SST-6000, SST-3100
SERVO DRIVES AND MOTORS

COVERS –UXX AND –TXX MODELS

VERSION 2.1/DECEMBER 16, 2008

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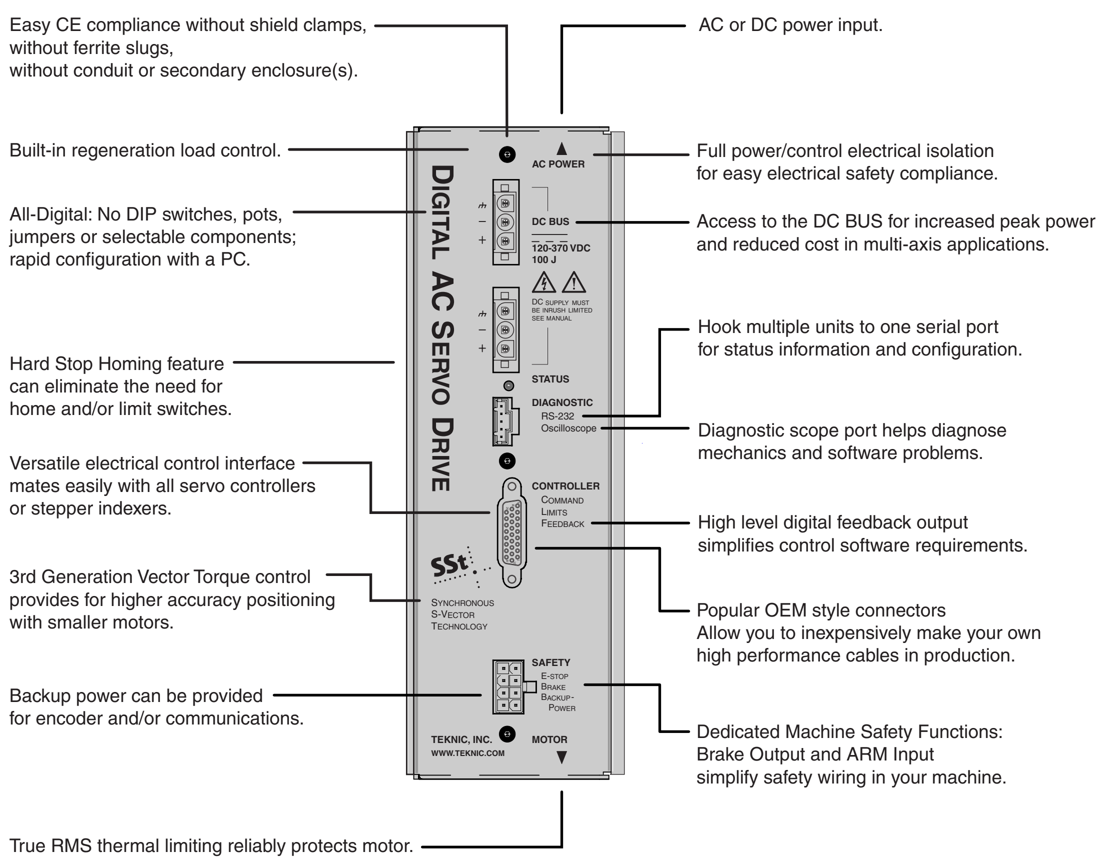
OVERVIEW

The SSt-6000/3100 servo drives have been designed to simplify installation in OEM production environments. The electrical, mechanical, and operational features are designed to support simple, repeatable production of complex machines. Examples of this include:

- Operational features added to eliminate sensors and simplify control harness wiring.
- Electrical and operational features added to help OEMs meet compliance agency requirements including electrical safety, RF compatibility and machine safety.
- Connectors selected specifically for wide availability of mating connectors and commonly available tooling at harness shops.
- Rapid configuration and built-in troubleshooting tools to help simplify and speed up development, production, and field service.

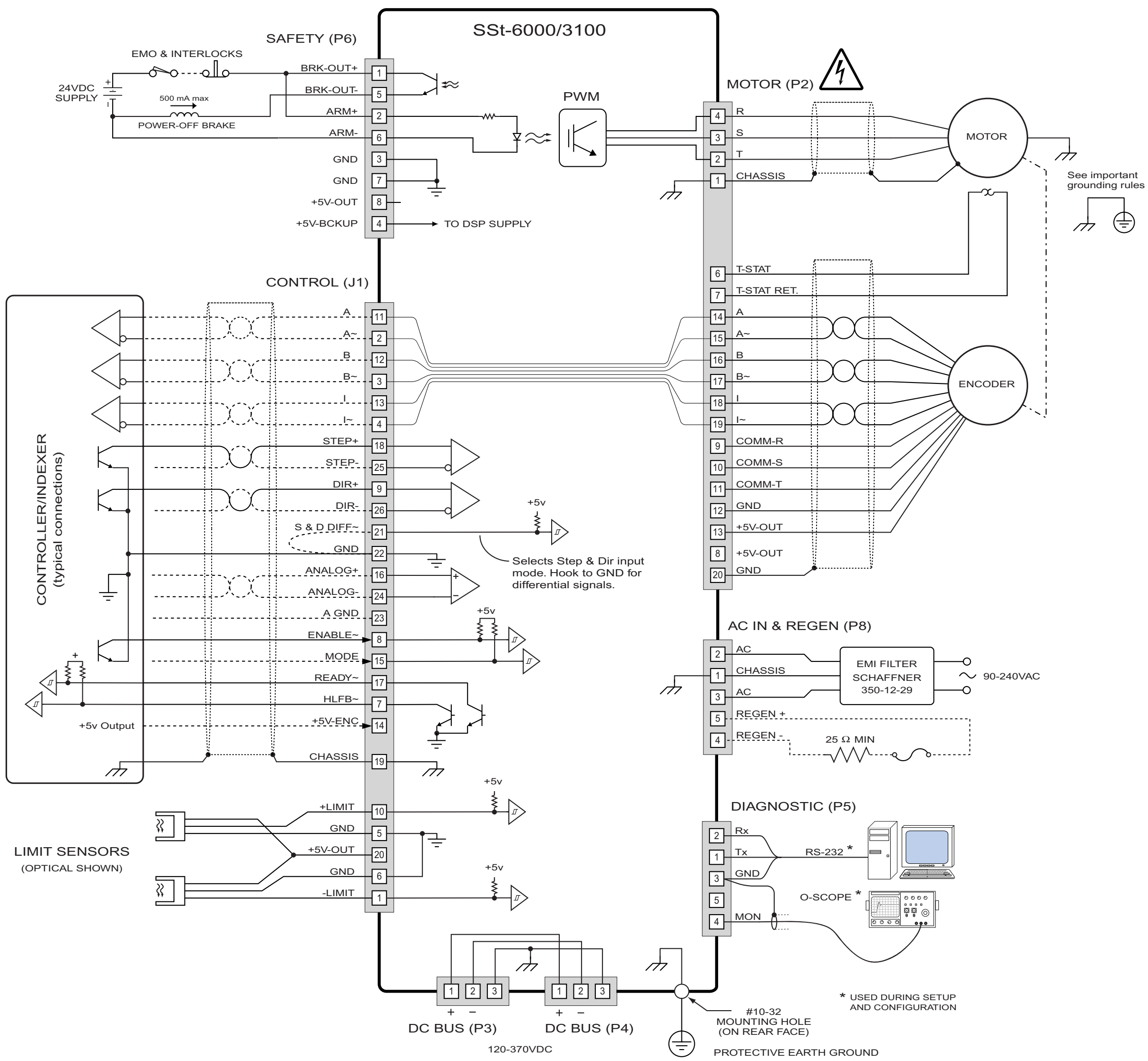
All of these features significantly reduce the total cost of ownership of SSt servo drives in OEM equipment.



SSt-6000/3100 Installation Features

ELECTRICAL INSTALLATION

The figure below illustrates *one possible set* of interconnections that might be used when installing the SSt-6000/3100 into your machine project. This diagram is intended to provide a general overview of an example SSt-6000/3100 installation. While significant detail is provided in this diagram, it should not be used as a definitive reference. Many time and cost saving details are shown in the schematic fragments and text that follow. The reader is strongly advised to read this entire section as well as the "Golden Rules" of installation found in Appendix E before integrating the SSt-6000/3100 servo drives into a machine.



Typical SSt-6000/3100 Hookup

CE USE INSTRUCTIONS

You may notice that there is no section in this manual entitled "Regulatory Compliance" with special instructions. That's because there is no special additional installation work required for your installation to comply with CE electrical safety (LVD) and electromagnetic interference requirements. If you follow the simple instructions in this manual your installation should meet the following EN specifications:

EN 61010	"Safety requirements for electrical equipment for measurement, control and laboratory use" This standard covers hazards from electrical shock, fire, excessive temperature and radiation.
EN 50081-2	"Electromagnetic compatibility- Generic emission standard: Part 2 Industrial environment" This standard covers conducted and radiated RF emissions. Testing was done to the limits in EN 55022, Class A.
EN 50082-2	"Electromagnetic compatibility- Generic immunity standard: Part 2 Industrial environment" This standard covers immunity to Electrical Fast Transients (EN 61000-4-4) caused typically by power switching relays, Surges (EN 61000-4-5) caused typically by lightning, Electro-Static Discharge (EN 61000-4-2) usually caused by personnel, conducted and radiated RF immunity (EN 61000-4-6 & EN 61000-4-3 respectively) caused by radio communication or other industrial equipment.

Wherever possible, we have referenced the applicable standards and terminology used in the EN documents.

POWER INPUT/DISTRIBUTION

Power can be supplied to the SSt-6000/3100 drives via the AC line connector (P8) or by the DC bus ports provided on the front panel (P3, P4). Supplying single phase AC power is the simplest. However, supplying DC power derived from a 3 phase AC source can boost the peak power output of the drives by up to 50%[1]. Contact your Teknic sales engineer for an application note.

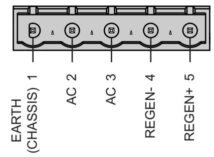
The DC ports can also be used to allow sharing of the bus capacitors when powering from a single phase source, often boosting the peak power and eliminating or reducing the need for external regeneration resistors (see below).

AC POWER INPUT

The SSt-6000/3100 drives are internally fused[2] on both AC lines with UL listed 250V fuses (Bussman/MDA-10 or Littlefuse/326 010). Therefore, no fusing or breakers are required for protection from internal drive failures. You may, however, need to add protection for your wiring *up to* the drive to meet safety certification.

1 DC power must be filtered and conditioned to meet Category 1 power quality in order to satisfy CE safety requirements. Category 1 power is protected such that voltage spikes and transients cannot be applied to the equipment in question.

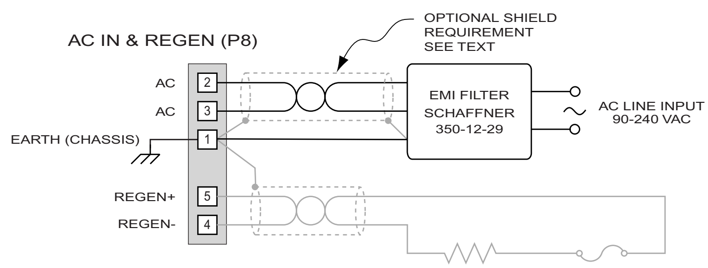
2 The internal fuses are not user serviceable parts. Return non-functioning unit to the factory for service. Fuse Information is provided strictly for certification, safety assessment and evaluation.



Connector P8 - AC in & Regenerative Power Output

If current protection is added to the SSt-6000/3100 AC supply circuits it should be in the form of time delay fuses or thermal delay breakers normally used for motor starting applications. Proper current protection will help prevent nuisance trips from in-rush currents during power-up.

Only one external component is required with the SSt-6000/3100 drives to pass the required CE emissions standard (EN-50081-2): an AC line filter. A Shaffner model 350-12-29 filter was used during the CE emissions tests. This filter has enhanced low frequency suppression and is a perfect match for the SSt-6000/3100. The filter should be mounted on the same bulkhead or frame as the SSt-6000/3100 drive with no more than 10” of twisted wires between the drive and the filter. The filter can be located at a greater distance from the drive if shielded twisted pair wiring is used and if there is a continuous frame between the SSt-6000/3100 drive and the filter. See figure below.



Typical AC Input wiring

REGENERATION HOOK-UP

Regeneration energy control is sometimes required when decelerating high inertia, inclined or vertical loads. In these situations an external resistor may be required to effectively dissipate the energy regenerated into the drive’s DC bus capacitors. This safety shutdown occurs when the SSt-6000/3100 drive’s internal DC bus exceeds 390VDC (in which case an I/V safety shutdown will occur).

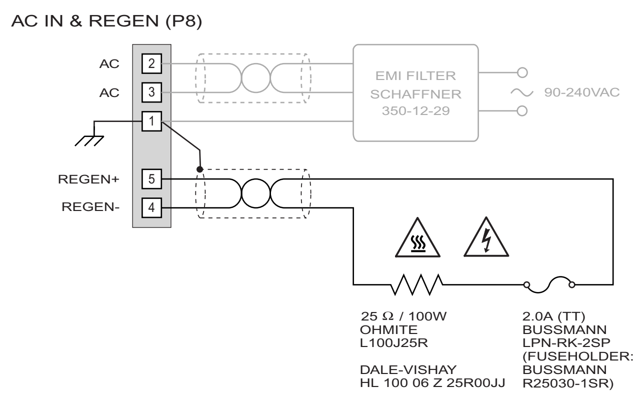
To avoid this safety shutdown, install one of the external regeneration resistors listed below. This will allow the SSt-6000/3100 drive to automatically dump excess energy into it. A 100-watt resistor is sufficient for nearly all applications. See suggested part numbers below. **Note:** It is important that all other signal wiring be kept at least 12 inches away from the resistors to minimize noise coupling.

VENDOR	INDUCTIVE RESISTOR P/N
Ohmite	L100J25R
Dale-Vishay	HL 100 06 Z 25R00JJ 25Ω5%

WARNING!

The regeneration terminals on P8 are shock hazards that may have up to 400VDC present. Hazardous voltages may remain on these terminals for up to one minute after the removal of AC power (unless a fast discharge solution is implemented). All connections to these terminals should be marked as an electrical shock hazard and must not be user accessible.

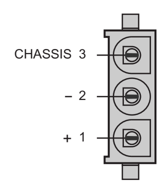
When in operation, the 25 ohm regeneration resistor may become extremely hot (at the limit, up to 270 degrees C). It should not be user accessible, should be marked "HOT, DO NOT TOUCH" and labeled with the IEC heat symbol or guarded so service personnel cannot touch it.



Typical Regeneration Load Circuit

OPTIMUM POWER DISTRIBUTION: DC POWER BUSSING

When you use more than one SSt-6000/3100 drive in your system, you can increase the ability of the system to accept regeneration energy from an axis and increase the peak power capacity of SSt-6000/3100 drives by bussing the DC power. DC power can be bussed between several SSt-6000/3100 drives. This technique connects the capacitor storage banks of all of the drives, generally reducing the voltage drop during heavy acceleration and minimizing bus voltage rise due to regeneration during axis deceleration.



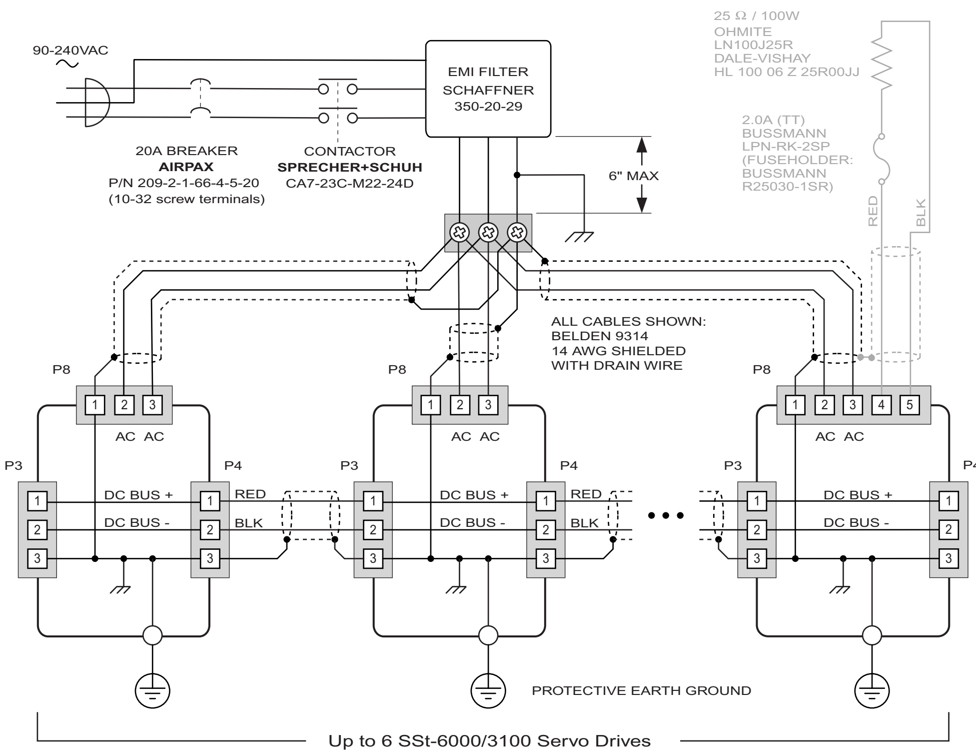
DC Bus Connectors P3 and P4

The DC busses of up to six SSt-6000/3100 drives can be connected together via jumper cables at connectors P3 and P4 as shown in Fig. 7; however, the DC-bussed drives must be supplied with the identical AC power source.

WARNING!

The DC bus connectors (Appendix F: P3 and P4) are shock and energy hazards that may have up to 400VDC present with up to 100 joules available per connected drive. Although the connectors are fully shrouded during mating and are rated for this voltage you should be extremely careful when wiring these signals. DO NOT PLUG IN OR REMOVE THESE CONNECTORS WHEN AC POWER IS APPLIED. Hazardous voltages may remain on these DC connectors for up to one minute after the removal of AC power (unless a fast discharge solution is implemented). Connecting this DC circuit to exposed terminals should be avoided if possible. If this circuit is connected to exposed terminals, the terminals should be marked as an electrical shock hazard and must not be user accessible.

The figure on the following page illustrates an excellent, inexpensive way to distribute single-phase power to a group of SSt-6000/3100 drives. This circuit shares a circuit breaker, contactor, EMI filter and a regeneration resistor (if required) between all of the connected drives.



Bussing AC and DC Power to Increase Peak Power

When several SSt-6000/3100 drives are turned on simultaneously, a requirement of DC bussing, large inrush currents will result. This has the potential to blow breakers or fuses in your machine, so a delay breaker or time delay fuses (normally used in motor starting applications) should be used. Airpax makes a reasonably priced breaker (P/N 209-2-66-4-5-20) that is well suited to this purpose.

An alternative to this AC/DC bussing approach is to supply the drives with DC power directly using an external rectifier. This method offers several advantages including soft start capability and the ability to supply the drives with 3-phase power. The most salient advantage of supplying the drives with 3-phase power is increased peak output power. Contact your Teknic sales engineer for more information on this method.

GROUNDING & SHIELDING REQUIREMENTS

The SSt-6000/3100 drives have several grounds:

GND: This is the reference terminal for all digital control and feedback signals and logic shield. GND is completely isolated from the motor power circuits, and the CHASSIS ground.

CHASSIS: CHASSIS is connected to all CHASSIS (SHIELD) pins and connector shells, the case, and to the Protective Earth Ground Terminals.

Protective Earth Ground Terminals:
These are special CHASSIS terminals that are used to bond the unit to the machine safety ground (Earth) for electrical safety purposes. These terminals are the #10-32 mounting holes on the flat face of the case extrusion. Either or both of these terminals must be connected to the frame of the machine which must be connected to the machine's Protective Earth Terminal.

AGND: This is the analog command reference terminal that is internally connected to GND

IMPORTANT GROUNDING RULES

In order to meet EN-50082-2 and EN-50081-2 RF emissions and immunity specifications and to meet EN-61010 electrical safety specifications (for CE/UL compliance) the following rules must be followed:

1. Protective Earth Ground must be connected to the machine's safety ground, usually by mounting the SSt-6000/3100 drive to a grounded panel or frame. These mounting holes are also the main RF ground for the unit and should be grounded to the machine frame to meet RF emissions.
2. The AC input filter must be mounted on the same panel as the SSt-6000/3100 drive within 10" of the drive. Alternately, the power must be run through shielded cable to the filter, and the

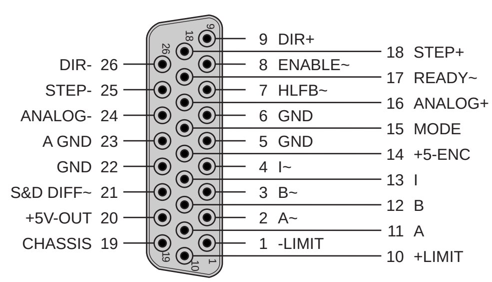
shield terminated at both the filter case and the CHASSIS pin on the drive power connector.

3. The motor phase cable must be shielded with the shield connected to the motor case and, at the drive end, to the CHASSIS pin on the motor connector (Appendix F: P2, pin 1). The shield lead length at the drive end of the cable should be as short as possible with a 2.0” maximum length.
4. The encoder and commutation sensor cable must be separately shielded from the motor phase cable and the shields should not touch at any point. The shield should be terminated to GND on the motor connector (Appendix F: P2, pins 12, 20). The shield for this cable should be left unconnected at the motor end (don’t connect it to the motor’s case).
5. Controller wiring should be fabricated with shielded cable and the shields connected to chassis ground at both ends. Pin 19 on the controller connector (J1) and the connector shell are connected to the chassis for this purpose.
6. The motor must have both a low impedance ground path to protective earth and an RF path to the SSt-6000/3100. This is usually provided by the motor mounting screws and the chassis metal of the machine. In cases where the motor is isolated (as during machine construction) appropriate steps must be taken to meet grounding requirements.

CONTROLLER INTERFACE

The SSt-6000/3100 servo drive can be commanded from standard digital step and direction positioning signals or a standard +/-10V analog command signal from a servo controller. Because of reduction of delays and coordination between the vector torque control and velocity/position control, the highest performance is generally available using digital positioning signals. All control signals are available on J1 (see figure below).

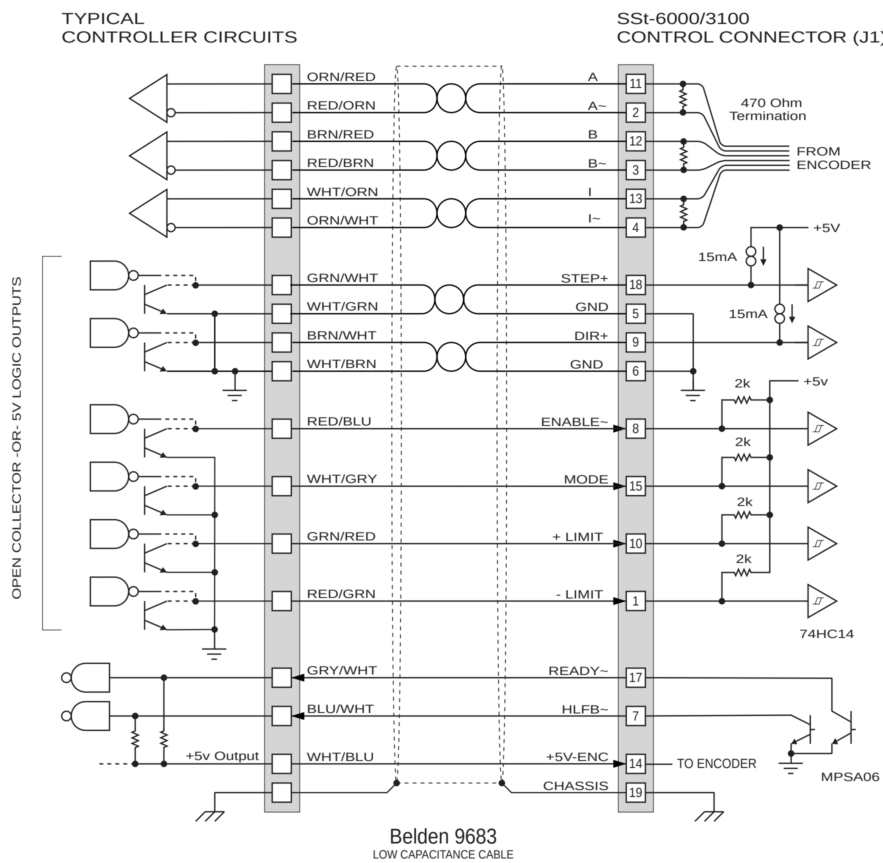
PIN DESCRIPTIONS (J1)



Controller connector (J1)

DIGITAL DRIVE INTERFACE

For the highest servo performance the U version of the SSt servo drive should be run from digital position command signals from a servo controller or stepper motor indexer. The drive responds to standard, all-digital, step and direction signals and returns high level feedback of move completion and/or tracking. Fig. 9 shows typical connections from a SSt-6000/3100-U to a digital controller using low capacitance, shielded, twisted pair cable. The electrical properties of this inexpensive, readily available cable help minimize crosstalk and noise that can adversely affect signal integrity, especially in longer cable runs.



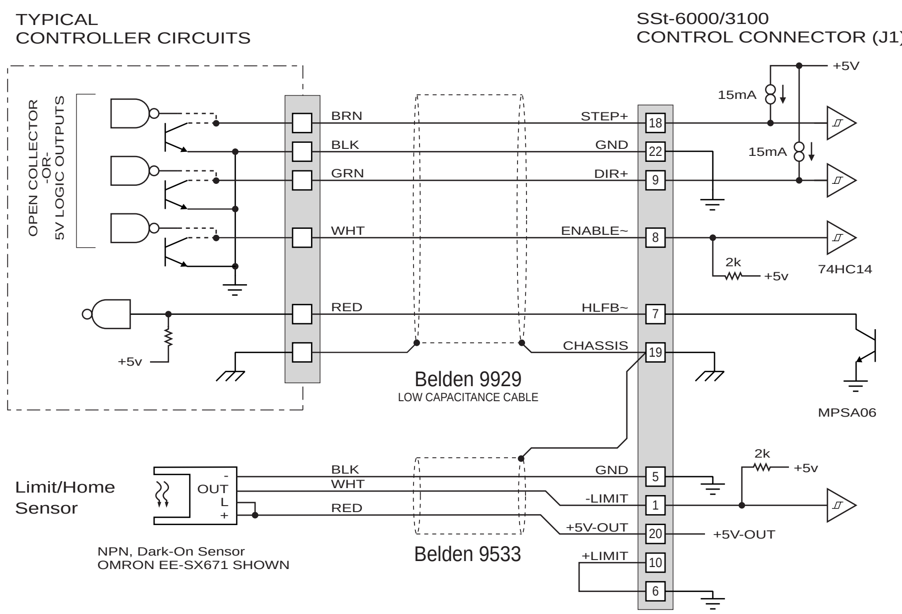
Typical Digital Drive Interface (U versions only)

WIRING THE OUTPUT CONTROL SIGNALS (HLFB AND READY)

Both the HLFB~ and the Ready~ circuits are open collector outputs with no pull-up resistors. They are rated for switching non-inductive loads up to 40V at a maximum of 100mA. These outputs are compatible with TTL and CMOS logic inputs when a pull-up resistor is used. They can also be used directly to switch non-inductive loads such as LEDs. If you wish to use these outputs with an inductive load such as a relay coil, you must connect a snubber diode across the coil to prevent the inductive spike from damaging the output transistor.

SIMPLIFIED, HIGH RELIABILITY INTERFACE

In general, the vast majority of problems with electronic control systems in automated machines can be traced to interconnect problems due to electrical noise, crosstalk or simply the numerous opportunities for unreliable connections. One way to make your machine more reliable is to use fewer signals, thus reducing the number of connections in your control harness. This not only increases reliability, but it also reduces cost and generally makes troubleshooting easier. The SSt-6000/3100-U drives facilitate this in positioning mode by providing the HLFB~ (High Level Feed Back) signal, limit switch homing feature (or the HardStop Homing feature) and by having dedicated safety functions (Appendix F, P6) that eliminate the need for interrupting logic circuits in the control harness. Such an interface is shown in the figure below.



High Reliability, Simplified Digital Control Interface (U version only)

One of the biggest reliability improvements is facilitated by not monitoring (and therefore not wiring) high speed, noise prone encoder signals to your controller. Instead, the HLFB~ signal indicates the completion of a move (or high tracking error) and can be used to sequence moves in your machine without having to continuously monitor the encoder. In most installations a simplified, low cost, high reliability control interface can be constructed as shown in Fig. 10, often eliminating the need for a “breakout” printed wiring board(s). If you want to monitor the encoder position for display purposes or for manual adjustments, you can still use this high reliability interface and read the encoder position(s) through the serial interface on the diagnostic connector (one serial port on your host controller can talk to multiple SSt servo drives).

The digital interface shown above is ideal for situations when a “zero-cost” software based controller is used. For more information on how the SSt servo drives can be controlled this way, contact your Teknic sales engineer for a free application note.

HIGH LEVEL FEEDBACK (HLFB) SIGNAL OPERATION

The High Level Feedback (HLFB) signal can output rapid, high level Boolean feedback to your controller, thus reducing the software burden when your application is scheduling and monitoring moves. The HLFB signal can be configured in three modes: InRange, MoveDone and All Systems Go (ASG). The different modes of operation are described in the following text and illustration.

HLFB=MoveDone

When the HLFB pin is configured to operate in MoveDone mode, the HLFB signal de-asserts at the start of a commanded move and asserts when the command is complete and the axis has settled within a programmable position window (around the final position), for a programmable qualification time. The MoveDone signal is updated by the SSt servo drive's DSP every 250uS and uses the measured velocity, acceleration and jerk in a fuzzy algorithm to eliminate false triggering. It is typically used as a trigger to synchronize events in a point to point application.

HLFB=InRange

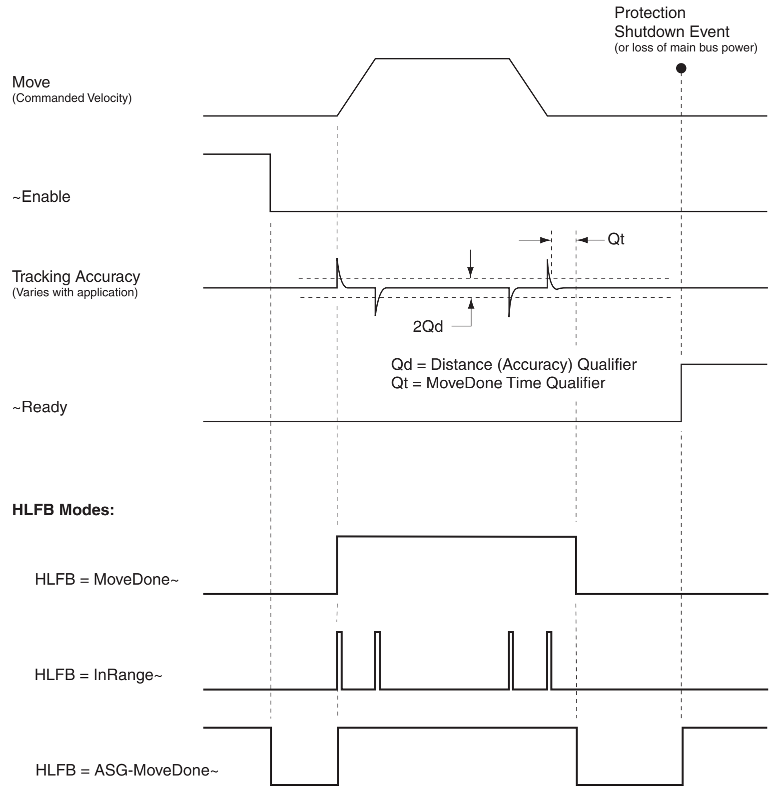
The HLFB pin can also be configured to operate in InRange mode. In this mode, the HLFB signal acts as a trigger to alert the controller that the axis under control has fallen out of a programmable position accuracy window. This mode is often used in CNC applications to indicate a worn tool and/or to throttle back the feed rate.

HLFB=ASG-MoveDone

The ASG-MoveDone (All Systems Go & Move Done) mode of the HLFB pin was developed to help minimize the I/O requirement of the SSt drive as, for example, when implementing the "High Reliability Interface". In this mode, the HLFB signal acts as a consolidated error/trigger signal that can be used in point to point applications.

In ASG-MoveDone mode the HLFB pin is de-asserted when a move is in operation (not MoveDone), the SSt drive is disabled, a safety shutdown has occurred or the SSt drive has lost bus power. This signal is only asserted (true, on, low) when a move is complete and the SSt servo drive is fully ready to accept a move as shown in the timing diagram that follows[3].

3 There is also an ASG-InRange mode that is not documented here for CNC or contouring applications, contact your Teknic sales engineer for details.



HLFB Timing Modes and Operation

STEP & DIRECTION SIGNALING

SSt-6000/3100 drives can connect directly to any stepper motor indexer or pulse source using industry-standard Step and Direction signals. The Step and Direction signals from the indexer can be open-collector, TTL-level driven signals or differential line driven signals (RS-422 levels). Shielded wiring should be used for these signals (shielded, twisted pair wiring is preferred for the Step input).

Because SSt servo drives respond to Step and Direction signals up to several megahertz in frequency, they will also respond to high frequency pulses generated by noise. The most common source of spurious Step and Direction pulses is conducted noise caused when several digital signals share a ground path with the Step and Direction signals, therefore:

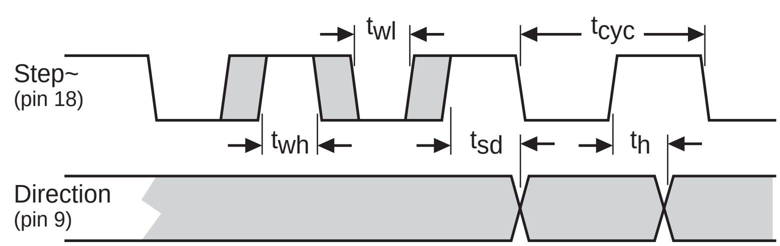
Care should be taken to ground the twisted pair wiring for the Step and Direction signals directly at the controller/indexer card’s output connector and not at a central system frame ground or other ground point. Using a breakout board can also be problematic because the cable between the controller/indexer and the breakout board typically shares the SSt’s isolated control ground with other digital signals. This condition can induce noise into the Step and Direction signals. If you do elect to use a breakout board, the cable between the controller/indexer and breakout board should be kept as short as possible.

If your system exhibits symptoms such as "walking", drifting or repeatability problems, it is highly likely that the Step and Direction wiring is faulty.

Step Polarity & Timing

In TTL input mode SSt-6000/3100 servo drives will be commanded to rotate one step when the Step line transitions from a low level to a high level (known as "positive edge triggered"). The required timing for both the Step and Direction signals is shown in Fig. 12.

Note: The timing diagram below (Fig.12) is applicable to both TTL and differential modes of operation. In differential mode, the signal connected to pin 25 is simply the inverted version of the pin 18 signal shown below. Similarly, the direction signal on pin 26 is the inverted version of the pin 9 signal.



Step and Direction Timing

t_{wl}	Time pulse width low
t_{wh}	Time pulse width high
t_{sd}	Time step to direction change
t_h	Time to hold direction after step + edge
t_{cyc}	Period, Time between consecutive cycles

The minimum time for t_{wl}, t_{wh}, t_{sd}, and t_h is 218nS. The minimum time for t_{cyc} is 436nS. There is no maximum limit for any of these timing variables.

If you wish, you can reduce t_{wl}, t_{wh}, t_{sd}, and t_h to 120nS and t_{cyc} to 240nS by adjusting the command input digital filter using Quickset. This will allow you to operate with input signals as fast as 4.2MHz with some degradation in noise immunity. Contact your Teknic sales engineer for details on how to do this.

Direction Polarity Wiring

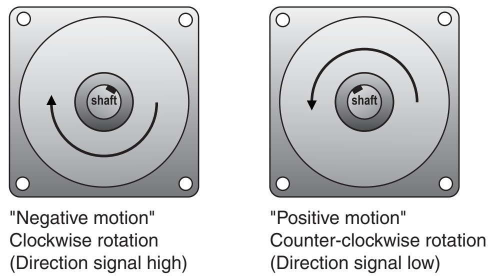
The SSt-6000/3100 has the ability to accept TTL Step and Direction control signals or Differential Step and Direction control signals. The input style is selected using the S&D DIFF~ signal on the Control Connector (Appendix F: J1, Pin 21). The differential mode is selected by connecting a jumper from Pin 21 to a gnd pin on the Control Connector (J1). To Select TTL mode, pin 21 is left unconnected, and an internal pull-up keeps the drive in TTL mode.

In TTL input mode, with a standard motor cable, the motor position is controlled by the Step+ signal (Apendix F: J1,pin 18) and the DIR+ or Direction signal (Appendix F: J1, pin 9). These lines control the motor position as defined below:

With the Direction line at a logic high level, the motor will rotate clockwise for each pulse of the Step+ signal, which the internal position register (displayed in the SSt-QuickSet™ Status window) will decrement.

With the Direction line at a logic low level, the motor will rotate counter-clockwise for each pulse of the Step+ signal, and the internal position register will increment for each pulse of the Step line.

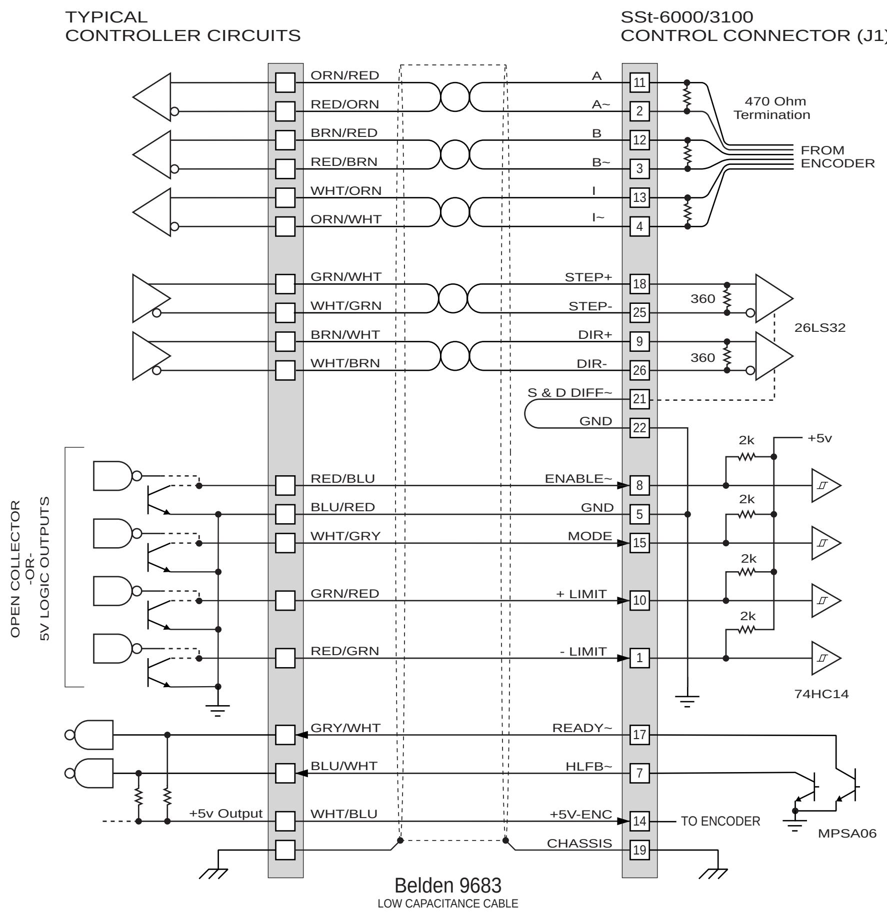
You can reverse the natural direction of an SSt servo drive by clicking the Reverse checkbox in SSt-QuickSet's Inputs and Limits window.



Direction signal and motor rotation (view is looking into the motor shaft)

USING DIFFERENTIAL STEP & DIRECTION SIGNALS

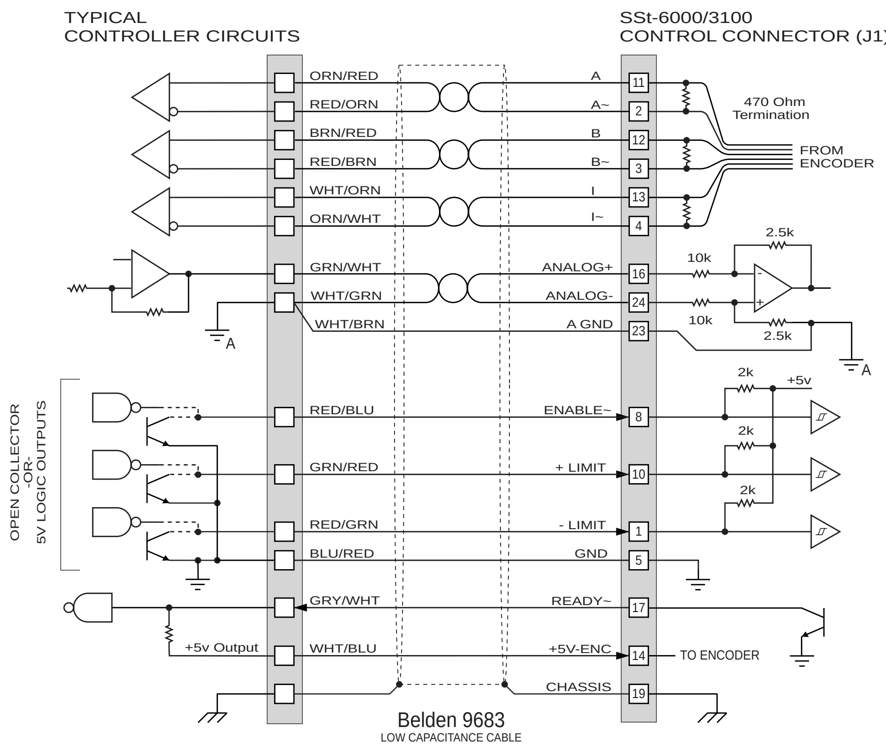
Some controllers put out line driven differential step and direction signals in order to reduce noise often present in long cable runs. To set the SSt drive to accept differential step and direction signals, you must ground pin 21 on Control Connector J1 to one of the digital ground pins (5, 6, or 22). **Important: Do not ground pin 21 to analog ground (pin 23) on connector J1. See appendix F for connector pinouts.**



Using Differential Step and Direction Signaling (-U versions only)

ANALOG COMMAND INTERFACE

The SSt-6000/3100 drives can be used with a traditional servo controller as a high performance vector torque control drive with a standard ±10V input (–T or –U models). In this mode, the HLFB and the Mode pins are inactive and do not need to be connected. A typical analog interface to a controller is shown in Fig. 14:



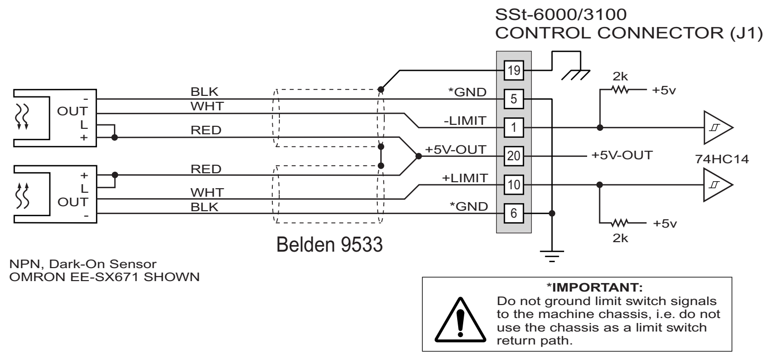
Typical Analog Command Interface.

LIMIT SWITCH WIRING

Limit switch inputs are available on Controller Connector P1. See Appendix F for pinouts. Normally closed switches are wired between the limit inputs and GND. Alternately, the limit switch inputs can be driven low by an open collector output or TTL level output limit switch. The limit signals can be wired directly to the SSt drive from the switches or they can be routed through the controller cable from the controller's interface board.

If you don't plan to wire limit switches to the SSt-6000/3100 drive, the limit pins (1 and 10) on connector P1 must be jumpered to GND pins (5 and 6). Failure to jumper the limit pins to GND (if you are not running the actual limits to the drive) will render the drive inoperable, as the drive will "think" that the axis is in both limits.

The most popular limit switches are optical interrupt switches such as the Omron SX series shown in Fig. 15.



Optical limit switches wired directly to the SSt-6000/3100 drives (Omron SX series shown)

LIMIT SWITCH MODES

The limit switch inputs can operate in one of two modes: torque/force mode or position mode. In torque/force mode, any torque or force that would push the axis further into the limit is inhibited. This is the traditional servo amplifier limit switch mode, however it is passive in terms of stopping the axis' momentum. Position mode limits are available on SSt-6000/3100-U drives. Position mode limits will actively servo to the measured position on the asserting edge of the limit switch signal. When used with optical limit sensors, position mode limits are very accurate and can be used for homing the axis in most situations, eliminating the need for separate home sensors and encoder index calibrations.

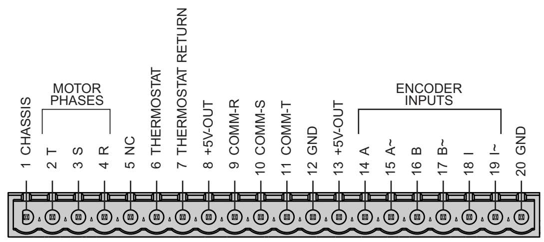
HARDSTOP HOMING (NO LIMIT SWITCHES REQUIRED!)

HardStop Homing is an advanced control mode available on SSt-6000/3100-U positioning drives that can eliminate the need for limit switches in many applications. In this mode, the SSt-6000/3100 detects the increase in torque that occurs when axis motion is inhibited by a hard stop. The torque is then relaxed to a pre-configured value and all steps into the hard stop beyond that point are discarded, and the axis is gently held against the hard stop. The first step away of the hard stop resets the SSt servo drive's position register (and moves away from the hard stop).

Teknic originally engineered HardStop Homing to emulate the crude method of stalling a stepper motor into a hard stop; however, use in numerous applications has proven HardStop Homing a very accurate and reliable way to home a servo axis. Obviously, the axis must be able to withstand collisions into the hard stop for HardStop Homing to be viable. Although this may sound tricky to achieve, it can usually be accomplished with simple bumpers or pneumatic shock absorbers. In fact, shock absorbers are robust under all conditions including power removal. Call your Teknic sales engineer for assistance in selecting a bumper or shock.

Although HardStop Homing has several built in anti-falsing features, in a few situations it can false trigger. To avoid this, the Mode input (Appendix F: J1, pin 15) can be used to toggle the drive's hard stop homing functionality only when the axis is actually homing. The Mode input should be wired to an output line on your controller when HardStop Homing is used.

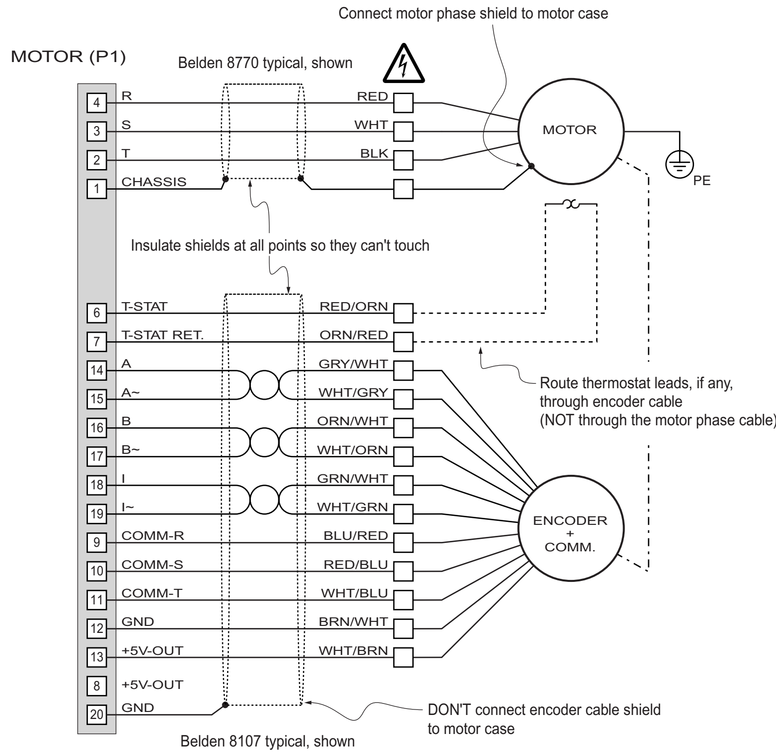
MOTOR CABLE CONSTRUCTION



Motor Connector (P2)

Motor cables for SSt-6000/3100 drives should be constructed according to the following:

1. Motor phase leads should be kept as short as possible after they exit the cable shield, preferably under 1”.
2. The motor phase cable shield termination should be kept short at both ends, preferably under 1.5”.
3. Use 18AWG or larger shielded cable for the motor phases.
4. Use low capacitance, shielded twisted pair cable for the encoder and commutation sensor signals.
5. Run the thermostat leads, if any, in the encoder cable and NOT in the motor phase lead cable.
6. Commutation sensor signals (hall sensors) should be run in the encoder cable and NOT in the motor phase lead cable.
7. The motor phase cable shield should not touch the encoder cable shield at any point to eliminate RF return currents from adding common mode noise to GND. Cover exposed shield and drain wires with heat shrink tubing at termination points to prevent this.
8. Connect the motor phase cable shield to the motor case.
9. DON’T connect the encoder cable shield to the motor case.



Motor Cable Construction Details for Low Electrical Noise

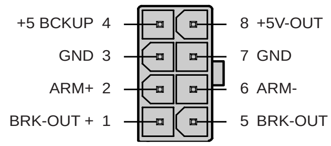
MACHINE SAFETY WIRING

WARNING!

SSt-6000 and SSt-3100 servo drives are used to control electrical and mechanical components in your machine that can be dangerous to human operators. Although the SSt servo drives provide a number of features to make safeguards easy to implement and safety requirements easy to comply with, safety testing and compliance is ultimately the responsibility of the machine builder. You should test your machine for safety under all possible conditions. Failure to do so can result in damage to equipment and/or serious injury to personnel.

THE SAFETY CONNECTOR

The SSt-6000/3100 drives are equipped with a dedicated safety connector that allows you to easily wire several safety functions on your machine. This connector includes an ARM input, a Brake output and an input for backup power. See figure on following page.



Safety Connector (P6)

The ARM input is a fully isolated input similar to a solid state relay input that operates from 3.5-24.0 VDC. When no current is flowing through the ARM input, hardware circuits inhibit the motor output stage from becoming active. *Note: Although this function is implemented in circuitry, it is not a single fault tolerant design.*

The BRK-OUT output is a fully isolated output similar to a DC solid state relay output that can directly drive resistive or inductive loads up to 500mA. It has an active 47V clamp so no catch diode is required across the driven coil. This BRK-OUT is intended to run a 24VDC power-off axis brake or motor phase interrupt/dynamic brake. It is active only when ALL of the following conditions are true:

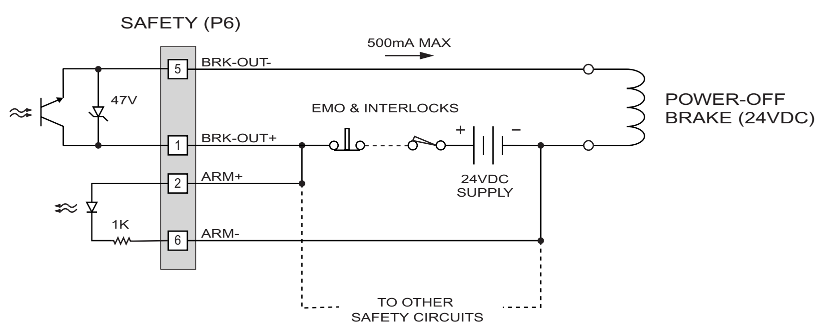
(1) The drive is enabled by the controller

(2) The ARM circuit is activated (has current flowing through it)

(3) The drive is not in a safety shutdown state

(4) Motor bus power is available

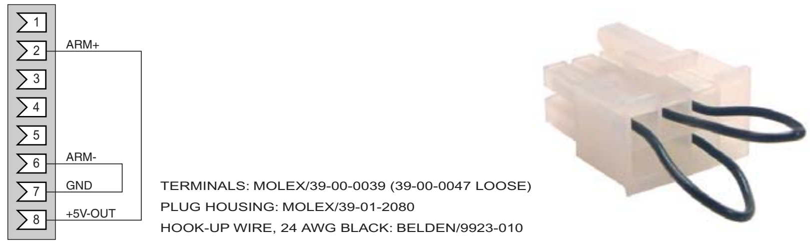
If the axis under control requires a brake, the BRK-OUT output can be used to engage a brake whenever the SSt servo drive is not in control of the motor. *Note: This BRK-OUT output function is implemented in a combination of firmware and hardware circuitry and is not a single fault tolerant design. The safety circuit should be wired so all of the safety interlocks, the EMO switch and the BRK-OUT output must be closed for the axis brake to be disengaged. See figure below*



Safety circuits using the Safety Connector (P6)

The circuits shown in Fig. 19 do not depend on the SSt-6000 safety circuit operation for the interlocks or EMO switch to operate the brake. They do, however, add automatic brake operation under all contingencies of drive power removal (fuse or breaker overload), drive safety shutdown events and errant software disabling from the control code.

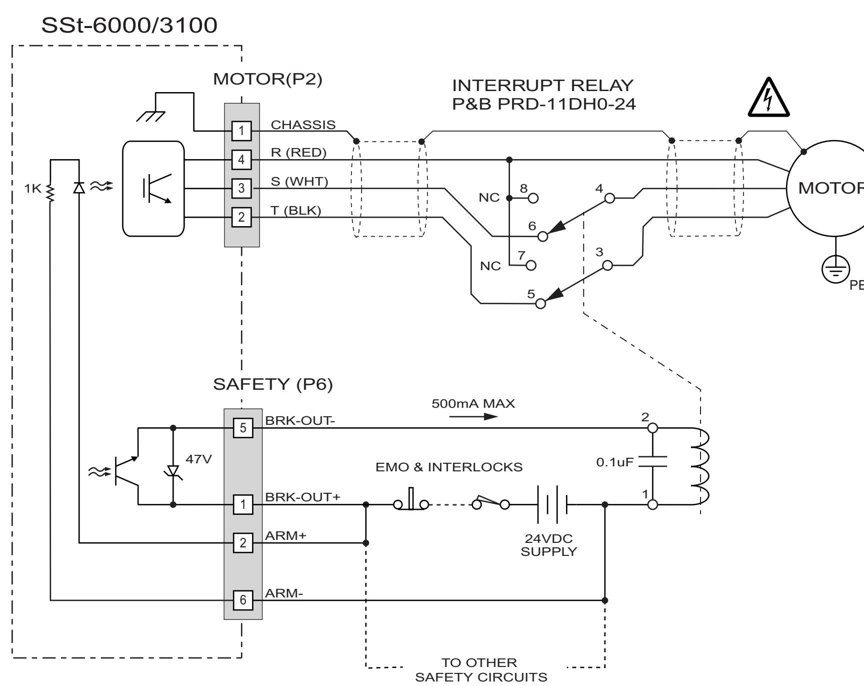
The +5Vout and GND pins are also available on this connector so the ARM input can be easily circumvented or “cheated” during engineering evaluation or when the safety of the axis is otherwise assured. (Fig. 20)



"Cheater plug" to ARM an SSt servo drive without an external supply (Teknic PN: SSt-6SJ)

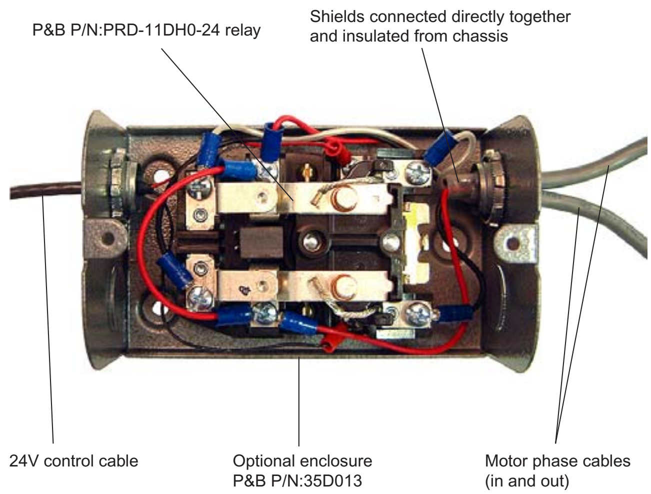
MOTOR PHASE INTERRUPT/DYNAMIC BRAKE

One alternative to a power-off axis brake is a motor phase interrupt / dynamic brake (see circuit diagram and construction details below). This method of braking is generally applicable when the load will not move due to gravitational forces. When a safety interrupt event occurs in this circuit, an electromagnetic relay disconnects the motor phases from the drive, while simultaneously shorting the phases together and disabling the drive's output stage. When the motor phases are shorted together, the motor becomes a dynamic (viscous) electromagnetic brake, halting axis motion much more quickly than frictional forces alone would. In fact, dynamic braking will oftentimes stop axis motion as quickly as a frictional power-off brake, depending on the application.



Motor Phase Interrupt/Dynamic Brake Circuit

To use this interrupt circuit, the relay is placed in line with the motor phase wiring and controlled identically as a power-off brake (see circuit above). In order to maintain low electromagnetic interference, the motor phase leads outside of the cable shield should be kept as short as possible, preferably 3" or less. The shield should be routed from the drive and motor side of the cable with no more than 1” of lead. This shield connection should not be allowed to touch the chassis to minimize RF ground loops. If the relay is mounted in an enclosure, as shown below, the enclosure should be grounded directly to the machine frame or chassis. A 0.1uF capacitor should be installed across the relay coil to keep noise out of the 24V safety circuits.



Construction Details:
Motor Phase Interrupt/Dynamic Brake Circuit

A Potter&Brumfield PRD-11DH0-24 relay has been tested in this application under worst case, full torque motor loading both while motoring and while in a locked shaft condition. The relay does not have to break the drive current under normal operation because the safety circuit disables the drive output before the contacts actuate. Having said that, the P&B relay was tested in this application even with the drive enabled, simulating a fault in the drive’s safety circuit. This P&B relay has oversized silver plated contacts, a large contact gap and a magnetic blowout feature for interrupting DC. It has survived more than 20,000 interrupt cycles under worst case conditions in testing, so no other relay should be used for this function unless it is tested under these worst case conditions.

BACKUP POWER

In situations where drive power is removed from the SSt-6000/3100 for safety requirements, you may want to maintain encoder feedback to your controller and/or serial communication with the drive. Two provisions have been designed into the SSt-6000 and SSt-3100 to accommodate backup power for these situations.

ENCODER POWER BACKUP

If you want to maintain power to the encoder when main power is removed, you can supply 5V power between GND and +5V-ENC (pins 5 and 14 on the controller connector, J1). If main power is removed from the drive while 5V is supplied to the +5V-ENC pin, the encoder will remain “alive” and all motion will be reported back to your controller even though the DSP within the drive, and hence any serial communications, will be turned off.

The requirements for the +5V-ENC backup power are 4.50-5.70V at 250mA.

LOGIC POWER BACKUP

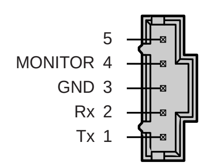
If you want to keep DSP operation and communications to the drive operational when main drive power is removed, you can supply 5V power between GND and +5V-BCKUP (pins 4 and 3 on Safety Connector P6). If main power is removed from the drive when this 5V is supplied to +5V-BCKUP, the drive's DSP, communications and encoder will remain active.

The requirements for the +5V-BCKUP power are 5.30-5.70V at 600mA.

Note: You should adjust the output voltage of the 5-volt backup supply so the voltage *at the Safety connector* (when it is plugged in) is above 5.30V. Even if your circuit works without this adjustment during initial engineering evaluation, you'll still have to check and adjust the supply voltage as indicated to avoid intermittent problems caused by variations and component tolerances.

DIAGNOSTIC CONNECTOR FUNCTIONS

Each SSt-6000/3100 drive is equipped with a diagnostic connector (P5) that provides two important functions supported by SSt-Quickset: Drive configuration via the RS-232 Configuration Port, and performance testing and diagnostics via the Real-Time Monitor Port.



Diagnostic connector (P5) view looking into SSt

REAL-TIME MONITOR PORT

The SSt servo drive includes a Real-Time Monitor Port (analog monitor output) for viewing system variables on an oscilloscope or for use with a data logger. This Real-Time port, typically viewed with a standard digital oscilloscope, provides a wealth of analytical information on the SSt servo drive and the mechanics to which it is connected.

A great benefit of the port's real-time nature is that you can use your oscilloscope to look at SSt servo variables while viewing other non-servo signals in your machine to verify controller timing and to find software bugs and delays.

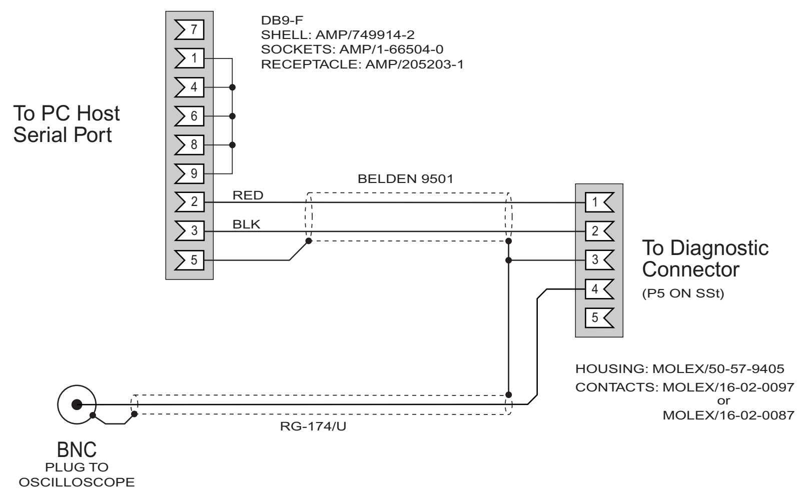
Actual velocity, commanded velocity, velocity error, tracking error, commanded torque, actual motor torque, and other variables can be displayed with ease. The Monitor output is configured using SSt-QuickSet™ as described in the SSt-QuickSet™ On-Line Help.

The monitor output is a 0.5-4.5 volt signal centered around a 2.5 volt "zero" reference. A 2.5 volt DC reference signal is also provided at the diagnostic connector (pin 5) for use with instruments that have differential inputs.

RS-232 CONFIGURATION PORT

An RS-232 interface is provided for configuring SSt servo drives using SSt-QuickSet™ software running on your PC. There is no need to install this interface permanently.

RS-232 handshaking signals are not provided or used by the SSt-1500. The Rx and Tx signals are fully RS-232 compatible. The communication format is 8 bit, asynchronous, half-duplex with a single start bit, a single stop bit and no parity at 57.6kBaud. It is recommended that the DCE CD, RI, DSR, and CTS input signals be connected to the DCE DTR signal to prevent noise from affecting the operation of the host computer (as shown below).

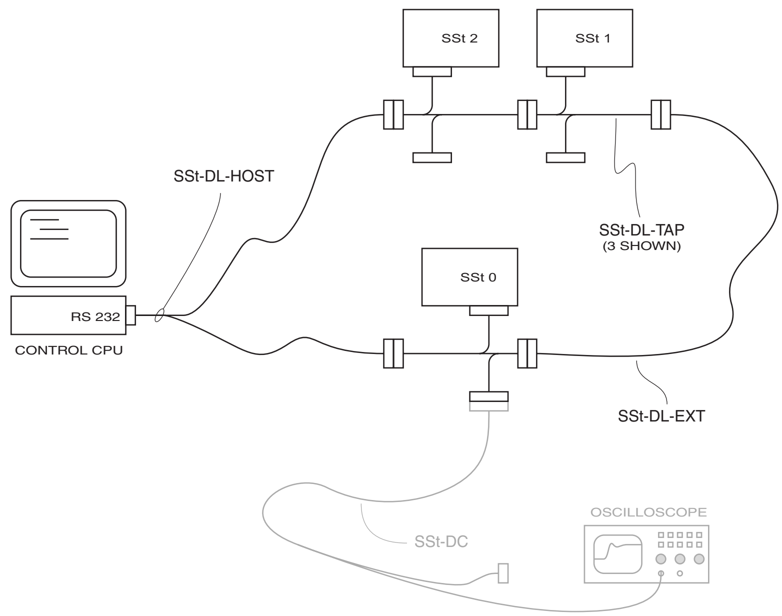


Diagnostic/Configuration Cable (SSt-DC)

HOOKING MULTIPLE DRIVES TO ONE SERIAL PORT

In some instances, you may want to hook multiple drives to a serial port on your host computer or controller for configuration management, error reporting or to eliminate the need for encoder wiring. This is done by daisy chaining the RS-232 serial port, available on the diagnostic connector, from one drive to another in a machine to form a SSt Data Loop.

Three cable types can easily be constructed to support the SSt Data Loop: a host cable (SSt-DL-HOST), a drive tap cable (SSt-DL-TAP), and an extension cable (SSt-DL-EXT). These cables can be snapped together in a modular fashion as shown below to form a SSt Data Loop of up to 30 drives.



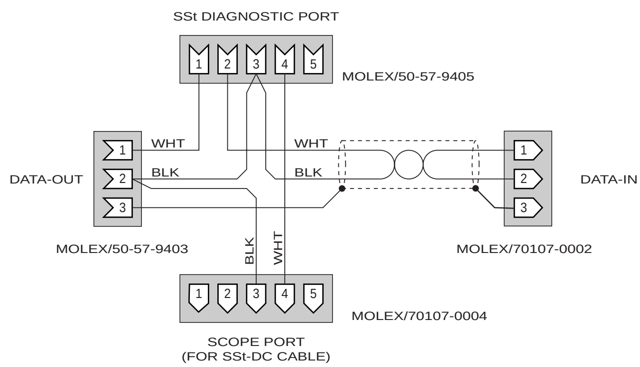
Typical SSt Data Loop (Allows one RS-232 port to communicate with multiple SSt servo drives)

SSt-Quickset 5.0 and later versions will talk to a group of up to 30 SSt servo drives (any mix of SSt-6000, SSt-3100, SSt-1500-Uxx or SSt-1000 models) for configuration and diagnostic purposes. Note: SSt-1500-Axx servo drives will not function in a SSt Data Loop.

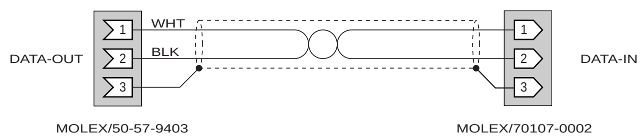
The standard SSt Data Loop cables shown below have several features:

1. Extension cables can be strung together to provide nearly any physical length link between drives.
2. Shielded, low capacitance cable provides excellent electrical performance while maintaining low RF immunity and emissions.
3. Low cost, positive locking, gas tight crimp connectors are reliable and easily terminated by automated crimp machinery.
4. The tap cable allows a diagnostic oscilloscope to be connected to any drive without disturbing the communication loop.

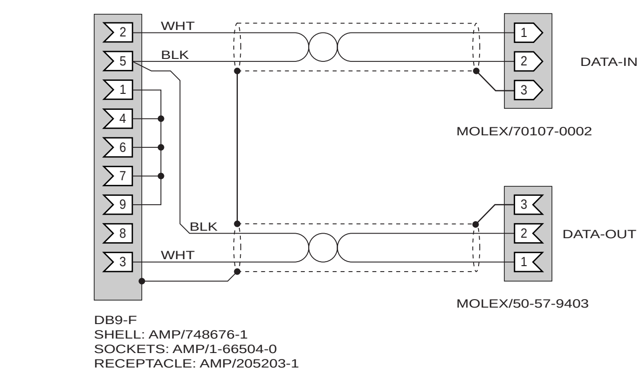
Drive Tap Cable (SSt-DL-TAP)



Extension Cable (SSt-DL-EXT)



Host Port Cable (SSt-DL-HOST)



COMMON COMPONENTS-

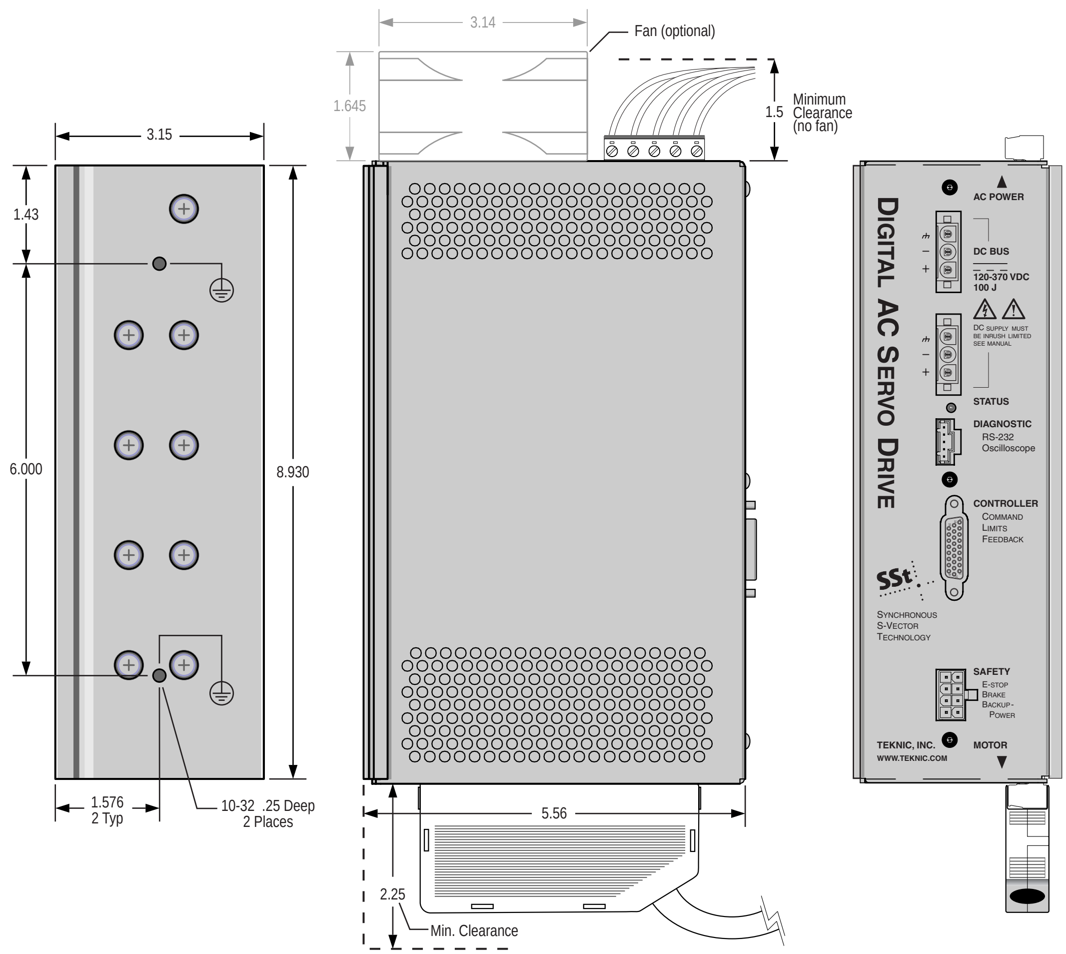
PINS FOR ALL MOLEX CONNECTORS: MOLEX/16-02-0077 (16-02-0109 LOOSE)
SOCKETS FOR ALL MOLEX CONNECTORS: MOLEX/16-02-0082 (16-02-0097 LOOSE)
BLACK HOOK-UP WIRE: BELDEN/83002-010
WHITE HOOK-UP WIRE: BELDEN/83002-009
SHIELDED TWISTED PAIR CABLE: BELDEN/9180

Construction Details: SSt Data Loop Cable Set
(See Appendix B for more details)

MECHANICAL INSTALLATION

DRIVE MOUNTING

The SSt-6000/3100 servo drives should be mounted on a metal panel or frame, with the AC power connector facing up as shown below. In this configuration, natural convection cooling will be maximized and the drive will deliver its rated current. The SSt-6000/3100 servo drives will operate in alternate mounting configurations, however the continuous current output of the drive will be de-rated and/or forced air cooling may be required to achieve the desired output current.



SSt-6000/3100 Mounting

Either of the two #10-32 mounting holes in the rear of the extrusion may be used as the Protective Earth Terminal (safety ground). At least one of these tapped holes should be securely fastened to a metal panel or the machine frame that is, in turn, connected to your machine's safety ground.

CURRENT RATINGS FOR VARIOUS MOUNTING CONFIGURATIONS

The continuous RMS current available from the SSt-6000/3100 is related to the internal operating temperature of the unit. The SSt-6000/3100 drives are internally protected and will shut down when the internal heat sink temperature at the power stage exceeds 70°C. The exact continuous current available from an SSt-6000/3100 drive is dependent upon the mounting configuration, the ambient temperature, the amount of heat sinking to the panel and the air flow currents in the vicinity of the drive.

The diagram below shows the continuous current available for three tested mounting configurations.

9.0A continuous
Vertical mount
on a metal panel,
40 degree C ambient

4.5A continuous
Lying on an insulated benchtop
40 degree C ambient

12.0A continuous
With recommended fan
Vertical mount
40 degree C ambient

(see text below for SSt-3100 current ratings)

Rated current for various SSt-6000 mounting configurations

As the above illustration indicates, it is best to mount the SSt-6000/3100 drive in a vertical orientation, on a metal panel in an open area. If the drive must be mounted in a horizontal position or in a constricted area, space should be budgeted for the optional fan. Then, if testing indicates the need for additional cooling (i.e. if thermal shutdowns occur), adding the optional fan will be a relatively simple matter.

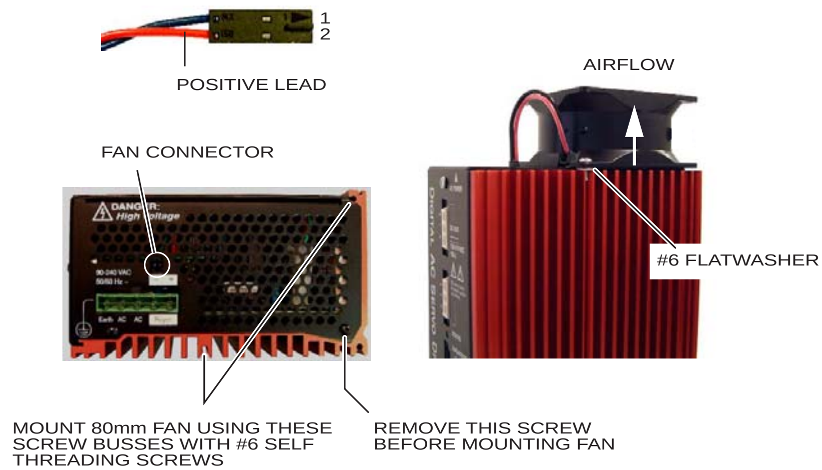
The SSt-3100 is rated at 6.0 amps continuous when mounted in a vertical orientation and at 4.5 amps continuous when mounted in a horizontal orientation. Since the continuous current is 6.0 amps, the addition of a fan does not provide the same benefit as it does on a 6000 except in a constricted area or if you desire to increase RMS from 4.5A to 6.0A in a horizontal orientation.

OPTIONAL FAN MOUNTING & WIRING

An optional fan can be mounted on the SSt-6000/3100 drive if forced-air cooling is required. These drives are equipped with a dedicated fan connector that can accommodate an 80mm², 12VDC brushless fan, drawing a maximum of 0.25 amps. Teknic recommends the Comair-Rotron Sprite DC (P/N SD12B1) pictured below.

FAN PREPARATION AND MOUNTING

1) Terminate both fan leads with Molex P/N 16-02-0097 terminals.
2) Insert the terminated fan leads into the connector housing (Molex P/N 50-57-9402). Insert the negative (black) wire into position #1; insert the positive (red) wire into position #2.
3) Remove the case cover screw nearest the corner of the extrusion and discard. This allows the fan to sit flush on the drive case. See diagram.
4) Secure the fan to the external screw busses using two #6-32 x 3/8” self-tapping screws and a #6 flatwasher. Orient the fan on the drive so that the air is drawn out of the drive.
5) Plug the fan into the drive’s onboard fan connector.

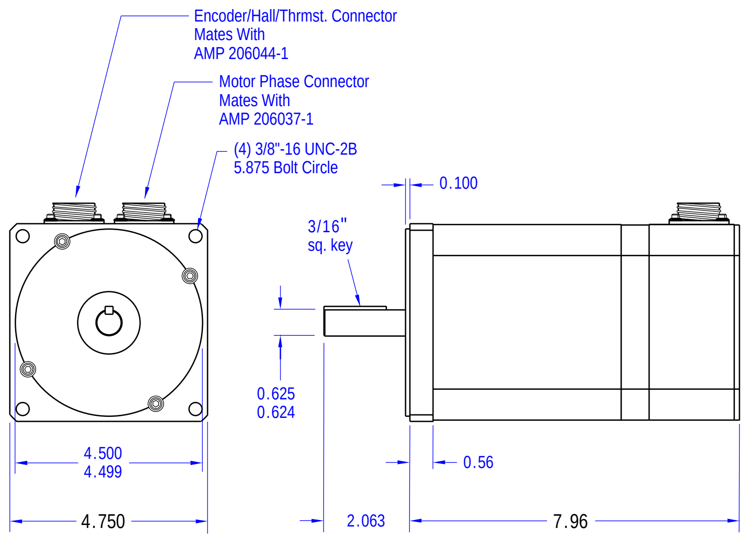


An 80mm Fan mounted directly to an SSt-6000/3100 case

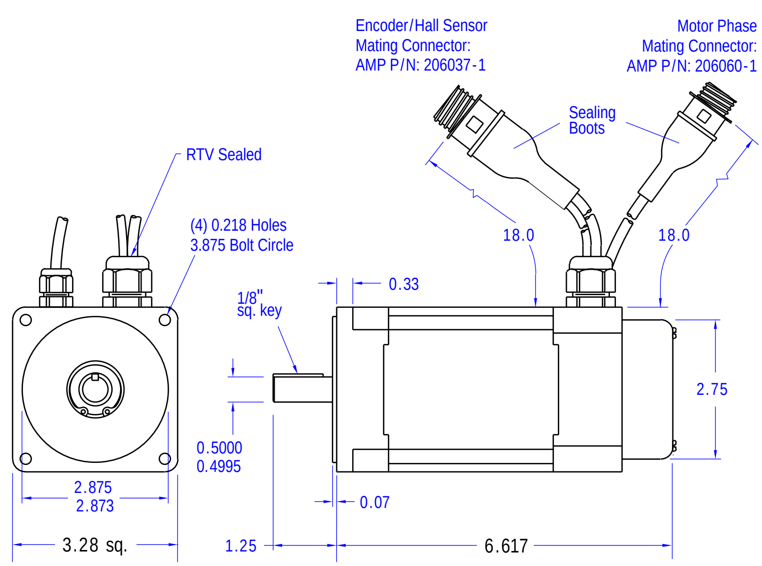
If the drive is mounted so that the fan is user accessible, it may be wise to install a fan guard. Qualtek makes a suitable fan guard (P/N 08172) that can be quickly installed on top of the fan using four #6-32 x 3/8” machine screws and nuts.

MOTOR OUTLINES

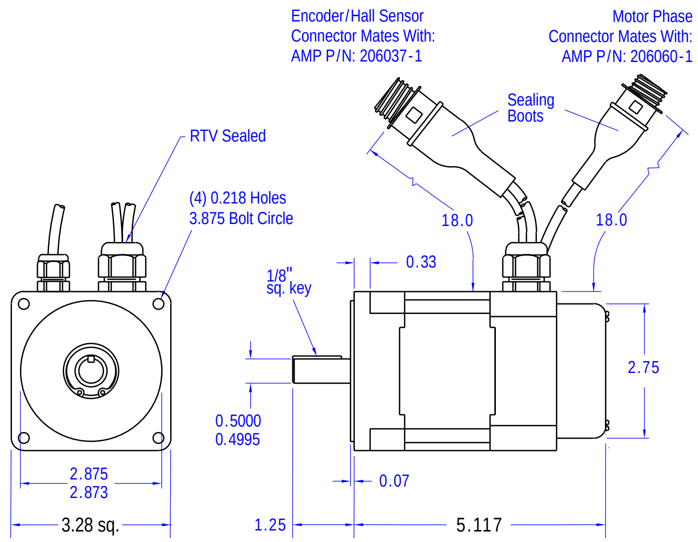
M4780



M3471, M3476



M3462, M3463


Encoder/Hall Sensor
Connector Mates With:
AMP P/N: 206037-1
Motor Phase
Connector Mates With:
AMP P/N: 206060-1
Sealing
Boots
RTV Sealed
(4) 0.218 Holes
3.875 Bolt Circle
18.0
18.0
0.33
1/8"
sq. key
2.75
0.5000
0.4995
0.07
2.875
2.873
3.28 sq.
1.25
5.117

APPENDIX A: LINKS TO 3RD PARTY COMPONENT DATASHEETS

COMPONENT	MANUFACTURER	PART NUMBER	LINK
Circuit Breaker	Airpax	209-2-1-66-4-2-20 (solderless connectors) 209-2-1-66-4-5-20 (10-32 screw terminals)	www.airpaxppp.com
Contactor	Sprecher+Schuh	CA7-23C-M22-24D	www.ssusa.cc
Line Filter	Schaffner	350-12-29 (12 Amp) 350-20-29 (20 Amp)	www.schaffner.com
Regeneration Resistor	Ohmite	L100J25R (inductive)	www.ohmite.com
Regeneration Resistor	Dale-Vishay	HL 100 06 Z 25R00JJ 25 5% (inductive)	www.ohmite.com
Regeneration Fuse	Bussmann	LPN-RK-2SP	www.bussmann.com
Regeneration Fuse Holder	Bussmann	R25030-1SR	www.bussmann.com
Motor Phase Interrupt Relay	Potter & Brumfield	PRD-11DH0-24	relays.tycoelectronics.com
Motor Phase Interrupt Relay Enclosure	Potter & Brumfield	35D013	relays.tycoelectronics.com
Cable Stock	Belden Wire and Cable	8107 (14 cond/24AWG) 8770 (3 cond/18AWG) 9314 (2 cond/14AWG) 9533 (3 cond/24AWG) 9683 (18 cond/24AWG) 9929 (5 cond/24AWG)	www.belden.com
Brushless Fan	NMB	3112KL-04W-B40-E00	http://www.nmbtech.com
Fan Guard	Qualtek	08172	www.qualtekusa.com
Photomicrosensor	Omron	EE-SX671	www.omron.com

A compilation of part specific data sheets for all 3rd party components described in this manual (in PDF format) is available online at http://www.teknic.com/, or by contacting your Teknic sales engineer.

APPENDIX B: STANDARD CABLE DRAWINGS

In this Appendix you'll find the drawings for all of the accessory cables for the SSt-6000/3100 servo drives. Although all of these cables can be purchased from Teknic, many OEMs, once in production, prefer to fabricate their own to accommodate custom lengths.

The following drawings are very complete in terms of their construction details and materials and have been proven in numerous applications. It is worth mentioning, however, that most problems customers have when first installing SSt drives are do to poorly fabricated (or mis-wired) cables. The following four guidelines will minimize cable problems and speed development when working with SSt servo drives:

CABLE CONSTRUCTION TIPS

#1 AVOID CABLES MADE WITH HAND TOOLS.

Hand crimping tools, when properly selected and used by a skilled operator, make good crimp connections. However, since these tools are expensive (typically $200 - $400 each) technicians rarely have every tool required to make proper crimps on all of the terminal types and wire sizes they encounter. Unfortunately, it's easy to use the wrong tool and not realize it, or even more likely, to use the wrong tool and think it's "probably OK". These hand tools are awkward, cumbersome to use and often require the operator to master a certain "feel". In addition, these hand tools don't have any built-in quality assurance features.

In certain instances, you may be forced to make a hand crimped cable when you're in a hurry for a custom length. If you do, be sure that you have the exact hand tool and die that the contact manufacturer recommends. Also, be sure to perform a visual inspection to ensure that the insulation is captured in the terminal's strain relief and perform a pull test on each connection before inserting it into the connector.

Under no circumstances, should you ever hand-make a cable to "save money". It's far less expensive to buy them from Teknic during engineering and pilot production and have a cable and harness manufacturer assemble cables for you in production. These machine-crimped cables will cost less than hand crimped versions and are likely to save thousands of dollars of debugging time.

#2 VERIFY THAT YOUR CABLE SHOP HAS THE PROPER GEAR.

Use a cable shop that has automated presses for wire termination and make sure they have the proper applicator "heads" (dies) for the exact terminals used. (If they don't, consider buying applicator heads for them). It's strongly preferred that they have presses with automatic "crimp height" checking as this in-process check is the main measure of termination quality. Making this 100% check without requiring human intervention is a key advantage. If they don't have these automatic crimp-height-checking presses, make sure their general procedures include checking the crimp height on first articles and periodically during a run of cables. Under no circumstances should you accept a shop using hand tools.

#3 SPECIFY 100% ELECTRICAL TESTING.

Specify that cables and harnesses be 100% electrically tested, preferably with resistance tests. The cable shop should have automated equipment by CableScan, DynaLab, CheckSum or other vendors for this purpose. The fixture cost for 100% electrical testing is low, ranging from $0-$200 per cable assembly and it's definitely worth it.

#4 DOUBLE CHECK THAT THE TERMINALS ARE PROPERLY SPECIFIED

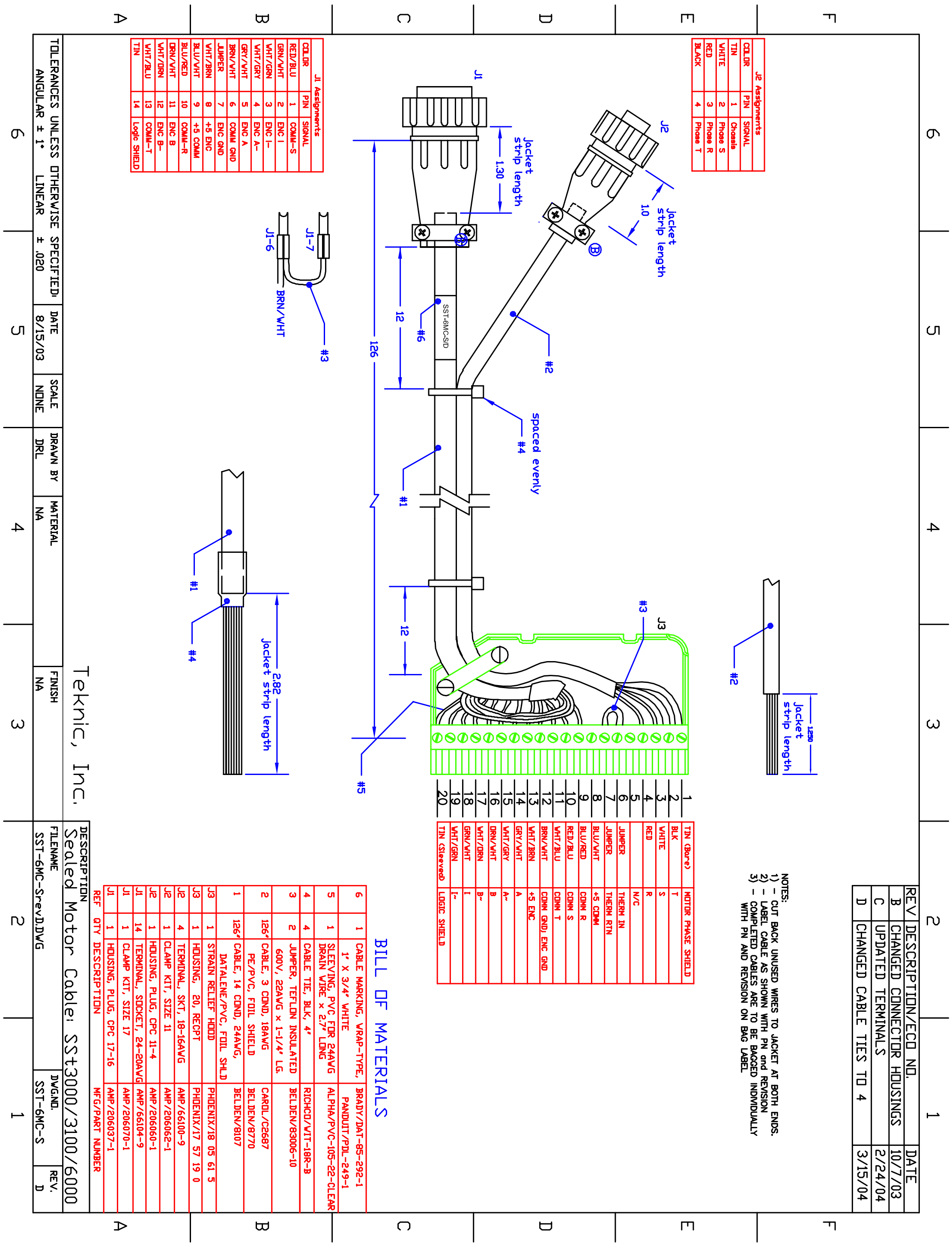
Check all your terminal specifications carefully. Research all of your drawings and make certain that the terminals specified can accept the gauge of wire used. Also, look carefully at the insulation diameter range supported by each terminal. If the insulation diameter range on the terminal is incorrect for the wire used, the individual wire strain relief will be compromised and this can lead to premature failure. Make certain that the plating between mating terminals is the same, using gold is great, but if you are mating with tin, use tin terminals to avoid any galvanic corrosion effects.

#5 PREPARE COMPLETE, PICTORAL DRAWINGS.

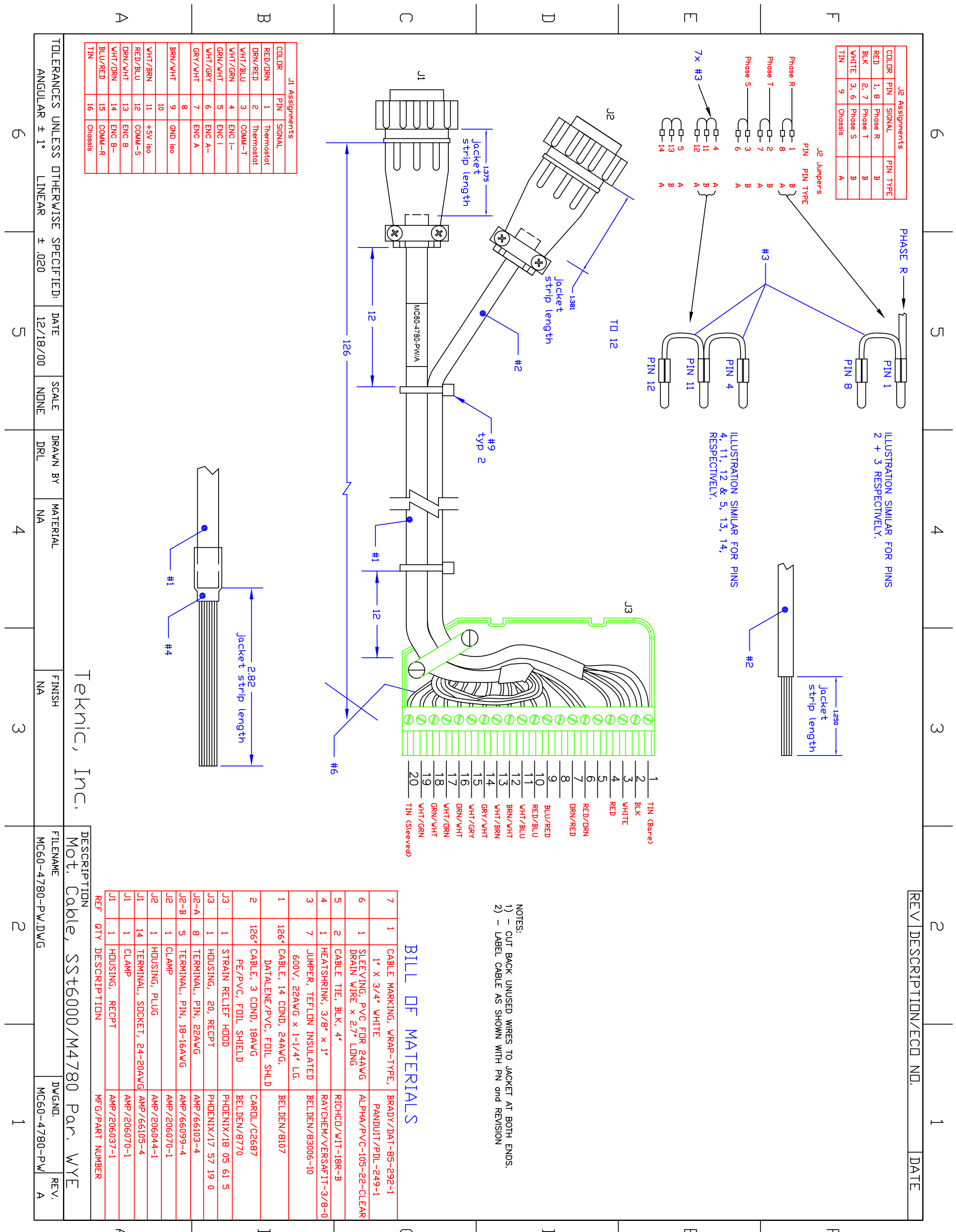
You'll notice that the drawings that follow are very pictorial in nature and call out many fabrication details for making a quality cable. If you have to create drawings for other cables it helps to make similar drawings.

To create drawings that are "pictorial" in nature include fabrication details such as jacket strip lengths, shield termination details, cable tie locations, marking details, etc. The more call-outs, detail views, explosions the better. Visual communication is key. Otherwise you will be getting whatever the shop considers "standard practice" which is likely to vary from day to day. Including the BOM right on the drawing is also very helpful in avoiding errors. (Making the drawings scale in cable length, generally helps reduce the drawing effort over time.)

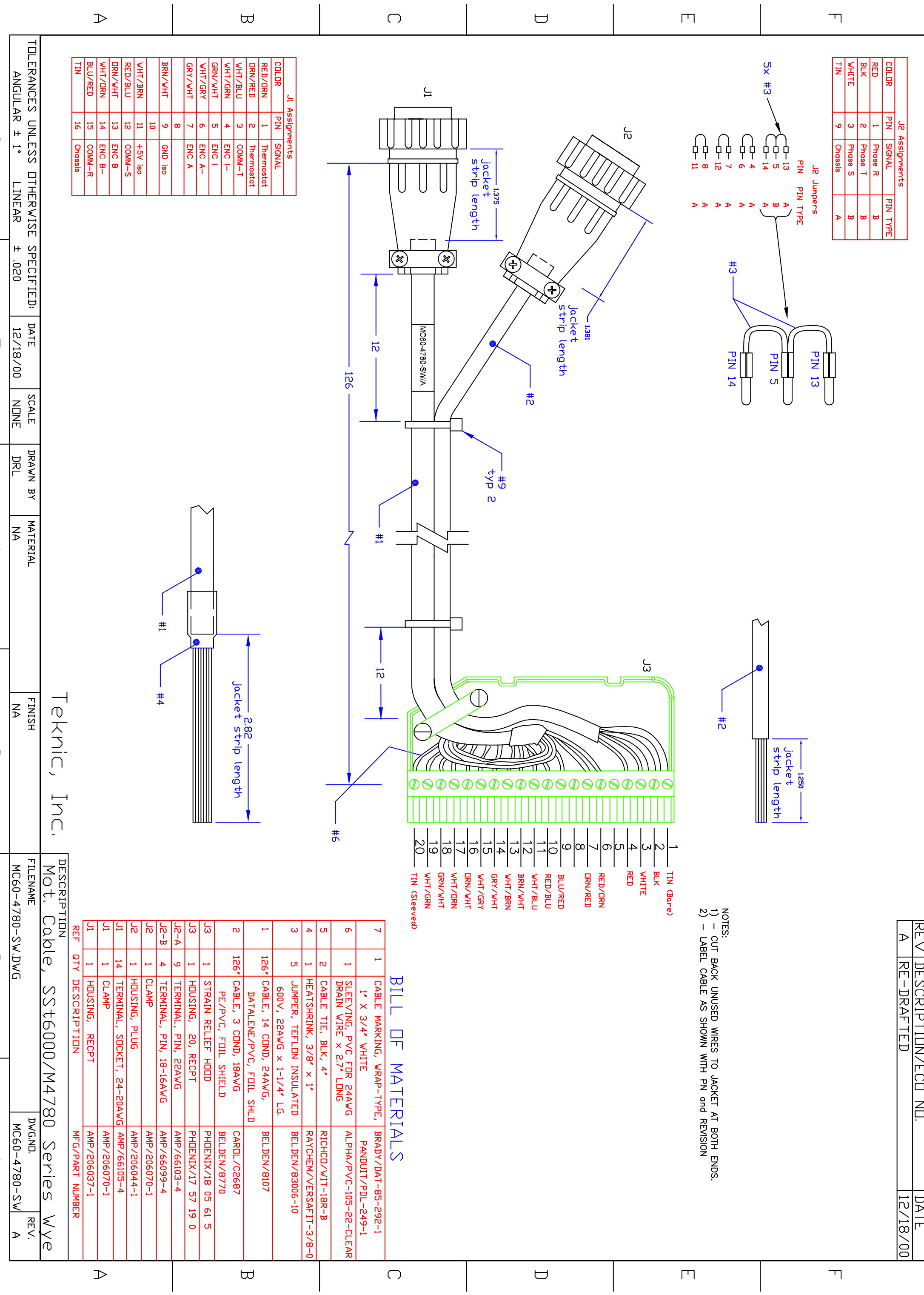
MOTOR CABLE FOR M3463, M3462, M3471 AND M3476 MOTORS



M4780 MOTOR CABLE (POWER VERSION)



M4780 MOTOR CABLE (TORQUE VERSION)



J2 Assignments

COLOR	PIN	SIGNAL	PIN TYPE
RED	1	Phase R	B
BLK	2	Phase T	B
WHITE	3	Phase S	B
TIN	9	Chassis	A

J2 Jumpers

PIN	PIN TYPE
13	A
5	B
14	A
4	A
6	A
7	A
12	A
8	A
11	A

J1 Assignments

COLOR	PIN	SIGNAL
RED/ORN	1	Thermostat
ORN/RED	2	Thermostat
WHT/BLU	3	COMM-T
WHT/GRN	4	ENC I-
GRN/WHT	5	ENC I
WHT/GRY	6	ENC A-
GRY/WHT	7	ENC A
	8	
BRN/WHT	9	GND iso
	10	
WHT/BRN	11	+5V iso
RED/BLU	12	COMM-S
ORN/WHT	13	ENC B
WHT/ORN	14	ENC B-
BLU/RED	15	COMM-R
TIN	16	Chassis

BILL OF MATERIALS

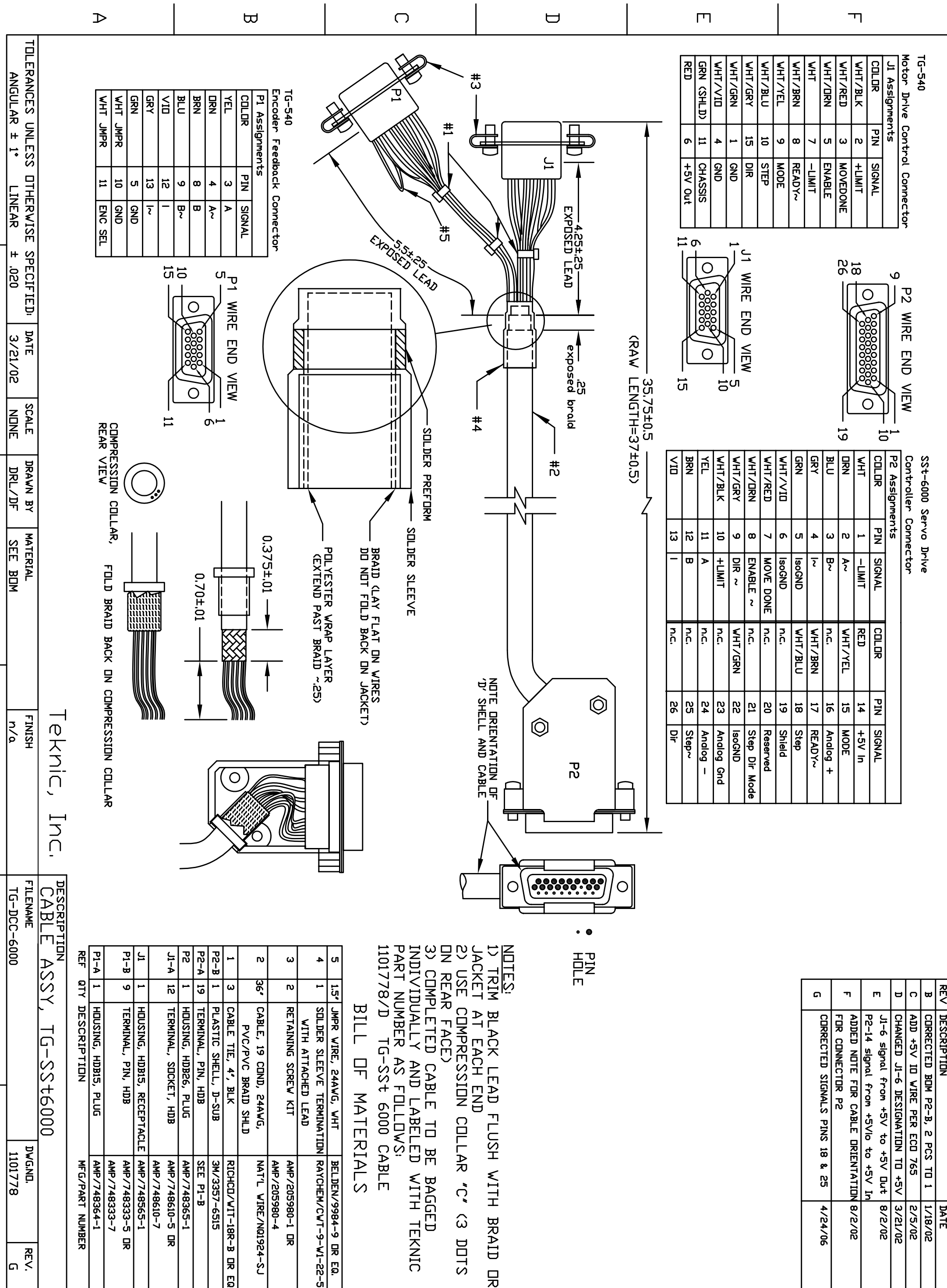
REF	QTY	DESCRIPTION	MFG/PART NUMBER
7	1	CABLE MARKING, WRAP-TYPE, 1" X 3/4" WHITE	BRADY/DAT-85-292-1 PANDUIT/PDL-249-1
6	1	SLEEVING, PVC FOR 24AWG DRAIN WIRE x 2.7" LONG	ALPHA/PVC-105-22-CLEAR
5	2	CABLE TIE, BLK, 4"	RICHCO/WIT-18R-B
4	1	HEATSHRINK, 3/8" x 1"	RAYCHEM/VERSAFIT-3/8-0
3	5	JUMPER, TEFLON INSULATED 600V, 22AWG x 1-1/4" LG.	BELDEN/83006-10
1	126"	CABLE, 14 COND, 24AWG, DATALENE/PVC, FOIL SHLD	BELDEN/8107
2	126"	CABLE, 3 COND, 18AWG PE/PVC, FOIL SHIELD	CAROL/C2687 BELDEN/8770
J3	1	STRAIN RELIEF HOOD	PHOENIX/18 05 61 5
J3	1	HOUSING, 20, RECPT	PHOENIX/17 57 19 0
J2-A	9	TERMINAL, PIN, 22AWG	AMP/66103-4
J2-B	4	TERMINAL, PIN, 18-16AWG	AMP/66099-4
J2	1	CLAMP	AMP/206070-1
J2	1	HOUSING, PLUG	AMP/206044-1
J1	14	TERMINAL, SOCKET, 24-20AWG	AMP/66105-4
J1	1	CLAMP	AMP/206070-1
J1	1	HOUSING, RECPT	AMP/206037-1

REV	DESCRIPTION/ECO NO.	DATE
A	RE-DRAFTED	12/18/00

TOLERANCES UNLESS OTHERWISE SPECIFIED:	DATE	SCALE	DRAWN BY	MATERIAL	FINISH	FILENAME	DWG.NO.	REV.
ANGULAR ± 1° LINEAR ± .020	12/18/00	NONE	DRL	NA	NA	MC60-4780-SW.DWG	MC60-4780-SW	A

DESCRIPTION: Mot. Cable, SSt6000/M4780 Series Wye

TG-DCC-6000: TG-540 TO SST-6000/3100 INTERFACE CABLE



TG-540
Motor Drive Control Connector
J1 Assignments

COLOR	PIN	SIGNAL
WHT/BLK	2	+LIMIT
WHT/RED	3	MOVEDONE
WHT/ORN	5	ENABLE
WHT	7	−LIMIT
WHT/BRN	8	READY~
WHT/YEL	9	MODE
WHT/BLU	10	STEP
WHT/GRY	15	DIR
WHT/GRN	1	GND
WHT/VIO	4	GND
GRN (SHLD)	11	CHASSIS
RED	6	+5V Out

SSt-6000 Servo Drive
Controller Connector
P2 Assignments

COLOR	PIN	SIGNAL	COLOR	PIN	SIGNAL
WHT	1	−LIMIT	RED	14	+5V In
ORN	2	A~	WHT/YEL	15	MODE
BLU	3	B~	n.c.	16	Analog +
GRY	4	I~	WHT/BRN	17	READY~
GRN	5	IsoGND	WHT/BLU	18	Step
WHT/VIO	6	IsoGND	n.c.	19	Shield
WHT/RED	7	MOVE DONE	n.c.	20	Reserved
WHT/ORN	8	ENABLE ~	n.c.	21	Step Dir Mode
WHT/GRY	9	DIR ~	WHT/GRN	22	IsoGND
WHT/BLK	10	+LIMIT	n.c.	23	Analog Gnd
YEL	11	A	n.c.	24	Analog −
BRN	12	B	n.c.	25	Step~
VIO	13	I	n.c.	26	Dir

REV	DESCRIPTION	DATE
B	CORRECTED BOM P2-B, 2 PCS TO 1	1/18/02
C	ADD +5V IO WIRE PER ECO 765	2/5/02
D	CHANGED J1-6 DESIGNATION TO +5V	3/21/02
E	J1-6 signal from +5V to +5V Out P2-14 signal from +5Vio to +5V In	8/2/02
F	ADDED NOTE FOR CABLE ORIENTATION FOR CONNECTOR P2	8/2/02
G	CORRECTED SIGNALS PINS 18 & 25	4/24/06

TG-540
Encoder Feedback Connector
P1 Assignments

COLOR	PIN	SIGNAL
YEL	3	A
ORN	4	A~
BRN	8	B
BLU	9	B~
VIO	12	I
GRY	13	I~
GRN	5	GND
WHT JMPR	10	GND
WHT JMPR	11	ENC SEL

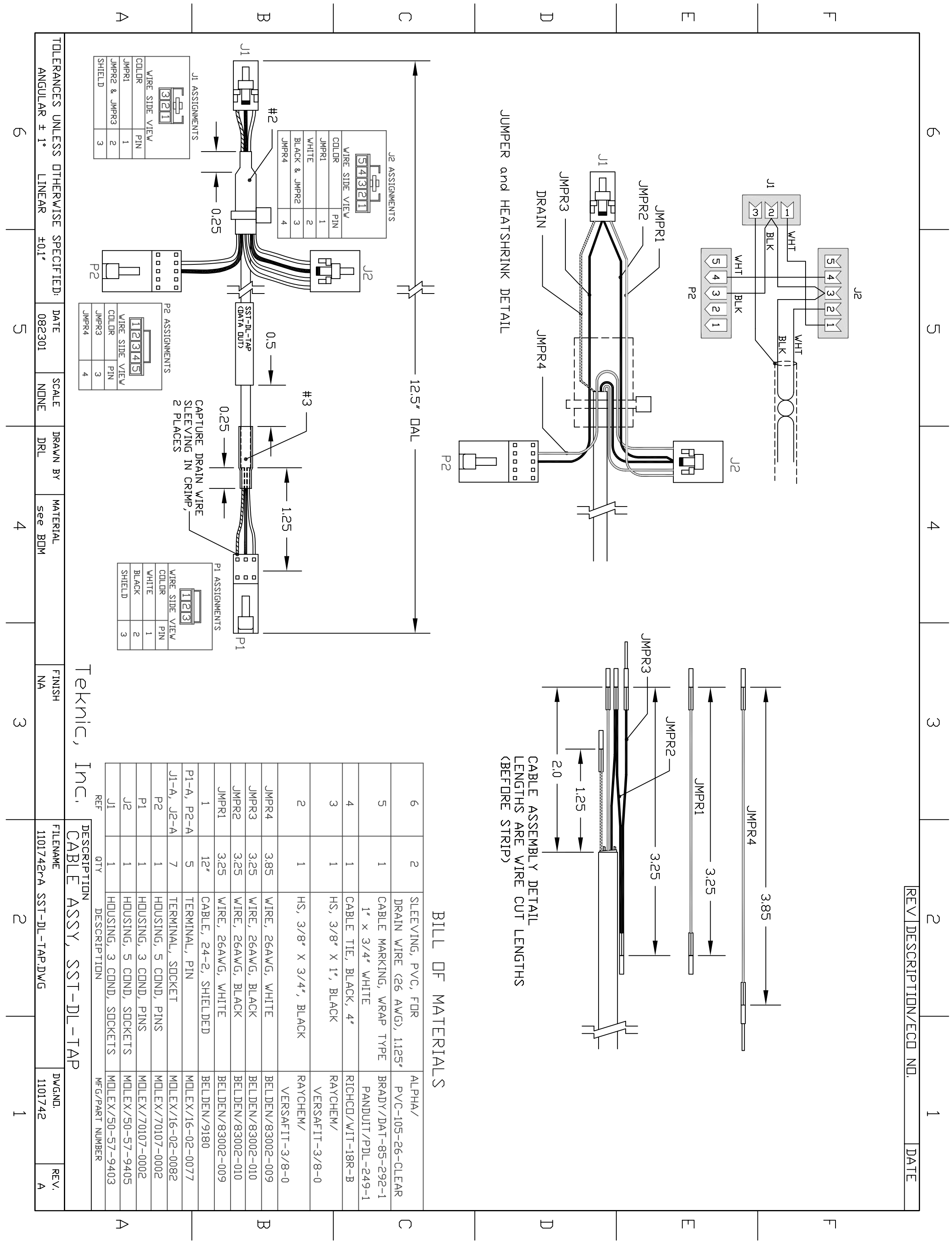
NOTES:
1) TRIM BLACK LEAD FLUSH WITH BRAID OR JACKET AT EACH END
2) USE COMPRESSION COLLAR "C" (3 DOTS ON REAR FACE)
3) COMPLETED CABLE TO BE BAGGED INDIVIDUALLY AND LABELED WITH TEKNIC PART NUMBER AS FOLLOWS:
1101778/D TG-SSt 6000 CABLE

BILL OF MATERIALS

REF	QTY	DESCRIPTION	MFG/PART NUMBER
5	1.5'	JMPR WIRE, 24AWG, WHT	BELDEN/9984-9 OR EQ.
4	1	SOLDER SLEEVE TERMINATION WITH ATTACHED LEAD	RAYCHEM/CWT-9-W1-22-5
3	2	RETAINING SCREW KIT	AMP/205980-1 OR AMP/205980-4
2	36"	CABLE, 19 COND, 24AWG, PVC/PVC BRAID SHLD	NAT'L WIRE/NQ1924-SJ
1	3	CABLE TIE, 4", BLK	RICHCO/WIT-18R-B OR EQ.
P2-B	1	PLASTIC SHELL, D-SUB	3M/3357-6515
P2-A	19	TERMINAL, PIN, HDB	SEE P1-B
P2	1	HOUSING, HDB26, PLUG	AMP/748365-1
J1-A	12	TERMINAL, SOCKET, HDB	AMP/748610-5 OR AMP/748610-7
J1	1	HOUSING, HDB15, RECEPTACLE	AMP/748565-1
P1-B	9	TERMINAL, PIN, HDB	AMP/748333-5 OR AMP/748333-7
P1-A	1	HOUSING, HDB15, PLUG	AMP/748364-1

TOLERANCES UNLESS OTHERWISE SPECIFIED:	DATE	SCALE	DRAWN BY	MATERIAL	FINISH	DESCRIPTION / FILENAME	DWG.NO.	REV.
ANGULAR ± 1° LINEAR ± .020	3/21/02	NONE	DRL/DF	SEE BOM	n/a	CABLE ASSY, TG-SSt6000 / TG-DCC-6000	1101778	G

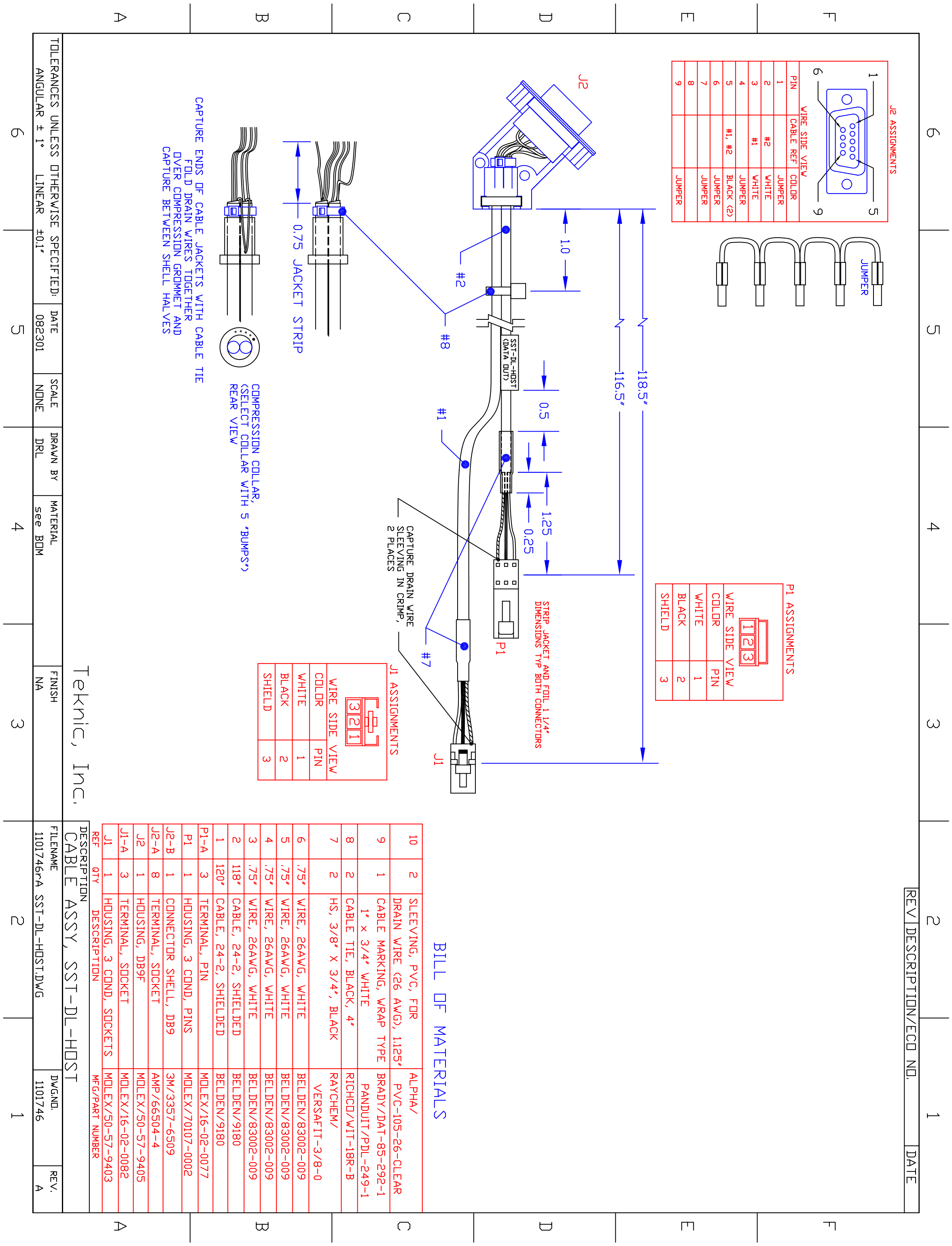
SST-DL-TAP



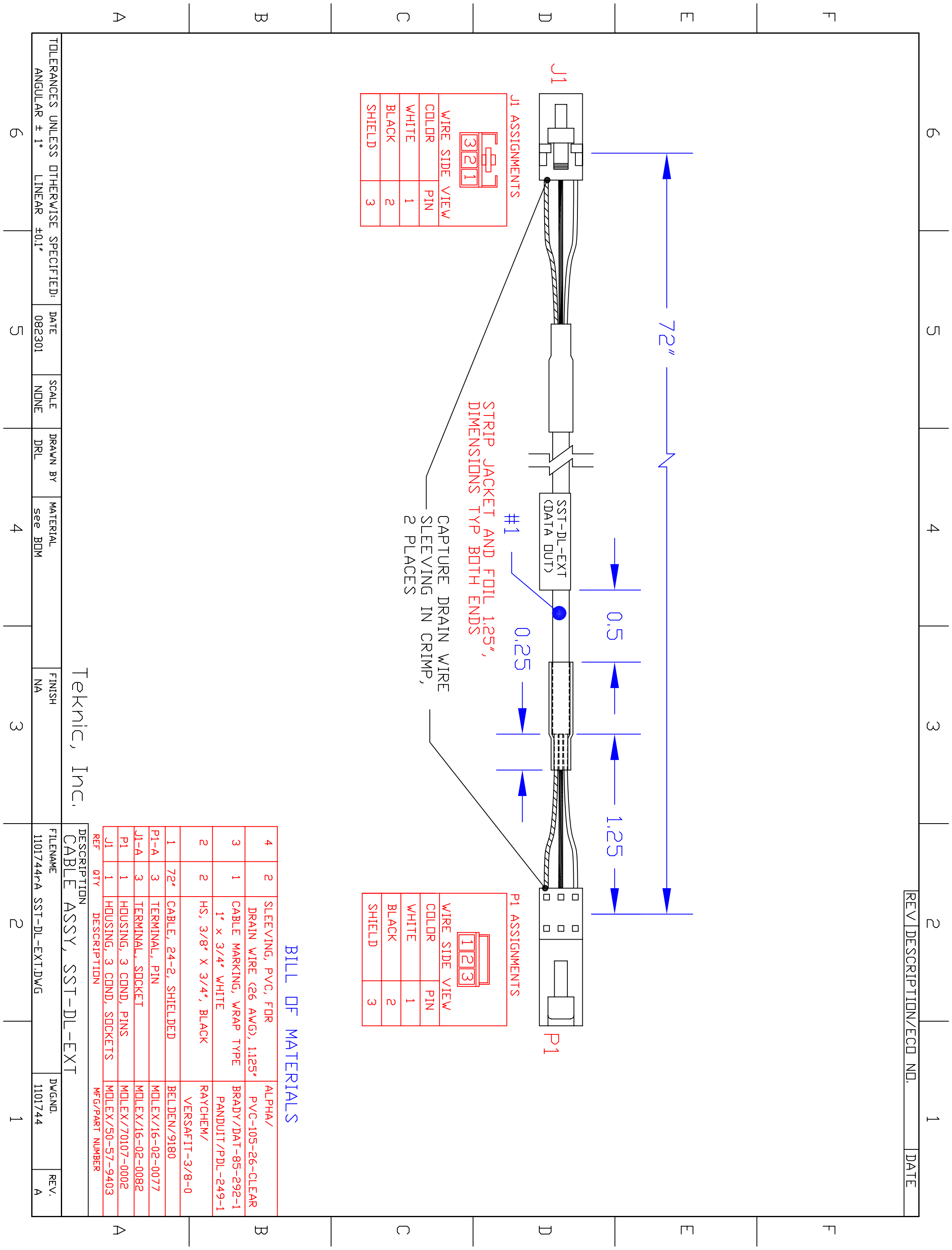
BILL OF MATERIALS

REF	QTY	DESCRIPTION	MFG/PART NUMBER
6	2	SLEEVING, PVC, FOR DRAIN WIRE (26 AWG), 1.125"	ALPHA/ PVC-105-26-CLEAR
5	1	CABLE MARKING, WRAP TYPE 1" x 3/4" WHITE	BRADY/DAT-85-292-1 PANDUIT/PDL-249-1
4	1	CABLE TIE, BLACK, 4"	RICHCO/WIT-18R-B
3	1	HS, 3/8" X 1", BLACK	RAYCHEM/ VERSAFIT-3/8-0
2	1	HS, 3/8" X 3/4", BLACK	RAYCHEM/ VERSAFIT-3/8-0
JMPR4	3.85	WIRE, 26AWG, WHITE	BELDEN/83002-009
JMPR3	3.25	WIRE, 26AWG, BLACK	BELDEN/83002-010
JMPR2	3.25	WIRE, 26AWG, BLACK	BELDEN/83002-010
JMPR1	3.25	WIRE, 26AWG, WHITE	BELDEN/83002-009
1	12"	CABLE, 24-2, SHIELDED	BELDEN/9180
P1-A, P2-A	5	TERMINAL, PIN	MOLEX/16-02-0077
J1-A, J2-A	7	TERMINAL, SOCKET	MOLEX/16-02-0082
P2	1	HOUSING, 5 COND, PINS	MOLEX/70107-0002
P1	1	HOUSING, 3 COND, PINS	MOLEX/70107-0002
J2	1	HOUSING, 5 COND, SOCKETS	MOLEX/50-57-9405
J1	1	HOUSING, 3 COND, SOCKETS	MOLEX/50-57-9403

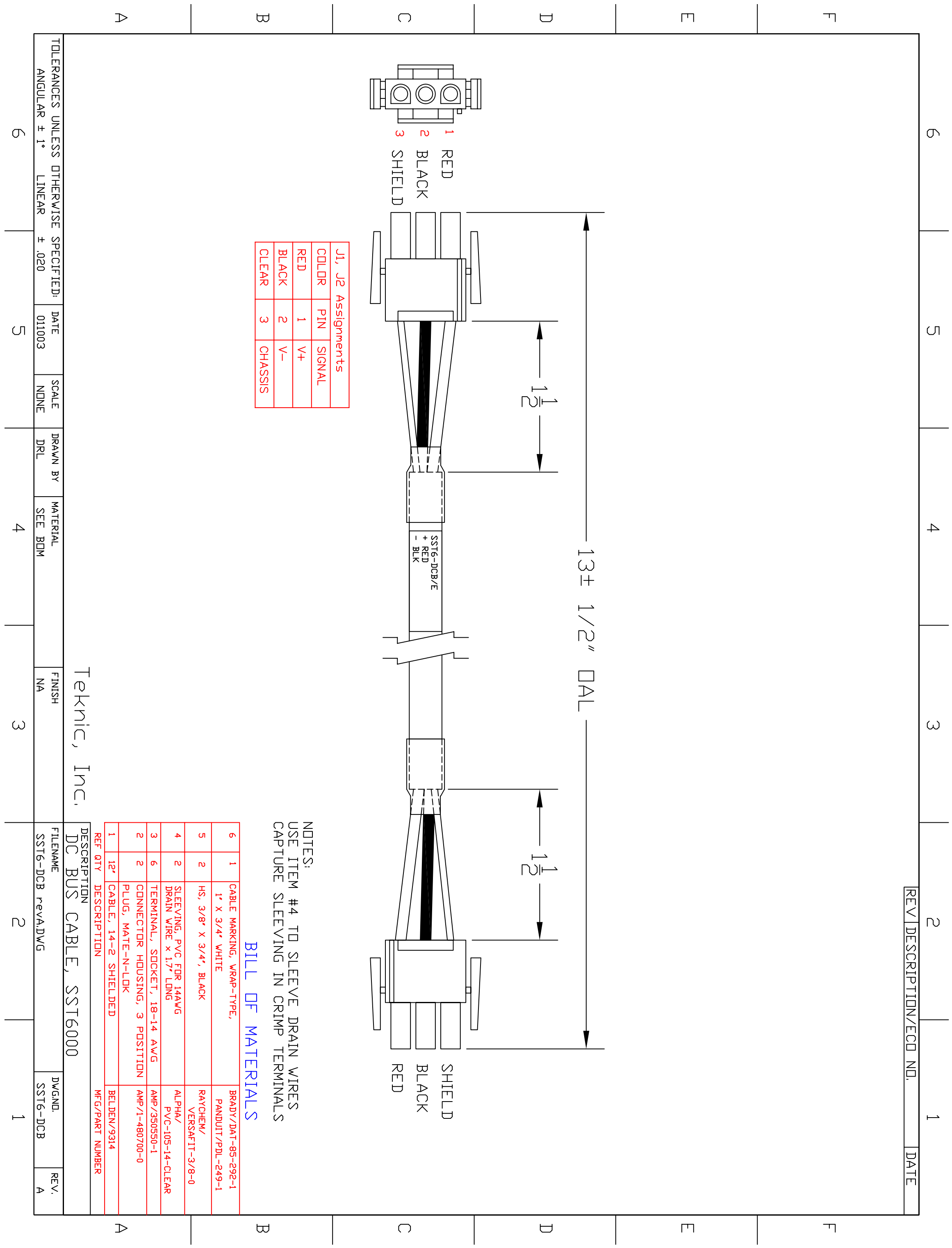
SST-DL-HOST


J2 ASSIGNMENTS
WIRE SIDE VIEW
PIN | CABLE REF | COLOR
1 | | JUMPER
2 | #2 | WHITE
3 | #1 | WHITE
4 | | JUMPER
5 | #1, #2 | BLACK (2)
6 | | JUMPER
7 | | JUMPER
8 | |
9 | | JUMPER
JUMPER
J2
1.0
#2
#8
0.75 JACKET STRIP
SST-DL-HOST (DATA OUT)
118.5"
116.5"
0.5
#1
1.25
0.25
CAPTURE ENDS OF CABLE JACKETS WITH CABLE TIE
FOLD DRAIN WIRES TOGETHER
OVER COMPRESSION GROMMET AND
CAPTURE BETWEEN SHELL HALVES
COMPRESSION COLLAR,
(SELECT COLLAR WITH 5 "BUMPS")
REAR VIEW
CAPTURE DRAIN WIRE
SLEEVING IN CRIMP,
2 PLACES
#7
P1
STRIP JACKET AND FOIL 1 1/4"
DIMENSIONS TYP BOTH CONNECTORS
P1 ASSIGNMENTS
WIRE SIDE VIEW
1 2 3
COLOR | PIN
WHITE | 1
BLACK | 2
SHIELD | 3
J1 ASSIGNMENTS
WIRE SIDE VIEW
3 2 1
COLOR | PIN
WHITE | 1
BLACK | 2
SHIELD | 3
J1
BILL OF MATERIALS
10 | 2 | SLEEVING, PVC, FOR DRAIN WIRE (26 AWG), 1.125" | ALPHA/ PVC-105-26-CLEAR
9 | 1 | CABLE MARKING, WRAP TYPE 1" x 3/4" WHITE | BRADY/DAT-85-292-1 PANDUIT/PDL-249-1
8 | 2 | CABLE TIE, BLACK, 4" | RICHCO/WIT-18R-B
7 | 2 | HS, 3/8" X 3/4", BLACK | RAYCHEM/ VERSAFIT-3/8-0
6 | .75" | WIRE, 26AWG, WHITE | BELDEN/83002-009
5 | .75" | WIRE, 26AWG, WHITE | BELDEN/83002-009
4 | .75" | WIRE, 26AWG, WHITE | BELDEN/83002-009
3 | .75" | WIRE, 26AWG, WHITE | BELDEN/83002-009
2 | 118" | CABLE, 24-2, SHIELDED | BELDEN/9180
1 | 120" | CABLE, 24-2, SHIELDED | BELDEN/9180
P1-A | 3 | TERMINAL, PIN | MOLEX/16-02-0077
P1 | 1 | HOUSING, 3 COND, PINS | MOLEX/70107-0002
J2-B | 1 | CONNECTOR SHELL, DB9 | 3M/3357-6509
J2-A | 8 | TERMINAL, SOCKET | AMP/66504-4
J2 | 1 | HOUSING, DB9F | MOLEX/50-57-9405
J1-A | 3 | TERMINAL, SOCKET | MOLEX/16-02-0082
J1 | 1 | HOUSING, 3 COND, SOCKETS | MOLEX/50-57-9403
REF | QTY | DESCRIPTION | MFG/PART NUMBER
REV | DESCRIPTION/ECO NO. | DATE
TOLERANCES UNLESS OTHERWISE SPECIFIED:
ANGULAR ± 1° LINEAR ±0.1"
DATE 082301
SCALE NONE
DRAWN BY DRL
MATERIAL see BOM
FINISH NA
Teknic, Inc.
DESCRIPTION
CABLE ASSY, SST-DL-HOST
FILENAME 1101746rA SST-DL-HOST.DWG
DWG.NO. 1101746
REV. A

SST-DL-EXT


J1
J1 ASSIGNMENTS
WIRE SIDE VIEW
3 2 1
COLOR | PIN
WHITE | 1
BLACK | 2
SHIELD | 3
72"
STRIP JACKET AND FOIL 1.25",
DIMENSIONS TYP BOTH ENDS
#1
SST-DL-EXT
(DATA OUT)
CAPTURE DRAIN WIRE
SLEEVING IN CRIMP,
2 PLACES
0.5
0.25
1.25
P1 ASSIGNMENTS
WIRE SIDE VIEW
1 2 3
COLOR | PIN
WHITE | 1
BLACK | 2
SHIELD | 3
P1
BILL OF MATERIALS
4 | 2 | SLEEVING, PVC, FOR DRAIN WIRE (26 AWG), 1.125" | ALPHA/ PVC-105-26-CLEAR
3 | 1 | CABLE MARKING, WRAP TYPE 1" x 3/4" WHITE | BRADY/DAT-85-292-1 PANDUIT/PDL-249-1
2 | 2 | HS, 3/8" X 3/4", BLACK | RAYCHEM/ VERSAFIT-3/8-0
1 | 72" | CABLE, 24-2, SHIELDED | BELDEN/9180
P1-A | 3 | TERMINAL, PIN | MOLEX/16-02-0077
J1-A | 3 | TERMINAL, SOCKET | MOLEX/16-02-0082
P1 | 1 | HOUSING, 3 COND, PINS | MOLEX/70107-0002
J1 | 1 | HOUSING, 3 COND, SOCKETS | MOLEX/50-57-9403
REF | QTY | DESCRIPTION | MFG/PART NUMBER
Teknic, Inc.
TOLERANCES UNLESS OTHERWISE SPECIFIED:
ANGULAR ± 1°   LINEAR ±0.1"
DATE 082301
SCALE NONE
DRAWN BY DRL
MATERIAL see BOM
FINISH NA
DESCRIPTION
CABLE ASSY, SST-DL-EXT
FILENAME 1101744rA SST-DL-EXT.DWG
DWG.NO. 1101744
REV. A
REV DESCRIPTION/ECO NO.
DATE

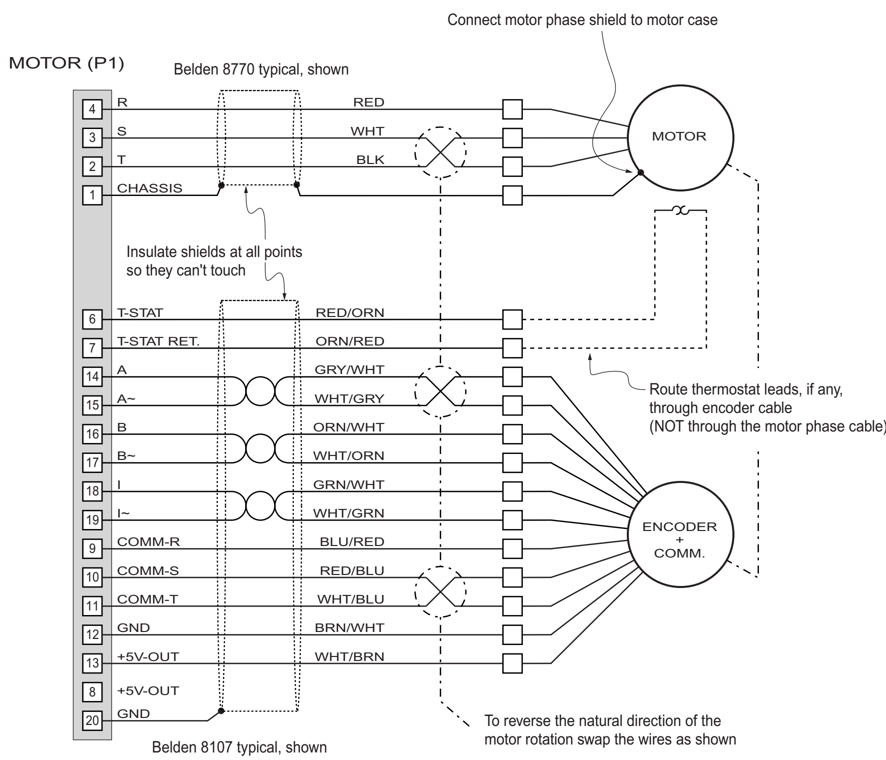
DC BUS JUMPER CABLE



APPENDIX C: REVERSING A MOTOR'S NATURAL DIRECTION

By selecting the Reverse checkbox in the SSt-QuickSet™ software, it is easy to reverse the "natural" rotational direction of a motor attached to a SSt-6000/3100 drive without the need for the modified motor cable described below. Reversing motor direction in this way does not, however, reverse the "direction" in which the software's quadrature counter visually reports shaft rotation. Whether the direction of rotation is considered to be positive or negative, the counter will always increment when the motor shaft rotates in a CCW direction and will always decrement when the shaft rotates in a CW direction.

If you have a requirement to reverse motor operation such that the SSt-Quickset™ software reports quadrature counts in the opposite direction (i.e. CCW rotation decrements the counter and CW rotation increments it), a modified motor cable will be necessary. The diagram below shows the appropriate wire pair swaps that must be made to a "standard" motor cable to ensure proper reverse drive-motor operation. Please consult your Teknic sales engineer if your application requires reverse drive-motor operation.



Motor Cable Construction Details for Reverse Motor Operation

CAUTION- THE LIMIT SWITCHES WILL ALSO HAVE TO BE PHYSICALLY SWAPPED WHEN USING THIS REVERSE DRIVE-MOTOR CABLE. FAILURE TO DO SO CAN RESULT IN SERIOUS MACHINE DAMAGE AND/OR BODILY INJURY. BE SURE TO CHECK THE OPERATION OF THESE SWITCHES (MANUALLY AT LOW SPEEDS) BEFORE OPERATING YOUR MACHINE.

APPENDIX D: AUDITING THE CONTROL SIGNALS

The SSt-6000/3100 servo drives have many features to help make them immune to electrical noise and marginal signals, including:

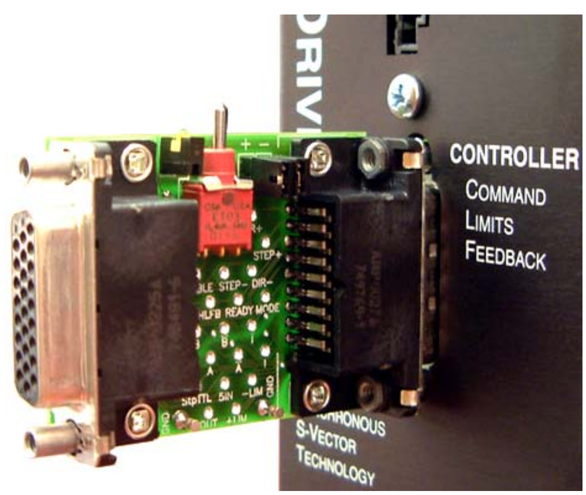
1. Analog and digital filtering of the high-speed step and direction signals and encoder signals,
2. Encoder bad sequence detection.
3. Digital filtering of the commutation start-up (Hall) signals,
4. Slew rate limiting on the PWM motor drive outputs,
5. Dedicated shield pins on all connectors,
6. Careful internal designs of "RF" barriers and signal planes,
7. An all-metal case.

Installations that follow all of the recommendations in this manual have been proven to be free from problems. However, because the SSt-6000/3100 is so tolerant, it's easy to overlook a marginal wiring/grounding/interface problem when first testing the SSt-6000/3100. These problems may then later result in inconsistent positioning or seemingly random protection shutdowns. So, to ensure that your electrical installation is robust, it is strongly recommended that you audit the electrical control signals once your system is fully installed.

Most of the problems that occur in normal installations are due to the fidelity of control signals supplied to the SSt drive. These can be corrupted by high frequency ground loops, high capacitance cable, induced noise from other equipment, and incompatible command signals from the controller (or indexer).

CONTROLLER CONNECTOR

To assist in auditing these signals, Teknic provides the SSt-ADT assembly shown below. This in-line board allows you to easily probe the control signals without disturbing your control harness.



SSt-ADT: Control Signal Audit Board

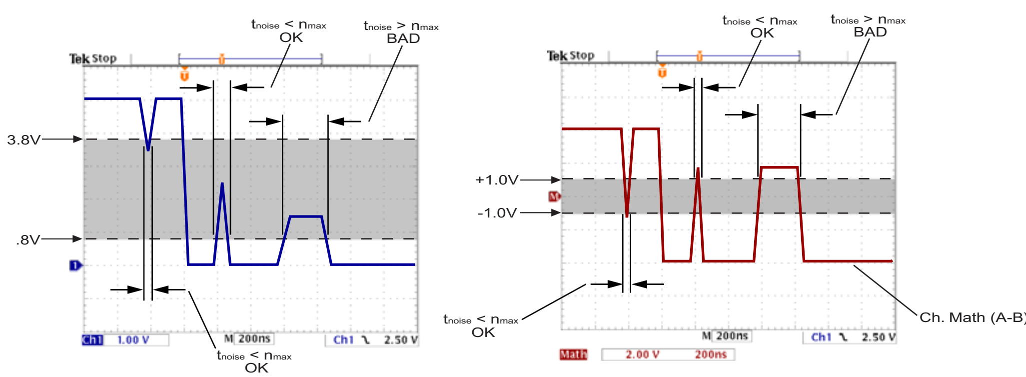
STEP & DIRECTION SIGNALS

The SSt-6000/3100 can receive either TTL (single-ended) mode or differential mode (RS-422 levels) signals. The default input mode is TTL. To set the drive to accept differential Step and Direction signals, simply connect a jumper between S & D DIFF~ (pin 21) and GND (pin 22) on the control connector (J1). If available on the controller/indexer that you are using, differential mode should be used for the Step and Direction signals, as it offers higher noise immunity than does TTL mode.

Step and Direction signals in TTL input (single-ended) mode require the low level input to be less than .8V, and the high level input be greater than 3.8V. Differential Step and Direction signals must be greater than 1.0V.

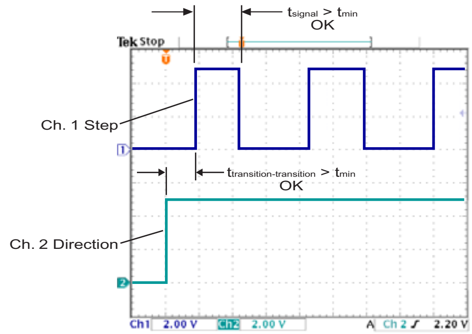
There is a maximum allowable noise pulse width that the SSt-6000/3100 input circuit will filter. This maximum allowable noise pulse width (n_{max}) varies according to the *Max. Step Input* setting in SSt-Quickset™. See the table and diagrams below.

Although the SSt-6000/3100 will remove noise pulses as shown below, for best engineering margin, your goal should be to eliminate any nosie from reaching into the gray zones shown below.



TTL (Left) and Differential (Right) Step and Direction signal noise limits (n_{max})

MAX. STEP INPUT SETTING IN SST-QUICKSET™	MAX. ALLOWABLE NOISE PULSE WIDTH (N_{MAX})	MIN. ALLOWABLE STEP PULSE WIDTH OR DIRECTION TRANSITION TO STEP TRANSITION TIME(T_{MIN})
1.25MHz	90nS	218nS
4.20MHz	45nS	119nS



Step and Direction signal minimum pulse width limits (t_{min})

The Step and Direction signals must be of a minimum pulse width in order for them to be recognized by the drive as valid Step or Direction signals. The minimum pulse width (t_{min}), which is illustrated and given in the table above, is dependent upon the *Max. Step Input* setting as configured by SSt-QuickSet™. This value is also the minimum allowable time between adjacent Step and Direction signals (i.e. the minimum amount of time between the transition of the Direction signal and then the Step signal, or vice versa).

The Step and Direction signals can easily be audited using the SSt-ADT Control Signal Audit board.

AUDITING TTL STEP AND DIRECTION SIGNALS

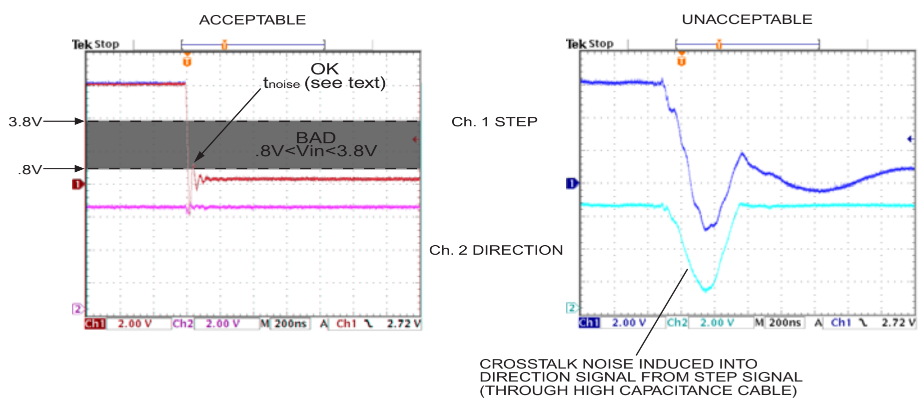
1. Attach an oscilloscope probe (ch.1) to the STEP+ test point, and attach it's ground lead to one of the GND turrets located towards the bottom part of the SSt-ADT board.
2. Attach another oscilloscope probe (ch. 2) to the DIR+ test point, and attach it's ground lead to one of the GND turrets located towards the bottom part of the SSt-ADT board.
3. Set each channel's VERTICAL SENSITIVITY to 2V/division and input coupling to DC. The vertical position of ch. 1 should be at the center line of the scope's display, and ch. 2 should be positioned below ch.1, towards the bottom of the display (but not so low so as to obscure any possible negative-going signal transitions or noise). Refer to the scope shot below labeled 'Acceptable'.
4. Set the oscilloscope to trigger as follows:

TRIGGER SOURCE	ch. 1
TRIGGER LEVEL	+2.5V
TRIGGER MODE	NORMAL
TRIGGER COUPLING	DC
TRIGGER POLARITY	positive-going ( )
HORIZ. TIMEBASE	200nS/division

   The horizontal position (trigger point) should be set two or three major divisions away from the Left side of the display.
5. Ensure that the motor is properly connected to the motor connector P2. Apply AC power to the drive, as well as power to the controller/indexer (if neither are already powered). If you are

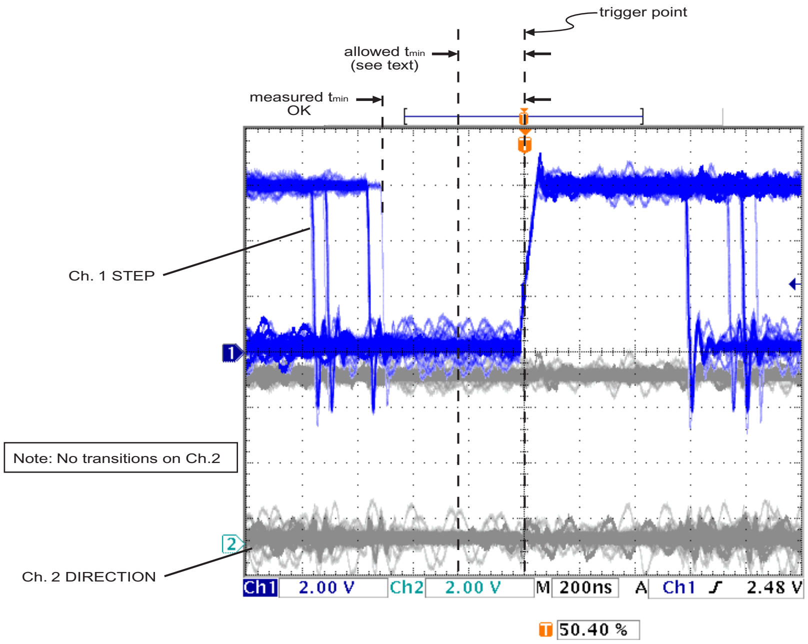
using Teknic's ControlPoint system, run the ControlPoint RPE software on the host PC.

6. The controller/indexer can now send Step and Direction signals to the drive to be observed. Along with sending Step signals, the Direction line should also be toggled so that it's integrity can be evaluated as well. This can be accomplished by sending alternating positive moves (+motion) and negative moves (-motion). If you are using Teknic's ControlPoint RPE software, a simple repetitive point-to-point move can be done by using the < > button. Although it is possible to simply send steps to the drive while the drive is disabled (i.e. not actually moving the attached motor), it is important to send steps to an enabled drive and to move the motor. The reception of the signals at the drive will not change in either case, but any noise that may be being induced by actually moving the motor can now be observed.



Examples of Acceptable and Unacceptable single-ended Step and Direction signals

7. A common problem with the Step and Direction signals is that of infrequent noise pulses. Set the scope's display persistence time to infinite (:). Allow the scope to run for several minutes in order to capture any noise pulses that may be corrupting the signals. See the table and diagrams above for the maximum allowable noise pulse width (n_{max}).
8. Using cursors, measure the minimum width of the Step and Direction signals (t_{min}). The minimum width of these signals must be at least as wide as what is outlined in the table and diagram above.
9. Using cursors, measure the minimum time between any two Step and Direction signal transitions (also t_{min}). The minimum time between any two signal transitions must be at least what is outlined in the table above. This measurement is shown in the scope shot below.



Measurement of Step and Direction minimum allowable transition-transition time (t_{min})

10. Set the display persistence back to it's previous setting (typically AUTO).
11. Using the scope's SINGLE SEQuence function (whereby the scope displays and holds the waveform after it sees a valid trigger), capture the step logic signal by pressing the SINGLE SEQ (or similar) button once the scope is properly triggering on the signal.
12. Examine the rise time of the signal (typically <50nS), and look for the absence or presence of any noise spikes or pulses. The signals should look relatively quiet (i.e. free of noise pulses that would be great enough in amplitude and pulse width to appear to the drive as valid Step or Direction signals). Low level input should be less than .8 volts, and high level input should be greater that 3.8 volts.
13. Allow the scope to run again by pressing the RUN/STOP button.
14. Change the TRIGGER POLARITY to negative-going ( ).
15. As in steps 7-13 above, re-capture the signal and examine the falling edge of the Step signal.
16. Change the TRIGGER POLARITY back to positive-going ( ), and the TRIGGER SOURCE to ch. 2 (Direction).
17. Ensure that the Direction line is being toggled (see step 6. above). As in steps 7-13 above, re-capture the signal and examine the rising edge of the Direction signal.
18. Change the TRIGGER POLARITY to negative-going ( ).
19. As in steps 7-13 above, re-capture the signal and examine the falling edge of the Direction signal.

Some digital oscilloscopes equipped with advanced triggering allow the user to trigger on pulses of a certain duration (or below a certain duration). This technique may be helpful when noise pulses are very narrow (i.e. narrower than any expected valid Step or Direction signal).

If it is suspected that Step and Direction signals are being compromised via noise induced from other equipment, a signal from the possible noise source can be used to trigger the scope. This technique requires the use of an isolated scope probe which will allow the scope to view two separate signals, each having their own separate (isolated) ground.

AUDITING DIFFERENTIAL STEP AND DIRECTION SIGNALS

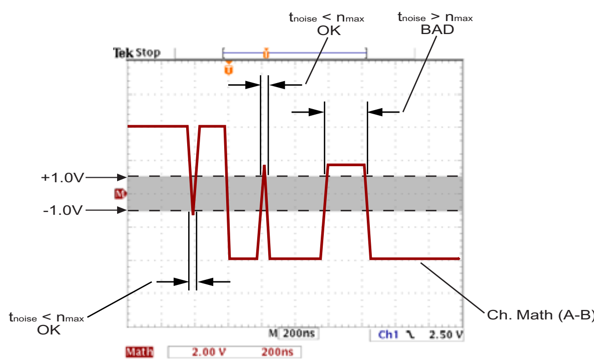
If differential Step and Direction signaling is being used, refer to the *Auditing the Encoder Signals (Differential)* section below for voltage limits and techniques for auditing differential signals. Steps 5. – 17. in the TTL procedure above should then be followed as well to ensure proper timing. Note that Step+ and Step- (or Dir+ and Dir-) will correspond to encoder signals A and A~ (or B and B~).

ENCODER SIGNALS

The main encoder signals (A, A~, B, and B~) are the signals that originate at the motor's encoder. The encoder signals pass through the drive (where they are monitored by the DSP), and may continue on to your controller/indexer. The encoder signals must be differentially greater than1.0V relative to each other.

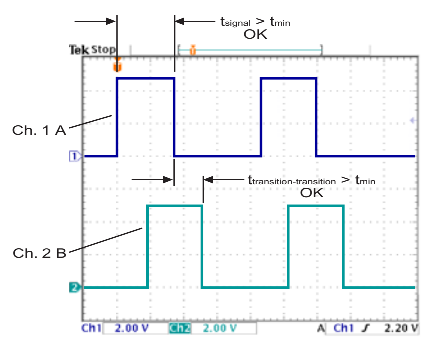
There is a maximum allowable noise pulse width. This maximum allowable pulse width of noise (n_{max}) varies according to the *Max. Step Input* setting as set in SSt-QuickSet™. See the table and diagrams below.

Although the SSt-6000/3100 will remove noise pulses as shown below, for best engineering margin, your goal should be to eliminate any nosie from reaching into the gray zones shown below.



Differential encoder signal noise limits (n_{max})

MAX. ENCODER LIMIT SETTING IN QUICKSET	MAX. ALLOWABLE NOISE PULSE WIDTH (N_{MAX})	MIN. ALLOWABLE A TO B OR B TO A TRANSITION TIME(T_{MIN})
10MHz	90nS	100nS
15MHz	45nS	67nS



Encoder signal minimum pulse width limits (t_{min})

The encoder signals must have a minimum edge A to edge B transition time (and vice versa) in order for them to be recognized by the drive as valid encoder signals. The minimum transition time (t_{min}), which is illustrated and given in the table above, is dependent upon the drive's *Max. Encoder Limit* setting as configured by SSt-QuickSet™.

The encoder signals can also be observed using the SSt-ADT Control Signal Audit board.

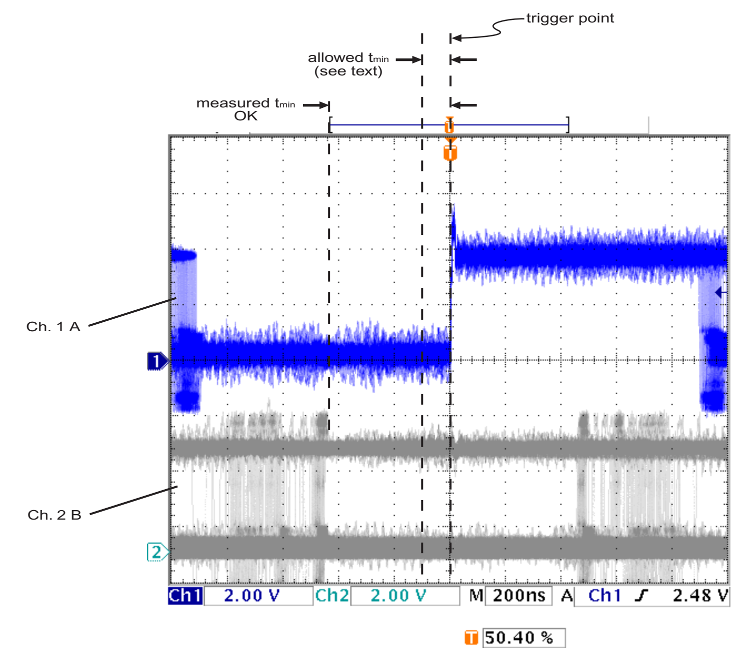
Differential encoder signals can be monitored by an oscilloscope using two methods. Doing a 'basic' audit of both encoder signals (A and B) together involves simply probing on test points A (Ch. 1) and B (Ch. 2), and using the GND turrets on the SSt-ADT board for both channels. This method can be used to verify whether the encoder signals are relatively clean, as well as to verify proper minimum transition time between phases. The encoder signals should also be probed differentially when noise is suspected or observed during a 'basic' audit. Differential probing involves looking at the difference between A and A~ signals (separately from the B and B~ signals) and removes any common mode noise present from the display.

AUDITING THE ENCODER SIGNALS (BASIC)

1. Attach an oscilloscope probe (ch.1) to the A test point, and attach it's ground lead to one of the GND turrets located near the bottom of the SSt-ADT board.
2. Attach another oscilloscope probe (ch. 2) to the B test point, and attach it's ground lead to one of the GND turrets located towards the bottom part of the SSt-ADT board.
3. Set each channel's VERTICAL SENSITIVITY to 2V/division and input coupling to DC. The vertical position of ch. 1 should be at the center line of the scope's display, and ch. 2 should be positioned below ch.1, towards the bottom of the display (but not so low so as to obscure any possible negative-going signal transitions or noise). Refer to the Left scope shot below.
4. Set the oscilloscope to trigger as follows:
   TRIGGER SOURCE ch. 1
   TRIGGER LEVEL +2.5V
   TRIGGER MODE NORMAL
   TRIGGER COUPLING DC
   TRIGGER POLARITY positive-going ( )
   The TIMEBASE should be set initially to ~200µS/division, but the optimal timebase setting for this part of the signal audit will be dependent on the encoder speed used.
5. Ensure that a motor is properly connected to the motor connector P2. Apply AC power to the drive, as well as power to the controller/indexer (if neither are already powered). If you are using Teknic's ControlPoint system, run the ControlPoint RPE software on the host PC.
6. After enabling the drive, command the controller/indexer to move the motor. The motor should be run at maximum application speed (i.e. the fastest, longest possible move).
7. Using the scope's SINGLE SEQuence function (whereby the scope displays and holds the waveform after it sees a valid trigger), capture both A and B encoder signals together by pressing the SINGLE SEQ (or similar) button once the scope is properly triggering on the signal. It may be necessary to repeat this several

times before both encoder signals (with transitions) are displayed together.

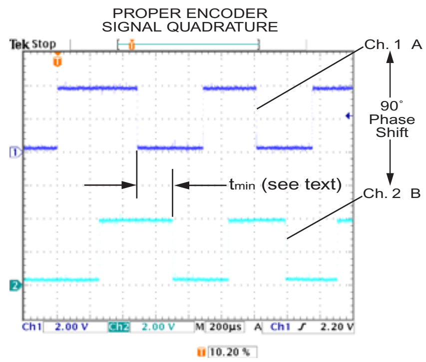
8. Examine the encoder signals together, look for the absence or presence of any noise spikes or pulses. The signals should be relatively noise-free. Note: It is not possible using this 'single-ended' probing technique to verify whether or not the encoder signals are within their high and low voltage limits (remember, the actual 'reference' for the A encoder is A~, not GND, which is what we are using for our ground presently). However, if these signals have less than 500mV of noise present, a differential audit is probably not necessary.
9. Examine the A and B encoder signals, it should look as though there is a ~90° phase shift (one of the signals is leading or lagging the other by ~90°). At any given point in time there should only be one signal that is transitioning. See the scope shot above for example encoder signal displays.
10. Change the timebase of the scope from its present setting to 200nS/division.
11. Allow the scope to run again by pressing the RUN/STOP button.
12. Set the scope's persistence time to infinite (:). Allow the scope to run for several minutes in order to capture any noise pulses or short transitions that may be corrupting the signals.



Measurement of encoder signal minimum allowable transition-transition time (t_{min})using infinite persistence setting

13. Set the persistence back to it's previous setting (typically AUTO).
14. Using the scope's RUN/STOP function, capture both A and B encoder signals together by pressing the RUN/STOP button once the scope is properly triggering on the signal.
15. Examine the rise time of the signal and look for the absence or presence of any noise spikes or pulses.

16. Allow the scope to run again by pressing the RUN/STOP button.
17. Change the TRIGGER POLARITY to negative-going ( ).
18. As in steps 6-16 above, re-capture the signal and examine the falling edge of the A signal.
19. Change the TRIGGER POLARITY back to positive-going ( ), and the TRIGGER SOURCE to ch. 2 (B).
20. As in steps 6-17 above, re-capture the signal and examine the rising edge of the B signal.
21. Change the TRIGGER POLARITY to negative-going ( ).
22. As in steps 6-17 above, re-capture the signal and examine the rising edge of the B signal.



Basic encoder signal auditing

If the encoder signals appear to be noisy (defined as >500mV of noise or drifting), differential noise on the encoder signals and the differential Step and Direction signals can be observed using the following method. Note that using this differential probing method only allows you to look at one set of signals at a time (i.e. A vs. A~, B vs. B~, STEP+ vs. STEP-, or DIR+ vs. DIR-).

This probing method takes advantage of the commonly available oscilloscope math function "*A-B*" (whereby channel 1 is subtracted from channel 2, and the resultant waveform is displayed as a 'third' channel). This will allow you to view the true differential encoder signal.

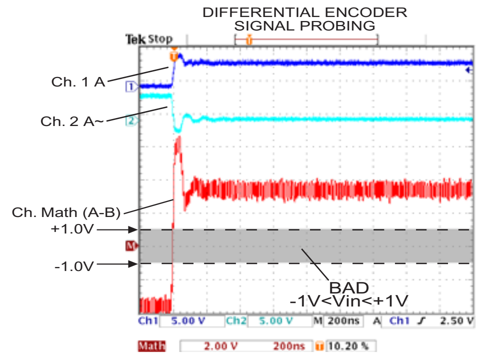
AUDITING THE ENCODER SIGNALS (DIFFERENTIAL)

1. Attach an oscilloscope probe (ch.1) to the A test point, do not connect it's ground lead yet.
2. Attach another oscilloscope probe (ch. 2) to the A~ test point.
3. Twist the ground leads from both probes together, and attach them both to one of the GND turrets located towards the bottom part of the SSt-ADT board.
4. Set each channel's VERTICAL SENSITIVITY to 5V/division and input coupling to DC. The vertical position of ch. 1 should be near the top of the scope's display, and ch. 2 should be positioned ~1.5 major divisions below ch. 1. Refer to the Right scope shot below.
5. Set the scope's *A-B* math function VERTICAL SENSITIVITY to 2V/division. The vertical position of the *A-B* math function should be approximately three major divisions from the bottom of the display. See the Right scope shot above.
6. Set the oscilloscope to trigger as follows:
   TRIGGER SOURCE ch. 1

TRIGGER LEVEL	+2.5V
TRIGGER MODE	NORMAL
TRIGGER COUPLING	DC
TRIGGER POLARITY	positive-going ( )
HORIZ. TIMEBASE	200nS/division

The horizontal position (trigger point) should be set one or two major divisions away from the Left side of the display.

7. Ensure that a motor is properly connected to the motor connector P2. Apply AC power to the drive, as well as power to the controller/indexer (if neither are already powered). If you are using Teknic's ControlPoint system, run the ControlPoint RPE software on the host PC.
8. After enabling the drive, command the controller/indexer to move the motor. The motor should be run at maximum application speed (i.e. the fastest, longest possible move).
9. A common problem with the encoder signals is that of infrequent noise pulses. Set the scope's persistence time to infinite (:). Allow the scope to run for several minutes to capture any noise pulses that may be corrupting the signals.
10. Set the persistence back to it's previous setting (typically AUTO).
11. Examine the A and A~ encoder signals, as well as the resultant *A-B* waveform. Although the differential encoder signals should ideally look like those shown in the scope shots above, the drive has the ability to recover valid encoder signals that have fairly high amplitude noise signals imposed on them. The *A-B* waveform may appear noisy, but there must be no noise pulses that transition into the 1.0V area around ground (see the scope shot below).
12. Allow the scope to run again by pressing the RUN/STOP button.
13. Change the TRIGGER POLARITY to negative-going ( ).
14. As in steps 9-13 above, re-capture the signal and examine the falling edge of the encoder signals.
15. Change the TRIGGER POLARITY back to positive-going ( ), and the TRIGGER SOURCE to ch. 2 (A~).
16. As in steps 9-13 above, re-capture the signal and examine the rising edge of the encoder signals.
17. Change the TRIGGER POLARITY to negative-going ( ).
18. As in steps 9-13 above, re-capture the signal and examine the falling edge of the encoder signals.
19. Repeat steps 1-19 above, using the test points B and B~ instead of A and A~.



Differential encoder signal auditing

OTHER DIGITAL INPUTS

The other digital inputs (+Limit, -Limit, Mode, and Enable~) require the low level input to be less than .8V, and the high level input be greater than 3.8V. The most common problem with these signals is not having a pull-up resistor on the controller end of the signal. Check to see that these signals cycle. The +LIM, -LIM, MODE, and ENABLE test points on the SSt-ADT Control Signal Audit board are provided for this purpose.

DIGITAL OUTPUTS

The digital outputs Ready~ and HLFB~ are open collector outputs. They must be pulled up at the controller board (typically to the controller board's +5V through a 5k resistor). Refer to the instructions given for the auditing of single-ended step and direction signals when auditing these outputs. The READY and HLFB test points on the SSt-ADT Control Signal Audit board are provided for this purpose.

SAFETY CONNECTOR

If logic power backup is being used, measure the supplied voltage at +5 BCKUP (pin 4) to GND (pin 3) on the safety connector (P6). Verify that it is 5.3-5.7 volts when the AC power is removed.

If the ARM input is being driven by logic level signals, check that the voltage between ARM+ (pin 2) and ARM- (pin 6) is greater than 4.0V when the drive is to be "armed".

If a brake is installed insert an amp meter in series with the brake and disarm the drive, make sure the current to the brake does not exceed 500mA.

MOTOR CONNECTOR

The commutation signals (COMM-R, COMM-S, and COMM-T) originate at the motor and are available at the motor connector P2 (as pins 9,10, and 11 respectively). If the commutation sensors are to be used (as set in QuickSet), it is important to audit these signals as well. The voltage limits for digital high and digital low for the commutation sensor outputs are not TTL limits. Low level input must be less than 1.5 volts. High level input must be greater than 4.6 volts. The ground for these signals is also available at the motor connector (P2) as GND (pin 12).

A likely source of noise is due to ground loops that may be caused by improper wiring. It is important to verify that CHASSIS ground and GND (which is used for the encoder and commutation sensor signals) be isolated in the motor cable. To verify that they are isolated, remove all other connectors from the drive and connect the motor and cable to the drive, put an ohmmeter between GND (pin 20) and chassis ground (pin 1) on the motor connector. Make sure it reads open circuit. Also, make sure that the motor phase cable shield is connected to both the motor case and pin 1 on the motor connector (P2).

APPENDIX E: INSTALLATION GOLDEN RULES

Teknic has developed the following set of 18 simple "Golden Rules" for SSt-6000/3100 servo system installation. Following these rules will prevent potential electrical problems. The installation will be largely immune to electrical noise, generate a minimum of electrical interference, meet safety requirements and perform as expected. *If you read only one thing in this manual, these rules should be it!*

Rules 1,2, 6-8,10-12 & 14 are especially important for proper operation and have been highlighted in gray.

GROUNDING & SHIELDING

1. Ground all SSt-6000/3100 servo drives to the machine chassis or frame. Make sure the frame is connected to the machines Protective Earth Terminal (safety ground).
2. Connect all cable shields to chassis ground pins on the SSt-6000/3100 connectors whenever shielded cable is used.

POWER

3. Use 18 AWG or heavier wire to connect AC power to the SSt-6000/3100 drive.
4. Use thermal breakers or time delay fuses rated for motor staring for protecting AC power to SSt-6000/3100 servo drive(s).
5. If DC power is bussed, use shielded 16AWG or heavier cable for connecting DC power. Make sure to connect the shields to pin 3 on P3 and P4.
6. AC power wiring between the EMI filter and SSt-6000/3100 servo drive should be shorter than 10" and the filter should be grounded to the same panel or frame member as the SSt-6000/3100. If longer wiring between the drive and filter is required, it should be made from shielded cable.

MOTOR CABLES

7. Use heavy gauge *shielded* cable for the motor phase wiring. Cable with 18AWG conductors can be used up to 12-foot cable lengths. Longer cable assemblies should use cable with 16AWG conductors. Cables in excess of 25 feet will begin to affect the torque-speed curve of the motors and should be avoided, if possible.
8. Make sure the motor phase cable shield is grounded to pin 1 on the motor connector (P2) at the drive end and to the motor case at the motor end.
9. Use shielded, twisted pair cable for the encoder, commutation (Hall) sensor and thermostat signals. The encoder signal pairs A and A~, B and B~ and I and I~ should be twisted together. Low capacitance (under 20pf/ft) cable is strongly recommended, especially if the encoder signals will be routed through the drive to the controller. Low capacitance cable insulation is typically made from polyethylene, polypropylene, Teflon®, FEP, etc.
10. Don't ground the encoder cable shield to the motor case or allow it to touch the motor phase shield at any point.

11. Don't run the motor's commutation (Hall) signals through the motor phase cable at any point.
12. Don't run the thermostat signals, if any, through the motor phase cable at any point.

CONTROLLER/INDEXER INTERFACING

13. Use pull-up resistors on the Ready~ and HLFB~ output signals from the SSt servo drive. These pull-up resistors can be connected to a supply voltage of up to 24V.
14. Be sure the step and direction outputs on the controller can sink 15mA or more.
15. Use shielded cable for all control signal connections to the controller connector. The controller cable should be made from low capacitance cable (under 20pf/ft). Low capacitance cable insulation is typically made from polyethylene, polypropylene, Teflon®, FEP, etc. The recommend cable stock shown in the application diagrams in this manual has excellent electrical properties and low cost.
16. Audit the control signals for:
    Step & Direction noise and levels,
    Step & Direction timing,
    Encoder A and B phases for noise, levels and quadrature.
17. If using the logic power backup, make sure the supplied voltage ***at the drive*** is above 5.20V under worst case conditions.
18. Use shielded cable for routing +5V-BCKUP, GND or +5V from the safety connector (P6).

APPENDIX F: QUICK REFERENCE

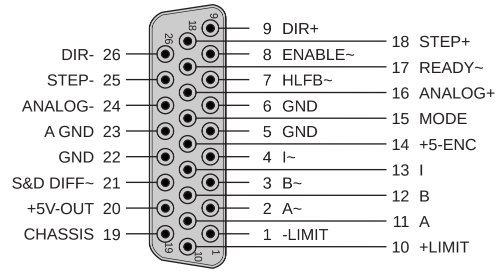
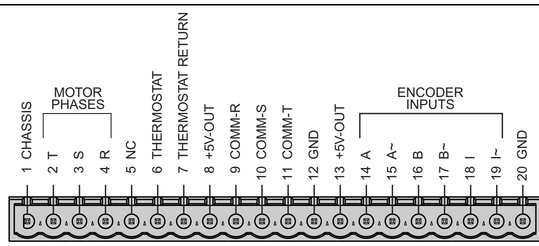
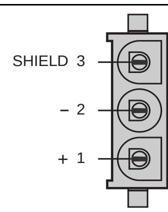
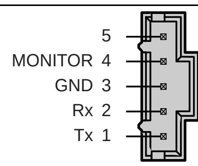
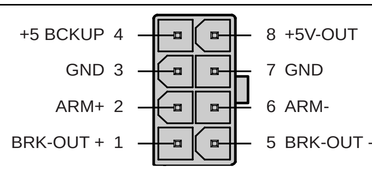
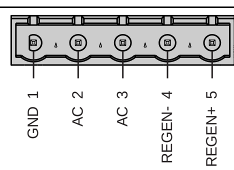
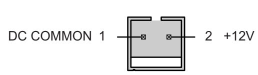
SPECIFICATIONS

General	Dimensions:	3.15"W x 8.93"H x 5.54"D
	Weight:	4.4 Lbs. (2 Kg.)
Environmental	Temperature:	0?C-40?C
	Humidity:	0% - 90% non-condensing
Supply Requirements (Use either AC or DC)	AC Input Voltage:	100 - 240 VAC Nominal (50-60 Hz.)
	AC Input Current:	Max. 10Amps (Time Delay Fused)
	DC Input Voltage:	120 - 370 VDC (Nominal 340 VDC) ♦
	DC Input Current:	Max. 10Amps (Time Delay Fused)
Output	PWM Ripple Current:	27 KHz
	Current Capability:	12A RMS* mounted vertically with forced air cooling 9A RMS* mounted vertically on a metallic bulkhead 4A RMS* in any mounting configuration in free air 23A Peak (5 seconds)
Protection:		Protected on a cycle-by-cycle basis against phase-to-phase shorts and shorts to ground. Fused.
Encoder Input	Type:	differential incremental encoder inputs with or without index. Digitally filtered with bad sequence detection
	Rate:	15 MHz Maximum, post quadrature
	Courtesy Power:	SSt servo drive can supply +5V @ 200mA.
Step & Direction Inputs	Isolated Format:	TTL level Schmidt triggered inputs with 470 ohm pull-up resistors to +5VDC, or Differential Signaling (Style selected by jumper wire on control connector)
	Rate:	4.2 MHz Maximum
Real-time Monitor Port	Features:	Configurable digital filtering, User defined scaling factors (High Zoom magnification available), Sync pulses at beginning of moves
	Variables:	tracking (position) error, commanded velocity, actual torque, actual velocity, velocity error, commanded torque, and 7 other variables
	Configuration memory	non-volatile storage (eeprom)
	Format:	0.5 - 4.5V analog signal (0=2.5V)
Vector Commutation	Vector Error:	0.1% or less
	Type:	Sinewave—Indirect, voltage vector dq current control with PI compensator with proprietary enhancements.
	Calculation Rate:	13.5 kHz
Analog Command Input	Format:	Torque commanded using a Differential analog voltage input.
	Impedance:	10K ohms (each input to ground)
	Scale:	SSt-6000: 2.3 Amps per volt , ±10 volt range. (10 % of peak output per volt of input) SSt-3100: 1.0 Amp per volt, ±10 volt range.

* Peak value of the sine output current on any given phase when the motor is rotating.
♦The DC Supply must be in-rush limited. Contact Teknic for details

CONNECTOR PINOUTS

Viewed looking into drive

CONNECTOR	PINOUT	MATING COMPONENTS
J1 **CONTROL**		Mating plug: AMP/748365-1 Crimp pins: AMP/748333-5 or 748333-7 Housing-backshell: 3M/3357-6515
P2 **MOTOR**		Mating connector: Phoenix Contact/17 57 19 0 Strain relief housing: Phoenix Contact/18 05 61 5
P3, P4 **DC BUS**		Mating Housing: AMP/1-480700-0 Crimp sockets: AMP/350550-1
P5 **DIAGNOSTIC**		Mating housing: Molex/50-57-9405 Crimp sockets: Molex/16-02-0097 or 16-02-0087
P6 **SAFETY**		Mating housing: Molex/39-01-2080 Crimp sockets: Molex/39-00-0039
P8 **AC &** **REGEN.**		Mating connector: Phoenix Contact/17 67 03 8 Strain relief housing: Phoenix Contact/18 03 91 8
FAN **CONNECTOR**		Mating connector: Molex/50-57-9402 Crimp sockets: Molex/16-02-0097 or 0087