Three phase sine wave inverter - 3KVA to 30KVA

MEDI has designed and developed DSP based three phase / single phase sine wave inverter. This inverter can be used for the following applications –

1. Offline inverter with contactor change over
2. Lift inverter
3. Solar inverter with no-load shut down and load-restart along with priority solar charging
4. Inverter for online applications with frequency locking with mains (inverter frequency locked with the mains frequency) so there will not be any oscillation in the output voltage because of the beat frequency between mains and inverter. You should use a separate online charger for this.

This design can be used for single phase up to 15KVA and three phase up to 30KVA. For computer load, we can add-on the battery-less online UPS along with this inverter.

{youtube}vJlacZOCDcE{/youtube}

No load shut down and load restart – in a 30KVA three phase inverter if there is no load on all the three phases, the inverter will automatically shut down. During this shut down, the inverter will consume only 15mA. When there is a load of even 15VA connected to any phase among the three phases, the DSP will detect the load and restart the system.

This is especially useful in solar applications as the energy consumption in shut down mode is extremely low. Hence this feature is very suitable for energy saving applications.

It has priority solar charging, i.e. if a solar panel is connected, while charging from the solar panel the mains charger will be standby. After charging from the solar panel, if the battery is not fully charged, only then mains charger will be activated. So we can save the electricity.

Direct mountable IGBT driver – This half bridge IGBT driver can be mounted directly on the half bridge IGBT module. When the IGBT driver is used externally, they should be connected using wires to the gate and emitter. This wire connection is not very efficient method as the inductance of the wire length will come in the driving circuit. So the wire length should always be as minimal as possible. This gave us the idea to design a circuit with shortest wire length; hence we have come up with 'Direct mountable IGBT driver'. This apparently has no wire length so no unwanted inductance will disturb the gate drive.

In addition to the structure, the advantage in this circuit is Miller Clamping. During turn off, a low impedance path will be provided for the gate to the negative (-8V). When the collector voltage suddenly increases, this will happen during the turn on of the other IGBT, the gate voltage of the Miller clamped IGBT will not raise through the Miller capacitance because the gate is clamped through a low impedance source to the negative supply.

Soft turn off protection during short circuit – During short circuit or heavy load, the saturation (collector) voltage of the IGBT will increase. When this voltage will increase beyond a threshold limit the gate voltage of the IGBT will be turned off smoothly through a high impedance path. This is in order to protect the IGBT from fast di/dt which will cause high fly back voltage that may damage the IGBT during turn off.

During short circuit the current through the IGBT is very high. If you suddenly turn off the IGBT during this time, the rate of change of current (di/dt) will be very high. Due to the high di/dt, the lead inductance of the IGBT itself will produce a high fly back voltage which will damage the IGBT. This cannot be protected using any external snubber or diode clamping. Hence, turning off the IGBT smoothly during short circuit is very important. This way the di/dt will be very less and there will not be any fly back voltage that can cause any damage to the IGBT.

A low cost 16 character single line LCD will be of scrolling type, showing 'your company name' and the status of the inverter such as batt voltage, mains voltage, and inverter output voltage, inverter standby on/off, charger on/off, mains / solar charging and many more.

It is very simple to handle and very easy to set the values in the menu driven set-up mode. In the menu driven set-up, we can see all the parameters in LCD like battery low – 21V, inverter voltage – 220V etc. By using the Up & Down keys, we can change the values. For ex: Battery low – 21V, by using the 'Up' key, you can increase the value to 21.2, 21.3 ….22, 23… By using the 'down' key you can decrease the value to 20.8, 20.7…..20, 19…If you want to set battery low at 21.4V, press the 'enter' key at 21.4 then this value will be fed to the memory and battery low will be set for 21.4V. There is no need of any preset. (In the conventional method of using a preset, we cannot view the set voltage, after setting the preset, we have to evaluate by varying the battery voltage and check if the battery low warning and cut is coming at the set voltage. Moreover, due to the mechanical vibrations and ageing, there are chances for the preset to shift the set position)

Single phase prevention – For loads like motor and star-delta transformers if one or more phases are missing or missing phase is linked with the other phase (for example – in a three phase connection, if the three phases are R,Y and B. If R is missing and Y is linked with R, then the result will be Y,Y,B) In such conditions, it may result in the load drawing heavy current and may cause damage of the motor / transformer. The DSP will sense these errors and cut off the mains from the output and the inverter will switch on.

In this case, the LCD will indicate faulty condition as “Single Phase” along with buzzer warning.

Phase imbalance – If all phases are correct but the voltages in each phase are imbalanced then the motor or three phase star-delta transformers will draw high current and may result in damaging.

For example: If all phase angle of R, Y, B are correct but R and Y = 230V and B = 100V, then the phase imbalance occurs.

In such conditions, the mains input will cut off from the output and the inverter will provide the supply.

In this case, the LCD will indicate faulty condition as “Phase Imbalance” along with buzzer warning.

Phase sequence error – In a three phase motor, if the connecting sequence is R-Y-B or Y-B-R or B-R-Y the motor will rotate clockwise. But, if the connecting sequence is B-Y-R or Y-R-B or R-B-Y then the motor will rotate anti-clockwise. This will cause severe problems in industries. The DSP will sense the phase sequence of the AC input, if it is reversed the mains input will cut off from the output and the inverter will provide the supply.

In this case, the LCD will indicate faulty condition as “Phase sequence error” along with buzzer warning.

User settable

- online / offline

- single phase / three phase

In the menu driven set-up, you have the option of selecting ‘online’ or ‘offline’. If you select ‘offline’ the system will work as offline inverter. If you select ‘online’ the system will lock the inverter frequency with the mains frequency so there will not be any oscillation in the output voltage because of the beat frequency between mains and inverter. You should use a separate online charger for this.

In the menu driven set-up, you have the option of selecting ‘single phase’ or ‘three phase’. If you select ‘single phase’ the system will work as single phase inverter. Then you can use only two IGBT half bridge modules and two IGBT driver boards. In this case you can take 15KVA maximum. If you select ‘three phase’ the system will work as three phase inverter. You should use three IGBT half bridge modules and three IGBT driver boards. In this case you can take

30KVA maximum.

Features

1. LCD will display –

> battery voltage

> inverter output voltage in each phase

> load in VA in each phase

> mains voltage in each phase

> phase sequence error (instead of RYB if you connect BYR)

> phase imbalance (voltage difference between phase more than +/- 20%)

> Single phase prevention

> charger on/off

> solar charging /mains charging

> inverter standby on/off

> overload : if load is above 100%

> overload trip

> short circuit trip

2. Menu driven set-up. There is no preset, the parameters such as battery low, charging current, inverter output voltage, load etc can be set by scrolling up and down keys and press enter.

3. Priority solar charging

4. No load shut down and auto restart on load

5. Inbuilt SMPS type constant current charging with full charge cut-off.

6. 20 KHz operating frequency while charging, absolutely no sound.

7. Pure sine wave output

8. DSP based very low component cost design

9. Single sided PCB, easy to assemble

SPECIFICATION

POWER RATING : 30 KVA

CONTROL DEVICE : DIGITAL SIGNAL PROCCESSING

POWER DEVICES : IGBT

INPUT BATTERY VOLTAGE : 96V (12V * 8 BATTERIES) TO 768V (12V * 64 BATTERIES)DC

OUTPUT VOLTAGE : 220 V AC +/- 1% PER PHASE (SETTABLE)

OUTPUT CONFIGURATION : THREE PHASE, 4 WIRE, STAR

OUTPUT FREQUENCY : 50 Hz / 60Hz (SETTABLE)

OUTPUT FREQUENCY LOCK RANGE

WITH MAINS : 45 – 55 Hz / 55 – 65 Hz

OUTPUT WAVE SHAPE : SINOSOIDAL

OUTPUT T.H.D : < 2 %

AC INPUT : THREE PHASE, 4 WIRE

AC INPUT VOLTAGE RANGE : 120V TO 290V EACH PHASE

MAINS CHARGING : PWM

MAINS CHARGING CURRENT : SETTABLE FROM 0A to 15A

MAINS CHARGING VOLTAGE : 140 – 270 V AC

SOLAR CHARGING PRIORITY : YES

BATTERY LOW : SETTABLE

OUTPUT SHORT CIRCUIT PROTECTION : PROVIDED

SHT. CIRCUIT RESTART : AUTO AFTER 15 SECS (5 TIMES)

OVER LOAD : 200 % FOR 5 SECS.

OVER LOAD RESTART : AUTOMATIC (5 TIMES)

PC INTERFACE : RS-232

DISPLAY : L C D

EFFICIENCY : > 90%

NO LOAD SHUT DOWN AND

AUTO RESTART ON LOAD : PROVIDED

MINIMUM WATTAGE DETECTION : 15W

CURRENT CONSUMPTION DURING

NO-LOAD SHUT DOWN MODE : 15mA

ISOLATION : AC OUTPUT ISOLATED FROM BATTERY IN THE TRANSFORMER TYPE MODEL

AC OUTPUT NEUTRAL AND AC INPUT NEUTRAL AND BATTERY MID-POINT IS COMMON IN TRANSFORMER-LESS DESIGN (IN 768V (12V * 64 BATTERIES) MODEL)

OPERATING ENVIRONMENT

- TEMPERATURE : 0 to 40 deg C

- HUMIDITY : 0% - 90% (NON–CONDENSING)

INDICATIONS & ALARMS : LCD and BUZZER

Highlights

1. Full bridge configuration based on IGBT half bridge module

2. Only three IGBT half bridge modules are sufficient for three phase

3. Transformer-less ferrite based design is also possible

4. DSP based intelligent control

5. LCD based display for user-friendly display of parameters and status

6. Protection against phase imbalance and phase sequence error

7. Inbuilt single phase prevention

8. Protection against overload and short circuit

9. Buzzer indication for battery low, overload, single phase, phase imbalance, phase sequence error conditions. System continues normally if the error is corrected.

10. Cutoff and auto restart with permanent cut after 5 consecutive cut offs.

11. SMPS type constant current charger with full charge cutoff.

12. 20KHz switching frequency resulting in silent operation. No audible noise.

13. Pure sine wave output

14. Protection against accidental output feedback disconnection.

15. Indigenous design with proven technology