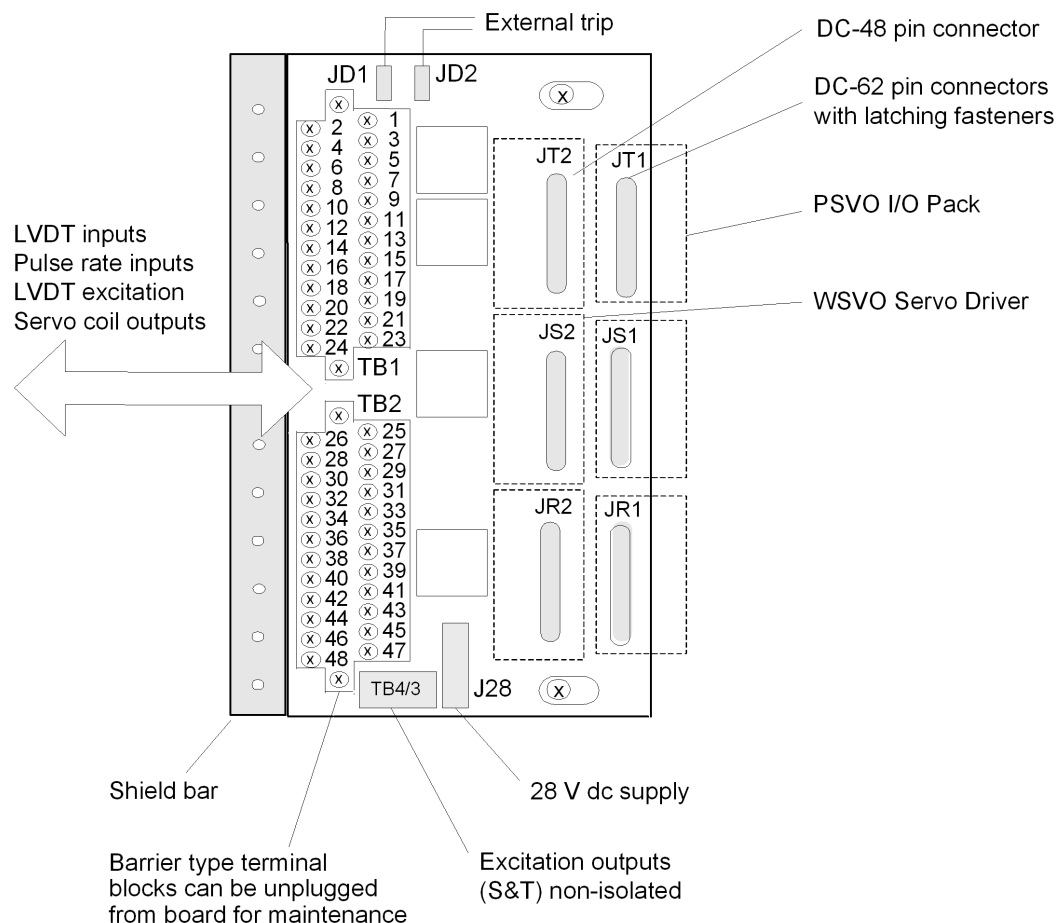


TSVC Servo Input/Output

Functional Description

The Servo Input/Output (TSVC) terminal board interfaces to two electro-hydraulic servo valves that actuate the steam/fuel valves. Valve position is measured with linear variable differential transformers (LVDT). TSVC is designed specifically for the PSVO I/O pack and the WSVO servo driver. The terminal board supports simplex and TMR configurations. Three 28 V dc supplies come in through plug J28. Plugs JD1 or JD2 are for an external trip from the protection module.



TSVC Servo Terminal Board

TSVCH1 T1 through T4 isolation transformers provide galvanic isolation between the WSVO's excitation output driver and the primary-side of the LVDT/R position sensor.

TSVCH2 excludes the isolation transformers T1 through T4 resulting in no galvanic isolation between the WSVO excitation driver output and the LVDT/R position sensor.

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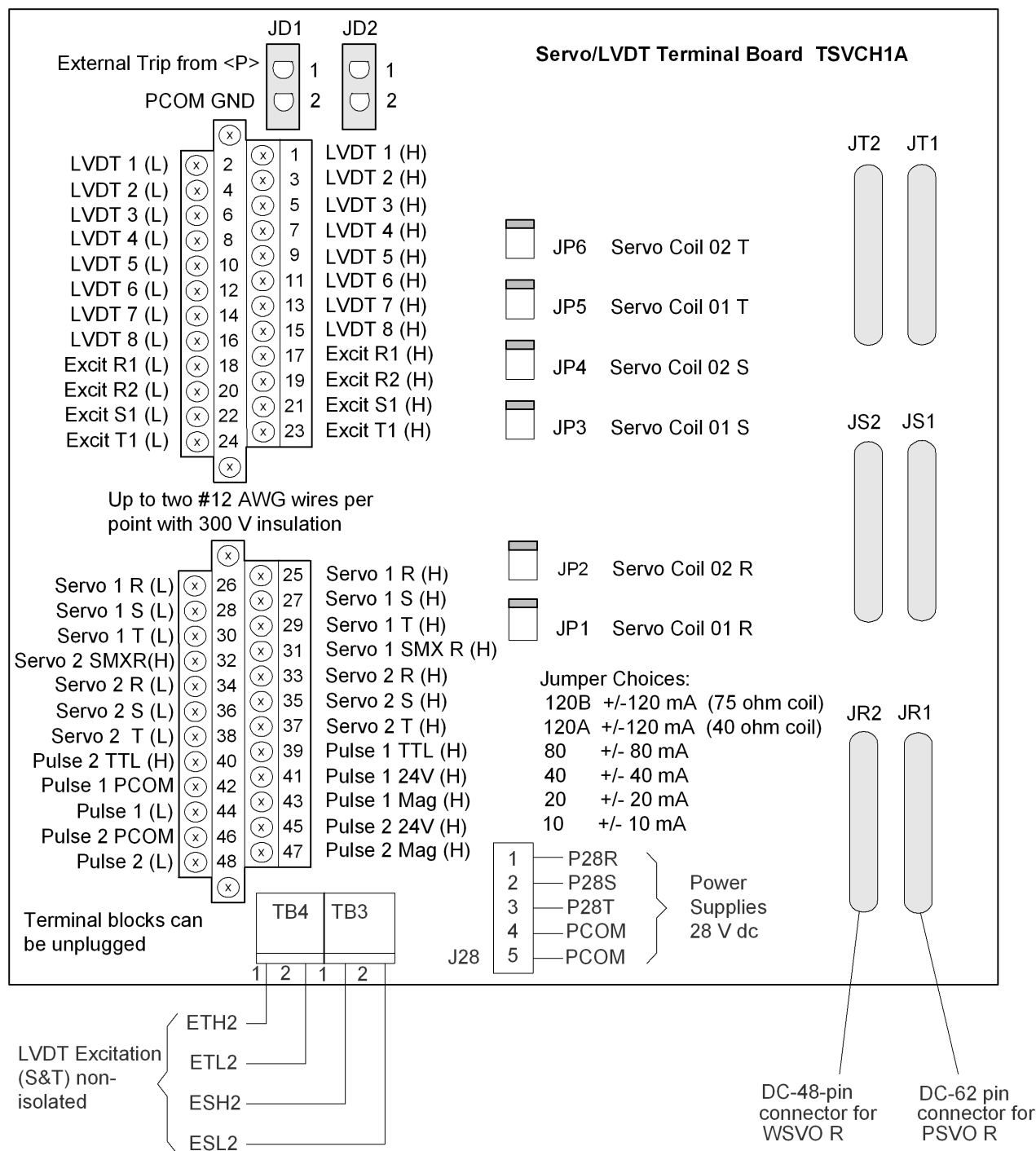


Installation

Sensors and servo valves are wired directly to two I/O terminal blocks. Each block is held down with two screws and has 24 terminals accepting up to #12 AWG wiring. A shield terminal strip attached to chassis ground is located immediately to the left of each terminal block. External trip wiring is plugged into either JD1 or JD2.

Each servo output can have three coils in TMR configuration. The size of each coil current is jumper selected using JP1, 3, 5 for Servo 1, and JP2, 4, 6 for servo 2.

Three 28 V dc power supplies for the R, S, and T board functions are connected to J28. Two non-isolated LVDT excitation sources for S and T are wired to terminal block TB3 and TB4.



Servo/LVDT Terminal Board Wiring

PSVO

The three J1 connectors for the PSVO I/O packs are R, S, and T. These plug into the DC-37 pin connector with latching fasteners, and bolt to a side bracket holding the I/O packs in place.

WSVO

The three J2 connectors for the WSVO servo drivers are R, S, and T. Each WSVO is held down with four screws. The WSVO servo driver and PSVO I/O pack are ordered as a set and should be replaced if diagnostics indicate a servo problem.

The PSVO I/O pack and WSVO driver can be replaced with the unit running by removing power from the failed channel with the corresponding manual enable switch, SW1, or SW2, or SW3. Power to each channel is indicated with LEDs on the board and LEDs on each solid-state power switch.

Operation

The TSVC servo terminal board provides two channels consisting of bi-directional servo current outputs, LVDT position feedback, LVDT excitation, and pulse rate flow inputs. It provides excitation for, and accepts inputs from, up to eight LVDT valve position inputs. There is a choice of one, two, three, or four LVDTs for each servo control loop. The two pulse rate inputs are used for gas turbine liquid fuel flow feedback measurement. Each servo output is equipped with an individual suicide relay under firmware control that shorts the PSVO output signal to signal common when de-energized, and recovers to nominal limits after a manual reset command is issued. Diagnostics monitor the output status of each servo voltage, current, and suicide relay.

The primary and emergency overspeed systems will trip the hydraulic solenoids independent of this circuit.

Each of the servo output channels can drive either one or two-coil servos in simplex applications, or two or three-coil servos in TMR applications. The two-coil TMR applications are for 200# oil gear systems where each of two control PSVOs drive one coil each, and the third PSVO has no servo coil interface. Servo cable lengths up to 300 m (984 ft) are supported with a maximum two-way cable resistance of 15 Ω . Since there are many types of servo coils, a variety of bi-directional current sources are jumper selectable.

For simplex applications, a trip override relay K1 is provided on the terminal board, which is controlled from the PPRO protection module. If an emergency overspeed condition is detected in the protection module, the K1 relay will energize, disconnect the servo output, and apply a bias to drive the control valve closed. This is only used on simplex applications to protect against the servo amplifier failing high, and is functional only with respect to the servo coils driven from <R>.

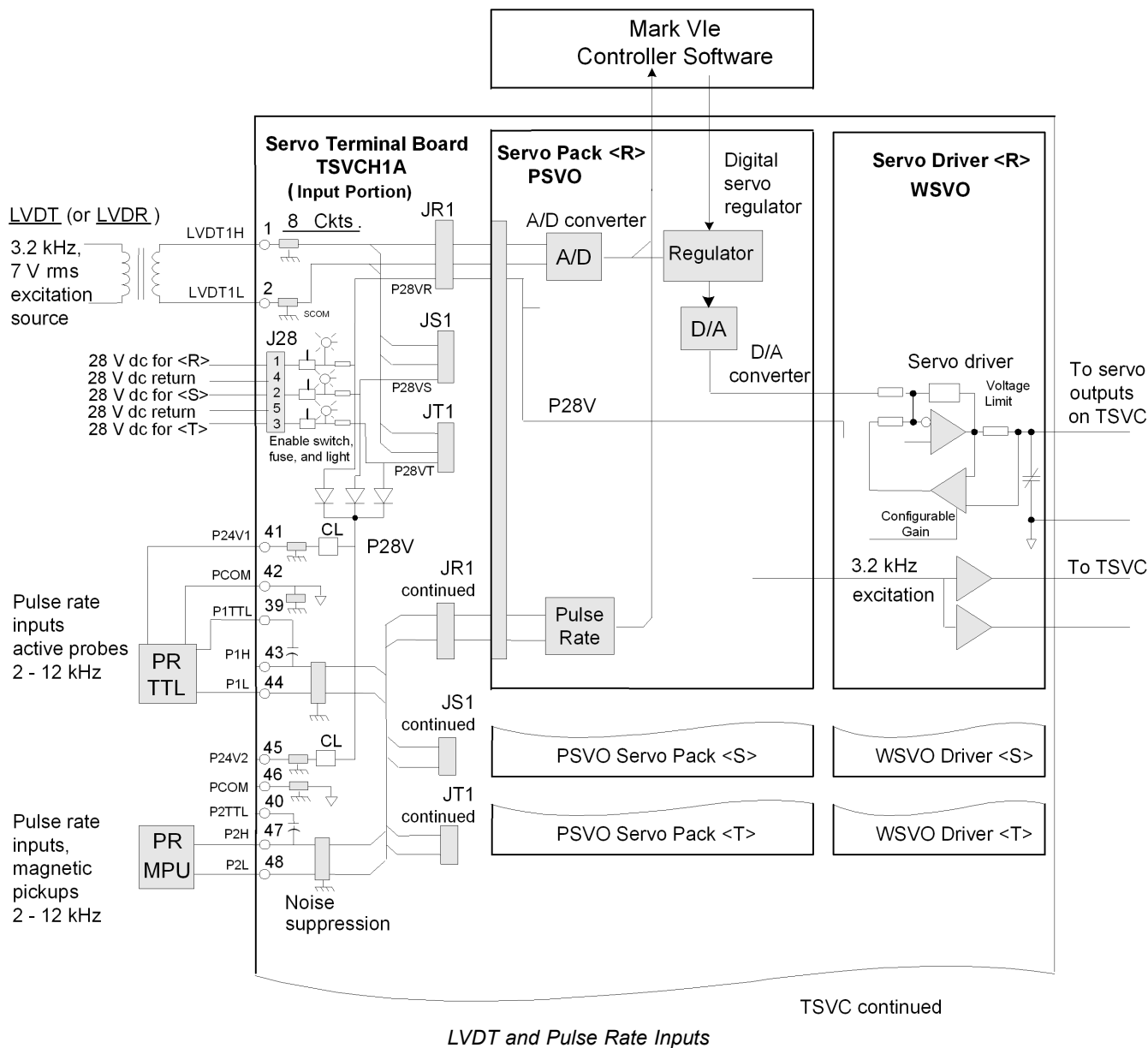
For Simplex applications that require this backup protection relay, verify that the JPDM or JPDS wiring includes jumpers between the PR, PS, and PT connectors on either TB1 or TB2 to energize the T bus, and that the TSVC SW1 is in the ON position. The TSVC green DS1 LED (indicating that P28T is available) should be lit if power is being supplied for the K1 relay. Illumination of the DS1 LED is sufficient to demonstrate that power to energize the K1 relay is available.

**Caution**

For simplex applications that have a connection to the TSVC JD1 or JD2 (the K1 relay is being used) verify that SW1 is in the *ON* position, and verify that the green DS1 LED is lit. This indicates that the necessary P28T power is available. If the DS1 LED is not lit, then the K1 trip override relay will not provide the intended protection.

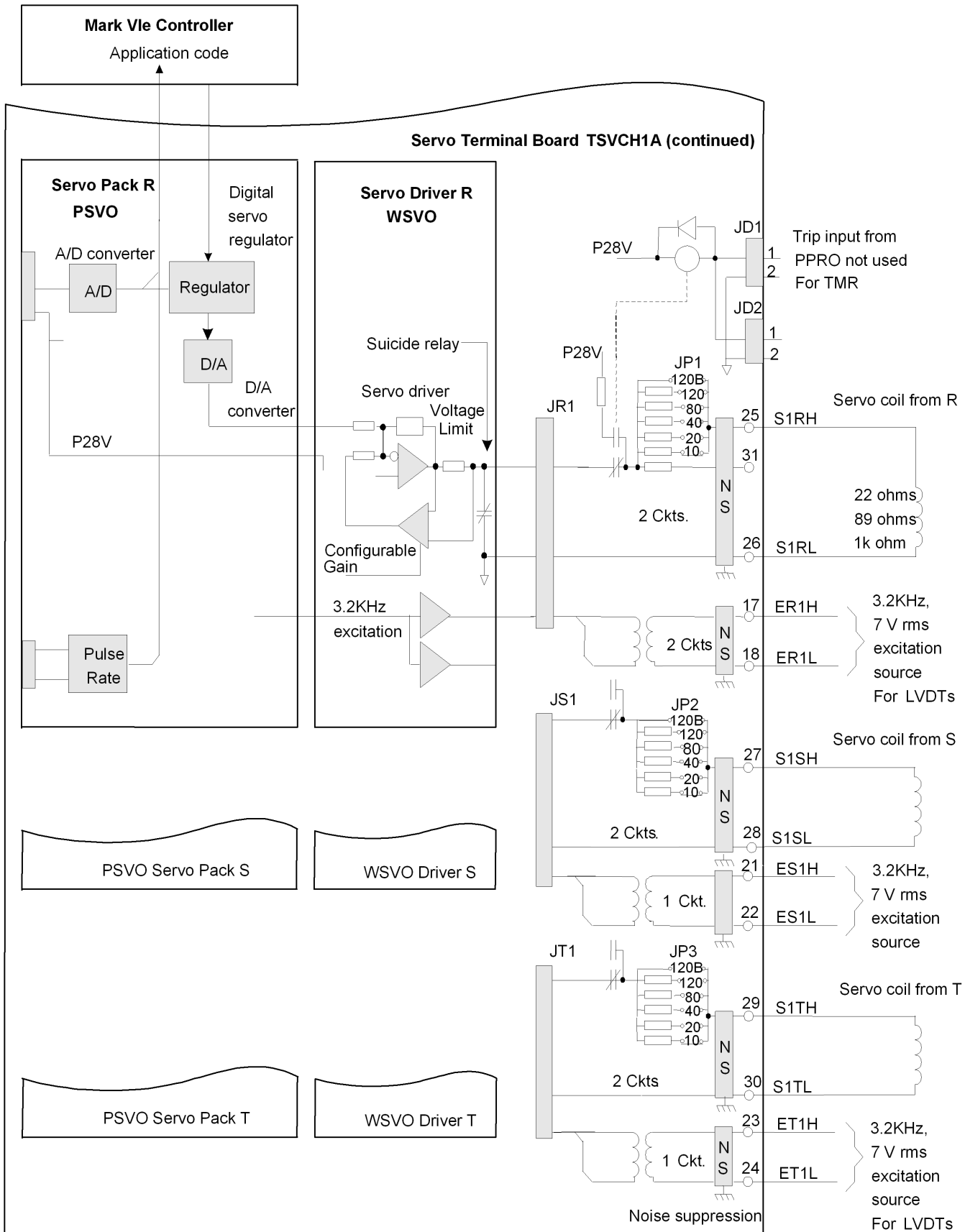
LVDT Excitation

In TMR applications, the LVDT signals fan out to three I/O packs through JR1, JS1, and JT1. A single 5-pin connector brings power into the TSVC where the three voltages are diode high-selected and current limited to supply 24 V dc to the pulse rate active probes.



Note Only two pulse rate probes on one TSVC are used.

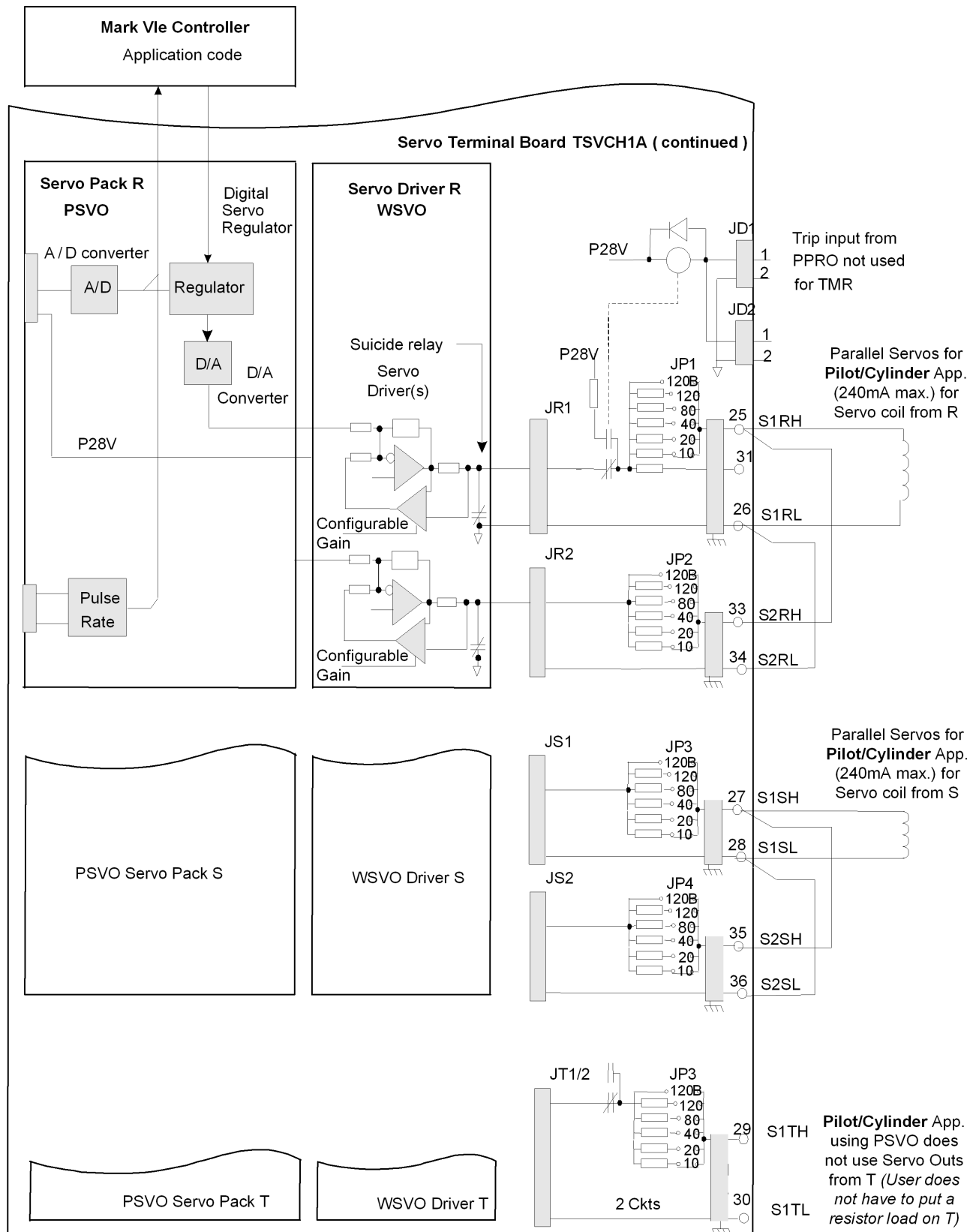
For TMR systems, each servo channel has connections to three output coils with a range of current ratings up to 120 mA, selected by jumper.



TSVC Servo Coil Outputs and LVDT Excitation

Pilot Cylinder Servo Control

The pilot cylinder regulator types are used on low-pressure hydraulic systems with an inner pilot position loop. Both servo outputs must be assigned to the same regulator. Each servo output is configured for ± 120 mA current, yielding a total current of ± 240 mA. The following figure displays approved wiring options and jumper settings.



Servo Coil Resistance

The following table defines the standard servo coil resistance and their associated internal resistance, selected with the terminal board jumpers displayed in the previous figures. In addition to these standard servo coils, it is possible to drive non-standard coils by using a non-standard jumper setting. For example, an 80 mA, 125 Ω coil could be driven by using a jumper setting 120B.

Note The excitation source is isolated from signal common (floating) and is capable of operation at common mode voltages up to 35 V dc, or 35 V rms, 50/60 Hz.

Servo Coil Resistance and Associated Internal Resistance

Jumper Label Coil Type	Nominal Current	Coil Resistance (Ohms)	Internal Resistance (Ohms)	Application
101	±10 mA	1000	180	Simplex and TMR
202	±20 mA	125	442	Simplex
403	±40 mA	62	195	Simplex
404	±40 mA	89	195	TMR
805	±80 mA	22	115	TMR
120A	±120 mA (A)	40	46	Simplex
120B	±120 mA (B)	75	10	TMR
Note This table does not apply when the servo outputs are paralleled.				

The governing equation for determining if the user needs to select a non-standard terminal board jumper position is

$$R_{ILIM_Calculated} = ((12,000 / Servo_MA_OUT) - (Num_Servo_Outs * (RCOIL / Coil_Parallel))) - 10$$

where:

R_{ILIM_CALCULATED} is the maximum terminal board current-limiting resistance in ohms the WSVO servo driver can withstand to push 100% *Servo_MA_OUT* current through the coil. A negative value implies an unreal resistance highlighting an incorrect value for *RCOIL*, *Servo_MA_OUT*, and so forth.

Num_Servo_Outs equals 1 for single servo driver output and equals 2 for two servo driver outputs paralleled.

Servo_MA_OUT is the configuration parameter in the ToolboxST Servo Component Editor, Hardware tab, PSVO or PSVP, Servo tab. The value in milli-amperes defines the servo actuator nominal current.

RCOIL is the servo actuator resistance per coil in ohms.

Coil_Parallel is the configuration parameter found in the ToolboxST Component Editor, Hardware tab, PSVO or PSVP, Servo tab. The value equals 1 for a single coil and equals 2 for two coils paralleled. If the inequality

Jumper Setting Internal Resistance (from table above) > R_ILIM_CALCULATED

is True, then the WSVO will not have the capability to drive 100% current. Select the next lowest terminal board current-limiting resistance from the Internal Resistance column in the *Servo Coil Resistance and Associated Internal Resistance* table.

If the new Internal Resistance value meets the condition

Jumper Setting Internal Resistance $\leq$ R_ILIM_CALCULATED

then use this terminal board current-limiting resistor jumper setting.

The following is an example of this formula:

$R_{ILIM_Calculated} = ((12,000 / 80) - (1 * (125 / 1))) - 10 = 15 \text{ ohms}$

where only one single servo driver output used, the servo actuator resistance is 125 ohms per coil, the nominal current is 80 mA and the servo actuator coils are not paralleled. Based on this calculation, Jumper 120B is selected with the ToolboxST application PSVO or PSVP configuration parameters defined as given in the equation above.

Valve Position

Control valve position is sensed with either a four-wire LVDT or a three-wire linear variable differential reluctance (LVDR) transducer. Redundancy implementations for the feedback devices are determined by the application software to allow the maximum flexibility. LVDT/Rs can be mounted up to 300 m (984 ft) from the turbine control with a maximum two-way cable resistance of 15 Ω .

Two LVDT/R transformer isolated excitation sources are located on the terminal board for simplex applications and another two transformer isolated excitation sources for TMR applications. A fifth and sixth non-isolated excitation source are provided for the customer's use. Excitation voltage is 7 V rms and the frequency is 3.2 kHz with a total harmonic distortion of less than 1% when loaded.

A typical LVDT/R has an output of 0.7 V rms at the zero stroke position of the valve stem, and an output of 3.5 V rms at the designed maximum stroke position (some applications have these reversed). The LVDT/R input is converted to dc and conditioned with a low pass filter. Diagnostics perform a high/low (hardware) limit check on the input signal and a high/low system (software) limit check.

Pulse Rate

Pulse rate inputs support both passive magnetic pickups and active pulse rate transducers (TTL type) interchangeable without configuration. Normally, these inputs are not used on steam turbine applications, but are usually for liquid fuel flow measurement, and monitoring flow divider feedback in gas turbine applications. Pulse rate inputs can be located up to 300 m (984 ft) from the turbine control cabinet. This assumes shielded-pair cable is used with typically 70 nF single ended or 35 nF differential capacitance and 15 Ω resistance.

A frequency range of 2 to 12 kHz can be monitored at a normal sampling rate of either 10 or 20 ms. Magnetic pickups typically have an output resistance of 200 Ω and an inductance of 85 MHz excluding cable characteristics. The transducer is a high-impedance source, generating energy levels insufficient to cause a spark.

Specifications

Item	Specification
Number of inputs	Eight LVDT windings Two pulse rate signals, magnetic or TTL External trip signal to shut off servo outputs
Number of outputs	Two servo valves, three coils each, $\pm(10, 20, 40, 80, 120)$ mA Four excitation sources for LVDTs (transformer isolation) Two excitation sources for LVDTs (no transformer isolation) Two 24 V dc excitation sources for pulse rate transducers TSVCH2 has 6 sources with no isolation
Power supply voltage	Nominal 24 V dc from three supplies P28R, P28S, P28T
Power supply current	5 A dc (Poly-Fuse or current limit rating for each input is 1 A dc)
LVDT excitation output	Frequency of 3.2 ± 0.2 kHz Voltage of 7.00 ± 0.14 V rms
Pulse rate input	Minimum signal for proper measurement at 2 Hz is 33 mVpk, and at 12 kHz is 827 mVpk
Magnetic PR pickup signal	Generates 150 V p-p into 60 Ω
Active PR pickup signal	Generates 5 to 27 V p-p into 60 Ω
Fault detection	Servo current out of limits or not responding Regulator feedback signal out of limits Failed ID chip
Physical	
Size	33.02 cm high x 17.8 cm wide (13 in x 7 in)
Technology	Surface-mount
Temperature	Operating: -30 to 65°C (-22 to 149 °F)

Diagnostics

PSVO makes diagnostic checks on the terminal board components as follows:

- The output servo current is out of limits or not responding, creating a fault.
- The regulator feedback (LVDT) signal is out of limits, creating a fault. If the associated regulator has two sensors, the bad sensor is removed from the feedback calculation and the good sensor is used.
- If any one of the above signals go unhealthy a composite diagnostic alarm, L#DIAG_PSVO occurs. Details of the individual diagnostics are available from the ToolboxST* application. The diagnostic signals can be individually latched, and reset with the RESET_DIA signal if they go healthy.
- Each cable connector on the terminal board has its own ID device that is interrogated by the I/O processor. The ID device is a read-only chip coded with the terminal board serial number, board type, revision number, and the J connector location. When this chip is read by the I/O processor and a mismatch is encountered, a hardware incompatibility fault is created.

Configuration

In a simplex system, servo 1 is configured for the correct coil current with jumper JP1, and servo 2 is configured with jumper JP2. In a TMR system, each servo output can have three coils. In this case, each coil current is jumper selected using JP1, JP3, and JP5 for servo 1, and JP2, JP4, and JP6 for servo 2. All other servo board configuration is done from the ToolboxST application.

Power must be applied to the three channels, so check that all three switches SW1, SW2, and SW3 are ON, and the power indicators for P28 R, S, and T are lit.

Notes