1 - PnP 5000 SYSTEM OVERVIEW

The PnP 5000 (Plug and Play – Patent Pending) power generation control system incorporates a unique modularized design of the system components permitting efficient installation of the control hardware and setup of the operating parameters controlling the prime mover and the generator.

Power generation systems historically have been designed for installation of 15 to 20 individual components, which require numerous man-hours to install, connect and coordinate all of the hardware elements comprising the complete control system. By introduction of the concept of standardization for the interconnection cabling, the interface structure of the hardware components and the system programming, the PnP system effectively eliminates 90% of the man-hours needed to assemble and setup the control system.

Human errors during the wiring production process are eliminated by use of standardized prefabricated wiring interconnects thus eliminating the possibility of mistakes during the wiring process. The hardware needed to be physically mounted into the system located on the front door panel and the interior back pan assembly has been reduced to three components. The efficiency of the system design dramatically reduces the associated costs for manufacturing the complete control system.

The manufacturing and service efficiency concepts of the design reduce the total amount of man-hours needed to approximately 2 to 3 hours total per individual generator control cubicle. This timeframe only relates to the installation of hardware and installation of all control interconnect wiring for the control electronics and power supply. The 2 to 3 total man-hours do not include the time needed to manufacture and assemble the physical aspects of the cubicle structure.

Once the structure is assembled, with the circuit breaker and main bus assembly installed, only one door cut out is needed for installation of the entire control cubicle door mounted hardware. The control system requires that only two physical pieces of hardware need to be mounted onto the cubicle back pan assembly located inside the control cubicle. All interconnect wiring is quickly made by installation of prefabricated color-coded, keyed cable interconnects that can only plug into the correct corresponding connector.

The three main assemblies are generally described below.

Door Panel Assembly PnPDC5000-Temp

The control cubicle door panel assembly consists of two pieces of control hardware physically mounted to a common template. The template is manufactured from high quality brushed aluminum. The two hardware assemblies attached to the template overlay are the microprocessor based MMI (Man Machine Interface) and the operator control interface board.

The main control element of the PnP control system is a microprocessor based MMI, which is fully programmable and incorporates a liquid crystal graphical display (assembly number PnP7500-5000). The MMI interfaces with the analog portion of the control system to provide speed control of the prime mover and excitation control of the generator. The controller is physically mounted to the control cubicle front door mounting template (assembly number PnPDC5000-Temp). The graphical display is utilized for display of all metering functions and can also be used to access historical system events that may be used for trouble shooting or system analysis.

The microprocessor-based MMI controller is complete with a 4 line digital and graphical display. The display screen offers the operator access to real time system information that includes all typically displayed power generation parameters such as KW, KVAR, 3 Phase Currents, 3 Phase Voltages, Frequency, etc… The digital display also offers the operator access to other real time system information such as system harmonics, power consumed and power factor with graphical phasor display. Graphical historical trending of all system information complete with power management system interface software is available as an option to the standard control system.

The MMI is fully programmable by use of the front panel access keypad or means of the RS 232 communications port and laptop utilizing the Vista programming and analysis software package (optional). The MMI can also be supplied with a variety of communications port protocols (profibus, modbus, modbus+, etc…) for direct communication with power management or power monitoring systems.

Refer to section 2 of this manual for detailed operating and program information of th MMI.

The second piece of hardware on the control cubicle front door mounting template is the operator control interface board (assembly number PnPDC-5050-A). The interface board is fully encapsulated and provides indications of system operating status, provides the operator control interface and provides the quick connection interface between the MMI and the Motherboard back pan assembly via two color coded, keyed wiring interconnection control cables.

Visual indications supplied by the interface board are located on the front of the door panel assembly. These visual indications include generator operating status, prime mover operating status, main breaker status, synchronization status and status of the master load share control unit. The visual indications are provided by low voltage, high intensity LED's, thus the typical maintenance associated with most other visual indications are eliminated, as the typical incandescent bulb style indicators are not used. The LED's are an integral part of the PnPDC-5050-A assembly.

The interface board also allows the operator direct control inputs for system operation. The operator has the ability to control the prime mover speed, generator voltage adjustment and circuit breaker operation. The prime mover mode switch provides selections for OFF, IDLE, RUN SPEED and REMOTE control of the engine/generator set by an external source such as a power management system.

Each individual generator controller incorporates it's own stand-alone synchronization check circuit, thus providing a redundant feature for this purpose. The breaker close push button located on the interface board is positioned next to the "IN Sync" LED indication. When the LED is illuminated the breaker close push button is enabled and can be depressed to close the breaker and placing the generator online in parallel operation with other control units already online.

A complete description of these functions can be found in section 3 of this manual.

The door panel assembly is mounted with one door cut out. A mounting template is provided with the PnP system for ease of installation. The mounting template is of sufficient design to allow for use with a sheet metal nibbling tool or other such production tool as needed. The mounting holes for the template are direct overlays for the mounting holes attaching the door panel assembly, thus after the cut out is made the door panel assembly can be directly attached and is ready for the control wiring interconnection to the Mother Board back pan assembly.

The door panel assembly control interconnect wiring physically connects to the Mother Board back pan assembly by means of two prefabricated, color coded, keyed plug and receptacle control cables. The keyed control cables can only be connected to the correct corresponding mating connection receptacle thus eliminating the possibility of human error during the interconnect process.

Refer to the system wiring interconnection philosophy Fig 1-1 in this section for details.

Mother Board Backpan Assembly PnP-MTRBD-5000

The Motherboard assembly is designed to quickly mount to the control cubicle back pan by means of four ¼-20 slotted mounting screws. In general the motherboard contains the integration housing for engine/generator control electronics, the synchronization electronics, load sharing electronics for any other control units connected to the common AC distribution bus and the system power supply which includes all distributive system safety fusing. The framework assembly is manufactured from high grade anodized aluminum.

The Mother Board back pan assembly (assembly number PnP-MTBRD-5000) also provides a vehicle for integration of control signals collected, processed and distributed between the plug in analog control boards, the generator PT's and CT's and the door panel assembly components. Located at the top of the assembly are the color-coded, keyed receptacles that are specially designed to accept only the correct corresponding matching keyed control interconnect plug.

Six circuit board slots are provided for the control boards. Five slots are needed for system operation. The sixth slot is designated for the optional 500 Htz PWM control interface in the event the prime mover is a Caterpillar B series engine or other such pulse width speed control units. The control boards are sized for standard Eurocard PCB dimensions. A forced air-cooled heat sink assembly is attached to the left end of the Motherboard. The heat sink incorporates the generator excitation SCR's and the power supply circuit protection zener diodes. The heat sink is attached to the Motherboard assembly via an internally hinged connector with quick release latches located on the front of the heat sink assembly. This design allows for ease of access to all of the mounted components.

Each circuit card is securely attached to the Motherboard cage housing using screw type quick connects. All self aligning card connectors are mil spec rated and are of the gold flash over nickel plated, solder connection style.

Field connections to the prime mover and generator control are provided by screw type terminal connections located on the front of the circuit boards associated with each of the functions. High current circuit breaker interconnect screw type terminals are provided for operation of the breaker close and under voltage release coil physically located within the circuit breaker. This design allows for control interface with a wide variety of circuit breakers, which includes medium voltage breaker operators. The contacts are isolated and are designed to accept an externally supplied breaker control voltage or use of the internally generated PnP control voltage.

The complete Motherboard assembly with all associated functions and individual circuit board descriptions can be found in section 3 of this manual.

Control Power Transformer PnPCPT5001

The PnP control system utilizes one control transformer to provide a variety of integrated functions. The transformer is quickly mounted to the control cubicle back pan by means of four ¼ - 20 screws. The transformer (assembly number PnPCPT5001) is encapsulated with a protective coating and is over sized by 35% to alleviate voltage droop problems associated with 6 pulse consumers of load connected to the main distribution bus. The VA rating of the transformer will vary and is dependant upon the power needed for full excitation of the generator to be controlled.

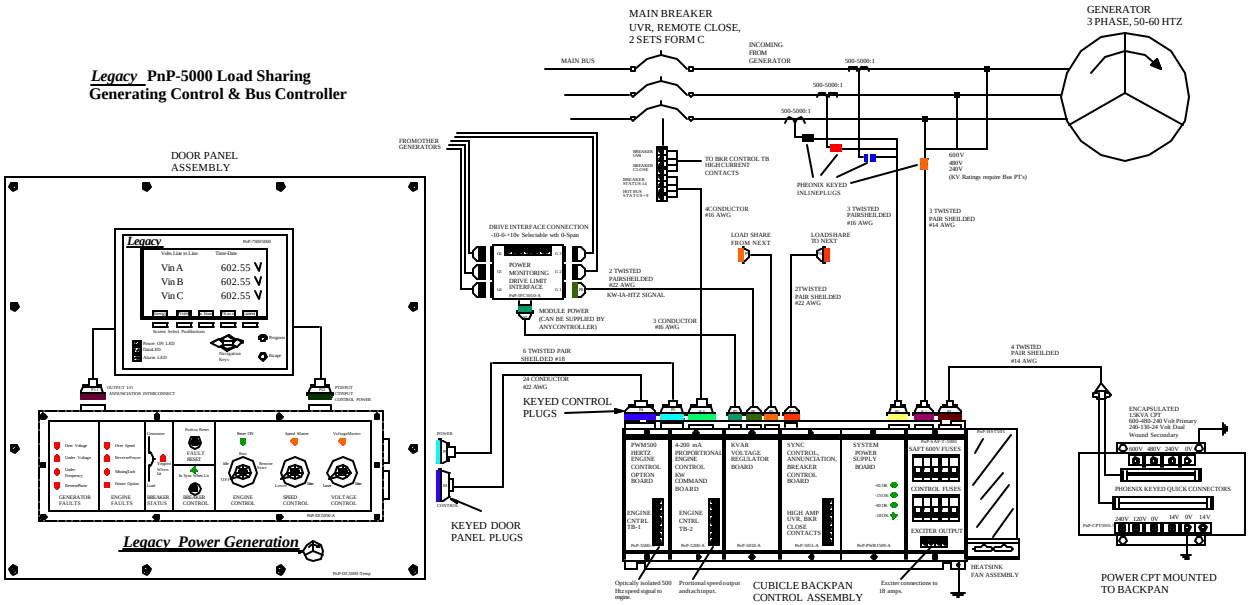
This design is unique in nature, as most comparable control systems require a minimum of three control transformers to be installed and wired for system control.

The primary and secondary wiring connections are attached to Phoenix keyed connectors with screw down fasteners thus the prefabricated power interconnection cables can only be connected to the correct corresponding connector. Selection of the proper primary input voltage is easily made by selection of the proper termination point located on the Phoenix keyed connector.

The primary voltage has three taps. These are for 600 volt, 480 volt and 240 volt direct inputs. The secondary winding is of a dual winding design which provides either 240 volt or 120 volt single phase power for the generator excitation control power and a dual center tapped 14 volt winding for conversion to the power needed for the control electronics.

Control Wiring Interconnect

Figure 1-1 below depicts the unique PnP system wiring interconnection method. Note that the concept has dramatically simplified the system interconnections.



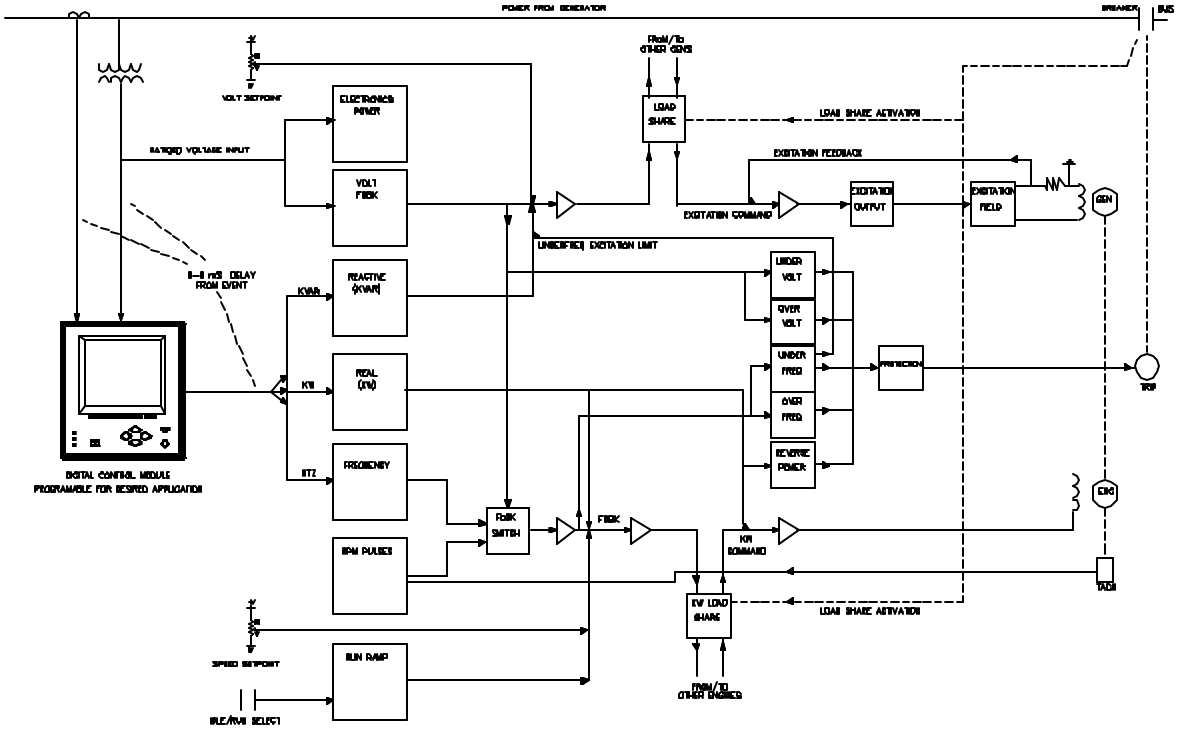
PnP System Interconnection Philosophy
Fig. 1-1

Flow of Controlled Functions

Figure 1-2 below represents an elementary block diagram of the PnP control system. The flow of processed signals from the feedback system to the control output signals is viewed from left to right. Note that the programmable controller processes the system feedbacks. The solution is then passed to the analog circuits for interface with system hardware such as the engine, generator and main circuit breaker.

The PnP control system combines new proven microprocessor technology with a time proven durable analog control interface.

NOTE : The bus sync and drive interface portion of the controls are not shown below.



PnP Elementary Functional Block Diagram
Fig. 1-2