



सत्यमेव जयते

भारत सरकार  
रेल मंत्रालय  
GOVERNMENT OF INDIA  
MINISTRY OF RAILWAYS

अनुसंधान अभिकल्प एवं मानक संगठन  
रेल मंत्रालय

**RESEARCH DESIGNS AND STANDARDS ORGANISATION  
MANAK NAGAR, LUCKNOW-226011**

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**RDSO Specification No. RDSO/PE/SPEC/TL/0142-2010 (Rev. 0)**

**TECHNICAL SPECIFICATION FOR 100 VA INDIVIDUAL STATIC INVERTER  
FOR LAPTOP/MOBILE CHARGING POINT IN COACHES**

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1.	-	'0'	-	Adoption of ICF's specification no. ICF/ELEC/922 dated 20.06.2006

अनुमोदित  
APPROVED

कार्यकारी निदेशक/पी.एस. एवं ई.एम.यू.  
Executive Director / PS & EMU

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## TECHNICAL SPECIFICATION FOR 100 VA INDIVIDUAL STATIC INVERTER FOR LAPTOP/MOBILE CHARGING POINT IN COACHES

### 1.0 SCOPE

- 1.1 This specification covers the requirements of design, manufacture and supply of 100 VA static inverters to be provided in Self Generation type coaches of Indian Railways for operating Laptops and Cell phone chargers.
- 1.2 These Inverters will have a dc two wire system input with voltage variation from 90 to 140 volts dc and ripple content of 15% with lead acid battery always connected in the system.
- 1.3 This inverter shall also be retrofitted in existing coaches. As such based on the availability of space, the dimensions of the inverter requires changes as such Type 'A' (Horizontal type) and Type 'B' (Vertical type) have been included in the specification.



### 2.0 SERVICE CONDITIONS

- 2.1 The inverter shall be rugged in construction and shall be suitable for mounting inside the coach.
- 2.2 The equipment shall operate satisfactorily under the following climatic conditions:-
  - (a) Variation of ambient temperature from 0°C to 55 °C with 100% relative humidity.
  - (b) Heavy rainfall with thunder storms.
  - (c) Dusty and corrosive atmosphere.
- 2.3 The equipments shall withstand satisfactorily the vibrations and shocks (as per Specn. IEC -61373) normally encountered in service as indicated below:-
  - (a) Maximum vertical acceleration .. 3.0 g
  - (b) Maximum longitudinal acceleration .. 3.0 g
  - (c) Maximum transverse acceleration .. 3.0 g

('g' being acceleration due to gravity)
- 2.4 The vibrations are of sine wave form and the frequency of vibration is between 1 Hz and 50 Hz. The amplitude 'a' expressed in 'mm' is given as a function of 'f' by equation.
 

$a = 25 / f$  for value between 1 Hz and 10 Hz.

$a = 250 / f^2$  for values between 10 Hz and 50 Hz.
- 2.5 In the direction corresponding to the longitudinal movement of the vehicle, the equipment is subjected for 2 minutes to 50 Hz vibrations of such a value that the maximum acceleration is equal to 3 g.  
(amplitude a=0.3 mm)

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### 3.0 CONSTRUCTIONAL REQUIREMENTS:

#### 3.1 TYPE-A (Horizontal Type)

The maximum overall dimensions shall be L=185mm, B=100mm, Depth= 65mm and cut-out dimension L=155mm, B=100mm & Depth= 65mm for TYPE-A inverter as per the sketch enclosed as ANNEXURE-B.

#### 3.1.1 TYPE-B (Vertical Type)

The maximum overall dimensions shall be L=120mm, B=185mm, Depth= 65mm and cut-out dimension L=90mm, B=155mm & Depth= 65mm for TYPE-B inverter as per the sketch enclosed as ANNEXURE-B.

3.2 The base shall have 4 fixing holes, 2 per side, of size M6.

3.3 The equipment shall be encased in a CRCA sheet to IS:513 (Latest) having IP 23 protection.

**Note:** The housing drawing and overall arrangements shall be approved at the time of prototype testing.

3.4 For dissipation of heat from the power components heat sinks shall be provided. The heat sinks should be so located as to reject heat outside directly. The heat sink shall be designed for natural ventilation. For better heat rejection, the heat sink should be painted black in colour.

**Note:** Use of the body/housing of the inverter for heat transfer or as Heat sink is permitted, provided that (a) the heat sink is insulated electrically and (b) that increase in temperature of the body does not exceed 10 °C over the ambient at the hottest zone. All the material used in the inverter shall be fire retardant conforming to UL94 V0.

### 3.5 FASTENERS

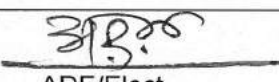
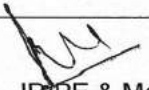
3.5.1 Fasteners used in the inverter shall be zinc plated and passivated according to IS:1573 (Specification for electroplating coatings of zinc on iron and steel)

3.5.2 The minimum size of the fasteners shall be M4.

### 3.6 WIRING TERMINATIONS

3.6.1 All wiring inside the equipment shall be with multistranded copper cables having PTFE insulation to JSS Specification No. 51034 (latest) and shall be of adequate size. The cable size shall be so determined that the current density of 3 Amps/Sq.mm is NOT exceeded and the minimum size of cable shall NOT be less than 0.50 Sq.mm.

3.6.2 All the terminations other than those on the PCB shall be crimped terminals. The windings of transformers and chokes used in the inverter, which shall be of minimum class 'F' insulation and shall be terminated with proper terminal boards/blocks.

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- 3.7 Terminal block (Wago product item no. 731-132 or equivalent) suitable for cable connection upto 2.5 Sq.mm shall be provided either at the top or any of the two side wall inside of the housing. The firm shall take prior approval for using any other type/make of terminal block. A clear positive and negative marking of permanent nature shall be provided for their easy identification to avoid wrong connections. For output termination, one 5 pin shuttered socket of 6A 230V AC rating, suitable for insertion of 2 pin charger in 3 pin as well as 2 pin holes, conforming to IS: 1293 (latest version) shall be provided on the front mounting plate. LED indications shall be provided for input & output supply. Piano type one way 10A, 230V AC switch conforming to IS: 3854 (latest version) shall also be provided for inverter ON/OFF. The switch and socket shall be provided in a cover frame 3-module with powder coated steel plate 4"X3". Switch, socket and cover frame shall confirm to UL-94V0 for fire retardancy. Switch shall be suitable for 1,20,000 switching operation.

ESS ESS KAY model no. NV-200 for switch, NV-219 for socket and NV-262 for cover frame with plate of signature NV series or similar models of MK (Honeywell)/Crabtree make shall be used.

### 3.8 RELIABILITY

- 3.8.1 The PCB, Components and Assembly of the unit shall conform to RDSO Specn. No. ELRS/SPEC/SI/0015 – Oct. 2001. The Mean Time Between Failures (MTBF) of the component shall be 10 years.

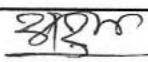

#### 3.8.2 COMPONENT RATING

- 3.8.2.1 Only MOSFET shall be used for handling the power. The rating of the MOSFET proposed to be used shall be clearly indicated, along with calculations establishing their adequacy, in terms of Voltage and Current, duly also furnishing the technical data sheets for the device.
- 3.8.2.2 The rating, as reckoned for ambient of 65°C versus loading, shall be 4 for 'Current' and 2 for 'Voltage' for all other components.

Note : (i) The junction temperature of the power devices as corrected for an ambient of 65 °C, shall be atleast 20 °C , lower than the maximum permissible limit specified by the Device manufacturer. The junction temperature shall be computed from Heat sink temperature, measured at a point closest to the fixing base of the power device and the Thermal effects of Device losses as reckoned from the thermal impedences of Heat sink to case and case to junction. In case switching losses are not possible to be computed with any degree of accuracy, a factor of 5 °C may be added to the computed junction temperature and the figure arrived at thus, duly corrected for 65 °C ambient shall have 20 °C margin.

- (ii) The manufacturer shall submit calculations to prove the adequacy of rating of the power devices offered and shall furnish the technical pamphlet with all parameters of the device, proposed to be used.

- 3.9 The housing of the inverter shall be powder coated with black colour to a thickness of not less than 50 microns.

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- 3.10 The name plate to be rivetted to the backside of the housing shall be in screen printed anodised Aluminium sheet of not less than 0.5 mm thick. It shall, besides the name of the Manufacturer with their logo and Equipment, contain the input/output voltage, VA rating and a simple Block connection diagram indicating mode of connection, and serial number of the equipment with first two digits for Year of manufacture, next two digits for Month of manufacture, next digit for 'Version' and next four digits for manufacturer serial number.

### 3.11 FUSE

- 3.11.1 The equipment shall be provided with a 3.0 A, replaceable glass fuse at input.

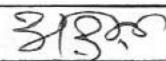

## 4.0 TECHNICAL REQUIREMENTS

- 4.1 a. Input voltage range : 90V dc to 140 V, dc (The equipment shall switch-off at voltages below 90 and voltages above 140 (within 2 V of the limits).
- b. Nominal voltage : 110 V dc
- c. Output voltage : 110V ac +/- 5% Sinusoidal
- d. Output frequency : 50 Hz +/- 3%
- e. Capacity (Minimum) : 100 VA at 110V ac (shall be capable of taking laptop starting current) – as per clause k.
- f. Waveform of output : As close to sinusoidal as possible. Total harmonic content shall not exceed 5% RMS at the output voltage as measured by an RMS distortion measuring instrument
- g. Over voltage : Shall be able to withstand at the input 200 V dc, for one minute.
- h. Transient voltage : Shall be able to withstand Transient Surges of 4.0 kV for one micro sec, or 1.5 kV for 50 micro second. (Ref: IEC-60571).
- i. Short circuit at output : Shall be able to withstand short circuit across output terminals without damage.
- j. Open circuit : Shall be able to withstand output in open circuit and with input connected to supply.
- k. Capacity to meet Starting conditions : Shall be able to meet 4.0 times the current equal to full rated current of the inverter for 3 seconds. (Beyond this period the equipment shall shut-off without damage).

Note : 1. Beyond 4.0 times the rated current, the equipment may get switched 'OFF' immediately, such that its components do not get damaged.

2. Provision of an Inverse Time Protection with reference to overload conditions shall also be acceptable. The manufacturer shall indicate the protection strategy adopted.

- l. Incorrect polarity : Shall be protected against polarity reversal at the input
- m. Efficiency : Shall be not less than 80%.
- n. Environmental Conditions : The inverter shall meet the requirements as per the Specn. IEC 60571.
- o. Degree of protection : IP-23 as per IEC 60529

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- p. Other Requirements : (i) It shall not be necessary for earthing INVERTER's housing or any of its terminals for its satisfactory operations.  
(ii) Any earth fault in the supply system or the output load, shall not affect its performance or prove injuries to the equipment or persons in any way.

## 5.0 TESTS

### 5.1 PROTO TYPE TESTS



The following tests shall constitute the Proto type test for the static inverter. These tests shall be carried out on one sample manufactured by the prospective supplier in the presence of representative from RDSO/any authority nominated by IR to establish conformity of the product to the Specification, in all respects.

- |   |                  |
|---|------------------|
| (a) Physical dimension and constructional features verifications test | .. Clause 6.1)   |
| (b) Performance characteristic test and Rating Test                   | .. (Clause 6.2)  |
| (c) Over voltage test   | .. (Clause 6.3)  |
| (d) Open circuit test   | .. (Clause 6.4)  |
| (e) Load break test   | .. (Clause 6.5)  |
| (f) Under voltage test  | .. (Clause 6.6)  |
| (g) Short Circuit test  | .. (Clause 6.7)  |
| (h) Temperature rise test   | .. (Clause 6.8)  |
| (i) High voltage test   | .. (Clause 6.9)  |
| (j) Insulation resistance test  | .. (Clause 6.10) |
| (k) Reverse polarity test   | .. (Clause 6.11) |
| (l) Transient voltage test  | .. (Clause 6.12) |
| (m) Environmental Test  | .. (Clause 6.13) |
| (n) Endurance Test (i) and (ii)                                       | .. (Clause 6.16) |
| (o) Efficiency Test   | .. (Clause 6.17) |

### 5.2 TYPE TEST

All tests as in clause 5.1, except for items (l) and (m). Type test shall be conducted on ONE unit selected at random in each order.

Note : Notwithstanding the above, the purchaser may reserve the right to ask for any of the tests that have been exempted.

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### 5.3 ACCEPTANCE TEST

The following tests shall constitute the acceptance tests. These tests shall be conducted on the samples selected at random to establish conformity of the lot to be supplied with the requirements of the Specification. These shall be conducted on 10% or minimum 5 units in each lot offered.

- (a) Physical dimension and constructional features verification test .. (Clause 6.1)
- (b) Performance characteristic and Rating test .. (Clause 6.2)
- (c) Over voltage test .. (Clause 6.3)
- (d) Open circuit test .. (Clause 6.4)
- (e) Short circuit test .. (Clause 6.7)
- (f) Temperature rise test (one in a lot) .. (Clause 6.8)
- (g) High Voltage test .. (Clause 6.9)
- (h) Insulation Resistance Test (Dry) .. (Clause 6.10)
- (i) Reverse polarity test .. (Clause 6.11)

### 5.4 ROUTINE TESTS



The following shall constitute the routine tests. These tests shall be carried out on all the inverters to be supplied. The manufacturer shall carry out these tests and submit the results to the inspecting agency, prior to offering the lot for acceptance test.

- (a) Physical dimensional and constructional feature verification test .. (Clause 6.1)
- (b) Performance characteristic and rating test .. (Clause 6.2)
- (c) Over voltage test .. (Clause 6.3)
- (d) Insulation Resistance test .. (Clause 6.10)
- (e) Reverse polarity test .. (Clause 6.11)

### 5.5 MEASURING INSTRUMENTS

5.5.1 Accuracy of instruments used during tests shall be of 0.5 class accuracy as per IS:1248/1958. Instrument shall be essentially free from errors due to wave distortion. Use of TRUE RMS type digital ammeter and voltmeter is preferable. Analog meters if used shall be of Moving coil type for dc measurements, and for ac measurements Moving Iron type and wattmeters shall be Dynamometer type. The range of the measuring instruments shall not exceed 1.5 times the Quantities measured.

5.5.2 The instruments should have been calibrated within a year of the usage date.

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**6.0 TESTS****6.1 PHYSICAL DIMENSION AND CONSTRUCTIONAL FEATURES VERIFICATION TEST**

The physical dimension of the inverter shall be checked in accordance with the dimensions and drawing approved by RDSO. The various constructional features of the inverter and the Specification of the various components shall be checked to ensure that they conform to the requirements of this Specification and RDSO Specification ELRS/SPEC/SI/0015-Oct 2001.

Note : (i) During the Prototype Tests, the makes and ratings of the essential components shall be recorded and the same shall be verified randomly during subsequent inspection stages in the bulk supplies.

(ii) The manufacturer shall not change the make and ratings of the 'active' components without prior written permission of the purchaser.

(iii) For Routine and Acceptance Tests, use of 'Go-Nogo' gauges or Templates may be used for dimensional checks.

**6.2 PERFORMANCE CHARACTERISTIC TEST AND RATING TEST**

6.2.1 The inverter shall be tested with a variable resistive load of 100VA. The dc input voltage to the inverter shall be gradually varied from zero and the voltage at which the inverter switches 'on' and the rated output voltage registered shall be recorded both under open circuit and with the load connected to the rated value. This input voltage shall not exceed 90V dc. The voltage shall be increased to 140V dc in steps of 10 V and the following readings shall be taken over the entire range from 90V to 140 V dc. The output load shall be adjusted for open circuit, 50% and 100% loading.

- i) Output voltage
- ii) Output frequency
- iii) Output Total Harmonic Content of Voltage
- iv) Output ac current
- v) Input voltage (dc)
- vi) Input current (dc)

Note : The Total Harmonic Content in percentage shall be measured with an RMS Distortion Measuring Instrument -This shall be done in Prototype and Type Test. at 90V, 110V, 125V and 140V dc input voltages.

**6.2.2 RATING TEST**

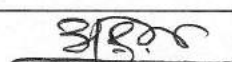
6.2.2.1 For Acceptance and Routine tests, the cut in and cut out voltages shall be recorded and the other recordings need be made only at rated input voltage and under open circuit and full load conditions.

**6.3 OVER VOLTAGE TEST**

6.3.1 The inverter while working at its full rated load shall be subjected to an input dc voltage of 200 V for one minute. The inverter shall work satisfactorily after completion of this test.

NOTE: Switching OFF the inverter beyond the operating range through internal control to avoid over loading of the same is acceptable.

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#### 6.4 OPEN CIRCUIT TEST

- 6.4.1 The inverter shall be operated at 140V dc without load under open circuit for a period of ONE hour during Prototype and Type tests and for 5 minutes during Acceptance tests. The inverter shall perform satisfactorily after completion of the test.

#### 6.5 LOAD BREAK TEST

- 6.5.1 The inverter shall be fully loaded with input voltage of 140 V dc, after connecting a contactor in series with a resistive load. Allow the load current to pass for one minute, break the load by opening the contactor. Repeat the test for 3 times. The inverter should withstand the test successfully.

#### 6.6 UNDER VOLTAGE TEST

- 6.6.1 The inverter with and without load shall be connected to dc supply and be kept at a value at which it gets 'switched off' at the under voltage limit, for a period of ONE hour. The inverter shall function satisfactorily after conclusion of the test.

#### 6.7 SHORT CIRCUIT TEST

- 6.7.1 The inverter output connections shall be shorted together and maximum of the voltage range 140 V dc be applied at the input terminals of the inverter and the inverter shall be 'ON' for half an hour in this condition. The unit shall be tested for the performance after this test and the inverter shall function satisfactorily.

NOTE : Against 'Acceptance' Test the duration of the test shall be limited to 60 seconds.

#### 6.8 TEMPERATURE RISE TEST

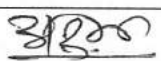
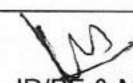
- 6.8.1 The inverter shall be connected to 90V dc input with full rated loading of 100VA at the output with resistive load and the equipment shall be kept 'ON' continuously until thermal stability is reached as reckoned from the Temperature Rise of three consecutive constant half hourly readings, at the wound components, housing or the device heat sink, whichever takes the longest time (in any case the Test duration need not exceed Four hours). The temperature values of the Heat sink of the power device (as close its base as possible), wound components, housing and switching capacitors, if any shall be recorded.

- 6.8.2 The maximum temperature computed corrected to 65°C ambient shall be well within limits prescribed for the various other components.

Power Devices : 20°C below max. Permissible Jn. Temp.  
Wound Components : 70°C temp. Rise (Class F)

NOTE : In the Prototype test, by way of an Investigative Test, the Inverter shall be tested for its Thermal Capability, as in clause 6.8.1 however, connecting two Laptops/Cell Phone Chargers.

- 6.8.3 All the parameters be recorded and device Junction Temperature is also computed corrected for 65 degree C ambient along with that of other components.

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## 6.9 HIGH VOLTAGE TEST

- 6.9.1 The Inverter input and output terminals shall be shorted and inter connected and a High Voltage of 1.5 kV ac for ONE minute shall be applied between the terminals so shorted and the housing. There shall be no breakdown.

## 6.10 INSULATION RESISTANCE TEST

- 6.10.1 The insulation resistance of the inverter shall be measured with 500V megger as given below:-

(a) Between input terminals shorted together and the housing with output being kept in open circuit condition.

(b) Between the output terminals shorted together and keeping the input terminals in open circuit.

The insulation resistance values measured thus shall not be less than 10 Mega ohms in each test.

## 6.11 REVERSE POLARITY TEST

The inverter shall be subjected to Reverse polarity supply at 140 V dc, at the input and kept for 5 minutes.

The equipment shall perform satisfactorily on restoring normal supply.

Note : For Acceptance and Routine tests, the duration of test shall be ONE minute.

## 6.12 TRANSIENT VOLTAGE TEST or VOLTAGE SURGE TEST

- 6.12.1 A Transient voltage of 4 kV for one micro-second OR 1.5 kV for 50 micro second shall be applied at the input terminals of the inverter as indicated in IEC: 60571 (latest). The test shall be considered satisfactory if the unit performs satisfactorily, without showing any abnormality.

## 6.13 ENVIRONMENTAL TEST

The inverter shall be subjected to environmental test as per the following:

### 6.13.1 DRY HEAT TEST

The unit shall be connected to the 90 V dc, input supply and rated load and be kept in a chamber with an elevated temperature of  $70 \pm 2^\circ\text{C}$  for 6 hours as specified in IEC: 60571 (latest). After completion of the test, the inverter shall be checked for satisfactory performance.

### 6.13.2 DAMP HEAT TEST

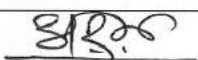
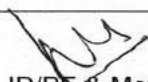
This test shall be conducted as per relevant clause of IEC 60571(latest).

## 6.14 TEST FOR IP PROTECTION

This test shall be conducted for IP 23 on complete unit for dust and water protection conforming to IEC 60529 .

## 6.15 TEST FOR VIBRATION

This test shall be conducted as per relevant clause of IEC 61373 (latest).

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## 6.16 ENDURANCE TEST

### 6.16.1 CONTINUOUS RUN TEST

The inverter with input voltage at 90V dc and at its full rated load of 100VA (resistive) shall be kept at a temperature  $55 \text{ deg.C} + 2 \text{ deg. C}$  continuously for 48 hours (2 days). On being tested with normal supply (110 V dc), the inverter shall perform satisfactorily.

Note : For type test, this test shall be conducted at prevailing ambient for 24 hours.

### 6.16.2 ON-OFF CYCLE TEST

The inverter shall be subjected to endurance test at 90V dc input and 100 VA loading for 1000 'ON' and 'OFF' cycles, each cycle comprising of 20 seconds 'ON' and 10 seconds 'OFF'. After completion of the test the inverter shall function satisfactorily when tested for performance.

Note : For type test, this test shall be conducted for 100 cycles.

## 6.17 EFFICIENCY TEST

The dc input to the inverter shall be measured with the help of suitable range of moving coil or digital ammeter and voltmeter of specified accuracy. The output of the Inverter shall also be measured with the help of moving iron voltmeter, ammeter and either moving iron or Dynamometer type wattmeter. The efficiency of the inverter shall be determined at the rated value on resistive load as well as on inductive load of 100 VA with 0.8pf. In both the cases, the efficiency should not be less than 80%.

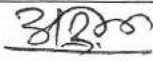
## 7.0 MARKING

The inverter shall be provided with an anodised aluminium Name Plate and rivetted to the back side of the inverter marked with the following information:-

- Name of the manufacturer with logo
- Type
- Serial Number ( first Two digits the year of manufacture, next two digits the month, one digit version code and next four digits running serial number.
- Wiring diagram ( with sketch) indicating the position of Terminals
- Rated input voltage range
- Nominal Input Voltage
- VA rating
- Rated output voltage at nominal voltage
- Rated output current at nominal voltage.
- Frequency

## 8.0 GUARANTEE

The inverter shall be guaranteed for satisfactory performance for a period of 24 months from the date of commissioning or 30 months from the date of supply whichever is earlier. Any design defect, defective material, under rated component used etc. have to be corrected and merely replacement of defective parts will not be considered adequate. Complete investigation report along with remedial measure taken to avoid re-occurrence of similar failure in future for each defect/failure shall be submitted to RDSO and purchaser for each case.

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## 9.0 FAILURES DURING WARRANTY PERIOD OR UNDER MAINTENANCE CONTRACT

The details of failures, action taken to arrest reoccurrence of similar failure in future, failure report, investigation report, failure analysis are to be submitted to RDSO and purchaser railways.

In case of repeated failures, necessary changes in design on the units put in service or in production line are to be made by the manufacturers free of cost. Investigation tests, if considered necessary, are to be arranged / conducted by the manufacturer.

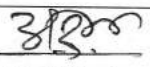

## 10.0 APPROVAL BY RDSO

- 10.1 The prototype of the inverter shall have RDSO's approval. The firm shall submit in-house test results, circuit diagrams, dimensioned drawing and MTBF calculation of the inverter to RDSO for examination before witnessing of the prototype tests and approval.
- 10.2 The manufacturer shall also submit details like make, type, reliability, grade, rating and loading of various electronic components used in the circuit along with reliability prediction, calculations based on actual loading of various components. The temperature rise of the various components under the most adverse conditions shall also be declared. The inverter shall be accepted for prototype test only if the reliability prediction calculations show that MTBF is not less than  $4 \times 10^4$ .

## 11.0 INFORMATION TO BE SUBMITTED

The manufacturer shall submit the following information before manufacturing of prototype unit in printed form and neatly compiled in a booklet form as well as in soft copy :-

- (a) Clause-by-clause comment on the specification
- (b) Detailed specification of the offered inverter, transformer (if any), inductor, input fuses, input MCB and data sheets of components.
- (c) Details of protections provided and their effectiveness/proposed set values and range and working principle.
- (d) Details of semi-conductor devices used and their specification and data sheets.
- (e) Circuit diagrams along with bill of material and circuit description and working principle.
- (f) Safety margins in voltage, current, thermal (for junction temperature) along with the limit values for power devices, inductors and transformer (if any) etc.
- (g) Declared output voltage wave-form, power factor and regulation.
- (h) Drawings and details of dimensions, mounting arrangement and weight.
- (i) Detailed description/explanation of circuit adopted and its salient advantages.
- (j) Burn in procedure followed for components/assembled cards. The temperature and duration of burn in period shall be indicated or procedure followed to ensure reliable components and premature PCB failure.
- (k) Duty cycle considered for inverter design for continuous and short time ratings.
- (l) Service experience for the offered unit or similar units.
- (m) Data sheet duly filled as per Annexure-A.
- (n) reliability prediction calculations show that MTBF is not less than  $4 \times 10^4$ .
- (o) Temperature rise of the various components under the most adverse conditions shall also be declared.

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- (p) A set of different coloured photographs of the inverter which clearly shows the outside and inside details in different photographs.
- (q) Details of facilities available at their works for manufacture of this unit as required in the RDSO specification ELRS/SPEC/SI/0015.

## 12.0 SPARES AND MAINTENANCE MANUAL


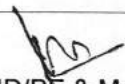
A list of spares required for maintenance, if required, shall be supplied with the inverter in printed form and neatly compiled in a booklet form.

The operating and maintenance manual giving instructions for installation, maintenance and circuit diagram with voltages at salient points to locate faults, list of components with brief specifications and manufacturers etc. trouble shooting and testing procedure after repair shall be supplied. In addition to above, working principle, precautions to be taken, fault diagnostic up to component level, component testing before its fitment, component handling etc. shall be included in the maintenance manual. The original numbers on IC, transistors and other components shall not be erased or painted. Moulded blocks with hybrid circuit are not acceptable.

## 13.0 SAMPLING

The sampling and rejection for conducting various tests shall be done as per IS:4095 (latest edition).

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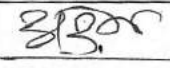

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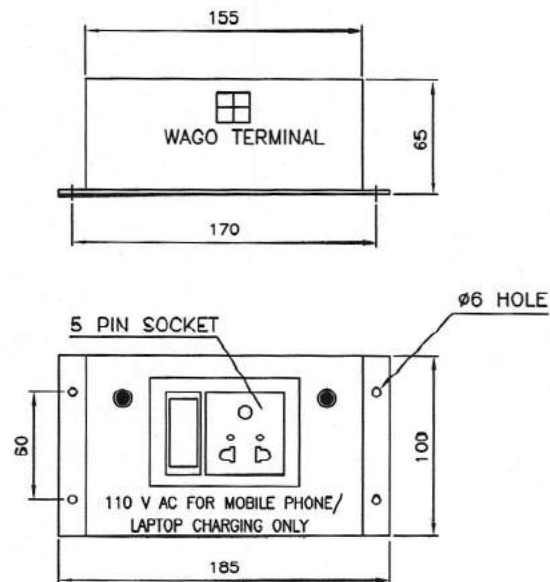
**ANNEXURE-A**

The following technical information shall be submitted by the manufacturer before developing prototype unit:-

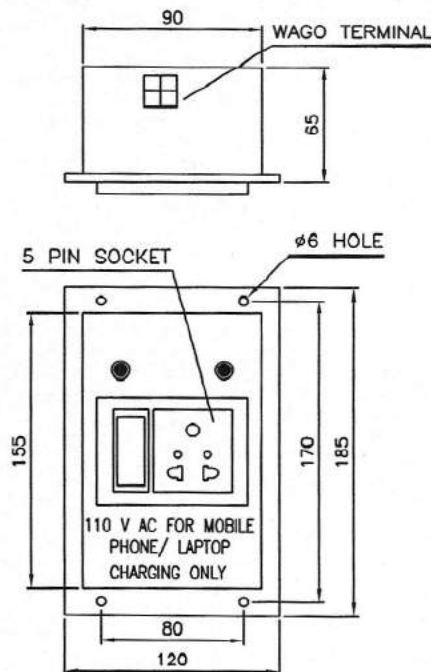
- I. Profile of the firm
- II. Previous experience on similar products
- III. Clause-wise comments on the specification
- IV. Technical Requirements:
  - 1) Type of Inverter
  - 2) Input Nominal voltage and operating voltage range
  - 3) Output
    - (a) Voltage
    - (b) Frequency
    - (c) Rating –VA
    - (d) Efficiency
  - 4) Brief write up on the principle of operation with block schematic diagram.
  - 5) Rating of main component especially the power devices (alongwith technical pamphlets and calculation for adequacy).
  - 6) Factor of safety adopted for each component.
  - 7) Temperature rise limit or Jn. Temp. or Case Temp.
    - (a) Diode
    - (b) Transistor
    - (c) Capacitor
    - (d) Resistor.
    - (e) MOSFET
  - 8) Any earthing is required for circuit operation
  - 9) Protective circuits employed with details.
  - 10) Details of in-house test facilities available.
  - 11) Vibration limits conformity.
  - 12) Deviations from the specification, if any.

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## ANNEXURE-B

SCHEMATIC DIAGRAM FOR 100VA INVERTER

## TYPE - A FOR AC COACHES



## TYPE - B FOR NON-AC COACHES

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