
	TECHNICAL SPECIFICATION	Doc No. REG-20210193/03	
Rudrapur	GROUP : REG	Rev no	00

TECHNICAL SPECIFICATION

(Power Optimizers, Power Conditioners/Inverters and Accessories)

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1. Scope of Supply:-

Supply of Power Optimizers, PCU/string inverters (Rating 50kVA to 200kVA) for 5MWp (AC), 1.3ILR/6.5 MWp (DC) ground mounted Solar Power Plant.
Inverters must be compatible with Power Optimizer.

Note: During the installation of the supplied items, supplier shall provide assistance or depute technical person (if required) for proper installation and commissioning.

2. Place of Supply:

Place of supply :- "Nalanda University –Rajgir, Bihar".

3. Technical Specification:-

(A) Power Optimizers:-

A power optimizer shall be combination of both a string and micro inverter. This module-level power electronic (MLPE) device shall be used to increase the solar panel system's energy output by constantly measuring the maximum power point tracking (MPPT) of each individual solar string and adjusts DC characteristics to maximize energy output. The panel optimizers relay performance characteristics via a monitoring system to facilitate operations and any necessary solar panel maintenance. Built-in safety features like rapid-shutdown response etc shall be considered for this product. Efficiency shall not be less than 98%, standby voltage shall not go beyond 1.5 V for safety, optimizer shall be capable to Mitigates all types of module mismatch losses, from manufacturing tolerance to partial shading, provide module / string level monitoring, etc.

Minimum 4no modules to be connected through 1no Optimizer ie, 4:1 ratio.

Supply of Power optimizers comprise of all related mounting accessories like screws, washer, nut/bolt, etc.


(B) Power Conditioner Units/Inverters:-

(i) General :-

The DC power produced is fed to inverter for conversion into AC. In a grid interactive system AC power shall be fed to the grid at three phase 11 KV AC bus (step up transformer – 0.415/11kV is available). Power generated from the solar system during the daytime is utilized fully by powering the loads and feeding excess power to the grid as long as grid is available.

In cases, where solar power is not sufficient due to more demand or cloud cover etc. the building loads shall be served by drawing required energy from the grid. The inverter



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should always give preference to the Solar Power and will use Grid power only when the Solar Power is insufficient to meet the load requirement.

Each PCU should be rated minimum 50kVA with DC voltage range 1000 V – 1500V and AC Voltage 415 V alongwith the following provisions & characteristics:-

- The inverter shall be a true sine wave inverter for a grid interactive PV system. The output of the inverter must synchronize automatically its AC output to the exact AC voltage and frequency of the grid.
- Inverter shall continuously monitor the condition of the grid and in the event of grid failure, the inverter automatically switches to off-grid supply within 20-50 milliseconds. The solar system is resynchronized with two minutes after the restoration of grid.
- Grid voltage shall be continuously monitored and in the event of voltage going below a preset value and above a preset value, the solar system shall be disconnected from the grid within the set time. Both over voltage and under voltage relays shall have adjustment voltage (50% to 130%) and time settings (0 to 5 Seconds).
- Metal Oxide Varistors (MOVs) shall be provided on DC and AC side of the inverter.
- The inverter control unit shall be so designed so as to operate the PV system near its "Maximum Power Point (MPP)", the operating point where the combined values of the current and voltage of the solar modules result in a maximum power output.
- The degree of protection of the outdoor inverter panel shall be at least IP- 65.

Note:-


1. PCU/String Inverters must be compatible with Power Optimizers.
2. Total system will be monitored through SCADA. All required inputs (software & hardware) & technical support for monitoring at module level shall be provided on free of charges basis as & when required including API interface, if required.
3. PCU must have sufficient protection on DC side. **In case protection is not available in the offered PCU/string inverter then DCDBs shall be provided free of cost.**

(ii) Technical & Other features.

(a) Typical Features:-


1. Purpose : The power conditioner unit shall convert DC produced by SPV array and adjust the voltage & frequency levels to suit the Grid.
2. Grid supervision : All three phases shall be supervised with respect to rise / fall in programmable threshold values of frequency & the power section of the plant. The plant shall get disconnected / connected from the grid in case of a grid fault / after normal grid conditions have resumed.

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3. Type & technology : IGBT based and should utilize a circuit topology and components suitable for meeting the specifications.
4. Output voltage on AC side : 415 +10%, - 15% V AC at 50 Hz
A dedicated isolation transformer housed in the PCU enclosure shall be supplied to match the PCU output voltage to the utility grid voltage. If necessary, PCU/Solar Inverter voltage range should be reconfigured as per site requirements.
5. DC system voltage : The electrical safety of the array installation is of the utmost importance. Array electrical configuration shall be in such a way that, the MPPT shall operate with maximum efficiency, between the low and high temperature of the site.
6. Maximal Current ripple : 3%
7. Power Factor : 0.95 inductive to 0.95 capacitive.
8. No load losses : < 1% of rated power
9. Ambient room temperature : 5 to 55 °C
10. Housing Cabinet :
 - a) PCU is housed in suitable switch cabinet, with min IP 21 degree of Ingress Protection.
 - b) Weatherproof, rodents & insect proof
 - c) Components and circuit boards mounted inside the enclosures clearly identified with appropriate permanent designations, which shall also serve to identify the items on the supplied drawings.
 - d) All doors, covers, panels and cable exists shall be gasketed or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped with locks. All openings shall be provided with grills or screens with openings no larger than 0.95 cm (about 3x8 inch).
11. Display : Liquid crystal display shall at least be provided on the inverters front panel or on Separate data logging/display device to display following
 - DC Input Voltage
 - DC Input current
 - AC Power output(kW)
 - Current time and date
 - Time active
 - Time disabled
 - Time Idle
 - Temperatures (c)



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- Converter status

(b) Other important features:-

1. Electrical safety : The PCU shall include appropriate self-protective and self diagnostic feature to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU's safe operating range due to internal or external causes.

The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices and not by the existing site utility grid service circuit.

- a) General
- b) Over/under voltage :
 - Mains (Grid) over-under voltage and frequency protection.
 - Over voltage protection against atmospheric lightning.
 - Protection against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.

- c) Islanding : Protection against islanding

- d) Accidental open circuit : Full protection against accidental open circuit and reverse polarity at the input.

- e) Internal Faults : Inbuilt protection for internal faults including excess temperature, commutation failure, overload and cooling fan failure is obligatory


- f) Galvanic Isolation : Galvanic isolation is provided to avoid any DC component being injected into the grid and the potential for AC components appearing at the array.

- Galvanic isolation shall be provided between the inverter/ PCU and grid to avoid any DC component being injected into the grid and the potential for AC components appearing at the array.

- The specification of the isolation transformer shall be as follows:

- Capacity: 125% of capacity of the PV modules (i.e., a 12.5 kVA transformer shall be used for a 10 kW PV system, and so on)
- System: 3-phase, 4-wire
- Input voltage range: 320-480 V AC
- Output voltage range: 380-435 V AC

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- Output voltage for single phase: 220-240 V AC
- Tap change: Manual, V+/-20%, V+/-10%, V+/-0%
- Operating frequency: 48-52 Hz
- Efficiency: >98.5%
- Impedance: 4-10%
- Output waveform: Zero distortion
- Insulation class: Class F
- Leakage current: <20 mA
- Cooling: AN
- Enclosure: IP 21 (if indoors)
- IP 54 (if outdoors)
- Normal Operating Temperature: 0-60°C
- Cable entry: Separate input/ output enclosed cable entry
- Standard: IS 2026

- Further, it is also observed at various locations throughout the distribution grid that the grid voltage would consistently be greater or less than the acceptable voltage window of many inverters and PCUs. Moreover, this variation may be only for particular days of a week, seasonal, or for a limited time.

- In such a case, the Contractor shall study/ measure the point of interconnection of the PV system consistently for at least one week to identify the voltage range experienced at the interconnection point of the distribution grid.


Consequently, the Contractor shall adjust the input/ output of the isolation transformer to appropriate tap settings so that the voltage on the inverter side of the transformer is always within the acceptable voltage window of the inverter. The appropriate tap setting shall be conveyed to NALANDA UNIVERSITY by the contractor.

g) Earth Fault Supervision : An integrated earth fault detection device is provided to detect eventual earth fault on DC side and shall send message to the supervisory system

h) Disconnection & Islanding : a) Disconnection of the PV generator in the event of loss of the main grid supply is achieved by in built protection within the power conditioner. This may be achieved through rate of change of current, phase angle, unbalanced voltages, or reactive load variants.

b) Operation outside the limits of power quality as described in technical data sheet shall cause the power conditioner to disconnect the grid. Additional parameters requiring automatic disconnection are:




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- Neutral voltage displacement
- Over current
- Earth fault &
- Reverse power

In each of the above cases, tripping time shall be less than 0.5 seconds. Response time in case of grid failure due to switch off or failure based shutdown should be well within 60 seconds.


- Automatic reconnection after the Grid restoration : PCU has facility to reconnect the Inverter automatically to the grid following restoration of grid, subsequent to grid failure condition.
- Array Ground fault : Provided
- Operator interface : LCD and keypad operator interface, Menu driven.
- Fault conditions : Automatic fault conditions reset for all parameters like voltage, frequency and /or black out.
- Control Logic : Using watch dog timers.
- Failure detection
- Parameter access : All parameters accessible through an industry standard communication link.
- DC-AC conversion efficiency : 93% for output ranging from 20% to full load
Idling current at no load shall not exceed 2% of the full load current.
- DC isolation : Provided at the output by means of a suitable isolating transformer.
- Parallel operation with Grid : Provided & capable of interrupting line-to-line fault currents and line to ground fault currents.
- Unbalanced output load : PCU is able to withstand an unbalanced output load to the extent of 30%.
- PCU generated harmonics : Shall not exceed a total harmonic current distortion of 5%, a single frequency current distortion of 3%, and single frequency current distortion of 1%, when the first through the fiftieth integer harmonics of 50Hz are considered.
- Circuit separation : High voltage & power circuits separated from low voltage & control circuits.

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14. Internal wiring : a) Cables :PVC Cu cables as per relevant international Standards.
b) Cable connections : suitable terminations
c) PVC channel with covers to house the cables.
15. High voltage test : PCU with stand high voltage test of 2000 Vrms between either the input or the output terminals and the cabinet (chassis).
16. EMI (Electromagnetic interface) : PCU shall not produce EMI which cause malfunctioning of electronic & electrical instruments including communication equipments which are located within the facility in which the PCU is housed.
17. Display on front panel & indicators : a) instantaneous PCU ac power output and the DC voltage current and power input:-
b) Accuracy of display : 3% of full scale factor or better.
c) Display visible from outside the PCU enclosure.
d) Operational status of the PCU, alarms, trouble indicators and AC and DC disconnect switch positions shall also be communicated by appropriate message.
18. Emergency OFF : Emergency OFF button is located at an appropriate position on the unit.
19. Grounding : PCU includes ground lugs for equipment and PV array groundings. The DC circuit ground is a solid single point ground connection.
20. Exposed surfaces : Exposed surfaces of ferrous parts are thoroughly cleaned, primed, and painted and suitably protected to survive a nominal 30 years design life of the unit.
21. Factory Testing :
 - Tested to demonstrate operation of its control system and the ability to be automatically synchronized and connected in parallel with a utility service, prior to its shipment.
 - Operation of all controls, protective and instrumentation circuits demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.
 - Demonstration of utility service interface protection circuits and functions, including calibration and functional trip tests of faults and isolation protection equipment.
 - Operation of startup, disconnect and shutdown controls also to be tested and demonstrated, stable operation of the PCU and response to control signals shall also be tested and demonstrated.

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- Factory testing include measurement of phase currents, efficiencies, harmonic content and power factor. All tests shall be performed 25, 50, 75 and 100% of the rated nominal power.
- Factory test report (FTR): Should be supplied with the unit after all tests. The FTR shall include.
- Detailed description of all parameters tested qualified and warranted.

22. MPPT

- : Maximum power point tracker is integrated in the power conditioner unit to maximize energy drawn from the array. The MPPT shall be microprocessor based to minimize power losses. The MPPT shall have provision (manual setting) for constant voltage operation. The MPPT unit shall confirm to IEC 62093 for design qualification.

23. Operating Modes

- a) Night or sleep mode : where the Inverter is almost completely turned off, with just the timer and control system still in operation, losses < 2 W per 5 kW
- b) Standby mode: where the control system continuously monitors the output of the solar generator until pre-set value is exceeded (typically 10 W).

Operational of MPP tracking mode: the control system continuously adjust the voltage of the generator to optimize the power available. The power conditioner shall automatically re-enter standby mode input power reduces below the standby mode threshold. Front panel display providing the status of the PCU, including AC power output & DC current voltage and power input, and unit fault indication.

Shut down / standby mode with its contact open under the following conditions before attempting an automatic restart after an appropriate time delay; in sufficient solar power output.

a) *Insufficient solar power input :*


When the power available from the PV array is insufficient to supply the losses of the PCU, the PCU shall go to a standby/ shutdown mode. The PCU control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

b) *Utility -Grid over or under voltage :*

The PCU shall restart after an over or under voltage shutdown when the utility grid voltage has returned to within limits for a minimum of two minutes.

c) *Utility-Grid over or under frequency :*

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The PCU shall restart after an over or under frequency shutdown when the utility grid voltage has returned to the within limits for minimum of two minutes.

24. Inverter / Array Size Ratio : The ratio of the Inverter continuous power rating and the array peak power rating shall be maximum 80% to 90%. This is because better overall annual yield can be obtained by allowing the Inverter to operate for longer periods closer to optimal efficiency.
25. Data Logging System : All major parameters available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital front panel at any time the current values, previous values for up to a month and the average values.

The following parameters shall be accessible via the operating interface display :

- Daily generation
- AC voltage
- AC output current
- Output power
- DC input voltage
- DC input current
- Time active
- Time disabled
- Time Idle
- temperatures (C)
- Converter status


Protective function limits viz., AC over voltage, AC under voltage, Over frequency, under frequency, ground fault, PV starting voltage, PV stopping voltage, over voltage delay, under voltage delay over frequency, ground fault delay, PV starting delay, PV stopping delay.

26. Communication Interfacing : The communication interface shall be integral part of inverter and shall be suitable to be connected to SCADA/remote monitoring system via LAN or web using either a standard modem or GSM/WiFi mode.

Inverters must be provided a communication interface (for remote monitoring system/SCADA) which shall be able to support :-

- Real time data logging
- Event Logging
- Operational Mode



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- Set point editing

To measured and displayed following parameters continuously:-

- Ambient Temperature
- Isolation DC Current and Voltage
- DC injection into the grid
- Efficiency of the inverter
- Solar system efficiency
- Display of I-V curve of solar system
- Error logs
- Any other parameter considered necessary by supplier

Note:- The stored data should be represented through hourly, daily, monthly, etc. graphs and easily downloadable in .csv or .xls format.


(iii) **Standard & Certificates:-**

For Power Conditioners/Inverters following certificates shall be submitted by the bidder

- | | |
|--|-----------------------------------|
| • Efficiency Measurements- | IEC 61683 |
| • Environmental Testing- | IEC 60068-2 (6,21,27,30,75,78) |
| • Electromagnetic Compatibility (EMC) | IEC 61000 series – relevant parts |
| • Electrical Safety | IEC 62109-1&2 |
| • Protection against islanding of Grid | IEEE 1547/UL 1741 / equivalent |
| • Other sub-system components | BIS standards |

Note:- In case, sufficient DC protection is not available in the supplied PCU/inverter, then separate DCDB for each PCU/inverters shall be supplied free of cost by bidder. This also includes supply of 2nos DCDBs as spares.



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4. Additional documents required for technical evaluation –

A. **PV Syst Report** – Bidders are required to submit PV Syst report mandatorily along with technical bid. Details required for preparing PV Syst report are as follows –


S No	Particulars	Detail	Remarks
1	Site	Nalanda University	Single piece of land
2	Location	Rajgir	
3	District	Nalanda	
4	State	Bihar	
5	Pin Code	803 116	
6	Site Latitude	25.00 deg N	
7	Site Longitude	85.22 deg E	
8	Nearest Railway Station	Rajgir	
9	Module rating	325Wp, DCR category	
10	Module detail	BHEL Make, Model - L24315P-325W	Data sheet attached
11	No of Modules	>20,000nos	
12	Module layout	True south	
13	Layout Philosophy	2P/ 20Modules per bed	

B. **Design Philosophy** indicating string & array details – Key parameters are to be indicated clearly.

C. **Installation/O&M manuals** for string inverters/optimizers are to be submitted.

D. **QAP** – Tentative QAP is attached. However, bidder to submit QAP for approval.

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5. Bill of Quantity

S No	Item	Rating	Quantity	UoM	Remarks
Main Supply					
1	Power Optimizers	4:1 or above	5000	KW (AC)	considering 20,000nos modules.
2	PCU/String inverters	50kVA to 200kVA	5000	KW (AC)	for 5MWp AC capacity
Spares Supply					
1	Power Optimizers	4:1 or above	50	Nos	Offered optimizer rating
2	PCU/String inverters		2	Nos	Offered inverter rating.

Note:

1. PCU/Inverter quantity shall be 5000kW(AC), 1.3ILR/6500kWp(DC).
2. Above quantities under "Main supply" are tentative & may vary as per offered design philosophy. However, Total 5MWp AC capacity to be ensured irrespective of quantities to be used.
3. To meet design philosophy parameters (like no of modules per string restrictions, etc), if more than 20,000 nos modules are required to meet the design, then additional module will be supplied by BHEL. However, **additional quantity of optimizers including accessories to meet 5MW (AC) capacity shall be supplied at no extra cost.**
4. Power optimizers include related accessories like screw, washer, nut/bolt, etc. is under supplier's scope.
5. Different/Mixed rating/type/make of PCU/inverters/optimizers are NOT allowed. Only single rating/type/make is required.
6. Spares are to be supplied as per indicated quantity of same rating/type/make considered in the main project.
7. DCDBs (if required) to be supplied free of cost along with each PCU/inverter. In such case, bidders are required to submit relevant drawings & documents along with the technical bid.
8. Accordingly, 2nos DCDBs of same rating will be supplied as Spares at no extra cost.




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MAKE LIST

S.No.	Equipment	Make
1	Optimizer	Solar Edge/ Tigo Energy/ Enphase - equivalent OR any other PSU, GoI fulfilling the technical requirement and approved supplier for CPSU (Tranche-II) Phase-II Scheme being run by the SECI and reconigned by MNRE.
2	Inverter	Schneider/ Delta/ ABB/ SMA/ Huawei/ Solar Edge/ Hitachi/ Siemens OR any other PSU, GoI fulfilling the technical requirement and approved supplier for CPSU (Tranche-II) Phase-II Scheme being run by the SECI and reconigned by MNRE.

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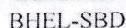
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DEVIATION SHEET

S.No.	Technical Deviation	Remarks

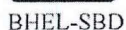
Note:- Technical Deviation(s) mentioned anywhere in the offer except “Deviation Sheet” shall not be accepted & will not be considered for the evaluation of offer.

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DY. Engr/REG.



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PRAKASH BABU
Dy. Engr/REG.

MANUFACTURING QUALITY PLAN		Customer: NALANDA UNIVERSITY Project: SMVp AC Main - Supplier: BHEL RUDRAPUR								
MANUFACTURER'S NAME AND ADDRESS Component Fabrication Plant(CFP) RUDRAPUR		Item: String Inverter Sub-System: NA								
QF No: QP/GMS/INVERTER/NU Rev No: 00 Date: 07/05/2021 Page: 01 of 01										
Sl. No	Component & Operation	Characteristics	Class	Type of Check	Quantum of Check M	Reference Document	Acceptance Norms	Format of Record	Agency M C N	Remarks
1	Raw Material / Incoming Materials									
1.1	PCB	Internal Quality by Manufacturer	Critical	Electrical	100%	Per drawings and specifications	Defined tolerance	Data collection in the system	V	V
1.2	Metal Material	Internal Quality by Manufacturer	Critical	Verification of Test Report	100%	Per drawings and specifications	Defined tolerance	Data collection in the system	V	V
1.3	Plastic Material	Internal Quality by Manufacturer	Critical	Verification of Test Report	100%	Per drawings and specifications	Defined tolerance	Data collection in the system	V	V
1.4	Cables	Internal Quality by Manufacturer	Critical	Verification of Test Report	100%	Per drawings and specifications	Defined tolerance	Data collection in the system	V	V
1.5	Rubber Material	Internal Quality by Manufacturer	Critical	Verification of Test Report	100%	Per drawings and specifications	Defined tolerance	Data collection in the system	V	V
1.6	Electrical components	Approved Vendor List ONLY	Critical	Verification of compliance	100%	Manufacturer Part Number in PDM system	Pass/Fail	Data collection in the system	V	V
2	Manufacturing Process Check									
	SMT		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	AOI		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	PCBA WASHING		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	WAVE SOLDERING		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	AVI		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	ICT TEST		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
2.1	In Process Test									
	FUNCTIONAL TEST		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	COATING		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	ASSEMBLY		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
	HIPOT		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
2.2	Final Test									
	ATE		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
2.2.1	Visual Inspection Test		Critical	Measurement	100%	EMS system	Tolerance in the spec	Routine test report	P	V
2.2.2	LED Test		Critical	Measurement	100%	EMS system	Tolerance in the spec	Routine test report	P	V
2.2.3	General Functional Test		Critical	Measurement	100%	EMS system	Tolerance in the spec	Routine test report	P	V
2.2.4	THD		Critical	Measurement	100%	EMS system	Tolerance in the spec	Routine test report	P	V
2.2.5	Operation frequency range test		Critical	Measurement	100%	EMS system	Tolerance in the spec	Routine test report	P	V
2.2.6	Operating voltage range test		Critical	Measurement	100%	EMS system	Tolerance in the spec	Routine test report	P	V
2.3	EOL		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
2.4	Inverter Validation		Critical	Measurement	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
2.5	Fulfillment		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V
2.6	Packing & Shipment		Major	Visual	100%	Assembly instructions, flow defined in EMS system	Tolerance in the spec	Data collection in the system	V	V

Doc. No: QP/GMS/INVERTER/NU

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Reviewed By: *[Signature]*

Approved By: *[Signature]*

Approval Seal

LEGEND:
 ** M: MANUFACTURER/SUB-SUPPLIER C: MAIN SUPPLIER, N: NU
 P: PERFORM W: WITNESS AND V: VERIFICATION.

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 RUDRAPUR
 10/05/2021