GTEC UPS MODEL:

PULSE 650/850 VA

SERVICE MANUAL

www.gtec-power.eu

1.0 Revision Summary

REVISION	Date	DESCRIPTION	Prepared By	Approved By
Rev. A	2016-6-21	Formal Release	Gangxiong	

Table of Contents

1 Introduction

PULSE series is an off-line power system that has a step wave output. It prevents impulse, surge, sag and power outage situations. It provides the UPS output load with a reliable source. It has the following functions:

1.1 Boost:

If the utility voltage drops to line boost activated point*, the AVR will be activated and increase the input voltage by 1.2 times of incoming utility voltage according to input voltage value.
*Boost activated point: 207VAC (1.2 times)

1.2 Buck:

If the utility voltage reaches to line buck activated point, the AVR will be activated and decrease the input voltage by 0.85 times of incoming utility voltage.
*Buck activated point: 253VAC

1.3 50/60Hz Automatic Frequency Selection:

The output frequency will automatically match the input frequency (50 or 60Hz).

1.4 Cold start (DC start):

The UPS is equipped with DC start function to turn on the UPS without input source.

1.5 Green Power Function:

When the load can hardly be detected in battery mode, the UPS will shut down for energy saving.

This manual contains block diagram, principle of operation, system outline and troubleshooting.

2 Block Diagram

The Block diagram of PULSE series (refer to Figure S-1) is divided into the following parts:

2.1 Main Relay (MAIN-RY):

This is a switch used to the UPS between line mode and battery mode.

2.2 Boost Relay (BOOST-RY):

At line mode, this is a switch used to boost UPS output voltage 20% or 40% when the utility voltage is under line boost activated point. (Refer to Boost activated point table in P.4)
Relay OFF: line voltage is normal
Relay ON: line voltage is under line boost activated point.

2.3 Buck Relay:

At line mode, this is a switch used to lower UPS output voltage 15% when the utility voltage is over line buck activated point. (Refer to Buck activated point table in P.4)
Relay OFF: line voltage is normal
Relay ON: line voltage is over line buck activated point

2.4 Main Transformer (MAIN TX):

The Main transformer has three functions:

2.4.1 Inverter Transformer

It provides voltage to UPS output and performs a full-bridge transformer when UPS is at battery mode.

2.4.2 Boost/Buck

The output coils have an output ratio. Thus the output voltage at boost mode is given by (Boost Relay ON):
$V_{OUT} = V_{IN} * 1.2$ for boost

The Buck relay is ON when the utility voltage is beyond line buck activated point. It can lower 15% of input voltage:
$V_{OUT} = V_{IN} * 0.85$

2.4.3 Charger:

The battery is charged by the mains through transformer and full-bridge inverter.

2.5 Line Sense

The MCU detect the mains by input voltage and frequency signals converted from the amplifier.

2.6 CPU (FREESCALE/MC9S08FL8CBM)

The Central Process Unit

2.7 Electricity Switch

It controls the +5Vdc and +12Vdc supplies.
+12Vdc Control Power Generator.
Provide +5Vdc (generated from 78L05 regulator) and +12Vdc power supply.

2.8 Charger:

The source for the Charger comes from the mains through the transformer and full-bridge inverter. The charger is controlled with high frequency technology and the acceptable charging voltage is 13.5~13.9V.

2.9 Inverter Circuit:

The inverter circuit is based on a full-bridge circuitry.

2.10 Interface Circuit:

The UPS display device contains one LED (or three-LED as option, or LCD as option) and one switch.

2.11 Batteries:

Acts as a power supply source while the UPS is on battery mode. Different types of batteries are used for different models of UPS:
650VA: 12V7Ah *1 pc or equal capability
850VA: 12V9Ah *1 pc or equal capability

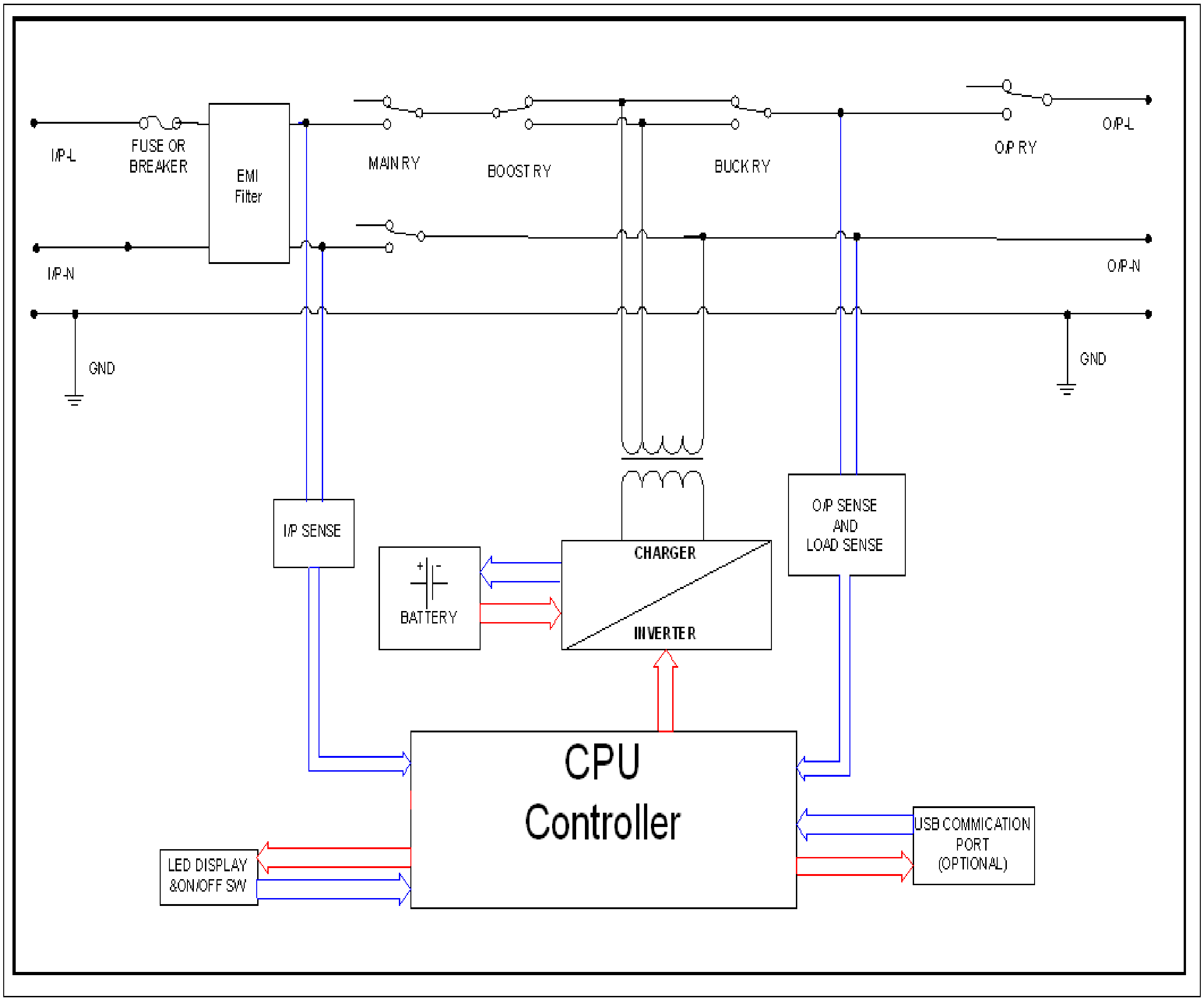


Figure S-1 Block Diagram

3 Control power circuit

The control power (+12Vdc and +5Vdc) comes from the following sources (Figure S-2-1).

3.1 Start without input AC power (Cold start):

A "Cold start "is described as follows:

3.1.1 When "ON/OFF" switch (SW1) is pressed, a positive battery current flows through SW1 to charge C16.

3.1.2 Q8 base receives a HI pulse and turn on (signal bypass C16 at t=0, and charge C16 at t>0).

3.1.3 When Q8 turns on, the Q8 collector will drop to LOW and turn on Q7 (MPS2907A).

3.1.4 When Q7 turns on, the positive battery voltage via Q7 collector and establishes a +12Vdc power supply. The +12Vdc power supply passes through U03 (78L05) for LCD mode or U3(3843) for LED mode generating a +5Vdc logic power supply. And CPU send HI signal (shutdown) to sustain Q8 on.

3.1.5 Figure W-1 shows the pulse on the C16, i.e. the base signal of Q8 during the cold start.

3.2 AC start from the following sources Figure S-2-2:

3.2.1 When we connect UPS to the utility, half-wave rectifier will activate Q8 through D10 and Q10.

3.2.2 If "ON/OFF" switch is pressed, Q7 turns on and establishes a +12Vdc and +5Vdc power supply similar to "Cold start".

The SHUTDOWN network, triggered by pin2 of the CPU, is used to shutdown the UPS on battery mode. When a battery is in low battery voltage status, the CPU sends a "Low" signal to turn off Q8. This causes Q7 to be turned off and isolates the control power from batteries.

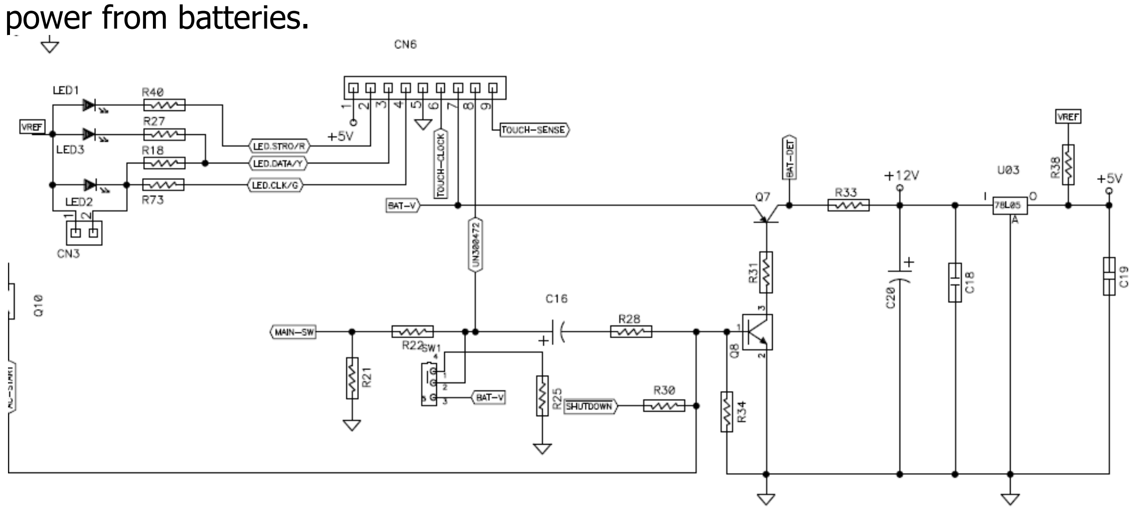


Figure S-2-1 Control Power Circuit (+12Vdc and +5Vdc)

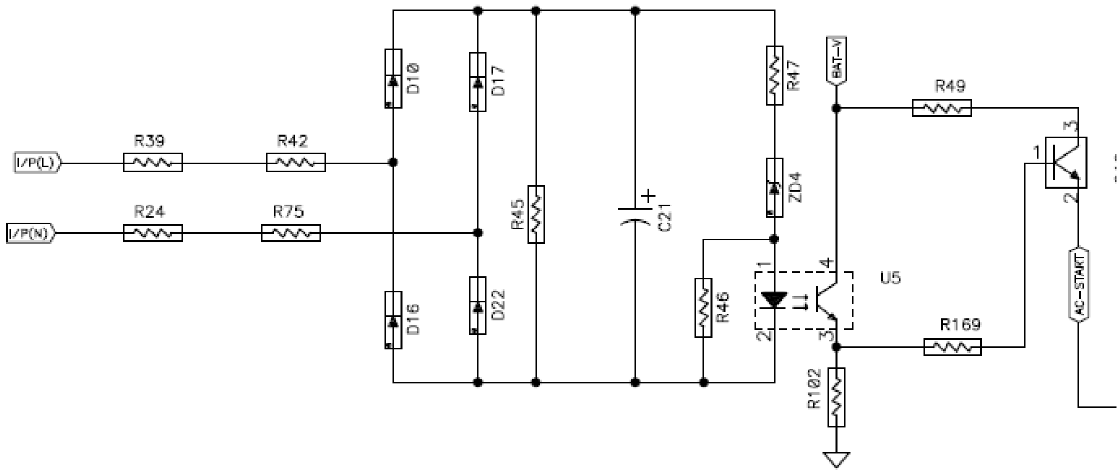
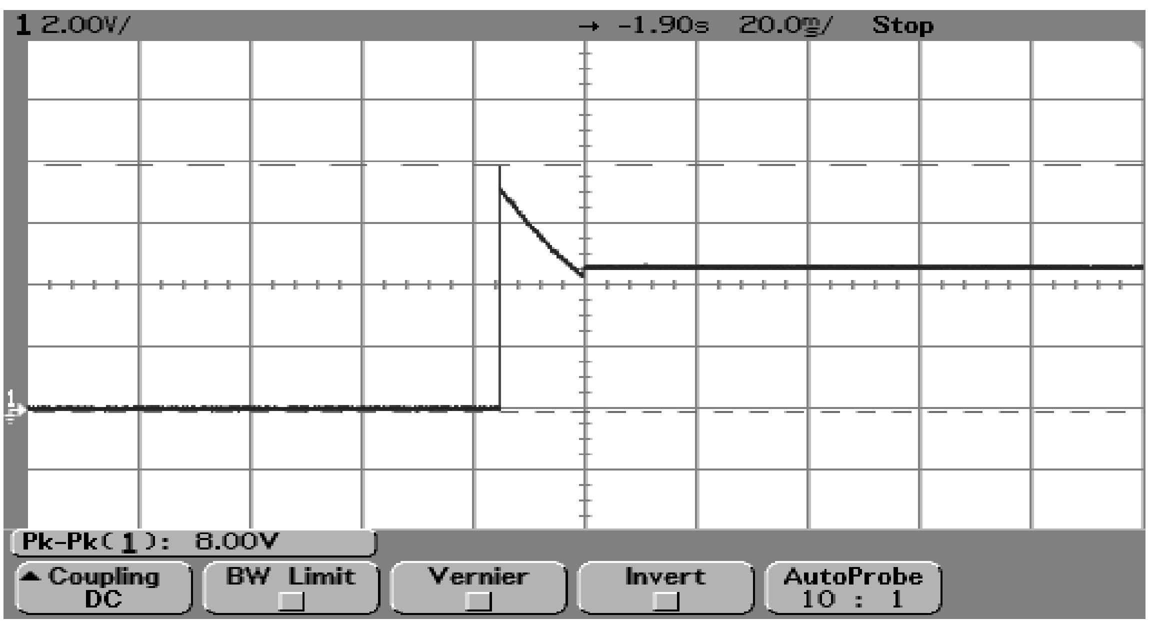


Figure S-2-2 AC start Circuit



CH1: C16 → GND

Figure W-1 Cold Start

4 Battery Charger

The flow chart of charger is described as follows: (Figure S-3-A & Figure S-3-B)

4.1 When UPS is connected to the utility, the control power (+5Vdc) will be established and the CPU will start to work.

4.2 When CPU turns on Main Relay (RY1), the AC power flows into Main Transformer.

4.3 Charging current will be generated from the inverter coil of the Main Transformer.

4.4 A PWM IC 3843 is used to adjust the charging voltage and charging current. (Refer to Figure S-3-A) The charging voltage can be set by changing the value of R86, R87, and R82. The charging current can be set by changing the value of R66 and R83.

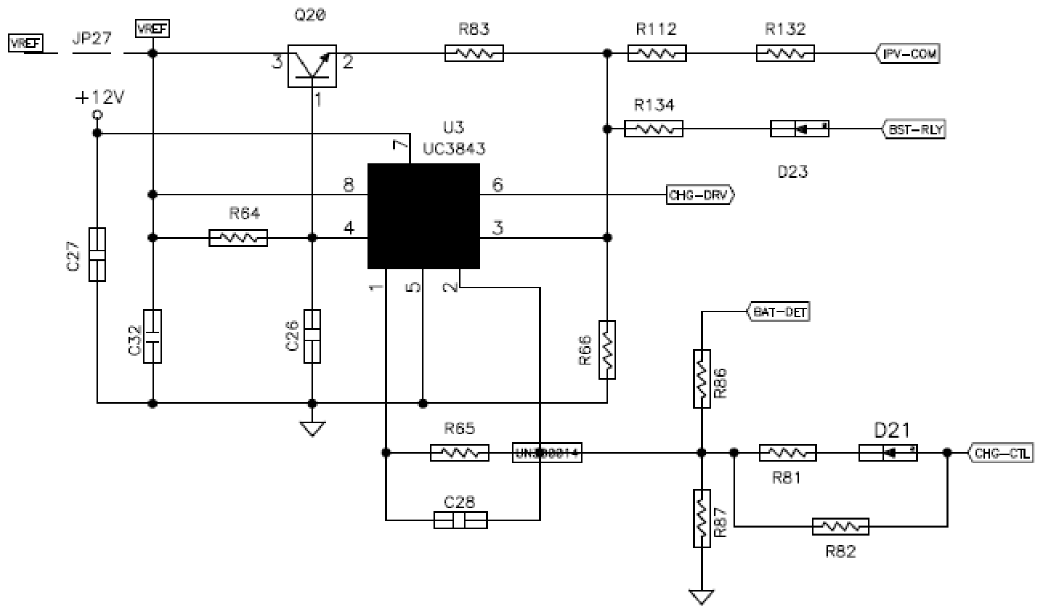


Figure S-3-A Charger Control Circuit

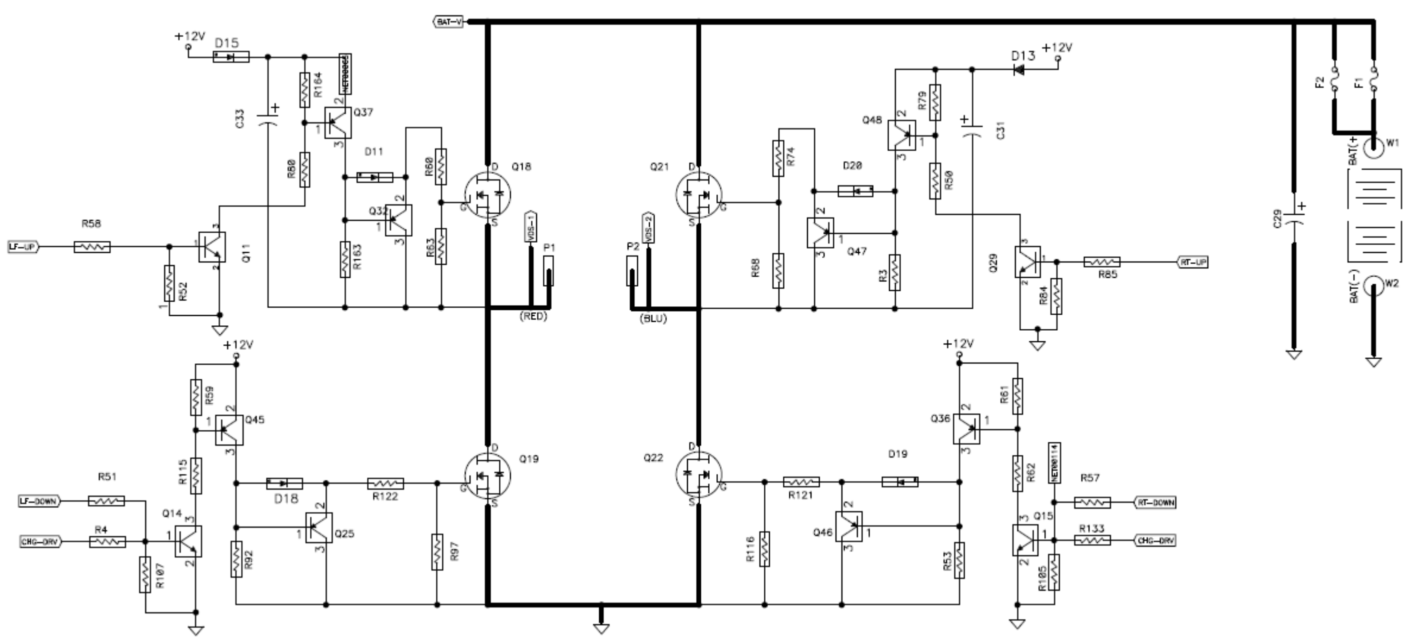


Figure S-3-B Charger Control Circuit

Line and Zero-Crossing Detection

Please refer Figure S-4

4.5 Line Detection

The input voltage is fully rectified and generates a signal. The signal will be sent to pin 23 of CPU through a voltage divider at LM324. By monitoring this rectified sinusoidal voltage, the CPU can identify if the utility is normal or abnormal. There are two methods to evaluate if line voltage is abnormal.

4.5.1 Waveform detection:

If breakout occurs, the CPU is able to immediately detect it and transfers to battery mode. The waveform detection has a short response time.

4.5.2 RMS value detection:

CPU calculates input RMS value every cycle. If RMS value is not in acceptable range for 3 cycles, UPS will transfer to battery mode. Compared to waveform detection, although it will take longer response time, the RMS value can be accurately detected.

4.6 Zero Crossing Detection

Zero Crossing Detection is used to minimize the phase difference between the Inverter voltage and the input line voltage while UPS is switched from battery mode to line mode. If the phase difference is too large, it will generate excess energy which may damage the internal passive components such as relays.

The Zero Crossing signal is generated by the following conditions:

4.6.1 The signal is half-bridge rectified waveform from line input. The voltage drive Q4 (2222ASM) on or off.

4.6.2 The Zero Crossing signal comes from the collector of Q4 and goes through MCU pin 32.

4.6.3 Refer to Figure W-2. The waveform of ZERO-CRO from Q4 collector and Line-I/P.

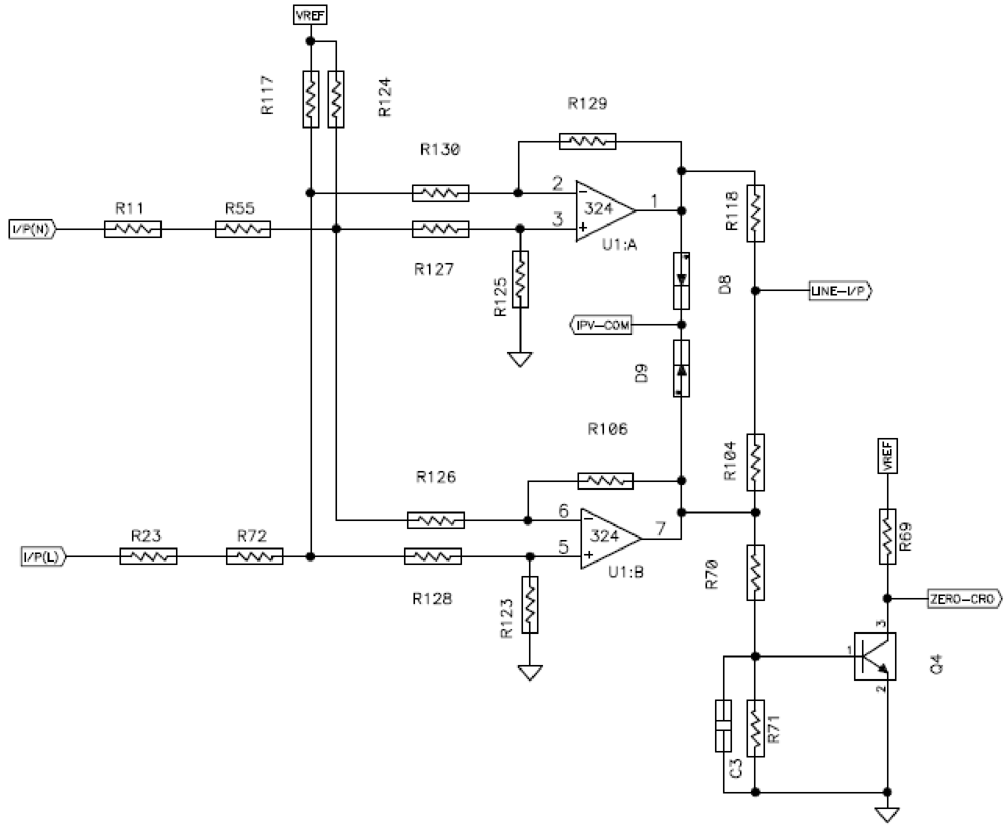
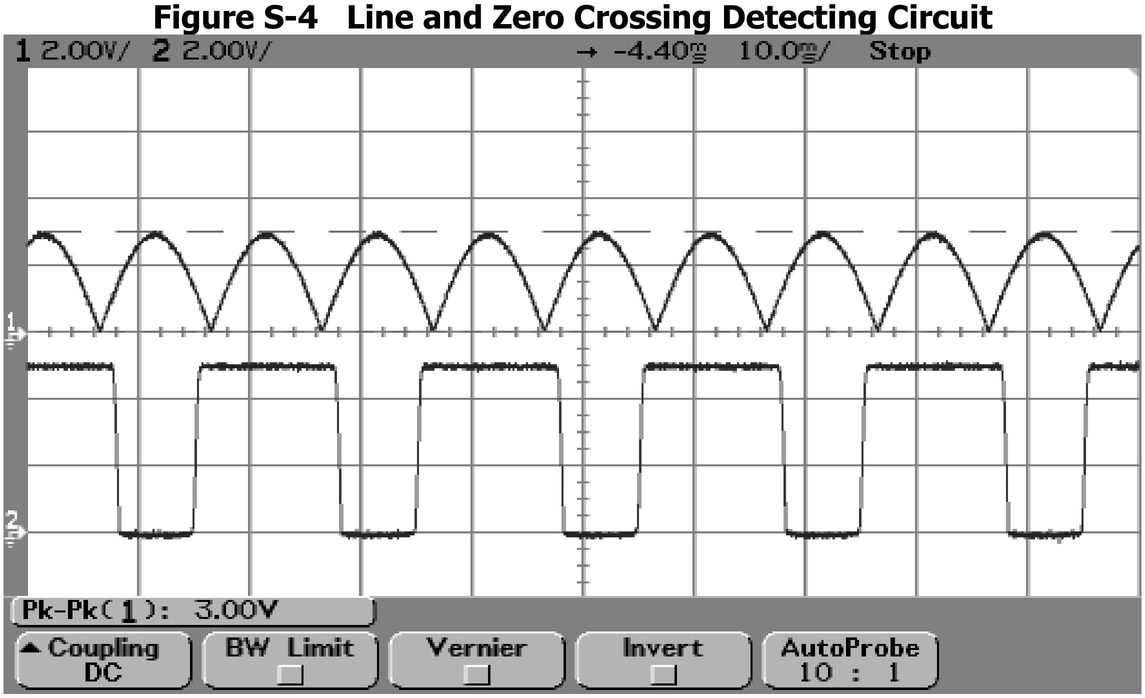


Figure S-4 Line and Zero Crossing Detecting Circuit



CH1: Q4 collector
CH2: Line-I/P

Figure W-2 Zero Crossing

5 Inverter Operation

Refer to the Inverter circuit diagram, the LF-UP, LF-DOWN, RT-DOWN and RT-UP signals are generated by CPU. Figure W-3 illustrates the waveforms of LF-UP, LF-DOWN, RT-DOWN and RT-UP while the system is at no load condition. The duty cycles of LF-UP, LF-DOWN, RT-DOWN and RT-UP signals are controlled by returned signal of output voltage (Please refer to Charger circuit) to get a stable output.

The gates of MOSFETs are driven by transistors Q18/Q19/Q21/Q22 which are controlled by the LF-UP，LF-DOWN，RT-UP and RT-DOWN. Those signals are from CPU pin28, 27, 29 and 30 directly or indirectly. Figure W-3 (1) shows the collector waveforms for CPU pin28, 27, 29 and 30 while the system is at no load condition at battery mode.

These inverter transistors are turned on and off alternately to transfer DC voltage of battery to an AC stepwave output voltage, and then magnifies through the transformer to generate a stable 230VAC（120Vac）output.

According to the diagram shown on “Figure W-3 Control logic (1)”, while the driving signal LF-DOWN.VGS and RT-DOWN.VGS both get HI simultaneously in battery mode, the step output waveform get approximately zero, which is named CLAMP. In full-bridge circuit, unlike push-pull circuitry having isolated CLAMP circuitry and driven signal, the CLAMP signals are included in inverter drive logic.

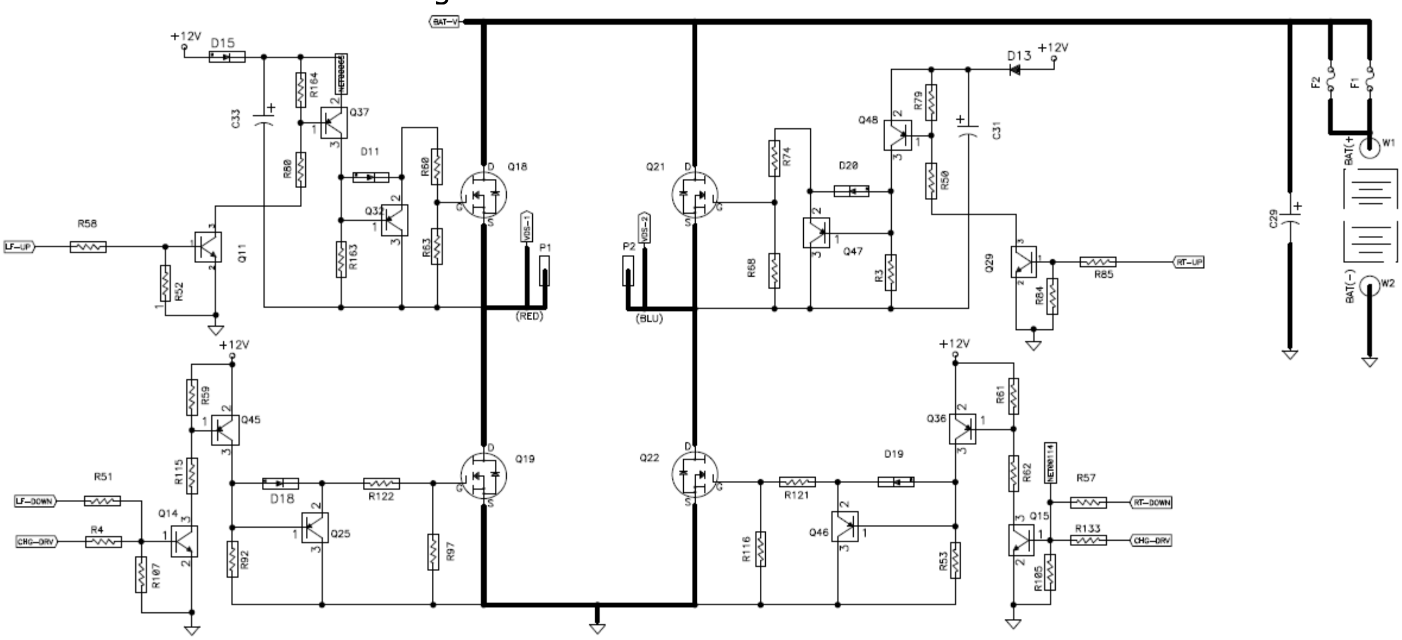


Figure S-5 Inverter circuit

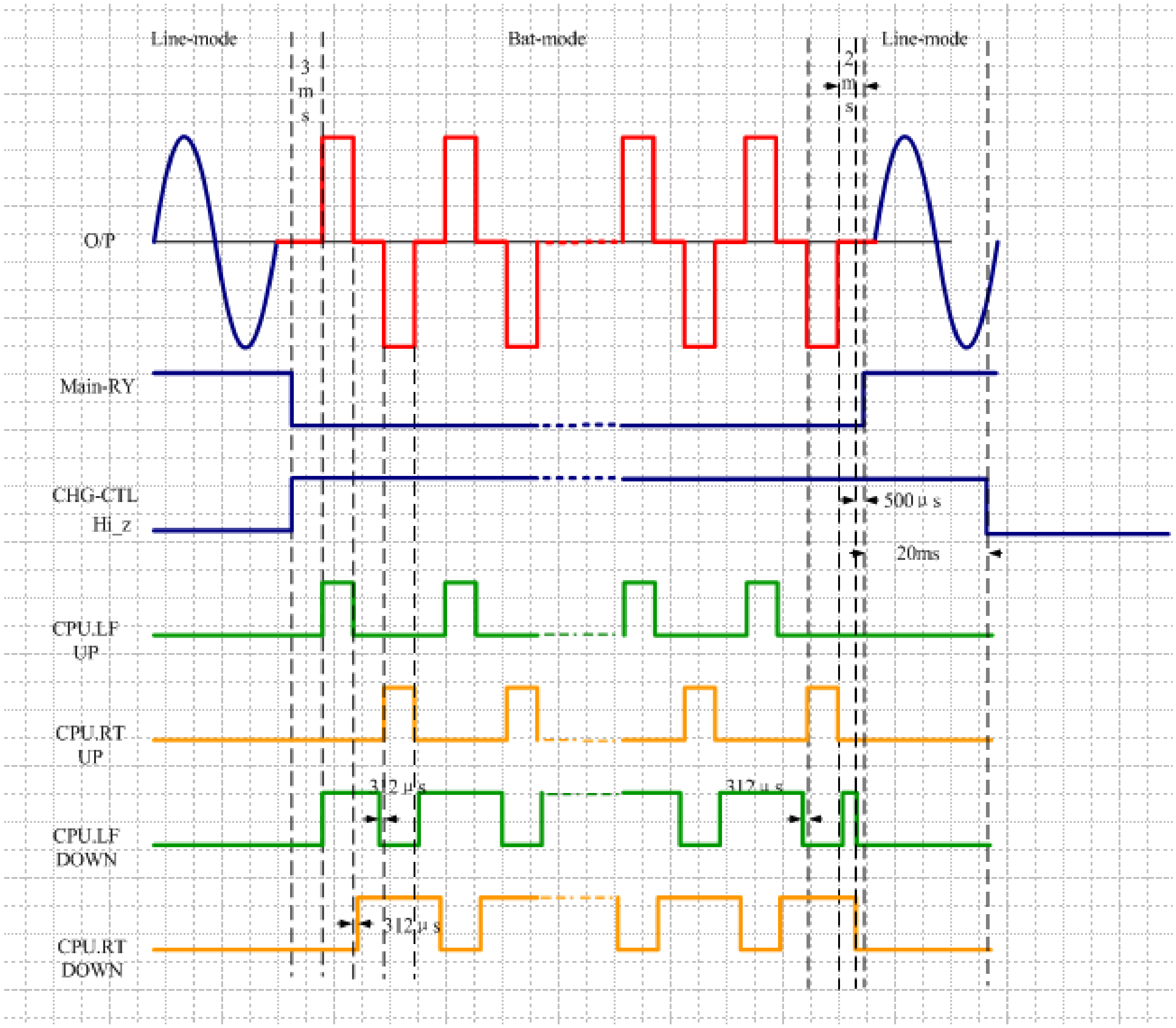


Figure W-3 Control logic (1)

6 Active Clamp

The purpose of Clamp is to pull down the output voltage while two sets of Inverter MOSFET are OFF. The Clamp effect is active during the period of 0Vac at battery mode. CLAMP principle is shown in the last paragraph of Chapter 6 Inverter Operation.

7 Microprocessor(CPU) Control Circuit

The CPU is supplied by +5Vdc power supply to pin4 with ground pin at pin5. An extra oscillation circuitry consisting of C6, C7, and crystal XL1 is connected to pin6 &7. PULSE) series with the CPU model is MC9S08FL8CBM. The pin definition is listed below(Figure S-6):

PIN	FUNCTION(NEO4 C E)
Pin1	LED.CLK/G
Pin2	Shutdown control
Pin3	I/P relay control
Pin4	Power supply
Pin5	Ground
Pin6	Oscillation circuit
Pin7	Oscillation circuit
Pin8	Boost relay control
Pin9	Buck relay control
Pin10	O/P Relay control
Pin11	VOLTAGE MODEL detection
Pin12	Load detection
Pin13	VA MODEL detection
Pin14	Wave DETECTION
Pin15	LED STRO/R
Pin16	LED DATA/Y
Pin17	Buzzer control
Pin18	TXD
Pin19	RXD
Pin20	Main-SW detection
Pin21	Touch clock detection
Pin22	Touch sense detection
Pin23	I/P_V detection
Pin24	O/P_V detection
Pin25	Charge control
Pin26	Battery voltage detection
Pin27	LF-DOWN
Pin28	LF-UP
Pin29	RT-UP
Pin30	RT-DOWN
Pin31	green DETECTION
Pin32	ZERO-CRO control

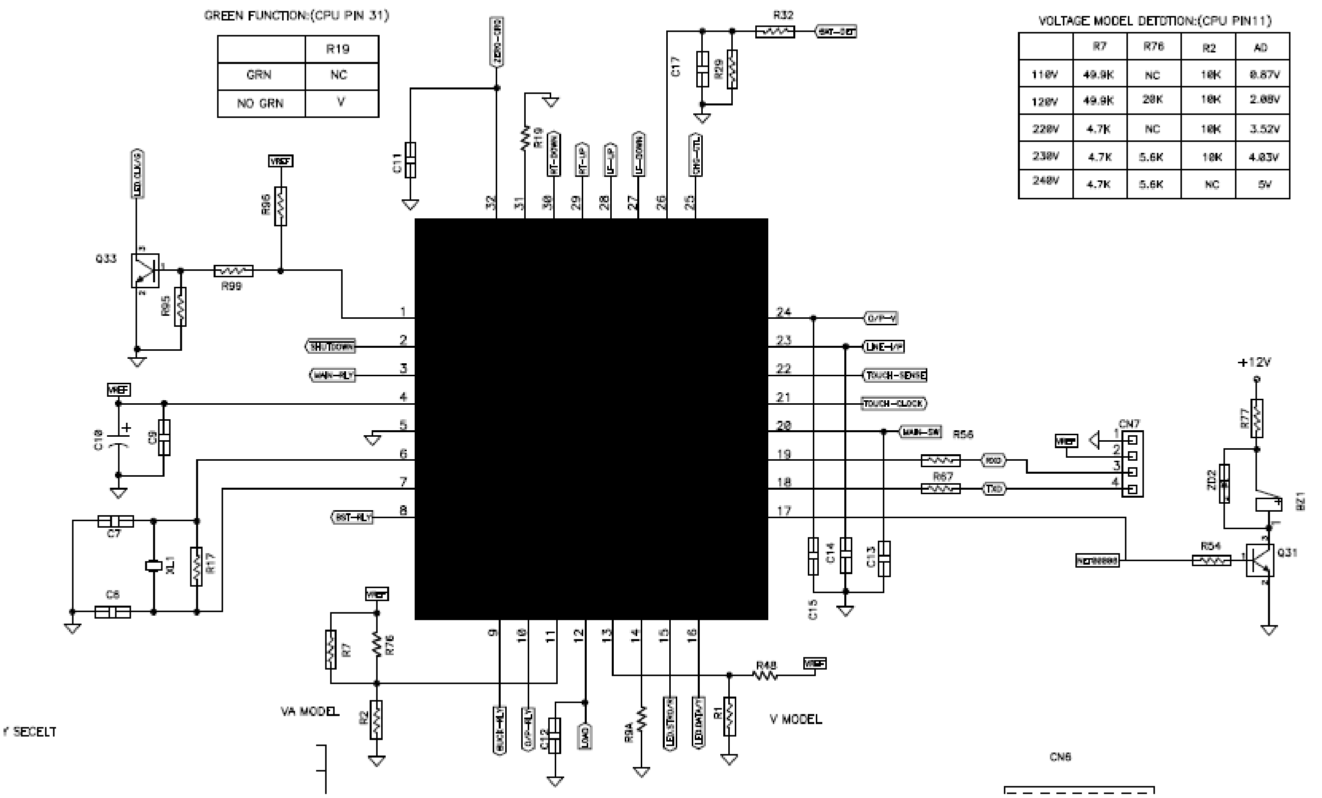


Figure S-6 CPU Control Circuit

8 Relay Circuit

Figure S-7 is the relay circuit.

1).The RY1 and RY5 (main relay) is used to switch between line and battery modes. When the UPS is changing from battery to line mode, CPU pin15 is set to HI to turn on Q1 (2222ASM) and activates RY1 and RY5. Alternatively, if the UPS is changing from line mode to battery mode, CPU pin15 is set to LOW and turn off Q1. This causes RY1 and RY5 to be OFF and return to its normal state.

2).R6, R5, D7 , C2 and Q2 are used to speed up the relay transfer action, so the power failure time can be shorten to minimum. When UPS transfers to battery mode, C2 is charged by the +12 Volts. After the main relay makes contact, C2 provides instantaneus power to the relay coils. This will increase the magnetic force and shorten the transfer time from battery mode to line mode by switching the relay. See Figure W-6 for voltage changes on C2, during transfer time from line to battery mode.

3).CPU pin14 is used to the drive signal for RY2 (boost relay). When the mains input voltage is low as within boost activated point, pin14 sends a high signal to turn on Q3 (2222ASM). This will activate the RY2, and UPS will transfer to the Boost mode. When the mains input voltage increases back to reach inactivated boost point, the UPS will return to normal mode by sending a LOW signal from pin14. This forces RY2 to switch to its normal position (OFF). At battery mode, pin14 is always set to LOW and RY2 is disabled.

4).Buck situation is the similar process. CPU pin13 is used to drive signal for RY3 (buck relay). When the mains input voltage rises beyond buck activated point, CPU pin13 sends a high signal to turn on RY3. When the mains input voltage decreases below the inactivated buck point, the UPS returns back to normal mode by sending a LOW signal from pin13.

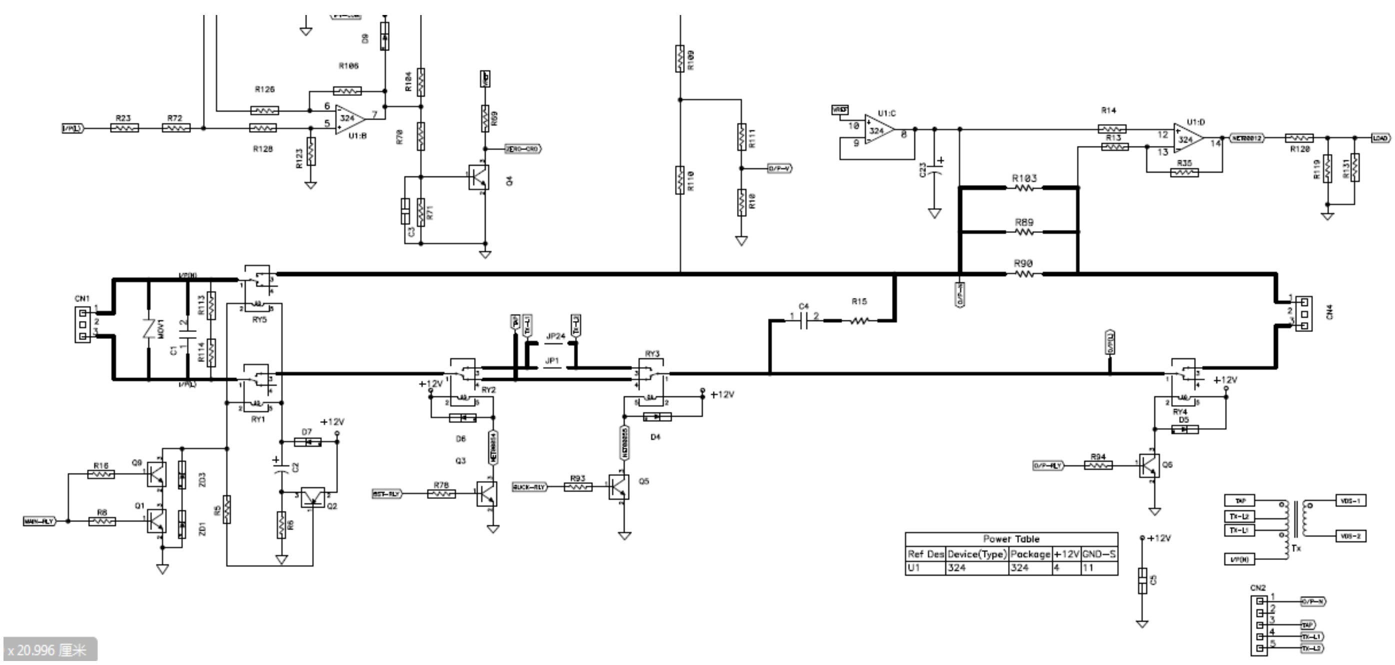
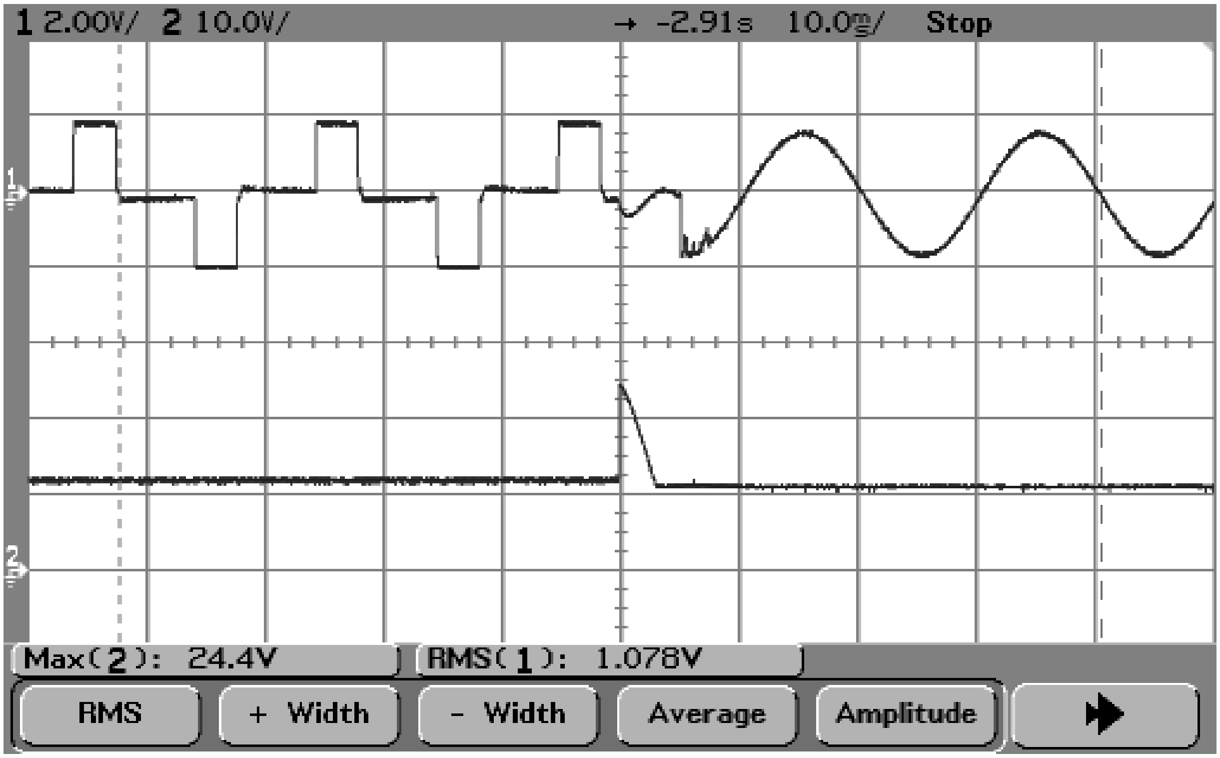


Figure S-7 Relay Circuit



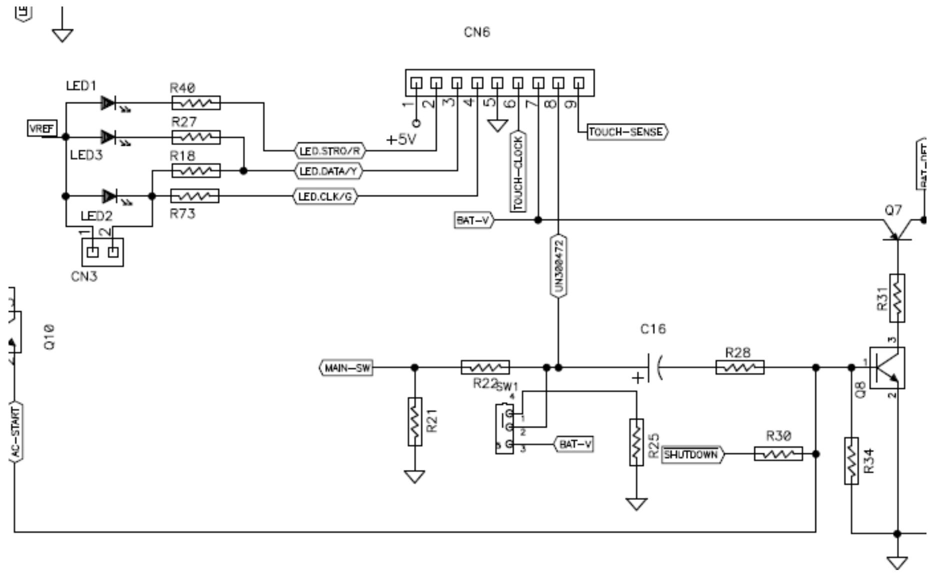
CH1 : C2(+) → GND
CH2 : Output Voltage (1/200V)

Figure W-6 Output waveform vs voltage change for relay speed-up circuit

9 Displays, Audio Alarm and Control Button

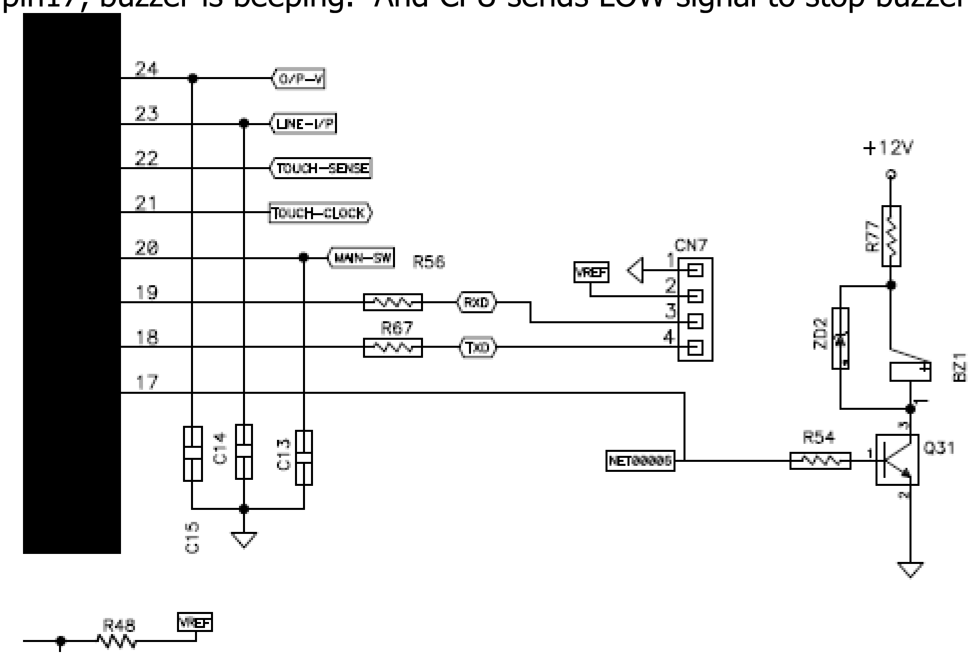
9.1 Control button

ON/OFF Button: Push it to turn on UPS, and push again to turn off UPS. (Please refer to Chapter 3 for cold start & AC start)



9.2 Audio alarm

The buzzer is controlled by pin17 of CPU. When CPU sends a HI signal to buzzer from pin17, buzzer is beeping. And CPU sends LOW signal to stop buzzer.



9.3 Display (Figure S-8)

There are 3 LEDs on Main-board or LCD on Panel-board.

While control button is turned on, CPU sends a LOW signal to turn on LED or LCD.

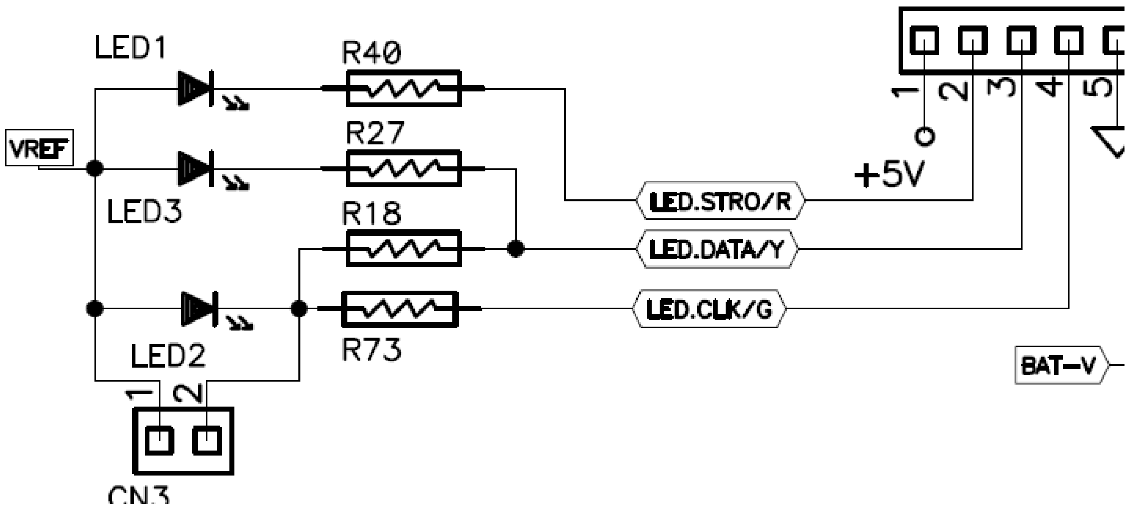


Figure S-8 Display Circuit

10 Load Detection Circuit

Load detection circuit is shown on Figure S-9.
The output current is detected by resistance R89//R90//R103. Output current flow through the R89//R90//R103 is converted to a voltage signal (0~5 Volts)，then the small voltage signal is amplified through U1:B(Amplifier).
For the CPU, the negative voltage is not acceptable ，so the zero point refers to about 2.5V（A voltage divider at R120 and R119 through +5Vdc）.
Then CPU can receive output current value of the UPS.
Note：U1:A is voltage follower.

10.1 At line/boost/buck mode and battery mode: The current value multiplies output voltage to get output VA value and multiplies 230V output voltage to get output Watt value.

10.2 For the different loads，the power factor is different. Thus between the VA value and the Watt value, the load choose most bigger.

10.3 Refer to Figure W-7. The waveform of Load.

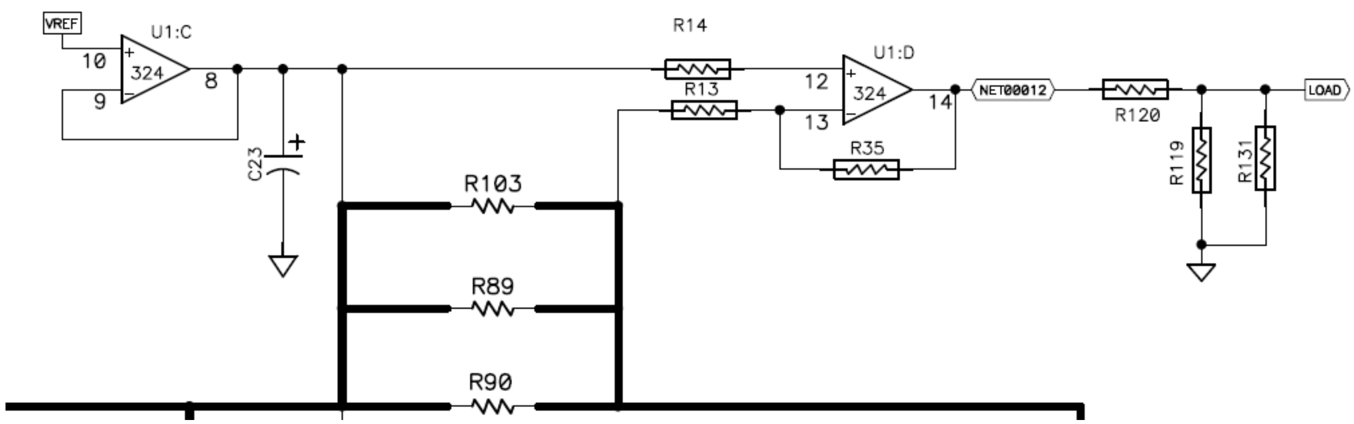


Figure S-9 Load Detection Circuit

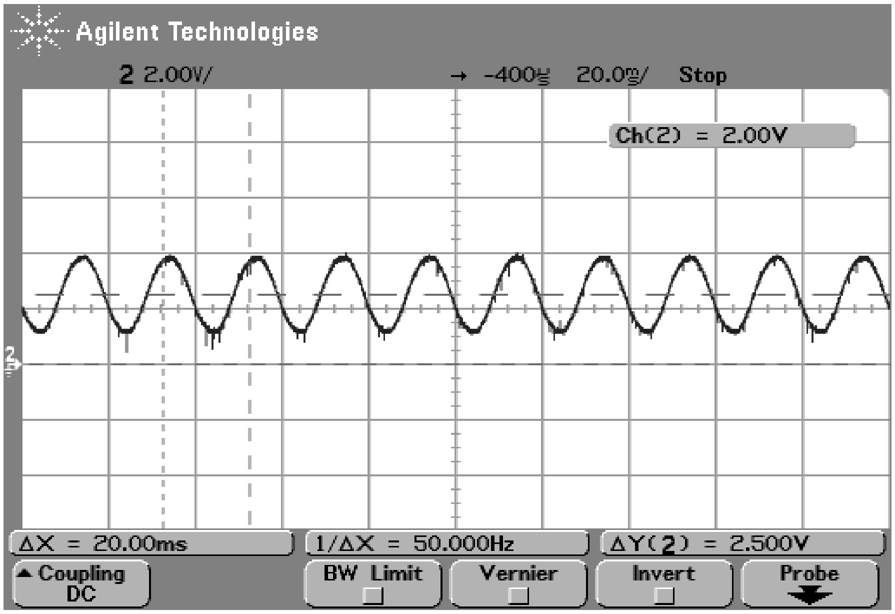


Figure W-7 Load Signal Waveform

11 Troubleshooting

WARNING

11.1 Troubleshooting can be done by qualified engineer or technician only.

11.2 Use isolated AC source for your oscilloscope to prevent floating voltage problem between UPS chassis ground and system reference ground.

11.3 Before opening the cover, turn off the main switch and unplug the input power cord.

11.4 Because hazardous voltage may remain in the DC capacitors, wait for at least 5 minutes after turning off the UPS and disconnecting the power cord before open its cover.

11.5 Do NOT plug in the input power cord before you reconnect the connectors of battery to prevent unwanted sparks.

Please follow the steps below when you want to repair a problematic unit:

11.6 Visual inspection

This is the first step to check the UPS after opening its cover. Be sure to do the visual inspection because it can help you to identify most problems. Major items that should be checked are listed below:

11.6.1 Are there any connectors or terminals loose?

11.6.2 Are there any components burn-out or discolored?

11.6.3 Especially the power components on the heat sink?

11.6.4 Are there any capacitors broken or leakage? Check all the components listed above and replace which is abnormal.

11.7 Troubleshooting flowchart

To prevent from hurting yourself and damaging the UPS, be sure to obey the sequences of flowchart listed below.

11.7.1 Battery mode examination (please refer to Figure W-8)

Procedure:

1. Replace batteries by DC power supply and turn on it(12V<Vbat<13.7V,current limit>3A). Check if there is current limit phenomenon for DC power supply.
2. One or more MOSFETs (Q18,Q19,Q21,Q22) is D-S short. Check and replace abnormal.
3. Check if both buzzer beeps and LED flash for once.
4. Check if +5Vdc on CPU pin 4 is normal.
5. Check if clock signals on CPU pin6 and7 are correct(Vpeak is equal to about +5V，Frequency is equal to 19.66MHz).
6. Check if battery sense on CPU pin26 is correct(About Vbat/3).
7. Replace the PCBA.

8. Check and Replace abnormal C17,R29andR32.
9. Check and Replace abnormal R16andC8.
10. Replace abnormal crystal XL1 C7,C6,R17andR18.
11. Check there is +5Vdc on U03/U3 output .
12. Check if Q7(2907 collector) is normal.
13. Check and Replace abnormal Q7, R34, R28, R30, Q8, and R31andC16.
14. Check there is +5Vdc on U03 output. Also Replace abnormal U03 (Resistance is less than 100ohm between pin4 and pin5) and CPU(Resistance is less than 100ohm between pin4 and pin5).
15. Replace PCBA.
16. Check and Replace abnormal SW1.
17. Check if buzzer beeps continuously.
18. Check if there is overload exist,and if the signal on CPU pin12 is abnormal.
19. Check and Replace abnormal U1,R13,R14,R35,R120,R119andC23.
20. Checkand Replace abnormal Q11,Q14,Q15,Q16,Q17,Q36,Q25,Q26,Q29,Q20,Q23 and Q37.
21. Check if buzzer beeps continuously.
22. Replace PCBA.
23. Check if the output voltage is nomal.(Accord for SPEC)
24. Replace PCBA.

13.7.2 Line mode examination (please refer to flowchart Figure W-9)

If battery mode examination is OK, then do the line mode examination as below.

1. Replace batteries by DC power supply and turn on it(12V<Vbat<13.7V,current limit>3A). Check if there is current limit phenomenon for DC power supply.
2. Check if the UPS keep at the battery mode.
3. Check if buzzer beeps continuously.
4. Check if battery voltage is too high (overcharge:$V_{battery} \geqslant 14.5V$).
5. Replace PCBA.
6. Check input voltage and check main/buck/boost relay is normal.
7. Replace abnormal RY1,RY2,RY3 and RA1.
8. Check output voltage could accord for SPEC.
9. Replace PCBA.
10. Check if Line I/P voltage on CPU pin21 is normal（HV UPS : Pin23 RMS voltage is about $V_{I/P}$ /108; LV UPS : Pin23 RMS voltage is about $V_{I/P}$ /57）.
11. Replace abnormal LM324
12. Check zero-cro on CPU pin4 is normal（Vpeak is equal to +5V, Frequency is equal to Line I/P frequency）.
13. Replace abnormal Q4.

14. Replace PCBA.

Figure W-8 Battery Mode Examination Flowchart

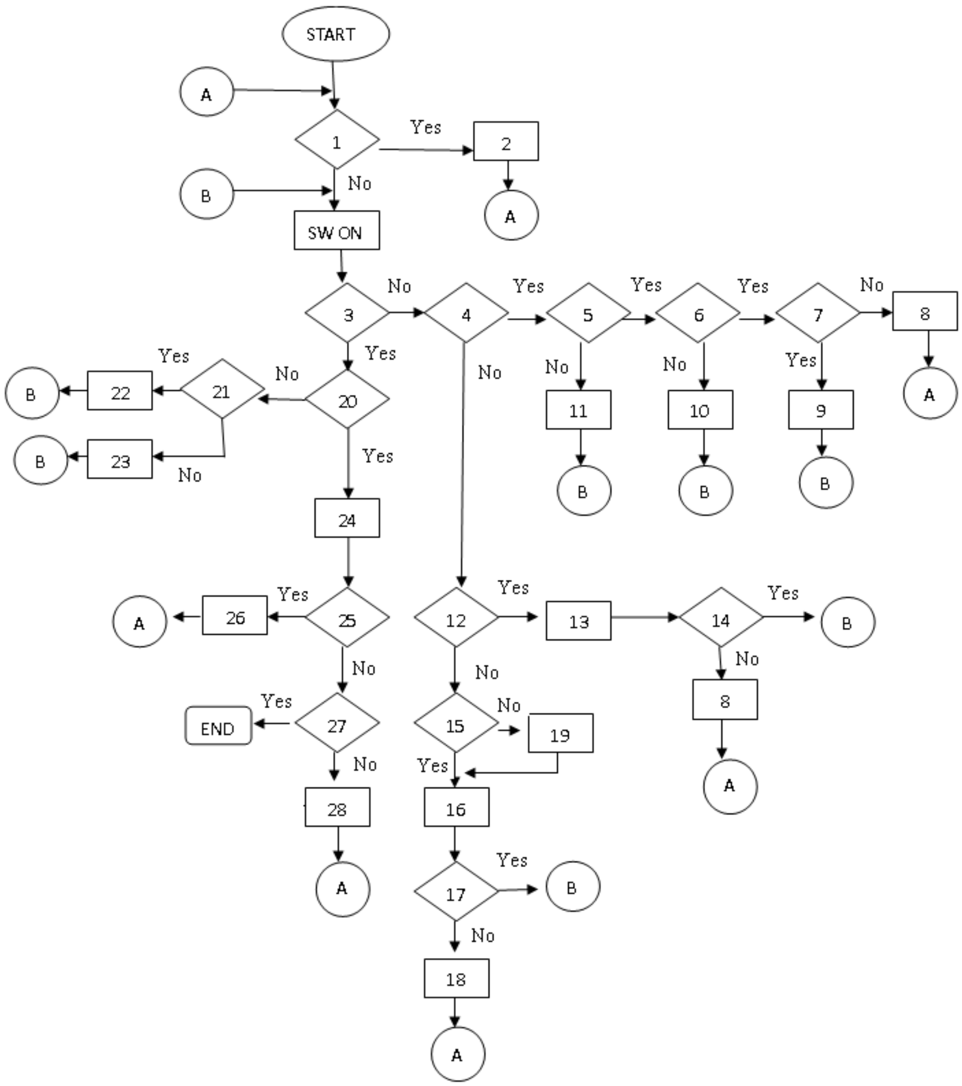


Figure W-9 Line Mode Examination Flowchart