

DelCEN 2500 HV: Protection Features

Product code : IPVCI 2.5MW HV 00
Product Description : SOLAR INVERTER 2500kW HV
(DelCEN2500 HV)

Delta's 2.5MW, 1500Vdc Grid tied Solar central inverter is designed with in built protection features to ensure maximum availability for the end user. Redundancy is built into for all the critical protections to ensure the safe operation of the Inverter due to volatile grid and harsh environmental conditions. Both functional and operational safety is addressed in terms of both hardware and software protections as per IEC62109-1,-2. This document provides details of various protection features offered by DelCEN2500 HV. The protection features are categorised into 3 main categories listed below.

1. DC side protections:

- a. **Over Voltage protection:** The inverter is protected against over Voltages generated from DC panel side, Surge Voltages by means of continuous monitoring of the DC bus Voltages.
- b. **DC Surge Voltage protection:** The inverter is protected with Type 1 + 2, Surge Protection devices to ensure the protection against the surge Voltages on DC terminals. These devices are continuously monitored for the status and the unit is tripped once these devices are activated for the protection.
- c. **Insulation monitoring and protection:** The inverter is equipped with an insulation monitoring device (in case of Floating DC systems) which monitors the sanity of the Insulation level on the DC side in terms of Insulation resistance. It consists of 2 levels of setting, namely pre warning threshold and trip threshold. This information is sent to the Central SCADA system to alert the site Engineers to take proactive action for rectifying the insulation issues. In case of grounded DC system (non-floating DC system) this device is disabled and the DC- is grounded through the Fuse equipped with an MCB and a Fuse with status monitoring switch inside the inverter. In case of insulation failure resulting in excessive earth leakage current flowing through the MCB/Fuse, the MCB trips resulting in alarm to the Central SCADA system alerting the site Engineers to take necessary corrective actions. Fuse here works as a redundant protection.
- d. **Reverse Polarity Protection:** Each of the incoming DC string or Zone connection is equipped with PV rated fuses on the positive polarity connection. During Pre-commissioning, in case there is a reverse polarity connection due to human error, the corresponding fuse opens since the other strings feeds the current to this wrong Polarity connection fuse.
- e. **Short Circuit Protection:** The inverter is equipped with motorised DC load break switch which

is issued ON/OFF command by the Inverter controller. In a rare event of the DC+ and DC- Short within the Inverter, the Inverter has a mechanism to measure the rate of fall of the DC bus Voltage with respect to time (dV/dt) which then triggers the opening of the DC Load break switch as well as the ACB on the AC side to cut the flow of the Short circuit Energy flowing feeding this fault.

2. AC side protections

- a. **AC surge Voltage protection:** The inverter is equipped with Type 1+2 AC surge Voltage protections which is MOV and Spark gap based technology. The DC off set is also taken into consideration during the operation of the device. The device status is continuously monitored and the inverter is tripped in case the Surge protection becomes active with remote alarm.
- b. **ACB with built in LSIG:** The Air circuit breaker (ACB) used as a disconnection device on AC side inside the inverter with remote ON/OFF and Trip command, has built in Microprocessor based Electronic trip unit LSIG. L stands for overload protections with time delay. S stands for Short circuit protection with Time delay, I stands for the Instantaneous Short Circuit protection without time delay and G stands for protection against unbalance phase currents. The protection threshold limits and the time delays are all settable through the dip switch settings.
- c. **AC Voltage band protection:** The inverter is protected against the variation of the Grid Voltages due to Grid fluctuations beyond control. The protection thresholds are programmable based on the grid conditions.
- d. **Frequency band protection:** The inverter is protected against the Variation in the frequency of the grid voltage when the frequency deviates beyond certain band. The Frequency band is programmable.
- e. **Over Current Protections:** The inverter is protected in case of over current by limiting the Maximum current setting in the parameter setup. The power output of the inverter is will be restricted to this value during its peak operating point.

3. General protections

- a. **PLL protection:** Before the start of the Generation, the Inverter must synchronise to the grid in order to feed the Power into the grid. This synchronization is done through phase locked loop method. The synchronization is continuously monitored during the Inverter operation and protection of the Inverter is initiated in case the synchronisation with the grid goes beyond the synchronization band width.
- b. **Anti-islanding protection:** The Inverter is designed to protect itself against entering the islanding mode of operation. The Inverter complies to the Anti-islanding requirements of IEEE 1547 which requires that the Inverter identifies the creation of Island and immediately shuts down within 2 secs.]
- c. **LVRT and HVRT:** The inverter is designed to ride through the low voltage, Zero Voltage and high Voltages on the grid side for certain duration without getting disconnected to the Grid.

The inverter complies to the CEA (Central Electricity Authority) guidelines with respect to the LVRT and HVRT.

- d. **Emergency Stop:** Inverter is equipped with door emergency button which is connected to the safety chain of the Inverter. In case of an emergency this button is manually pressed and leads to the fail safe shutdown of the inverter.
- e. **Door switch protections:** Door switches are provided to each of the doors and interlocked with the safety chain of the Inverter. The Inverter trips and gets disconnected from the Grid in case anyone opens the door during the Inverter operation. These switches can be disabled during maintenance and test operations.
- f. **Temperature protections:** The inverter and its critical components are protected against abnormal over temperatures. The temperatures are continuously monitored and compared with the safe threshold limits. The Temperature data is logged for later analysis. All the components are designed for the required insulation class to withstand the temperatures they may be subjected to during the Inverter operation.
- g. **Protection against Coolant Pressure:** Since the Inverter is liquid cooled with closed loop circulation, there are pressure switches set at pre warning threshold and trip threshold which protects the Inverter in case of any rare event of coolant liquid leakages. Also the inverter is designed to have collector trays all along the Cooling circuit which ensures that there shall not be any coolant spillage on the electrical components and other live parts.
- h. **Climatic protection:** The Inverter is Equipped with the Humidity sensor which continuously monitors the level of Humidity inside the Inverter in terms of %RH and will not allow the Inverter to start if the Humidity levels are above the preset value. Instead, panel heaters are turned on to reduce the Humidity to the acceptable limit before the Inverter is turned ON.
- i. **Protection against communication loss:** The Inverter is equipped with communication polling with various communication ports which ensures that the ports do not hang during the Inverter active status.
- j. **Microprocessor watch dog:** This feature ensures that the main Inverter controller does not go to unknown state machine and continuously monitors the microprocessor functioning.
- k. **Smoke detector:** The inverter trips in case of any smoke detected within the panel and avoids further fire mishap.

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