

CIRCUIT DESCRIPTION

CD-6C332-02
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APPENDIX 1A
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COMMON SYSTEMS
3B BATTERY CHARGER
CIRCUIT

CHANGES

D. Description of Changes

D.1 Removed the alarm leads from positions 3, 4, 5, and 6 of connector J109B. This action prevents ambiguity in alarm reporting from the 3B unit when powering an LM23 multiplex in conjunction with a SLC³ 96 system. Also, removal of the leads corrects an inoperable condition when an LM12 multiplex is co-powered from the 3B with either a SLC 96 system or an LM23.

D.2 The modified 3B battery chargers are designated Series 2.

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DEPT 54531-JTH-DHM

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SECTION I - GENERAL DESCRIPTION

1. PURPOSE OF CIRCUIT

1.01 This circuit provides signal-grade 48 Vdc power for two loop-electronic loads at remote locations. It has provisions to charge either one or two strings of 25-Ah, sealed, lead-acid, standby batteries, and to transfer the two 48-volt loads to the batteries when commercial power fails. In addition, the circuit provides two 117-Vac outputs to power the battery shelf heaters, and two alarm signals: one when commercial power fails; the other when a high dc load voltage, an open battery string, or a low battery string voltage condition occurs.

2. GENERAL DESCRIPTION OF OPERATION

2.01 The rectifier circuit provides two dc outputs: one supplies 48 volts at 0 to 8.5 amperes to power two external loads; and the other supplies 64 volts at 0 to 2.5 amperes to the battery-charging circuits. It should be noted that the outputs are floating on this circuit; therefore, the circuit common (+ 48 volt output) must be grounded externally to properly polarize the outputs as negative voltages.

2.02 A ferroresonant transformer is used to isolate the rectifier outputs from the ac input source and to provide the secondary voltages required. The output voltages are regulated by the triac-firing circuit for changes in line, load, frequency, and temperature. The 48-volt output is regulated along with the sensed 64 volts because the 48-volt output is derived from part of the same secondary winding which provides 64 volts to the charging circuits.

2.03 With the control circuit disconnected and the secondary saturating, the output voltages are limited to 20% above the normal regulated values. This is an important feature since most of the control circuitry is contained on a plug-in unit and most applications will not require a power-down to replace a faulty control unit.

2.04 When commercial power fails, a relay is energized to connect the batteries to the 48-volt outputs and a power alarm signal is generated. The ac sensing circuitry has a built-in hysteresis, which helps to keep the relay energized for at least 20 seconds. This feature is provided to prevent chattering of the relay.

2.05 Two sensing circuits continuously monitor the 48-volt output voltage. One circuit deactivates a relay at a predetermined low-voltage point to disconnect the batteries from the load to prevent an excessive discharge of the batteries. The other sensing circuit generates a minor alarm signal for high voltage on the 48-volt output when ac is present and suspends a fast charge (high-rate) while the high-voltage condition exists. A minor alarm is also generated by other circuits for an open battery string or a low battery string voltage condition.

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2.06 The battery charging circuits provide dual-rate charging for the standby batteries. For all anticipated discharge conditions, the high-rate charge is designed to return more capacity to the batteries than was removed during discharge. A low-rate or float-charge current is used to keep the batteries in a fully-charged condition.

2.07 Additional charging flexibility is provided by two manual, pushbutton switches. Batteries may be placed, at any time, on a 24-hour high-rate charge with the HI switch, or shifted from a high-rate to low-rate charge with the LO switch. A lighted HI lamp provides visual indication of high-rate charge. The RESTART switch permits manual restarts to connect the batteries to the loads in situations where ac power is unavailable and the power transfer relay is de-energized.

SECTION II - DETAILED DESCRIPTION

1. RECTIFIER CIRCUIT (FS 1)

1.01 The primary winding (1-2) of the ferroresonant transformer (T1) is connected to the ac supply through fuse F1, which provides overload protection for the input. Fuse F2 provides overload protection for the battery shelf heater circuits.

1.02 The transformer is constructed with magnetic shunt paths which provide an equivalent high leakage inductance between the primary winding and the secondary windings. This inductance is tuned, with an ac capacitor (C1) connected across the secondary winding 10-11, to a frequency near the 60-Hertz source frequency in order to obtain a high-Q, series-resonant circuit. With power applied to the primary winding and with the control circuit disconnected, the resonant circuit produces (across the capacitor winding) a voltage of sufficient amplitude to cause saturation of the secondary portion of the iron of the transformer each half-cycle of the input. Thus, the half-cycle average output voltage is independent of the input voltage over its specified range, but the voltage will vary with frequency and temperature.

1.03 The full-wave rectified 48-volt output is obtained from T1 center-tapped winding 3-4-5 and diode assembly CR1. Similarly, the full-wave rectified 64-volt output supplied to the charging-circuits is obtained from T1 center-tapped winding 6-4-9 and diode assembly CR2. Capacitor C4 filters the 48 volts and C3 filters the 64 volts. After turnoff, capacitors C4 and C3 are discharged by bleeder resistors R3 and R2 respectively.

1.04 The plug-in circuit pack (YL1B) and its plug-in circuit module (CM1B) provide the vast majority of the 3B control circuitry. The circuitry for both of these

units is shown and described in detail in SD-7CD-6C332-01.

FERRO CONTROL CIRCUIT

1.05 The ferro control circuit consists of a voltage reference, bias voltage source, integrator, differential amplifier, comparator, and a triac firing circuit. The triac Q1 and its related circuitry are mounted on the chassis. Capacitor C2 and resistor R1 form a snubber network used to reduce voltage spikes across Q1 during turn on and turn off. Inductor L1 provides a controlled leakage inductance to output winding 10-11.

1.06 The output of T1 winding 12-13 is applied to pins 47 and 48 of YL1B, wherein it is full-wave rectified and then processed to provide an internal, regulated 12-volt source that: supplies the 5-volt reference; the amplifier package; and the triac firing circuit.

1.07 The 5-volt reference output is one input of the differential amplifier. The 64 volts across C3- pins 3 and 7, 32 of YL1B- is sensed and reduced to 5 volts by a voltage divider. This sensed 5 volts is the second input to the differential amplifier. The differential amplifier output is applied to the comparator.

1.08 A timing waveform is obtained from T1 winding 14-15 via pins 45 and 46 on YL1B. This voltage is integrated, full-wave rectified, and is applied as the second input to the comparator. The comparator output supplies a train of pulses to a transistor. When this transistor is gated on, a voltage drop is developed across pins 4 and 44 that fires the triac. The triac is turned off at the end of the half-cycle when the anode current falls to zero.

1.09 The pulse train output of the comparator has a duty cycle and pulse position which are determined by the amplified error voltage. Increasing the sensed voltage advances the leading edges of the pulse train thereby causing the triac to turn on earlier during each half-cycle. This causes the secondary flux buildup to terminate sooner, thus lowering the average amplitude of the secondary flux enough to maintain the desired output voltage.

POWER TRANSFER & ALARM CIRCUITRY

1.10 When the ac detector circuit senses loss of ac on the secondary winding 3-4-5 of T1 via pins 15 and 40, relay K1 is energized and connects the batteries to the 48-volt outputs through diode assembly CR3. CR3 provides an isolating diode for each battery string to prevent one string from loading down the other when the string voltages are unequal. Resistors R5 and R6 are each in series with a battery string to limit the surge current when K1 is

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energized. The resistors are also used to monitor battery discharge current, so that high-rate recharge time may be adjusted for heavy discharge intervals.

1.11 When the ac outage is greater than 22-1/2 seconds, a delay circuit will continue to cycle. In other words, a counter will count up for 22-1/2 seconds, reset, and count again. Thus, when ac is restored, the power transfer relay K1 will deactivate within 22-1/2 seconds after power is restored.

1.12 When ac fails, a power alarm is generated by a switch closure across the power alarm terminals.

1.13 Assuming that ac is present, a high voltage on the 48V output suspends high-rate charge and activates a relay which provides a switch closure across the minor alarm terminals. The minor alarm (MN ALM) lamp, on YL1B, is activated when that relay is energized. The minor alarm relay may also be turned on by other circuitry.

BATTERY CHARGING & CONTROL CIRCUITRY

1.14 Transistor Q2, resistor R9, and diode CR4 are part of one battery string charging circuit. Transistor Q3, resistor R10, and diode CR5 are part of another battery string charging circuit. Transistor Q2 and components in YL1B form a simple current-regulating circuit. The other circuit composed of transistor Q3 and associated components function in a similar manner. The HI lamp, on YL1B, is lighted while the high-rate charge circuits are active.

1.15 The high-rate charge circuits supply a constant current for a fixed time period which is proportional to the battery's previous discharge rate and time. Specifically, the batteries are given 2.5 hours of high-rate charge for each hour of discharge at normal rates. Normal rate is defined as less than 2 amperes per string. However, for discharge rates greater than 2 amperes per string, the batteries will receive 3.75 hours of high-rate charge for each hour of discharge. This is necessary since battery recharge efficiency is less than 100% and the battery's life can be prolonged by minimal overcharge. Actual capacity acquired by a battery during high-rate recharge is dependent on the battery's condition previous to the recharge and the battery's input and temperature during the recharge period.

1.16 During low-rate or float charging, transistors Q2 and Q3 are both turned off. The circuit, composed of a resistor in YL1B, which is in parallel with the series combination of resistor R9 and diode CR4, in series with the 64-volt transformer

64-volt transformer output, supplies current to one battery string. The other battery string receives its float current via a similar circuit composed of another resistor in YL1B, resistor R10 and diode CR5.

1.17 The low-rate or float charge current is a function of the battery string voltage. The lower the string voltage, the greater the current and vice versa. This relationship supplies the necessary current to keep the batteries in a charged condition over the operating temperature range. With the exception of those cases when temperatures are extreme, it is expected that the float current will, in time, fully charge those batteries not fully charged during the high-rate charge period.

1.18 For string voltages greater than 56.5 volts (the difference between 64 volts and the zener diode breakdown plus one forward diode drop), only a 261 ohm resistor is effectively in series with the 64-volt source. However, for string voltages less than 56.5 volts, the zener diode (CR4 or CR5) is broken down and the 46.4 ohm resistor (R9 or R10) parallels the 261-ohm resistor to increase float current as the string voltage decreases.

2. OPERATIONAL FEATURES & MISCELLANEOUS CIRCUITS

2.01 On power-up, a four-stage high-rate counter in YL1B is set for the full 24-hour recharge period. This is accomplished by the time delay provided by a resistor and capacitor to ensure reset of the counter. Operating the HI switch also resets the counter; operating the LO switch terminates high-rate charge by forcing the counter to the all-1's state.

2.02 For each battery charging circuit, there is a detector circuit which detects an open battery circuit or low battery string voltage, and which provides a minor alarm signal when the batteries are on float charge. During high-rate charge, the minor alarm is inhibited for both of the above conditions. Also, since each detector circuit is wired through its respective battery connector, each detector circuit is active only when a battery string is connected.

2.03 Fuses and diodes in YL1B provide protection to keep charging circuit failures from compromising battery standby capacity and to prevent circuit damage should batteries be connected with reversed polarity.

2.04 Momentarily, operating the RESTART switch S1 activates battery transfer relay K1 for situations where ac power is either off or unavailable, the transfer

relay is unenergized, and the batteries have available capacity. This situation could occur: (1) When it is desirable to operate a system by exchanging batteries during an extended power outage; (2) when it is necessary to power a system with batteries before ac is available; or (3) when a system power-down occurs through human error while ac is off.

SECTION III - REFERENCE DATA

1. WORKING LIMITS

1.01 AC Input

105 to 129 Vrms; 57 to 63 Hz.

1.02 AC Output

117 Vrms, (to power battery shelf heaters).

1.03 DC Output Rating

<u>Output</u>	<u>Regulation</u>	<u>Amperes</u>	<u>Ripple</u>
48V	±4%	0 to 8.5	<2 Vp-p

1.04 Trouble Voltage

The output voltage should not exceed 60 volts under any operating condition.

1.05 Ambient Temperature

-40° to 160°F

2. FUNCTIONAL DESIGNATIONS

2.01 None.

3. FUNCTIONS

3.01 This circuit is designed to perform the following functions:

- (a) To provide signal grade 48-volt dc power for electronics at remote locations
- (b) To provide charging for one or two strings of 25 ampere-hour, sealed, lead-acid standby batteries; to connect the batteries to the 48-volt load when ac power fails; and to provide ac power for battery shelf heaters.

4. CONNECTING CIRCUITS

4.01 This power unit will function with the following:

- (a) Remote terminal equipment

(b) KS-21906 L4 batteries and the 128A apparatus mounting.

5. MANUFACTURING TESTING REQUIREMENTS

5.01 Continuity of all paths shall be verified. All components shall meet their own requirements.

5.02 Functional tests for listed line and load conditions shall verify the AC and DC ratings specified in the Working Limits portion of this section.

6. PROTECTION AND MAINTENANCE

6.01 Input fuses F1 and F2 will protect the input ac wiring in case power transformer T1 fails or faults occur in the battery heater circuits.

6.02 This circuit does not provide load protection; therefore, external protective devices must be provided if load circuit protection is required.

6.03 The circuit common (+48 volt output) must be grounded externally to polarize the output as a negative voltage.

CAUTION: HIGH VOLTAGES are present at the transformer, input fuses, and at various circuit components near the transformer. Under no circumstances should the top cover be removed, repairs be attempted, or attempts made to access circuit points from underneath the chassis prior to disconnecting the batteries and input power.

7. TAKING EQUIPMENT OUT OF SERVICE

7.01 To take the rectifier out of service, (1) disconnect the batteries, and (2) disconnect the input power via the P112 connector.

7.02 The plug-in control circuit, YL1B, can be replaced with the ac input power on; however, the 48-volt output will be greater than 52 volts (depending upon load) while YL1B is removed. After replacement of YL1B, the batteries will be temporarily (about 25 seconds) connected to the 48-volt output, and the battery control circuits will be initialized to high-rate charge the batteries for 24 hours. If the batteries are known to be fully charged at the time of plug-in replacement, the LO pushbutton switch should be activated to restore the batteries to float condition.

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