I/O Boards

Most I/O boards, are single width VME boards, of similar design and front cabinet, using the same digital signal processor (TMS320C32).

The central processing unit (CPU) is a high-speed processor designed for digital filtering and for working with data in IEEE 32-bit floating point format. The task scheduler operates at a 1 ms and 5 ms rate to support high-speed analog and discrete inputs. The I/O boards synchronize their input scan to complete a cycle before being read by the VCMI board. Contact inputs in the VCCC and VCRC are time stamped to 1 ms to provide a sequence of events (SOE) monitor.

Each I/O board contains the required sensor characteristic library, for example thermocouple and RTD linearizations. Bad sensor data and alarm signal levels, both high and low, are detected and alarmed. The I/O configuration in the toolbox can be downloaded over the network to change the program online. This means that I/O boards can accept tune-up commands and data while running.

Certain I/O boards, such as the servo and turbine board, contain special control functions in firmware. This allows loops, such as the valve position control, to run locally instead of in the controller. Using the I/O boards in this way provides fast response for a number of time critical functions. Servo loops, can be performed in the servo board at 200 times per second.

Each I/O board sends an identification message (ID packet) to the VCMI when requested. The packet contains the hardware catalog number of the I/O board, the hardware revision, the board barcode serial number, the firmware catalog number, and the firmware version. Also each I/O board identifies the connected terminal boards via the ID wire in the 37-pin cable. This allows each connector on each terminal board to have a separate identity.

I/O Processor Board	Terminal Board	I/O Signal Types	No. per I/O Processor Board	Type of Terminal Board	Comments
VAIC	TBAI (2)	Analog inputs, 0–1mA, 4–20 mA, voltage	20	TMR, simplex	
			4		
		Analog outputs, 4–20 mA, 0–200 mA			
VAOC	TBAO	Analog outputs, 4–20 mA	16	TMR, simplex	
VCCC and VCRC	TBCI (2)	Contact inputs	48	TMR, simplex	(VCCC is two slots)
	TRLY (2)	Relay Outputs (note 1)*	24	TMR, simplex	
VCCC	TICI (2)	Point Isolated Contact inputs	48	TMR, simplex	VCCC-only in place of TBCI. (optional)
VGEN	TGEN	Analog inputs, 4–20 mA	4	TMR, simplex	
		Potential transformers	2		
		Current transformers	3		
	TRLY	Relay outputs (optional)	12		for FAS (PLU)
VPRO (3)	TPRO	Pulse rate	3	TMR	Emergency Protect
		Potential transformers	2		
		Thermocouples	3		
		Analog inputs, 4–20 mA	3		

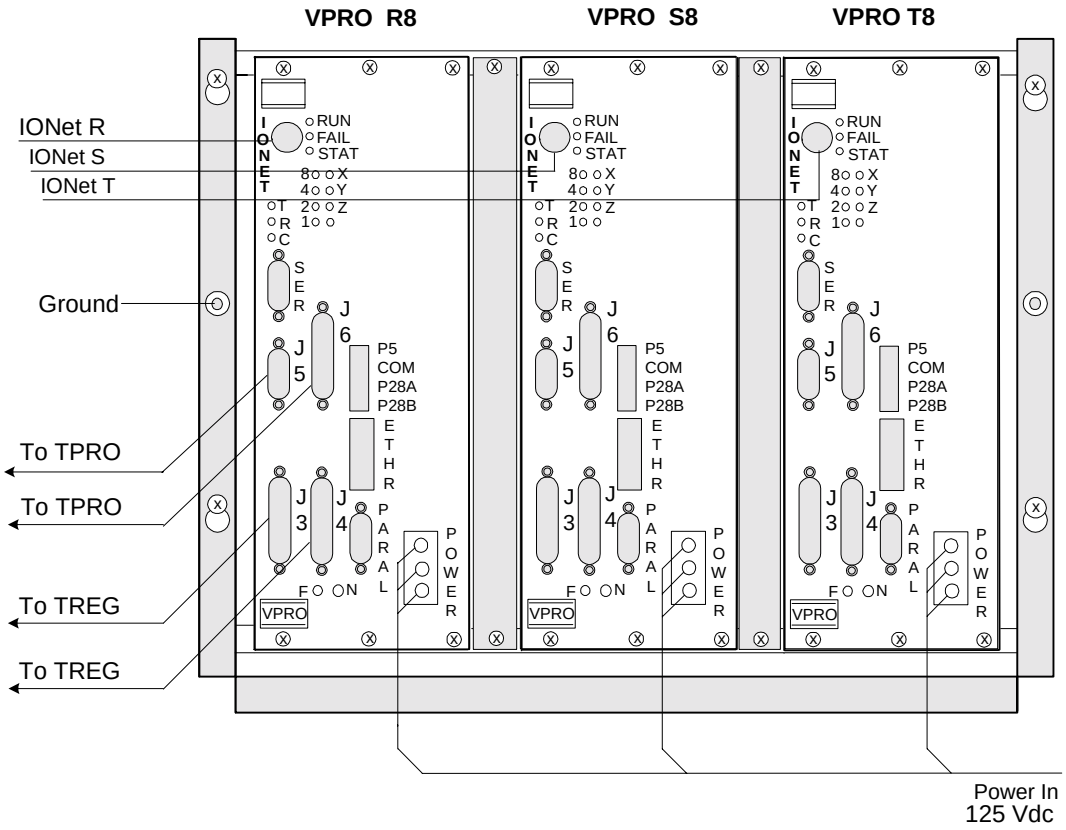
	TREG (2)	Solenoid drivers	6	TMR	Gas turbine
		Trip contact inputs	7		
		Emergency stop	2		Hardwire,Trip ,Clamp
	TREL	Solenoid drivers	3	TMR	Large steam
		Trip contact inputs	7		
	TRES	Solenoid drivers	3	TMR, simplex	Small/medium steam
		Trip contact inputs	7		
VPYR	TPYR	Pyrometers (4 analog inputs each)	2	TMR, simplex	
		KeyPhasor shaft position sensors	2		
VRTD	TRTD,	Resistance Temperature Devices (RTD)	16	TMR, simplex	3 wire
VSVO	TSVO (2)	Servo outputs to valve hydraulic servo	4	TMR, simplex	Trip, Clamp, Input
		LVDT inputs from valve	12		
		LVDT excitation	8		
		Pulse rate inputs for flow monitoring	2		
		Pulse rate excitation	2		
VTCC	TBTC	Thermocouples	24	TMR, simplex	
VTUR	TTUR	Pulse rate magnetic pickups	4	TMR, simplex	
		Potential transformers, gen. and bus	2		
		Shaft current and voltage monitor	2		
		Breaker interface	1		
	TRPG	Flame detectors (Geiger Mueller)	8	TMR, simplex	Gas turbine
		Solenoid drivers (note 2)*	3		
	TRPL	Solenoid drivers	3	TMR	Large steam
		Emergency stop	2		
	TRPS	Solenoid drivers	3	TMR, simplex	Small/med. steam
		Emergency stop	2		
VVIB	TVIB (2)	Shaft vibration probes (Bently Nevada)	16	TMR, simplex	Buffered using BNC
		Shaft proximity probes (Displacement)	8		
		Shaft proximity reference (KeyPhasor)	2		

*Note 1: Refer to the table in the section *Relay Terminal Boards*

*Note 2: VTURH2 occupies two slots and supports two TRPG boards, flame detector support on only the first TRPG.

Turbine Protection Module

The Turbine Protection Module (VPRO) and associated terminal boards (TPRO and TREG) provide an independent emergency overspeed protection for turbines that do not have a mechanical overspeed bolt. The protection module is separate from the turbine control and consists of triple redundant VPRO boards, each with their own on-board power supply, as shown in the following figure. VPRO controls the trip solenoids through relay voting circuits on the TREG, TREL, and TRES boards.



Turbine Protection Module with Cabling Connections

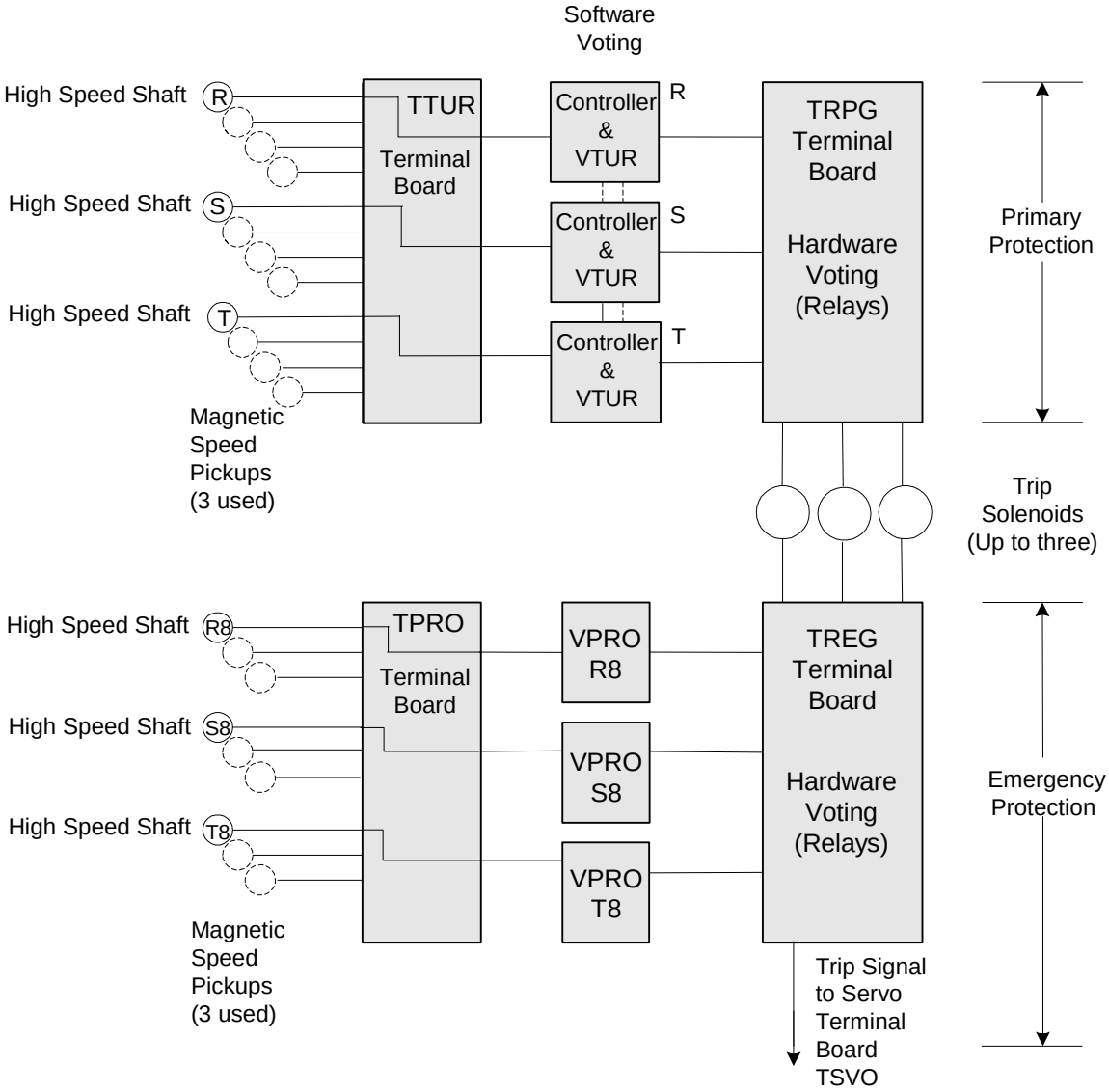
The TPRO terminal board provides independent speed pickups to each VPRO, which processes them at high speed. This high speed reduces the maximum time delay to calculate a trip and signal the ETR relay driver to 20 ms. In addition to calculating speed, VPRO calculates acceleration which is another input to the overspeed logic.

TPRO fans out generator and line voltage inputs to each VPRO where an independent generator synchronization check is made. Until VPRO closes the K25A permissive relay on TTUR, generator synchronization cannot occur. For gas turbine applications, inputs from temperature sensors are brought into the module for exhaust over temperature protection.

The VPRO boards do not communicate over the VME backplane. Failures on TREG are detected by VPRO and fed back to the control system over the IONet. Each VPRO has an IONet communication port equivalent to that of the VCMI.

Turbine Protection

Turbine overspeed protection is available in three levels, control, primary, and emergency. Control protection comes through closed loop speed control using the fuel/steam valves. Primary overspeed protection is provided by the controller. The TTUR terminal board and VTUR I/O board bring in a shaft speed signal to each controller where they are median selected. If the controller determines a trip condition, the controller sends the trip signal to the TRPG terminal board through the VTUR I/O board. The three VTUR outputs are 2/3 voted in three-relay voting circuits (one for each trip solenoid) and power is removed from the solenoids. The following figure shows the primary and emergency levels of protection.



Primary and Emergency Overspeed Protection