

TCM-30/40 - Turbine Control Module



The TCM-30 is the Turbine Control Module for non-governed turbine systems. The TCM-40 offers the same features as the TCM-30, and also provides an integral PID governor. Both Modules are the heart of the Powerbase Platform. The Modules replace typical hydropower generation control systems such as PLCs. PLCs often require considerable system integration with other components and add to the hardware and software engineering costs.

The TCM-30/40 is programmed with the Powerbase Setup Guide. The guide is Windows compatible and features step-by-step programming instructions, online help and rule checks. The rule check feature prevents the user from inadvertently entering any incorrect parameters. This software is included with the GDI-20.

The TCM-30/40 is designed for easy configuration and setup. The “expert” software of the embedded controller operates most types of turbines and associated peripheral equipment.

Typical components include:

- circuit breaker closure
- wicket gate/runner blade operation
- wicket gate/runner blade proportional inputs
- HPU control (dump valve, oil pressure, oil contamination, etc.)
- water maintenance gate
- headpond/trashrack/tailrace sensor input
- power factor correction capacitor control for induction generators
- cooling water
- turbine brakes
- turbine speed

For sites requiring additional I/O, an Expansion Module (EXP-30) is available. This Module replaces a PLC and allows the user to customize system functions, without the need for complex programming. The priority menu system of the EXP-30 ties the new I/O functions into the TCM-30/40 program. To program the EXP-30, the user enters basic English sentences rather than complex computer language code.

At start-up, the TCM-30 opens the wicket gates and controls the Hydraulic Power Unit (HPU) or another hydraulic servo unit. The water flow causes the turbine drive shaft to rotate. The generator RPM is measured with a tachometer/speed sensor located on the generator drive shaft.

For double regulated systems, the TCM-30 contains a 2 dimensional CAM table which relates the wicket gate position to the runner blade angle.

The TCM-30 controls turbine speed and (for synchronous generators only) regulates the speed with pulse width modulation of the Hydraulic Power Unit (HPU) until the internal, programmable synchrocheck relay allows the breaker to close. The TCM-30 can be operated in a manual gate control mode or an automatic water level maintenance mode using a Water Level Sensor (WLS). As many as three WLS can be installed to monitor the headpond, trashrack build-up and tailrace water levels. The fully automatic start, synchrocheck, stop, synchronizing and "system trip" recovery functions allow the power station to operate unattended for extended periods of time.

The TCM-40 expands the TCM-30 features and provides an IEEE Std. 125-1998 compliant, PID governor and turbine simulation/commissioning system, for single regulated turbines.

The TCM-40 replaces the pulse-width modulation control of the wicket gates/runner blades with full PID control. The output uses ± 10 VDC which sends a signal to the proportional HPU. The governor is IEEE Std. 125-1998 compliant and contains a full plant simulation tool. The simulation tool sends data to the Microsoft Excel graphing program. Powerbase manufactures a full line of proportional and non-proportional HPUs to fit your specific system requirements.

Turbine Parameters	Generator Type
<ul style="list-style-type: none"> •any water turbine with a maximum overspeed rating of 4,000 RPM •single or double regulation •wicket gate and/or butterfly valve control •the Powerbase Setup Guide features "expert system" software which configures the system and allows for easy commissioning •user defined expansion I/O 	<ul style="list-style-type: none"> •synchronous or Induction •3 phase output any termination system (Wye, Delta) •any excitation system
User Defined I/O (Optional Expansion Module - EXP- 30)	Exciter Control
<ul style="list-style-type: none"> •16 digital outputs, 24 digital inputs •2 analog outputs, 3 analog inputs •user defined function and "name tagging" for SCADA identification •user defined priority level to any event with TCM-30 control logic •PLC expansion capabilities does not require any additional programming or debugging 	<ul style="list-style-type: none"> •on/off control of exciter or voltage regulator at specific turbine speed •built-in synchrocheck relay ($\pm 10\%$ fixed voltage window, $\pm 20^\circ$ maximum phase angle window)
Hydraulic Control	Water Resource Control
<ul style="list-style-type: none"> •high or low pressure servo operation •low cost PWM operation for speed •proportional control valve is not required •nitrogen accumulator(s) provide automatic safety dump on fault or loss of station power •oil level, pressure and coolant status monitor •wicket gates, runner blades, dump valve and disk brakes operation 	<ul style="list-style-type: none"> •controls gross headpond •adjusts runner blade angle to wicket gate position •monitors trashrack build up and sends an alarm/trip signal •start/stop and regulate features for headpond reading

TCM-40 PID Governor	Governor Simulation
<ul style="list-style-type: none"> •IEEE Std. 125-1998 compliant •±10VDC output to HPU gate/blade control servo •retains all peripheral features of TCM-30 •expanded I/O available with EXP-30 	<ul style="list-style-type: none"> •provides complete plant simulation/commissioning and tuning capabilities •expert system calculates PID initial gain settings •serial port output provides Microsoft Excel graphing capabilities
Left Side Panel Output	Left Side Panel Input
<ul style="list-style-type: none"> •Open Main Breaker (Ch 15, J18) •Close Main Breaker (Ch. 14, J20) •Exciter OFF/PFC Relay (Ch. 13, J4) •Brakes OFF (Ch.11, J6) •Dump Valve ON/ Governor ESD (Ch.10, J7) •Cooling Water Spare (Ch.9, J8) 	<ul style="list-style-type: none"> •User Trip #1/Shear Pin (Ch. 15, J21) •User Trip #2/Governor Error (Ch.14, J22) •Cooling Differential (Ch. 13, J23) •Cooling H2O Pressure Low (Ch.12, J24) •Main Breaker Closed (Ch.11, J30)
Right Side Panel Output	Right Side Panel Input
<ul style="list-style-type: none"> •Blades Open/Governor Start (Ch.1, J1) •Blades Close/Governor Stop (Output Ch.2. J2) •Gates Open/ Governor Raise Setpoint (Output Ch.3, J3) •Gates Close/Governor Lower Setpoint (Output Ch.4, J4) •Brakes ON (Output Ch.5, J5, systems with brakes only) •Open/Close Maintenance Gate (J6 - open, J20 - close, systems with motor operated brakes only) •Cooling Water (Ch.8, J21) 	<ul style="list-style-type: none"> •Synchronism Check (synchronous generators only) •HPU Oil Differential (Ch.10, J23) (for HPUs with contamination filters) •HPU Oil Level Low (Ch.9, J22) •HPU Oil Pressure Low (Ch.8, J14) •Dump Valve Closed (Ch.7, J13) •Cooling Water Flow OK (Ch.6, J12) •Brakes On Feedback (Ch. 5, J11) •WMG Closed (Ch. 4, J10) •WMG Open (Ch. 3, J9) •Blades Position and Gates Position

TCM-30/40 Technical Specifications

Input/Output	
analog inputs	<ul style="list-style-type: none"> •wicket gate and runner blade position, 4-20mA, 8 bit resolution •3 additional provided with expansion chassis
analog outputs	<ul style="list-style-type: none"> •TCM-30 - no analog outputs •TCM-40 - wicket gate PID output and ± 10VDC, 12 bit resolution •2 additional outputs on EXP-30 Module
digital inputs	<ul style="list-style-type: none"> •16 additional in EXP-30 •externally wetted, detection of: <ul style="list-style-type: none"> -coolant water flow -cooling water filter differential pressure -cooling water pressure -hydraulic oil reservoir low -hydraulic oil contamination sensor -hydraulic oil pressure low -main breaker (contactor) closure -2 channels, user defined "soft trip" -disk brakes activated -hydraulic dump valve open -water maintenance gate open/closed -shear pin sensor
special I/O	<ul style="list-style-type: none"> •internally wetted, generator shaft speed •Optocom (RS-485) bus for inter-module communication
General Purpose Outputs	
<ul style="list-style-type: none"> •dry contact form "C", 277VAC/30VDC @ 10A resistive or 220 VDC @ 0.5A inductive •24 additional outputs in EXP-30 •open main breaker (pulsed and continuous) •close main breaker (pulsed and continuous) •under voltage release (continuous) •exciter off (synchronous, pulsed) PFC relay (induction, continuous) •exciter on (synchronous, pulsed or continuous) •brakes on (pulsed or continuous) •brakes off (pulsed or continuous) •HPU dump valve/emergency shutdown •cooling water on/off •secondary cooling water on/off •maintenance gate open/close (pulsed or continuous) 	
Isolation/Communications	
<ul style="list-style-type: none"> •high voltage, optically coupled proprietary Optocom (RS-485) communication interface between Powerbase Modules •1500 VAC high potential test isolation between bus and module •all logic circuits are ground potential 	

General	
power supply voltage	•world universal;100 to 240 VAC, 50/60 Hz. or 110 VDC to 340 VDC
power supply current	•power supply current 0.4 amperes, AC or DC
operating temperature	• -10°C to 50°C, ambient air
storage temperature	• - 20°C to 75°C
humidity	•0 to 95%, non-condensing, conformally coated circuits
EMC/transient protection	•meets European EMC Directive 1997, including radiated, conducted and immunity to EMC and electrical fast transients (IEC 801 and CISPR 11 and 14)
certification	•meets IEEE Std. 37.91-1985 and environmental testing to IEC requirements
shipping weight	•less than 5 kg