Title: AUTOMATIC MODULE CONFIGURATION IN A TELECOMMUNICATIONS POWER SYSTEM AND BATTERY CONFIGURATION WITH A CLICK

Abstract: An automatic configuration system for a telecommunications power system includes a power bus and a communications bus. A controller that is connected to the communication bus employs a serial communications protocol. A module transmits an identification signal to the controller that contains an identification number of the module. The modules include rectifier modules, battery connection modules and distribution modules. Each module transmits the identification signal after the module is initially connected to the power bus and the communications bus. The controller receives the identification signal and form the module. The controller stores the identification number and generates a module ID for the module that is transmitted to the module for use by the module in further serial communications with the controller. An automated battery configuration system for a telecommunications power system includes at least one rectifier module, a controller and at least one backup battery. A database system is associated with the controller stores a plurality of records that include a plurality of backup battery parameters. A user interface that is associated with the controller receives user-provided input of at least one battery specifying parameter. The user interface communicates with the database system to retrieve a selected one of the records based on the battery specifying parameter. The controller communicates with the database system and employs at least one of the parameters of the selected record to alter an operating setting of the telecommunications power system. The battery specifying parameters include a manufacturer designation and a model designation of the backup battery.

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AUTOMATIC MODULE CONFIGURATION IN
A TELECOMMUNICATIONS POWER SYSTEM
AND BATTERY CONFIGURATION WITH A CLICK

TECHNICAL FIELD OF THE INVENTION

This invention relates to telecommunications power systems. More particularly, this invention relates to automatic module configuration in a telecommunications power system and to a graphical user interface-enhanced system and method for configuring the telecommunications power system to work with different user-selected backup batteries.

BACKGROUND AND SUMMARY OF THE INVENTION

Telecommunications power systems generally employ rectifiers that generate a direct current (DC) voltage from an alternating current (AC) power source. Distribution modules include circuit breakers that connect the rectifiers to loads and that distribute current to the loads. The loads in a telecommunications power system typically include telephone switches, cellular equipment, routers and other associated equipment. In the event that AC power is lost, the telecommunications power systems generally rely on backup batteries to provide power and to prevent costly down time due to loss of service. Telephone switches, cellular equipment and routers normally carry data streams and/or thousands of calls that will be interrupted if power is lost causing a significant loss of revenue.

Conventional telecommunications power systems have typically required highly skilled engineers and technicians to design, to set up and to configure the telecommunications power system. Setting up the telecommunications power system with less skilled personnel is potentially dangerous due to the high current involved and is sometimes very costly when mistakes occur and service is interrupted. By requiring highly skilled engineers and technicians to be involved, the cost of operating the telecommunications power system remains relatively high. If a problem such as service interruption occurs, significant delays can occur while waiting for an engineer or technician with the proper training. In an effort to decrease the cost of ownership, manufacturers of telecommunications power systems continue to simplify their systems to decrease the expertise of personnel required to set up the systems and to diagnose problems.

Most consumers are unaware that the telephone companies provide a 48-volt direct current (DC) supply voltage via telephone lines for voice communications signals. The telephone lines carry the DC voltage to support the voice
communications signals even when the customer loses alternating current (AC) power. The DC voltage is provided by the telecommunications power systems that are generally situated at central office switching locations and other substations. The telecommunications power systems also power the switches and associated telecommunications equipment upon which the telephone infrastructure operates. The telecommunications power systems typically include banks of rechargeable batteries to ensure that the DC supply voltage can be maintained during AC power outages.

In addition to the switches, other telecommunications systems also require an uninterruptable supply of DC power. These systems include Internet switching and routing nodes, cellular telephone equipment, and other telecommunications system equipment. Although the voltage and current requirements may vary, all of these telecommunications systems need reliable DC power supplies with backup battery systems.

A bank of storage batteries for a moderate-sized telecommunications power system typically includes one or more large pallets of backup batteries that include one or more strings of 24 to 26 battery cells. When longer backup periods are desired, the number and/or size of battery strings is increased. Backup batteries for a typical installation represent a sizeable investment. Often, the backup batteries cost as much as or more than the remaining components in the telecommunications power system. Understandably, engineers focus on maximizing backup battery life while minimizing the operating costs.

Replacing backup batteries in the telecommunications power system can be an intimidating proposition. The telecommunications power systems are designed to deliver high current. Heavy-duty cables, typically several inches in diameter, are used to deliver the current. To optimize backup battery life, the telecommunications power systems generally need to be initially configured, reconfigured when new batteries are added, and/or reconfigured when the backup batteries are replaced. For example, the float voltages, maximum-operating voltages, charge current and other parameters vary from one type of battery to another due to differences in the construction of the backup batteries.

There are many manufacturers and models of backup batteries that can be used for telecommunications power systems. Configuring the telecommunications power systems to operate with a particular type of backup battery through conventional techniques requires the consideration of many parameters. Highly
trained engineers are needed to determine appropriate float voltages, alarms and other settings for a particular backup battery. The required use of highly skilled engineers increases the owning and operating costs of the telecommunications power system.

An automatic module configuration system according to the invention allows a telecommunications power system to be quickly and easily installed and later expanded. The automatic module configuration system includes modules that identify their serial number on a serial communications bus when initially connected to the telecommunications power system. A controller associated with the telecommunications power system receives and stores the serial number of the module and assigns a module ID for subsequent communications with the controller and other modules. Because an identifier packet of the serial communications protocol cannot accommodate the entire serial number, part of the serial number is coded into the identifier packet and the remaining part is coded in the data packet. If collisions between the data packets associated with two modules occur, new identifier packets and data packets are coded and transmitted until collision does not occur and the module ID is assigned.

The present invention provides a far more convenient and user friendly system for setting battery parameters in the telecommunications power systems. The invention provides a simple graphical user interface for selecting parameters such as a battery manufacturer and a battery model. The invention employs a user interface manager that receives the user input and interfaces with a database manager to access a database. The database manager uses the manufacturer and model designations to access a pre-stored table of parameters for a selected backup battery. The parameters, along with other user-supplied information, are used to generate the proper settings for a specific installation.

The software architecture of the preferred embodiment allows setup using a display screen and touch pad assembly located on the master controller or through a remote site using a web browser. Additionally the database can be updated from the remote site. Thus, a technician or engineer can reconfigure the telecommunications power system from a remote site. This allows additional flexibility in coordinating the schedules of maintenance personnel with an attendant reduction in the overall cost to operate the system. Additionally, the technician can remotely modify, delete or add records for backup batteries to keep the database up to date.

For a more complete understanding of the invention, its objects and its
advantages, refer to the following specification and to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a block diagram illustrating a telecommunications power system that includes a frame that is connected to multiple loads, and a battery pallet with a plurality of battery cells according to the invention;

FIG. 2 is a functional block diagram of FIG. 1;

FIG. 3 is a functional block diagram of a partially configured telecommunications power system;

FIG. 4 is a functional block diagram of the load distribution module of FIGS. 2 and 3 in further detail;

FIG. 5 is a functional block diagram of the rectifier module of FIGS. 2 and 3 in further detail;

FIG. 6 is a functional block diagram of the battery connection module of FIGS. 2 and 3 in further detail;

FIG. 7A illustrates an identifier packet employed by a serial communications protocol;

FIG. 7B illustrates a data packet employed by the serial communications protocol; and

FIG. 8 is a flow chart illustrating steps for automatically configuring a module for communications in the serial communications system.

FIG. 9 is a block diagram of a telecommunications power system according to the invention that includes a frame that is connected to a plurality of loads and a battery pallet with a plurality of batteries;

FIG. 10 is a functional block diagram of the telecommunications power system of FIG. 1;

FIG. 11 is a functional block diagram of the distribution module of FIG. 1 in further detail;

FIG. 12 is a functional block diagram of the rectifier module of FIG. 1 in further detail;

FIG. 13 is a functional block diagram of the battery connection module of FIG. 1 in further detail; and

FIG. 14 is a functional block diagram illustrating a battery configuration system according to the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1, a telecommunications power system 10 includes one or
more frames 12 that include a rack 16. A direct current (DC) bus 30 includes first and second conductors 32 and 34 that extend along the rack 16 in a vertical direction. An insulating layer (not shown) separates the first and second conductors 32 and 34. A communications bus 40 is located adjacent the DC bus 30 and likewise includes a layer (not shown) that insulates the communications bus 40 from the first and second conductors 32 and 34.

The design of the telecommunications power system 10 is modular such that the capacity of the system can be easily changed by adding or removing modules from the telecommunications power system 10. The design of the telecommunications power system 10 has been optimized through the use of modular connectors (not shown) to facilitate the connection and disconnection of the modules from the frame 12.

The telecommunications power system 10 includes one or more battery connection modules 44 that are connected to the DC bus 30 and the communications bus 40. The battery connection module 44 is connected to a pallet of batteries 48 that includes a plurality of battery cells 50. In a preferred embodiment, each battery cell 50 provides a two-volt output and a relatively high current output. The battery cells 50 are connected into battery strings (identified at 106 in FIG. 2) that contain 24 to 26 battery cells. Each battery string provides 48 VDC for telephone switch and router applications. Depending upon the length of time desired for the battery backup period and the size of loads to be supplied, the size and/or number of batteries may be varied. Skilled artisans can appreciate that other voltages, string sizes and packaging arrangements can be employed if desired.

One or more distribution modules 56 are connected to the DC bus 30 and the communications bus 40. The distribution modules 56 distribute power to one or more loads 60 such as telecommunications switches, cellular equipment and routers. For example in FIG. 1, the distribution module 56-1 delivers power to loads 66, 68 and 70. The distribution module 56-2 delivers power to loads 72, 74, 76, and 78. Connections between the loads and the backup batteries have been omitted for purposes of clarity.

A master controller 86 is connected to the DC power bus 30 and the communications bus 40. The master controller 86 includes a display 90 and an input device 94 that may include a touch pad 96 and buttons 98 and 100. An alternate display can be a computer monitor. The input device 94 and the display 90 can be combined into a touch screen display. A keyboard and a mouse may be employed. The master controller 86 preferably provides an Internet browser-like interface that is navigated using the touchpad 96 in a conventional point-and-click manner or using the
touchpad 96 and the buttons 98 and 100. Alternately, a text-based, menu-driven interface can be provided.

The telecommunications power system 10 further includes one or more rectifier modules 104 that are connected to the DC bus 30 and the communications bus 40. Each of the rectifier modules 104 is individually connected through a circuit breaker (not shown) to one or more AC power sources 105 such as that provided by utilities or other power generating devices.

Referring now to FIG. 2, the telecommunications power system 10 in FIG. 1 is illustrated in further detail. In use, the AC power source 105 provides voltage that is typically between 80 and 300 VAC and that has a frequency between 45 and 65 Hz. The rectifier modules 104 rectify the AC power and provide a controllable output voltage and current. For telephone switch and router applications, the rectifiers are rated at 48 VDC nominal at 50 or 200 amps. During operation, the rectifiers 104 operate at a float voltage that is typically between 52 and 54 VDC (depending upon battery characteristics) to prevent battery discharge. Skilled artisans can appreciate that other voltage and current levels may be provided by the rectifiers without departing from the spirit of the invention.

Depending upon the type of batteries employed, the output voltage of the rectifier modules 104 will normally be higher than 48 volts. One or more battery strings 106 are connected to the battery module 44. Typically, the rectifier modules 104 operate at a float voltage of the batteries such that the batteries during normal operation discharge little or no current and the backup batteries are maintained in a charged state. The rectifier modules 104 preferably include a shunt and an analog to digital (A/D) converter for sensing rectifier voltage and rectifier current. The rectifier module 104 transmits the rectifier voltage and current signals to the controller 86 via the communications bus 40. Preferably, the controller employs a serial communications protocol that is insensitive to noise. In a preferred embodiment, the communications system employs CAN protocol such as CAN 2.0B.

The distribution modules 56 include one or more circuit breakers that are preferably modular plug-in circuit breakers to facilitate installation and removal. The distribution module connects the loads 60 to the power bus 30.

Referring now to FIG. 3, a partially configured telecommunications power system 107 is illustrated. Reference numerals from FIGS. 1 and 2 are used where appropriate. Initially, the master controller 86 is connected to the DC bus 30 and the communications bus 40. Preferably, at least one rectifier module 104 and/or a backup
battery is connected to provide power for the master controller 86. As each of the
modules (distribution module 56-1, rectifier module 104-1 and battery connection
module 44) are connected to the DC bus 30 and the communications bus 40, the
modules automatically interface with the master controller 86 to configure the modules
for further communications with the master controller 86 and other modules in the
telecommunications power system 10.

The modular design of the telecommunications power system 10 allows a less
experienced technician to add modules to the telecommunications power system 10 as
needed. The technician simply places a module in an appropriate position in the rack
16 and slides the module in. The master controller periodically transmits an
acknowledgment request signal to the modules. If the module was not previously
configured, the module generates an identification signal which is received by the
controller 86. The identification signal contains a serial number of the module and a
request for a module ID. The master controller 86 receives the identification signal,
stores the serial number, and assigns the module ID to the module for further serial
communications with the master controller 86 and other modules. The controller 86
stores the serial number and the module ID for each module that is connected to the
telecommunications power system 107 in a table that is stored in memory of the
controller 86. Once the module is configured, it sends a data packet containing the
module ID to the master controller 86 to acknowledge receipt of the module ID. When
subsequent acknowledgment request signals are transmitted by the master controller
86, the module transmits an acknowledgment message containing the module ID. If the
module fails to send an acknowledgement message in response to the
acknowledgement request signal, the master controller 86 assumes that the module
has been removed and/or is defective.

Referring now to FIG. 4, the distribution module 56 is illustrated in further detail
and includes a neuron 120, a contactor 124, an input/output (I/O) interface 128, an
analog to digital (A/D) converter 132, and a shunt 136. Sensing leads 140 and 142
sense a voltage across the contactor 124. The contactor 124 provides load
disconnection. The neuron 120 actuates the contactor 124 through the I/O interface
128. Because contactors are a single point of failure, some system operators opt for
battery disconnection instead of load disconnection. When the contactor 124 fails,
power to the loads is interrupted. When battery disconnection is used, the load is not
interrupted when the contactor fails. Both types of disconnection may be employed if
desired.
Loads 60 are connected through circuit breakers (not shown) to the distribution module 56. Sensing leads 140 and 144 measure a voltage drop across the shunt 136 so that a calculation of load current is made by the neuron 120 and the A/D convertor 132. Sensing leads 144 and 146 measure a voltage drop across the loads 60. The neuron 120 performs local calculations and processing and provides I/O communications with the master controller 86 and other modules.

Referring now to FIG. 5, the rectifier module 104 is illustrated and includes a rectifier 150, a shunt 152, an A/D converter 154, a neuron 156 and an I/O interface 160. The rectifier 150 is connected to the AC power source 105. The rectifier 150 rectifies the alternating current power input and provides a controllable DC voltage and current output. Sensing leads 170 and 172 measure a voltage drop across the shunt 152 that is used to calculate the rectifier output current. Sensing leads 170 and 174 sense a voltage across the rectifier output. The neuron 156 performs local processing and calculations and provides I/O communications with other modules and the master controller 86.

Referring now to FIG. 6, the battery connection module 44 is illustrated in further detail. The battery control module 44 includes a contactor 190, a shunt 192, an A/D converter 194, an I/O interface 196, and a neuron 200. The contactor 190 connects and disconnects batteries from the telecommunications power system 10. In particular, the master controller 86 and/or the neuron 200 opens the contactor 190 when the backup batteries discharge below a low voltage disconnect threshold. Sensing leads 204 and 206 sense a voltage drop across the contactor 190. Sensing leads 206 and 208 sense a voltage drop across the shunt 192 that used to calculate the current output of the batteries. Sensing leads 208 and 210 measure a voltage across the batteries. The A/D converter 194 communicates with the I/O interface 196 to provide the current and voltage measurements. The neuron 200 performs local processing and calculations and communicates with other modules and the master controller 86.

Referring back to FIG. 3, when the modules 44, 56 and 104 are initially connected to the telecommunications power system 107, the neurons 120, 156 and 200 transmit the identification signals on the communications bus 40 when the acknowledgement request signal from the master controller 86 is received. The identification signals generated by the modules are received by the master controller 86. The identification signals contain the serial numbers of the modules. The controller stores the serial numbers and assigns module IDs for the modules. The controller 86 transmits the module IDs to the neurons 120, 156 and 200. Subsequent
communications to and from modules via the communications bus 40 employ the module IDs. When the master controller 86 transmits the acknowledgement request signal, the modules transmit the acknowledgment message that contains the module ID.

Referring now to FIG. 7A and 7B, when communicating using a serial communications protocol, each message contains an identifier packet 220 and a data packet 224. The identifier packet 220 contains system information and the module ID during normal communications that occur after configuration. The identifier packet 220 is typically followed by the data packet 224 that generally contains data.

A problem arises when the serial number of the module that is to be connected requires more bits than are available for the module ID in the identifier packet 220. In this situation, only a portion of the serial number can be used in the identifier packet of the identification signal when the module is initially connected. The possibility exists that more than one module will be connected to the communications bus 40 at the same time. Problems occur when the portion of serial number that is selected for one module and that is used in the identification packet matches a portion of the serial number for another module that is used in an identifier packet of a second identification signal.

The CAN serial communications protocol employs arbitration on identifier packets. For example when a first module is initially connected, the first bit of the identifier packet of the identification signal for the first module is sent. If an identifier packet of an identification signal for another module has the same first bit, the second bits of both identifier packets are sent. If the second bits are different, the CAN protocol gives priority to the identifier packet with the "1" bit and the identifier packet with the "0" bit is delayed until after the identifier packet and the data packet of the "priority" message is sent. If, however, two modules have the same identifier packets, a collision will occur in the data packets. Both messages fail when a collision occurs. Since the data packet contains the remaining part of the serial number that is presumably a unique number/letter combination, the data packet for the two modules will never be the same even if the identifier packets are the same. Even when the identifier packets are the same, the data packets are different, a collision is bound to occur and both messages fail.

The CAN protocol defines a 29-bit identifier packet 220 and an 8 byte data packet 224. Some of the bits in the identifier packet may be inherent to the CAN protocol and the remaining bits are user-defined. The identifier packet employed in the
present invention includes a priority field 226 that contains bits 26-28. Bits 21 through 25 (identified at 228) are currently reserved. A first serial number field 230 includes bits 13 to 20 and contains a byte of the serial number. A flow field 231 contains bit 12 and is set to "0" when a message is traveling from a neuron to the master controller 86. The flow field 231 is set to "1" when the message is travelling from the master controller 86 to the neuron. A command field 232 contains bytes 10 and 11 and identifies an auto configuration function, a peer to peer function, a master to slave function, and a slave to master function. A byte location field 234 contains bits 8 and 9 that identify a first serial number byte of the serial number that is contained in the identifier packet. A second serial number field 236 contains a second byte from the serial number of the module.

The data packet 224 contains a byte "0" with a command field 242 and a neuron group field 244. Bytes 1 through 6 preferably contain consecutive bytes from the serial number of the module when the identification signal is sent.

Initially, the identifier packet contains the 1st byte of the serial number in the first serial number field 230 and the 2nd byte in the second serial number field 236. The 3rd through 8th bytes of the serial number are assigned to the 1st through the 6th bytes, respectively, of the data packet 224. If arbitration occurs, the identifier packet 220 and the data packet 224 remain unchanged. The priority message continues to be sent and the non-priority message is delayed.

If a collision occurs, the identifier packet 220 and the data packet 224 for both modules are changed. The first serial number field 230 is replaced with the 3rd byte of the serial number and the second serial number field 236 is replaced with the 4th byte of the serial number. The 1st through 4th bytes of the data packet 224 are filled with the 5th through 8th bytes of the serial number. The 5th and 6th bytes of the data packet 224 are filled with the 1st and 2nd bytes of the serial number.

If a second collision occurs, the first serial number field 230 is replaced with the 5th byte of the serial number. The second serial number field 236 is replaced with the 6th byte of the serial number. The 1st and 2nd bytes of the data packet 224 are replaced with the 7th and 8th bytes of the serial number. The 3rd through 6th bytes of the data packet 224 are replaced with the 1st through 4th bytes of the serial number. Skilled artisans can appreciate that other techniques for positioning and rotating the bytes of the serial number in the identifier packets and the data packets can be employed when collisions occur without departing from the spirit of the invention.

Referring now to FIG. 8, a flow chart illustrates steps for automatically configuring modules in the telecommunications power system 10. In the preferred
embodiment, control occurs in both the master controller 86 and the neurons associated with the modules being configured (such as neurons 120, 156 and 200 in FIG. 3). Skilled artisans can appreciate that other combinations of controllers and neurons may be employed for control. At step 250, control begins. At step 252, the neurons create an identification signal that includes an identifier packet and a data packet after initially being plugged into the rack 16. Alternately, the modules can be connected before the telecommunications system 10 is powered. At step 256, the neuron begins transmitting the identification signal by transmitting each bit of the identifier packet serially via the communications bus 40. At step 258, the neurons determine whether the identifier packet has been successfully sent. If arbitration occurs, the identifier packet may be delayed until the identifier packet can establish priority on the communications bus 40. If the identifier packet has not been sent, control loops back to step 256.

When the identifier packet is sent, control continues with step 260 to transmit the data packet. At step 262, the neuron determines whether there has been a collision with the data packet. If a collision occurs, control continues with step 264 where the neuron creates a new identification signal. The neuron moves the serial number bytes in the identifier packet and the data packet and changes the byte location field 234. Then, control loops to step 256.

If no collision occurs, control continues with step 266 where the master controller 86 stores the bytes of serial number of the module. Preferably, the controller 86 reassembles the bytes into the serial numbers of the modules. Control continues with step 268 where the master controller 86 assigns a module ID to the module. Control continues with step 270 where the master controller 86 transmits the module ID to the module. Then, control continues with step 274 where the neuron of the module employs the module ID in the identifier packets for subsequent serial communications. Control ends with step 276 for this module and controller continues in a similar sequence to configure the remaining modules.

Referring now to FIG. 9, a telecommunications power system 1010 is illustrated and includes one or more frames 1012 that include a rack 1016. A direct current (DC) bus 1030 includes first and second conductors 1032 and 1034 that extend along the rack 1016 in a vertical direction and that are separated by an insulating layer (not shown). A communications bus 1040 is located adjacent the DC bus 1030 and likewise includes a layer (not shown) that insulates the communications bus 1040 from the first and second conductors 1032 and 1034.

The design of the telecommunications power system 1010 is modular such
that the capacity of the system 1010 can be changed by adding or removing modules from the system 1010. The design of the telecommunications power system 1010 has been optimized through the use of modular connectors (not shown) to facilitate the connection and disconnection of the modules from the frame 1012.

The telecommunications power system 1010 includes one or more battery connection modules 1044 that are connected to the DC bus 1030 and the communications bus 1040. The battery connection module 1044 is connected to a pallet of backup batteries 1048 that includes a plurality of battery cells 1050. In a preferred embodiment, each of the battery cells provides a two-volt output and a relatively high current output. The battery cells 1050 are typically connected into battery strings (identified at 1106 in FIG. 10) that contain from 24 to 26 battery cells. Each battery string provides 48 VDC for telephone switch and router applications. The number and/or capacity of the backup batteries may be varied depending upon the length of time desired for the battery backup and the size of load to be supplied.

Skilled artisans can appreciate that other voltages, string sizes and packaging arrangements can be employed for telecommunications power systems having other power requirements.

One or more distribution modules 1056 are connected to the DC bus 1030 and the communications bus 1040. The distribution modules 1056 distribute power to one or more loads 1060 such as telecommunications switches, cellular equipment and routers. For example in FIG. 9, the distribution module 1056-1 delivers power to loads 1066, 1068 and 1070. The distribution module 1056-2 delivers power to loads 1072, 1074, 1076, and 1078. The number of distribution modules depends on the size and number of the loads that are associated with the telecommunications power system 1010.

A master controller 1086 is connected to the DC power bus 1030 and to the communications bus 1040. The master controller 1086 includes a display 1090 and an input device 1094 that preferably includes a touch pad 1096 and buttons 1098 and 1100. An alternate display can be a computer monitor. The input device 1094 and the display 1090 can be combined in a touch screen display. A keyboard and/or a mouse may also be employed. The master controller 1086 preferably provides an internet browser-like interface that is navigated using the touch pad 1096 in a conventional point-and-click manner or using the touch pad 1096 and the buttons 1098 and 1100. Alternately, text-based and/or menu-driven interfaces can be provided.
The telecommunications power system 1010 further includes one or more rectifier modules 1104 that are connected to the DC bus 1030 and the communications bus 1040. A generator 1102 supplies the rectifier modules 1104 when AC power from an AC source 1105 is lost. Referring now to FIG. 10, the backup batteries are typically connected in battery strings 1106 containing 24 to 26 battery cells. The AC power source 1105 is connected to the rectifier modules 1104 using circuit breakers 1107. The generator 1102 provides backup AC power using a transfer switch (not shown) in a conventional manner when AC power is lost. Connections between the loads, the generator, and the backup batteries have been omitted in FIG. 9 for purposes of clarity.

In use, the AC power source 1105 provides voltage that is typically between 80 and 300 VAC at a frequency between 45 and 65 Hz. The rectifier modules 1104 rectify the AC voltage provided by the AC sources 1105. The rectifier modules 1104 provide a controllable output voltage and current and are rated at 48 volts nominal and 50 or 200 amps. Skilled artisans can appreciate that other rectifier voltage and current outputs can be provided depending upon the requirements of the telecommunications power system 1010.

Depending upon the type of backup batteries employed, the output voltage of the rectifier modules 1104 will be set higher than 48 volts. Typically, the rectifier modules 1104 operate at a float voltage of the backup batteries during normal operation so that the backup batteries do not discharge current. The float voltage is typically set between 52 and 54 VDC depending upon the characteristics of the backup batteries.

The rectifier modules 1104 preferably include a shunt, sensing leads, and an analog to digital (A/D) converter for sensing rectifier voltage and current. The rectifier module 1104 transmits digital signals representing the rectifier voltage and current (in addition to other digital control and communications signals) to the controller 1086 via the communications bus 1040. Likewise, the battery control modules 1044 and the distribution modules 1056 include a shunt, sensing leads, and an analog-to-digital converter for sensing battery and load voltages and currents. Preferably, the controller 1086 employs a serial communications protocol that is insensitive to noise. In a preferred embodiment, the communications system employs serial communications using a CAN protocol such as CAN version 2.0B.

The distribution modules 1056 include one or more circuit breakers (not
shown) which are preferably modular plug-in type circuit breakers to facilitate connection and disconnection of the loads 1060. The distribution module 1056 connects the loads 1060 to the DC power bus 1030.

Referring now to FIG. 11, the distribution module 1056 is illustrated in further detail. The distribution module 1056 includes one or more circuit breakers (not shown) that are located between the loads 1060 and the DC bus 1030. The distribution module 1056 includes a contactor 1150, a shunt 1154, an A/D converter 1158, an I/O interface 1162, and a neuron 1166. The contactor 1150 is controlled by the neuron 1166 through the I/O interface 1162. The contactor 1150 connects and disconnects the loads 1060 and is provided if the telecommunications system operator desires load disconnection. Otherwise, the contactor 1150 can be omitted to prevent the single point of failure. If the contactor 1150 fails, power to the loads is interrupted and service will be lost. If battery disconnection is substituted (as in FIG. 13) and a contactor fails, the loads still receive power.

The neuron 1166 is preferably a controller that includes a processor and memory (not shown). The neuron 1166 performs local processing for the distribution module 1056 and I/O communications between the distribution module 1056, the master controller 1086, and other modules in the telecommunications power system 1010. The I/O module 1162 is connected to the neuron 1156 and to the A/D converter 1158. The A/D converter 1158 includes sensing leads 1170 and 1172 that sense a voltage across the contactor 1150. The sensing lead 1170 and sensing lead 1174 sense a voltage across the shunt 1154 so that a load current can be calculated. The sensing leads 1174 and 1176 sense a voltage output across the loads 1060.

Referring now to FIG. 12, the rectifier modules 1104 are illustrated in further detail and include a rectifier 1180, a shunt 1182, an A/D converter 1184, an I/O interface 1186, and a neuron 1188. The neuron 1188 performs local processing functions for the rectifier module 1104 and controls I/O communications between the rectifier module 1104, the master controller 1086 and other modules in the telecommunications power system 1010. The A/D converter 1184 includes sensing leads 1190, 1192, and 1194. The A/D converter 1184 senses a rectifier voltage using the sensing leads 1192 and 1194 and a rectifier current by sensing a voltage across the shunt 1182 using leads 1190 and 1192.

Referring now to FIG. 13, the battery connection module 1044 is illustrated and includes a neuron 1200, an I/O interface 1202, an A/D converter 1204, a shunt 1206 and a contactor 1208. The neuron 1200 performs local processing functions
and I/O communications between the battery connection module 1044, the master controller 1086 and other modules in the telecommunications power system 1010. The contactor 1208 is controlled by the neuron 1200 through the I/O interface 1202. The A/D converter 1204 includes sensing leads 1210, 1212, 1214, and 1216. The A/D converter 1204 senses a battery voltage using the leads 1214 and 1216. The A/D converter 1204 senses a battery current by sensing a voltage drop across the shunt 1206 using the leads 1212 and 1214. The A/D converter 1204 senses a voltage across the contactor 1208 using the leads 1210 and 1212.

Referring now to FIG. 14, the master controller 1086 is illustrated in further detail. The master controller includes an I/O interface 1230 that is connected to a processor 1234 and memory 1238. The memory 1238 includes random access memory (RAM), read only memory (ROM) and/or a storage device such as a hard drive, a floppy drive, an optical drive, or other suitable electronic memory storage. In use, the memory 1238 loads an operating system module 1240. A database manager 1242 communicates with a database 1244 that contains one or more relational tables 1248. One of the relational tables 1248 contains a plurality of rows of backup battery parameter records. Each record contains a plurality of backup battery parameters that relate to a single type of backup battery. Each of the backup battery parameter records is uniquely identifiable using a primary key. One or more data fields may be used to create the primary key.

A user interface manager 1250 provides a graphical user interface (GUI) 1254 for user interaction. Alternately, a menu-driven or text-based menu can be substituted for the GUI 1254. In addition to other screens, the GUI 1254 includes a battery selection screen 1258. A backup battery selection interface 1260 identifies the type of backup batteries used in the telecommunications power system 1010 along with other battery configuration information. In a preferred embodiment, the backup battery selection interface 1260 allows the user to select and/or input a first backup battery parameter that is used to identify the type and/or characteristics of the backup batteries used in the telecommunications power system 1010. A product brand name, a serial number or a Universal Product Code (UPC) may be sufficient to uniquely identify the type of backup batteries to be used. Alternately, one or more additional parameters may be needed (in combination with the first parameter) to uniquely identify the type of backup battery used.

In a preferred embodiment, the backup battery parameter is a manufacturer designation. A drop-down list box 1264 for selecting the manufacturer of the backup
batteries is used. Since manufacturer typically make more than one type of battery, a second parameter is preferably a model designation of the backup battery. A drop-down list box 1268 allows the user to select a model designation for the manufacturer. Drop-down list boxes 1264 and 1268 facilitate data entry and data integrity by requiring the user to select from a list that is provided by the database 1244. Entry of invalid manufacturers due to typographical errors is avoided. When the user selects the manufacturer using the drop-down list box 1264, the model designations provided in the drop-down list box 1268 are preferably limited to those associated with the manufacturer. The manufacturer and model designations are used in combination to create the primary key for accessing the relational table 1248. The primary key is used to lookup additional parameters for the backup batteries that have been identified.

The user enters the number of backup battery strings 1106 in the telecommunications power system 1010 using a text box 1272. Data validation using acceptable ranges can be employed to verify the users input. For example, the number of strings in a telecommunications power system 1010 is typically limited between a first number and a second number (such as 1 and 99). The user enters the number of cells per string in text box 1274. Range checking is likewise employed to limit the number of cells per string between a third number and a fourth number (such as 24 and 26). A capacity per string, typically specified in Amps-Hours (AH), is also input using a text box 1276. Command buttons 1280 and 1284 allow the user to approve or cancel the changes.

In addition to the manufacturer and model designations, the battery database 1244 preferably contains parameters relating to a cell float voltage. One or more of the following parameters may be included: a recommended cell float voltage at a nominal temperature (NFVC); a maximum cell float voltage at the nominal temperature (HFC); a maximum cell float voltage with temperature compensation (TCM) at the nominal temperature (HFCTCM); a minimum cell float voltage at the nominal temperature (LFC); and a minimum cell float voltage with TCM at the nominal temperature (LFCTCM).

The battery database 1244 preferably contains one or more parameters relating to voltage alarm thresholds. One or more of the following parameters may be included: a high voltage alarm threshold per cell (HVC); a low voltage alarm threshold per cell (LVC); a high voltage shut down alarm threshold per cell (HVSDDC); a battery on discharge alarm threshold per cell (BODC); and a battery on discharge
alarm threshold with TCM per cell (BODCTCM).

Other likely parameters include an equalized voltage per cell (EQLC); a temperature compensation slope (TCS); a maximum recharge current in percentage of the AH rating (MRC %); a nominal operating temperature (NOT); and/or a maximum operating temperature (MOT).

By designating the manufacturer and the model, the correct parameters can be assigned to appropriate system operating settings. Data entry errors are significantly reduced over manual entry methods. In a preferred embodiment, all of the parameters listed above are stored in the records of the relational table 1248.

Skilled artisans can appreciate that one or more of the parameters listed above can be omitted from the records of the relational table 1248 without departing from the spirit of the invention. Likewise, parameters in addition to those listed above can be included in the relational table 1248.

In use, the master controller 1086 and/or the neurons 1166, 1188, and 1200 use the parameters to operate the telecommunications power system 1010. A user employs the display 1090 and the I/O device 1094 of the master controller 1086 to access the user interface manager 1250 that provides the battery parameter interface 1260. Using the buttons 1098 and 1100 and/or the touch pad 1096, the user selects the manufacturer designation from the drop-down list box 1264 and the model designation using the drop-down list box 1268. Text boxes, text-based selection menus and other types of entry may be used. The user enters the number of strings in the telecommunications power system 1010 using the text box 1272. The user enters the number of cells per string in the text box 1274. The capacity per string is also input using the text box 1276. The command buttons 1280 and 1284 allow the user to approve or cancel the selections.

When the user approves the selections, the user interface manager 1250 communicates with the database manager 1242 and the database 1244. The database manager 1242 and the database 1244 identify a selected record using the manufacturer and model designations to access the relational table 1248. The related parameters are returned to the database manager 1242 for use by the master controller 1086. The master controller 1086 assigns the parameters to system operating settings that may be stored in another table in the database 1244 and/or in the memory 1238. The master controller 1086 operates the telecommunications power system 1010 based on the stored system operating settings.

The database manager 1242, the database 1244 and the relational table
1248 can be accessed remotely using a distributed communications system 1290 such as the Internet using a remote computer 1294. The remote computer 1294 may also be used to access the backup battery selection interface 1260 using a web browser. The remote computer 1294 sends commands that update the relational table by adding records for new types of backup batteries, modifies one or more records to reflect changes in the parameters, adds or deletes data fields in the relational table 1248 and/or deletes records for obsolete types of backup batteries. By providing access via the distributed communications system 1290, the remote computer 1294 can keep the relational tables 1248 of one or more telecommunications power systems 1010 up to date.

As can be appreciated from the foregoing, the automatic module configuration system according to the invention dramatically simplifies module set up. The skill level required to setup the system or to increase system capacity through the addition of distribution modules, battery connection modules, and/or rectifier modules is decreased as compared to conventional systems. By simplifying set up, the owning and operating costs are reduced.

Those skilled in the art can now appreciate from the foregoing description that the broad teachings of the present invention can be implemented in a variety of forms. Therefore, while this invention has been described in connection with particular examples thereof, the true scope of the invention should not be so limited since other modifications will become apparent to the skilled practitioner upon a study of the drawings, the specification, and the following claims.
CLAIMS
What is claimed is:

1. An auto-configuration system for a telecommunications power system, comprising:
   a power bus;
   a communications bus;
   a controller connected to said communications bus that employs a serial communications protocol; and
   a module that transmits an identification signal to said controller that contains an identification number of said module after said module is initially connected to said power bus and said communications bus,
   wherein said controller receives said identification signal from said module, stores said identification number and generates a module ID for said module which is transmitted to said module for use in subsequent serial communications.

2. The auto-configuration system of claim 1 wherein said identification signal includes an identifier packet and a data packet that comply with said serial communications protocol.

3. The auto-configuration system of claim 2 wherein said identifier packet contains fewer bits than are required to uniquely identify said identification number.

4. The auto-configuration system of claim 3 wherein said identification number is split between said identifier packet and said data packet.

5. The auto-configuration system of claim 4 wherein said identifier packet contains a command field and a data field that contains first and second bytes of said identification number.

6. The auto-configuration system of claim 5 wherein said identifier packet further includes a byte location field that identifies a location of said first and second bytes within said identification number.

7. The auto-configuration system of claim 6 wherein said serial communications protocol performs arbitration on said identifier packet.

8. The auto-configuration system of claim 7 wherein said module changes said identification signal when a collision occurs and resends a new identification signal.

9. A method of automatically configuring a telecommunications power system that includes a power bus, a communications bus, and a controller that is connected to said communications bus, comprising the steps of:
transmitting an identification signal to said controller that contains an
identification number for a module after said module is initially connected to said
power bus and said communications bus;

receiving said identification signal at said controller;

storing said identification number in said controller; and

generating a module ID for said module which is transmitted to said module
for use in subsequent serial communications.

10. The method of claim 9 further comprising the step of:
coding said identification signal with an identifier packet and a data
packet that comply with a serial communications protocol.

11. The method of claim 10 wherein said identifier packet contains fewer
bits than are required to uniquely define said identification number.

12. The method of claim 11 further comprising the step of:
splitting said identification number between said identifier packet and
said data packet.

13. The method of claim 12 further comprising the step of:
coding a command field and a data field that contains first and second
bytes of said identification number in said identifier packet.

14. The method of claim 13 further comprising the step of:
coding a byte location field that identifies a location of said first and
second bytes within said identification number in said identifier packet.

15. The method of claim 14 wherein said serial communications protocol
performs arbitration on said identifier packet.

16. The method of claim 15 further comprising the step of:
identifying when a collision occurs between said identification signal
for said module and a second identification signal for a second module.

17. The method of claim 16 further comprising the steps of:
generating a new identification signal for said first module; and
transmitting said new identification signal to said controller.

18. An automated battery configuration system for a telecommunications
power system of the type including at least one rectifier module and at least one
backup battery, comprising:
a controller;
a database system associated with said controller for storing a
plurality of records that include a plurality of backup battery parameters; and
a user interface associated with said controller for receiving user-
provided input of at least one battery specifying parameter,
wherein said user interface communicates with said database system
to retrieve a selected one of said records based on said battery specifying parameter,
and
wherein said controller communicates with said database system and
employs at least one of said parameters of said selected record to modify an
operating setting of said telecommunications power system.

19. The automated battery configuration system of claim 18 wherein said
user interface includes a graphical user interface.

20. The automated battery configuration system of claim 18 wherein said
user interface includes a text-based, menu-driven interface.

21. The automated battery configuration system of claim 18 wherein said
user interface is accessed using a display and an input device that is associated with
said controller.

22. The automated battery configuration system of claim 18 wherein said
user interface is accessed using a remote computer through a distributed
communications system.

23. The automated battery configuration system of claim 18 wherein said
battery specifying parameter includes a manufacturer designation of said backup
battery.

24. The automated battery configuration system of claim 18 wherein said
battery specifying parameter includes a model designation of said backup battery.

25. The automated battery configuration system of claim 18 wherein said
parameters include at least one of a high voltage alarm, a low voltage alarm, a float
voltage of said backup battery, a temperature-based parameter, and a backup
battery discharge alarm.

26. The automated battery configuration system of claim 18 further
comprising:
a distributed communications system;
a remote computer that is connected to said distributed communications
system, wherein said remote computer modifies at least one of said plurality of
records.

27. The automated battery configuration system of claim 18 wherein said
user interface receives user-provided input of at least one of the following: a number
of backup battery strings, a number of cells per string, and a capacity per string.

28. A method for automatically configuring a backup battery system for a telecommunications power system of the type including at least one rectifier subsystem and at least one backup battery, comprising the steps of:

storing a plurality of records in a database, wherein each record includes a plurality of backup battery parameters;

receiving user-provided input of at least one battery specifying parameter;

communicating with said database to retrieve a selected one of said records based on said battery specifying parameter; and

employing at least one of said parameters of said selected record to modify an operating setting for said telecommunications power system.

29. The method of claim 28 further comprising the step of:

providing a graphical user interface for receiving said user-provided input.

30. The method of claim 28 further comprising the step of:

accessing a user interface using a display and an input device that is associated with a controller.

31. The method of claim 28 further comprising the step of:

accessing a user interface using a remote computer through a distributed communications system.

32. The method of claim 28 further comprising the step of:

designating at least one battery specifying parameter to be a manufacturer designation of said backup battery.

33. The method of claim 28 further comprising the step of:

designating at least one battery specifying parameter to be a model designation of said backup battery.

34. The method of claim 28 wherein said parameters include at least one of a high voltage alarm, a low voltage alarm, a float voltage of said backup battery, a temperature-based parameter, and a backup battery discharge alarm.

35. The method of claim 28 further comprising the step of:

receiving user-provided input of at least one of the following: a number of backup battery strings, a number of cells per string, and a capacity per string using a user interface.