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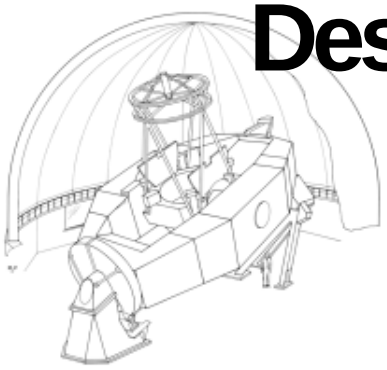
TCS3 Electronics: Hazard Analysis and T3 Design



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1 Hazards Overview

This document will attempt to present the potential hazards connected with operating the IRTF as it relates to the TCS and how the TCS3 and associated systems negate these hazards to put the telescope in a safe condition for operation, maintenance, and facility protection. This document will mainly concentrate on the design of the T3 electronics that is associated with the TCS3 system.

1.1 Potential Hazards

The major hazards areas are: ensuring the telescope is in a safe condition before enabling the system, bringing the telescope to a safe condition after loss of control, and disabling the telescope for maintenance. The table below lists the known hazards and how they are handled by the TCS3 system.

Hazard	Telescope Condition	TCS3 module(s) responding to condition
Loss of Motor	Runaway	Software, T3 over speed circuit, stop and emergency safety switches to software and T3 circuit
Loss of Motor Amplifier	Runaway	Software, T3 over speed circuit, stop and emergency safety switches to software and T3 circuit
Loss of one Motor Amplifier Drive Signal	Runaway	Software, T3 over speed circuit, stop and emergency safety switches to software and T3 circuit
Loss of Motor Tachometer	Runaway	Software, T3 over speed circuit, stop and emergency safety switches to software and T3 circuit
Loss of Encoder	Runaway	Software, T3 over speed circuit, stop and emergency safety switches to software and T3 circuit
Jammed Telescope or dome	Slow or no movement, excessive amplifier current	Software, T3 over current and thermal disable circuit, amplifier thermal disable
Loss of TCS3 computer	Runaway or no movement	T3 watchdog circuit, over speed circuit, operator intervention
Loss of T3 electronics	Loss of fault detection	Software, operator intervention
Loss of motor controller card	Runaway or no movement	T3 motor control signal, T3 over speed circuit, stop and emergency safety switches to software and T3 circuit
Loss of safety switch	Runaway	Three levels of switches: slew, stop, emergency stop
Inadvertent movement of telescope or dome while maintenance is being performed	Personnel safety	T3 Keyed Lockout switch signal, software lockout signal

Platform not stowed	Platform, telescope damage	Software, operator intervention
Crane not stowed	Crane, telescope damage	Software, operator intervention
Telescope in slew speed nearing the end of axis	Runaway?	Software detection, slew safety switch to software

Table 1Hazards

1.2 Response to Hazards

In all cases when a fault condition exists, the motor amplifier drive inputs, the dome amplifier drive inputs, the system power relay and the brake release relay will be disabled by the T3 electronics board.

1.3 Enabling the Telescope

To enable the system the operator must have the dome key switch in the enabled position, the telescope key switch in the enabled position, the emergency stop button in the released state and all external signals must be in their safe state; the external safety signals can be found on the top sheet of the T3 electronics schematic. The TCS3 computer can also lockout the system so this signal must in its unlocked state (high). The TCS motor controller card must then issue a low to high to low reset pulse to the T3 board which will activate the TCS enable signal that enables all five power amplifiers. The TCS then issues the system power enable command which then enables the system power relay which supplies AC power to the motor, the telescope brakes, and the counterweight brakes. The TCS then issues the brake release command which releases the telescope brakes. The telescope is then ready for operation.

2 Overview of the T3 Electronics Board

The philosophy behind the T3 electronics board is that it monitors safety critical signals during telescope operation and provides a second line of defense in the event that the TCS3 computer fails. The board also contains circuitry for the HA and Dec tachometers. The board is resident in the T3 electronics box along with the associated interface hardware for the motor controller board and draws its power from a power supply located in the box.

2.1 Over speed and Over current

These circuits detect an over speed and over current condition for the HA and Dec axis. The signals are brought to a variable voltage divider and compared to a precision ±1V reference. The circuit is essentially the same as the TCS1 system with an improved voltage reference.

2.2 Tachometer Circuit

This circuit provides the signal conditioning, filtering and summing of the tachometer signals. It is the same circuit used in the TCS1 system and was used in the Simulink simulation of the servo system.

2.3 Fault Logic

The fault logic is contained in a separate project schematic to create the VHDL file. The VHDL file is then used to create the configuration file for the XC9500 CPDL using the Xilinx toolset. The external signal connections are noted on the top sheet of the T3 project. As shown on the fault logic sheet, many signals are buffered with an inverter in order to drive the LEDs on the TO panel along with the Opto-22 digital inputs.

2.4 Watchdog Timer

A watchdog timer is used to monitor the health of the TCS3 computer. The TCS3 computer will output a 10 Hz, 50% duty cycle signal to the timer. The timer is set to trigger if it does not detect a falling edge within 150ms. A zero ohm resister may be removed to increase the timeout period to 600ms.

3 TO Panel

The TO Panel contains the LED indicators for the safety switches and the system enable signals. It also contains the system enable key switch, the over ride key switch, floor light switch, and the emergency stop button. The override key switch allows the day crew to override the safety switches in order to move the telescope past the safety switches to the end of the axis for maintenance purposes. The board also contains a joystick that is connected to an Opto-22 unit to allow for manual telescope positioning. The LEDs and switches are shown in the figure 1 and a rough cut at the physical layout is shown in figure 2.

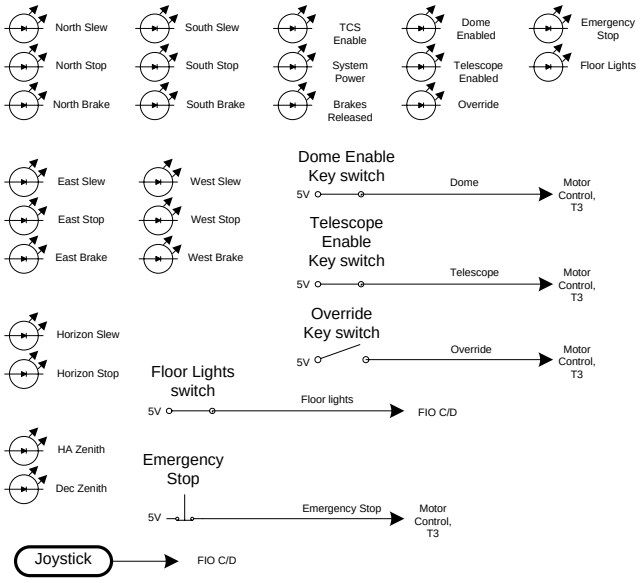

Figure 1 TO Panel Components

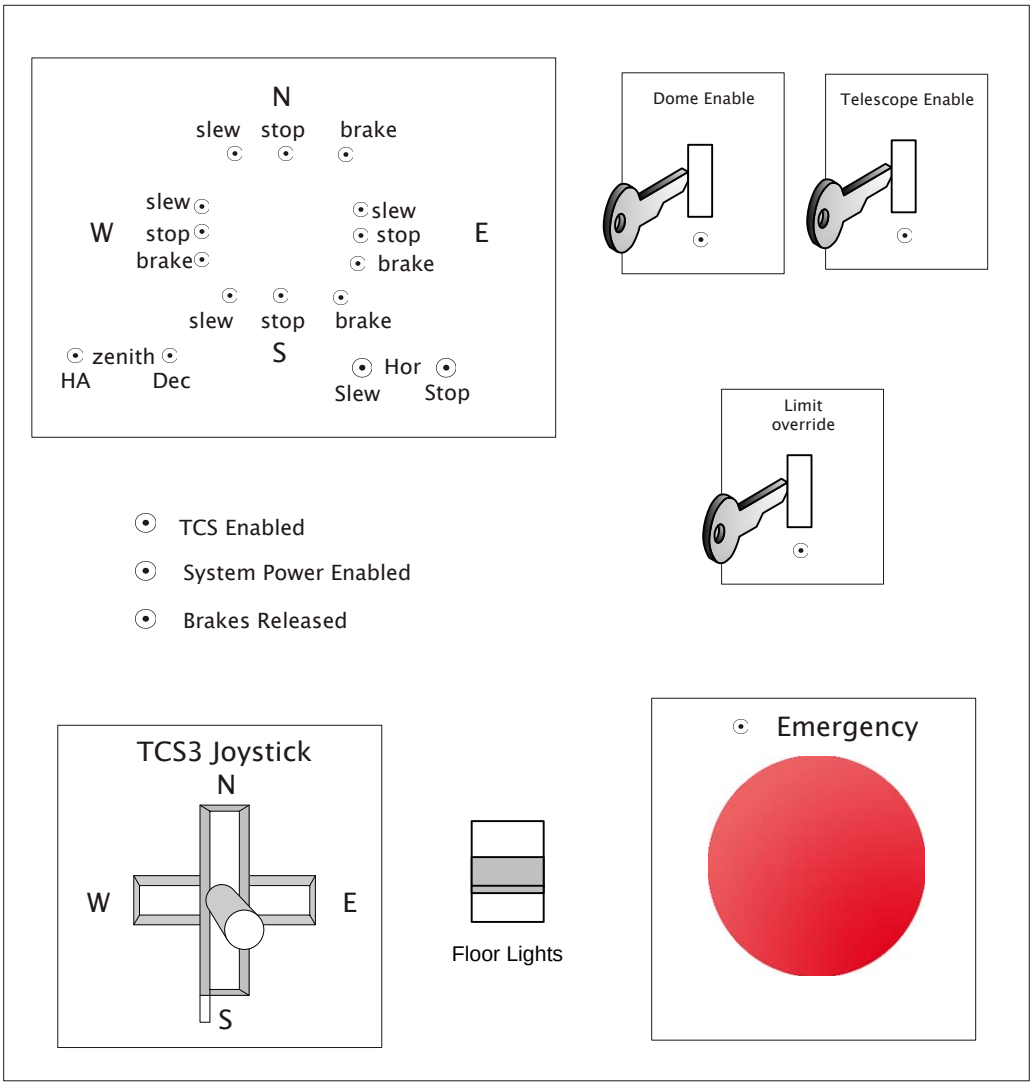

Figure 2 TO Panel Layout