TA330
Medium Power Linear Drive

Hardware Applications MANUAL

Revision 2.01

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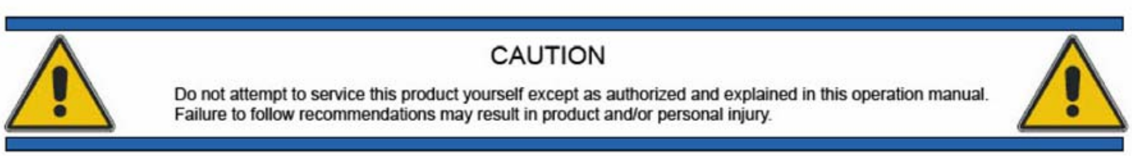
Trust Automation products contain static sensitive parts that may be damaged if handled improperly. We strongly encourage you to follow proper ESD procedures when handling electronic components. Removing component covers, except where expressly permitted, may expose products to static damage and increase the risk of premature failure.

High voltages are present in some Trust Automation products. Maintenance or repair should only be performed by qualified personnel and only under power down conditions. Maintenance and repair shall be limited to those items described in this operating manual as user approved. All other repair and maintenance shall be performed by Trust Automation, Inc.



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1.0 Features and Setup

1.1 Introduction

The TA330 is a Linear Drive for brushed and brushless servo motors. It is a general purpose device for use in many applications including high and very high resolution staging, linear stages, high inertia mismatched stages and very low inductance motors.

The TA330 is a 4^{th} generation Trust Automation Linear Drive. This linear three-phase servo motor drive allows OEMs to integrate the latest technology available for sinusoidal motor control. Sinusoidal commutation of three-phase brushless servo motors plus a Linear Drive Power Stage eliminates the familiar cogging and torque-ripple problems that plague most trapezoidal digital drives. Control is consistent and smooth at any velocity. For ultra low noise applications, (e.g. transducers, sensors, etc.), the TA330 accepts an externally generated 24VDC input. This external supply provides the lowest noise setup, disabling the internal DC supply. For applications that do not require the very low noise level, the TA330 incorporates an internal DC supply, eliminating the external 24VDC supply requirement.

The TA330 is a highly configurable device with three common configuration modes. The TA330 will drive one single phase DC brushed motor in bridged mode. It will drive one three phase DC brushless motor using Hall Effect sensor feedback or one three phase AC brushless motor using external sinusoidal commutation. Digital on the fly gain control, Dynamic Transconductance or DTS, allows the application to modify the drive transconductance/gain on-the-fly. This permits both high acceleration control and high resolution control where normally one of these parameters is sacrificed in favor of the other.

All Trust Automations drive products are built for safety, installation ease and long life. The TA330 housing reduces the risk of operator injury and protects the drive ensuring longer useful life. All connections utilize pluggable terminal connectors making them easy to install and remove while reducing risk of connection error. The TA330 fans are thermally controlled variable speed, allowing for quiet operation during non-peak power output.

1.2 Setup

The TA330 is configurable for several drive options. Some of these options are shown in the application example section. The TA330 will drive a single brushless motor in sinusoidal or trapezoidal mode. In either case, the drive may be setup for fixed or dynamic transconductance. The TA330 will drive brushed motors as well as brushless motors.

1.3 Amplification Mode

Torque

Torque mode is the most commonly used Drive mode. In torque mode, the drive produces a current proportional to the commanded input voltage. The current produced is directly proportional to the torque. The Transconductance, (measured in Amps per Volt), can be calculated by the following equation:

$g_m = I_o / V_c$

g_m = current gain (Transconductance)
I_o = output current (worst case)
V_c = command voltage

Example:

If: I_o desired = 6A and V_c (max) = 10V
Then: g_m = 6 / 10 or 0.6A/V

Note: Current output is limited by Ohm's Law (for a static motor)
I_{max} is limited by the following equation for a single supply application scenario:

I_{max} = Bus Voltage – 5V / Motor Impedance (in Ohms)

For a commanded input voltage of ±10V, the output current settings are 6A, 10A, 14A and 18A. These are also the current limits in this mode. Custom current limits can be preset by the factory. Please contact support@trustautomation.com to discuss requirements.

1.4 Drive Modes

Sinusoidal

Sinusoidal operation provides the smoothest output for commutating a DC brushless motor. In this mode, the TA330 is designed to accept two command input signals (A & B phases) from a motion controller that is performing the commutation based upon encoder feedback. The TA330 derives the third phase (C) internally. (See application examples 5.2 and 5.3.)

Trapezoidal

Trapezoidal operation is also available on the TA330. This is the simplest configuration used to drive a DC brushless motor. In this mode, the motors Hall Sensors are connected to J1 and the command input signal (±10V) are connected to the "A" command signal inputs. (See application examples 5.1 and 5.4)

1.5 Command Signal Input

Differential Inputs

The use of differential input helps to reduce or eliminate potential noise susceptibility. If a differential input is desired or required, signal connections to the TA330 are made at J2. Inputs are provided for two of the three phases and the TA330 derives the third phase. (See application examples 5.1, 5.2, 5.3 and 5.4)

Single-Ended Inputs

Many systems operate satisfactorily with a single-ended command signal configuration. Many controllers only offer single-ended command signals, with a common ground. Single-ended configurations are accommodated by referencing the A- and B- signals to AUX GND and the controller's common ground.

1.6 Current Limit

The current limit is set via SW1, positions 5 and 6. (See table 4.9). The current limit in transconductance mode is dynamic with a maximum of 18A. Please note the 18A limit is a peak limit for less than one second.

1.7 Thermal Limits

The TA330 is internally thermally protected. The TA330 heatsink temperature is monitored and upon reaching a heatsink temperature of 70°C, a FAULT output is generated but the drive remains enabled. Upon reaching a heatsink temperature of 90°C, the Enable input is cancelled and the drive is disabled. When the heat sink reaches a safe operating temperature, the drive will re-enable.

1.8 Dynamic Transconductance Selection

A feature pioneered by Trust Automation, Dynamic Transconductance, or DTS, enables on-the-fly changes to the transconductance settings. This is accomplished by logically controlling the DTS bits D0 and D1 through pins 5 and 6 of J2. This feature is advantageous in frictionless systems (i.e. air bearing x-y systems) where the inertia is high. This situation necessitates high currents at start of motion or change of direction, but requires high precision, high resolution control when at speed. Often there is a large difference between the Transconductance optimum for acceleration and the Transconductance needed for high performance velocity stability. This switching provides a seamless Transconductance change and dramatically improves the scanning performance of velocity based systems.

1.9 ENABLE

The ENABLE input, active high or low selectable at SW1 position 4, (see table 4.8), must be pulled to AUX GND or logic high for the TA330 to operate. The ENABLE is pulled up internally (to AUX +5V), therefore if connection is lost to the ENABLE input, the drive will disable (if set for active low). Optical isolation is available when +5V is user supplied at connector J1 or J2.

The TA330 must not be enabled during power up. If the drive is powered up enabled, the drive will not enable and will assert FAULT. The ENABLE must then be cleared and re-asserted to enable the drive.

Note: A minimum sinking capability (I_{OL}) of 5mA is required.

Note: Logic low input minimum voltage (V_{IL}) is 0.8V. Logic high input minimum voltage (V_{IH}) is 2.0V. See circuit in the following figure:

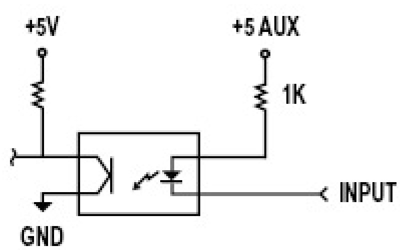

Figure 1 - Enable Circuit

1.10 FAULT

The TA330 FAULT circuit, active high or low selectable at SW1 position 3, (see table 4.8), will output a logic low or logic high upon over-current or thermal overload. Optical isolation is available when +5VDC is user supplied. FAULT is referenced to AUX GND.

Note: Logic output high minimum voltage (V_{OH}) is 2.5V. Logic output low maximum voltage (V_{OL}) is 0.8V. See circuit in the following figure.

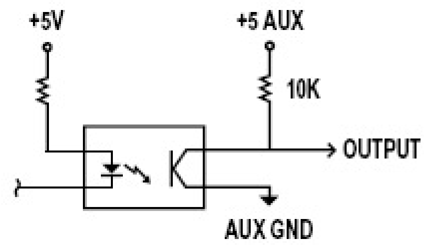

Figure 2 - Fault Circuit

1.11 Ground Connections

Command and Signal Logic

If a single-ended command input signal is used, reference the signal A- and B- to AUX GND on connector J2.

1.12 Power Supply

Drive power

Connect the positive supply positive (+) to V+ and the positive supply negative (-) to GND. Connect the negative supply positive (+) to GND and the negative supply negative (-) to V-. (See figure 3 below)

A dual (bipolar) power supply must be used to power the TA330 Drive. A regulated switcher supply is suitable for most applications and they are small, affordable and highly available. In some cases, particularly where there is great concern for noise interference, a linear power supply, regulated or unregulated, will be required. For unregulated supplies, verify that the voltage supplied either at V+ or at V- does not exceed the absolute maximum supply voltage of ±75V.

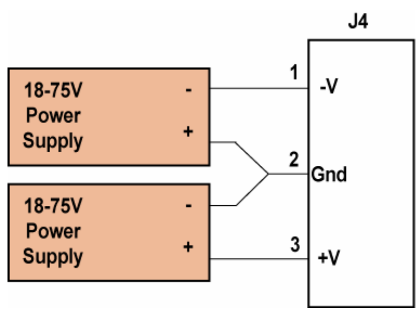

Figure 3 - Drive Power Connection

1.13 External 24VDC Supply

The TA330 internal logic may be powered by an external 24VDC source or by an internal DC source. The external source provides power through a connection made at J5. The internal source provides power automatically but is disabled if an external source is connected.

If internally powered, some noise may be generated by this supply that may have an effect on the drive performance. The noise level is small, but could be a factor depending on the application. If externally powered, the electrical noise level is further reduced, providing the quietest operation possible. When externally powered, there will be about 40mV of noise at about 250 KHz. When internally powered, there will be about 60mV at about 160 kHz.

1.14 Power Dissipation Calculations

Since the TA330 Power Section is a class AB Stage, voltage not applied to the motor is converted to heat. Heat generated by the drive is directly proportional to the voltage drop multiplied by the motor current. Heat dissipation is a critical factor when the motor is in a stalled condition (low voltage at the motor, but high current output). The TA330 is limited to a maximum of 500W continuous dissipation assuming the load is not stalled. Peak dissipation depends on specific conditions including temperature, load dynamics (stalled or moving) and event time. For most accurate peak dissipation allowable, see the SOA chart, section 2.4.

To determine the applications potential heat dissipation at the drive, use the following equation:

$P_D = I_{motor} (V_{supply} - V_{motor})$

P_D = power dissipated by the drive
I_{motor} = motor current (worst case)
V_{supply} = total supply voltage
V_{motor} = voltage across the motor (worst case)

Example:

V_{supply} = 96V
V_{motor} = 10V
I_{motor} = 8A

P_D = 8A (96V-10V)
= 516W

2.0 General Specifications

2.1 Electrical Specifications

FEATURE	UNIT	
Supply Voltage		
Bipolar	V	± 12 – ± 75
Equivalent Motor Voltage	V	(subtract ~ 5V from drive input voltage)
External 24V Supply	VDC	24 ± 5% @ 0.5A
Maximum Output Current	A	See SOA Chart
Fault		TTL Level 0 or 1
Enable		TTL Level 0 or 1
Command Input	VDC	±10 (±12 max)
Command Input Impedance	KΩ	400
Torque Gain	A/V	0.6 - 1.8
Bandwidth	kHz	5.0

Table 1 - Electrical Specifications

2.2 Mechanical Specifications

FEATURE	UNIT	
Length	in (cm)	14.90 (37.85)
Width	in (cm)	7.69 (19.53)
Height	in (cm)	4.70 (11.94)
Weight	lb (kg)	13.5 (6.12)

Table 2 - Mechanical Specifications

2.3 Environmental Specifications

FEATURE	DETAILS
Maximum Altitude	6,560ft (2,000 meters)
Temperature (ambient)	
Normal operation	5° C to +40° C
Temperature derating	See SOA Chart – Section 2.4
Storage	-40° C to +70° C
Heatsink	+70° C Maximum
Heat Dissipation (@ 25° C)	
Continuous	500W
Peak	See SOA Chart – Section 2.4
Airflow	Internal fans, variable speed, thermally controlled
Humidity	
Operating	10% to 70%, non-condensing
Storage	10% to 95%, non-condensing
Pollution Degree 2	

Table 3 - Environmental Specifications

2.4 TA330 Safe Operating Area Curve (SOA)

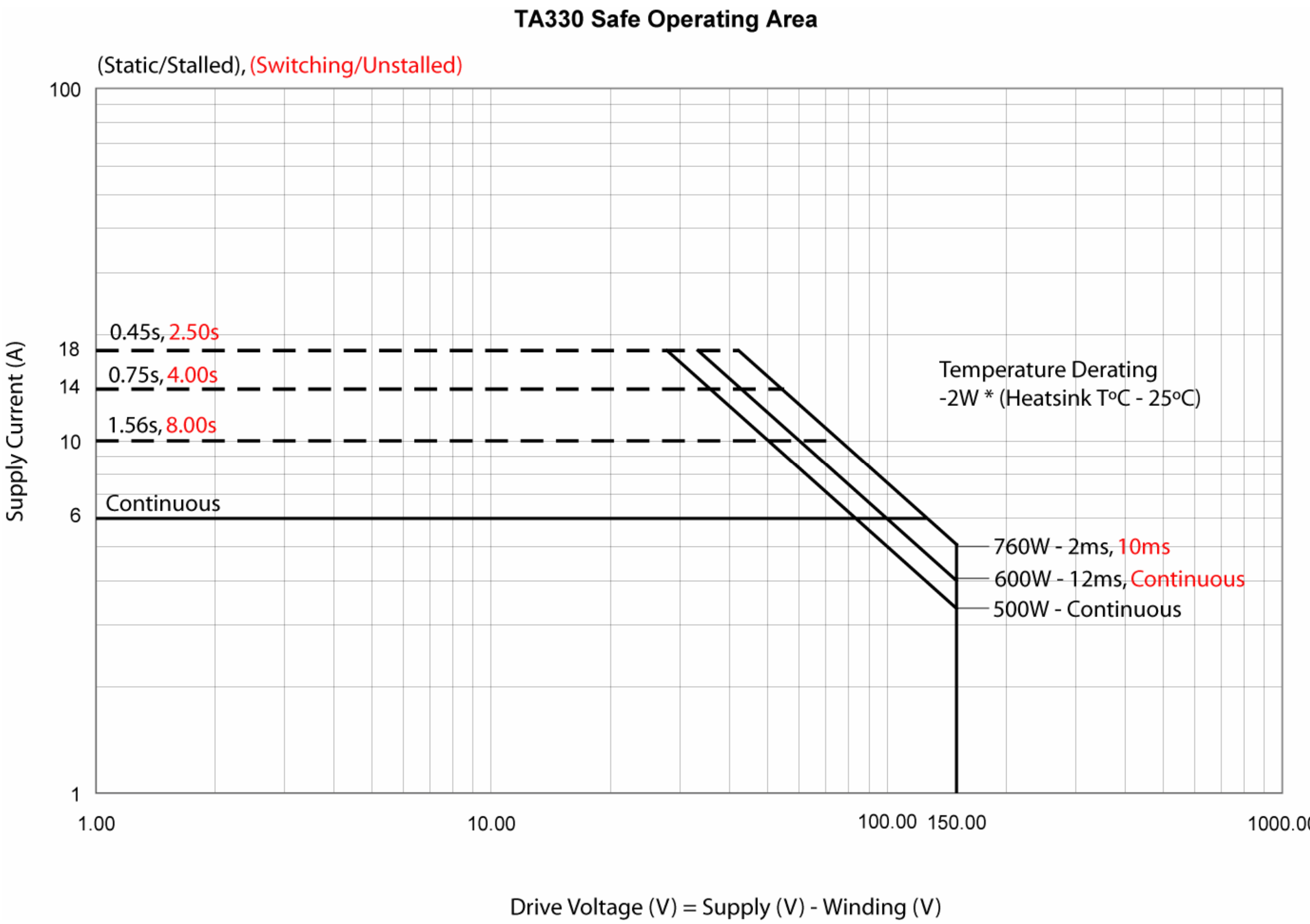

Figure 4 - TA330 SOA Curve

3.0 Mechanical Information

3.1 Dimensions

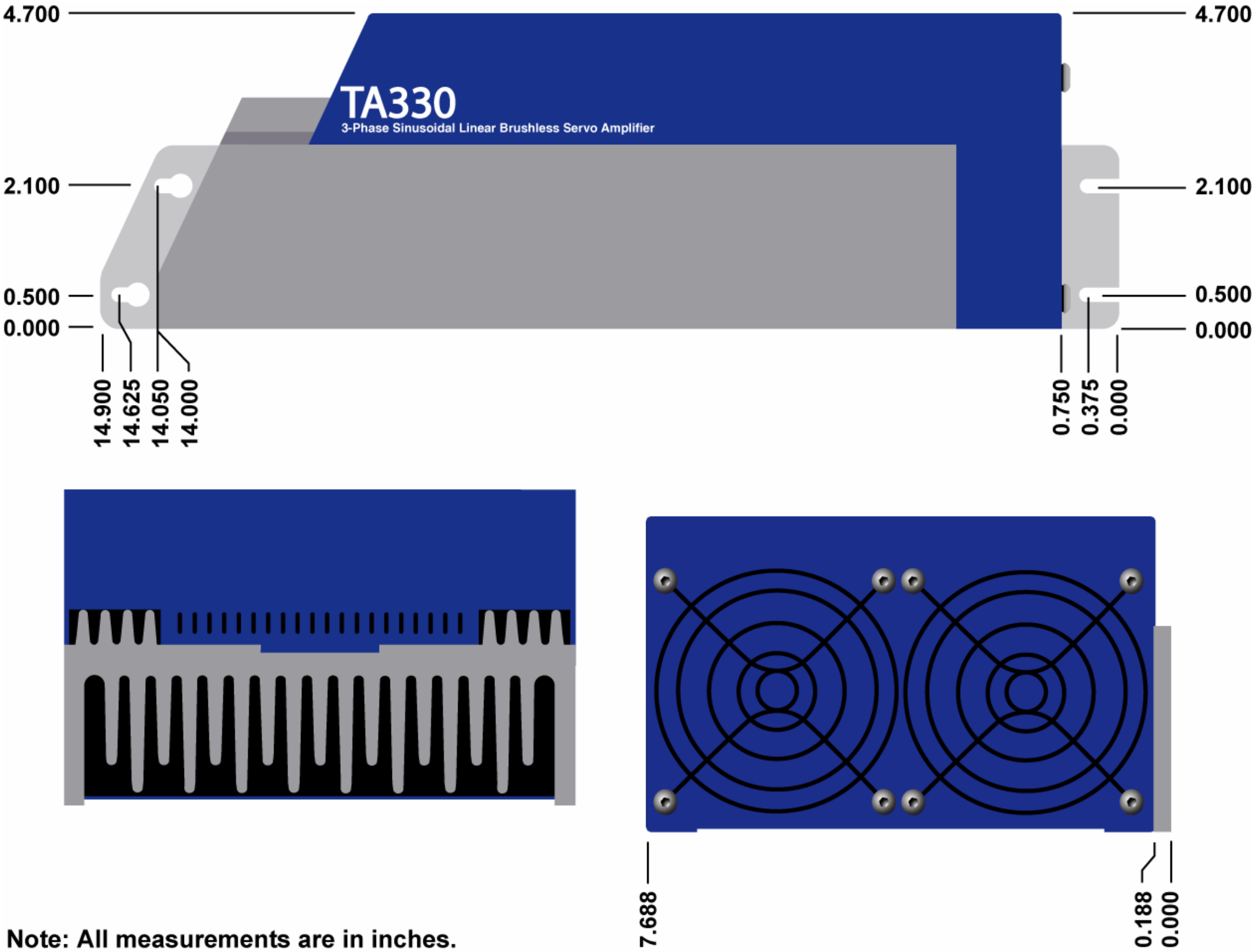

Figure 5 - TA330 Mechanical Dimensions

4.0 Connector and Switch Information

4.1 Front Panel Connector and Switch Layout

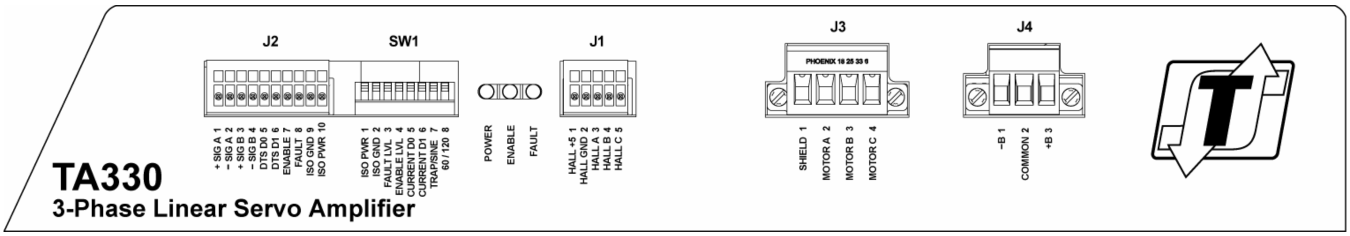

Figure 6 - TA330 Front Panel

4.2 Connector Types

Connector #	# Pins	Manufacturer & Part Number	Description
J1	5	Wago P/N 733-105	Hall Sensors
J2	10	Wago P/N 733-110	Command Signals
J3	4	Phoenix 1825336	Motor Connections
J4	3	Phoenix 1777992	Motor Power
J5	2	Phoenix 1827703	External 24VDC Supply

Table 4 - Connector Types

4.3 J1 – Hall Sensor Input

Pin #	Description
1	Hall +5V (20mA Maximum)
2	Hall GND (Referenced to AUX GND)
3	Hall A
4	Hall B
5	Hall C

Table 5 - Hall Sensor Input Connector

4.4 J2 – Motor Command Signals

Pin #	Description
1	Command Signal Input Phase A+
2	Command Signal Input Phase A-
3	Command Signal Input Phase B+
4	Command Signal Input Phase B-
5	Dynamic Transconductance Select Bit D0
6	Dynamic Transconductance Select Bit D1
7	ENABLE (Referenced to AUX GND)
8	FAULT (Referenced to AUX GND)
9	AUX GND (Optionally tied to GND)
10	V_{AUX} (User supplied +5V, for Optional Optical Isolation)

Table 6 - Motor Command Signals Connector

4.5 J3 – Motor Connections

Pin #	Description
1	Shield (tied to chassis)
2	Motor Phase A
3	Motor Phase B
4	Motor Phase C

Table 7 - Motor Connections Connector

4.6 J4 – Motor Power

Pin #	Description
1	B- Supply
2	Common (Optionally referenced to GND)
3	B+ Supply

Table 8 - Motor Power Connector

4.7 J5 – External 24VDC Supply

Pin #	Description
1	24V External Supply
2	Common (Referenced to GND)

Table 9 - External 24VDC Supply Connector

4.8 SW1 - Switch Settings

Switch #	Function – (0 / Down /ON)	Function – (1 / Up / OFF)
1	TA330 Supplied +5V (20mA Maximum)	User Supplied +5V (For Optical Isolation)
2	AUX GND Tied to GND	AUX GND Isolated from GND
3	/FAULT (FAULT low true output)	FAULT (FAULT high true output)
4	/ENABLE (Drive enabled on low Input)	ENABLE (Drive enabled on high input)
5	Gain and DTS Settings	See Following Chart for Function Selection
6	Gain and DTS Settings	See Following Chart for Function Selection
7	Trapezoidal Commutation	Sinusoidal Commutation
8	60° Hall Commutation	120° Hall Commutation

Table 10 - Switch Settings

(Note: “Down” is toward the heatsink, “Up” is away from the heatsink)

4.9 SW1 – Switch 5 and 6, Fixed Gain and DTS Settings

Setting	SW1-5 (DTS D0)	SW1-6 (DTS D1)
10Vin = 6Aout	Down (0)	Down (0)
10Vin = 10Aout	Up (1)	Down (0)
10Vin = 14Aout	Down (0)	Up (1)
10Vin = 18Aout	Up (1)	Up (1)
DTS Active	Up (1)	Up (1)

Table 11 - Fixed Gain and DTS Switch Settings

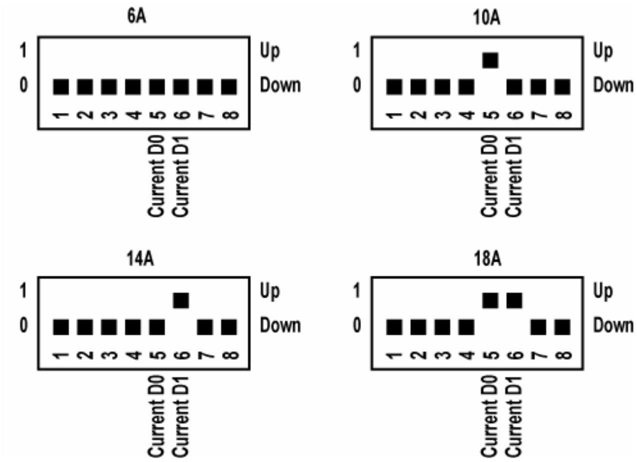

Figure 7 - DTS Switch Operation

(Note: “Down” is toward the heatsink, “Up” is away from the heatsink)

5.0 Application Examples

5.1 Brushless Motor, Trapezoidal, Hall Commutation, Isolated Inputs

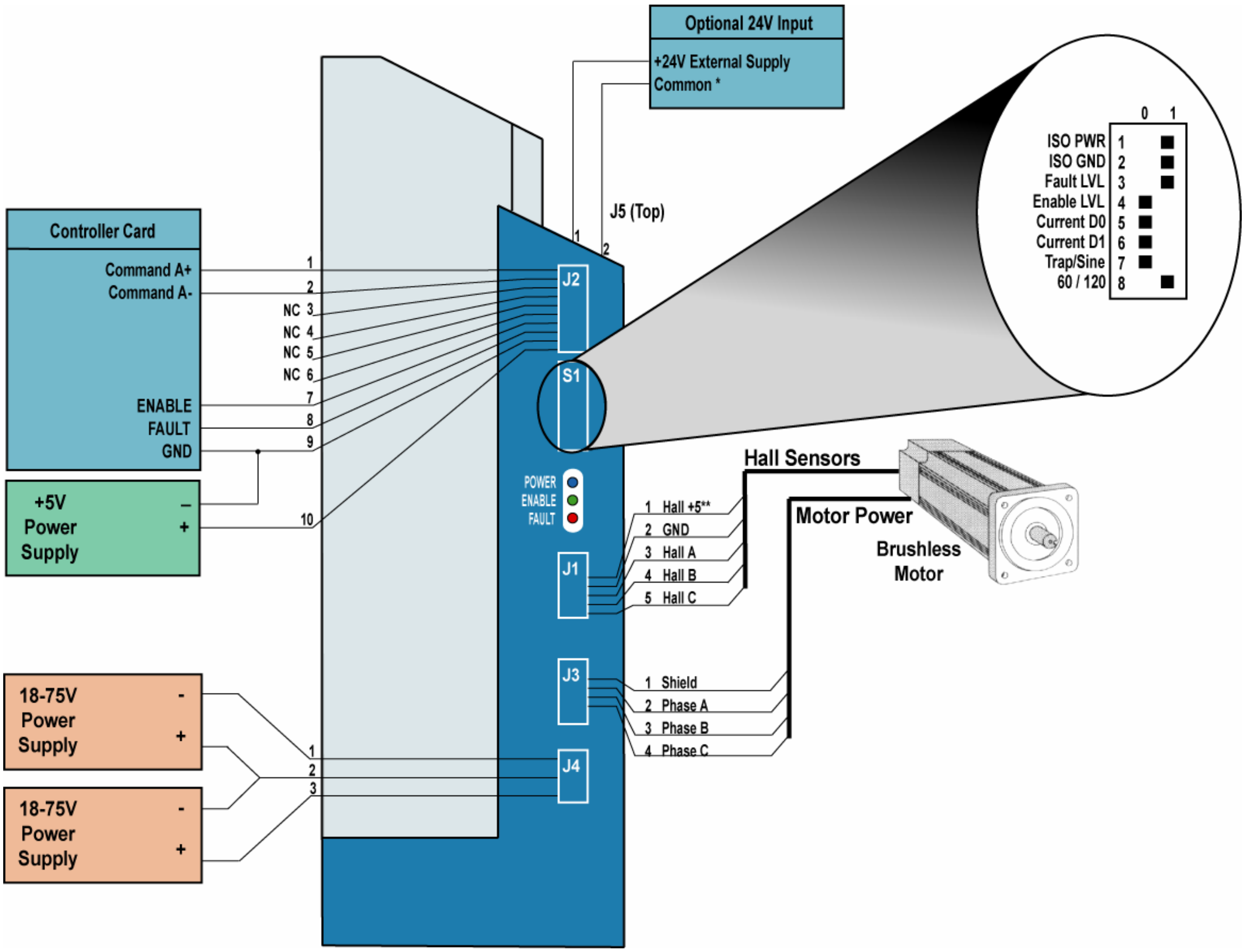

Figure 8 - Application Example 1

This figure shows the TA330 operating in Trapezoidal mode, active high fault, active low enable, driving a single brushless servo motor, using Hall Effect sensors for commutation. The TA330 is set for a fixed current limit of 6A with a transconductance of 0.6A/V and 120° Hall commutation. The logic lines are isolated, requiring a user supplied +5.0VDC.

5.2 Brushless Motor, Sinusoidal

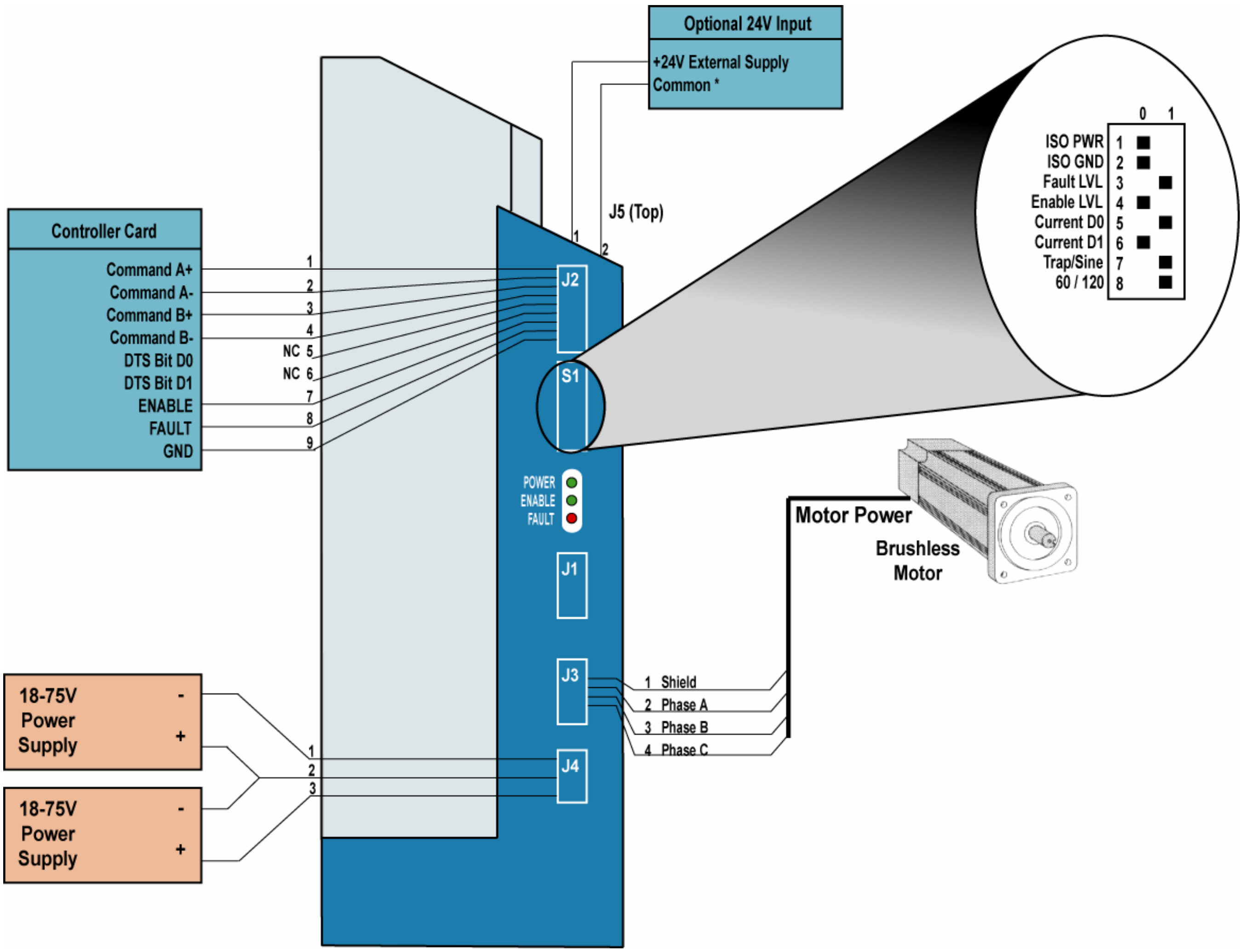

Figure 9 - Application Example 2

This figure shows the TA330 operating in Sinusoidal mode, active high fault, active low enable, driving a single brushless servo motor. The TA330 is set for a fixed current limit of 10A with a transconductance of 1.0A/V. The TA330 logic lines are not isolated.

5.3 Brush Motor, Bridge Mode

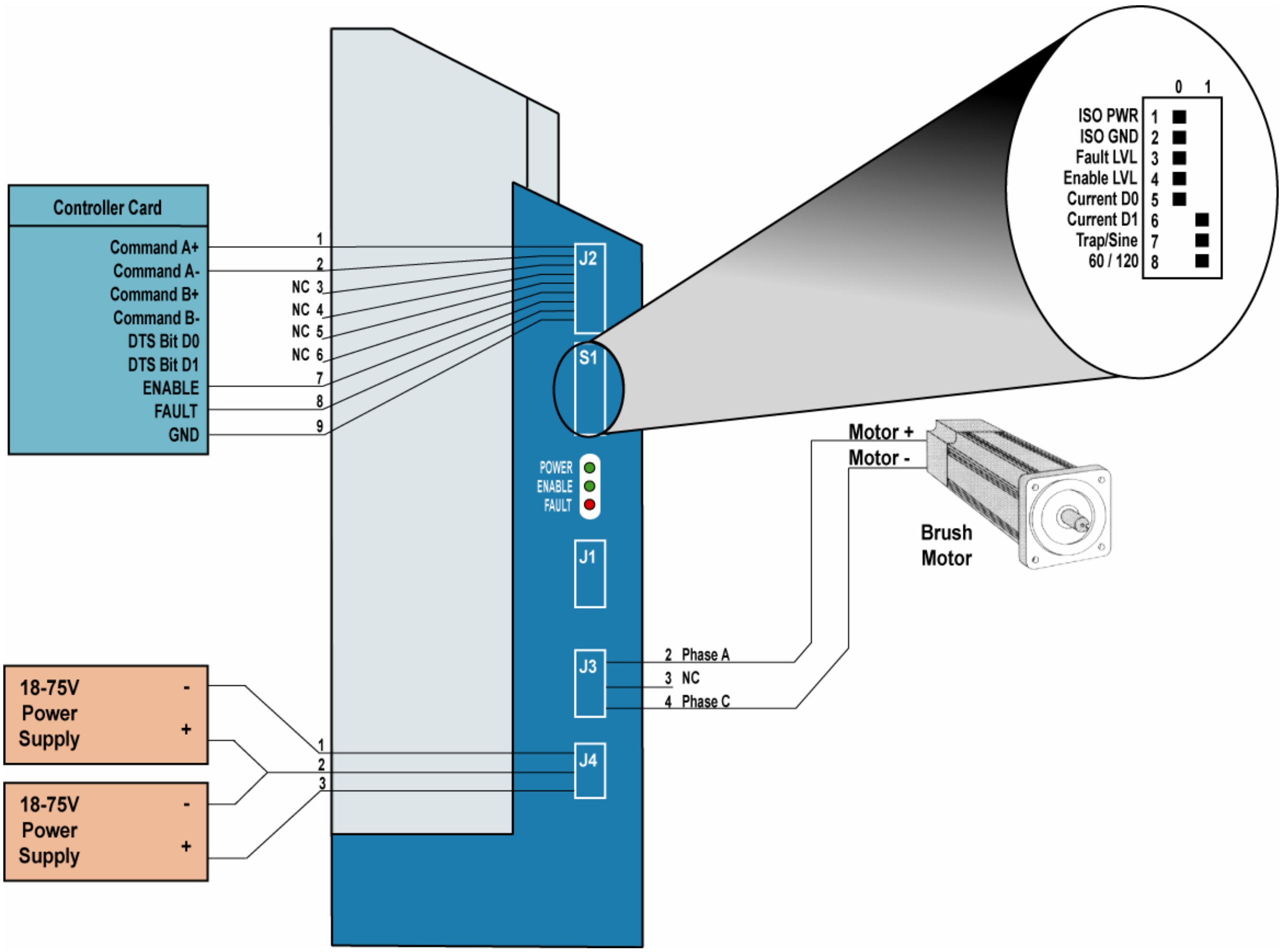

Figure 10 - Application Example 3

This figure shows the TA330 operating in brushed bridge mode, driving a single brush type servo motor, active low fault enabled. The TA330 is set for a fixed current limit of 14A with a transconductance of 0.7A/V. The TA330 logic lines are not isolated.

5.4 Brushless Motor, Trapezoidal, DTS

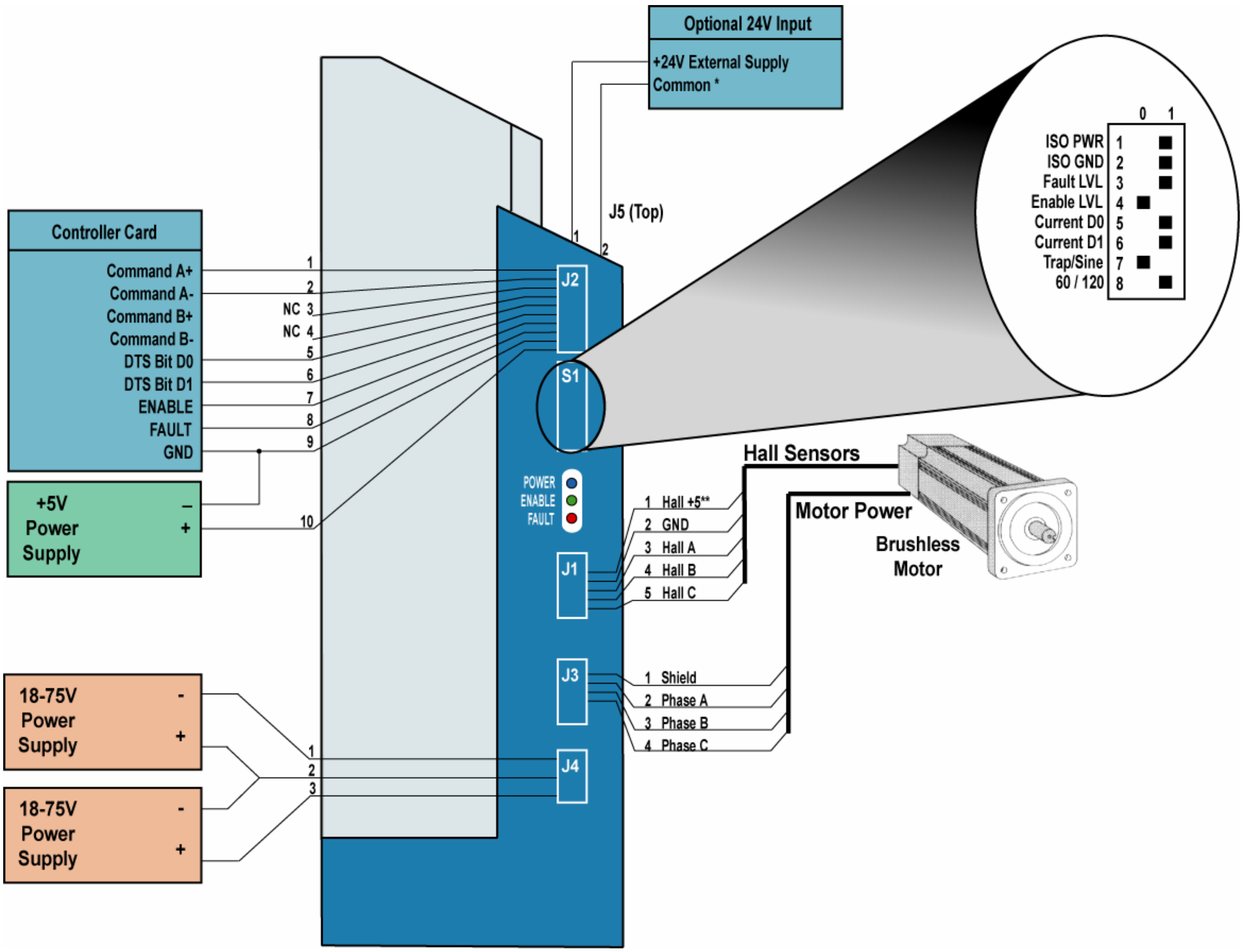

Figure 11 - Application Example 4

This figure shows the TA330 operating in Trapezoidal mode, driving a single brushless servo motor, using Hall Effect sensors for commutation. The TA330 is set for DTS (Dynamic Transconductance with an 18A current limit) and 120° Hall commutation. The logic lines are isolated, requiring a user supplied +5.0VDC.

6.0 Warranty

Trust Automation Inc.
(Limited 1 Year Warranty)

GENERAL - All hardware products sold by Trust Automation Inc. are warranted against defects in material and workmanship for a period of **one (1) year** from the date of shipment. If you believe that a Trust Automation Inc. hardware product you have purchased has a defect in material or workmanship, or has failed during normal use within the warranty period, please contact Trust Automation Inc. at (805) 544-0761 for assistance and/or a Return Material Authorization Number (RMA#).

If product repair or replacement is necessary, the Customer will be responsible for all return shipping charges, freight, insurance and proper packaging to prevent damage in transit, whether or not the product is covered by this warranty. During the warranty period, product determined by Trust Automation Inc. to be defective in form or function will be repaired or, at Trust Automation Inc.'s option, replaced at no charge. Trust Automation Inc. will pay the return shipping charges (ground for US based shipments, most economical air for international shipment. Customer may elect to change shipment method and pay the difference.), for products that have been repaired or replaced. All duties and taxes remain the responsibility of the customer. All shipments of repaired or replaced products will be F.O.B. at Trust Automation Inc. headquarters in San Luis Obispo, California.

For tracking purposes, products to be repaired or replaced must be returned to Trust Automation Inc. with a Trust Automation Inc. RMA#, and a Purchase Order. The standard charge for non-warranty repair work is $120 per hour, plus parts with a minimum charge of $120. Trust Automation will provide repair cost estimate prior to performance of out of warranty repair work.

Material and workmanship used in the repair and replacement of Trust Automation products under this warranty are warranted additionally against defects for a period of ninety (90) days from the date of return shipment to the customer.

LIMITATIONS - This warranty does not apply to damage resulting from accidents or any Customer actions, such as mishandling, misuse, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. No other warranties are expressed or implied. Trust Automation Inc. liability shall be limited to the actual purchase price of any defective unit or units of equipment to which a claim is made, and shall in no event include the Customer's manufacturing costs, lost profits or goodwill, or any other direct, indirect, special, incidental or consequential damages.

7.0 TA330 Hardware Revision History

Revision	Date	Description
A.0	24 Feb 06	BETA Hardware Release
A.1	9 Sep 2006	Manufacturing Release. Firmware update to allow proper operation of drive over temperature shutdown.

8.0 TA330 Manual Revision History

Revision	Date	Description
v1.00	24 Feb 06	Initial Release (BETA)
v1.01	27 Feb 06	Incremental corrections (BETA)
v1.02	3 Mar 06	Incremental corrections (BETA)
v1.03	18 Apr 06	Incremental corrections (BETA)
v1.04	3 May 06	Incremental corrections (BETA)
v1.05	13 Jun 06	Fixed Fig. 4 SW1, position 7 description. (Final BETA release)
v2.00	9 Sep 06	Manufacturing Release. Added SOA chart, updated electrical characteristics section. Removed requirement for 24V external supply for full voltage range operation. Updated unipolar/bipolar power supply descriptions, removing unipolar as an option. Updated application examples to reflect bipolar supply only operation.
v2.01	11 Oct 06	Corrected table 7/8, section 4.5/4.6. Corrected pin numbering. Updated application examples with same information. Added power supply connection diagram in 1.12. Removed application example 3 which is no longer a recommended setup mode.