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OPERATION
&
SERVICE MANUAL

for

CONTREX®

Model CXB1525
Model CXB2040

Brushless Amplifier System

MANUAL#: 0001-0200
REVISION: E
DATE: 11-07-97

8900 Zachary Lane N., Maple Grove, MN 55369 U.S.A.

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READ THIS!

Model CXB1525/CXB2040
Brushless Servo Motor/Amplifier SETUP

When a servo kit is purchased from CONTREX, the resolver has been aligned, and the motor/amplifier tuned for a 1:1 inertia match. The factory settings of the potentiometer's and switch's are recorded in the CXB1525/CXB2040 manual and on SK1650 for easy reference.

The only potentiometer's that may need adjustment are the Loop Gain pot, which is shipped set at full CCW (off) and the Compensation pot, if the inertia is not a 1:1 match.

M-SERIES PRODUCT SETUP

There are drawings included with the servo kit showing the proper wiring between the CXB amplifier and the M-Series. On the M-Series, set the Isolator Voltage Reference jumper to "Internal Reference" as shown in chapter 2 of the M-Series manual. Next adjust the "On Board Scale Pot" for a maximum output voltage of 10VDC as shown in chapter 4 of the M-Series manual. Reconnect all of the labeled wires between the motor and CXB amplifier. Also make sure there is a good earth ground connection to the CXB amplifier chassis and from the CXB amplifier chassis to the motor.

AMPLIFIER SETUP

Once the wiring is complete, enable the CXB amplifier with the M-Series powered up, but **NOT** in RUN. There is now a zero volt speed command to the CXB amplifier. Slowly rotate the Loop Gain pot CW from its present "off" (full CCW) position to the "on" position (full CW). The motor shaft should now hold position. If the motor acts erratically or runs at high speed turn the Loop Gain pot full CCW, shut off power and check wiring.

Consult CONTREX, Inc. if application assistance is needed. When in doubt, do not hesitate to put all adjustments back to the recorded settings and start over.

You may now move on to the M-Series calibration.

SK1651 Rev. 1

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CALIBRATION - SETUP RECORD
Model CXB1525/CXB2040
Brushless Servo Amplifier System

Date:
Model Number:
Serial Number:
Customer Order Number:

ENCODER
Resolution:

DIP SWITCH CONFIGURATION

Dip Switch	S1	S2	S3
1	ON / OFF	ON / OFF	ON / OFF
2	ON / OFF	ON / OFF	ON / OFF
3	ON / OFF	ON / OFF	ON / OFF
4	ON / OFF	ON / OFF	ON / OFF
5	ON / OFF	ON / OFF	ON / OFF
6	ON / OFF	ON / OFF	ON / OFF
7	ON / OFF	ON / OFF	ON / OFF
8	ON / OFF	ON / OFF	ON / OFF

POTENTIOMETER SETTING

Pot	Name of Pot	Test Point	Setting (Ohms)	Notes
RV2	SIG 1 (Signal 1)	J3-A to J3-F	_____	Sets MAX speed of motor
RV3	SIG 2 (Signal 2)	J3-B to J3-F	_____	Shipped fully CCW
RV4	TACH (Tach Gain)	J3-C to J3-F	_____	Sets system bandwidth
RV5	BAL (Balance)	N/A	_____	Used to null any offsets in system
RV6	COMP (Compensation)	J3-D to J3-F	_____	Sets system bandwidth
RV7	I LIMIT (Current Limit)	J3-E to J3-F	_____	Sets Maximum motor current
RV8	LOOP (Loop Gain)	N/A	_____	Shipped fully CCW (OFF)

* To measure pot settings: RV8 must be set fully CCW and AC power must be off.
* Before making adjustments to the pot settings, please consult CONTREX Inc..

MAX RPM _____ Vin = _____ RPM

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INTRODUCTION

CONTREX brushless motors and amplifiers offer the ultimate in low maintenance and high performance motion-control. CONTREX offers a full line of matched motors and amplifiers to meet virtually every motion-control application.

This manual provides all the technical information necessary to install, configure, operate, and maintain our TORQUE-SWITCH™ series, brushless servo-motor amplifiers, models CXB1525 and CXB2040. These amplifiers contain the high performance of sinusoidal motor current with the efficiency of pulse-width modulation (PWM).

We suggest that you take the time to read this manual from cover-to-cover before attempting to work with these amplifiers for the first time. If at any time you have questions not addressed in this manual, or have any special requirements, please feel free to call and discuss them with a CONTREX applications engineer. We are happy to provide both off-the-shelf and custom products. With over two decades in the motion control business, we have a vast pool of applications knowledge waiting to assist you.

Thank you for selecting CONTREX for your motion-control needs. It is our goal to save you time and money, and to provide you with a superior product.

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CHAPTER ONE: DESCRIPTION, FEATURES AND SPECIFICATIONS

1.1 DESCRIPTION:

This brushless amplifier system has been designed to offer you, our customer, a large degree of flexibility and customization with a standard, in stock product. Each amplifier module consists of a standard power output board with one of our three types of personality modules mounted on it. (To help you understand the various brushless amplifier and motor system combinations and their respective advantages and disadvantages, please refer to chapter two of this manual which describes the theory of operation). Following is a brief description of these personality modules and their mode(s) of operation:

(1) **SINE/RESOLVER MODE** - In this mode of operation, a brushless motor with an integral resolver is required. The personality module contains a resolver to digital converter which provides the positional information to the amplifier that is required to commutate the motor. This positional information is also used by the personality module to emulate a quadrature encoder output. This personality module can be configured for the following two different types of operation:

(a) VELOCITY MODE - In this mode of operation, the personality module generates a tachometer signal which is used to close a velocity loop in the amplifier. Please see section 2.3, 2.5, 2.8 of this manual for more detailed information.

(b) CURRENT MODE - In this mode of operation, which is also commonly referred to as torque mode, sine wave currents in the motor are produced that are directly proportional to the input signal. Please see section 2.5, 2.7, 2.9 of this manual for more detailed information.

1.2 FEATURES:

1.2.1 Stand Alone One Axis Amplifier:

- Line operated AC power operation: Fused AC input for single or three phase input with solid state zero-crossing switch which limits in-rush current protection at turn-on. No power isolation transofrmer is required.
- Fused Regen clamp circuit (shunt regulator) with LED indicator and 50W internal load resistor bank bleeds off excess DC Buss voltage when decelerating a large load inertia. Additional regen resistors can be connected externally.
- Bridge rectifier(s) and filter capacitor.
- Cooling Fans.

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• Surface mount technology:	Constructed with surface mount components.
• Complete isolation:	Complete isolation from input to output.
• Silent operation:	Carrier frequency is 20KHz.
• Short circuit protection:	Complete short circuit and ground fault protection.
• LED diagnostics:	red LED(S) illuminate to display various fault conditions and a green LED illuminates to indicate normal operating conditions.
• Encoder emulation:	Encoder emulation comes standard with line driver outputs, quadrature and zero index.
• Frequency response (Velocity Loop):	750 Hz minimum.
• Frequency response (Current Loop):	2 KHz minimum.
• Dual signal inputs:	Two single-ended or one differential. Both single-ended inputs may be use simultaneously. All inputs have up to 15,000 A/V gain, and all inputs will accept ±13VDC.
• Dual mode operation:	The standard amplifier may be configured for simulated velocity (RPM) control or current (torque) control.
• Current limit:	Maximum motor current is adjustable.
• Digital limit/enable Inputs:	Three separate logic inputs can stop the motor in either or both directions. Inputs may be configured for active-high or active-low, pull-up or pull-down termination, and a 0 to +15V or 0 to +5V range.
• Encoder outputs:	Incremental (quadrature) position outputs with separate index. 19 different encoder counts, from 125 to 4096 counts/revolution , are available. Differential line-driver output devices sink and source 40mA.
• Tachometer output:	DC output proportional to motor RPM.
• Fault Input/Output:	Open-collector output goes low in the event of a fault. This input is configured so that externally forcing this output low will inhibit amplifier. This allows all fault outputs in a multi-axis system to be connected together (wire-ORed) to shut down all amplifiers should any amplifier have a fault.
• Fault input/output:	Open-collector output goes low in the event of a fault. This input is configured so that externally forcing this output low will inhibit amplifier. This allows all fault outputs in a multi-axis system to be connected together (wire-ORed) to shut down all amplifiers should any amplifier have a fault.

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• Manual and external fault reset:	Push button and a separate input is provided to reset the amplifier after a fault.
• High-Speed Electronic Circuit Breaker (HS/ECB):	Instantly shuts down the amplifier in the event of a short across the outputs and or ground fault protection. (i.e. amplifier exceeds 80A for 10 micro seconds)
Low-Speed Electronic Circuit Breaker (LS/ECB):	Shuts down the amplifier if the amplifier is operated above the maximum continuous current rating for a pre-determined period 3 seconds).
• Fold back current limit:	Folds back the continuous current delivered by the amplifier to a preset value if the amplifier is operated above the maximum continuous current rating for a pre-determined period.
• Over/under voltage and over temperature:	These circuits constantly monitor motor and amplifier power-supply voltages, and motor and amplifier-heatsink temperature. They will shut down the amplifier in the event of any out-of-specification condition. (The over voltage protection circuit is set to turn on at +250VDC for 120 VAC line input and +450 VDC for 240 VAC line input.)

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1.3 SPECIFICATIONS:

This section contains the specifications for the brushless trapezoidal, sine/resolver and two or three phase input current mode D.C. Servo Amplifiers. These specifications also include power supplies for the amplifiers.

NOTE: All data in this section is based on the following ambient conditions: 120 ^{o}F (50 ^{o}C) maximum. Forced air cooling.

1.3.1 STAND ALONE ONE AXIS AMPLIFIER:

The stand alone one axis amplifier contains a single amplifier module, a DC power supply, a cooling fan, fusing and shunt regulator in a sheet metal enclosure. The shunt regulator within the DC power supply has a 50W internal load resistor bank which bleeds off excess DC Buss voltage when decelerating a large load inertia. An external shunt regulator resistor can be connected (Consult with factory).

NOTE: Customer must specify the input AC voltage (105-120VAC/205-250VAC) when ordering (see chapter 3: model numbering), so that the proper fan can be installed.

1.3.1.1 Input and Output Power**:**

Input Power/ Buss Voltage(B+)	Output Power (current)			
	CXB1525		CXB2040	
	R.M.S.	Peak	R.M.S.	Peak
120VAC/170VDC	15A	25A	20A	40A
240VAC/340VDC	10A	25A	15A	35A

1.3.1.2 Signal Inputs**:**

Amplifier Model	Signal Input	Maximum Voltage (VDC)	Minimum Impedance S	Velocity Gain Amp./Volt	Current Gain Amp./Volt
CXB Series	Differential	±13	10,000	15,000(min.)	0-5
CXB Series	Single-ended	±13	10,000	15,000(min.)	0-5

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1.3.1.3 Digital Inputs**:**

- +/-Limit, Inhibit & Reset: 40/-0.5V max. Terminated by 10,000S.
- Fault (as input): 40/-0.5V max. Terminated by 10,000S.
- Typical for all digital inputs: Digital inputs have hysteresis with thresholds at 1/3 and and 2/3 of +5V or +15V depending on range select jumper.

1.3.1.4 System**:**

- Drift offset over temperature reference to input: 0.01mV/ ^{o} C max.
- Frequency response (Velocity loop): 750Hz min.
- Frequency response (Current loop): 2KHz min.
- Dead band: None.
- Form factor: 1.01.

1.3.1.5 Outputs**:**

- Fault (as output): Active low. Open-collector output can sink 500mA max.
- Absolute motor current(J1-3): 10A/V.
- Tachometer : 1000S source impedance, a high input impedance meter must be used (1M S /volt). Maximum Tachometer output voltage for 12 bit = 1.5V/KRPM, 14 bit = 2V/KRPM.
- Encoder outputs: (SMA8215) Standard TTL levels with 20mA sink or source capability.

1.3.2 Mechanical

Model	L x W x H (inches)	Weight (lbs)
CXB1525 (Stand Alone Amplifier)	9.025 x 4.00 x 4.96	5.25
CXB2040 (Stand Alone Amplifier)	9.025 x 4.00 x 4.96	5.25

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CHAPTER TWO: THEORY of OPERATION

2.1 INTRODUCTION:

This chapter contains the basic control theory of how brush-type and brushless servo motors and amplifiers operate. It also compares and contrasts the advantages and disadvantages of brushless and brush-type motors and amplifiers to help you select which is best suited for your application. The following is a summary of the topics:

- The theory behind an amplifer driving DC servo-motors.
- A comparison between brush-type and brushless motors.
- A comparison between trapezoidal mode and sinusoidal mode.
- The advantages and disadvantages of trapezoidal amplifier systems.
- A comparasion between velocity mode and current mode.
- Various kinds of velocity feedback.
- Commutation using resolver.
- Current mode in sine/resolver or trapezoidal amplifier vs two/three phase input current amplifier.
- Protection circuits.

2.2 DRIVING DC SERVO-MOTORS:

The torque of any DC motor is proportional to motor current: the stronger the magnetic field, the stronger the pull. Motor current may be controlled in two ways: linear and PWM (Pulse-Width Modulation). Linear control is achieved by simply inserting a resistance in series with the motor. This resistance is usually a partially turned-on transistor. The transistor is said to be in its "linear" region. Linear amplifiers are simple, accurate, and effective. However, they are very inefficient and they generate a lot of heat. Linear amplifiers are used when low electrical noise, high bandwidths (2KHz or higher) and or low inductance (less than 1mH) motors are used. In pulse-width modulation the control devices (output transistors) are rapidly turned full-on and full-off. The ratio of the on-time (the pulse width) and off-time determines the average motor current. Refer to figure 2.1. For example: if the output is on 25% of the time and off 75% of the time, the average motor current is approximately 25% of maximum.

A coil of wire, such as the windings of a motor, forms an inductor. Inductors resist changes in current. This resistance to change, known as reactance, acts to dampen or average the high-current spikes that would otherwise occur when the output devices are on. In fact, if motor inductance is low, external inductors may have to be added in series with each motor lead to ensure proper operation.

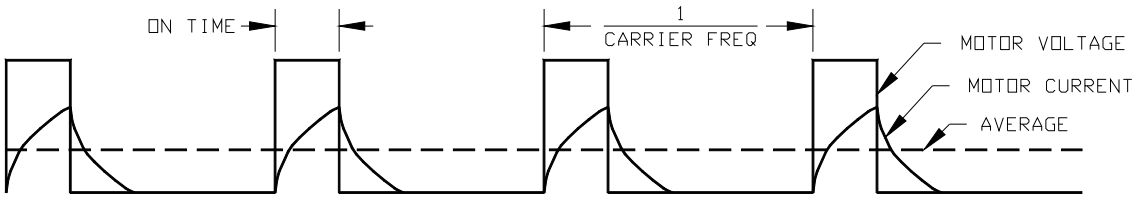


Figure 2.1
Pulse Width Modulation Waveform

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2.3 SERVO LOOPS:

A basic velocity-mode servo-loop for a brush-type motor is shown in figure 2.2a. An external controller commands a given velocity (RPM). The velocity-loop summing-amplifier compares this command with the actual motor velocity, supplied by a DC tachometer on the motor shaft, and produces an error voltage proportional to the difference between the actual and commanded velocity.

The velocity error is used to command motor current in the inner servo-loop. The current- loop summing-amplifier compares the command current (velocity error) with the actual current in the motor and produces an error voltage proportional to the difference between the actual and commanded current.

Finally, the current-error signal is used to produce an output (linear or PWM) to drive the motor.

The velocity loop may be bypassed, and an external current command fed directly to the current loop. In this case, the external command signal controls the torque of the motor, rather than the velocity. This is known as current-mode operation.

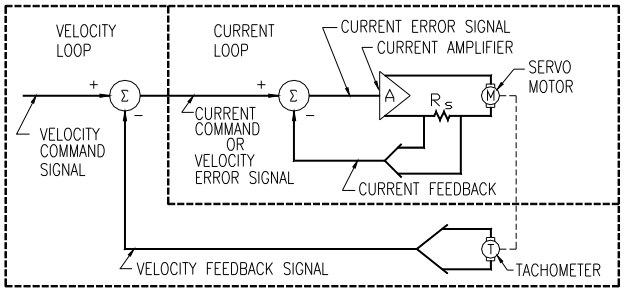


Figure 2.2a
Velocity-mode sevo loop for a brush-type motor

The servo-loops of a brushless amplifier (figure 2.2b) operate in much the same way, except there are now three current loops, one for each phase of the motor.

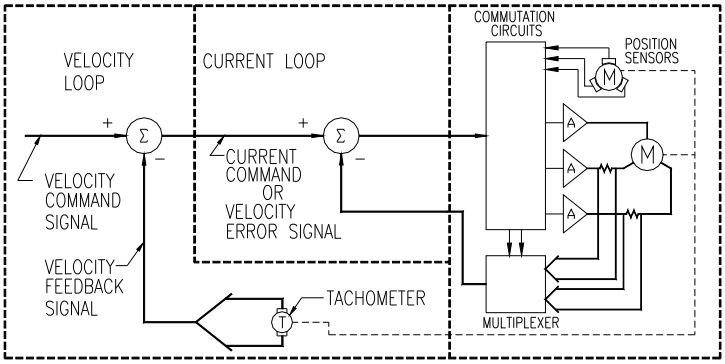


Figure 2.2b
Velocity-mode sevo loop for a brushless motor

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2.4 BRUSHED MOTORS vs. BRUSHLESS MOTORS:

There are two basic types of motor design that are used for high-performance motion control systems: brush-type PM (permanent magnet), and brushless-type PM. As you can see in figure 2.3, a brush-type motor has windings on the rotor (shaft) and magnets in the stator (frame). In a brushless-type motor, the magnets are on the rotor and the windings are in the stator.

To produce optimal torque in a motor, it is necessary to direct the flow of current to the appropriate windings with respect to the magnetic fields of the permanent magnets. In a brush-type motor, this is accomplished by using a commutator and brushes. The brushes, which are mounted in the stator, are connected to the motor wires, and the commutator contacts, which are mounted on the rotor, are connected to the windings. As the rotor turns, the brushes switch the current flow to the windings which are optimally oriented with respect to the magnetic field, which in turn produces maximum torque.

In a brushless motor there is no commutator to direct the current flow through the windings. Instead, an encoder, hall sensors or a resolver on the motor shaft senses the rotor position (and thus the magnet orientation). The position data is fed to the amplifier which in turn commutates the motor electronically by directing the current through the appropriate windings to produce maximum torque. The effect is analogous to a string of sequencing Christmas lights: the lights seem to chase each other around the string. In this case, the magnets on the rotor "chase" the magnetic fields of the windings as the fields "move" around the stator.

The relative advantages and/or disadvantages of a brush-type motor/amplifier combination vs. a brushless motor/amplifier combination can be significant. On the next page is a summary of advantages and disadvantages of brush type motor/amplifiers and brushless type motor/amplifiers to help you decide which type to select for your applications.

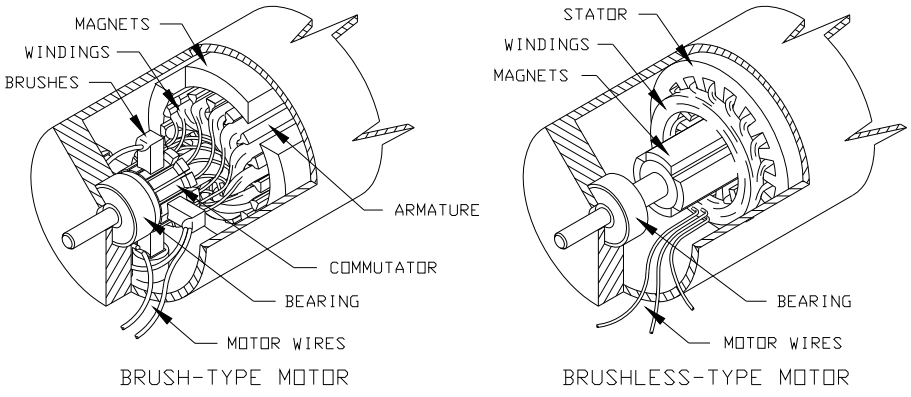


Figure 2.3
Brush-type and Brushless-type Motors

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BRUSHLESS MOTORS/AMPLIFIERS	BRUSHED MOTORS/AMPLIFIERS
ADVANTAGES	**DISADVANTAGES**
No scheduled maintenance and no brush dust is generated.	Motor brushes must be checked periodically for wear and excess brush dust.
Higher RPM limits.	Approximately 3000RPM maximum.
Lower inertia/torque ratio.	Higher inertia to torque ratio.
Dissipates heat more efficiently due to windings being located in stator.	Not as efficient at dissipating heat. Heat is trapped at rotor and shortens bearing life.
Safer for explosive atmospheres. Quieter and less electrical noise generated.	Brushes spark and generate electrical and audible noise.
DISADVANTAGES	**ADVANTAGES**
Amplifiers are complicated and expensive.	Amplifiers are simpler and less expensive.
Higher torque ripple.	Lower torque ripple.
No Industry standard packaging.	Industry standard packaging.

2.5 SINUSOIDAL vs. TRAPEZOIDAL:

Figure 2.4 shows the two most common waveforms used to drive a brushless motor. Note that in each case, there are actually three different waveforms. Each waveform drives a motor winding and is 120 ^{o} out-of-phase with the other two. Again, the waveform may be generated from a DC source by linear or PWM techniques.

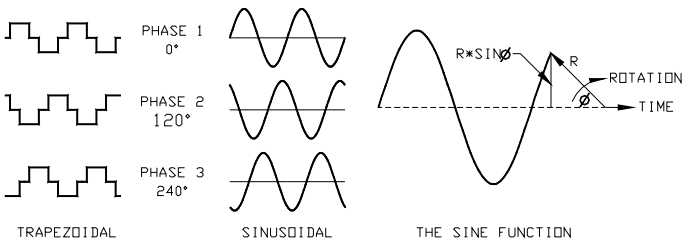


Figure 2.4
Trapezoidal and sinusoidal waveform used to drive brushless motor.

The first waveform is known as trapezoidal or six-step since the voltage is literally stepped from winding to winding (like the Christmas-light analogy). This is the simplest and least expensive method of driving a brushless motor. Its principal disadvantage is that the large current steps produce high torque ripple. (Torque ripple is a repetitive fluctuation in torque as the motor turns and is independent of load.)

The second waveform is known as sinusoidal. To minimize torque ripple, the motor current needs to be constantly varied according to the orientation of the magnets and windings. As it happens, this is a sine function. In fact, a sine wave is defined as a rotating radius (like a motor shaft) revolving through time (see figure 2.4). A sine wave is the most natural way to drive a motor and produces the minimum torque ripple.

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2.6 THE ADVANTAGES AND DISADVANTAGES OF A TRAPEZOIDAL AMPLIFIER SYSTEM:

A trapezoidal motor has three stator windings and together with the rotor magnets are designed so that the magnetic flux coupling between them produce a constant torque. The torque of the motor is proportional to the three stator phase currents which are 120 ^{o} out-of-phase to the other two. Shaft position sensors are required to provide the commutation signals to commutate the motor. The two most common sensor types are Hall-effect sensors and an optical encoder with commutation tracks.

A common class of applications for trapezoidal amplifiers is for motor speed control. Classically, this is implemented by adding a brushless DC tachometer to the motor shaft and driving the motor through a velocity controlled servo loop. A high performance velocity loop can be implemented in this manner.

Another way of implementating the motor speed control is by using a simulated digital tachometer synthesized by the motor commutation signals. The commutation signals are used to trigger an one shot signal at every transition of the commutation signals. After smoothing, a voltage proportional to velocity (RPM) is obtained.

Two additional system features were implementated in the synthesized tachometer design:

1 At 100% of full RPM, the PSEUDO-TACH voltage is limited by the power supply voltage. If an RPM is commanded above 100% RPM, the servo will run away. To prevent this from occuring, the absolute value of the PSEUDO-TACH signal is compared to a 95% of full RPM reference. If the PSEUDO-TACH signal exceeds this value, an over speed latch is set and the servo is disabled.
2 The PSEUDO-TACH one shot pulse is buffered and brought to the control interface. The controller can use this signal to determine the exact velocity (RPM) of the motor.

2.7 CURRENT MODE vs. VELOCITY MODE:

The fundamental difference between current mode and velocity mode is that in current mode, an external command signal controls the torque of the motor, rather than the velocity. In velocity mode, an external command signal controls the velocity (RPM) of the motor, rather than the torque. In a current mode amplifier, the command signal is proportional to the motor current, thus it is also proportional to the torque of the motor. In a velocity mode amplifier, the current loop amplifier stage is preceded by a high gain error amplifier which compares the command signal and the tachometer feedback signal.

Current mode amplifiers are usually used in Position Control Systems where no tachometer feedback is required. While velocity mode amplifiers are usually used in Classic Cascaded Contol Systems where there are position, velocity and current loops in the system. Velocity loops tend to have a higher bandwidth and operate better near zero speed.

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2.8 TACHOMETER (VELOCITY MODE) FEEDBACK OPTIONS:

The following is a list of ways one can choose to implement tachometer feedback in order to drive the motor through a velocity controlled servo loop:

- Brush-type and brushless DC mechanical tachometer.
- Simulated tachometer using the motor commutation signals (PSEUDO-TACH).
- Sinusoidal resolver.
- Simulated tachometer using the encoder signals.

The simplest way to simulate the actual velocity of the motor is by installing a mechanical brush-type or brushless DC tachometer on the motor shaft which converts the velocity of the motor into DC voltage.

The second method is to synthesize a digital tachometer using the motor commutation signals (refer to section 2.6).

In the third method, with a sine/resolver amplifier an analogue tachometer signal is generated as part of the Resolver-to-Digital conversion process and is immediately available for use thru the dip-switch options for velocity mode(S1-7).

The fourth method is to have an optical encoder installed on the motor shaft to determine the direction and position of the motor as it runs. The incoming encoder signals are converted into quadrature clock pulses. The frequency of this clock pulses changes with the velocity of the motor and the up/down clock output signals change with the direction of which the motor is running at. The frequency of the clock is then converted into the tach DC voltage signal using the Frequency-to-Voltage converter.

2.9 COMMUTATION USING RESOLVER:

The Resolver-to-Digital converter generates the necessary excitation for the resolver, and converts the resolver's sine and cosine signals into position data. This position information is used to amplitude modulate the velocity error signal into three-phase, sinusoidal and current-error signals like the one in section 2.3.

2.10 CURRENT MODE IN SINE/RESOLVER OR TRAPEZOIDAL AMPLIFIER vs. TWO OR THREE PHASE INPUT CURRENT MODE AMPLIFIER:

The fundamental difference between the current mode in sine/resolver or trapezoidal amplifiers and the two or three phase input current mode amplifiers is that in the former case, the commutation of the command and feedback signals is done within the amplifier itself. The latter case accepts two or three 120^{o} out of phase commutated drive signals. In other words, the user's controller has to do the commutation of the command and feedback signals themselves. The user can either input two or three commutated drive signals. If the user has chosen two phase input, the third phase is generated as the negative sum of the other two inputs.

2.11 PROTECTION CIRCUITS:

The High- and Low-Speed Electronic Circuit Breakers(HS/ECB and LS/ECB) protect the amplifier and motor from being damaged by high motor current(specified max. peak and rms current values). The Over Temperature and Over Voltage detection circuits will shut off the amplifier when the temperature of the amplifier or the buss(B+) voltage exceeds a specified limit. Also, there are circuits which limit the motor from running in either or both directions.

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CHAPTER THREE: MODEL NUMBERING

3.1 INTRODUCTION:

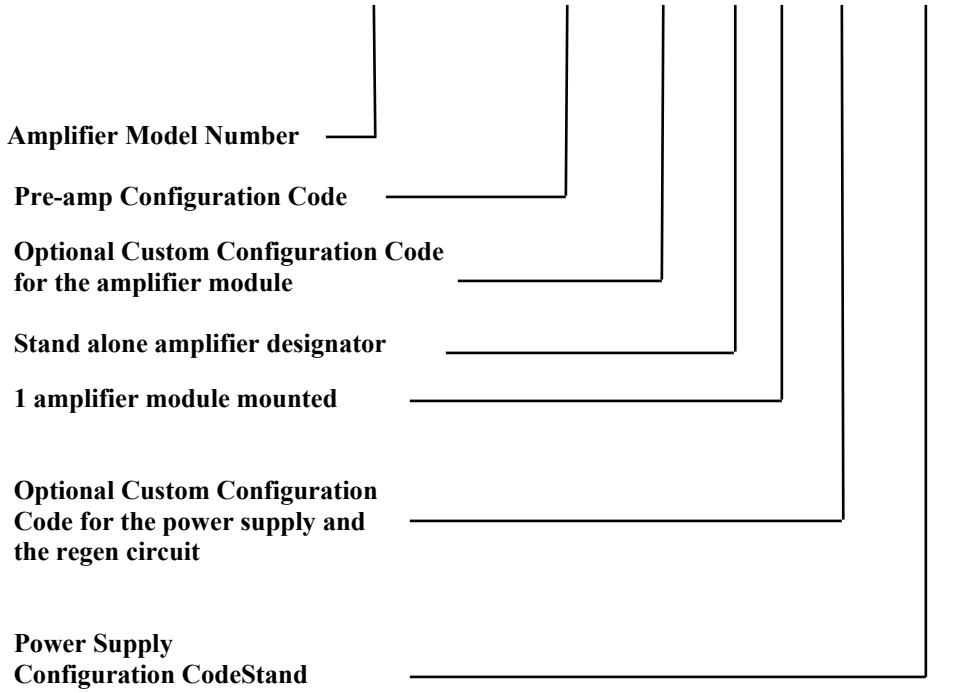
This chapter contains the model numbering system for the stand alone one axis amplifier and applications. The model numbering system is designed so that you, our customer will be able to create the correct model number of the product that you need as quick and as accurately as possible.

3.2 STAND ALONE AMPLIFIER MODULES:

3.2.1 SINE/RESOLVER MODE:

3.2.2 SINE/RESOLVER MODE:

CXB1525/CXB2040 - YYYYYYY - QQQ - 1A - 1 - ZZ - RRR



Amplifier Model Number

Pre-amp Configuration Code

Optional Custom Configuration Code for the amplifier module

Stand alone amplifier designator

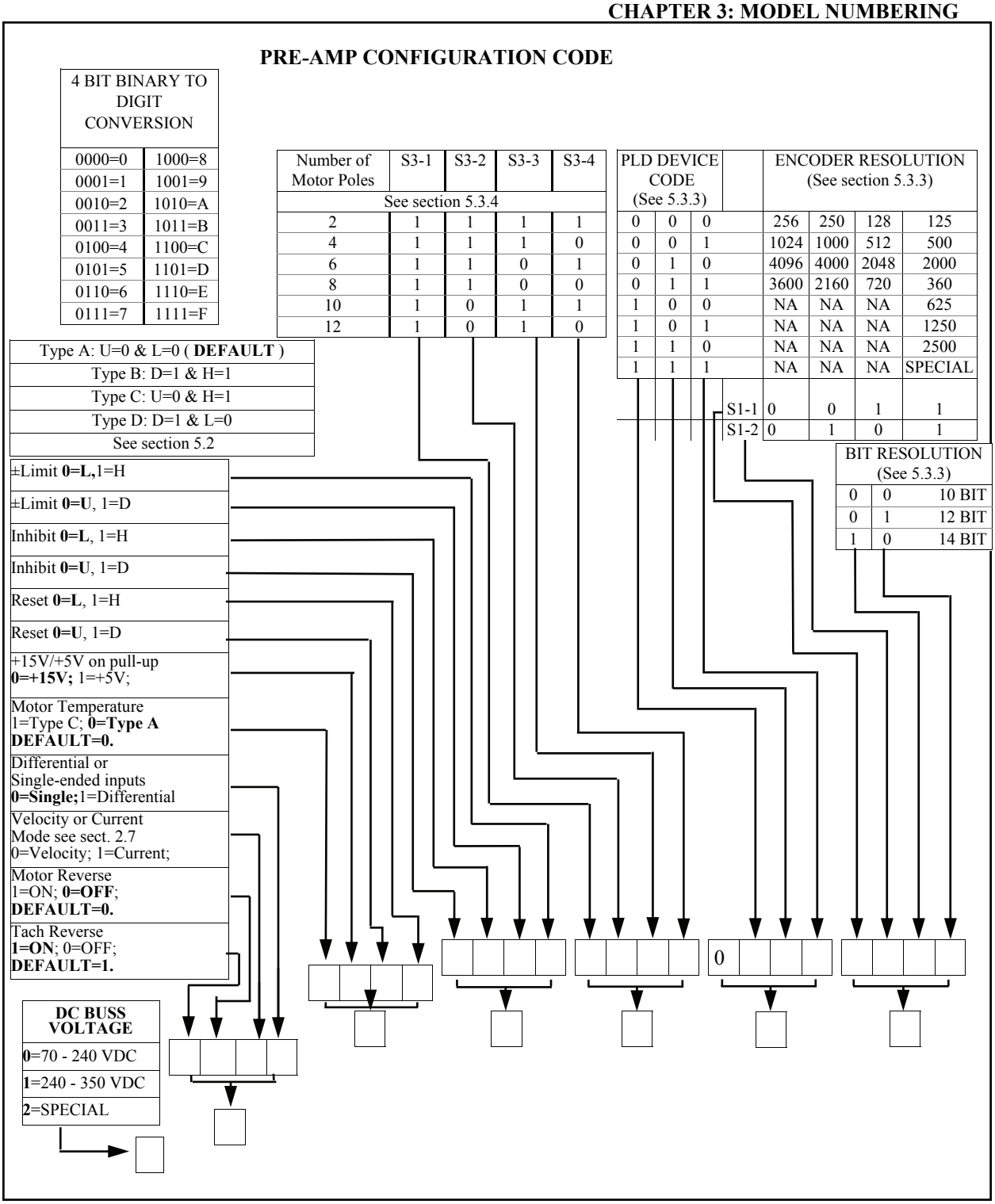
1 amplifier module mounted

Optional Custom Configuration Code for the power supply and the regen circuit

Power Supply Configuration CodeStand
00 = 120VAC 1 PHASE IN, 170VDC BUSS
01 = 120VAC 3 PHASE IN, 340VDC BUSS
02 = 240VAC 1 PHASE IN, 340VDC BUSS
03 = 240VAC 3 PHASE IN, 340VDC BUSS

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PRE-AMP CONFIGURATION CODE



4 BIT BINARY TO DIGIT CONVERSION	
0000=0	1000=8
0001=1	1001=9
0010=2	1010=A
0011=3	1011=B
0100=4	1100=C
0101=5	1101=D
0110=6	1110=E
0111=7	1111=F

Number of Motor Poles	S3-1	S3-2	S3-3	S3-4
See section 5.3.4				
2	1	1	1	1
4	1	1	1	0
6	1	1	0	1
8	1	1	0	0
10	1	0	1	1
12	1	0	1	0

PLD DEVICE CODE (See 5.3.3)			ENCODER RESOLUTION (See section 5.3.3)			
0	0	0	256	250	128	125
0	0	1	1024	1000	512	500
0	1	0	4096	4000	2048	2000
0	1	1	3600	2160	720	360
1	0	0	NA	NA	NA	625
1	0	1	NA	NA	NA	1250
1	1	0	NA	NA	NA	2500
1	1	1	NA	NA	NA	SPECIAL

S1-1	0	0	1	1
S1-2	0	1	0	1

BIT RESOLUTION (See 5.3.3)		
0	0	10 BIT
0	1	12 BIT
1	0	14 BIT

Type A: U=0 & L=0 (**DEFAULT**)
Type B: D=1 & H=1
Type C: U=0 & H=1
Type D: D=1 & L=0
See section 5.2

±Limit **0=L,**1=H

±Limit **0=U**, 1=D

Inhibit **0=L**, 1=H

Inhibit **0=U**, 1=D

Reset **0=L**, 1=H

Reset **0=U**, 1=D

+15V/+5V on pull-up
0=+15V; 1=+5V;

Motor Temperature
1=Type C; **0=Type A**
DEFAULT=0.

Differential or
Single-ended inputs
0=Single;1=Differential

Velocity or Current
Mode see sect. 2.7
0=Velocity; 1=Current;

Motor Reverse
1=ON; **0=OFF**;
DEFAULT=0.

Tach Reverse
1=ON; 0=OFF;
DEFAULT=1.

DC BUSS VOLTAGE
0=70 - 240 VDC
1=240 - 350 VDC
2=SPECIAL

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CHAPTER FOUR: INSTALLATION

4.1 INTRODUCTION:

This chapter provides the necessary information to make all the wiring connections for the amplifiers to operate properly.

4.2 MOUNTING:

Appendix A contains all the wiring diagrams, assembly drawings, and mechanical information necessary to install the amplifiers. The amplifier package should be mounted in a clean, dry enclosure, free of dust, oil, or other contaminants.

NEVER INSTALL THE AMPLIFIER PACKAGE IN ANY LOCATION WHERE FLAMMABLE OR EXPLOSIVE VAPORS ARE PRESENT.

IMPORTANT: Muffin fan(s) are mounted along one edge of the baseplate to provide cooling. At least 3 inches must be allowed between the fan side and the side opposite the fans and any other surface. The clearance to any other side of the amplifier package is not critical, although sufficient space should be allowed for easy wiring and servicing.

4.3 WIRING:

4.3.1 RFI/EMI and Wiring Technique:

IMPORTANT: All PWM equipment inherently generates radio-frequency interference (RFI), and wiring acts as antennae to transmit this interference. In addition, motors inherently generate electromagnetic interference (EMI). Unless the wiring is very short, some sort of shielding on the motor wires is necessary to meet FCC RFI/EMI guidelines and to protect other equipment from the effects of RFI/EMI. We recommend that shielded wire be used, or the wires should be run in metallic conduit. The shield or conduit should be connected to the amplifier baseplate, which in turn must be earth grounded. In addition, a conductor of the same gauge as the motor wires must be connected from the motor case to the amplifier baseplate to provide protection from shock hazard. The earth grounding is necessary to meet National Electrical Code (NEC) requirements as well as suppressing RFI/EMI.

Additional RFI suppression may be obtained by placing inductors in each motor lead near the amplifier. Consult a CONTREX applications engineer for inductor recommendations. CONTREX stocks a complete line of inductors for virtually every application.

IMPORTANT: The signal wiring to the resolver and the signal inputs to the amplifier are susceptible to noise pickup. Excessive noise pickup will cause erratic amplifier operation. We urge that each signal input be run in a twisted-pair, shielded cable. The hall-sensor signal lines, the resolver excitation lines, and the resolver output lines should be run in a three twisted-pair, shielded cable. In each case the shield should be terminated at the amplifier end only to a common terminal. We also recommend that the signal lines be kept as far as possible from any power or motor wires.

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4.3.2 Wire Size and Type:

IMPORTANT: To ensure safe operation, CONTREX strongly recommends that all wiring conform to all local and national codes.

RECOMMENDED WIRE SIZE and TYPE:

MOTOR WIRES:	14AWG, shielded - STANDARD. 12AWG, shielded - HIGH POWER.
MOTOR CASE GND:	Same as motor wires, or use metallic conduit.
MAIN POWER:	Same as motor wires.
SIGNAL INPUT:	22AWG, twisted-pair, shielded.
LOGIC INPUTS/OUTPUTS:	22AWG, shielded with its return lead.
EXTERNAL TACHOMETER:	22AWG, twisted-pair, shielded.
RESOLVER OUTPUTS and EXCITATION :	22AWG, three twisted-pairs, over-all shielded.

4.3.3 Connector Size and Type:

4.3.3.1 The Power and Motor Connector of the Stand Alone Amplifier:

- Motor - J2 of the Stand Alone Amplifier:
  Mating Connector: PHOENIX CONTACT, COMBICON Plugs in 7.62mm Pitch
  (P/N: GMVSTBR 2.5/3-ST-7.62):
  - with vertical plug-in direction to the conductor axis.
  - 3 positions.
  - Color: green.

- Power Input - J6 of the Stand Alone Amplifier:
  Mating Connector: PHOENIX CONTACT, COMBICON Plugs in 7.62mm Pitch
  (P/N: GMVSTBW 2.5/4-ST-7.62):
  - with vertical plug-in direction to the conductor axis.
  - 4 positions.
  - Color: green.

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4.3.3.2 The Signal Connector:

The signal connectors are supported by the molex® **KK .100" (2,54mm) Centerline Connector System.**

A. J1 of MAIN AMP:

- MATING CONNECTOR: molex® 2695 Series .100" (2,54mm) *Center Crimp Terminal Housing* **(PART# 22-01-3175)**:
  - red nylon housing.
  - 15 positions.
  - with polarizing rib.
- CRIMP TERMINALS: molex® *Crimp Terminals* **(PART# 08-55-0102)**:
  - 15 microinch select gold plated.
  - brass.

B. J4 and J5 of SINE/RESOLVER PRE-AMP:

J4 has 7 pins and J5 has 5 pins and their corresponding mating connectors have 7 and 5 positions. Their molex® part numbers are as follows:

- J4 MATING CONNECTOR PART NUMBER: **22-01-3077**.
- J5 MATING CONNECTOR PART NUMBER: **22-01-3057**.

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4.4 SINGLE AMPLIFIER MODULE CONNECTIONS:

4.4.1 Main Amplifier Module - Sine/Resolver Mode:

SIGNAL NAME	TERMINAL	NOTES
MOTOR R	J2-3	Phase R of the motor.
MOTOR S	J2-2	Phase S of the motor.
MOTOR T	J2-1	Phase T of the motor.
SIGNAL 1+	J1-1	Differential signal input.
SIGNAL 1-	J1-2	Differential signal return.
SIGNAL 2+	J1-3	Single-ended signal 2 in.
COMMON	J1-4	Single-ended signal2 return.
TACH OUT	J1-5	DC output proportional to RPM.
COMMON	J1-6	Tachometer common.
ABS I	J1-7	Absolute value of the motor current (10A/V)
LIMIT +	J1-8	Inhibits the motor in + direction.
LIMIT -	J1-9	Inhibits the motor in - direction.
INHIBIT	J1-10	Inhibits the motor in both directions.
FAULT	J1-11	Goes low for a fault on this amplifier, or inhibits the amplifier when forced low.
COMMON	J1-12	Digital common.
RESET IN	J1-13	Resets fault latch.
MTR TEMP	J1-14	Motor over temperature switch input.
UNUSED	J1-15	

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4.4.2 Pre-amp Module - Sine/Resolver Mode:

SIGNAL NAME	TERMINAL	NOTES
ENCODER (J4):		
A	J4-1	Phase A signal output.
$\overline{A}$	J4-2	Negative phase A signal output.
B	J4-3	Phase B signal output.
$\overline{B}$	J4-4	Negative phase B signal output.
Z	J4-5	Phase Z signal output.
$\overline{Z}$	J4-6	Negative phase Z signal output.
COM	J4-7	Common ground.
RESOLVER (J5):		
SIN	J5-1	Sine signal input.
COM	J5-2	Sine/Cosine return.
COS	J5-3	Cosine signal input.
COM	J5-4	Excitation return.
EXC	J5-5	Excitation signal input.

4.5 STAND ALONE AMPLIFIER INPUT POWER CONNECTIONS

Aside from the single amplifier module connections, a stand alone amplifier also consists of the following connections:

SIGNAL NAME	TERMINAL	NOTES
GND	J6-1	Ground
AC	J6-2	AC Power Input.
AC	J6-3	AC Power Input. (Single Phase - L2)
AC	J6-4	AC power input. (Single Phase - L1)

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CHAPTER FIVE: CONFIGURATION

5.1 INTRODUCTION:

Each amplifier has several configuration options. This chapter describes these options and how to implement them. If desired, CONTREX will be happy to pre-configure your amplifiers.

NOTE: Each amplifier module is configured and shipped according to the model number (instructions to construct a model number is in chapter three) when the order is placed. It is important for the user to realize that any adjustment on the dip-switches by the user will result in discrepancies between the model number and the actual configuration of the amplifier.

5.2 LOGIC INPUT CONFIGURATION:

There are five logic inputs: Limit +, Limit -, Inhibit, Reset In, Motor Temp. The first four may be configured for active-high or active-low signals, and pulled-up or pulled-down termination (type A, B, C, and D). The motor-temp may be configured for active-high or active-low signals, and is always pulled-up (type A, and C). All five logic inputs have a selectable 0 to +5VDC or 0 to +15VDC range.

Type "A": Requires grounding of input to disable the amplifier (pull-up, active-low).

Type "B": Requires a positive voltage at input to disable the amplifier (pull-down, active-high).

Type "C": Requires grounding of input to enable the amplifier (pull-up, active-high).

Type "D": Requires a positive voltage at input to enable the amplifier (pull-down, active-low).

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5.3 SINE/RESOLVER MODE AMPLIFIER CONFIGURATION:

The following table shows the dip switches that need to be configured for the Type A, B, C, and D configurations. The standard configuration is shown in bold.

	TYPE A	TYPE B	TYPE C	TYPE D
LIMIT ±	S2-8 - OFF S2-5 - ON	S2-8 - ON S2-5 - OFF	**S2-8 - OFF** **S2-5 - OFF**	S2-8 - ON S2-5 - ON
INHIBIT	S2-7 - OFF S2-4 - ON	S2-7 - ON S2-4 - OFF	**S2-7 - OFF** **S2-4 - OFF**	S2-7 - ON S2-4 - ON
RESET IN	**S2-6 - OFF** **S2-3 - ON**	S2-6 - ON S2-3 - OFF	S2-6 - OFF S2-3 - OFF	S2-6 - ON S2-3 - ON
MTR TEMP	S2-2 - ON	not available	**S2-2 - OFF**	not available
FAULT	standard	not available	not available	not available

5.3.1 +15V/+5V Logic Level Configuration (DEFAULT:S2-1=OFF):

- +15V: S2-1 = OFF.
- +5V: S2-1 = ON.

5.3.2 Standard Configuration for Sine/Resolver Velocity Mode and Current Mode:

DIP-SWITCH	NAME	VELOCITY MODE	CURRENT MODE
S1-1	ENCODER / 2	See section 5.3.3	
S1-2	ENCDR * 125 / 128	See section 5.3.3	
S1-3	(NOT USED)	OFF	OFF
S1-4	MTR REVERSE	(normally OFF)	
S1-5	TACH REVERSE	(normally ON)	
S1-6	INTEGRATOR	(normally OFF)	
S1-7	VEL MODE	ON	OFF
S1-8	CUR MODE	OFF	ON

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5.3.3 Encoder Output Resolution Configuration:

Refer to Appendix B drawing 8000-1430 and 8000-1431. There are nineteen standard resolutions. Up to four resolutions are contained in a single PLD. To configure the pre-amp for a given resolution, ensure that you have the correct PLD (U13) and then configure the dip-switches S1-1 and S1-2 as shown below.

Resolution	PLD CODE	PLD PART NUMBER	S1-1	S1-2	BITS MIN.
125	000	8000-1212	ON	ON	10
128	000	8000-1212	ON	OFF	10
250	000	8000-1212	OFF	ON	10
256	000	8000-1212	OFF	OFF	10
500	001	8000-1213	ON	ON	12
512	001	8000-1213	ON	OFF	12
1000	001	8000-1213	OFF	ON	12
1024	001	8000-1213	OFF	OFF	12
2000	010	8000-1214	ON	ON	14
2048	010	8000-1214	ON	OFF	14
4000	010	8000-1214	OFF	ON	14
4096	010	8000-1214	OFF	OFF	14
360	011	8000-1218	ON	ON	12
720	011	8000-1218	ON	OFF	12
2160	011	8000-1218	OFF	ON	14
3600	011	8000-1218	OFF	OFF	14
625	100	8000-1215	ON	ON	12
1250	101	8000-1216	ON	ON	14
2500	110	8000-1217	ON	ON	14

The BITS refer to the Resolver-to-Digital resolution which must be factory configured. Encoder resolution may be changed at any time to a resolution which requires the same or fewer bits. Increasing the bits increases the possible encoder resolution, but decreases the maximum motor RPM (refer to Section 5.3.5).

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5.3.4 Motor Pole Configuration:

Dip-switch S3-1, S3-2, S3-3 and S3-4 configures the pre-amp for the number of poles in the motor. They are also used to set up certain calibration modes. Refer to the chart below and set the dip switches for the correct number of poles.

MOTOR:	S3-1	S3-2	S3-3	S3-4
2 POLE	ON	ON	ON	ON
4 POLE	ON	ON	ON	OFF
6 POLE	ON	ON	OFF	ON
8 POLE	ON	ON	OFF	OFF
10 POLE	ON	OFF	ON	ON
12 POLE	ON	OFF	ON	OFF
ZERO	ON	OFF	OFF	ON
INDEX	ON	OFF	OFF	OFF

5.3.5 PLD BIT Configuration:

	S3-5	S3-6	S3-7	S3-8	MAX RPM	TACH VOLTS V/1000 RPM
10 BIT	ON OFF	ON ON	ON ON	ON ON	62,400 31,200	0.13 0.26
12 BIT	ON OFF	OFF OFF	OFF OFF	ON ON	15,000 7,800	0.5 1.0
14 BIT	ON OFF	OFF OFF	ON ON	OFF OFF	3,900 1,950	2.0 4.0

The Tach. Volts (V/1000RPM) are given for the MAX. RPM of the BIT resolution. Consult a CONTREX applications engineer should you have any questions.

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CHAPTER SIX: START UP AND CALIBRATION

6.1 INTRODUCTION:

This chapter contains the procedure required to calibrate and set up the amplifier. All adjustments are made on the pre-amp. Refer to Appendix B, drawing 8000-1430 & 8000-1431 for the sine/resolver mode.

IF AMPLIFIER IS A REPLACEMENT OR ORDERED WITHIN A KIT, CALIBRATION IS USUALLY NOT NEEDED.

Calibration requires an oscilloscope, a voltmeter, and a step-voltage source. The step source may be a flashlight battery or floating power-supply with a series switch. A servo- system calibrator known as a Battery Box which includes an adjustable bipolar output, reversing switch, and pulse switch will facilitate calibration and repair. A Battery Box is available from CONTREX, part number BB-700.

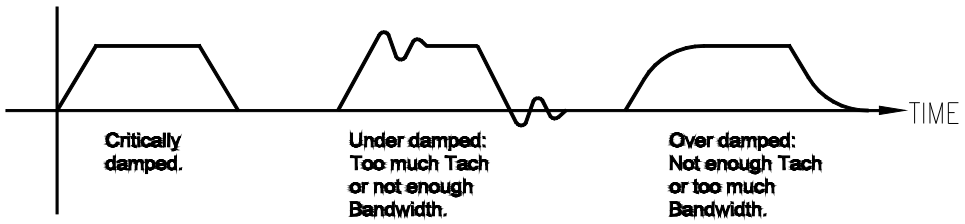


Figure 6.1
Critically, Under and Over damped waveforms

6.2 SAFETY PRECAUTIONS:

Before starting calibration, the following safety precautions should be observed:

1. Check for any loose or damaged components.
2. Check that all connections are tight.
3. Be sure that the motor mechanism is clear of obstructions. If the mechanism has limited motion, e.g: a lead-screw, set the mechanism to mid-position.
4. Disconnect the signal and auxiliary inputs.
5. Be sure the Loop-Gain pot(s) are fully CCW.
6. Remove input fuses on the baseplate and apply main power. Check for the correct AC voltage at fuses. The motor supply voltage will be 1.4 times this value. Remove power and reinstall fuses.
7. Work on only one amplifier at a time.

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6.3 SINE/RESOLVER MODE AMPLIFIER CALIBRATION:

6.3.1 Overview of Potentiometer:

POTS	NAME OF POT	NOTE
RV2	SIG 1 (Signal 1)	Sets the input voltage to RPM ratio, e.g. 10V=2000RPM (velocity mode) or input voltage to torque ratio, e.g. 10V=25A (current mode) required by your system for the single-ended input.
RV3	SIG 2 (Signal 2)	Same as Signal 1 input.
RV4	TACH (Tach Gain)	Used in conjunction with the compensation to set the system bandwidth. Not used in current mode. Shipped at 75%.
RV5	BAL (Balance)	Used to null any offsets in system.
RV6	COMP (Compensation)	Used in conjunction with the tach to set the system bandwidth. Not used in current mode. Shipped set CW (minimum bandwidth).
RV7	I LIMIT (Current Limit)	Sets maximum motor current. Shipped set CW (maximum current).
RV8	LOOP (Loop Gain)	Used to shut off uncalibrated amplifiers. When the loop gain is CCW, no current is delivered to the motor. Shipped set CCW (off).

6.3.2 Sine/Resolver Mode Amplifier Calibration - Velocity Mode:

NOTE: All pots except the Loop Gain are 12-turn.

1. Turn the Current Limit (RV7) to mid position and the Loop Gain (RV8) full CCW.
2. Apply main power and fan power.
3. Slowly turn the Loop Gain (RV8) CW. The Motor should be stopped or turning slowly. If the motor starts running away, turn Loop Gain (RV8) CCW, switch TACH REVERSE (S1-5) from OFF to ON (or vice versa) or reverse the TACH OUT and COMMON at J1-5 and J1-6 and retest. Leave the Loop Gain (RV8) full CW for all remaining adjustments.
4. Slowly move the Balance (RV5) back and forth. Set the Balance midway between the points where the motor begins turning in either direction.
5. Connect the oscilloscope to ABS I (J1-7) and the battery box to Signal 2 Input. The voltage at J1-7 is a function of motor current: 1V=10A. While applying a step input voltage, adjust the Current Limit (RV7) for the desired peak current. If the desired peak current cannot be achieved with the pot full CW, increase the input voltage or increase the Signal Gain (RV3).

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The purpose of the following procedure is to set the system bandwidth to obtain a critically-damped response with the maximum possible tach gain. There are many possible settings of Tach Gain and Compensation which will yield a critically damped waveform. The optimum setting will occur when the Tach Gain is as CW as possible and the Compensation is as CCW as possible.

However, the servo-loop may become unstable (the motor oscillates or hunts) with a very low (near CCW) setting of Compensation. In this case, stability is the limiting factor. At no time should the servo-loop be allowed to be unstable.

Amplifiers are normally shipped with the Tach Gain (RV4) set at 75%. This is a good place to start. If you are unsure of where the Tach Gain is set, turn the Tach Gain fully CW (up to 12 turns), then CCW 3 turns.

6. Move the oscilloscope to the TACH OUT (J1-5), set the battery box for a steady DC voltage and adjust the input voltage or Signal 2 gain for about 400RPM.

7. Pulse the input and compare the waveform with figure 6.1.

8. Adjust the Compensation pot CCW until the waveform is critically damped or one hook overshoot. Then proceed to step 10.

9 If the desired waveform cannot be obtained by adjusting the Compensation pot, back off (CCW) the Tach Gain pot a few turns and repeat step 8.

10. Do not adjust the Tach Gain or Compensation pots for the rest of the calibration procedure.

11. With the battery box still connected at J1-3 and J1-4 for single-ended input (or if your system uses the differential input, move battery box to J1-1 and J1-2), set battery box for a known DC voltage. Adjust Signal 1 Gain (RV3) or (RV2 for differential input) to obtain the desired motor velocity.

12. If the motor is rotating the wrong direction for a given input polarity, turn the Loop Gain pot full CCW. Switch MTR REVERSE (S1-4) from OFF to ON (or vice-versa). Turn the Loop Gain pot back to full CW.

13. Remove the battery box, and repeat only step 4.

14. Calibration complete. Reconnect signal wires.

NOTE: All pots except the Loop Gain are 12-turn. See Section 5.3.2 for current mode configuration.

6.3.3 Sine/Resolver Mode Amplifier Calibration - Current Mode:

1. Turn the current limit (RV7) to mid position and the Loop Gain (RV8) full CCW.

2. Apply main power and fan power. Slowly turn the Loop Gain (RV8) full CW. Motor should be stopped or turning slowly.

3. Set Balance (RV5) for 0V at ABS I (J1-7).

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4. Connect the oscilloscope to ABS I (J1-7), and the battery box to the Signal 2 Single-ended Input (J1-3 and J1-4). The voltage on J1-7 is a function of motor current: 1V=10A. While pulsing a step input voltage, adjust the Current Limit for the desired peak current. If the desired peak current cannot be achieved with the pot full CW, increase the input voltage or increase the Signal 2 Gain (RV3).

5. With battery box still connected at J1-3 and J1-4 for single-ended input (or if your system uses the differential input, move battery box to J1-1 and J1-2), set the battery box for a known DC voltage. Apply ± input signal pulses and adjust the Signal 2 Gain pot (RV2) or (RV1 for differential input) to obtain the desired current gain of the amplifier.

6. If the motor is rotating the wrong direction for a given input polarity, turn the Loop Gain pot full CCW. Switch MTR REVERSE (S1-4) from OFF to ON (or vice-versa). Turn the Loop Gain pot back to full CW.

7. Remove battery box, and repeat step 3.

8. Calibration complete. Reconnect signal wires.

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6.4 CALIBRATION-SETUP RECORD:

It is good practice to keep a record of all pot settings. Doing so will facilitate calibration on future units and repair on this unit. Although not a substitute for the calibration procedure, it will at least get you "in the ballpark." Remove the power and allow all capacitors to discharge before taking measurements. Note: The balance pot should not be measured in this fashion, set per step 4 in the calibration procedure.

POT/DIP-SWITCHES	AMP1	AMP2	AMP3	AMP4	AMP5	AMP6
TACH J3-C to J3-F (S)						
SIG. 1 J3-A to J3-F (S)						
SIG. 2 J3-B to J3-F (S)						
COMP J3-D to J3-F (S)						
CURRENT LIMIT J3-E to J3-F (S)						
Signal input to Tach ratio: _V Signal / _V Tach						
LIMIT(PULL UP/DN) S2-8						
INHIBIT(PULL UP/DN) S2-7						
RESET(PULL UP/DN) S2-6						
LIMIT(ACTIVE HI/LOW) S2-5						
INHIBIT(ACTIVE HI/LOW) S2-4						
RESET(ACTIVE HI/LOW) S2-3						
MTR TEMP(ACTIVE HI/LOW) S2-2						
+15/+5 S2-1						

Date data taken: / / Serial number S/N:_____
Model number CXB_____

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6.5 RESOLVER ALIGNMENT:

Note: CONTREX motors with built-in resolvers are factory aligned. Consult a CONTREX applications engineer prior to attempting a resolver realignment. Failure to do so may void the warranty.

Note: Consult a CONTREX applications engineer before aligning a non-CONTREX motor/resolver. Some motor/resolvers require procedures other than that described here.

Note: Dip-switches S3-1, S3-2, S3-3 and S3-4 allow the converter to be operated in one of eight modes. The first six modes set the number of motor "poles". One pole corresponds to one magnet, thus a motor with two "north" and two "south" magnets has four poles. The number of electrical revolutions is equal to one-half the number of poles. An electrical revolution refers to the arc-length the motor will rotate when one complete sine-wave is applied. Therefore, a four-pole motor has two electrical revolutions and requires two sine-waves to make one mechanical (shaft) revolution. The significance of this is, any motor with more than one electrical revolution will have more than one electrical "index" (0^{o} position), while there is only one mechanical index. From an electrical viewpoint, any index may be used, however from a mechanical viewpoint, using a different electrical index may alter the mechanical index by as much as 180^{o} from its previous position. This will show itself as a change in where the encoder index (channel Z) pulse occurs.
Note that the emulated encoder has an index per mechanical (shaft) revolution.

Of the remaining two modes, the INDEX is used to generate an index output and is used for resolver alignment.

MOTOR:	S3-1	S3-2	S3-3	S3-4
2 POLE	ON	ON	ON	ON
4 POLE	ON	ON	ON	OFF
6 POLE	ON	ON	OFF	ON
8 POLE	ON	ON	OFF	OFF
10 POLE	ON	OFF	ON	ON
12 POLE	ON	OFF	ON	OFF
ZERO	ON	OFF	OFF	ON
INDEX	ON	OFF	OFF	OFF

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PROCEDURE:

All adjustments are made to the 8000-14 Sine/Resolver pre-amp. Refer to Appendix B, drawings 8000-1430 and 8000-1431.

1. Connect and configure the amplifier as described in the installation section. Do not apply power yet.
2. Loosen the resolver mounting-screws just enough to allow the resolver to be adjusted.
3. Note the positions of S3-1, S3-2, S3-3 and S3-4, then set S3-1, S3-2, S3-3 and S3-4 for **index** (i.e. S3-1:ON, S3-2:OFF, S3-3:OFF and S3-4:OFF).
4. Make sure the amplifier is in current mode (S1-7:OFF and S1-8:ON), and set S1-4 to the 'ON' position.
5. Apply power. Adjust the motor shaft until the red index LED lights.
6. Slowly apply signal input voltage SIGNAL 1+ and SIGNAL 1- (J1-1 & J1-2) for differential input or SIGNAL 2+ and COMMON (J1-3 & J1-4) for single-ended input until the motor shaft becomes reasonably "stiff" (then it can not be easily adjusted). **Use Caution!** This procedure is applying continuous current to the motor. An excessive CW setting may result in motor damage! The motor will rotate to the correct index position. The amount of rotation will be proportional to the alignment error.
7. Slowly rotate the resolver CW or CCW until the index LED is constantly illuminated. Tighten the resolver mounting screws, the LED should still be on.
8. Turn the power off.
9. Restore dip-switches (S3-1, S3-2, S3-3 and S3-4) for the number of poles for the motor being used. Set S1-4: OFF. If the amplifier is to be operated in velocity mode, then set S1-7:ON and S1-8:OFF.
10. Turn the power back on and apply a signal input command while monitoring the DC voltage at the tach. out (J1-5) with a digital voltmeter and record this voltage. Now reverse the polarity of the signal input command and record this voltage.

NOTE: Be sure to set the tach. out voltage for 1000 RPM (12-14 bit resolution)

11. If the difference between both of the above readings is less than 100mV, the motor is ready to operate. However, if the difference is greater than 100mV, proceed to step12.
12. Loosen the resolver mounting screws.
13. Alternately apply a positive and negative signal input command while monitoring the tach. out voltage at J1-5.
14. Rotate the resolver body slowly back and forth until the difference between both tach. out voltage readings is less than 100mV.
15. Tighten the resolver mounting screws and turn the power off.
16. Resolver alignment complete.

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CHAPTER SEVEN: MAINTENANCE, REPAIR, and WARRANTY

7.1 MAINTENANCE:

Contrex amplifiers do not require any scheduled maintenance, although it is a good idea to occasionally check for dust build-up or other contamination.

7.2 AMPLIFIER FAULTS:

If an amplifier should cease to operate and one or more of the fault LED's are lit, review the sections which follow on the fault in question for information and possible causes.

A FAULT CAN ONLY BE CAUSED BY ABNORMAL CONDITIONS. LOCATE AND CORRECT THE CAUSE OF THE FAULT BEFORE REPEATED RECYCLING OF POWER TO THE AMPLIFIER TO PREVENT POSSIBLE DAMAGE.

7.2.1 Table of Fault LED Conditions:

INPUT OR FAULT CONDITION	RUN LED	HS/ECB LED	LS/ECB LED	OVER VOLT LED	OVER TEMP LED	FAULT OUTPUT
NORMAL OPERATION	**ON**	OFF	OFF	OFF	OFF	NO
LIMIT + (ON)	**ON**	OFF	OFF	OFF	OFF	NO
LIMIT - (ON)	**ON**	OFF	OFF	OFF	OFF	NO
INHIBIT (ON)	**OFF**	ON	OFF	OFF	OFF	NO
RESET IN (ON)	OFF	OFF	OFF	OFF	OFF	NO
EXT. FAULT (ON)	OFF	OFF	OFF	OFF	OFF	**YES**
UNDER-VOLTAGE (+15V)	OFF	OFF	OFF	OFF	OFF	**YES**
HS/ECB (LATCHED)	OFF	**ON**	OFF	OFF	OFF	**YES**
LS/ECB (LATCHED)	OFF	OFF	**ON**	OFF	OFF	**YES**
OVER-VOLTAGE B+ (LATCHED)	OFF	OFF	OFF	**ON**	OFF	**YES**
OVER TEMP (LATCHED)	OFF	OFF	OFF	OFF	**ON**	**YES**

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7.2.2 Under-Voltage Fault:

When the +15VDC is below +12VDC, a level that would cause unreliable operation, the Run LED will turn off, a Fault Output is generated, and the amplifier is inhibited. This is not a latched condition: that is, if the problem is resolved the amplifier will resume operation.

The following is a list of possible causes:
1. Main AC line voltage is too low.
2. Bad rectifier bridge.
3. Bad DC buss filter capacitor.

7.2.3 Motor Over-Temp Fault:

When the motor temperature has reached a level that, if exceeded, would damage the motor, the Run LED will turn off, the OVER TEMP LED will turn on and a Fault Output is generated, and the amplifier is inhibited.

The following is a list of possible causes:
1. The continuous motor current is too high.
2. Binding or stalling of motor shaft due to excessive mechanical overload.
3. Motor rating too small for the load.

7.2.4 High-Speed Electronic Circuit Breaker (HS/ECB) Fault:

When the peak output of the amplifier exceeds 80A for 10 micro-seconds, the Run LED will turn off, the HS/ECB LED's are latched on, a Fault Output is generated, and the amplifier is inhibited.

The following is a list of possible causes:
1. Shorted motor leads.
2. Motor inductance too low.
3. Short from a motor lead to ground.

7.2.5 Low-Speed Electronic Circuit Breaker (LS/ECB) Fault:

When the RMS output of the amplifier exceeds the current set to protect the motor and or the maximum setting of the amplifier for 3 seconds, the Run LED will turn off, the LS/ECB LED's are latched on, a Fault Output is generated, and the amplifier is inhibited. Refer to section 1.3.1.1 for the amplifier rms settings.

The following is a list of possible causes:
1. Binding or stalling of motor shaft due to excessive mechanical overload.
2. Overload of amplifier output to motor.
3. Large reflected load inertia.

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7.2.6 Over Temp Fault:

When the heatsink and or motor temperature has reached a level that, if exceeded, would damage the output transistors or the motor, the Run LED will turn off, the OVER TEMP LED is latched on, a Fault Output is generated, and the amplifier is inhibited.

The following is a list of possible causes:

1. Loss of cooling air - Fans are defective or airflow is blocked.
2. Excessive rise in cooling air temperature due to cabinet ports being blocked or excessive hot air being ingested.
3. Extended operational duty cycle due to mechanical overload of motor or defective motor.
4. The motors thermal switch has been tripped due to excessive overloading.

7.2.7 Over Voltage Fault:

When the DC-Buss voltage reaches a level that, if exceeded, would harm the amplifier or motor, the Run LED will turn off, the Over-voltage LED's are latched on, a Fault Output is generated, and the amplifier is inhibited.

The following is a list of possible causes:

1. Main AC line voltage is too high.
2. Decelerating a large inertial load. When decelerating, a DC motor acts as a generator. If the inertial load is large, the generated voltage can pump-up the DC-Buss. If this fault occurs, you may need a Regen Clamp. Consult CONTREX.

7.2.8 Resetting A Fault:

The fault latch may be reset by pushing the Reset button, activating the Reset input J1-13 or by removing power and allowing the filter capacitor(s) to discharge. Note that the fault latch will not reset unless the fault has been cleared.

7.3 AMPLIFIER FAILURE:

If an amplifier should fail, that is, if it should cease to operate with no apparent fault, the drawings in appendices A and B will enable a skilled technician to trouble-shoot an amplifier to even lower levels.

The modular construction of the amplifier allows fast and easy repair. This is especially true due to the plug-in personality module card, since all user adjustments and configuration changes are made on this card. If an amplifier module should fail, simply unplug the pre-amp and plug it into a replacement amplifier.

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7.4 FACTORY REPAIR:

Should it become necessary to return an amplifier to CONTREX for repair, please follow the procedure described below:

1. Reassemble the unit, if necessary, making certain that all the hardware is in place.

2. Tag the unit with the following information:
   A. Serial number and model number.
   B. Company name, phone number, and representative returning the unit.
   C. A brief notation explaining the malfunction.
   D. Date the unit is being returned.

3. Repackage the unit with the same care and fashion in which it was received. Label the container with the appropriate stickers (e.g: FRAGILE: HANDLE WITH CARE).

4. Return the unit by the best means possible. The method of freight chosen will directly affect the timeliness of its return.

CONTREX also offers a one-day repair service in the unlikely event that your system is down and you do not have a replacement amplifier module.

7.5 WARRANTY:

Any product, or part thereof, manufactured by CONTREX, Inc., described in this manual, which, under normal operating conditions in the plant of the original purchaser thereof, proves defective in material or workmanship within one year from the date of shipment by us, as determined by an inspection by us, will be repaired or replaced free of charge, FOB our factory, Maple Grove, Minnesota, U.S.A. provided that you promptly send to us notice of the defect and establish that the product has been properly installed, maintained, and operated within the limits of rated and normal usage, and that no factory sealed adjustments have been tampered with. CONTREX liability is limited to repair or replacement of defective parts.

Any product or part manufactured by others and merely installed by us, such as an electric motor, etc., is specifically not warranted by us and it is agreed that such product or part shall only carry the warranty, if any, supplied by the manufacturer of that part. It is also understood that you must look directly to such manufacturer for any defect, failure, claim or damage caused by such product or part.

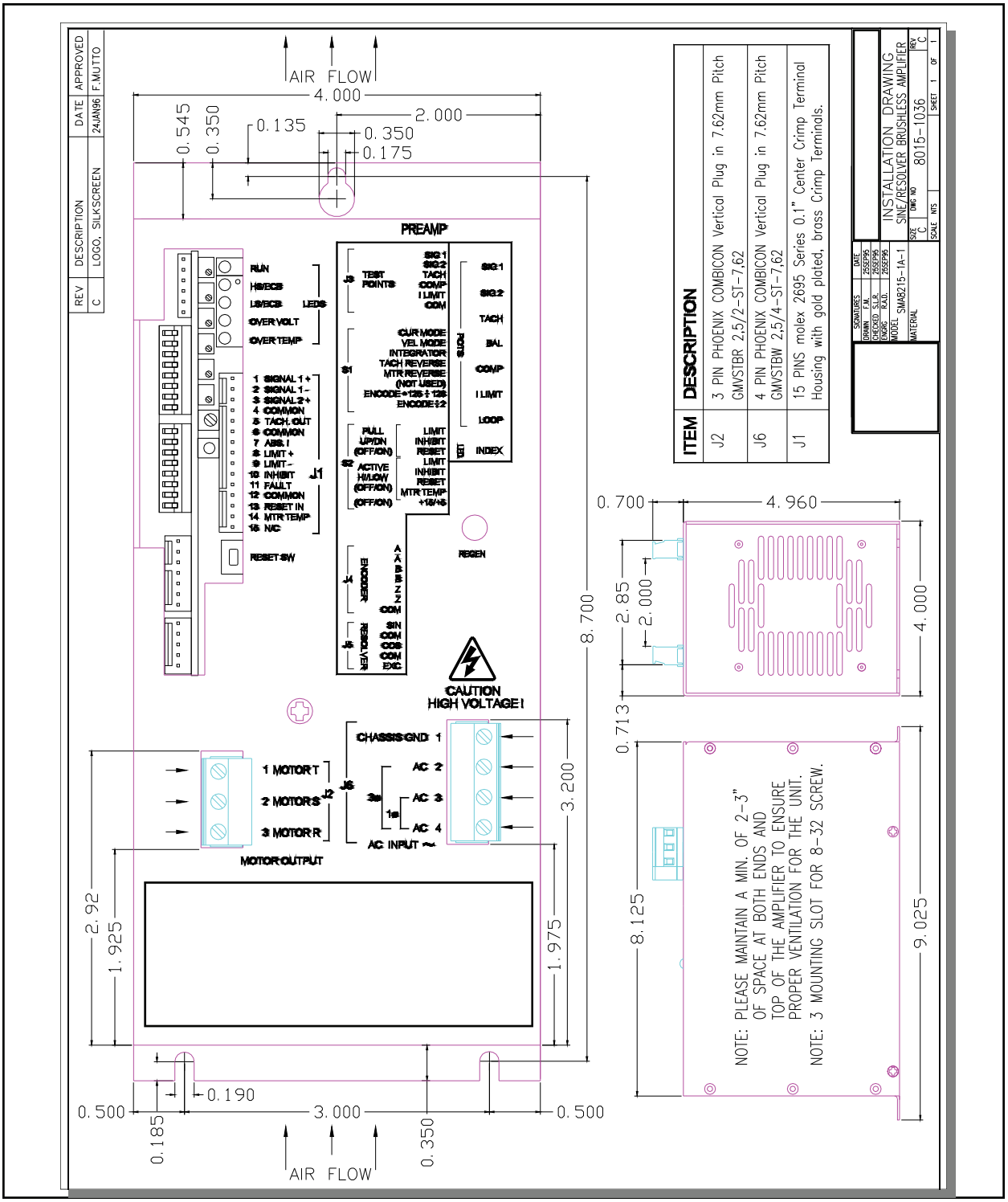
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APPENDIX A

AMPLIFIER DRAWINGS

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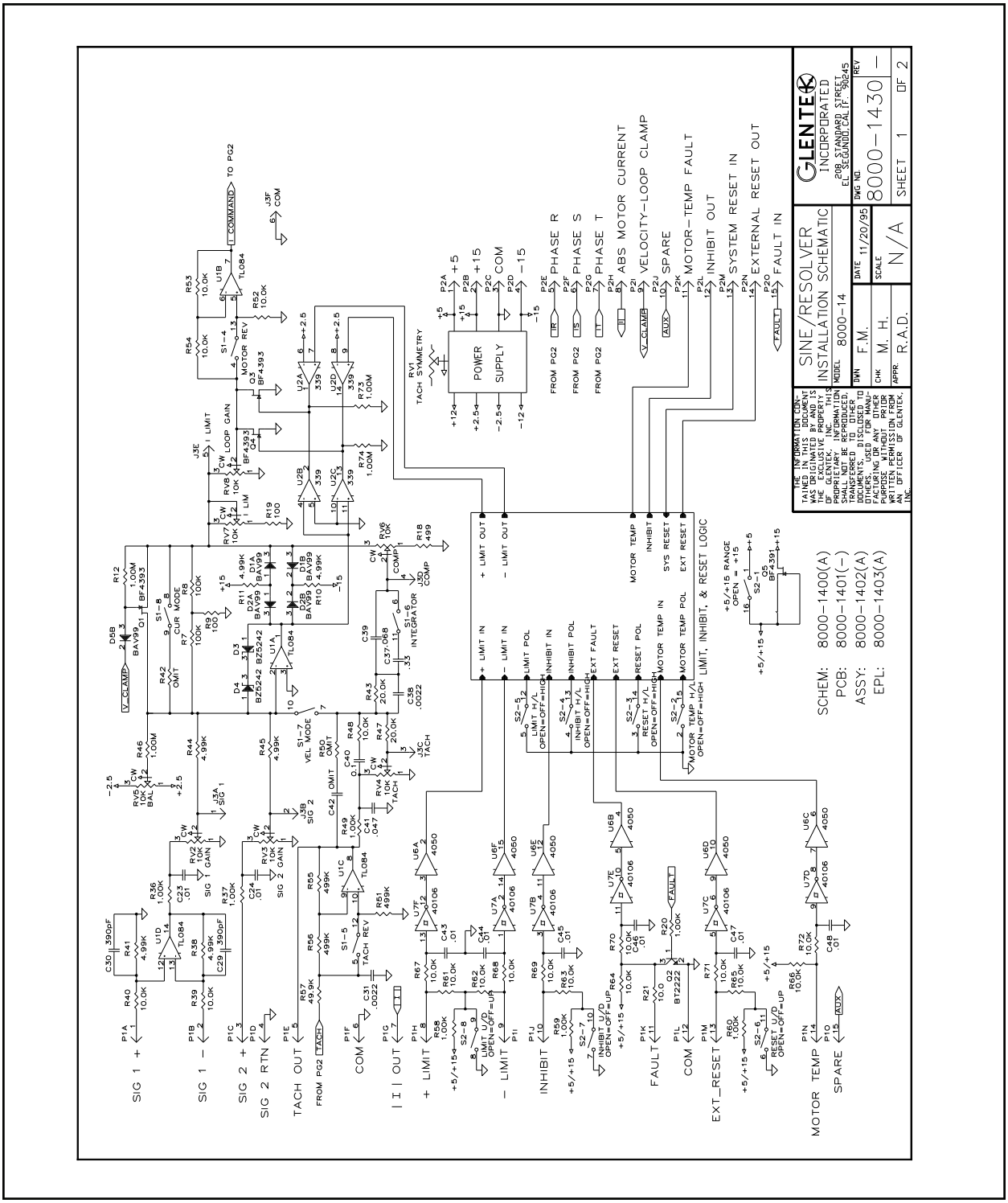


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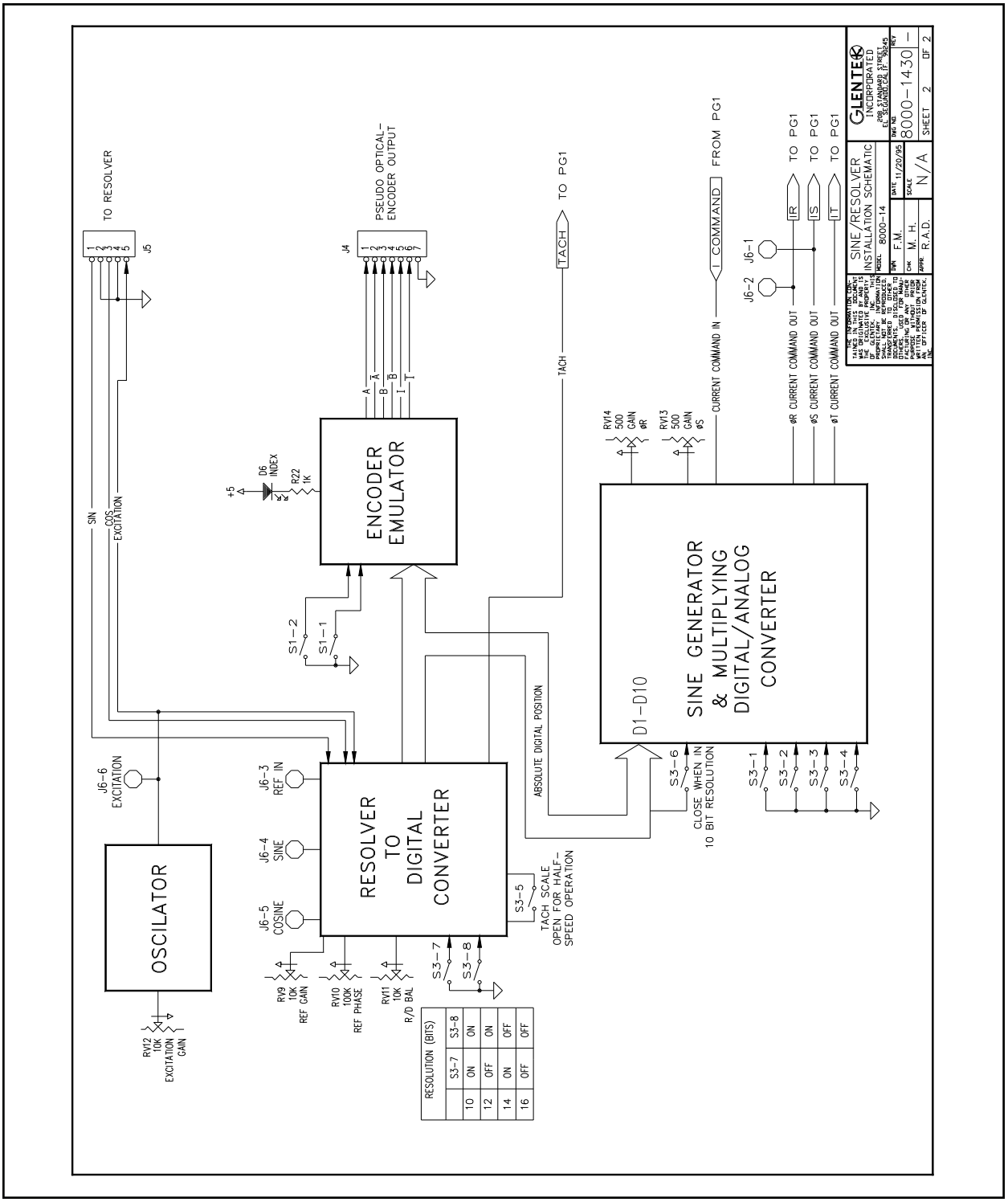
APPENDIX B

PERSONALITY MODULE

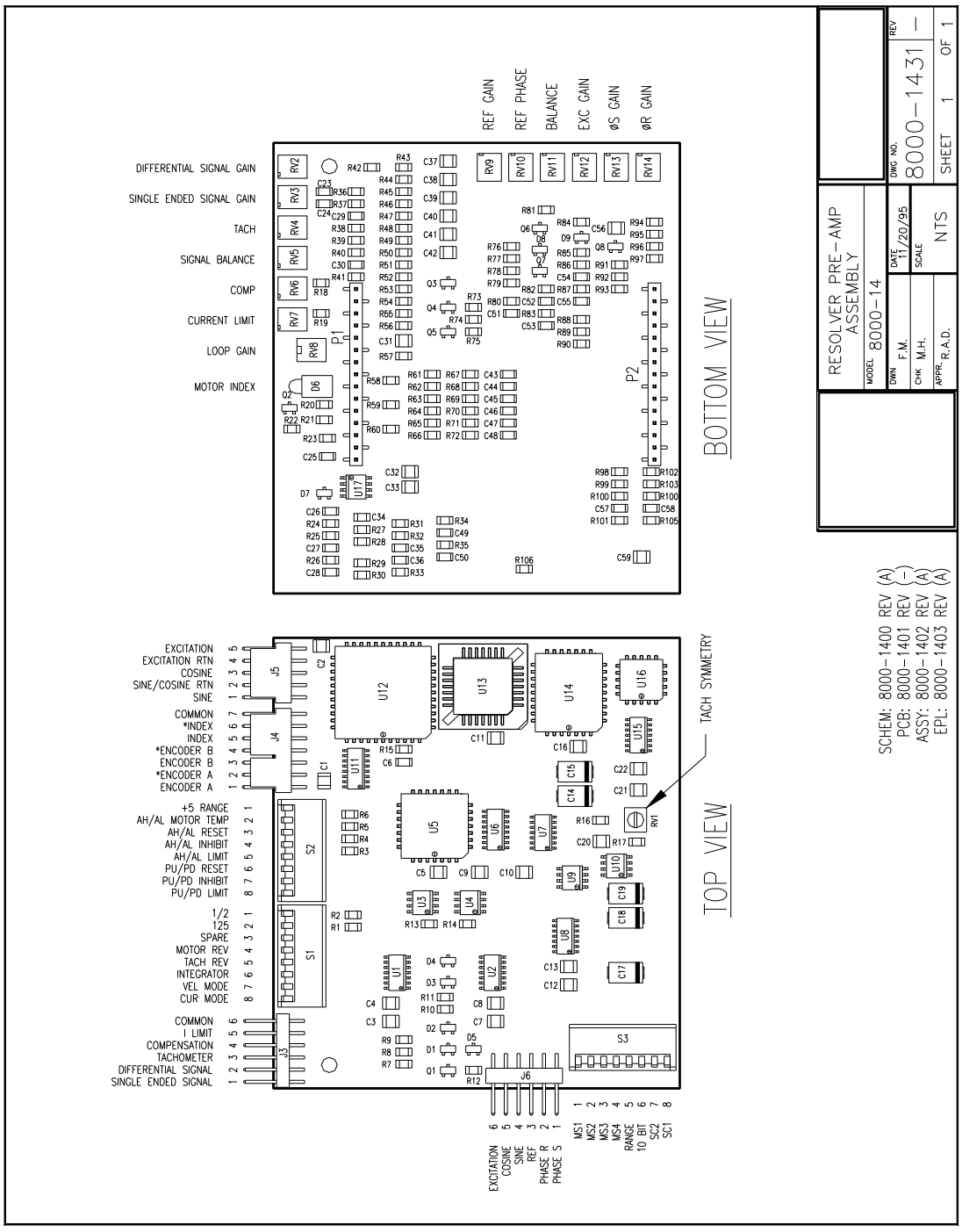
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NOTES

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NOTES

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High Bandwidth Brush Type Servo Amplifiers

- Linear Brush type servo amplifiers to 2.25KW
- PWM (Pulse-width-modulated) Brush type servo amplifiers to 70KW

High Bandwidth Brushless Servo Amplifiers

- Linear Brushless servo amplifiers to 2.25KW
- PWM (Pulse-width-modulated) Brushless servo amplifiers to 65KW

Permanent Magnet DC Brush Type Servo Motors

- Continuous Torques to 335 in. lb.
- Peak Torques to 2100 in. lb.

Permanent Magnet DC Brushless Servo Motors

- Continuous Torques to 1100 in. lb.
- Peak Torques to 2200 in. lb.

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