G Servo Motors

6.2.1 MAC-G Series Overview

Maximum Speeds:	600 to 7,000 RPM
Continuous stall torques:	5 to 640 lb-in
Peak Torques:	10 to 1,239 lb-in
Peak Acceleration:	up to 72,993 rad/sec^2
Rated Power:	0.20 to 13 HP
Position Encoder Resolution:	8,000 counts/rev after four times quadrature decode (up to 24,000 counts/rev optional)
Ambient Temperature:	0 - 40C
Enclosure Rating:	IP65 (Viton shaft seal standard)
Insulation:	Class F

Servomotor	Recommended Servodrive	Compatible Servodrives	
MAC-G005A1	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G006A1	**SAC-SW205**	SAC-SW210	
MAC-G006A2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G010A1	**SAC-SW205**	SAC-SW210	SAC-SW217
MAC-G010B1	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G011A1	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G011A2	**SAC-SW205**	SAC-SW210	
MAC-G011B2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G015A1	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G015A2	**SAC-SW205**	SAC-SW210	SAC-SW217
MAC-G015B2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G016A2	**SAC-SW205**	SAC-SW210	
MAC-G016B2	**SAC-SW203**	SAC-SW205	SAC-SW210

Table 30*, G-Series Servomotor and Servodrive Compatibility* *(continued on next page)*

Servomotor	Recommended Servodrive	Compatible Servodrives	
MAC-G019A1	**SAC-SW217**	SAC-SW220	
MAC-G019A2	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G019B2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G030A2	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G030B2	**SAC-SW205**	SAC-SW210	
MAC-G040A2	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G040B2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-G055A2	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G055A4	**SAC-SW205**	SAC-SW210	
MAC-G080A2	**SAC-SW217**	SAC-SW220	SAC-SW225
MAC-G080A4	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G115A2	**SAC-SW220**	SAC-SW225	SAC-SW235
MAC-G115A4	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G130A2	**SAC-SW217**	SAC-SW220	SAC-SW225
MAC-G130A4	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-G210A2	**SAC-SW220**	SAC-SW225	SAC-SW235
MAC-G210A4	**SAC-SW217**	SAC-SW220	SAC-SW225
MAC-G280A2	**SAC-SW235**	SAC-SW260	
MAC-G280A4	**SAC-SW225**	SAC-SW235	SAC-SW260
MAC-G360A2	**SAC-SW235**	SAC-SW260	
MAC-G360A4	**SAC-SW225**	SAC-SW235	
MAC-G640A2	**SAC-SW260**		

Table 30, *G-Series Servomotor and Servodrive Compatibility (continued from previous page)*

	Maximum Speed					
	Standard Position Encoder	Optional Position Encoders				
Servomotor	**8,000*** counts/rev	**6,000*** counts/rev	**8,192*** counts/rev	**12,000*** counts/rev	**16,384*** counts/rev	**24,000*** counts/rev
G005A1	**5,000**	5,000	5,000	4,000	N/A	2,000
G006A1	**6,000**	6,800	5,859	4,000		2,000
G006A2	**4,600**	4,600	4,600	4,000		2,000
G010A1	**5,500**	5,500	5,500	4,000		2,000
G010B1	**3,500**	3,500	3,500	3,500		2,000
G011A1	**6,000**	7,000	5,859	4,000		2,000
G011A2	**5,600**	5,600	5,600	4,000		2,000
G011B2	**3,800**	3,800	3,800	3,800		2,000
G015A1	**6,000**	6,300	5,859	4,000		2,000
G015A2	**5,600**	5,600	5,600	4,000		2,000
G015B2	**3,700**	3,700	3,700	3,700		2,000
G016A2	**5,000**	5,000	5,000	4,000		2,000
G016B2	**2,500**	2,500	2,500	2,500		2,000
G019A1	**5,625**	5,625	5,625	4,000		2,000
G019A2	**5,000**	5,000	5,000	4,000		2,000
G019B2	**3,700**	3,700	3,700	3,700		2,000
G030A2	**5,000**	5,000	5,000	4,000	2,929	2,000
G030B2	**2,600**	2,600	2,600	2,600	2,600	2,000
G040A2	**3,500**	3,500	3,500	3,500	2,929	2,000
G040B2	**1,700**	1,700	1,700	1,700	1,700	1,700
G055A2	**3,500**	3,500	3,500	3,500	2,929	2,000
G055A4	**3,700**	3,700	3,700	3,700	2,929	2,000

* Resolution after four times quadrature decode.

Table 31*, G-Series Servomotor Encoder Resolutions and Speeds* *(continued on next page)*

	Maximum Speed					
	Standard Position Encoder	Optional Position Encoders				
Servomotor	8,000* counts/rev	6,000* counts/rev	8,192* counts/rev	12,000* counts/rev	16,384* counts/rev	24,000* counts/rev
G080A2	**3,500**	3,500	N/A	3,500	2,929	2,000
G080A4	**3,700**	3,700		3,700	2,929	2,000
G115A2	**3,500**	3,500		3,500	2,929	2,000
G115A4	**3,700**	3,700		3,700	2,929	2,000
G130A2	**2,700**	N/A		2,700	2,700	2,000
G130A4	**3,500**			3,500	2,929	2,000
G210A2	**2,700**			2,700	N/A	2,000
G210A4	**3,500**			3,500		2,000
G210B4	**1,800**			1,800		1,800
G280A2	**2,700**			2,700		2,000
G280A4	**3,500**			3,500		2,000
G360A2	**2,000**			2,000		2,000
G360A4	**3,500**			3,500		2,000
G400B4	**1,300**			1,300		1,300
G640A2	**2,400**			2,400		2,000
G640B4	**1,300**			1,300		1,300

* Resolution after four times quadrature decode.

***Table 31**, G-Series Servomotor Encoder Resolutions and Speeds (continued from previous page)*

6.2.2 MAC-G Motor Specifications (for motors **without** brakes)

PERFORMANCE	**Units**	**G005A1**	**G006A1**	**G006A2**
Maximum Speed(7)	RPM	5,000	6,800	4,600
Continuous Stall Torque	lb-in (N-m)	5.0(1) (0.56)(1)	5.8(2) (0.66)(2)	5.8(2) (0.66)(2)
Rated Speed	RPM	3,700	4,800	4,000
Rated Torque	lb-in (N-m)	3.5(1) (0.40)(1)	4.8(2) (0.55)(2)	5.0(2) (0.56)(2)
Rated Power	HP watts	0.20 150	0.36 270	0.31 230
Peak Torque(5)	lb-in (N-m)	10 (1.1)	12 (1.4)	14 (1.6)
Continuous Stall Torque/Inertia	radians/sec^2	67,568	45,669	45,669
MECHANICAL				
Moment of Inertia(3)	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	0.0740 (0.084)	0.127 (0.143)	0.127 (0.143)
Friction Torque, Static	lb-in (N-m)	0.50 (0.056)	0.60 (0.068)	0.60 (0.068)
Servomotor Weight(3)	lbs (kg)	3.0 (1.4)	3.5 (1.6)	3.5 (1.6)
Maximum Radial Shaft Load(4)	lbs (N)	20 (89)	35 (156)	35 (156)
Maximum Axial Shaft Load	lbs (N)	15 (67)	20 (89)	20 (89)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW203	SW205	SW203
ServoWire Drive Input Power	VAC	115	115	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	2.4 (0.28)	1.8 (0.21)	3.6 (0.4)
Continuous Motor Current	amps$_{RMS/ø}$	2.0	3.1	1.6
Peak Motor Current(6)	amps$_{RMS/ø}$	6.2	9.8	4.9
Thermal Time Constant(6)	minutes	4	8	7

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/4" aluminum heatsink. Maximum case temperature is 100C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 6" x 6" x 1/4" aluminum heatsink. Maximum case temperature is 85C.

3 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

4 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

5 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

6 Motor current specifications independent of the drive selected.

7 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G010A1	G010B1	G011A1
Maximum Speed(8)	RPM	5,500	3,500	7,000
Continuous Stall Torque	lb-in (N-m)	10(1) (1.1)	9.4(1) (1.1)	11(2) (1.3)
Rated Speed	RPM	3,800	2,100	4,900
Rated Torque	lb-in (N-m)	7.0(1) (0.79)	8.4(1) (0.95)	9.4(2) (1.1)
Rated Power	HP watts	0.42 310	0.27 200	0.72 540
Peak Torque(6)	lb-in (N-m)	17(3) (1.9)(3)	16(3) (1.8)(3)	26(3) (3.0)(3)
Continuous Stall Torque/Inertia	radians/sec^2	72,993	68,613	44,534
MECHANICAL				
Moment of Inertia(4)	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	0.137 (0.155)	0.137 (0.155)	0.247 (0.279)
Friction Torque, Static	lb-in (N-m)	0.80 (0.090)	0.80 (0.090)	0.80 (0.090)
Servomotor Weight(4)	lbs (kg)	4.0 (1.8)	4.0 (1.8)	4.4 (2.0)
Maximum Radial Shaft Load(5)	lbs (N)	20 (89)	20 (89)	35 (156)
Maximum Axial Shaft Load	lbs (N)	15 (67)	15 (67)	15 (67)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW205	SW203	SW210
ServoWire Drive Input Power	VAC	115	115	115
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	2.5 (0.28)	3.9 (0.44)	2.0 (0.22)
Continuous Motor Current(7)	amps$_{RMS/ø}$	4.1	2.5	5.8
Peak Motor Current(7)	amps$_{RMS/ø}$	12	7.7	17
Thermal Time Constant	minutes	8	8	9

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/4" aluminum heatsink. Maximum case temperature is 100C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 6" x 6" x 1/4" aluminum heatsink. Maximum case temperature is 85C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G011A2	G011B2	G015A1
Maximum Speed[7]	RPM	5,600	3,800	6,300
Continuous Stall Torque	lb-in (N-m)	11[1] (1.3)[1]	11[1] (1.3)[1]	15[1] (1.7)[1]
Rated Speed	RPM	4,000	2,400	4,500
Rated Torque	lb-in (N-m)	9.8[1] (1.1)[1]	10[1] (1.2)[1]	13[1] (1.4)[1]
Rated Power	HP watts	0.62 460	0.39 290	0.91 680
Peak Torque[5]	lb-in (N-m)	24[2] (2.7)[2]	28 (3.2)	25[2] (2.9)[2]
Continuous Stall Torque/Inertia	radians/sec^2	44,534	44,534	42,017
MECHANICAL				
Moment of Inertia[3]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	0.247 (0.279)	0.247 (0.279)	0.357 (0.403)
Friction Torque, Static	lb-in (N-m)	0.80 (0.090)	0.80 (0.090)	1.0 (0.11)
Servomotor Weight[3]	lbs (kg)	4.4 (2.0)	4.4 (2.0)	5.3 (2.4)
Maximum Radial Shaft Load[4]	lbs (N)	35 (156)	35 (156)	35 (156)
Maximum Axial Shaft Load	lbs (N)	15 (67)	15 (67)	15 (67)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW205	SW203	SW210
ServoWire Drive Input Power	VAC	230	230	115
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	3.6 (0.40)	7.0 (0.79)	1.9 (0.21)
Continuous Motor Current[6]	amps$_{RMS/ø}$	3.2	1.6	8.0
Peak Motor Current[6]	amps$_{RMS/ø}$	9.8	4.8	24
Thermal Time Constant	minutes	8	8	9

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 6" x 6" x 1/4" aluminum heatsink. Maximum case temperature is 85C.

2 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

3 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

4 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

5 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

6 Motor current specifications independent of the drive selected.

7 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G015A2	G015B2	G016A2
Maximum Speed[8]	RPM	5,600	3,700	5,000
Continuous Stall Torque	lb-in (N-m)	15[1] (1.7)[1]	15[1] (1.7)[1]	16[2] (1.8)[2]
Rated Speed	RPM	4,000	2,400	3,600
Rated Torque	lb-in (N-m)	13[1] (1.5)[1]	14[1] (1.6)[1]	13[2] (1.5)[2]
Rated Power	HP watts	0.82 610	0.52 390	0.75 560
Peak Torque[6]	lb-in (N-m)	24[3] (2.8)[3]	29 (3.2)	35[3] (4.0)[3]
Continuous Stall Torque/Inertia	radians/sec^2	42,017	42,017	48,780
MECHANICAL				
Moment of Inertia[4]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	0.357 (0.403)	0.357 (0.403)	0.328 (0.371)
Friction Torque, Static	lb-in (N-m)	1.0 (0.11)	1.0 (0.11)	0.4 (0.045)
Servomotor Weight[4]	lbs (kg)	5.3 (2.4)	5.3 (2.4)	8.3 (3.8)
Maximum Radial Shaft Load[5]	lbs (N)	35 (156)	35 (156)	40 (178)
Maximum Axial Shaft Load	lbs (N)	15 (67)	15 (67)	25 (111)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW205	SW203	SW205
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	3.6 (0.41)	7.1 (0.80)	5.2 (0.59)
Continuous Motor Current[7]	amps$_{RMS/ø}$	4.2	2.1	3.1
Peak Motor Current[7]	amps$_{RMS/ø}$	12	6.4	11
Thermal Time Constant	minutes	8	8	8

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 6" x 6" x 1/4" aluminum heatsink. Maximum case temperature is 85C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/4" aluminum heatsink. Maximum case temperature is 100C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G016B2	G019A1	G019A2
Maximum Speed(8)	RPM	2,500	5,625	5,000
Continuous Stall Torque	lb-in (N-m)	16(1) (1.8)(1)	19(2) (2.1)(2)	19(2) (2.1)(2)
Rated Speed	RPM	1,600	4,500	4,000
Rated Torque	lb-in (N-m)	15(1) (1.7)(1)	16(2) (1.8)(2)	16(2) (1.8)(2)
Rated Power	HP watts	0.38 280	1.1 850	1.0 770
Peak Torque(6)	lb-in (N-m)	42 (4.7)	41(3) (4.7)(3)	50 (5.6)
Continuous Stall Torque/Inertia	$radians/sec^2$	48,780	40,685	40,685
MECHANICAL				
Moment of Inertia(4)	$in\text{-}lb\text{-}sec^2 x10^{-3}$ ($kg\text{-}m^2 x10^{-4}$)	0.328 (0.371)	0.467 (0.528)	0.467 (0.528)
Friction Torque, Static	lb-in (N-m)	0.40 (0.045)	1.2 (0.14)	1.2 (0.14)
Servomotor Weight(4)	lbs (kg)	8.3 (3.8)	6.2 (2.8)	6.2 (2.8)
Maximum Radial Shaft Load(5)	lbs (N)	40 (178)	35 (156)	35 (156)
Maximum Axial Shaft Load	lbs (N)	25 (111)	15 (67)	15 (67)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW203	SW217	SW210
ServoWire Drive Input Power	VAC	230	115	230
Torque Sensitivity, K_t	$lb\text{-}in/amp_{RMS/ø}$ ($N\text{-}m/amp_{RMS/ø}$)	10 (1.2)	1.8 (0.21)	3.7 (0.42)
Continuous Motor Current(7)	$amps_{RMS/ø}$	1.6	11	5.1
Peak Motor Current(7)	$amps_{RMS/ø}$	5.7	31	16
Thermal Time Constant	minutes	8	8	8

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/4" aluminum heatsink. Maximum case temperature is 100C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 6" x 6" x 1/4" aluminum heatsink. Maximum case temperature is 85C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G019B2	G030A2	G030B2
Maximum Speed[8]	RPM	3,700	5,000	2,600
Continuous Stall Torque	lb-in (N-m)	17[1] (2.0)[1]	30[2] (3.4)[2]	30[2] (3.4)[2]
Rated Speed	RPM	2,500	3,700	1,700
Rated Torque	lb-in (N-m)	17[1] (1.9)[1]	26[2] (2.9)[2]	28[2] (3.2)[2]
Rated Power	HP watts	0.67 500	1.5 1,100	0.75 560
Peak Torque[6]	lb-in (N-m)	29[3] (3.2)[3]	68[3] (7.7)[3]	67[3] (7.6)[3]
Continuous Stall Torque/Inertia	$radians/sec^2$	36,403	36,232	36,232
MECHANICAL				
Moment of Inertia[4]	$in\text{-}lb\text{-}sec^2x10^{-3}$ $(kg\text{-}m^2x10^{-4})$	0.467 (0.53)	0.828 (0.936)	0.828 (0.936)
Friction Torque, Static	lb-in (N-m)	1.2 (0.14)	0.50 (0.056)	0.50 (0.056)
Servomotor Weight[4]	lbs (kg)	6.2 (2.8)	12.0 (5.4)	12.0 (5.4)
Maximum Radial Shaft Load[5]	lbs (N)	35 (156)	40 (178)	40 (178)
Maximum Axial Shaft Load	lbs (N)	15 (67)	25 (111)	25 (111)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW203	SW210	SW205
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	$lb\text{-}in/amp_{RMS/ø}$ $(N\text{-}m/amp_{RMS/ø})$	7.1 (0.81)	5.1 (0.58)	10 (1.1)
Continuous Motor Current[7]	$amps_{RMS/ø}$	2.6	6.0	3.0
Peak Motor Current[7]	$amps_{RMS/ø}$	7.9	22	11
Thermal Time Constant	minutes	8	10	10

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 6" x 6" x 1/4" aluminum heatsink. Maximum case temperature is 85C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/4" aluminum heatsink. Maximum case temperature is 100C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	**Units**	**G040A2**	**G040B2**	**G055A2**
Maximum Speed[8]	RPM	3,500	1,700	3,500
Continuous Stall Torque	lb-in (N-m)	39[1] (4.4)[1]	39[1] (4.42)[1]	54[2] (6.1)[2]
Rated Speed	RPM	2,500	1,000	2,500
Rated Torque	lb-in (N-m)	36[1] (4.0)[1]	37[1] (4.2)[1]	47[2] (5.3)[2]
Rated Power	HP watts	1.3 1,000	0.58 430	1.7 1,300
Peak Torque[6]	lb-in (N-m)	102[3] (11)[3]	61[3] (6.9)[3]	102[3] (11)[3]
Continuous Stall Torque/Inertia	radians/sec^2	31,707	31,707	22,222
MECHANICAL				
Moment of Inertia[4]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	1.23 (1.39)	1.23 (1.39)	2.43 (2.74)
Friction Torque, Static	lb-in (N-m)	0.60 (0.068)	0.60 (0.068)	1.0 (0.11)
Servomotor Weight[4]	lbs (kg)	15 (6.6)	15 (6.6)	20 (9.1)
Maximum Radial Shaft Load[5]	lbs (N)	40 (178)	40 (178)	100 (445)
Maximum Axial Shaft Load	lbs (N)	25 (111)	25 (111)	50 (222)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW210	SW203	SW210
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	7.6 (0.86)	15 (1.7)	7.6 (0.86)
Continuous Motor Current[7]	amps$_{RMS/ø}$	5.1	2.4	7.1
Peak Motor Current[7]	amps$_{RMS/ø}$	19	9.1	25
Thermal Time Constant	minutes	10	10	12

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/4" aluminum heatsink. Maximum case temperature is 100C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G055A4	G080A2	G080A4
Maximum Speed[8]	RPM	1,850	3,500	1,850
Continuous Stall Torque	lb-in (N-m)	54[1] (6.1)[1]	83[2] (9.4)[2]	83[2] (9.4)[2]
Rated Speed	RPM	1,300	2,600	1,400
Rated Torque	lb-in (N-m)	50[1] (5.7)[1]	71[2] (8.0)[2]	76[2] (8.6)[2]
Rated Power	HP watts	1.1 770	2.8 2,100	1.6 1,200
Peak Torque[6]	lb-in (N-m)	102[3] (11)[3]	203[3] (23)[3]	203[3] (23)[3]
Continuous Stall Torque/Inertia	radians/sec^2	22,222	16,836	16,836
MECHANICAL				
Moment of Inertia[4]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	2.43 (2.74)	4.93 (5.57)	4.93 (5.57)
Friction Torque, Static	lb-in (N-m)	1.0 (0.11)	1.4 (0.16)	1.4 (0.16)
Servomotor Weight[4]	lbs (kg)	20 (9.1)	29 (13)	29 (13)
Maximum Radial Shaft Load[5]	lbs (N)	100 (445)	100 (445)	100 (445)
Maximum Axial Shaft Load	lbs (N)	50 (222)	50 (222)	50 (222)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW205	SW217	SW210
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	15 (1.7)	7.6 (0.86)	15 (1.7)
Continuous Motor Current[6]	amps$_{RMS/ø}$	3.6	11	5.5
Peak Motor Current[7]	amps$_{RMS/ø}$	12	38	19
Thermal Time Constant	minutes	22	16	16

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 10" x 10" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 12" x 12" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G115A2	G115A4	G130A2
Maximum Speed(7)	RPM	3,500	1,850	2,700
Continuous Stall Torque	lb-in (N-m)	116(1) (13)(1)	116(1) (13)(1)	130(1) (15)(1)
Rated Speed	RPM	2,600	1,400	1,800
Rated Torque	lb-in (N-m)	100(1) (11)(1)	107(1) (12)(1)	119(1) (13)(1)
Rated Power	HP watts	4.0 3,000	2.3 1,700	3.4 2,500
Peak Torque(5)	lb-in (N-m)	203(2) (23)(2)	203(2) (23)(2)	220(2) (25)(2)
Continuous Stall Torque/Inertia	radians/sec^2	16,044	16,044	13,786
MECHANICAL				
Moment of Inertia(3)	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	7.23 (8.17)	7.23 (8.17)	9.43 (10.7)
Friction Torque, Static	lb-in (N-m)	1.8 (0.20)	1.8 (0.20)	2.4 (0.27)
Servomotor Weight(3)	lbs (kg)	37 (17)	37 (17)	36 (16)
Maximum Radial Shaft Load(4)	lbs (N)	100 (445)	100 (445)	150 (667)
Maximum Axial Shaft Load	lbs (N)	50 (222)	50 (222)	50 (222)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW220	SW210	SW217
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	7.6 (0.86)	15 (1.7)	9.6 (1.1)
Continuous Motor Current(6)	amps$_{RMS/ø}$	15	7.7	13
Peak Motor Current(6)	amps$_{RMS/ø}$	54	27	39
Thermal Time Constant	minutes	16	16	16

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 12" x 12" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

2 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

3 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

4 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

5 Motor’s peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

6 Motor current specifications independent of the drive selected.

7 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G130A4	G210A2	G210A4
Maximum Speed[7]	RPM	1,750	2,700	1,750
Continuous Stall Torque	lb-in (N-m)	130[1] (15)[1]	210[1] (24)[1]	210[1] (24)[1]
Rated Speed	RPM	1,200	2,000	1,300
Rated Torque	lb-in (N-m)	121[1] (14)[1]	184[1] (21)[1]	191[1] (22)[1]
Rated Power	HP Watts	2.3 1,700	5.8 4,300	3.9 2,900
Peak Torque[5]	lb-in (N-m)	213[2] (24)[2]	458[2] (52)[2]	361[2] (41)[2]
Continuous Stall Torque/Inertia	radians/sec^2	13,786	11,053	11,053
MECHANICAL				
Moment of Inertia[3]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	9.43 (10.7)	19.0 (21.5)	19.0 (21.5)
Friction Torque, Static	lb-in (N-m)	2.4 (0.27)	3.0 (0.34)	3.0 (0.34)
Servomotor Weight[3]	lbs (kg)	36 (16)	51 (23)	51 (23)
Maximum Radial Shaft Load[4]	lbs (N)	150 (667)	150 (667)	150 (667)
Maximum Axial Shaft Load	lbs (N)	50 (222)	50 (222)	50 (222)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW210	SW225	SW217
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	16 (1.8)	9.6 (1.1)	16 (1.8)
Continuous Motor Current[6]	amps$_{RMS/ø}$	8.2	22	13
Peak Motor Current[6]	amps$_{RMS/ø}$	24	65	38
Thermal Time Constant	minutes	16	20	20

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 12" x 12" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

2 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

3 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

4 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

5 Motor's peak torque is limited by the peak current of the ServoWire[TM] Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

6 Motor current specifications independent of the drive selected.

7 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G280A2	G280A4	G360A2
Maximum Speed[7]	RPM	2,700	1,750	2,000
Continuous Stall Torque	lb-in (N-m)	280[1] (32)[1]	280[1] (32)[1]	360[1] (41)[1]
Rated Speed	RPM	2,000	1,300	1,500
Rated Torque	lb-in (N-m)	245[1] (28)[1]	252[1] (28)[1]	321[1] (36)[1]
Rated Power	HP watts	7.6 5,700	5.1 3,800	7.6 5,700
Peak Torque[5]	lb-in (N-m)	641[2] (72)	752[2] (85)	851[2] (96)
Continuous Stall Torque/Inertia	radians/sec^2	9,790	9,790	10,286
MECHANICAL				
Moment of Inertia[3]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	28.6 (32.3)	28.6 (32.3)	35.0 (39.6)
Friction Torque, Static	lb-in (N-m)	3.6 (0.41)	3.6 (0.41)	4.2 (0.47)
Servomotor Weight[3]	lbs (kg)	66 (30)	66 (30)	83 (38)
Maximum Radial Shaft Load[4]	lbs (N)	150 (667)	150 (667)	150 (667)
Maximum Axial Shaft Load	lbs (N)	50 (222)	50 (222)	50 (222)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW235	SW225	SW235
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	9.6 (1.1)	16 (1.8)	13 (1.4)
Continuous Motor Current[6]	amps$_{RMS/ø}$	29	17	28
Peak Motor Current[6]	amps$_{RMS/ø}$	87	51	83
Thermal Time Constant	minutes	22	22	23

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 12" x 12" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

2 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

3 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

4 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

5 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

6 Motor current specifications independent of the drive selected.

7 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

PERFORMANCE	Units	G360A4	G640A2
Maximum Speed[8]	RPM	1,750	2,400
Continuous Stall Torque	lb-in (N-m)	360[1] (41)[1]	640[2] (72)[2]
Rated Speed	RPM	1,300	1,600
Rated Torque	lb-in (N-m)	323[1] (36)[1]	580[2] (66)[2]
Rated Power	HP watts	6.6 4,900	13 10,000
Peak Torque[6]	lb-in (N-m)	752[3] (85)[3]	1,239[3] (140)[3]
Continuous Stall Torque/Inertia	radians/sec^2	10,286	8,989
MECHANICAL			
Moment of Inertia[4]	in-lb-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	35.0 (39.6)	71.2 (80.5)
Friction Torque, Static	lb-in (N-m)	4.2 (0.47)	9.8 (1.1)
Servomotor Weight[4]	lbs (kg)	83 (38)	98 (44)
Maximum Radial Shaft Load[5]	lbs (N)	150 (667)	250 (1,112)
Maximum Axial Shaft Load	lbs (N)	50 (222)	100 (445)
ELECTRICAL & THERMAL			
ServoWire Drive Model Number	SAC-	SW225	SW260
ServoWire Drive Input Power	VAC	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	16 (1.8)	11 (1.2)
Continuous Motor Current[76]	amps$_{RMS/ø}$	22	59
Peak Motor Current[7]	amps$_{RMS/ø}$	66	163
Thermal Time Constant	minutes	23	25

1 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 12" x 12" x 1/2" aluminum heatsink. Maximum case temperature is 100C.

2 Performance ratings are obtained with servomotor ambient temperature of 25C and with motor mounted to a 14" x 14" x 3/4" aluminum heatsink. Maximum case temperature is 100C.

3 Peak motor torque is limited by the peak current of the ServoWire drive. The next larger drive may be used to increase the amount of peak torque available.

4 Specifications for servomotors without brakes. Refer to the appropriate sections for servomotor specifications with brakes.

5 Maximum radial shaft load specification is for a load centered 1 inch (25.4 mm) from the face of the motor.

6 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

7 Motor current specifications independent of the drive selected.

8 Actual maximum speed dependent on motor encoder resolution. Refer to Table 31.

6.2.3 Specifications for G-Series Servomotors **With** Brakes

Motor	**Brake Holding Torque** lb-in (N-m)	**Motor Moment of Inertia** lb-in-sec^2 (kg-m^2)	**Motor Length** in (mm)	**Motor Weight** lb (kg)	**Brake Current @24VDC** (Amps)
MAC-G005	10.0 (1.13)	$0.099x10^{-3}$ ($0.112x10^{-4}$)	6.8 (173)	3.8 (1.7)	0.21
MAC-G006	24.0 (2.71)	$0.197x10^{-3}$ ($0.222x10^{-4}$)	6.55 (167)	6.5 (2.9)	0.60
MAC-G010	10.0 (1.13)	$0.162x10^{-3}$ ($0.183x10^{-4}$)	8.00 (203)	4.8 (2.2)	0.21
MAC-G011	24.0 (2.71)	$0.317x10^{-3}$ ($0.358x10^{-4}$)	7.45 (186)	7.4 (3.4)	0.60
MAC-G015		$0.427x10^{-3}$ ($0.482x10^{-4}$)	8.05 (207)	8.3 (3.8)	
MAC-G016	60.0 (6.77)	$0.478x10^{-3}$ ($0.540x10^{-4}$)	8.74 (222)	10.5 (4.8)	0.52
MAC-G019	24.0 (2.71)	$0.537x10^{-3}$ ($0.607x10^{-4}$)	8.80 (224)	9.2 (4.2)	0.60
MAC-G030	60.0 (6.77)	$0.978x10^{-3}$ ($1.11x10^{-4}$)	10.3 (261)	10.5 (4.8)	0.52
MAC-G040		$1.38x10^{-3}$ ($1.56x10^{-4}$)	11.8 (299)	16.8 (7.6)	
MAC-G055	240 (27.1)	$3.33x10^{-3}$ ($3.76x10^{-4}$)	10.6 (270)	26 (11.8)	0.88
MAC-G080		$5.83x10^{-3}$ ($6.59x10^{-4}$)	13.1 (333)	34.6 (15.7)	
MAC-G115		$8.13x10^{-3}$ ($9.18x10^{-4}$)	15.6 (397)	43 (19.5)	
MAC-G130	360 (40.7)	$11.7x10^{-3}$ ($13.2x10^{-4}$)	14.0 (356)	48 (21.8)	1.13
MAC-G210		$21.3x10^{-3}$ ($24.1x10^{-4}$)	16.7 (424)	63 (28.6)	
MAC-G280		$30.9x10^{-3}$ ($34.9x10^{-4}$)	19.4 (492)	78 (35.4)	
MAC-G360		$37.3x10^{-3}$ ($42.1x10^{-4}$)	22.1 (561)	93 (42.2)	
MAC-G640	1080 (122)	$79.7x10^{-4}$ ($90.1x10^{-4}$)	18.7 (494)	122 (55.3)	1.4

Table 32,*Specifications for G-Series Motors* ***With*** *Brakes*

6.2.4 MAC-G Motor Mating Connectors

Motors Without Brakes	Mating Connectors (used in cables) Motor Power Connector	Motor Feedback Connector
G005, G010, G006, G011, G015, G019	Bendix PT06E16-23S(SR) (Motor Power and Feedback are in a single connector)	
G016, G030, G040, G055, G080, G115	Bendix PT06E14-5S(SR)	Bendix PT06E14-18S(SR)
G130, G210, G280, G360	MS3106F-22-22S	
G640	MS3106F-32-17S	

***Table 33**, MAC-G Motor Mating Connectors for Motors **Without** Brakes*

For G005, G006, G010, G011, G015, G019 motors, the brake leads are in the combined power/feedback cable.
For G016, G030, G040, G055, G080, and G115 motors, the brake leads are in the motor power cable.
For G130, G210, G280, G360 and G640 motors, the brake leads are in the motor feedback cable.

Motors With Brake	Mating Connectors (used in cables) Motor Power Connector	Motor Feedback Connector
G005, G006, G010, G011, G015,G019	Bendix PT06E16-23S(SR) (Motor Power and Feedback are in a single connector)	
G016, G030, G040, G055, G080, G115	Bendix PT06E16-8S(SR)	Bendix PT06E14-18S(SR)
G130, G210, G280, G360	MS3106F-22-22S	Bendix PT06E16-23S(SR)
G640	MS3106F-32-17S	

***Table 34**, MAC-G Motor Mating Connectors for Motors **With** Brakes*

6.3 MAC-DE/DA/DB Servo Motors

6.3.1 MAC-DE Series Overview

Maximum Speed:	4,300 TO 4,500 RPM
Continuous stall torques:	2.8 to 42 lb-in
Peak Torques:	5.1 to 73 lb-in
Peak Acceleration:	up to 49,123 rad/sec^2
Rated Power:	0.13 to 2.0 HP
Position Encoder Resolution:	incremental: 8,192 cts/rev (after quadrature decode) absolute: 4,096 cts/rev (after quadrature decode)
Ambient Temp:	0 – 40C
Ambient Humidity:	20% to 80% (non-condensing)
Enclosure Rating	IP55
Insulation	Class B

Servomotor	**Recommended Servodrive**	**Compatible Servodrives**	
MAC-DE003A1	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-DE003A2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-DE006B1	**SAC-SW205**	SAC-SW210	SAC-SW217
MAC-DE006B2	**SAC-SW203**	SAC-SW205	SAC-SW210
MAC-DE008C1	**SAC-SW210**	SAC-SW217	
MAC-DE011C2	**SAC-SW205**	SAC-SW210	SAC-SW217
MAC-DE021D2	**SAC-SW205**	SAC-SW210	
MAC-DE042E2	**SAC-SW210**	SAC-SW217	SAC-SW220

Table 35, DE-Series Servomotor and Servodrive Compatibility

6.3.2 MAC-DA Series Overview

Maximum Speed:	4,500 RPM
Continuous stall torques:	28 to 140 lb-in
Peak Torques:	68 to 321 lb-in
Peak Acceleration:	up to 19,858 rad/sec^2
Rated Power:	1.3 to 6.6 HP
Position Encoder Resolution:	Incremental: 16,384 cts/rev (after quadrature decode) absolute: 32,768 cts/rev (after quadrature decode)
Ambient Temp:	0 – 40C
Ambient Humidity:	20% to 80% (non-condensing)
Enclosure Rating	IP65 standard (optional shaft oil seal)
Insulation	Calss F

Servomotor	Recommended Servodrive	Compatible Servodrives	
MAC-DA030F	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-DA055G	**SAC-SW217**	SAC-SW220	SAC-SW225
MAC-DA090H	**SAC-SW225**	SAC-SW235	
MAC-DA110J	**SAC-SW225**	SAC-SW235	SAC-SW260
MAC-DA140K	**SAC-SW235**	SAC-SW260	

Table 36, DA-Series Servomotor and Servodrive Compatibility

6.3.3 MAC-DB Series Overview

Maximum Speed:	3,000 RPM
Continuous stall torques:	25 to 665 lb-in
Peak Torques:	44 to 1000 lb-in
Peak Acceleration:	up to 5,017 rad/sec^2
Rated Power:	0.6 to 2.8 HP
Position Encoder Resolution:	incremental: 32,768 cts/rev (after quadrature decode) absolute: 32,768 cts/rev (after quadrature decode)
Ambient Temp:	0 – 40C
Ambient Humidity:	20% to 80% (non-condensing)
Enclosure Rating	IP65 standard (optional shaft oil seal)
Insulation	Class F

Servomotor	**Recommended Servodrive**	**Compatible Servodrives**	
MAC-DB025L	**SAC-SW205**	SAC-SW210	
MAC-DB055M	**SAC-SW210**	SAC-SW217	SAC-SW220
MAC-DB080N	**SAC-SW217**	SAC-SW220	
MAC-DB100P	**SAC-SW220**	SAC-SW225	
MAC-DB200Q	**SAC-SW220**	SAC-SW225	SAC-SW235
MAC-DB300R	**SAC-SW235**	SAC-SW260	
MAC-DB330S	**SAC-SW260**		
MAC-DB465T	**SAC-SW260**		
MAC-DB700U	**SAC-SW260**		

Table 37, DB-Series Servomotor and Servodrive Compatibility

6.3.4 MAC-DE/DA/DB Specifications

PERFORMANCE(1)	Units	DE003A1/I	DE003A2/I	DE006B1/I
Maximum Speed	RPM	4,500	4,500	4,500
Continuous Stall Torque	lb-in (N-m)	2.8 (0.32)	2.8 (0.32)	5.6 (0.64)
Rated Speed	RPM	3,000	3,000	3,000
Rated Torque	lb-in (N-m)	2.8 (0.32)	2.8 (0.32)	5.6 (0.64)
Rated Power	HP watts	0.13 100	0.13 100	0.25 190
Peak Torque(4)	lb-in (N-m)	5.1 (0.58)	8.2 (0.93)	14 (1.5)
Continuous Stall Torque/Inertia	radians/sec^2	49,123	49,123	30,270
MECHANICAL				
Moment of Inertia(2)	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	0.057 (0.065)	0.057 (0.065)	0.185 (0.209)
Friction Torque, Static	lb-in (N-m)	0.048 (0.0054)	0.048 (0.0054)	0.11 (0.012)
Servomotor Weight(2)	lbs (kg)	1.5 (0.7)	1.5 (0.7)	3.1 (1.4)
Maximum Radial Shaft Load(2)	lbs (N)	17 (78)	17 (78)	55 (245)
Maximum Axial Shaft Load	lbs (N)	11 (49)	11 (49)	15 (68)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW203/E	SW203/E	SW205/E
ServoWire Drive Input Power	VAC	115	230	115
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	1.4 (0.16)	3.5 (0.39)	2.3 (0.26)
Continuous Motor Current(5)	amps$_{RMS/ø}$	2.2	0.89	2.7
Peak Motor Current(5)	amps$_{RMS/ø}$	7.1	2.8	8.4
Thermal Time Constant	minutes	8	8	14
Insulation Class		B	B	B

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

PERFORMANCE[1]	Units	DE006B2/I	DE008C1/I	DE011C2/I
Maximum Speed	RPM	4,500	4,500	4,500
Continuous Stall Torque	lb-in (N-m)	5.6 (0.64)	8.4 (0.95)	11 (1.3)
Rated Speed	RPM	3,000	3,000	3,000
Rated Torque	lb-in (N-m)	5.6 (0.64)	8.4 (0.95)	11 (1.3)
Rated Power	HP watts	0.25 190	0.39 290	0.54 400
Peak Torque[4]	lb-in (N-m)	11 (1.3)	25 (2.8)	28 (3.2)
Continuous Stall Torque/Inertia	radians/sec^2	30,270	27,273	35,714
MECHANICAL				
Moment of Inertia[2]	in-lb-sec^2x10^{-3} (kg-m2x10-4)	0.185 (0.209)	0.308 (0.347)	0.308 (0.347)
Friction Torque, Static	lb-in (N-m)	0.11 (0.012)	0.20 (0.022)	0.20 (0.022)
Servomotor Weight[2]	lbs (kg)	3.1 (1.4)	4.6 (2.1)	4.6 (2.1)
Maximum Radial Shaft Load[2]	lbs (N)	55 (245)	55 (245)	55 (245)
Maximum Axial Shaft Load	lbs (N)	15 (68)	15 (68)	15 (68)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW203/E	SW210/E	SW205/E
ServoWire Drive Input Power	VAC	230	115	230
Torque Sensitivity, K_t	lb-in/$amp_{RMS/ø}$ (N-m/$amp_{RMS/ø}$)	3.1 (0.35)	2.2 (0.25)	4.7 (0.54)
Continuous Motor Current[5]	$amps_{RMS/ø}$	2.0	4.3	2.6
Peak Motor Current[5]	$amps_{RMS/ø}$	6.0	14	8.0
Thermal Time Constant	minutes	14	16	16
Insulation Class		B	B	B

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire[TM] Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

PERFORMANCE[1]	Units	DE021D2/I	DE042E2/I	DA030F/I
Maximum Speed	RPM	4,500	4,300	4,500
Continuous Stall Torque	lb-in (N-m)	21 (2.4)	42 (4.8)	28 (3.2)
Rated Speed	RPM	3,000	3,000	3,000
Rated Torque	lb-in (N-m)	21 (2.4)	42 (4.8)	28 (3.2)
Rated Power	HP watts	1.0 750	2.0 1,500	1.3 1,000
Peak Torque[4]	lb-in (N-m)	34 (3.9)	73 (8.3)	68 (7.7)
Continuous Stall Torque/Inertia	radians/sec^2	11,230	11,765	18,182
MECHANICAL				
Moment of Inertia[2]	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	1.87 (2.11)	3.57 (4.03)	1.54 (1.74)
Friction Torque, Static	lb-in (N-m)	0.32 (0.036)	0.53 (0.060)	0.43 (0.049)
Servomotor Weight[2]	lbs (kg)	10 (4.6)	15 (6.6)	10 (4.6)
Maximum Radial Shaft Load[2]	lbs (N)	88 (392)	110 (490)	154 (686)
Maximum Axial Shaft Load	lbs (N)	33 (147)	33 (147)	44 (196)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW205/E	SW210/E	SW210/E
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	5.7 (0.64)	6.1 (0.69)	5.7 (0.64)
Continuous Motor Current[5]	amps$_{RMS/ø}$	4.1	7.5	6.0
Peak Motor Current[5]	amps$_{RMS/ø}$	13	28	17
Thermal Time Constant	minutes	18	18	12
Insulation Class		B	B	F

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft load specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

PERFORMANCE[1]	Units	DA055G/I	DA090H/I	DA110J/I
Maximum Speed	RPM	4,500	4,500	4,500
Continuous Stall Torque	lb-in (N-m)	56 (6.3)	87 (9.8)	112 (13)
Rated Speed	RPM	3,000	3,000	3,000
Rated Torque	lb-in (N-m)	56 (6.3)	87 (9.8)	112 (13)
Rated Power	HP watts	2.5 1,900	4.0 3,000	5.2 3,900
Peak Torque[4]	lb-in (N-m)	101 (11)	217 (24)	207 (23)
Continuous Stall Torque/Inertia	radians/sec^2	19,858	14,032	13,176
MECHANICAL				
Moment of Inertia[2]	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	2.82 (3.19)	6.20 (7.01)	8.50 (9.60)
Friction Torque, Static	lb-in (N-m)	0.62 (0.070)	0.74 (0.083)	0.95 (0.11)
Servomotor Weight[2]	lbs (kg)	15 (7.0)	24 (11)	31 (14)
Maximum Radial Shaft Load[2]	lbs (N)	154 (686)	221 (980)	265 (1,176)
Maximum Axial Shaft Load	lbs (N)	44 (196)	88 (392)	88 (392)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW217/E	SW225/E	SW225/E
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	5.0 (0.56)	5.1 (0.58)	4.9 (0.55)
Continuous Motor Current[5]	amps$_{RMS/ø}$	12	19	24
Peak Motor Current[5]	amps$_{RMS/ø}$	42	56	77
Thermal Time Constant	minutes	23	33	36
Insulation Class		F	F	F

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

PERFORMANCE[1]	Units	DA140K/I	DB025L/I	DB055M/I
Maximum Speed	RPM	4,500	3,000	3,000
Continuous Stall Torque	lb-in (N-m)	140 (16)	25 (2.8)	53 (6.0)
Rated Speed	RPM	3,000	1,500	1,500
Rated Torque	lb-in (N-m)	140 (16)	25 (2.8)	48 (5.4)
Rated Power	HP watts	6.6 4,900	0.59 440	1.1 850
Peak Torque[4]	lb-in (N-m)	321 (36)	44 (4.9)	88 (10)
Continuous Stall Torque/Inertia	radians/sec^2	12,844	3,900	4,309
MECHANICAL				
Moment of Inertia[2]	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	10.9 (12.3)	6.41 (7.24)	12.3 (13.9)
Friction Torque, Static	lb-in (N-m)	1.1 (0.13)	0.43 (0.049)	0.65 (0.074)
Servomotor Weight[2]	lbs (kg)	37 (17)	12 (5.5)	17 (7.6)
Maximum Radial Shaft Load[2]	lbs (N)	265 (1,176)	110 (490)	110 (490)
Maximum Axial Shaft Load	lbs (N)	88 (392)	22 (98)	22 (98)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW235/E	SW205/E	SW210/E
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	5.4 (0.61)	7.3 (0.82)	7.3 (0.83)
Continuous Motor Current[5]	amps$_{RMS/ø}$	28	3.8	7.1
Peak Motor Current[5]	amps$_{RMS/ø}$	84	11	17
Thermal Time Constant	minutes	40	12	17
Insulation Class		F	F	F

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

PERFORMANCE[1]	Units	DB080N/I	DB100P/I	DB200Q/I
Maximum Speed	RPM	3,000	3,000	3,000
Continuous Stall Torque	lb-in (N-m)	74 (8.4)	102 (12)	196 (22)
Rated Speed	RPM	1,500	1,500	1,500
Rated Torque	lb-in (N-m)	74 (8.4)	102 (12)	165 (19)
Rated Power[4]	HP watts	1.7 1,300	2.4 1,800	3.9 2,900
Peak Torque	lb-in (N-m)	152 (17)	155 (18)	312 (35)
Continuous Stall Torque/Inertia	radians/sec^2	4,066	3,630	4,816
MECHANICAL				
Moment of Inertia[2]	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	18.2 (20.6)	28.1 (31.8)	40.7 (46.0)
Friction Torque, Static	lb-in (N-m)	0.87 (0.098)	1.0 (0.12)	1.4 (0.16)
Servomotor Weight[2]	lbs (kg)	21 (9.6)	31 (14)	40 (18)
Maximum Radial Shaft Load[2]	lbs (N)	154 (686)	265 (1,176)	331 (1,470)
Maximum Axial Shaft Load	lbs (N)	77 (343)	110 (490)	110 (490)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW217/E	SW220/E	SW225/E
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	7.4 (0.84)	6.5 (0.73)	7.3 (0.83)
Continuous Motor Current[5]	amps$_{RMS/ø}$	11	17	24
Peak Motor Current[5]	amps$_{RMS/ø}$	28	42	56
Thermal Time Constant	minutes	25	34	35
Insulation Class		F	F	F

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

9 Motor's peak torque is limited by the peak current of the ServoWire™ Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

4 Motor current specifications independent of the drive selected.

PERFORMANCE[(1)]	Units	DB300R/I	DB330S/I	DB465T/I
Maximum Speed	RPM	3,000	3,000	3,000
Continuous Stall Torque	lb-in (N-m)	300 (34)	345 (39)	450 (51)
Rated Speed	RPM	1,500	1,500	1,500
Rated Torque	lb-in (N-m)	252 (28)	310 (35)	425 (48)
Rated Power[(4)]	HP watts	5.9 4,400	7.4 5,500	10 7,500
Peak Torque	lb-in (N-m)	479 (54)	728 (82)	839 (95)
Continuous Stall Torque/Inertia	radians/sec^2	5,017	4,378	4,054
MECHANICAL				
Moment of Inertia[(2)]	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	59.8 (67.6)	78.8 (89.0)	111.0 (125.4)
Friction Torque, Static	lb-in (N-m)	2.3 (0.25)	3.0 (0.33)	4.2 (0.47)
Servomotor Weight[(2)]	lbs (kg)	51 (23)	66 (30)	88 (40)
Maximum Radial Shaft Load[(2)]	lbs (N)	331 (1,470)	397 (1,764)	397 (1,764)
Maximum Axial Shaft Load	lbs (N)	110 (490)	132 (588)	132 (588)
ELECTRICAL & THERMAL				
ServoWire Drive Model Number	SAC-	SW235/E	SW260/E	SW260/E
ServoWire Drive Input Power	VAC	230	230	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	8.1 (0.91)	7.8 (0.88)	8.2 (0.93)
Continuous Motor Current[(5)]	amps$_{RMS/ø}$	33	42	55
Peak Motor Current[(5)]	amps$_{RMS/ø}$	84	110	130
Thermal Time Constant	minutes	36	44	46
Insulation Class		F	F	F

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire[TM] Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

PERFORMANCE[(1)]	Units	DB700U/I
Maximum Speed	RPM	2,000
Continuous Stall Torque	lb-in (N-m)	665 (75)
Rated Speed	RPM	1,500
Rated Torque	lb-in (N-m)	620 (70)
Rated Power[(4)]	HP watts	14.75 11,000
Peak Torque	lb-in (N-m)	1000 (113)
Continuous Stall Torque/Inertia	radians/sec^2	2,671
MECHANICAL		
Moment of Inertia[(2)]	in-lb-sec^{2}x10^{-3} (kg-m2x10-4)	249.0 (281.4)
Friction Torque, Static	lb-in (N-m)	7.2 (0.81)
Servomotor Weight[(2)]	lbs (kg)	127 (58)
Maximum Radial Shaft Load[(2)]	lbs (N)	397 (1,764)
Maximum Axial Shaft Load	lbs (N)	132 (588)
ELECTRICAL & THERMAL		
ServoWire Drive Model Number	SAC-	SW260/E
ServoWire Drive Input Power	VAC	230
Torque Sensitivity, K_t	lb-in/amp$_{RMS/ø}$ (N-m/amp$_{RMS/ø}$)	11 (1.2)
Continuous Motor Current[(5)]	amps$_{RMS/ø}$	59
Peak Motor Current[(5)]	amps$_{RMS/ø}$	140
Thermal Time Constant	minutes	68
Insulation Class		F

1 Performance ratings are obtained with servomotor ambient temperature at 40C.

2 Specification for incremental encoder motor only. Refer to the Absolute Encoder and Brake Options Servomotor Performance Specifications section for specification of servomotor with absolute encoder and/or brake options.

3 Maximum radial shaft losd specification is for a load centered 0.2 inches (5 mm) from the end of the motor shaft.

4 Motor's peak torque is limited by the peak current of the ServoWire[TM] Drive. The Next larger drive may be used to increase the amount of peak torque available. Consult an ORMEC Applications Engineer for details.

5 Motor current specifications independent of the drive selected.

6.3.5 Specifications for DE/DA/DB-Series Motors with Incremental Encoders and Fail-Safe Brakes

The brake's holding torque is equivalent to the motor's rated torque. Also see **Table 41**, Specifications for Fail-Safe Brakes for DE/DA/DB-Series Motors (page 97).

Servomotor	**Servodrive**	**Inertia** lb-in-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	**Servomotor Length** inches (mm)	**Servomotor Weight** lbs (kg)	**Quadrature Output Res.** counts/rev
MAC-DE003A1/I_B	SAC-SW203	0.091 (0.103)	3.39 (86)	2.0 (0.9)	8,192
MAC-DE006B1/I_B	SAC-SW205	0.272 (0.307)	3.68 (94)	4.2 (1.9)	8,192
MAC-DE008C1/I_B	SAC-SW210	0.394 (0.446)	4.47 (114)	5.7 (2.6)	8,192
MAC-DE003A2/I_B	SAC-SW203	0.091 (0.103)	3.39 (86)	2.0 (0.9)	8,192
MAC-DE006B2/I_B	SAC-SW203	0.272 (0.307)	3.68 (94)	4.2 (1.9)	8,192
MAC-DE011C2/I_B	SAC-SW205	0.394 (0.446)	4.47 (114)	5.7 (2.6)	8,192
MAC-DE021D2/I_B	SAC-SW205	2.23 (2.52)	4.65 (118)	13 (5.9)	8,192
MAC-DE042E2/I_B	SAC-SW210	4.34 (4.91)	5.75 (146)	18 (8.2)	8,192
MAC-DA030F/I_B	SAC-SW210	1.73 (1.95)	7.60 (193)	13 (5.9)	16,384
MAC-DA055G/I_B	SAC-SW217	3.01 (3.40)	9.53 (242)	19 (8.6)	16,384
MAC-DA090H/I_B	SAC-SW225	7.84 (8.86)	9.33 (237)	31 (14)	16,384
MAC-DA110J/I_B	SAC-SW225	10.1 (11.5)	10.8 (274)	38 (17)	16,384
MAC-DA140K/I_B	SAC-SW235	12.5 (14.2)	12.4 (314)	44 (20)	16,384
MAC-DB025L/I_B	SAC-SW205	8.05 (9.10)	6.93 (176)	17 (7.7)	32,768
MAC-DB055M/I_B	SAC-SW210	13.9 (15.8)	7.83 (199)	21 (9.5)	32,768
MAC-DB080N/I_B	SAC-SW217	19.8 (22.4)	8.78 (223)	26 (12)	32,768
MAC-DB100P/I_B	SAC-SW217	35.0 (39.5)	8.54 (217)	42 (19)	32,768
MAC-DB200Q/I_B	SAC-SW225	47.6 (53.7)	9.57 (243)	52 (24)	32,768
MAC-DB300R/I_B	SAC-SW235	66.7 (75.3)	10.9 (277)	63 (29)	32,768
MAC-DB330S/I_B	SAC-SW260	85.7 (96.8)	12.2 (311)	77 (35)	32,768
MAC-DB465T/I_B	SAC-SW260	118 (133)	15.2 (385)	100 (45)	32,768
MAC-DB700U/I_B	SAC-SW260	261 (295)	15.1 (383)	143 (65)	32,768

Table 38*, Specifications for DE/DA/DB-Series Motors with* ***Incremental Encoders*** *and* ***Brakes***

6.3.6 Specifications for DE/DA/DB-Series Motors with Absolute Encoders

Servomotor	Servodrive	Moment of Inertia lb-in-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	Servomotor Length inches (mm)	Servomotor Weight lbs (kg)	Quadrature Output Res. Counts/rev
MAC-DE003A1/A	SAC-SW203	0.079 (0.089)	4.1 (102)	2.0 (0.9)	4,096
MAC-DE006B1/A	SAC-SW205	0.207 (0.234)	3.5 (87)	3.5 (1.6)	4,096
MAC-DE008C1/A	SAC-SW210	0.329 (0.372)	4.2 (107)	5.1 (2.3)	4,096
MAC-DE003A2/A	SAC-SW203	0.079 (0.089)	4.1 (102)	2.0 (0.9)	4,096
MAC-DE006B2/A	SAC-SW203	0.207 (0.234)	3.5 (87)	3.5 (1.6)	4,096
MAC-DE011C2/A	SAC-SW205	0.329 (0.372)	4.2 (107)	5.1 (2.3)	4,096
MAC-DE021D2/A	SAC-SW205	1.89 (2.14)	4.2 (106)	11 (4.8)	4,096
MAC-DE042E2/A	SAC-SW210	3.59 (4.06)	5.3 (134)	16 (7.1)	4,096
MAC-DA030F/A	SAC-SW210	1.65 (1.86)	6.4 (163)	11 (5.0)	32,768
MAC-DA055G/A	SAC-SW217	2.93 (3.31)	8.4 (212)	16 (7.4)	32,768
MAC-DA090H/A	SAC-SW225	6.31 (7.13)	8.4 (213)	25 (12)	32,768
MAC-DA110J/A	SAC-SW225	8.61 (9.73)	9.9 (250)	32 (15)	32,768
MAC-DA140K/A	SAC-SW225	11.0 (12.4)	11 (277)	39 (18)	32,768
MAC-DB025L/A	SAC-SW205	6.50 (7.34)	6.0 (152)	13 (5.9)	32,768
MAC-DB055M/A	SAC-SW210	12.4 (14.0)	6.9 (175)	18 (8.0)	32,768
MAC-DB080N/A	SAC-SW217	18.3 (20.7)	7.9 (199)	22 (10)	32,768
MAC-DB100P/A	SAC-SW217	28.2 (31.9)	7.1 (180)	31 (14)	32,768
MAC-DB200Q/A	SAC-SW225	40.8 (46.1)	8.2 (206)	41 (19)	32,768
MAC-DB300R/A	SAC-SW235	59.9 (67.7)	9.5 (240)	53 (24)	32,768
MAC-DB330S/A	SAC-SW260	79.8 (90.2)	11 (274)	66 (30)	32,768
MAC-DB465T/A	SAC-SW260	111 (125)	14 (348)	88 (40)	32,768
MAC-DB700U/A	SAC-SW260	249 (281)	14 (352)	127 (58)	32,768

Table 39**, Specifications for DE/DA/DB-Series Motors with **Absolute Encoders

6.3.7 Specifications for DE/DA/DB-Series Motors with Absolute Encoders and Fail-Safe Brakes

The brake's holding torque is equivalent to the motor's rated torque. Also see **Table 41**, Specifications for Fail-Safe Brakes for DE/DA/DB-Series Motors (page 97).

. **Servomotor**	**Servodrive**	**Inertia** lb-in-sec^{2}x10^{-3} (kg-m^{2}x10^{-4})	**Servomotor Length** inches (mm)	**Servomotor Weight** lbs (kg)	**Quadrature Output Res.** counts/rev
MAC-DE003A1/A_B	SAC-SW203	0.113 (0.128)	5.16 (131)	2.7 (1.2)	4,096
MAC-DE006B1/A_B	SAC-SW205	0.294 (0.332)	4.65 (118)	4.6 (2.1)	4,096
MAC-DE008C1/A_B	SAC-SW210	0.416 (0.470)	5.43 (138)	6.2 (2.8)	4,096
MAC-DE003A2/A_B	SAC-SW203	0.113 (0.128)	5.16 (131)	2.7 (1.2)	4,096
MAC-DE006B2/A_B	SAC-SW203	0.294 (0.332)	4.65 (118)	4.6 (2.1)	4,096
MAC-DE011C2/A_B	SAC-SW205	0.416 (0.470)	5.43 (138)	6.2 (2.8)	4,096
MAC-DE021D2/A_B	SAC-SW205	2.26 (2.55)	5.59 (142)	14 (6.2)	4,096
MAC-DE042E2/A_B	SAC-SW210	4.36 (4.93)	6.69 (170)	19 (8.6)	4,096
MAC-DA030F/A_B	SAC-SW210	1.84 (2.08)	8.15 (207)	14 (6.5)	32,768
MAC-DA055G/A_B	SAC-SW217	3.12 (3.53)	10.1 (256)	20 (9.0)	32,768
MAC-DA090H/A_B	SAC-SW225	7.95 (8.98)	9.88 (251)	32 (15)	32,768
MAC-DA110J/A_B	SAC-SW225	10.3 (11.6)	11.3 (288)	39 (18)	32,768
MAC-DA140K/A_B	SAC-SW235	12.7 (14.4)	12.9 (328)	45 (21)	32,768
MAC-DB025L/A_B	SAC-SW205	8.14 (9.20)	7.48 (190)	17 (7.9)	32,768
MAC-DB055M/A_B	SAC-SW210	14.0 (15.8)	8.39 (213)	22 (10)	32,768
MAC-DB080N/A_B	SAC-SW217	19.9 (22.5)	9.33 (237)	27 (12)	32,768
MAC-DB100P/A_B	SAC-SW217	35.0 (39.5)	9.09 (231)	43 (20)	32,768
MAC-DB200Q/A_B	SAC-SW225	47.6 (53.8)	10.1 (257)	52 (24)	32,768
MAC-DB300R/A_B	SAC-SW235	66.7 (75.4)	11.5 (291)	64 (29)	32,768
MAC-DB330S/A_B	SAC-SW260	85.7 (96.8)	12.8 (325)	79 (36)	32,768
MAC-DB465T/A_B	SAC-SW260	118 (133)	15.7 (399)	110 (50)	32,768
MAC-DB700U/A_B	SAC-SW260	261 (295)	15.6 (397)	144 (66)	32,768

Table 40**, Specifications for DE/DA/DB-Series Motors with **Absolute Encoders** and **Brakes

6.3.8 Specifications for Fail-Safe Brakes for DE/DA/DB-Series Motors

Servomotor	Servodrive	Holding Torque	Coil Resistance	Coil Voltage	Coil Current
		lb-in (N-m)	ohms (at 20C)	VDC	Amps (at 20C)
MAC-DE003A1/__B	SAC-SW203	4.3 (0.49)	114	24	0.23
MAC-DE006B1/__B	SAC-SW205	8.7 (0.98)	116	24	0.21
MAC-DE008C1/__B	SAC-SW210	17 (1.9)	89	24	0.29
MAC-DE003A2/__B	SAC-SW203	4.3 (0.49)	114	24	0.23
MAC-DE006B2/__B	SAC-SW203	8.7 (0.98)	116	24	0.21
MAC-DE011C2/__B	SAC-SW205	17 (1.9)	89	24	0.29
MAC-DE021D2/__B	SAC-SW205	32 (3.6)	77	24	0.31
MAC-DE042E2/__B	SAC-SW210	63 (7.1)	58	24	0.42
MAC-DA030F/__B	SAC-SW210	66 (7.8)	82	24	0.29
MAC-DA055G/__B	SAC-SW217	66 (7.8)	82	24	0.29
MAC-DA090H/__B	SAC-SW225	177 (20)	59	24	0.41
MAC-DA110J/__B	SAC-SW225	177 (20)	59	24	0.41
MAC-DA140K/__B	SAC-SW235	177 (20)	59	24	0.41
MAC-DB025L/__B	SAC-SW205	39 (4.4)	59	24	0.41
MAC-DB055M/__B	SAC-SW210	112 (13)	59	24	0.41
MAC-DB080N/__B	SAC-SW217	112 (13)	59	24	0.41
MAC-DB100P/__B	SAC-SW217	380 (43)	31	24	0.77
MAC-DB200Q/__B	SAC-SW220	380 (43)	31	24	0.77
MAC-DB300R/__B	SAC-SW220	380 (43)	31	24	0.98
MAC-DB330S/__B	SAC-SW220	646 (73)	25	24	0.98
MAC-DB465T/__B	SAC-SW220	646 (73)	25	24	0.77
MAC-DB700U/__B	SAC-SW220	744 (84)	18	24	1.33

***Table 41**, Specifications for Fail-Safe Brakes for DE/DA/DB-Series Motors*

6.3.9 Mating Connectors for DE/D A/DB-Series Motors Without Brakes

	Mating Connectors (used in cables)	
Motors Without Brakes	**Motor Power Connector**	**Motor Feedback Connector**
DE-Series	MS-3106F18-12S	MS3106F20-29S
DA030F, DA055G, DB025L, DB055M, DB080N	MS-3106F18-10S	MS3106F20-29S
DA090H, DA110J, DA140K, DB100P, DB200Q, DB300R	MS-3106F22-22S	
DB330S, DB465T, DB700U	MS-3106F32-17S	

Table 42, *MAC-D_ Motor Mating Connectors for Motors* ***Without*** *Brakes*

	Mating Connectors (used in cables)	
Motors With Brakes	**Motor Power Connector**	**Motor Feedback Connector**
DE-Series	MS-3106F18-12S	MS3106F20-29S
DA030F, DA055G, DB025L, DB055M, DB080N	MS3106F20-15S	MS3106F20-29S
DA090H, DA110J, DA140K, DB100P, DB200Q, DB300R	MS-3106F24-10S	
DB330S, DB465T, DB700U	MS-3106F32-17S MS-3106F10SL-3S*	

* Brake option requires separate brake cable. Same motor cable is used for motors with and without brake.

Table 43, *MAC-D_ Motor Mating Connectors for Motors* ***With*** *Brakes*

Chapter 7
Maintenance and Troubleshooting

7 Maintenance and Troubleshooting

7.1 ServoWire Drive Troubleshooting Guide

Indication	ALARM@	Status	Description
90-99 ***9A-9F***	144-153 154-159	Internal Drive Error	An unexpected failure has occurred in the ServoWire Drive software or hardware.
Defective hardware or software ⇒ Report error to Ormec Customer Service.			

Indication	ALARM@	Status	Description
A0	160	Drive Over Current (RMS)	The maximum rating for the continuous current output of the drive has been exceeded for more than 2 seconds at peak current.
When enabling axis with Servomotor connected	• Incorrect servomotor wiring ⇒ See Section 0 (page 29) for correct wiring. • Defective Servomotor ⇒ Replace Servomotor		
After applying control power with Servomotor disconnected	• Defective Servodrive ⇒ Replace Servodrive		
Under load or during acceleration.	• Drive and/or motor may be undersized for the application.		

Indication	ALARM@	Status	Description
A1	161	Over Current (Peak)	The maximum rating for the peak current output of the drive or the motor has been exceeded.
When enabling axis from MotionDesk's Direct Mode Window	MP.CONFIG has not yet configured the drive ⇒ Run MP.CONFIG before changing to a torque-producing mode.		

Indication	ALARM@	Status	Description
A2	162	Power Module Fault	The Power Module's self-protection has detected a short circuit, over current, over temperature or control supply under voltage.

Indication	ALARM@	Status	Description
A3 Bus Power LED not on	163	Low Bus Voltage	The bus voltage is too low. The trip point depends on the nominal input voltage, a MotionDesk software setting: • 115 VAC nominal input: trip point = 94 VDC • 230 VAC nominal input: trip point = 205 VDC
When the AC input voltage applied to L1 and L2 is at least 88 VAC	• Input voltage does not match MotionDesk software setting ⇒ Decrease software setting or increase applied AC input voltage.		
	• Main fuses blown or circuit breaker tripped ⇒ Correct main input power problem, and replace fuses or reset circuit breaker.		
	• Defective Servodrive ⇒ Replace Servodrive		
When the AC input voltage applied to L1 and L2 is at least 88 VAC or 166 VAC, depending on MotionDesk software setting	• Main fuses blown or circuit breaker tripped ⇒ Correct main input power problem, and replace fuses or reset circuit breaker		
	• Defective Servodrive ⇒ Replace Servodrive		

	ALARM@	Status	Description
A4	164	High Bus Voltage	The bus voltage is excessive. The trip point depends on the rated voltage of the motor, a MotionDesk software setting: • Motor rated for 115 VAC: trip point = 237 VDC • Motor rated for 230 VAC (or above): trip point = 425 VDC
When power is applied to the main circuit	• Applied voltage exceeds the Servomotor's rating ⇒ Reduce applied voltage. • MotionDesk software settings for ServoWire Drive Input Voltage are lower than desired applied voltage ⇒ Increase setting in MotionDesk software. • Defective Servodrive ⇒ Replace Servodrive		
While motor is in regeneration, or when drives share bus power, if any of the motors is in regeneration. Regeneration may exist during deceleration, or during downward motion in a non-counterbalanced vertical application, or in a tensioned unwind application.	• A regenerative discharge resistor is required by the application but is not present ⇒ Install regen resistor, reduce inertial load, or reduce max speed and/or acceleration. • The regenerative resistor installed has been damaged and is no longer fully functional ⇒ Install higher-wattage regenerative resistor, and reduce inertial load, or reduce max speed and/or acceleration.		

Indication	ALARM@	Status	Description
A5	165	Drive/Project Mismatch	MotionBASIC detected that the drive hardware does not match MotionDesk project settings. Either: • The size of the drive (current rating) doesn't match the drive selected in the MotionDesk project settings. – or – • The drive does not have the auxiliary encoder option (/P), but the MotionDesk project has an axis defined for it. – or – • The drive does not have the absolute encoder option (/A), but the MotionDesk project expects it.

Indication	ALARM@	Status	Description
A6	166	Drive Not Configured	An attempt was made to enable torque before the drive's setup parameters have been configured (MP.CONFIG must be run each time the drive's control power cycles on).

Indication	ALARM@	Status	Description
A7	167	Illegal While Drive Enabled	An attempt was made to write parameters for the 'Number of Poles ' or 'CNT.REV@' to the drive while the drive was enabled. The drive must be disabled before changing these parameters.

Indication	ALARM@	Status	Description
A8	168	Invalid Commutation Position	A Drive configured for a motor with an absolute encoder was commanded to enable when the absolute encoder was discharged, or while the commutation position was invalid, or the ABS output was toggled (ABS@ =ON :ABS@ =OFF) on a Drive configured for an incremental encoder. The commutation position is invalid on a drive *configured for an absolute encoder motor* when: • The Drive is powered up, prior to executing MP.CONFIG • an open encoder line is detected • TRAP.MODE@ is set to TRUE • 'Number Of Poles' is written • 'CNT.REV@' is written The commutation position becomes valid when the absolute encoder's position is read, which is most easily done by executing MP.CONFIG. Refer to the MotionBASIC Help POS.ABS@ chapter for further information regarding reading absolute encoder position. You can reset a discharged absolute encoder by running the following MotionBASIC code fragment. Refer to the MotionBASIC Help ABS.RESET@ chapter for further information. **ABSOLUTE.REZERO.PROCEDURE:** **MODE@(*axis*)=0** **MD.MODE@(*axis*)=0** **ABS.RESET { *axis* } IN 1 , 5*60000 ' Discharge capacitor for 5 minutes (time user units are msecs)** **MP.CONFIG { *axis* } ' Configure *axis*, including position poll of absolute encoder** **RETURN**
A9	169	Phase Loss	MotionBASIC detected the loss of a main power phase.
AA	170	No Bus Voltage	No bus voltage was detected.
AB	171	Soft Start Error	An overtemperature condition was detected in the drive powerblock, or a failure of the inrush current resistor.

Indication	ALARM@	Status	Description
E0	224	ServoWire Protocol Incompatibility	The ServoWire communications protocol in the drive is not compatible with the one in MotionBASIC
Either the drive's firmware should be changed to a version that is compatible with MotionBASIC, or MotionBASIC must be changed to a version that is compatible with the ServoWire Drive.			

Indication	ALARM@	Status	Description
E1	225	ServoWire Timeout	Isochronous communications (i.e. torque commands) from the ServoWire Axis Module were lost (The ServoWire dot will indicate if communications has been re-established).
This normally occurs when the drive has control power, but Orion controller loses control power, or the ServoWire Axis Module fails. In either case, once the cause has been corrected, the alarm can be cleared by setting AFAULT@ to 0 (or by cycling power on the drive).			

Indication	ALARM@	Status	Description
E2	226	ServoWire Cycle Time Exceeded	The loop update rate (LOOP.RATE@) is set too high to allow all the Drives on the network to send their isochronous data packets.

Indication	ALARM@	Status	Description
F0	240	Motor Over Current (RMS)	The motor's rating for continuous current has been exceeded by the actual RMS current for longer than allowed by the thermal time constant of the motor.

Indication	ALARM@	Status	Description
F1	241	Motor Encoder Open Wire	At least one motor encocer feedback channel (ENCA, ENCA', ENCB, ENCB' is not connected properly. (J3 pins 1,2,3,4).

Indication	ALARM@	Status	Description
F2	242	Auxiliary Encoder Open Wire	At least one pacer encoder feedback channel (AUXENCA, AUXENCA', AUXENCB, AUXENCB' is not connected properly. (J4 pins 1,2,3,4)

Indication	ALARM@	Status	Description
F3	243	Invalid Hall State	An unexpected combination of Hall inputs has occurred. Invalid states detected: U,V,W (J3 pins 7,9,11) all on at the same time. U',V',W' (J3 pins 8,10,12) all on at the same time. U,V,W (J3 pins 7,9,11) all off at the same time. U',V',W' (J3 pins 8,10,12) all off at the same time.
When enabling axis	• Bad feedback cable ⇒ Check pins above (see cable diagrams in Appendix E) • Wrong axis feedback type selected in MotionDesk Software settings ⇒ Correct software.		

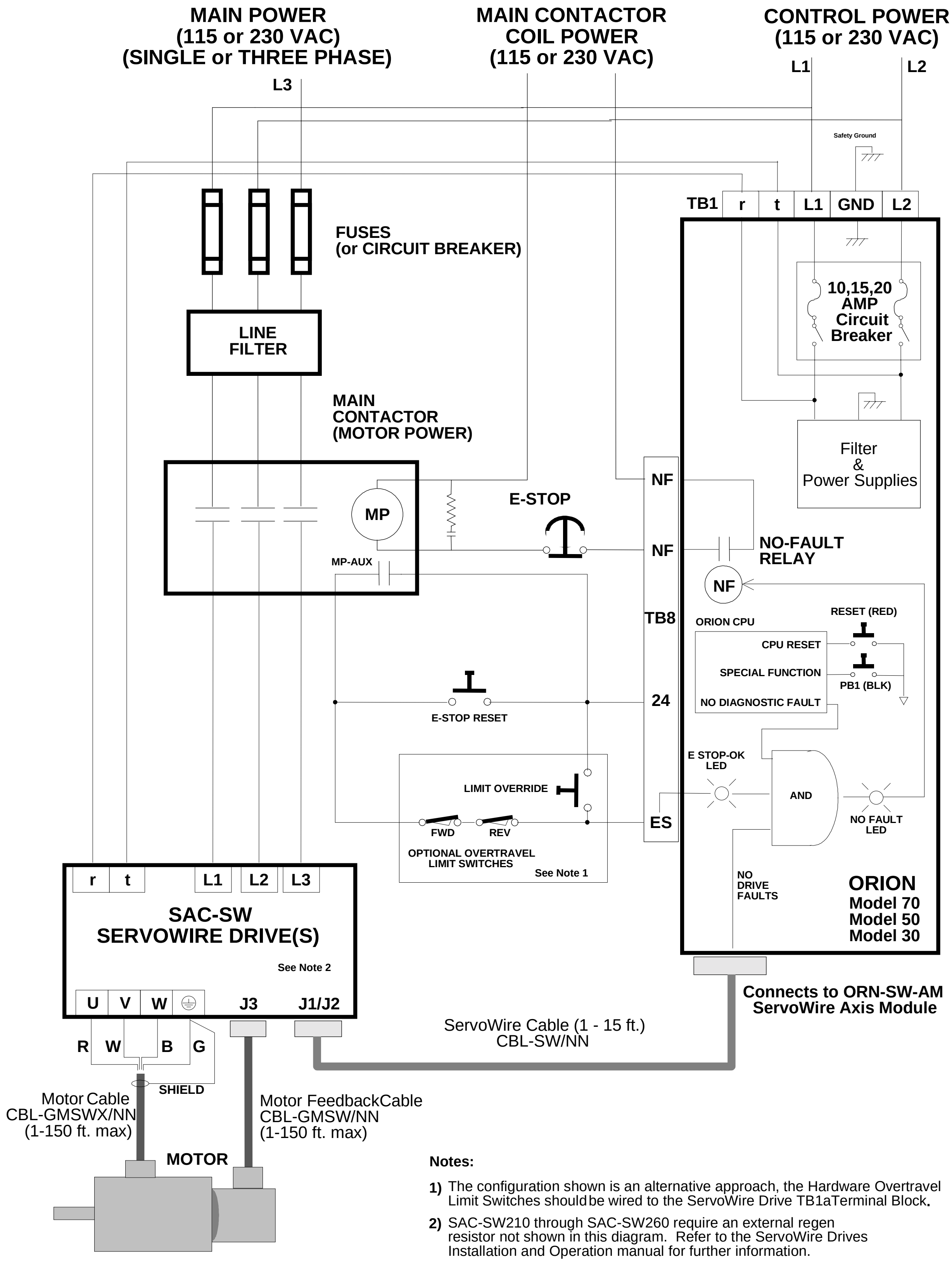
Indication	ALARM@	Status	Description

<table>
<tr><td>F4
HITEMP
LED is on</td><td>244</td><td>Motor Over Temperature</td><td>The thermal contact has opened (J3 pins 19 & 20) indicating that the motor is over temperature. This condition can not be reset until the motor has sufficiently cooled.</td></tr>
<tr><td colspan="3">When the motor is hot</td><td>• Motor is overloaded ⇒ Reduce motor load
• Excessive ambient temperature ⇒ Reduce ambient temperature to 25ºC</td></tr>
<tr><td colspan="3">When the motor is cool to the touch</td><td>• Faulty motor feedback wiring ⇒ Check cable and all termination points.
• Defective thermal switch in motor ⇒ Disconnect motor and test for continuity at motor pins. (See motor pinouts in Appendix E).
• Motor has no thermal switch, and MotionDesk software settings are configured to expect a closed contact. ⇒ Disable Thermal Contact in MotionDesk Axis Configuration
• Defective Servodrive ⇒ Replace Servodrive</td></tr>
</table>

7.2 Servomotor Troubleshooting Guide

Problem	Cause	What to do
Motor does not start	Loose Connection ⇒ Tighten connection	
	Wrong wiring ⇒ Correct wiring	
	Overload ⇒ Reduce load or use a larger motor	
	Motor defective	Measure voltage across motor terminals U, V, & W on the Servodrive. If correct, replace motor, otherwise replace servodrive.
	Servodrive Defective	
Locked Rotor	Wrong order of U, V, W	Check cabling.
Unstable Operation	Wrong motor selected in MotionDesk	Check & correct that software matches motor.
	Improper Tuning	Check that Inertial load specified in MotionDesk is less than or equal to the actual load seen by the motor. Check other tuning parameters.
	Wrong Wiring	Inspect and correct wiring of motor terminals U, V, & W and/or the encoder.
Motor Overheats	Excessive ambient temperature	Reduce ambient temperature below 40ºC, or use a larger motor.
	Motor dirty	Clean motor surface
	Overload	Reduce load or use a larger motor.
Unusual Noise	Motor loosely mounted	Tighten mounting bolts
	Motor misaligned	Realign
	Coupling out of balance	Balance coupling
	Noisy bearing	Check alignment, loading of bearing, lubrication.
	Vibration of driven machine	Check the machine's mechanical operation.
	Improper grounding and/or shielding	Check the servomotor, servodrive, and power supply grounding and shielding.
	Incorrect servo control loop tuning	Check the servo control loop tuning parameters.
Poor Velocity Regulation	Single phase main power (L1 & L2 only) on a drive expecting 3-phase power (SAC-SW210, SAC-SW217, SAC-SW220)	Use 3-phase power.
WARNING!!! **Turn off power before working on the Servomotor**		

Appendix A: System Wiring Diagram

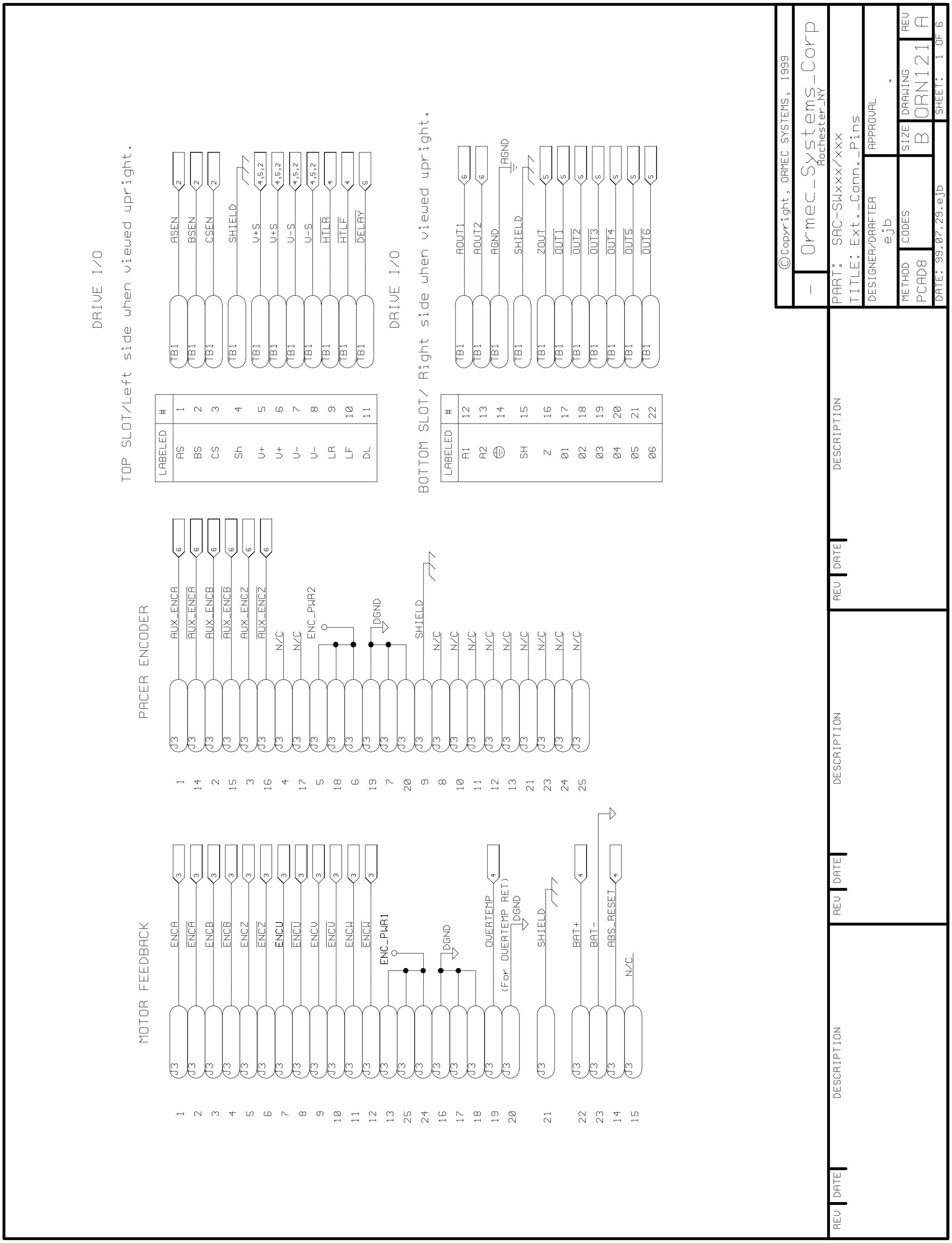


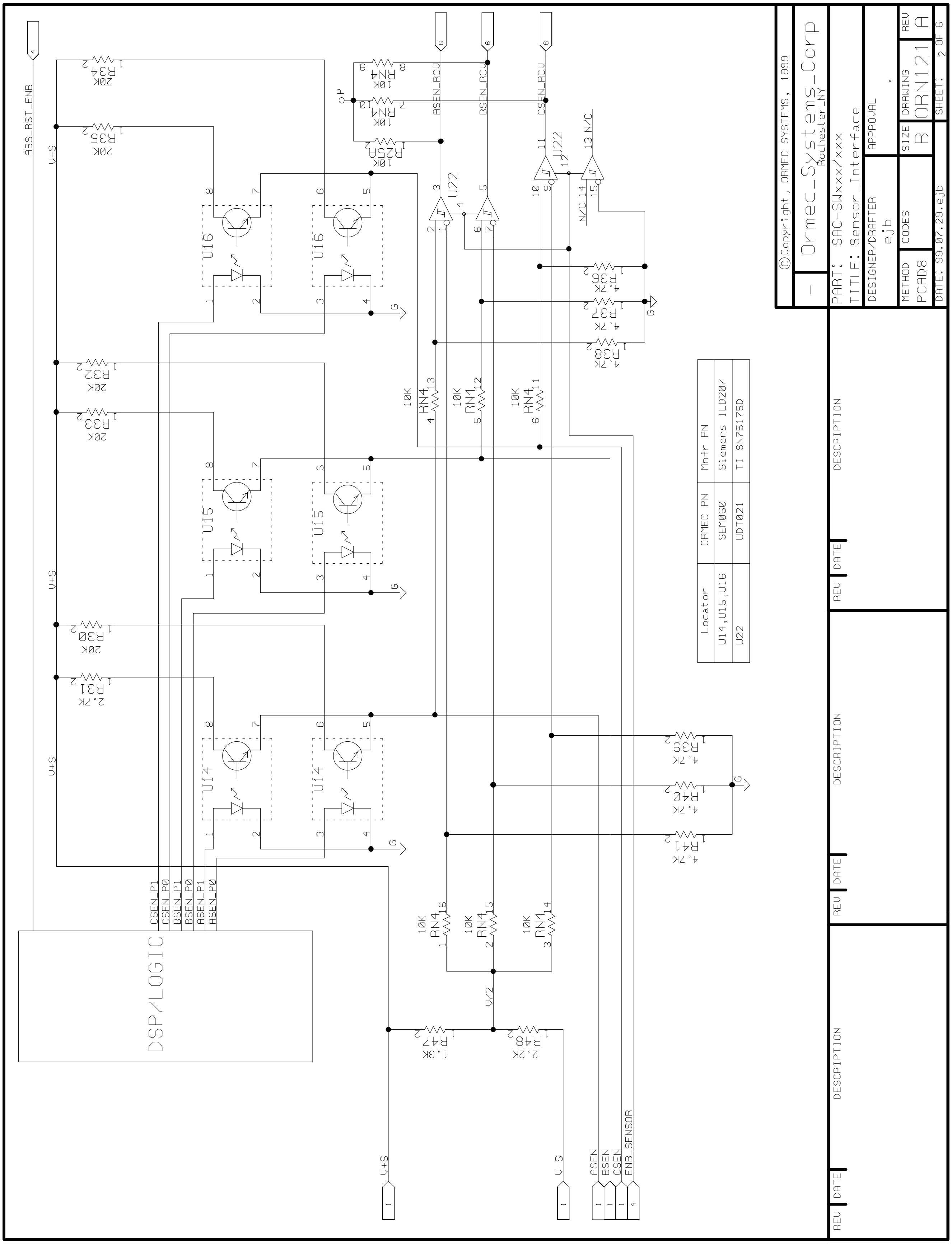
Notes:

1) The configuration shown is an alternative approach, the Hardware Overtravel Limit Switches should be wired to the ServoWire Drive TB1aTerminal Block.

2) SAC-SW210 through SAC-SW260 require an external regen resistor not shown in this diagram. Refer to the ServoWire Drives Installation and Operation manual for further information.

Appendix B: ServoWire Drive I/O Schematics




©Copyright, ORMEC SYSTEMS, 1999
Ormec_Systems_Corp
Rochester_NY
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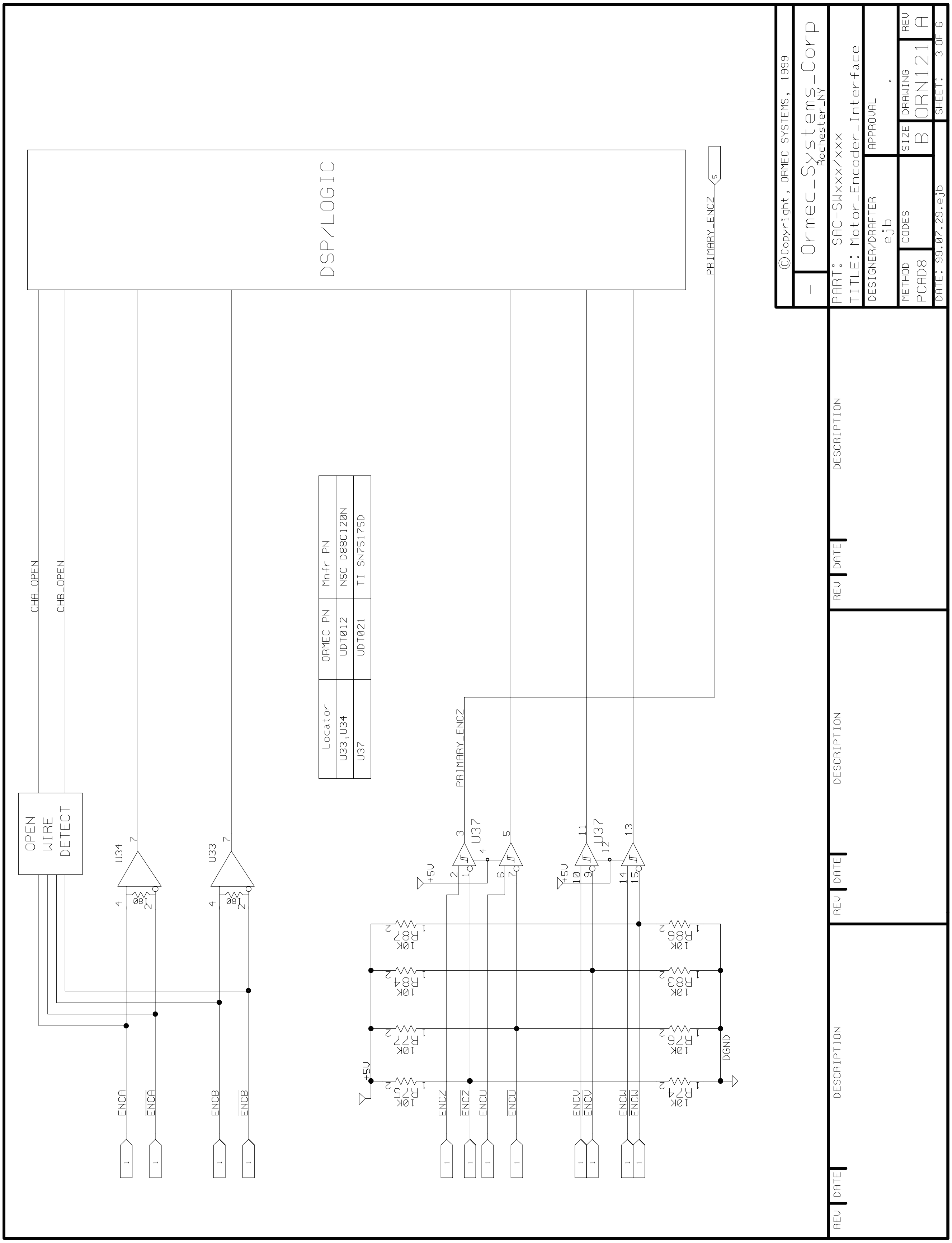
TITLE: Sensor_Interface
DESIGNER/DRAFTER
ejb
APPROVAL
METHOD
PCAD8
CODES
SIZE
B
DRAWING
ORN121
REV
A
DATE: 99.07.29.ejb
SHEET: 2 OF 6
Locator
U14,U15,U16
U22
ORMEC PN
SEM060
UDT021
Mnfr PN
Siemens ILD207
TI SN75175D
DSP/LOGIC
ABS_RST_ENB
CSEN_P1
CSEN_P0
BSEN_P1
BSEN_P0
ASEN_P1
ASEN_P0
ASEN_RCV
BSEN_RCV
CSEN_RCV
V+S
V-S
V/2
ASEN
BSEN
CSEN
ENB_SENSOR
DESCRIPTION
REV
DATE



DSP/LOGIC
PRIMARY_ENCZ
CHA_OPEN
CHB_OPEN
OPEN WIRE DETECT
U34
U33
U37
+5V
DGND
ENCA
ENCB
ENCZ
ENCU
ENCV
ENCW
10K
R87
R84
R77
R75
R86
R83
R76
R74
Locator | ORMEC PN | Mnfr PN
U33,U34 | UDT012 | NSC DS8C120N
U37 | UDT021 | TI SN75175D
©Copyright, ORMEC SYSTEMS, 1999
Ormec_Systems_Corp
Rochester_NY
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TITLE: Motor_Encoder_Interface
DESIGNER/DRAFTER ejb
APPROVAL
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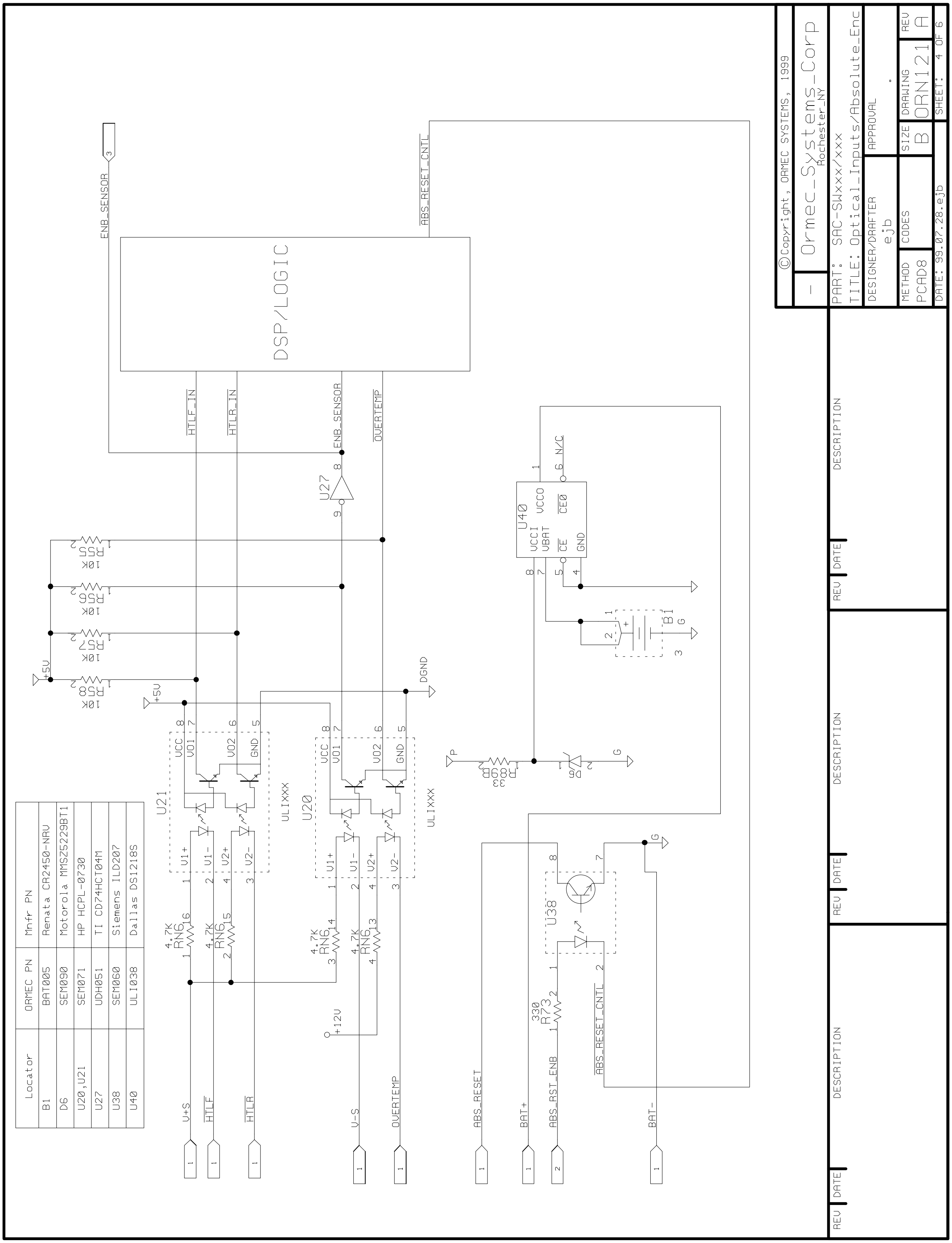
CODES
SIZE B
DRAWING ORN121
REV A
DATE: 99.07.29.ejb
SHEET: 3 OF 6
REV DATE DESCRIPTION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Ormec_Systems_Corp
Rochester_NY
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ejb
APPROVAL
METHOD
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CODES
SIZE
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DRAWING
ORN121
REV
A
DATE: 99.07.28.ejb
SHEET: 4 OF 6
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ABS_RESET_CNTL
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HTLR_IN
OVERTEMP
U27
U40
VCCI
VBAT
CE
GND
VCCO
CE0
N/C
B1
U21
U20
ULIXXX
U38
R73
330
D6
R33
R89B
R55
R56
R57
R58
10K
RN6
4.7K
+5V
+12V
DGND
V+S
HTLF
HTLR
V-S
ABS_RESET
BAT+
ABS_RST_ENB
BAT-
Locator
ORMEC PN
Mnfr PN
B1 BAT005 Renata CR2450-NRV
D6 SEM090 Motorola MMSZ5229BT1
U20,U21 SEM071 HP HCPL-0730
U27 UDH051 TI CD74HCT04M
U38 SEM060 Siemens ILD207
U40 ULI038 Dallas DS1218S
REV
DATE
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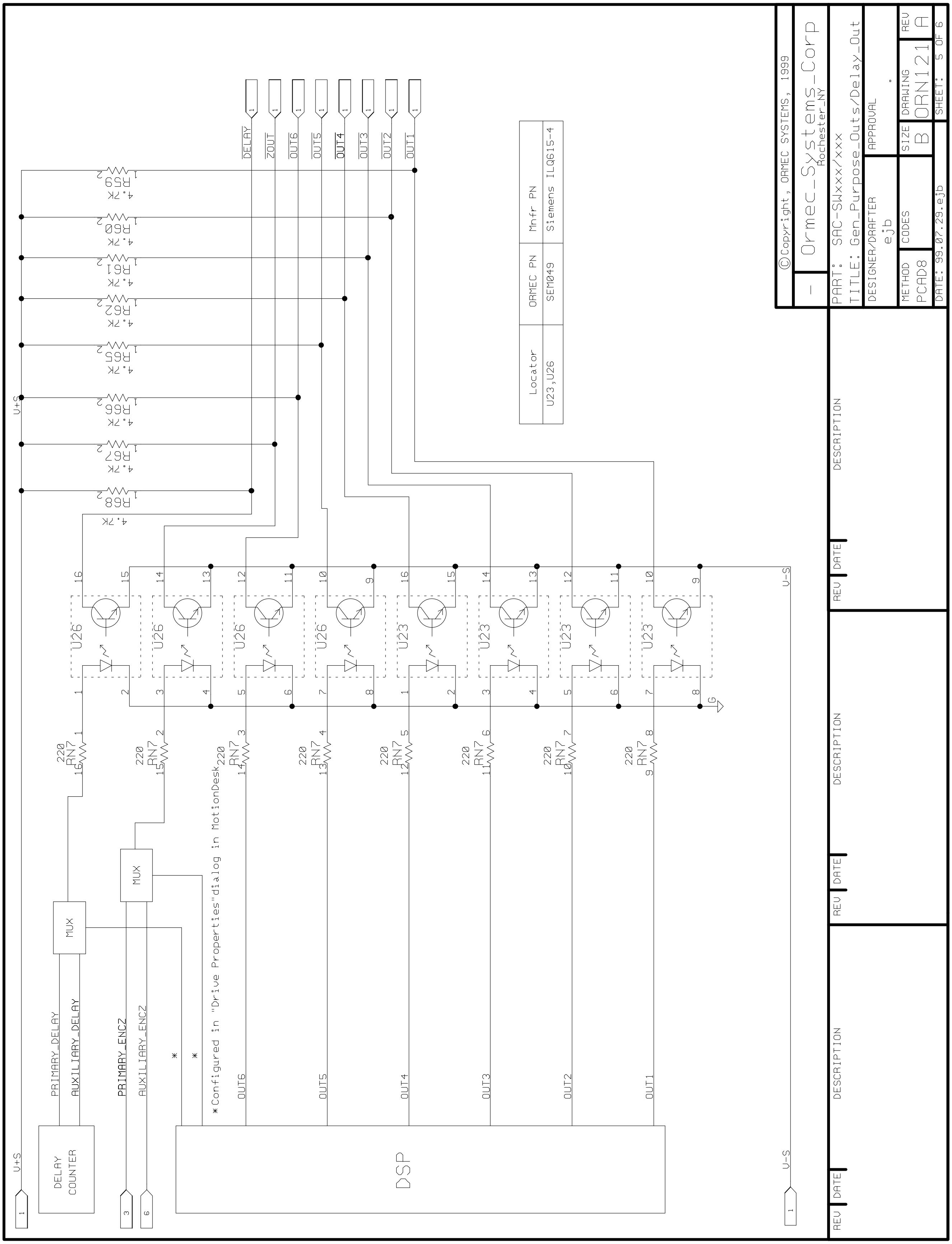
DELAY
ZOUT
OUT6
OUT5
OUT4
OUT3
OUT2
OUT1
V+S
V-S
DELAY COUNTER
MUX
MUX
DSP
PRIMARY_DELAY
AUXILIARY_DELAY
PRIMARY_ENCZ
AUXILIARY_ENCZ
*Configured in "Drive Properties" dialog in MotionDesk
Locator U23,U26
ORMEC PN SEM049
Mnfr PN Siemens ILQ615-4
©Copyright, ORMEC SYSTEMS, 1999
Ormec_Systems_Corp
Rochester_NY
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DESIGNER/DRAFTER ejb
APPROVAL
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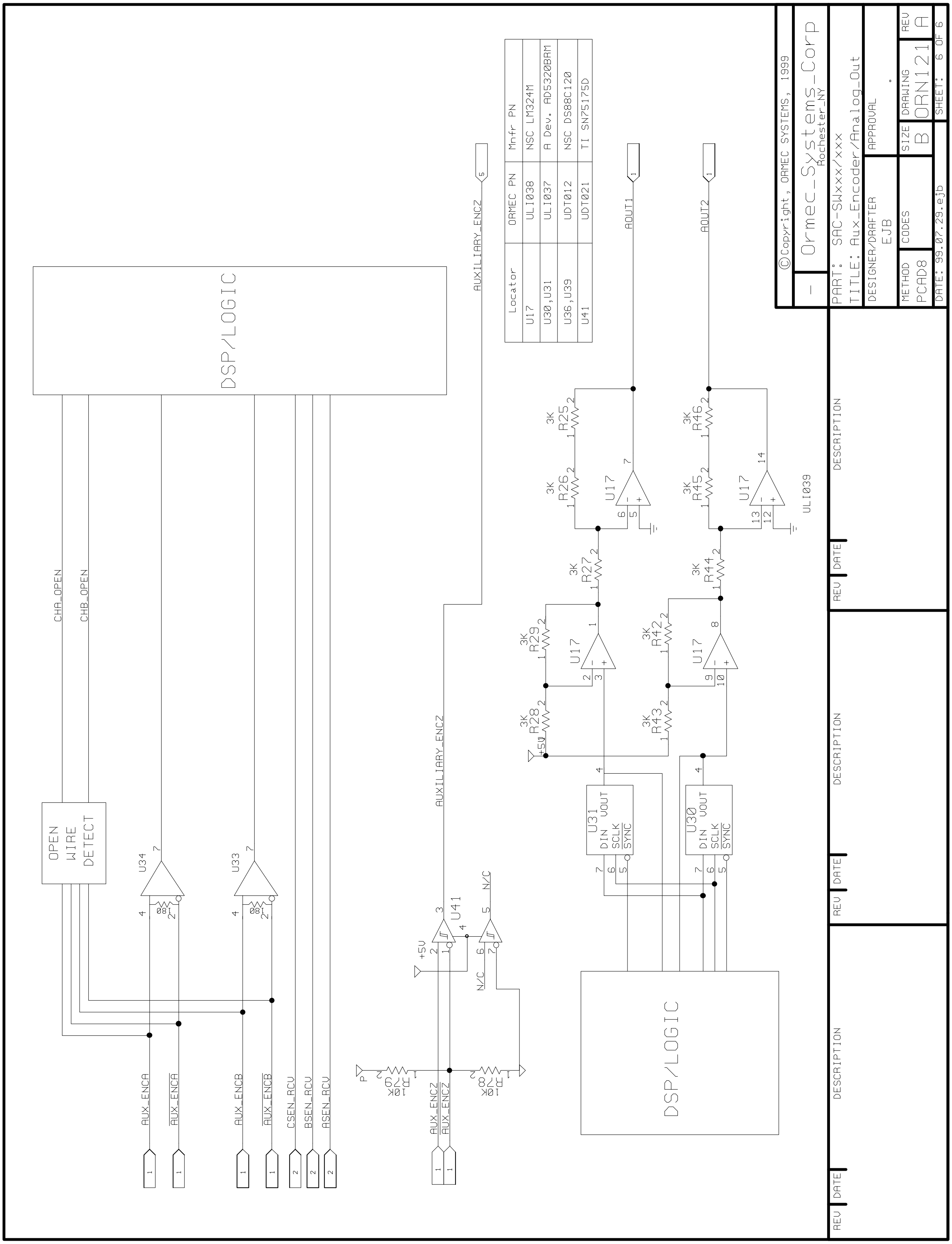
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AUX_ENCA
AUX_ENCA
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CSEN_RCV
BSEN_RCV
ASEN_RCV
AUX_ENCZ
AUX_ENCZ
U30
U31
U33
U34
U41
U17
DIN
SCLK
SYNC
VOUT
ULI039
Locator | ORMEC PN | Mnfr PN
U17 | ULI038 | NSC LM324M
U30,U31 | ULI037 | A Dev. AD5320BRM
U36,U39 | UDT012 | NSC DS8C120
U41 | UDT021 | TI SN75175D
©Copyright, ORMEC SYSTEMS, 1999
Ormec_Systems_Corp
Rochester_NY
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TITLE: Aux_Encoder/Analog_Out
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EJB
APPROVAL
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ORN121
REV
A
DATE: 99.07.29.ejb
SHEET: 6 OF 6
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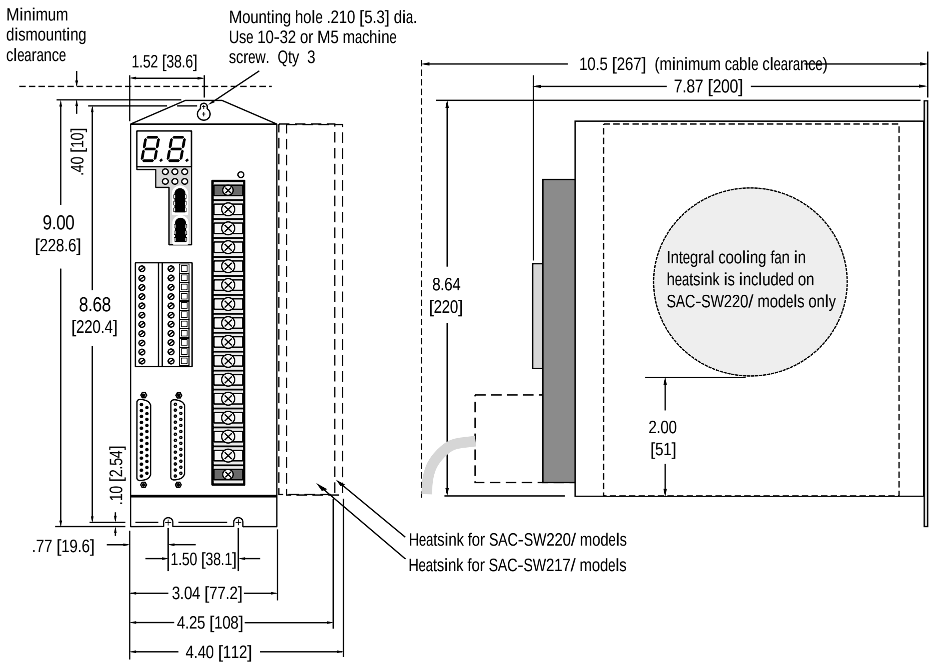
DATE

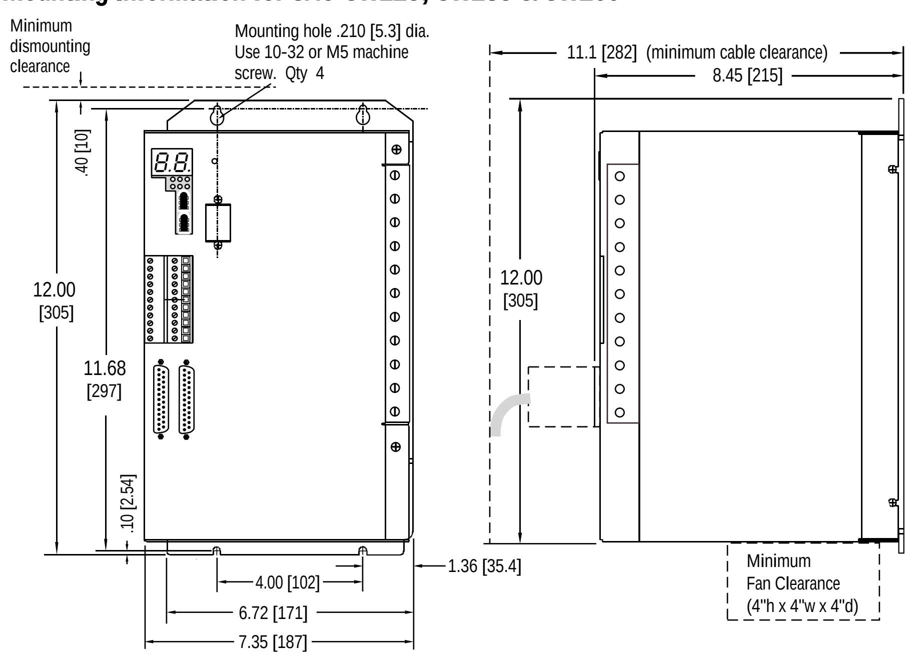
Appendix C: ServoWire Drive & Component Outline Drawings

ServoWire Drive

Mounting Information for SAC-SW203, SW205, SW210, SW217 & SW220



Mounting Information for SAC-SW225, SW235 & SW260



All dimensions in inches [mm]

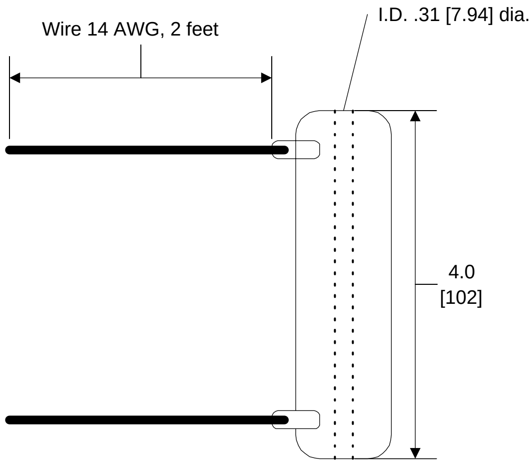
Additional clearance above, below and to the sides of the ServoWire Drives is also required for heat dissipation:
SAC-SW203, SAC-SW205 and SAC-SW210
Add 2” (51 mm) clearance top and bottom.
Add 1” (25 mm) clearance each side.

SAC-SW217
Add 2” (51 mm) clearance top and bottom.
Add 1.2” (31 mm) clearance each side.

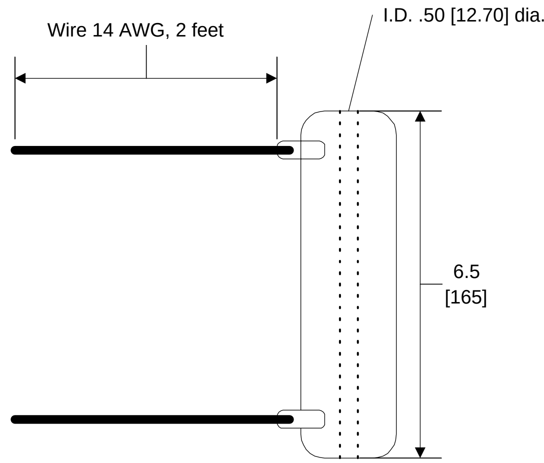
SAC-SW220
Add 2” (51 mm) clearance top and bottom.
Add 1” left-side, 2” (51 mm) right-side clearance

SAC-SW225, **SAC-SW235** and **SAC-SW260**
Add 2” (51 mm) clearance.
Add 4” (102 mm) clearance bottom.
Add 1” (25 mm) clearance each side.

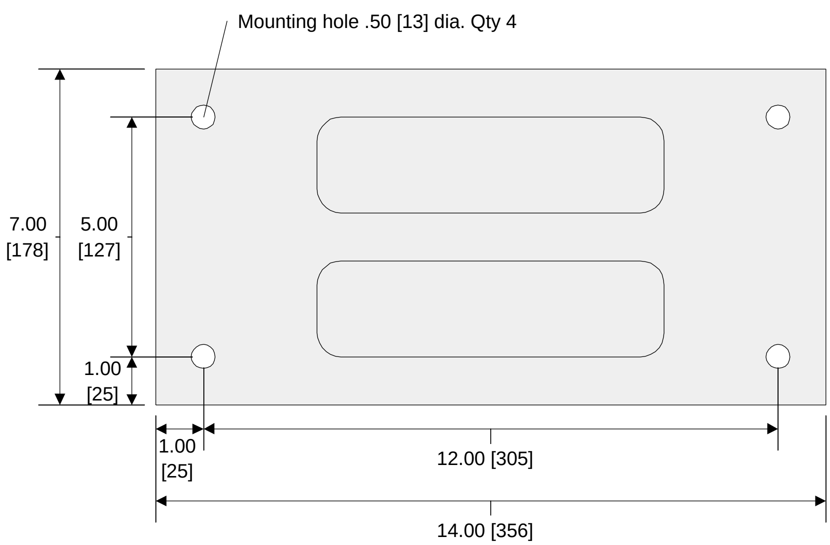
Regen Resistors



SAC-SWRR/0055

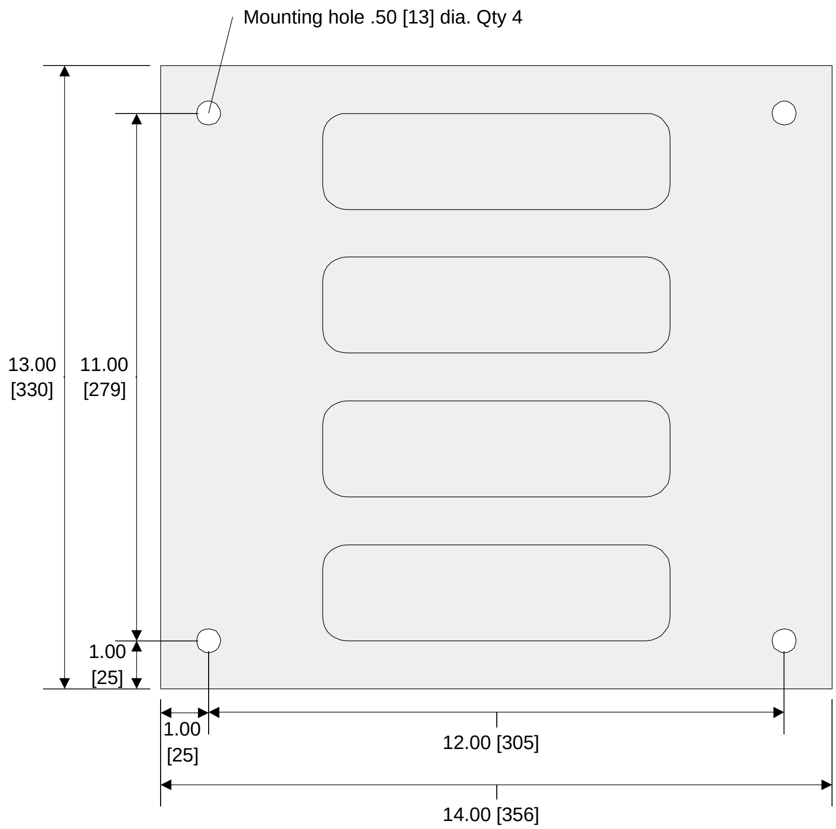


SAC-SWRR/0095



SAC-SWRR/0700, 0845, 0846

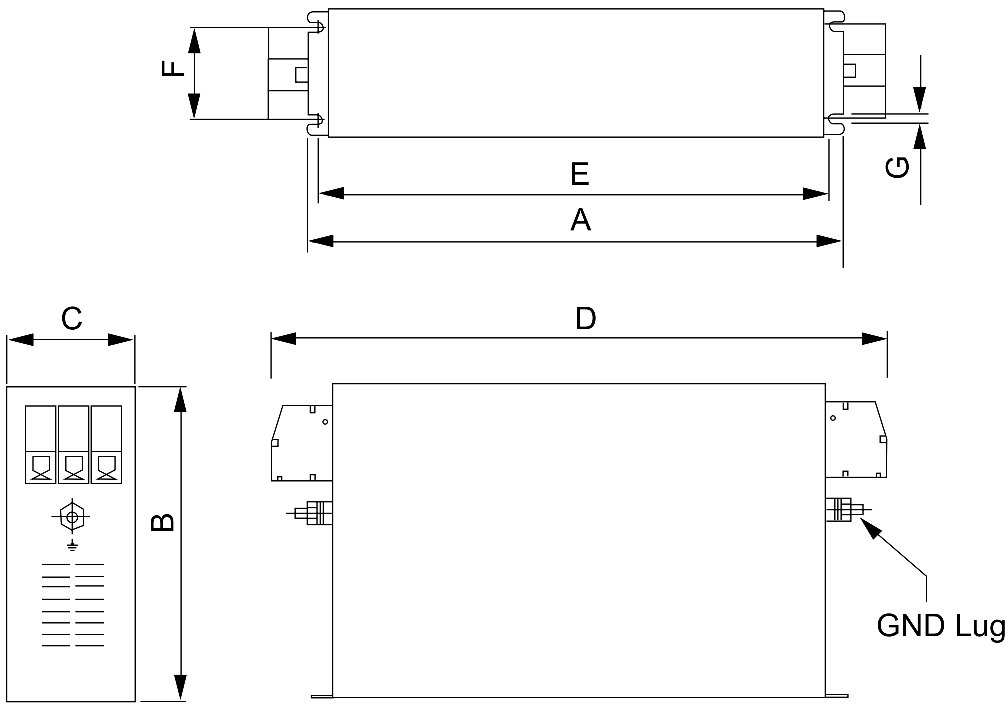
All dimensions in inches [mm]



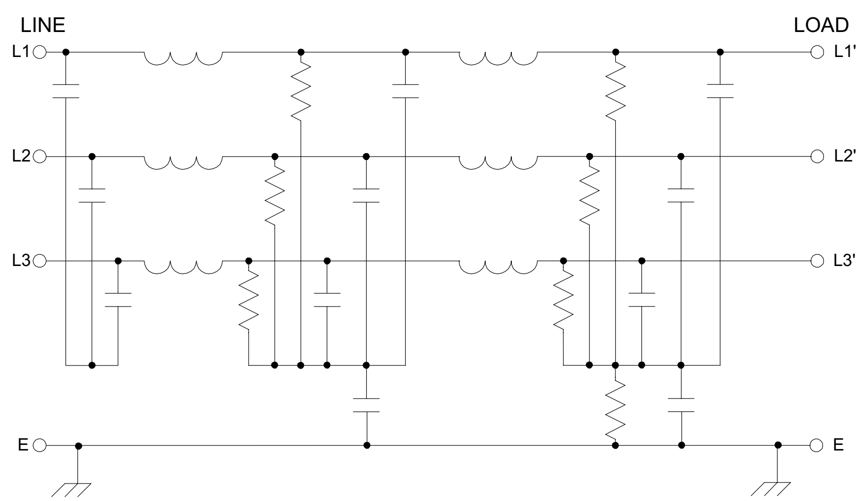
SAC-SWRR/1700

All dimensions in inches [mm]

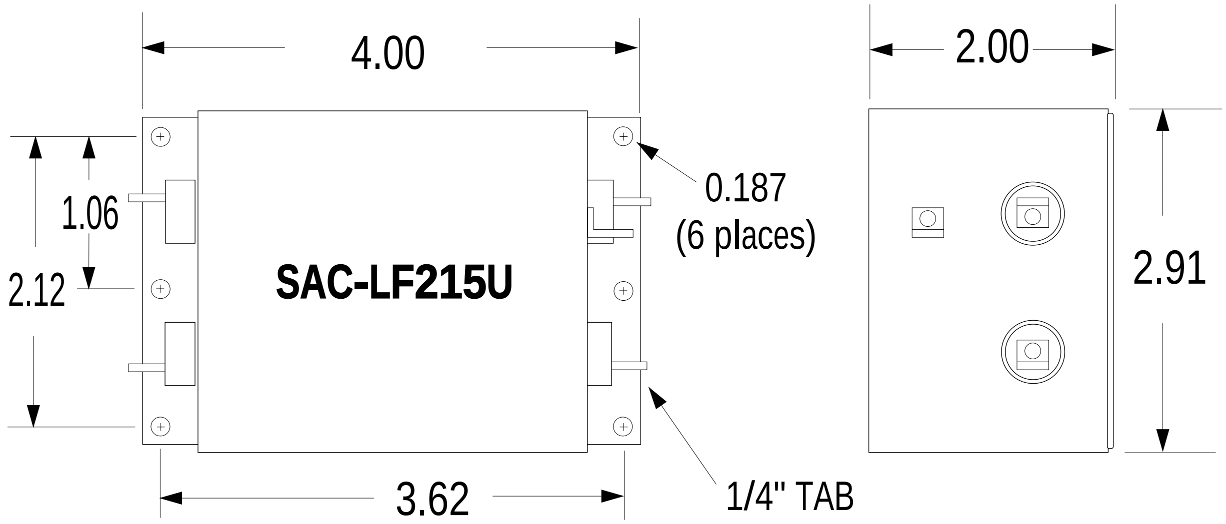
Line Filters: SAC-LF30C, 55C, & 100C



Line Filter	A	B	C	D	E	F	G	Units	GND Lug	Max. Wire Gauge
SAC-LF30C	13.2	5.9	2.4	13.9	12.6	1.4	0.3	inches	M5	6 AWG
	335	150	60	354	320	35	6.5	mm		10 mm2
SAC-LF55C	13.0	7.3	3.1	14.8	12.4	2.2	0.3	inches	M6	3 AWG
	329	185	80	377	314	55	6.5	mm		25 mm2
SAC-LF100C	14.9	8.7	3.5	17.2	14.3	2.6	0.3	inches	M10	1/0 AWG
	379	220	90	436	364	65	6.5	mm		50 mm2

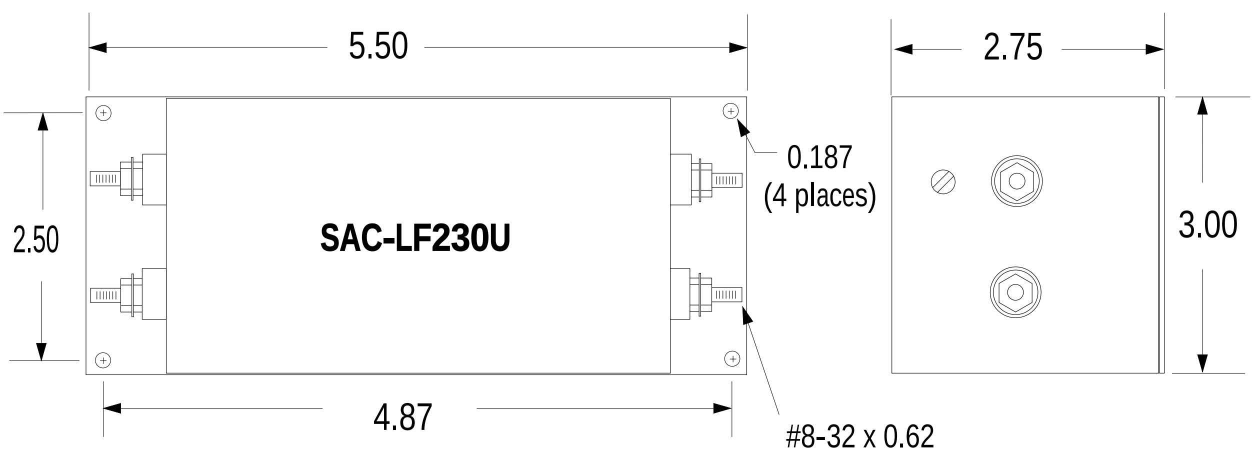


Line Filters: SAC-LF215U



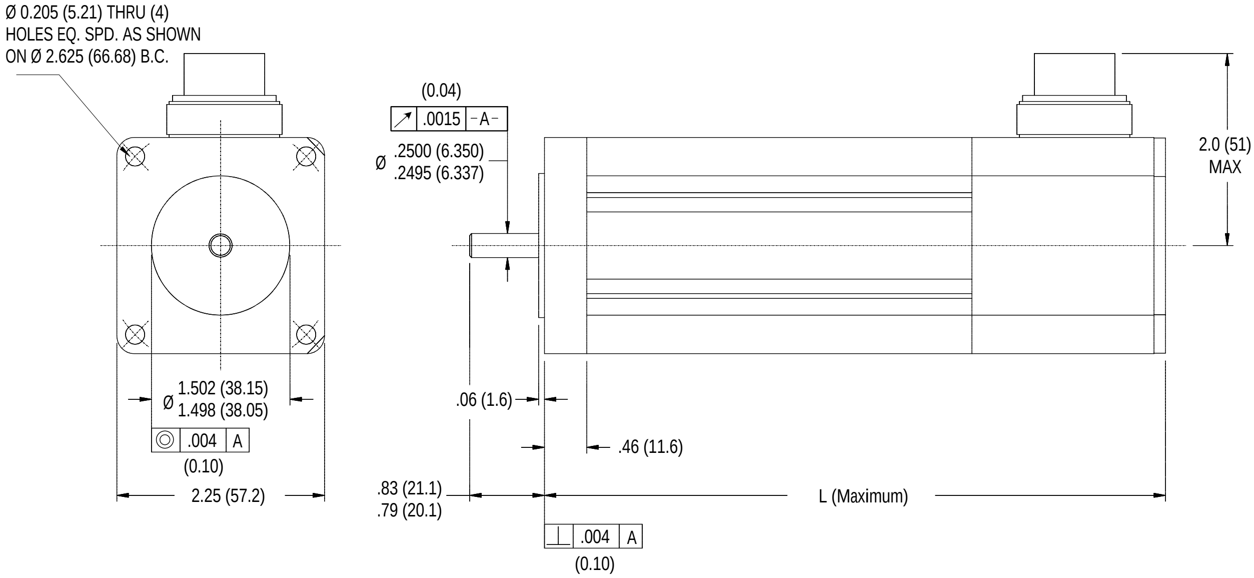
All dimensions in inches

Line Filters: SAC-LF230U



All dimensions in inches

MAC-G005, G010 English Frames (size 23)

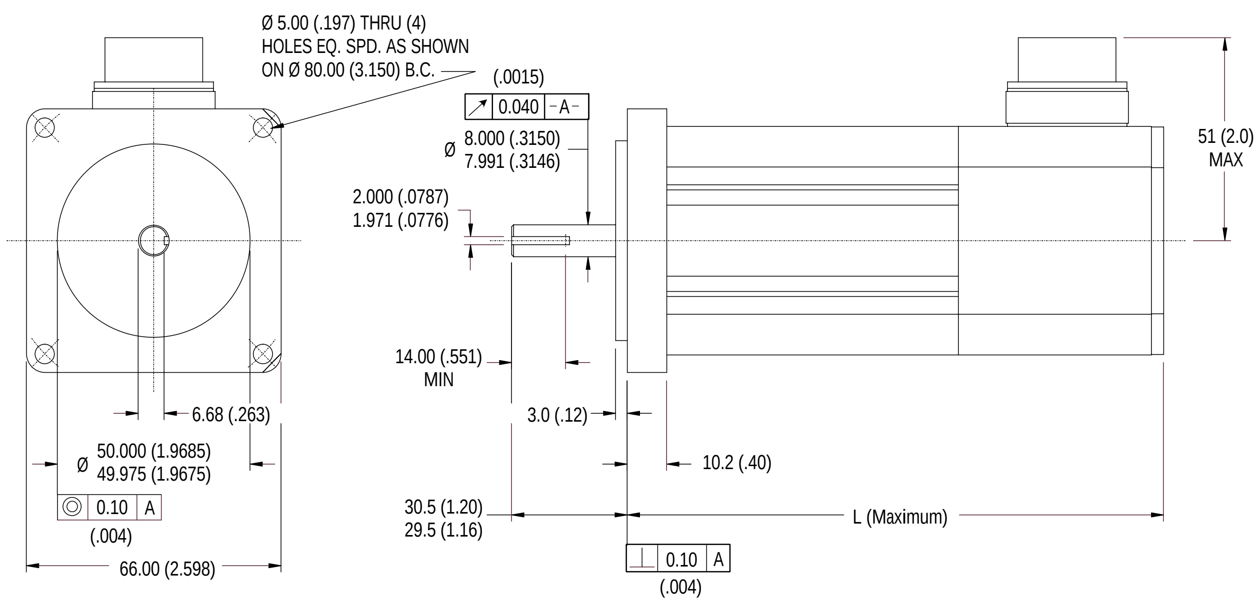


Motor	L* (Maximum)
MAC-G005A1/E MAC-G005B1/E	5.6 (143)
MAC-G010A1/E MAC-G010B1/E	6.8 (173)

Notes:
1. Min. cable clearance from motor centerline for the Motor cable is 7.0 inches (178 mm)
2. Brake option adds 1.2 (30.5) to L

All dimensions are in inches (mm)

MAC-G005, G010 Metric Frames

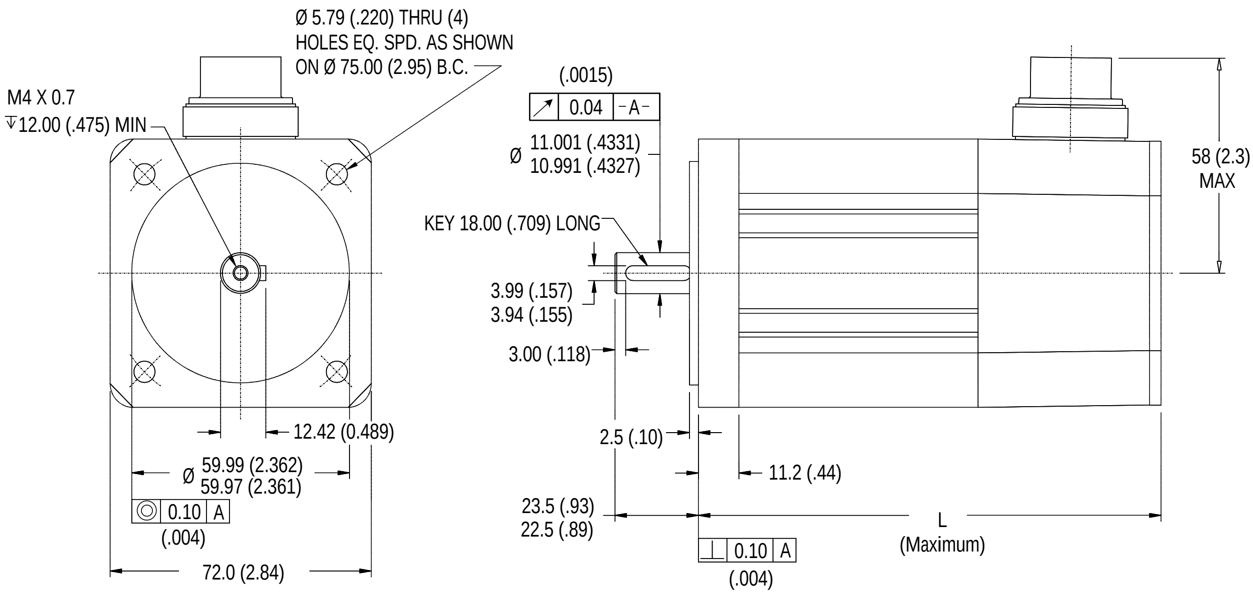


Motor	L* (Maximum)
MAC-G005A1/M MAC-G005B1/M	140.0 (5.5)
MAC-G010A1/M MAC-G010B1/M	170.0 (6.7)

Notes:
1. Minimum cable clearance from motor centerline for the Motor cable is 178 mm (7.0 inches)
2. Brake option adds 30.5 (1.2) to L

All dimensions are in mm (inches)

MAC-G006, G011, G015, G019 Metric Frames

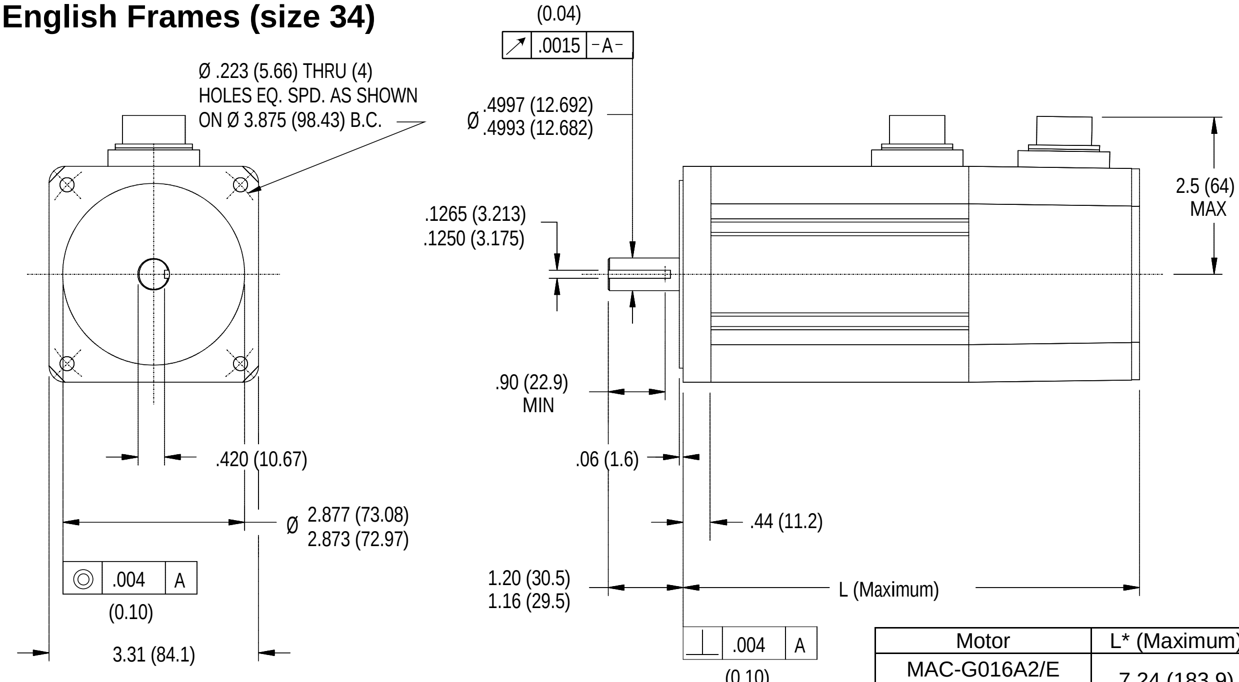


Motor	L (Maximum)
MAC-G006A1/M MAC-G006A2/M	128.1 (5.05)
MAC-G011A1/M MAC-G011A2/M MAC-G011B2/M	147.3 (5.8)
MAC-G015A1/M MAC-G015A2/M MAC-G015B2/M	166.4 (6.55)
MAC-G019A1/M MAC-G019A2/M MAC-G019B2/M	185.4 (7.3)

Notes:
1. Minimum cable clearance from motor centerline for the Motor cable is 191 mm (7.5 inches)
2. Brake option adds 30.5 (1.2) to L

All dimensions are in mm (inches)

MAC-G016, G030, G040 English Frames (size 34)



Motor	L* (Maximum)
MAC-G016A2/E MAC-G016B2/E	7.24 (183.9)
MAC-G030A2/E MAC-G030B2/E	8.74 (222.0)
MAC-G040A2/E MAC-G040B2/E	10.24 (260.1)

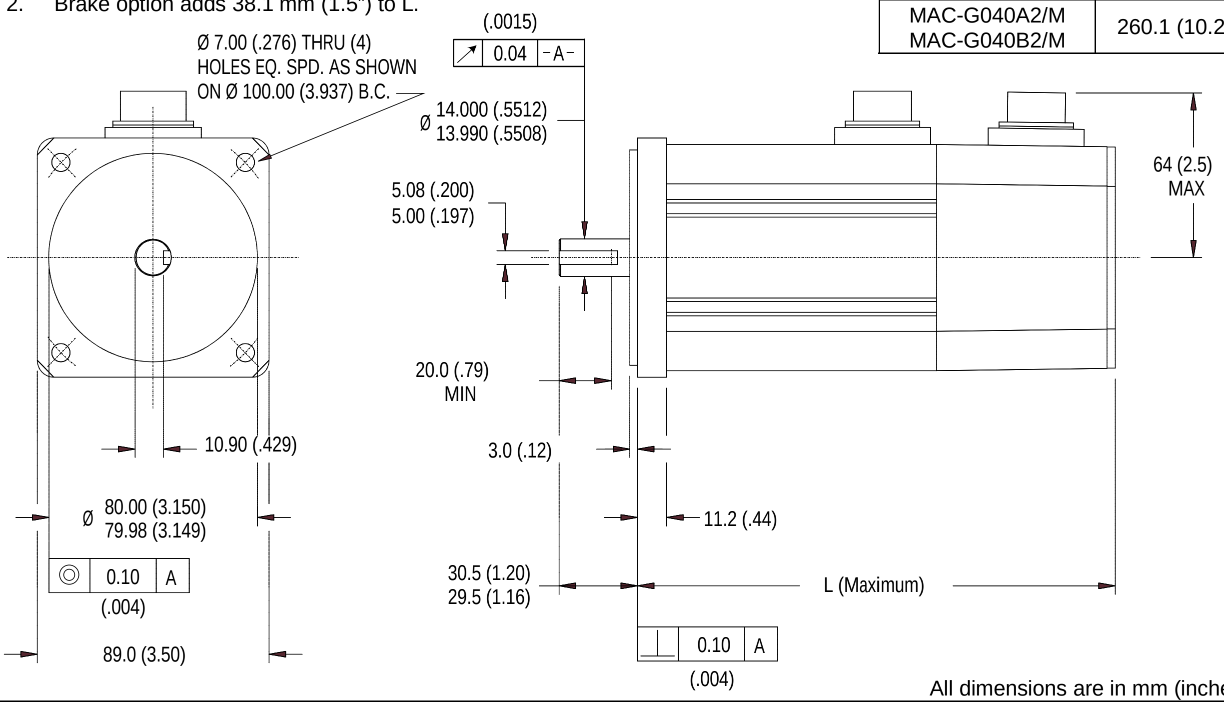
Notes:
1. Minimum cable clearance from motor centerline for the Encoder cable is 7.0 inches (178 mm); for the Motor cable it is 7.0 inches (178 mm).
2. Brake option adds 1.5 (38.1) to L

All dimensions are in inches (mm)

MAC-G016, G030, G040 Metric Frames

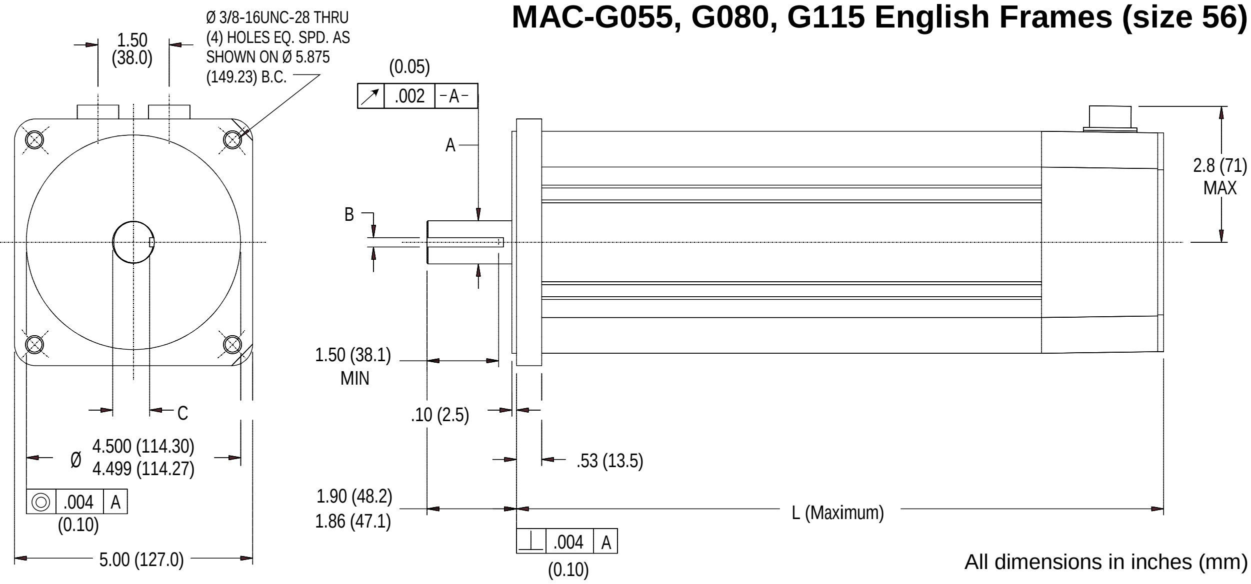
Motor	L* (Maximum)
MAC-G016A2/M MAC-G016B2/M	183.9 (7.24)
MAC-G030A2/M MAC-G030B2/M	222.0 (8.74)
MAC-G040A2/M MAC-G040B2/M	260.1 (10.24)

Notes:
1. Minimum cable clearance from the motor center line for the Encoder cable is 178 mm (7.0 inches); for the Motor cable it is 178 mm(7.0 inches)
2. Brake option adds 38.1 mm (1.5”) to L.



All dimensions are in mm (inches)

MAC-G055, G080, G115 English Frames (size 56)



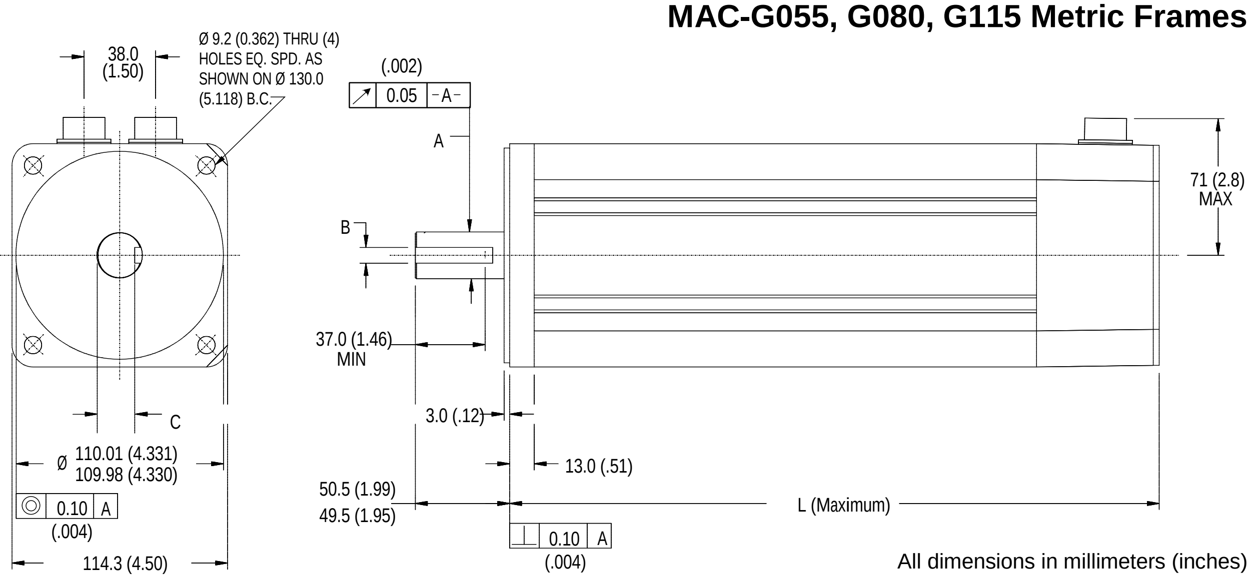
All dimensions in inches (mm)

Motor	A	B	C	L* (Max)
MAC-G055A2/E MAC-G055A4/E	.6245 (15.86) .6241 (15.85)	.1890 (4.80) .1875 (4.76)	.51 (13.0)	8.61 (218.7)
MAC-G080A2/E MAC-G080A4/E	8750 (22.23) .8745 (22.21)		.77 (19.6)	11.11 (282.2)
MAC-G115A2/E MAC-G115A4/E				13.61 (345.7)

Notes:

1. Minimum cable clearance from motor centerline for Encoder cable is 7.5 inches (191 mm); for the Motor cable it is 7.5 inches (191 mm)
2. Brake Option adds 2.0 (51) to L

MAC-G055, G080, G115 Metric Frames



All dimensions in millimeters (inches)

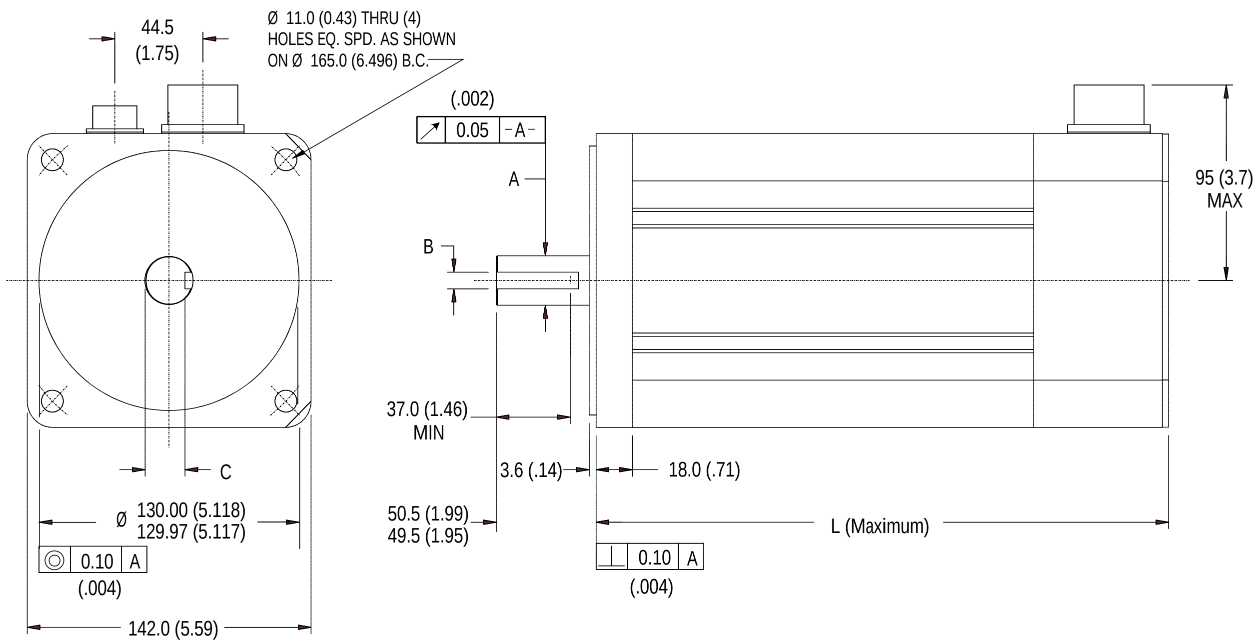
Motor	A	B	C	L* (Max)
MAC-G055A2 MAC-G055A4	19.000 (.7480) 18.987 (.7475)	6.00 (.240)	15.5 (.61)	218.2 (8.59)
MAC-G080A2 MAC-G080A4	24.000 (.9449) 23.987 (.9444)	8.00 (.315) 7.96 (.313)	20.0 (.79)	281.7 (11.09)
MAC-G115A2 MAC-G115A4				345.2 (13.59)

Notes:

1. Minimum cable clearance from motor centerline for Encoder cable is 191 mm (7.5 inches); for the Motor cable it is 191 mm (7.5 inches)
2. Brake Option adds 2.0 (51) to L

MAC-G130, G210, G280, G360 Metric Frames

All dimensions in millimeters (inches)



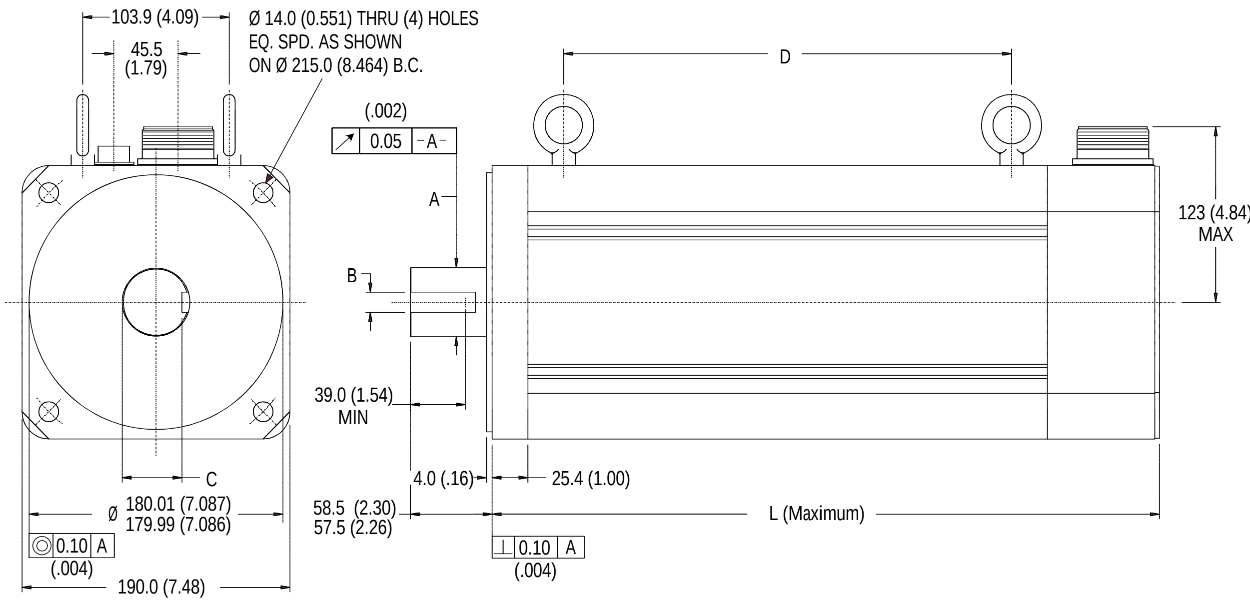
Motor	A	B	C	L* (Max)
MAC-G130A2 MAC-G130A4	24.000 (.9449) 23.987 (.9444)	8.00 (.315) 7.96 (.313)	20.0 (.79)	287.0 (11.29)
MAC-G210A2 MAC-G210A4				355.0 (13.99)
MAC-G280A2 MAC-G280A4	32.000 (1.2598) 31.987 (1.2593)	10.00 (.394) 9.96 (.392)	27.0 (1.06)	423.0 (16.69)
MAC-G360A2 MAC-G360A4				492.5 (19.39)

Notes:

1. Minimum cable clearance from Motor centerline for Encoder cable is 178 mm(7.0 inches); for the Motor cable it is 204 mm (8.0 inches)
2. Brake Option adds 68.6 (2.7) to L

MAC-G400, G640, Metric Frames

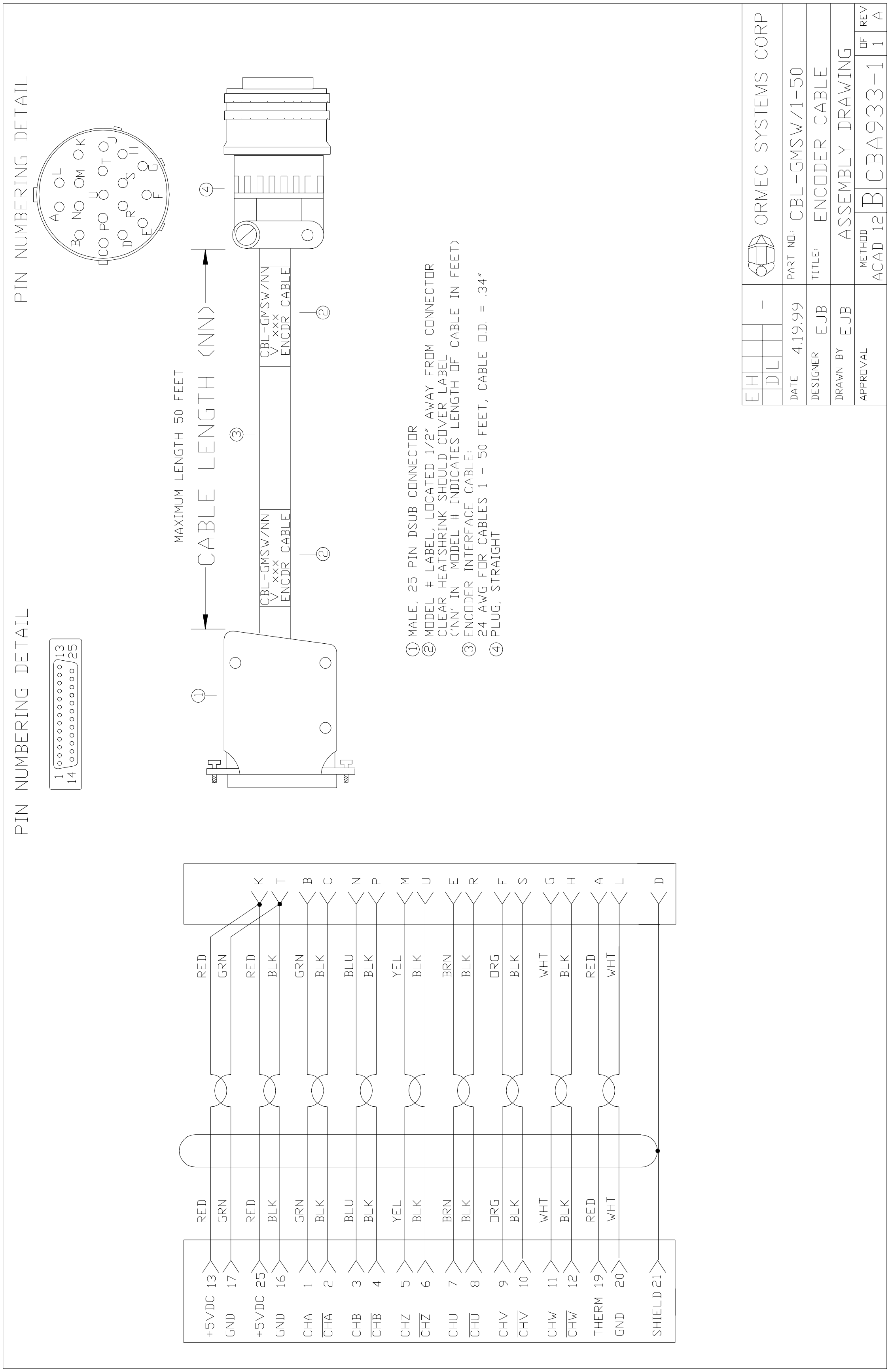
All dimensions are in millimeters (inches)

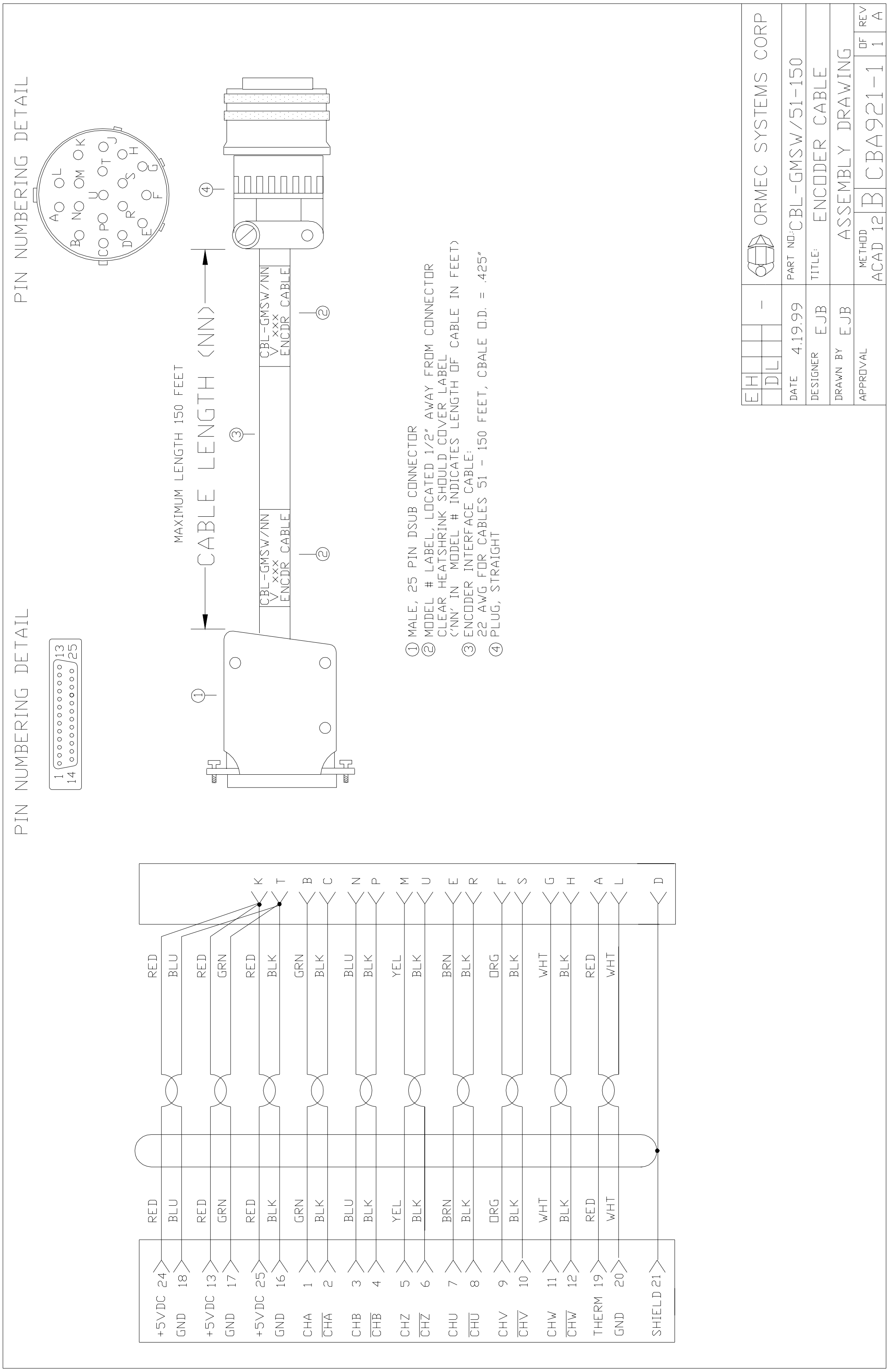


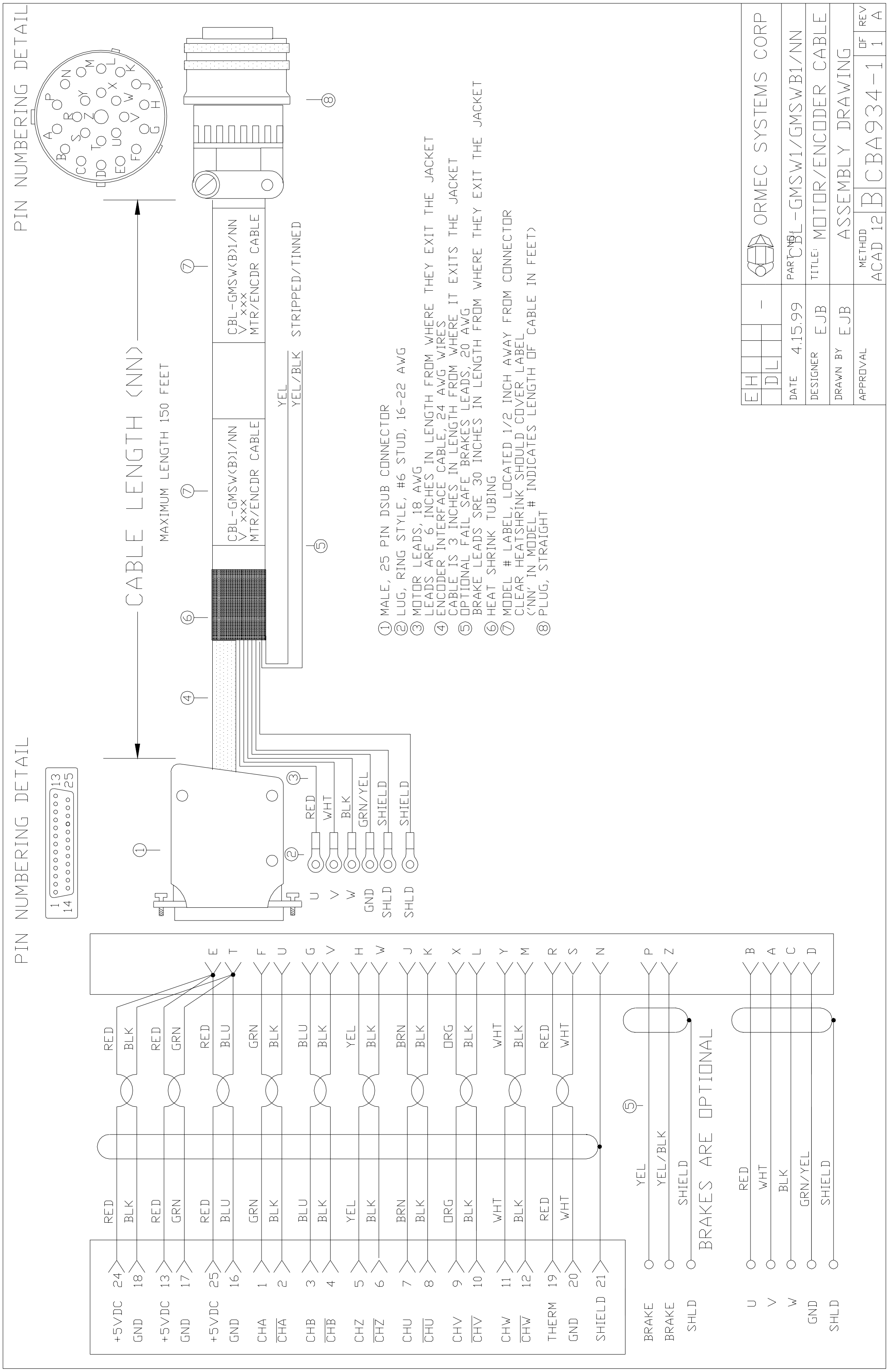
Notes:

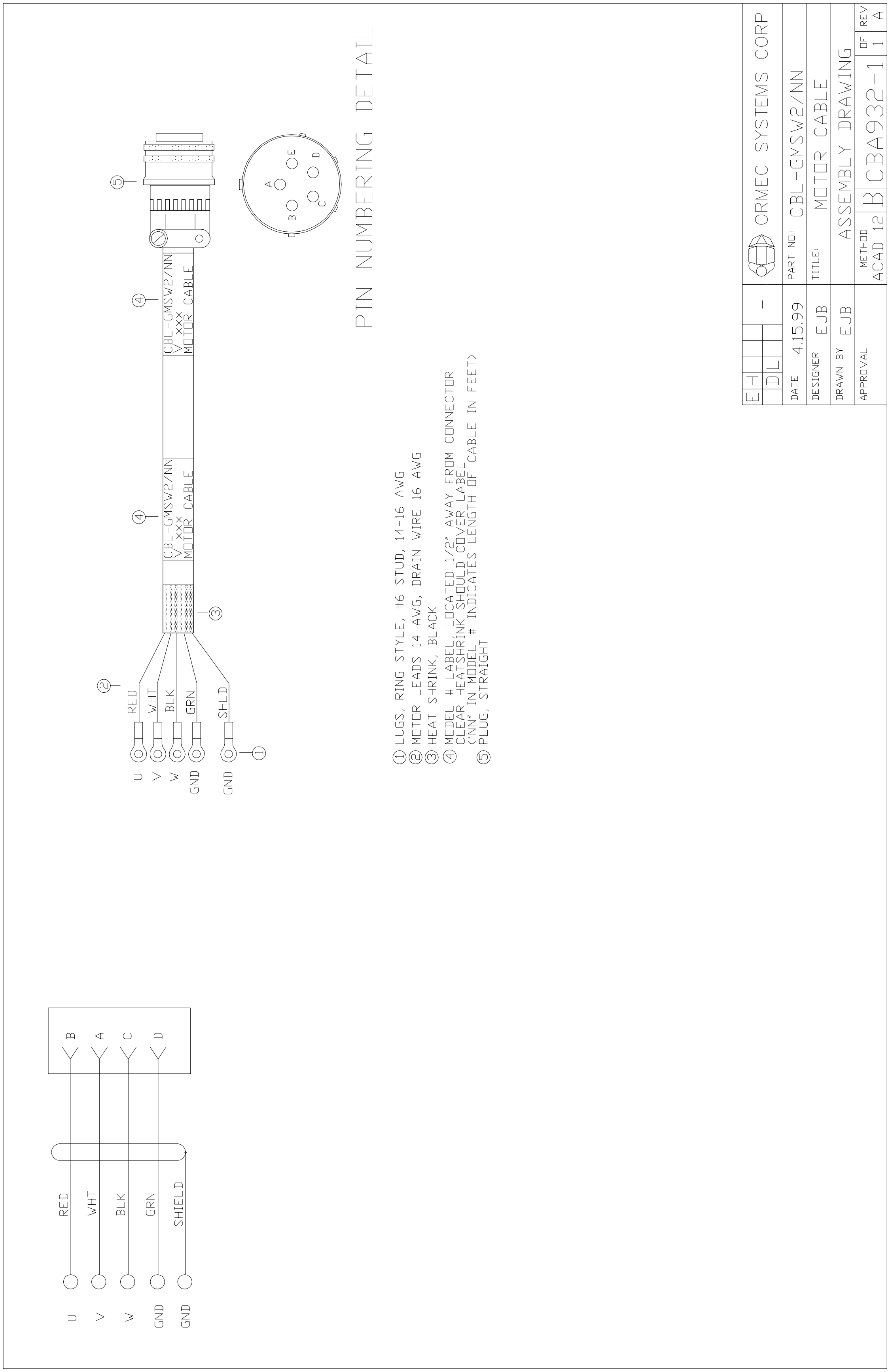
1. Minimum cable clearance from motor centerline for Encoder cable is 191 mm (7.5 inches); for the Motor cable it is 204 mm (8.0 inches)
2. *Brake option adds 76.2 mm (3.0 inches) to L and D

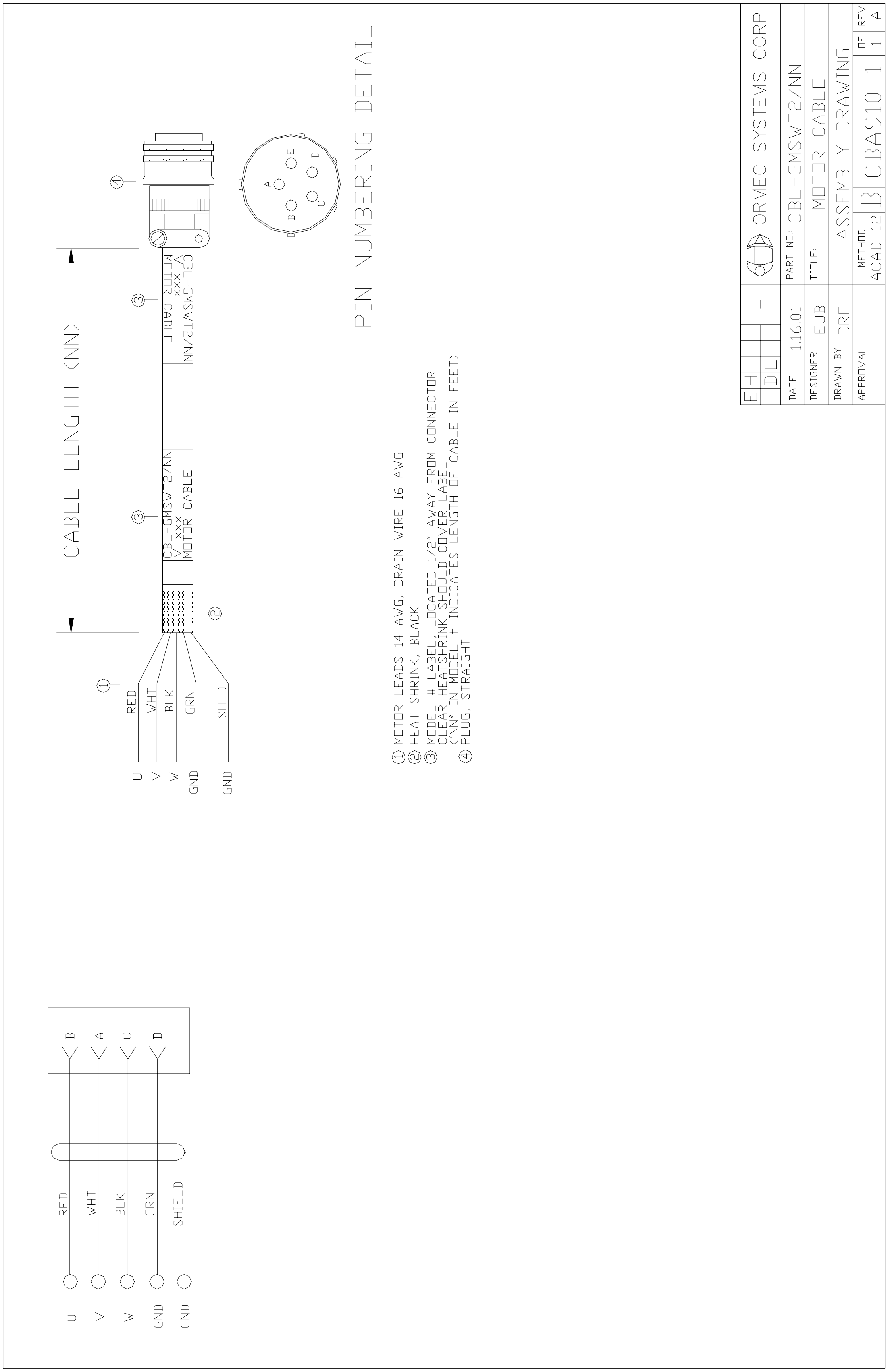
Dimensions	A	B	C	D	L* (Max)
MAC-G640A2	32.018 (1.26605) 31.998 (1.2598)	10.000 (.3937) 9.964 (.3923)	27.00 (1.063) 26.80 (1.055)	165.1 (6.50) 241.3 (9.50)	321.2 (12.65) 397.5 (15.65)


PIN NUMBERING DETAIL
PIN NUMBERING DETAIL
MAXIMUM LENGTH 50 FEET
CABLE LENGTH (NN)
CBL-GMSW/NN
V xxx
ENCDR CABLE
① MALE, 25 PIN DSUB CONNECTOR
② MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
('NN' IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
③ ENCODER INTERFACE CABLE:
24 AWG FOR CABLES 1 - 50 FEET, CABLE O.D. = .34"
④ PLUG, STRAIGHT
+5VDC 13
GND 17
+5VDC 25
GND 16
CHA 1
CHA 2
CHB 3
CHB 4
CHZ 5
CHZ 6
CHU 7
CHU 8
CHV 9
CHV 10
CHW 11
CHW 12
THERM 19
GND 20
SHIELD 21
RED GRN RED BLK GRN BLK BLU BLK YEL BLK BRN BLK ORG BLK WHT BLK RED WHT
K T B C N P M U E R F S G H A L D
ORMEC SYSTEMS CORP
PART NO: CBL-GMSW/1-50
TITLE: ENCODER CABLE
ASSEMBLY DRAWING
DATE 4.19.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B CBA933-1
OF 1 1
REV A

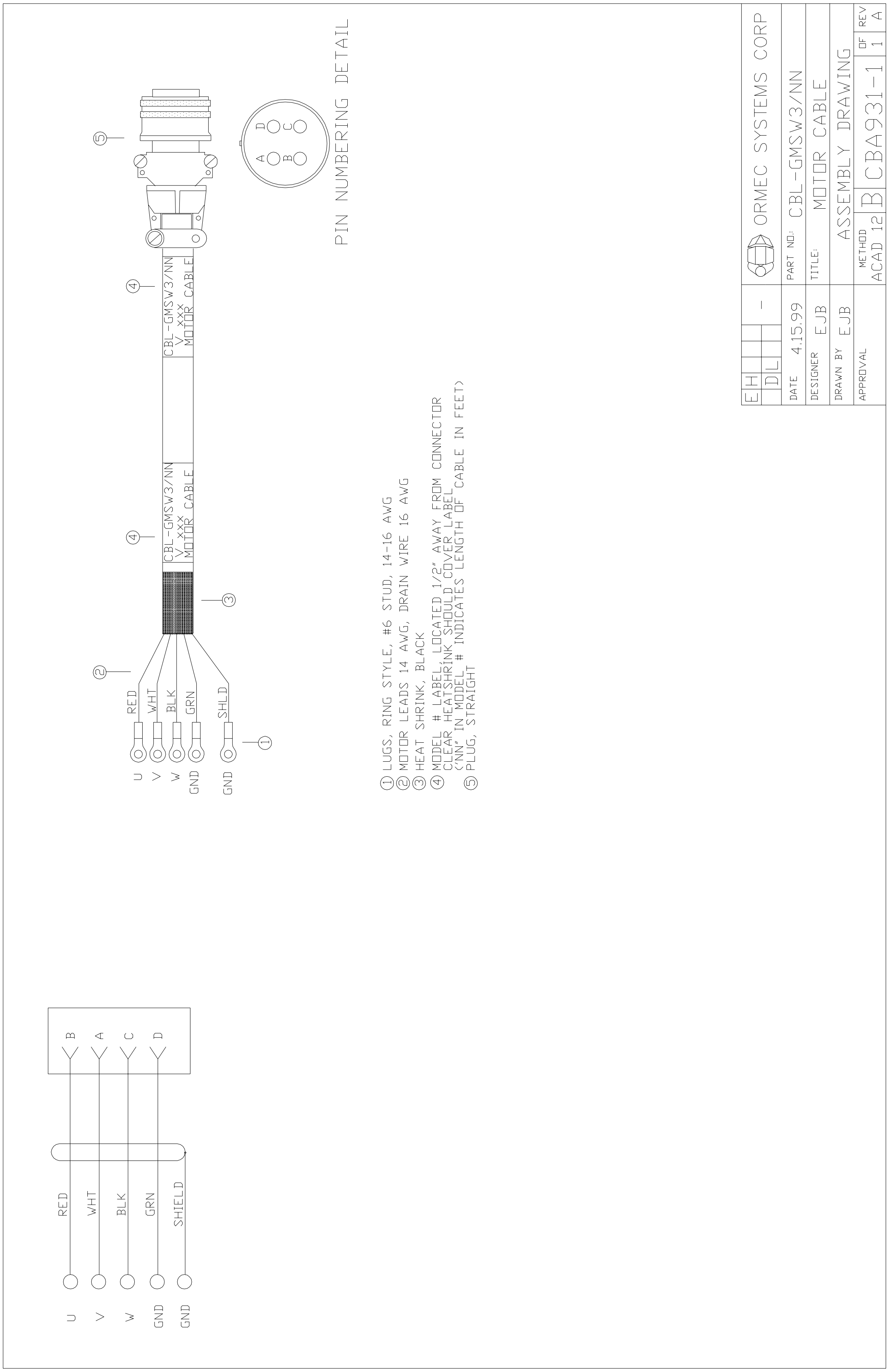

PIN NUMBERING DETAIL
PIN NUMBERING DETAIL
MAXIMUM LENGTH 150 FEET
CABLE LENGTH (NN)
CBL-GMSW/NN
V xxx
ENCDR CABLE
① MALE, 25 PIN DSUB CONNECTOR
② MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
('NN' IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
③ ENCODER INTERFACE CABLE:
22 AWG FOR CABLES 51 - 150 FEET, CBALE O.D. = .425"
④ PLUG, STRAIGHT
+5VDC 24
GND 18
+5VDC 13
GND 17
+5VDC 25
GND 16
CHA 1
CHA 2
CHB 3
CHB 4
CHZ 5
CHZ 6
CHU 7
CHU 8
CHV 9
CHV 10
CHW 11
CHW 12
THERM 19
GND 20
SHIELD 21
RED BLU RED GRN RED BLK GRN BLK BLU BLK YEL BLK BRN BLK ORG BLK WHT BLK RED WHT
K T B C N P M U E R F S G H A L D
ORMEC SYSTEMS CORP
PART NO: CBL-GMSW/51-150
TITLE: ENCODER CABLE
ASSEMBLY DRAWING
DATE 4.19.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B CBA921-1
OF 1
REV A
EH
DL

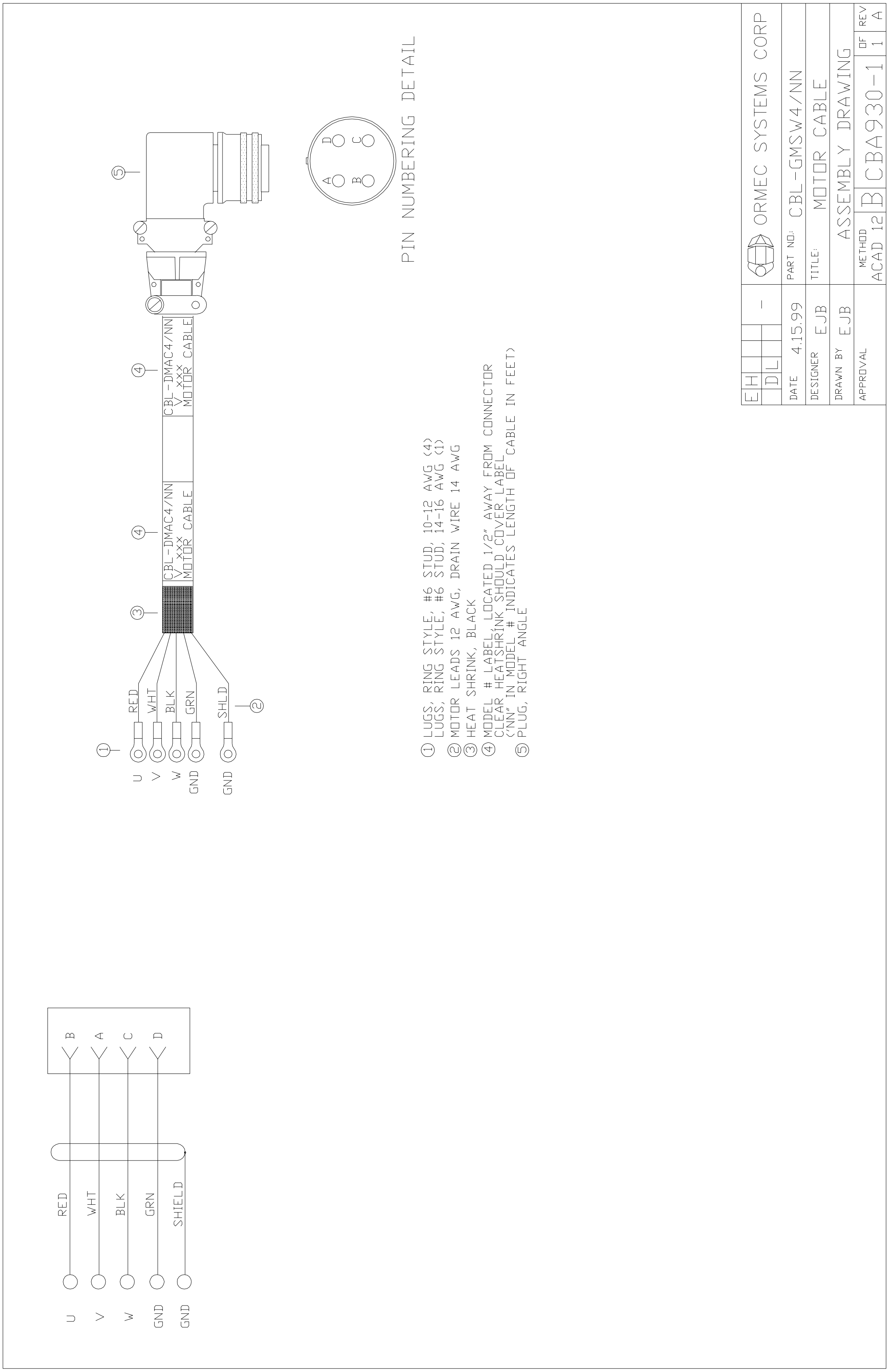

PIN NUMBERING DETAIL
CABLE LENGTH (NN)
MAXIMUM LENGTH 150 FEET
CBL-GMSW(B)1/NN
V xxx
MTR/ENCDR CABLE
STRIPPED/TINNED
YEL
YEL/BLK
RED
WHT
BLK
GRN/YEL
SHIELD
SHIELD
U
V
W
GND
SHLD
SHLD
① MALE, 25 PIN DSUB CONNECTOR
② LUG, RING STYLE, #6 STUD, 16-22 AWG
③ MOTOR LEADS, 18 AWG
LEADS ARE 6 INCHES IN LENGTH FROM WHERE THEY EXIT THE JACKET
④ ENCODER INTERFACE CABLE, 24 AWG WIRES
CABLE IS 3 INCHES IN LENGTH FROM WHERE IT EXITS THE JACKET
⑤ OPTIONAL FAIL SAFE BRAKES LEADS, 20 AWG
BRAKE LEADS SRE 30 INCHES IN LENGTH FROM WHERE THEY EXIT THE JACKET
⑥ HEAT SHRINK TUBING
⑦ MODEL # LABEL, LOCATED 1/2 INCH AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
('NN' IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
⑧ PLUG, STRAIGHT
+5VDC 24
GND 18
+5VDC 13
GND 17
+5VDC 25
GND 16
CHA 1
CHA 2
CHB 3
CHB 4
CHZ 5
CHZ 6
CHU 7
CHU 8
CHV 9
CHV 10
CHW 11
CHW 12
THERM 19
GND 20
SHIELD 21
BRAKE
BRAKE
SHLD
U
V
W
GND
SHLD
BRAKES ARE OPTIONAL
ORMEC SYSTEMS CORP
PART NO. CBL-GMSW1/GMSWB1/NN
TITLE: MOTOR/ENCODER CABLE ASSEMBLY DRAWING
DATE 4.15.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B CBA934-1
OF 1
REV A

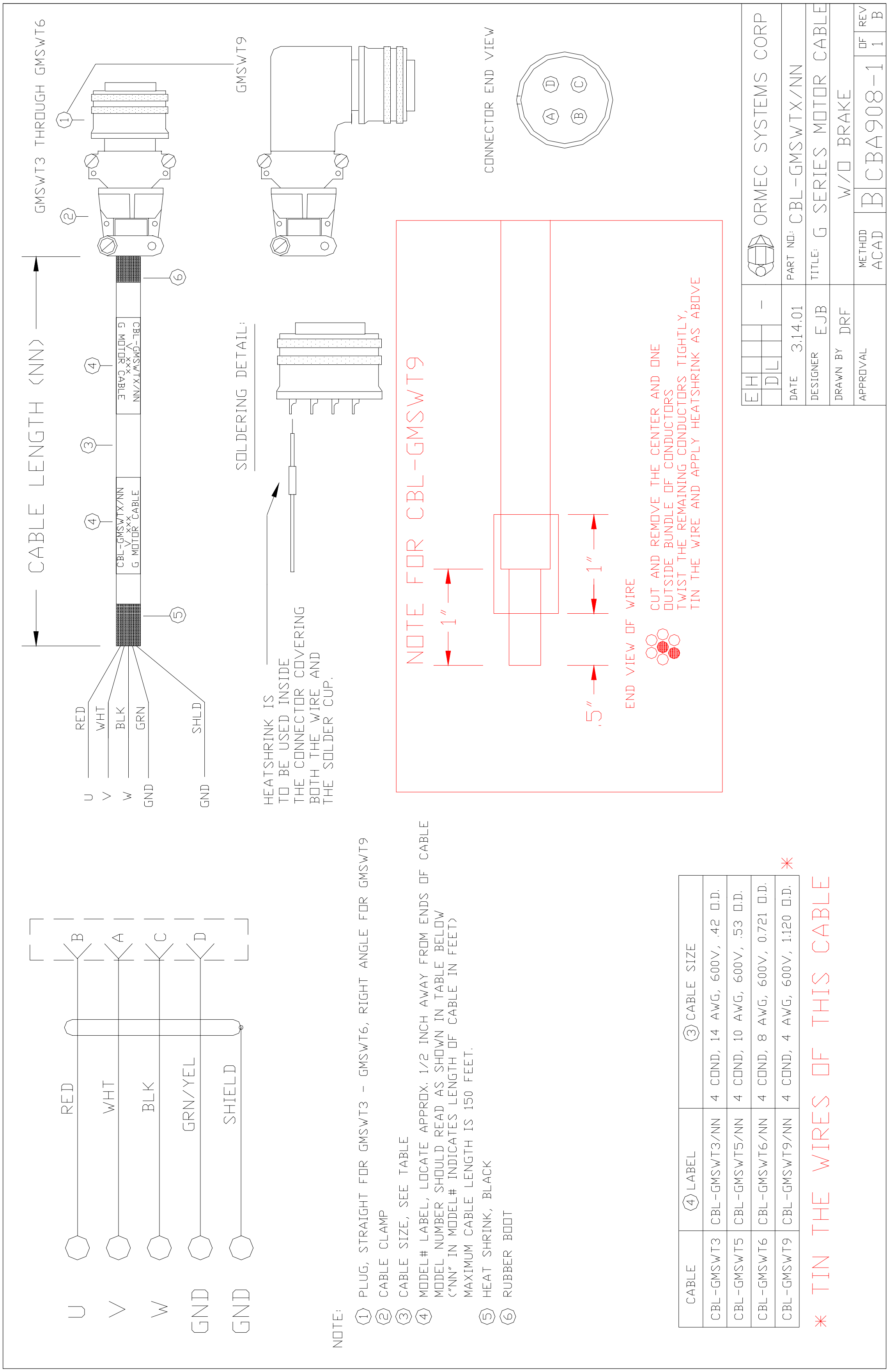

ORMEC SYSTEMS CORP
PART NO: CBL-GMSW2/NN
TITLE: MOTOR CABLE
ASSEMBLY DRAWING
DATE 4.15.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B
CBA932-1
OF 1
REV A
EH
DL
PIN NUMBERING DETAIL
A B C D E
CBL-GMSW2/NN
V xxx
MOTOR CABLE
RED WHT BLK GRN SHLD
U V W GND GND
1 LUGS, RING STYLE, #6 STUD, 14-16 AWG
2 MOTOR LEADS 14 AWG, DRAIN WIRE 16 AWG
3 HEAT SHRINK, BLACK
4 MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
5 PLUG, STRAIGHT
B A C D
RED WHT BLK GRN SHIELD
U V W GND GND



CABLE LENGTH (NN)
CBL-GMSWT2/NN
V xxx
MOTOR CABLE
PIN NUMBERING DETAIL
RED
WHT
BLK
GRN
SHLD
U
V
W
GND
GND
SHIELD
1 MOTOR LEADS 14 AWG, DRAIN WIRE 16 AWG
2 HEAT SHRINK, BLACK
3 MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
4 PLUG, STRAIGHT
ORMEC SYSTEMS CORP
PART NO.: CBL-GMSWT2/NN
TITLE: MOTOR CABLE
ASSEMBLY DRAWING
DATE 1.16.01
DESIGNER EJB
DRAWN BY DRF
APPROVAL
METHOD ACAD 12
B
CBA910-1
OF 1
REV A
EH
DL


PIN NUMBERING DETAIL
A B C D
CBL-GMSW3/NN
V xxx
MOTOR CABLE
RED WHT BLK GRN SHLD
U V W GND GND
SHIELD
① LUGS, RING STYLE, #6 STUD, 14-16 AWG
② MOTOR LEADS 14 AWG, DRAIN WIRE 16 AWG
③ HEAT SHRINK, BLACK
④ MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
⑤ PLUG, STRAIGHT
ORMEC SYSTEMS CORP
PART NO: CBL-GMSW3/NN
TITLE: MOTOR CABLE
ASSEMBLY DRAWING
DATE 4.15.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B CBA931-1
OF 1
REV A


ORMEC SYSTEMS CORP
PART NO: CBL-GMSW4/NN
TITLE: MOTOR CABLE
ASSEMBLY DRAWING
METHOD ACAD 12
B CBA930-1
OF 1
REV A
DATE 4.15.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
EH
DL
PIN NUMBERING DETAIL
A B C D
CBL-DMAC4/NN V xxx MOTOR CABLE
CBL-DMAC4/NN V xxx MOTOR CABLE
RED WHT BLK GRN SHLD
U V W GND GND
1 LUGS, RING STYLE, #6 STUD, 10-12 AWG (4)
LUGS, RING STYLE, #6 STUD, 14-16 AWG (1)
2 MOTOR LEADS 12 AWG, DRAIN WIRE 14 AWG
3 HEAT SHRINK, BLACK
4 MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
5 PLUG, RIGHT ANGLE
B A C D
RED WHT BLK GRN SHIELD
U V W GND GND

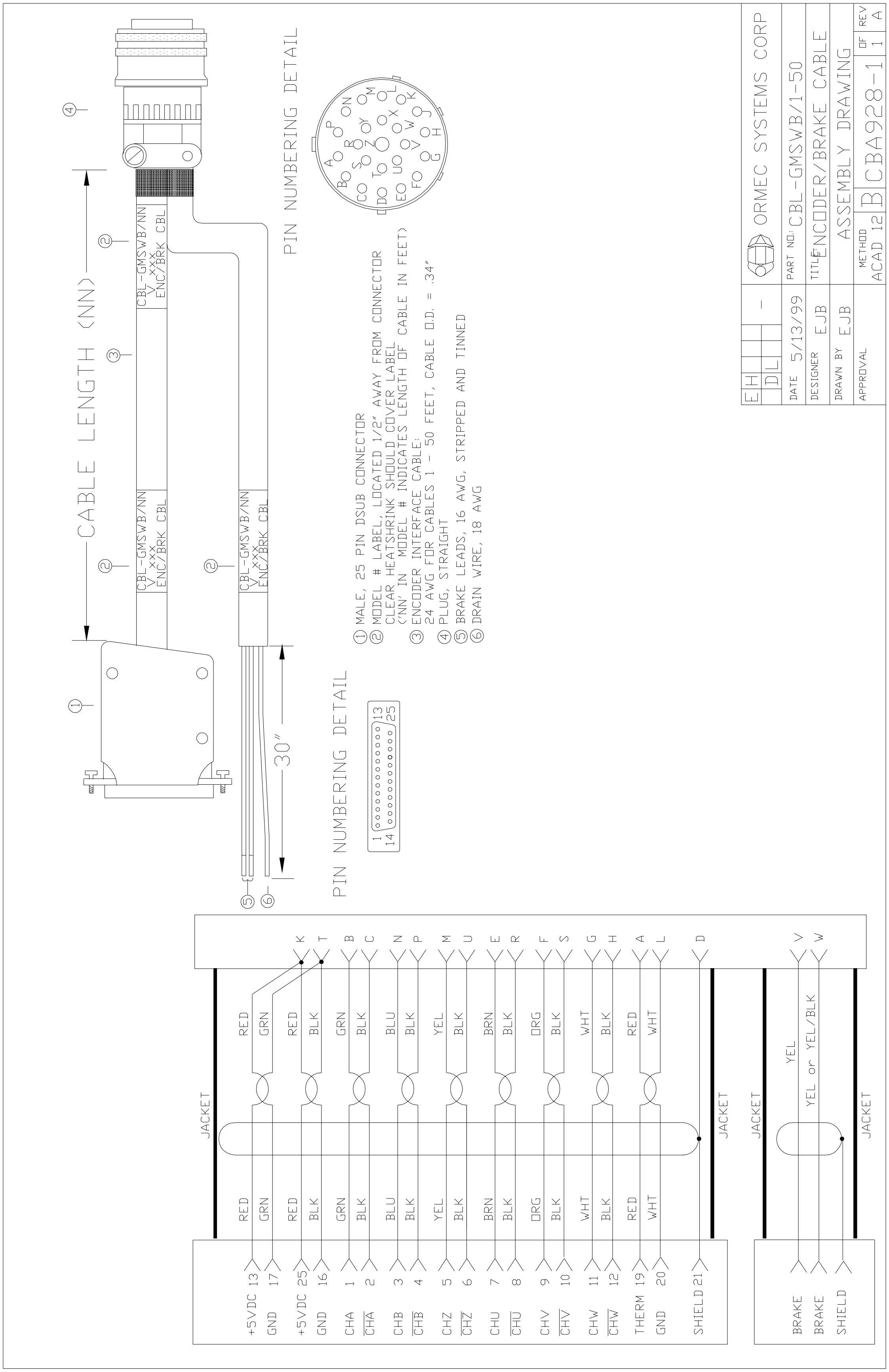


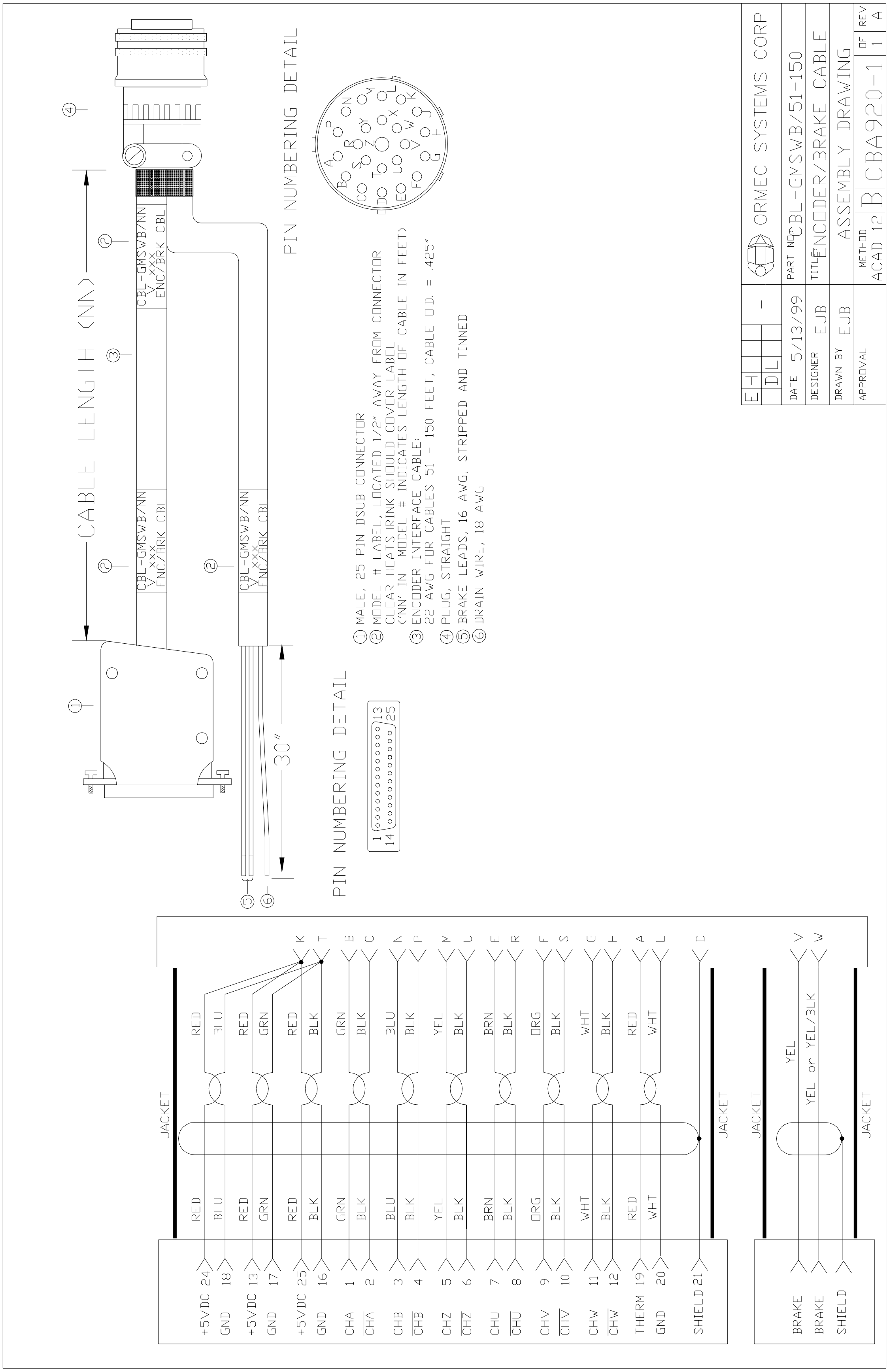
NOTE:

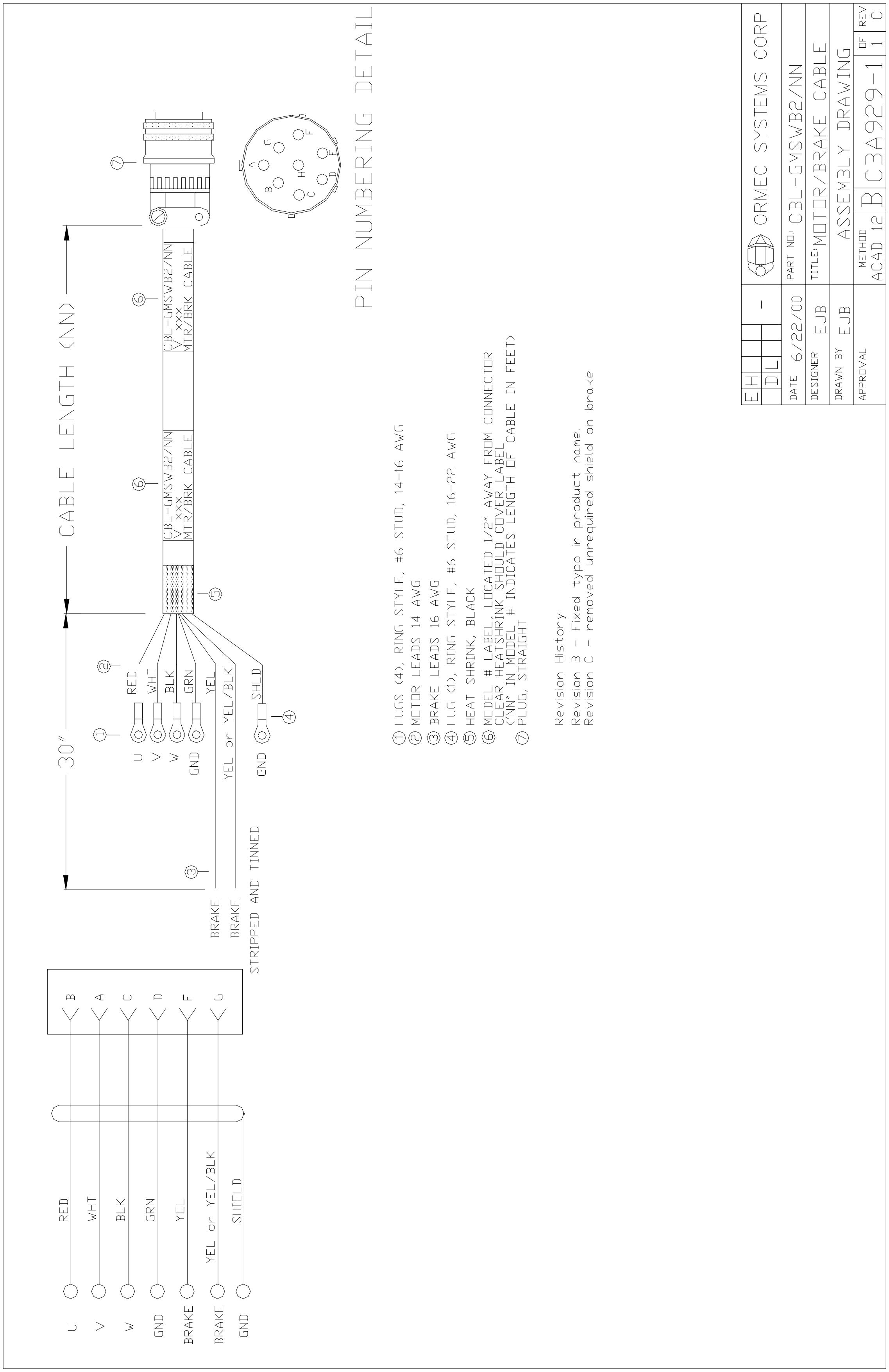
1. PLUG, STRAIGHT FOR GMSWT3 - GMSWT6, RIGHT ANGLE FOR GMSWT9
2. CABLE CLAMP
3. CABLE SIZE, SEE TABLE
4. MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE
   MODEL NUMBER SHOULD READ AS SHOWN IN TABLE BELOW
   ("NN" IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
   MAXIMUM CABLE LENGTH IS 150 FEET.
5. HEAT SHRINK, BLACK
6. RUBBER BOOT

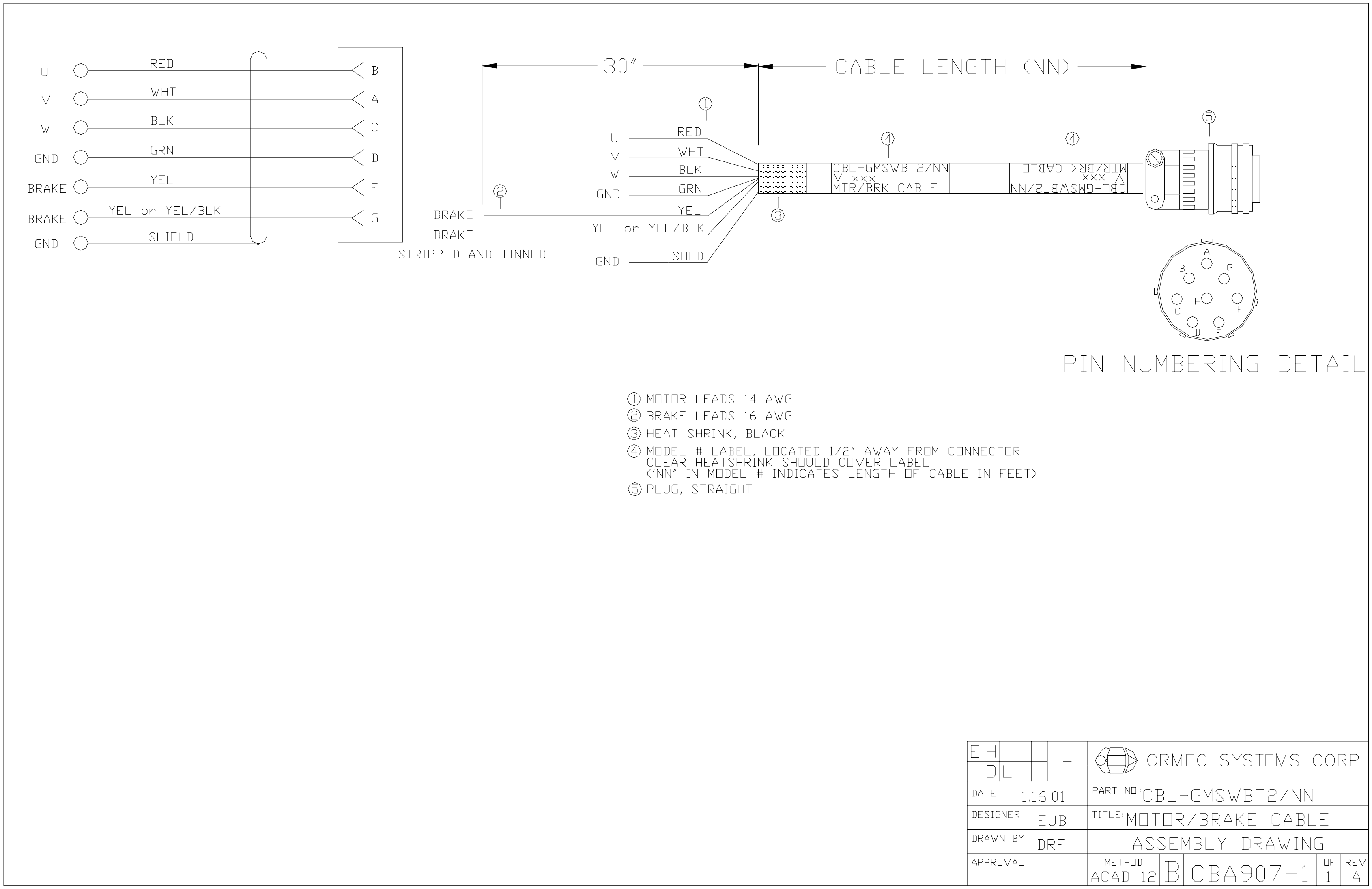
CABLE	(4) LABEL	(3) CABLE SIZE
CBL-GMSWT3	CBL-GMSWT3/NN	4 COND, 14 AWG, 600V, .42 O.D.
CBL-GMSWT5	CBL-GMSWT5/NN	4 COND, 10 AWG, 600V, .53 O.D.
CBL-GMSWT6	CBL-GMSWT6/NN	4 COND, 8 AWG, 600V, 0.721 O.D.
CBL-GMSWT9	CBL-GMSWT9/NN	4 COND, 4 AWG, 600V, 1.120 O.D. *

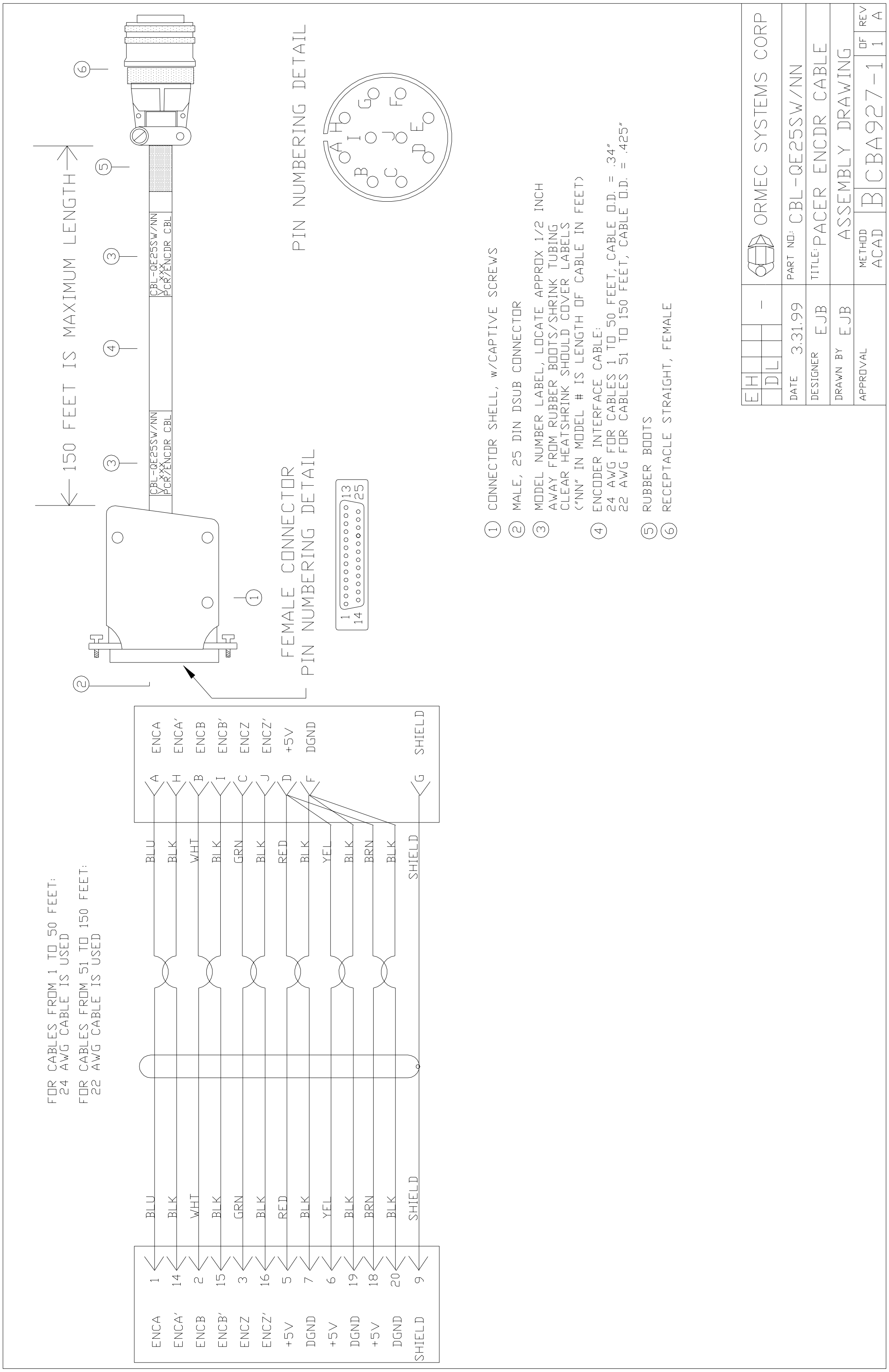
* TIN THE WIRES OF THIS CABLE

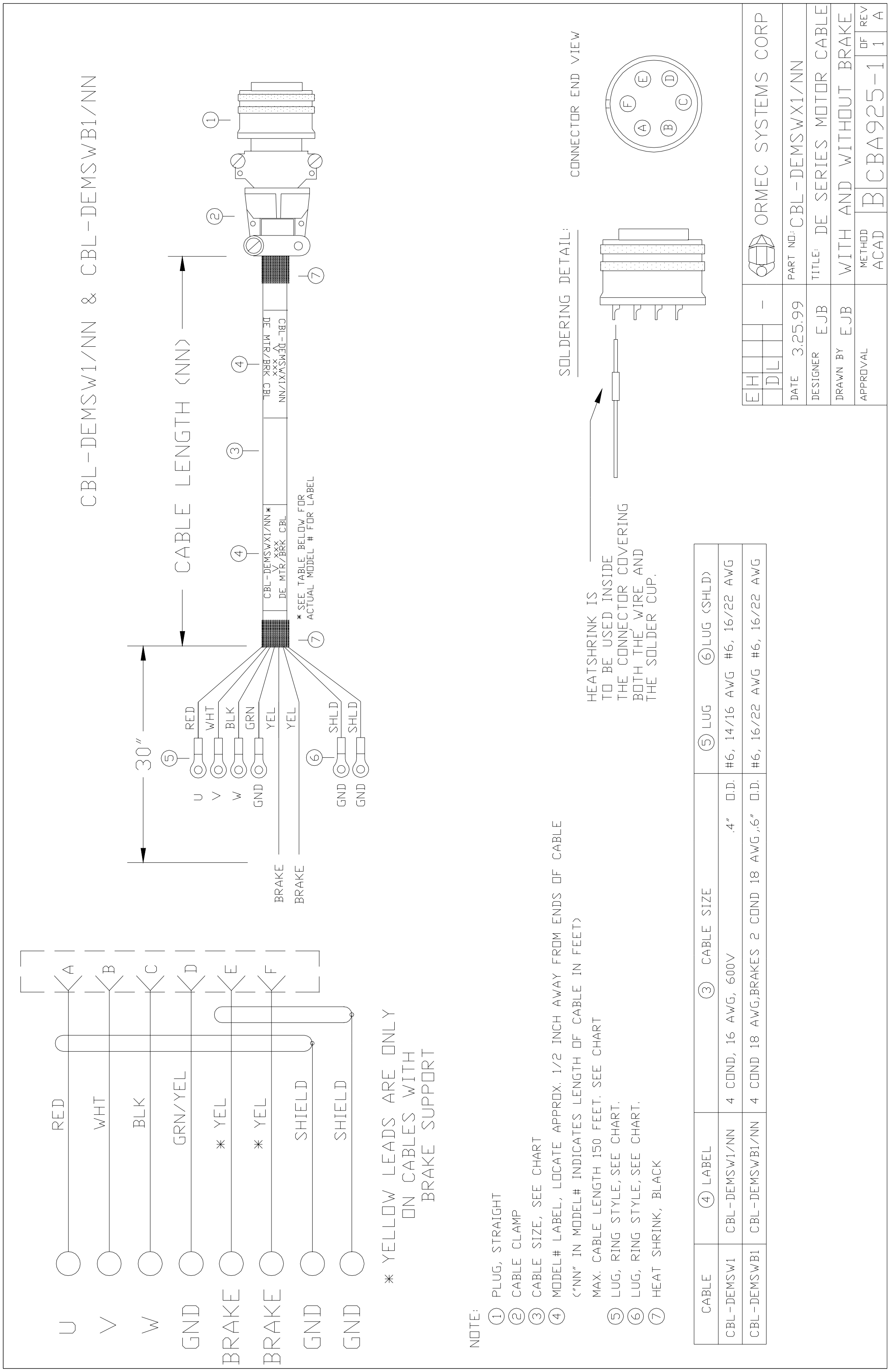

CABLE LENGTH (NN)
CBL-GMSWB/NN
V xxx
ENC/BRK CBL
30"
PIN NUMBERING DETAIL
PIN NUMBERING DETAIL
1 MALE, 25 PIN DSUB CONNECTOR
2 MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
('NN' IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
3 ENCODER INTERFACE CABLE:
24 AWG FOR CABLES 1 - 50 FEET, CABLE O.D. = .34"
4 PLUG, STRAIGHT
5 BRAKE LEADS, 16 AWG, STRIPPED AND TINNED
6 DRAIN WIRE, 18 AWG
ORMEC SYSTEMS CORP
PART NO: CBL-GMSWB/1-50
TITLE: ENCODER/BRAKE CABLE
ASSEMBLY DRAWING
METHOD ACAD 12
B
CBA928-1
OF 1
REV A
EH
DL
DATE 5/13/99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
JACKET
+5VDC 13 RED K
GND 17 GRN K
+5VDC 25 RED T
GND 16 BLK T
CHA 1 GRN B
CHA 2 BLK C
CHB 3 BLU N
CHB 4 BLK P
CHZ 5 YEL M
CHZ 6 BLK U
CHU 7 BRN E
CHU 8 BLK R
CHV 9 ORG F
CHV 10 BLK S
CHW 11 WHT G
CHW 12 BLK H
THERM 19 RED A
GND 20 WHT L
SHIELD 21 D
BRAKE YEL V
BRAKE YEL or YEL/BLK W
SHIELD


CABLE LENGTH (NN)
CBL-GMSWB/NN
V xxx
ENC/BRK CBL
PIN NUMBERING DETAIL
30"
1 MALE, 25 PIN DSUB CONNECTOR
2 MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
('NN' IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
3 ENCODER INTERFACE CABLE:
22 AWG FOR CABLES 51 - 150 FEET, CABLE O.D. = .425"
4 PLUG, STRAIGHT
5 BRAKE LEADS, 16 AWG, STRIPPED AND TINNED
6 DRAIN WIRE, 18 AWG
ORMEC SYSTEMS CORP
PART NO. CBL-GMSWB/51-150
TITLE ENCODER/BRAKE CABLE
ASSEMBLY DRAWING
DATE 5/13/99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B CBA920-1
OF 1 1
REV A
JACKET
+5VDC 24
GND 18
+5VDC 13
GND 17
+5VDC 25
GND 16
CHA 1
CHA 2
CHB 3
CHB 4
CHZ 5
CHZ 6
CHU 7
CHU 8
CHV 9
CHV 10
CHW 11
CHW 12
THERM 19
GND 20
SHIELD 21
BRAKE
BRAKE
SHIELD
YEL
YEL or YEL/BLK


PIN NUMBERING DETAIL
CABLE LENGTH (NN)
30"
CBL-GMSWB2/NN
V xxx
MTR/BRK CABLE
RED
WHT
BLK
GRN
YEL
YEL/BLK
SHLD
U
V
W
GND
YEL or YEL/BLK
GND
BRAKE
BRAKE
STRIPPED AND TINNED
B A C D F G
RED
WHT
BLK
GRN
YEL
YEL or YEL/BLK
SHIELD
U
V
W
GND
BRAKE
BRAKE
GND
1 LUGS (4), RING STYLE, #6 STUD, 14-16 AWG
2 MOTOR LEADS 14 AWG
3 BRAKE LEADS 16 AWG
4 LUG (1), RING STYLE, #6 STUD, 16-22 AWG
5 HEAT SHRINK, BLACK
6 MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
7 PLUG, STRAIGHT
Revision History:
Revision B - Fixed typo in product name.
Revision C - removed unrequired shield on brake
ORMEC SYSTEMS CORP
PART NO: CBL-GMSWB2/NN
TITLE: MOTOR/BRAKE CABLE
ASSEMBLY DRAWING
METHOD ACAD 12
B
CBA929-1
OF 1
REV C
DATE 6/22/00
DESIGNER EJB
DRAWN BY EJB
APPROVAL
EH
DL

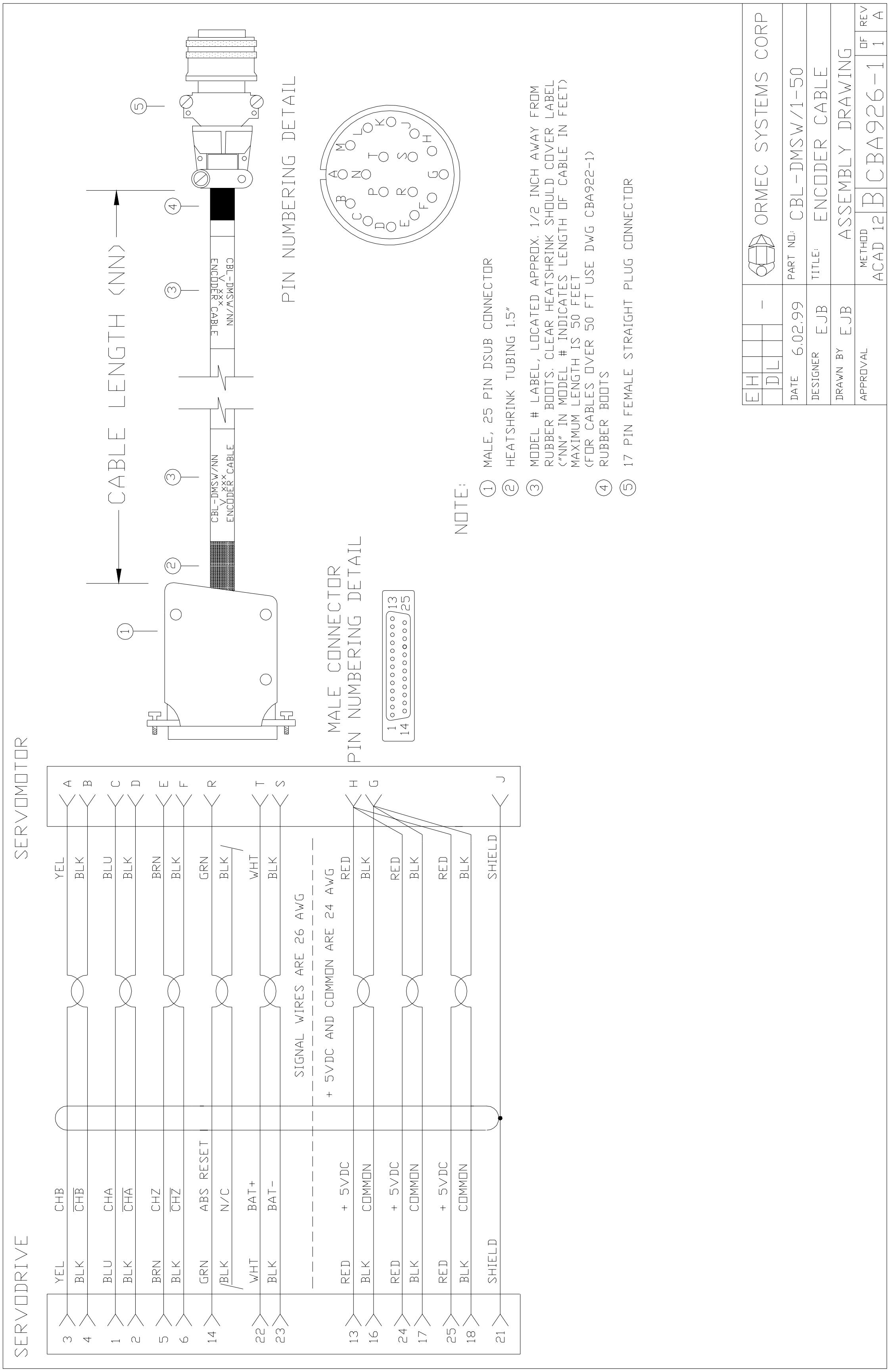

30"
CABLE LENGTH (NN)
U
V
W
GND
BRAKE
BRAKE
GND
RED
WHT
BLK
GRN
YEL
YEL or YEL/BLK
SHIELD
B
A
C
D
F
G
BRAKE
BRAKE
STRIPPED AND TINNED
U RED
V WHT
W BLK
GND GRN
YEL
YEL or YEL/BLK
GND SHLD
CBL-GMSWBT2/NN
V xxx
MTR/BRK CABLE
PIN NUMBERING DETAIL
A B G C H F D E
① MOTOR LEADS 14 AWG
② BRAKE LEADS 16 AWG
③ HEAT SHRINK, BLACK
④ MODEL # LABEL, LOCATED 1/2" AWAY FROM CONNECTOR
CLEAR HEATSHRINK SHOULD COVER LABEL
('NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET)
⑤ PLUG, STRAIGHT
ORMEC SYSTEMS CORP
DATE 1.16.01
DESIGNER EJB
DRAWN BY DRF
APPROVAL
PART NO: CBL-GMSWBT2/NN
TITLE: MOTOR/BRAKE CABLE
ASSEMBLY DRAWING
METHOD ACAD 12
B
CBA907-1
OF 1
REV A

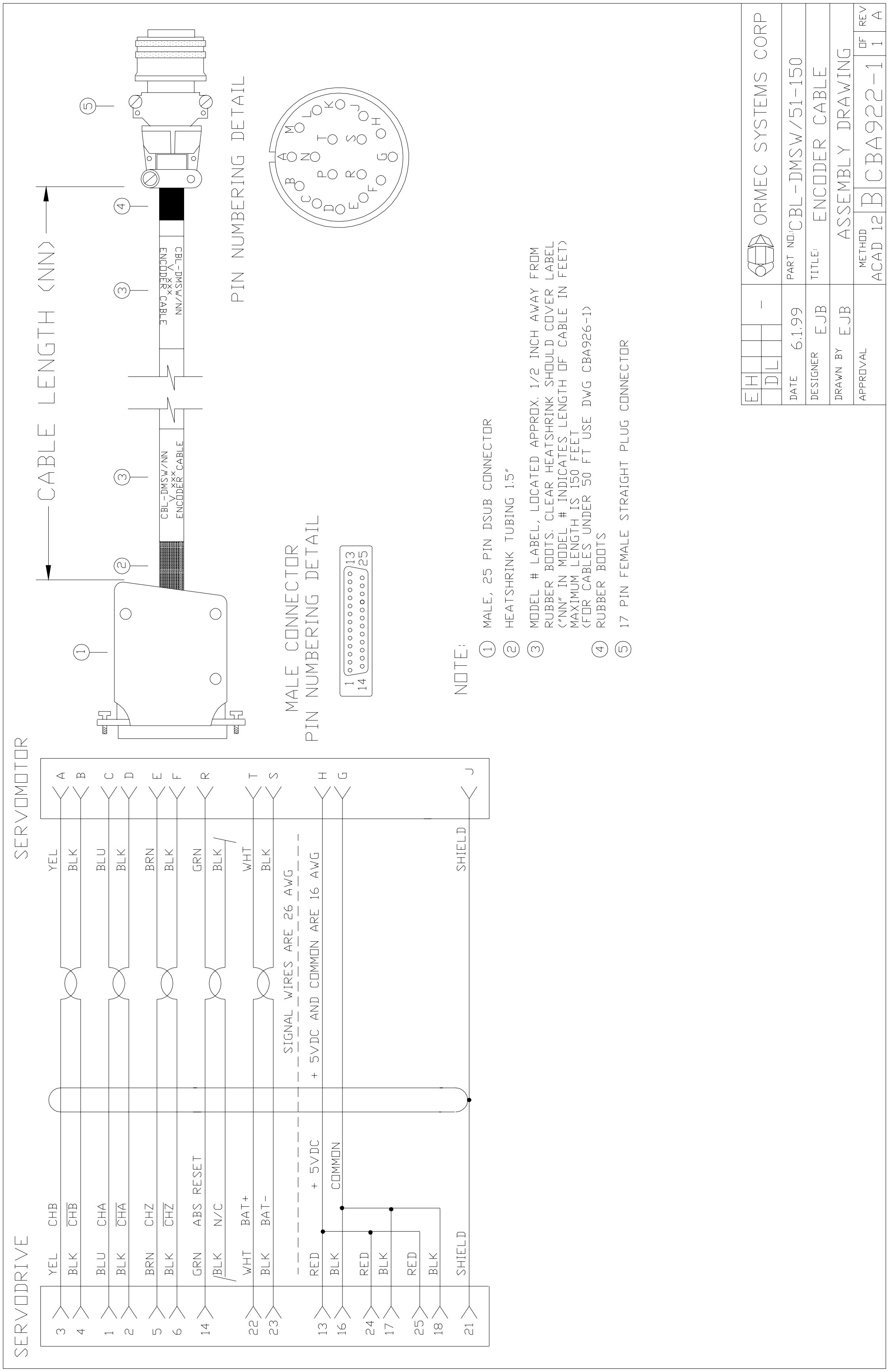

150 FEET IS MAXIMUM LENGTH
PIN NUMBERING DETAIL
FEMALE CONNECTOR PIN NUMBERING DETAIL
CBL-QE25SW/NN
PCR/ENCDR CBL
1 CONNECTOR SHELL, w/CAPTIVE SCREWS
2 MALE, 25 DIN DSUB CONNECTOR
3 MODEL NUMBER LABEL, LOCATE APPROX 1/2 INCH AWAY FROM RUBBER BOOTS/SHRINK TUBING CLEAR HEATSHRINK SHOULD COVER LABELS ("NN" IN MODEL # IS LENGTH OF CABLE IN FEET)
4 ENCODER INTERFACE CABLE: 24 AWG FOR CABLES 1 TO 50 FEET, CABLE O.D. = .34" 22 AWG FOR CABLES 51 TO 150 FEET, CABLE O.D. = .425"
5 RUBBER BOOTS
6 RECEPTACLE STRAIGHT, FEMALE
FOR CABLES FROM 1 TO 50 FEET: 24 AWG CABLE IS USED
FOR CABLES FROM 51 TO 150 FEET: 22 AWG CABLE IS USED
ENCA ENCA' ENCB ENCB' ENCZ ENCZ' +5V DGND SHIELD
A H B I C J D F G
BLU BLK WHT BLK GRN BLK RED BLK YEL BLK BRN BLK SHIELD
1 14 2 15 3 16 5 7 6 19 18 20 9
ENCA ENCA' ENCB ENCB' ENCZ ENCZ' +5V DGND +5V DGND +5V DGND SHIELD
ORMEC SYSTEMS CORP
PART NO: CBL-QE25SW/NN
TITLE: PACER ENCDR CABLE ASSEMBLY DRAWING
DATE 3.31.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD
B CBA927-1
OF 1
REV A

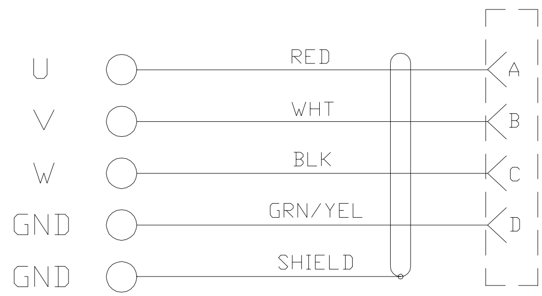


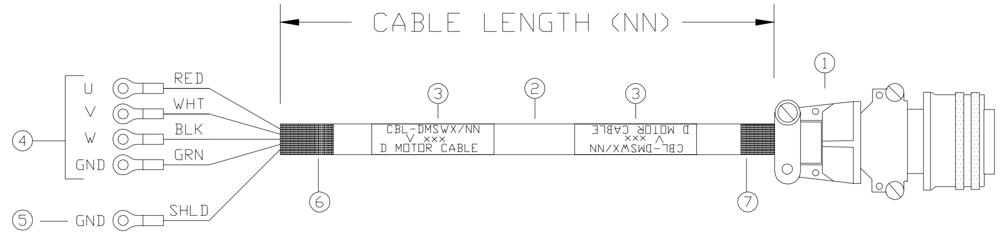
NOTE:
1. PLUG, STRAIGHT
2. CABLE CLAMP
3. CABLE SIZE, SEE CHART
4. MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ("NN" IN MODEL# INDICATES LENGTH OF CABLE IN FEET) MAX. CABLE LENGTH 150 FEET. SEE CHART
5. LUG, RING STYLE, SEE CHART.
6. LUG, RING STYLE, SEE CHART.
7. HEAT SHRINK, BLACK

CABLE	(4) LABEL	(3) CABLE SIZE	(5) LUG	(6) LUG (SHLD)
CBL-DEMSW1	CBL-DEMSW1/NN	4 COND, 16 AWG, 600V .4" O.D.	#6, 14/16 AWG	#6, 16/22 AWG
CBL-DEMSWB1	CBL-DEMSWB1/NN	4 COND 18 AWG, BRAKES 2 COND 18 AWG, .6" O.D.	#6, 16/22 AWG	#6, 16/22 AWG


CABLE LENGTH (NN)
CBL-DMSW/NN ENCODER CABLE
PIN NUMBERING DETAIL
MALE CONNECTOR PIN NUMBERING DETAIL
1 13
14 25
NOTE:
1 MALE, 25 PIN DSUB CONNECTOR
2 HEATSHRINK TUBING 1.5"
3 MODEL # LABEL, LOCATED APPROX. 1/2 INCH AWAY FROM RUBBER BOOTS. CLEAR HEATSHRINK SHOULD COVER LABEL ("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET) MAXIMUM LENGTH IS 50 FEET (FOR CABLES OVER 50 FT USE DWG CBA922-1)
4 RUBBER BOOTS
5 17 PIN FEMALE STRAIGHT PLUG CONNECTOR
SERVOMOTOR
SERVODRIVE
SIGNAL WIRES ARE 26 AWG
+ 5VDC AND COMMON ARE 24 AWG
3 YEL CHB YEL A
4 BLK CHB BLK B
1 BLU CHA BLU C
2 BLK CHA BLK D
5 BRN CHZ BRN E
6 BLK CHZ BLK F
14 GRN ABS RESET GRN R
BLK N/C BLK
22 WHT BAT+ WHT T
23 BLK BAT- BLK S
13 RED + 5VDC RED H
16 BLK COMMON BLK G
24 RED + 5VDC RED
17 BLK COMMON BLK
25 RED + 5VDC RED
18 BLK COMMON BLK
21 SHIELD SHIELD J
ORMEC SYSTEMS CORP
EH DL
DATE 6.02.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
PART NO: CBL-DMSW/1-50
TITLE: ENCODER CABLE ASSEMBLY DRAWING
METHOD ACAD 12
B CBA926-1
OF 1
REV A


CABLE LENGTH (NN)
CBL-DMSW/NN
V_xxx
ENCODER CABLE
PIN NUMBERING DETAIL
MALE CONNECTOR
PIN NUMBERING DETAIL
NOTE:
1 MALE, 25 PIN DSUB CONNECTOR
2 HEATSHRINK TUBING 1.5"
3 MODEL # LABEL, LOCATED APPROX. 1/2 INCH AWAY FROM RUBBER BOOTS. CLEAR HEATSHRINK SHOULD COVER LABEL ("NN" IN MODEL # INDICATES LENGTH OF CABLE IN FEET) MAXIMUM LENGTH IS 150 FEET (FOR CABLES UNDER 50 FT USE DWG CBA926-1)
4 RUBBER BOOTS
5 17 PIN FEMALE STRAIGHT PLUG CONNECTOR
SERVOMOTOR
SERVODRIVE
SIGNAL WIRES ARE 26 AWG
+ 5VDC AND COMMON ARE 16 AWG
YEL CHB
BLK CHB
BLU CHA
BLK CHA
BRN CHZ
BLK CHZ
GRN ABS RESET
BLK N/C
WHT BAT+
BLK BAT-
+ 5VDC
COMMON
RED
BLK
SHIELD
ORMEC SYSTEMS CORP
PART NO: CBL-DMSW/51-150
TITLE: ENCODER CABLE ASSEMBLY DRAWING
DATE 6.1.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
METHOD ACAD 12
B CBA922-1
OF 1
REV A

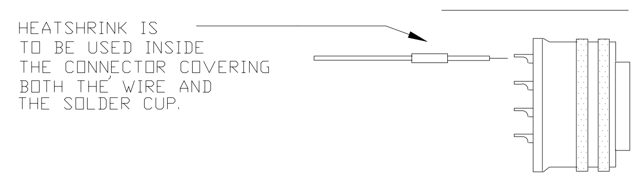




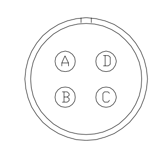
NOTE:

1. CABLE CLAMP
2. CABLE SIZE, SEE TABLE
3. MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE
   MODEL NUMBER SHOULD READ AS SHOWN IN TABLE BELOW
   ("NN" IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
   MAXIMUM CABLE LENGTH IS 150 FEET.
4. LUG, RING STYLE, SEE TABLE
5. LUG, RING STYLE, FOR DRAIN, SEE TABLE
6. HEAT SHRINK, BLACK
7. RUBBER BOOT

SOLDERING DETAIL:

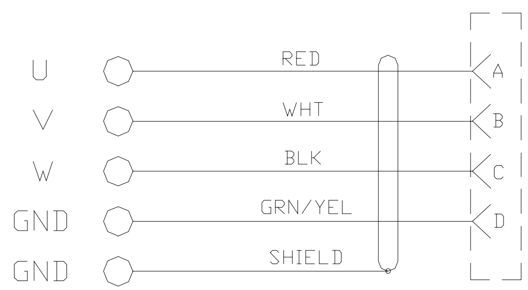


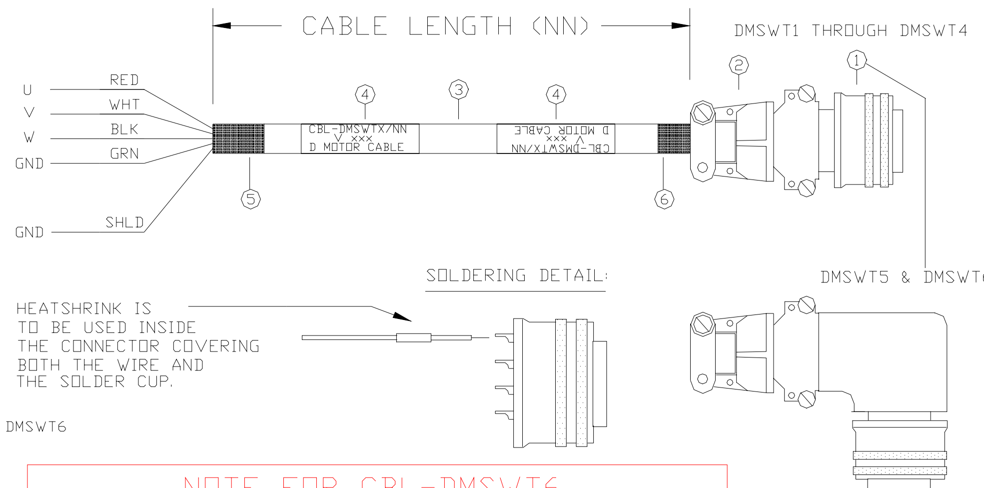
CONNECTOR END VIEW

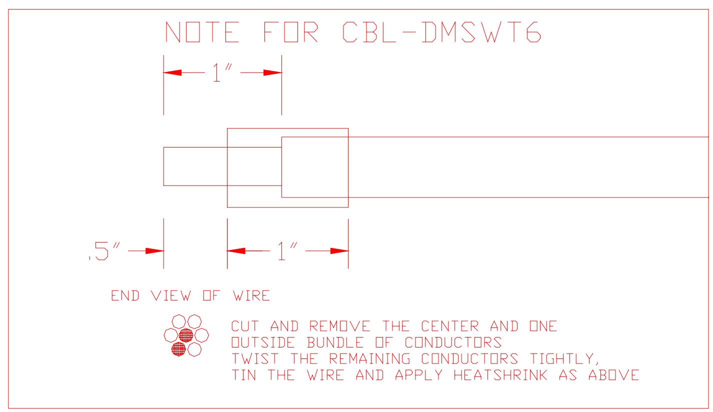


CABLE	(3) LABEL	(2) CABLE SIZE	(4) LUG	(5) DRAIN LUG
CBL-DMSW1	CBL-DMSW1/NN	4 COND, 14 AWG, 600V, .42" O.D.	#6, 14/16 AWG	#6, 14/16 AWG
CBL-DMSW2	CBL-DMSW2/NN	4 COND, 10 AWG, 600V, .53" O.D.	#6, 12/10 AWG	#6, 12/10 AWG
CBL-DMSW4	CBL-DMSW4/NN	4 COND 12 AWG, 600V, .46" O.D.	#6, 12/10 AWG	#6, 14/16 AWG

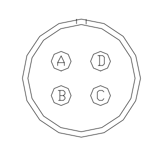
EH DL	-	ORMEC SYSTEMS CORP		
DATE	3.25.99	PART NO.: CBL-DMSWX/NN		
DESIGNER	EJB	TITLE: D SERIES MOTOR CABLE W/O BRAKE		
DRAWN BY	EJB			
APPROVAL		METHOD ACAD	B CBA924-1	OF 1 REV A







CONNECTOR END VIEW



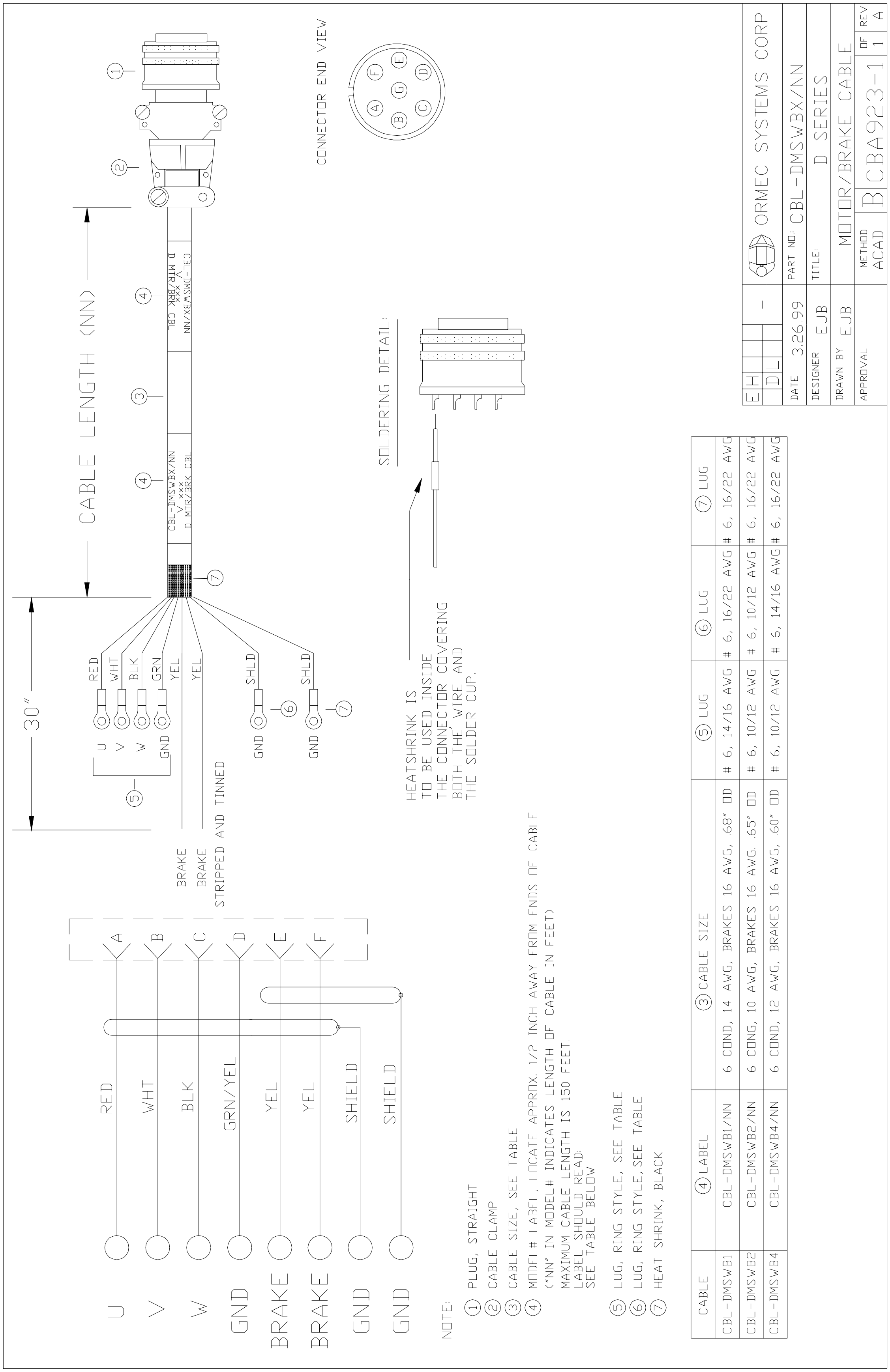
NOTE:

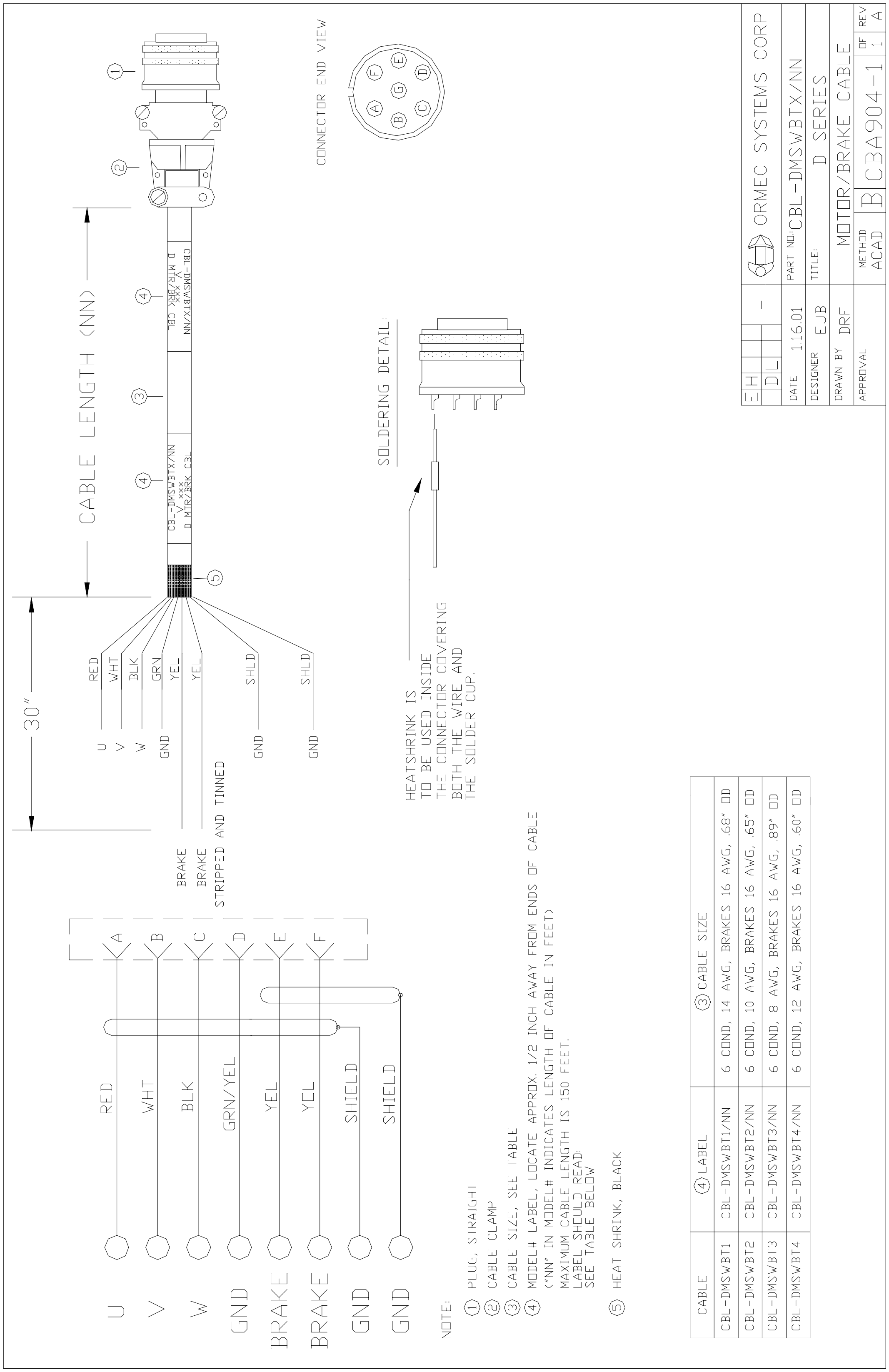
1. PLUG, STRAIGHT FOR DMSWT1 - DMSWT4, RIGHT ANGLE FOR DMSWT5 & DMSWT6
2. CABLE CLAMP
3. CABLE SIZE, SEE TABLE
4. MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE
   MODEL NUMBER SHOULD READ AS SHOWN IN TABLE BELOW
   ("NN" IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
   MAXIMUM CABLE LENGTH IS 150 FEET.
5. HEAT SHRINK, BLACK
6. RUBBER BOOT

CABLE	(4) LABEL	(3) CABLE SIZE
CBL-DMSWT1	CBL-DMSWT1/NN	4 COND, 14 AWG, 600V, 0.42 O.D.
CBL-DMSWT2	CBL-DMSWT2/NN	4 COND, 10 AWG, 600V, 0.53 O.D.
CBL-DMSWT3	CBL-DMSWT3/NN	4 COND, 8 AWG, 600V, 0.721 O.D.
CBL-DMSWT4	CBL-DMSWT4/NN	4 COND, 12 AWG, 600V, 0.46 O.D.
CBL-DMSWT5	CBL-DMSWT5/NN	4 COND, 6 AWG, 600V, 0.920 O.D. *
CBL-DMSWT6	CBL-DMSWT6/NN	4 COND, 4 AWG, 600V, 1.120 O.D. *

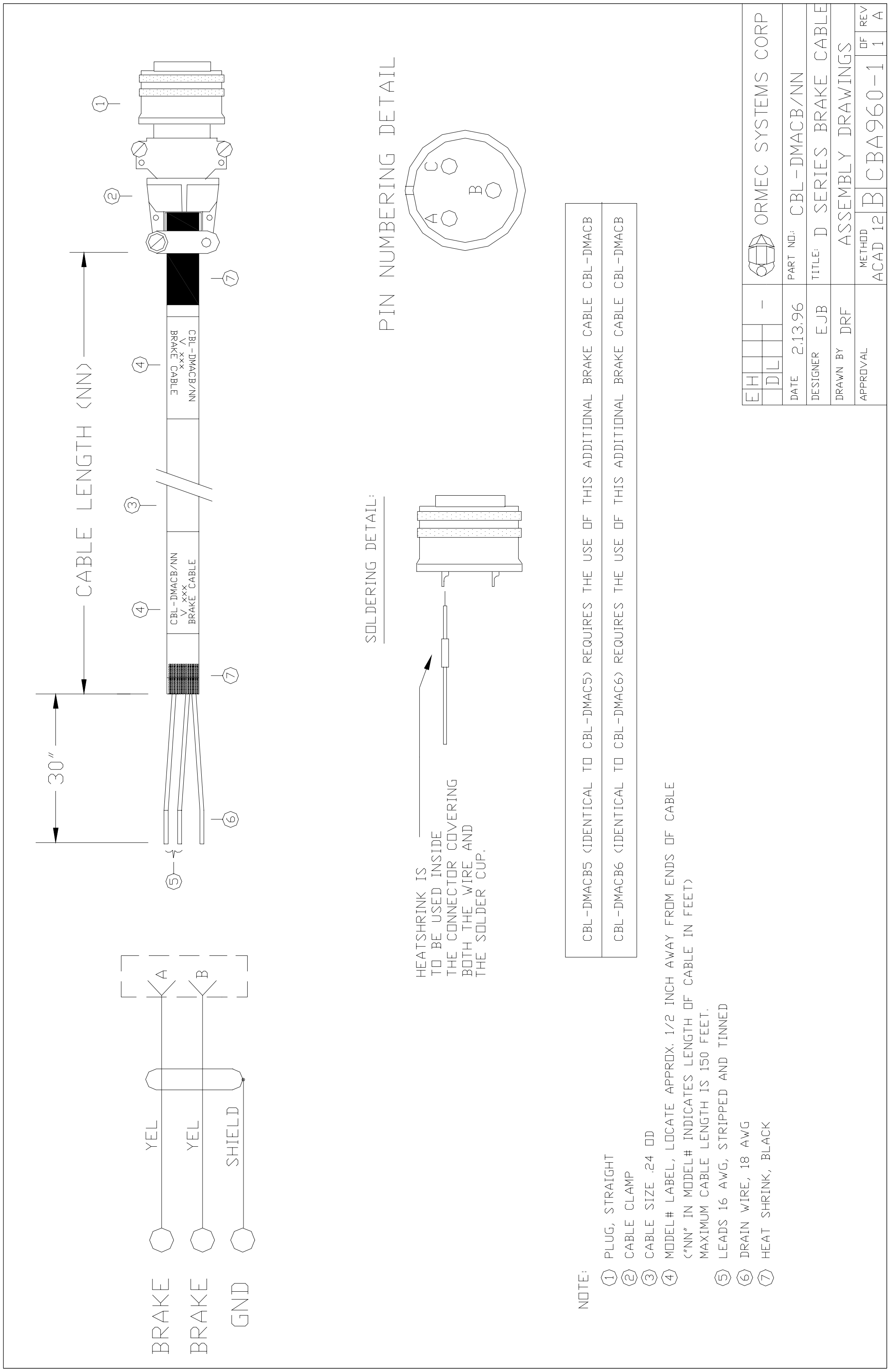
* TIN THE WIRES OF THESE CABLES

EH DL	-	ORMEC SYSTEMS CORP	
DATE	1.16.01	PART NO.: CBL-DMSWTX/NN	
DESIGNER	EJB	TITLE: D SERIES MOTOR CABLE	
DRAWN BY	DRF	W/O BRAKE	
APPROVAL		METHOD ACAD	B CBA905-1 OF 1 REV A


U
V
W
GND
BRAKE
BRAKE
GND
GND
RED
WHT
BLK
GRN/YEL
YEL
YEL
SHIELD
SHIELD
A
B
C
D
E
F
30″
CABLE LENGTH (NN)
RED
WHT
BLK
GRN
YEL
YEL
SHLD
SHLD
BRAKE
BRAKE
STRIPPED AND TINNED
CBL-DMSWBX/NN
V xxx
D MTR/BRK CBL
CONNECTOR END VIEW
SOLDERING DETAIL:
HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
NOTE:
1 PLUG, STRAIGHT
2 CABLE CLAMP
3 CABLE SIZE, SEE TABLE
4 MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ("NN" IN MODEL# INDICATES LENGTH OF CABLE IN FEET)
MAXIMUM CABLE LENGTH IS 150 FEET.
LABEL SHOULD READ:
SEE TABLE BELOW
5 LUG, RING STYLE, SEE TABLE
6 LUG, RING STYLE, SEE TABLE
7 HEAT SHRINK, BLACK
CABLE | 4 LABEL | 3 CABLE SIZE | 5 LUG | 6 LUG | 7 LUG
CBL-DMSWB1 | CBL-DMSWB1/NN | 6 COND, 14 AWG, BRAKES 16 AWG, .68″ OD | # 6, 14/16 AWG | # 6, 16/22 AWG | # 6, 16/22 AWG
CBL-DMSWB2 | CBL-DMSWB2/NN | 6 CONG, 10 AWG, BRAKES 16 AWG. .65″ OD | # 6, 10/12 AWG | # 6, 10/12 AWG | # 6, 16/22 AWG
CBL-DMSWB4 | CBL-DMSWB4/NN | 6 COND, 12 AWG, BRAKES 16 AWG, .60″ OD | # 6, 10/12 AWG | # 6, 14/16 AWG | # 6, 16/22 AWG
ORMEC SYSTEMS CORP
DATE 3.26.99
DESIGNER EJB
DRAWN BY EJB
APPROVAL
PART NO: CBL-DMSWBX/NN
TITLE: D SERIES
MOTOR/BRAKE CABLE
METHOD ACAD
B CBA923-1
OF 1
REV A



CABLE	(4) LABEL	(3) CABLE SIZE
CBL-DMSWBT1	CBL-DMSWBT1/NN	6 COND, 14 AWG, BRAKES 16 AWG, .68" OD
CBL-DMSWBT2	CBL-DMSWBT2/NN	6 COND, 10 AWG, BRAKES 16 AWG, .65" OD
CBL-DMSWBT3	CBL-DMSWBT3/NN	6 COND, 8 AWG, BRAKES 16 AWG, .89" OD
CBL-DMSWBT4	CBL-DMSWBT4/NN	6 COND, 12 AWG, BRAKES 16 AWG, .60" OD

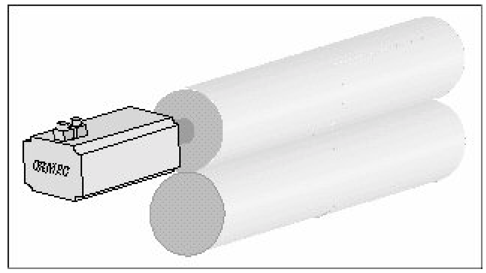

ORMEC SYSTEMS CORP
PART NO: CBL-DMACB/NN
TITLE: D SERIES BRAKE CABLE
ASSEMBLY DRAWINGS
METHOD ACAD 12
B CBA960-1
OF 1 1
REV A
DATE 2.13.96
DESIGNER EJB
DRAWN BY DRF
APPROVAL
PIN NUMBERING DETAIL
A B C
SOLDERING DETAIL:
CABLE LENGTH (NN)
30"
CBL-DMACB/NN V xxx BRAKE CABLE
CBL-DMACB/NN V xxx BRAKE CABLE
HEATSHRINK IS TO BE USED INSIDE THE CONNECTOR COVERING BOTH THE WIRE AND THE SOLDER CUP.
CBL-DMACB5 (IDENTICAL TO CBL-DMAC5) REQUIRES THE USE OF THIS ADDITIONAL BRAKE CABLE CBL-DMACB
CBL-DMACB6 (IDENTICAL TO CBL-DMAC6) REQUIRES THE USE OF THIS ADDITIONAL BRAKE CABLE CBL-DMACB
BRAKE
BRAKE
GND
YEL
YEL
SHIELD
NOTE:
1 PLUG, STRAIGHT
2 CABLE CLAMP
3 CABLE SIZE .24 OD
4 MODEL# LABEL, LOCATE APPROX. 1/2 INCH AWAY FROM ENDS OF CABLE ("NN" IN MODEL# INDICATES LENGTH OF CABLE IN FEET) MAXIMUM CABLE LENGTH IS 150 FEET.
5 LEADS 16 AWG, STRIPPED AND TINNED
6 DRAIN WIRE, 18 AWG
7 HEAT SHRINK, BLACK

Coupling High Performance Servos to Mechanical Loads

Application Note by Mick Oakley, Vice President, Customer Support Engineering

Introduction

Mechanical design for servos adds an additional set of constraints to the design rules normally used for power transmission design. These added constraints relate primarily to the stiffness of the system and inertial matching. Decisions on speed reducers, couplings, shaft configurations and many other critical aspects of the mechanical design are often made very early in the design process. Once made, these decisions can be very expensive and time consuming to change.



The intent of this Application Note is to communicate some design information and "rules of thumb" that we at ORMEC have found important in our many years of applying servos to industrial automation. Are these guidelines universal truths? Obviously any set of design rules will from time to time collide with a special case. However, the following guidelines will apply in the vast majority of cases and the prudent designer will only violate them after careful analysis and with a thorough understanding of the risks involved.

Why Be Concerned About The Load?

Knowledgeable servo designers are wary of using a servomotor to drive mechanisms whose moment of inertia is many times that of the motor itself. However, economic pressures and other technical advantages often cause engineers to want to direct drive high inertia loads. The main advantages they seek are to eliminate the cost, maintenance and inaccuracy of a reducer. While it is usually easier to avoid large inertia mismatches, with appropriate attention to detail, they can be made to work. One reason many designers lean towards direct drive, is to avoid the cyclical inaccuracies that gear reducers can introduce. The closed loop servo can monitor its actual speed and position and rapidly adjust for load disturbances. When the load inertia is many times the motor inertia, the motor has only a very small amount of kinetic energy compared to the load. To compensate for a sudden change in load, the servo amplifier must inject a large amount of energy into the servomotor very quickly. This demands a high gain, high bandwidth system. When you combine high gain, high bandwidth and large inertia mismatches, alarm bells should start to sound.

What constitutes a large inertia mismatch? At one time designers strove to achieve a 1:1 inertia match. They considered anything above 5:1 to be a potential problem. The application of digital technology to servo control, digital signal processors in particular, has relaxed that constraint. These days, mismatches of 100:1 or even 1000:1 can be made to work with careful mechanical design.

While good mechanical design is always important, inertia mismatches of 10:1 and above, can only work if the mechanical designer has paid careful attention to minimizing backlash and compliance in the design.

Backlash Effects

Backlash, sometimes called "lost motion", is a mechanical effect that allows you to turn the motor shaft without causing any motion at the load. Generally, you can rotate the motor shaft back and forth over a limited range. If you release the shaft, it will stay where it is.

Backlash, has the effect of temporarily uncoupling and re-coupling the load and the motor with changing speed and direction. When stopped, if there are insufficient external forces acting on the load, the motor may for all intents and purposes be disconnected from the load completely. If the servo is tuned to work well when the load is disconnected, it will have extremely poor performance when the load is connected. Likewise, if the servo is tuned for adequate performance, it will be unstable when the backlash disconnects the load.

The most common symptom of backlash is a "buzz" , often very loud, which occurs primarily when the motor is stopped. Often you can eliminate the buzz by applying a torque at the load. If you tune the servo to eliminate the "buzz", the system becomes very "soft". Sometimes the gain is so low that it cannot stabilize the position loop and the system may oscillate wildly at a low frequency (1-5 Hz)

The only way to solve the problem is to mechanically eliminate the backlash. If you do not eliminate the buzz, over time it may overheat the motor or ruin the mechanical system.

A common source of backlash is using a key-way or set screw to couple to the motor shaft. While key-ways are fine for lawnmowers, they are inadequate for high performance servos! A clamp style coupling, preferably a taper lock bushing, is the only acceptable way to couple to a servomotor shaft.

Another common cause of backlash is improperly adjusted spur gears or using gear reducers that are not designed for servo applications. Properly selected precision planetary gearheads, such as those manufactured by Bayside Controls Inc., Micron Instrument Corp. or Neugardt are generally quite good for servo applications. However, you must make sure the gearhead and primary pinion are mounted and adjusted properly. If you are not careful, improper mounting will introduce backlash into the system and it will deteriorate over time.

Compliance Effects

Compliance also allows you to rotate the input shaft without the load moving. However, with compliance you are actually "winding up" the mechanical system like a spring. When you release the input shaft, it will spring back close to its original position.

Compliance, or wind up, effects show up as a torsional resonant frequency which in turn causes the servo to be unstable. The instability generally shows up as a medium to high frequency oscillation in the order of 100 to 500 Hz. Unlike the "buzz" caused by backlash the sound is often a pure note and does not go away when the motor moves. The frequency does not change as you manipulate the servo tuning however the amplitude may change. Applying a friction load may also reduce the amplitude of the oscillation. As with the buzz caused by backlash, left uncorrected, this resonance will overheat the motor and possibly damage the mechanism.

Long drive shafts, where the bulk of the load inertia is some distance from the motor, are a common cause of this type of problem. It is often surprising how much windup can exist in what appears to be a rather substantial shaft. Take for example a 1 inch diameter stainless steel shaft about 18 inches long. When you apply a 500 in-lb. load the shaft will wind up almost 0.5 degrees.

Shaft Windup:

$\theta = \frac{360T}{2\pi S} \text{degrees}$	T is applied torque (in-lb.)
	S is the stiffness (in/rad)

Shaft Stiffness:

$S = \frac{\pi(OD^4)G}{32L} \text{in} - \text{lb} / \text{rad}$	**OD** is the inside diameter and **ID** is the outside diameter in inches.
	G is the shaft shear modulus (lb/in^2) *for a stainless steel shaft it is* ($11\text{x}10^6$).
	L is the length of the shaft in inches.

Natural Frequency:

$f = \frac{1}{2\pi}\sqrt{S\frac{(J_M + J_L)}{(J_M \cdot J_L)}}\,Hz$	**J_M** is the motor inertia (in-lb-sec^2) **J_L** is the load inertia (in-lb-sec^2)

If we take that same shaft and connect a MAC-DB200Q motor, with a moment of inertia of 0.0476 in-lb-s^2 , on one end and a load inertia of 100 times the motor inertia on the other end, the natural frequency of the system will be about 184 Hz.

Generally, if the natural frequency of the system is less than about 500 Hz, you may encounter resonance problems in high performance systems. There is no magic about the number 500, it is simply a rule of thumb. With a mechanical natural frequency above 500 Hz, you are unlikely to have a resonance problem. At frequencies below 500 Hz, the probability of resonance problems increases. In the above example, to achieve a natural frequency of 500 Hz, you would have to increase the shaft diameter to 1.6875 inches or decrease the shaft length to 2.5 inches.

The natural frequency will usually be determined by the least stiff portion of the drive train which is often the shaft coupling. Be sure to obtain stiffness specifications for any coupling you expect to use and complete the necessary calculations. If you have more than one "un-stiff" component in your drive train, the effects are additive in that the resulting overall stiffness is given by:

Stiffness for 'n' components:

$$S_T = \frac{1}{\frac{1}{S_1} + \frac{1}{S_2} + \frac{1}{S_3} + \dots \frac{1}{S_n}}$$

If the moment of inertia of components located between these couplings is significant compared to the overall load inertia, the calculations become a lot more complex and usually result in multiple resonant frequencies.

Often times, choice of couplings, shaft dimensions and attachment methods have surprising effects. No designer should approach the design of a servo driven mechanism, especially one with a significant inertial mismatch, without doing a careful analysis of the natural frequency of the mechanical system. "Seat of the pants" engineering is almost guaranteed to result in problems.

Coupling Selection

In any servo mechanism, selection of mechanical couplings is critical. When there is a large inertia mismatch it is doubly so. Many times it is the choice of coupling that causes the system to have a low resonant frequency. Helical style couplings are almost never stiff enough to avoid problems unless the load inertia is so low as to be insignificant. The best choice is a bellows style coupling with taper lock bushings.

If we take a typical inexpensive helical coupling rated for 500 in-lbs of torque, the stiffness will be approximately 72x10^3 in-lb/rad. If we use this coupling on the load system described earlier, it will limit the system natural frequency to less than 197 Hz. Clearly this type of coupling would not be adequate. So instead, if we take a similarly rated bellows coupling[1], its stiffness will be 433x10^3 in-lb/rad. This coupling would have a natural frequency of 480 Hz, which is much less likely to affect operation.

Generally, it is best to avoid helical, disc, oldham, split beam and jaw type couplers. Metal bellows will usually provide the best results. In addition to the coupling type you must also pay careful attention to how it is attached to the shafts. A clamping or taper lock is the best way to go. Always avoid keyways and set screws.

How to Tame Mechanical Load Problems

As said earlier, most mechanical load problems are really backlash and/or compliance problems. The solutions involve changing the mechanical design to eliminate any backlash and to raise the natural frequency above 500 Hz. Increasing the natural frequency can often be accomplished by selecting a stiffer coupling, increasing the diameter of shafts or decreasing the lengths of shafts.

Another way to increase reduce the possibility of instability is to add a speed reducer. This step can reduce the reflected inertia by the square of the reduction ratio. Adding speed reduction also increases resolution at the motor and improves performance at low load speeds. It also allows the motor to run at a higher speed which gives it more kinetic energy to overcome load disturbances. This in turn can reduce the gain and bandwidth requirements for the servo.

Obviously, adding a speed reducer adds the reducer's efficiency losses, in accuracy and compliance to the system so careful selection of the reducer type is critical.

Another helpful technique, although one with its own disadvantages, is to add notch filtering in the servodrive command. Ideally, a notch filter exactly counters the effect of the mechanical resonance and eliminates the system's ability to respond at that frequency. When properly designed and implemented, they work well without requiring mechanical changes. The disadvantages of notch filters are:

1) The filter will only work if the mechanism does not undergo significant changes overtime. As mechanisms wear or heat up, their natural frequencies can change. The natural frequency will also change as the load inertia changes. A once stable system may become unstable if the natural frequency shifts enough that the notch filter no longer cancels it out.

2) Many resonant loads have several natural frequencies. If you design a notch filter with a wide enough notch to cover all of the natural frequencies, you may end up with what is effectively a low pass filter which will reduce servo response considerably.

While many mechanical problems can be resolved using notch filters, they don't address the root cause of the problem and therefore are not a universal cure all.

Timing Belts

Timing belts are a very economical and surprisingly accurate way to provide modest speed reductions. For servo applications, you should choose a belt with a high tensile stiffness and low backlash. Belts that use an aramid tensile member and a modified curvilinear tooth profile are good in both qualities. Belt selection and design is a fairly specialized process and the reader would be well advised to consult one of the many excellent application guides published by belt manufacturers for assistance in this area. Another advantage of timing belts over other types of reducer is their very high efficiency, 95% or better. A disadvantage of timing belts is the added inertia of the pulleys. However, the added inertia can be minimized by modifying standard pulleys to reduce their mass. Custom pulleys can be made from light weight materials such as aluminum and are available from most belt manufacturers.

Timing belts designed for precise positioning have a tensile member that uses fibers with a very high tensile strength. These fibers are set at a diameter that is much larger than a typical direct drive shaft. If the belt system has been properly sized the stiffness of the system can be better than a solid steel shaft. In the example shown on page 3, the system had a shaft windup of 0.5 degrees with a 500 in-lb load. If you substitute a 37mm wide timing belt[2] using 6 inch pulleys[3] on 18 inch centers, the windup will be less than 0.25 degrees. When a speed reduction is used rather than 1:1, the windup decreases further.

To calculate the natural frequency of a timing belt system, you need to know the spring rate of the belt. This is available from the belt manufacturer and is normally called the EA factor. The EA factor for a belt varies with the tension of the belt and is usually shown on a chart that plots EA (lbs per inch width per unit strain) against belt load (lbs per inch width).

Calculations to determine natural frequency of a timing belt system:

$M_1 = \frac{J_1}{R_1^2}, M_2 = \frac{J_2}{R_2^2}$	**J_1** is the total moment of inertia at the driving pulley (in-lb-s^2). It includes the inertia of the pulley and everything connected to it.
	J_2 is the total moment of inertia at the load pulley(in-lb-s^2). It includes the inertia of the pulley and everything connected to it.
	R_1 is the radius of the driving pulley (inches).
	R_2 is the radius of the driven pulley (inches).
$S = \frac{EA \cdot width}{span}$ $F = \frac{1}{2\pi}\sqrt{S\frac{(M_1 + M_2)}{(M_1 \cdot M_2)}}Hz$	**S** is the belt stiffness (lb/inch). span is the belt span, which is the distance the belt spans between the initial contact points on the pulleys on the tension side of the belt (inches). width is the belt width (inches).
	span is the belt span, which is the distance the belt spans between the initial contact points on the pulleys on the tension side of the belt (inches).
	width is the belt width (inches).
	EA Belt spring rate in (lbs/inch width per unit strain).

The calculations for windup and resonant frequency of a timing belt system can get quite tricky since you must take belt tension and load forces into account when deciding what EA value to use[4] . Unless you are already familiar with the techniques, you should seek the assistance of your belt supplier. For the purpose of this Tech Note it is sufficient to say that it is not difficult to design a timing belt drive that is as stiff or stiffer than a typical direct coupled load. The main advantage of a timing belt system is not that it significantly increases the natural frequency but rather it changes the *amplitude of the resonance*. A timing belt system adds considerable damping to the system and for a given natural frequency, *will allow higher gain settings* before resonance becomes a problem. Another advantage is that it allows you to run the motor at a higher speed which, if the motor inertia is small compared to the load, will provide better operation.

One thing to remember is that resonances are usually a greater problem when the system is stopped that when it is moving under load. By reducing belt tension slightly, you can provide a measure of decoupling between the motor and load. This decoupling and the damping provided by the belt will often reduce resonance problems. Be careful not to reduce the tension too much or accuracy will suffer. A good rule of thumb is to make sure the "slack" side of the belt is always under some tension.

Another thing to remember is that too much belt tension can easily generate a radial load on the motor shaft which will drastically reduce bearing life. When belt tension must be high, always use a jack shaft with its own bearings to isolate the motor shaft from the radial load.

Summary

In summary, if you have a load to motor inertia mismatch greater than 10:1, or have a significant portion of the load inertia coupled through long shafts, you will need to carefully analyze your mechanical design. You will need to make sure there is no backlash and that the natural frequency is higher than 500 Hz. If you cannot achieve that, gear or belt reduction are the best alternatives for making it work. As a last resort, notch filtering may be practical in some special cases.

References

1. Rimtec, type ADK 60.

2. Gates Rubber Co. Poly Chain GT (Part # 14M-1400-37) http://www.gates.com/polychain.html).

3. Gates Rubber Co. (Part # 14M-34S-37).

4. Selecting Synchronous Belts for Precise Positioning, A.W. Wallin - Applications Engineer, Synchronous Drives Div., The Gates Rubber Co., Denver CO.

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