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POWER PLANT- 48 VDC FOR TELECOMMUNICAITON EQUIPMENT- TECHNICAL REQUIREMENTS

(This translation is for reference only)

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Foreword

TCVN 8687:2011 was prepared on basis of revision and transferring of TCN 68-162:1996 "Power plant 48 DCV for telecommunication equipment", refer to some technical documents on power plant -48 VDC of manufactures

TCVN 8687:2011 was prepared was prepared by the Posts and Telecommunications Technology Institute, proposed by Ministry of Information and Communications, considered and decided by Directorate for Standards, Metrology and Quality, and announced by Ministry of Science and Technology.

Power plant – 48 VDC for telecommunication equipment – Technical requirements

1 Scope

This standard specifies the technical requirements for the power plant -48 VDC for telecommunications equipment, including the following types:

- Power plant doesn't use switching techniques, the capacity to 2.5 kW, and
- Power plant uses switching technique (switching power plant).

This standard is the technical basis for the design and creation, management, quality assessment of the power plant -48 VDC for telecommunication equipment.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

TCVN 7189:2009 Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement

TCVN 7921-1:2008 Classification of environmental conditions. Part 1: Environmental parameters and their severities

TCVN 8241-4-2:2009 Electro Magnetic Compatibility (EMC). Part 4-2: Testing and measurement techniques. Electrostatic discharge immunity

TCVN 8241-4-3:2009 Electro Magnetic Compatibility (EMC). Part 4-3: Testing and measurement techniques. Immunity to radiate, radio-frequency, electromagnetic fields

TCVN 8241-4-11:2009 Electromagnetic compatibility (EMC) - Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests

IEC 61000-3-2, Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)

IEC 60950-1:2001, Information technology equipment – Safety – Part 1: General requirements

3 Terms and definitions

This standard applies the following terms and definitions:

3.1

-48 VDC power plant

Power plant is capable of meeting the following functions:

a) Supply power to telecommunication equipments with constant stable voltage and nominal load current.

b) Ability to switch float mode or equalizing mode for battery, warn and monitor the functions of the power cabinet.

Equipment function depending on design but complete power includes blocks as follows:

- Rectifier block supply power for equipment and float mode, also known as float rectifier
- Battery charger
- Switching and alarm arrangement

In case of using a battery then 2 units: float rectifier and battery charging are combined into a source block, but must still ensure the power supplying mode for the equipment, float mode and equalizing mode for battery.

3.2

Float Rectifier

Instrument unit changes alternating power source into continuous direct current source, ripple filtering, and supplying the regulated output voltage as well as the nominal output current

3.3

Battery charger

Instrument unit changes alternating current source into direct current source, used the first load or equalizing mode for one of the batteries and can supply power to the equipment in case the device supply unit is incidents.

3.4

Switching arrangement and alarm

Instrument unit has switching function to change the battery charging modes, monitor and warn operational status of function units as well as the status of the batteries, making sure not to interrupt power to the equipment even power failure.

3.5

Noise filter

Parts used to prevent high frequency interference effect from the source cabinet to alternating current network, and vice versa.

3.6

Lightning protection

Parts for lightning protection, destroy voltage spikes on the power cabinet to protect the power supply unit from the effects of lightning or other voltage spikes (voltage surge).

3.7

Float mode

The DC output voltage of power supply unit both provide device loading and charging the battery with voltage level so that the load line $\leq I_{float}$ regulated each type of battery and ensure the normal operation mode of device loading.

3.8

Equalizing mode

For the sources don't use switching techniques with specific load unit, batteries are removed from the device loading and is loaded with the appropriate voltage and the equalizing current regulated specific to each type of battery.

For the source uses switching technique or the source not use switching technique without specific load unit, DC output voltage both supply device loading and charge battery with voltage levels in accordance with equalizing mode specified for each type of battery and ensure the normal operation mode of device loading.

3.9

Over voltage / under voltage protection

Protection features of the source when the voltage at the input or output exceeds the permitted level.

3.10

Current limit

Protection features of the convolution output power, overload or weak battery, the power supply current will be limited to not damage power supply unit and devices attached.

3.11

Alarm arrangement

Alarm arrangement when occurring the unusual working status of the source (sound or image or both).

3.12

Trip

The ability to stop the operation of the float rectifier or the loader when something goes wrong, or the specifications are outside the working range of the source.

3.13

Rectifier

Unit that changes input AC power energy into DC energy with voltage and current according to requirements of switching technique.

3.14

Switching power plant

Power supply unit uses switching techniques to change input AC power energy into output DC power energy

4 Abbreviations

This standard applies to the following abbreviations:

HVSD	High voltage shut -down
SMR	Switching - mode rectifier
MCB	Miniature circuit breaker
DC	Direct current voltage
VAC	Alternating current Voltage

5 Technical requirements for power plant -48 VDC without switching technique

5.1 The technical standards for electricity

5.1.1 Input

Input must be designed with one phase AC source.

a) Frequency: 50 Hz ± 5 Hz

b) Input voltage 220 VAC ± 20 %

c) Anti-interference ability:

Power supply unit must not cause interference to other radio equipment placed together room. Any noise source must be filtered by high-frequency noise filter or appropriate shield grid so that:

- High-frequency noise voltage at the input, output not exceed 1500 μV in the frequency range from 50 kHz to 15 MHz.

- The reflections electric intensity of frequency range from 50 kHz to 15 MHz measured at point 1m from the source cabinet not exceed 20 μV/m, for the frequency range from 40 MHz to 70 MHz not exceed 10 μV/m .

d) The lightning protection ability

- Input must have lightning protection circuit and voltage spikes. Lightning protection circuit must be suspended both two branches of the AC input (see Figure 1).

- Residual voltage after the lightning protection is not greater than the value of the maximum input voltage (265 V).

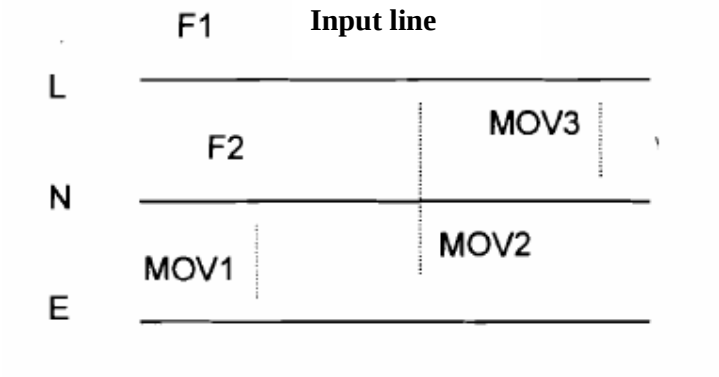

Figure 1 - AC input lightning protection circuit

5.1.2 Output

5.1.2.1 The float rectifier

Transition period to achieve the DC nominal output voltage when supplying power to the source cabinet from 3s to 5s.

In case, the power supply unit has both the float rectifier and equalizing charging make sure the power supply mode, float and equalizing mode.

a) Output voltage

Output voltage must be stable within the limits (51.5 ± 1.5) VDC with any value of the load current is less than or equal to the nominal current, when the input voltage change 20% and frequency of 50Hz ± 5 Hz

b) Output voltage drop

When the load current is greater than 100% to 110% of the nominal load, allowed output voltage down up to 47 VDC

c) Disturbance voltage and ripple

Disturbance voltage in the frequency range from 100 Hz to 20 kHz less than or equal to 2.5 mV of the effective when the nominal load, in parallel with the battery at the output and less than or equal to 4 mV of the effective if without batteries in parallel at the output

The output ripple less than 50 mV (peak - peak).

d) The nominal current

Nominal currents depending on each device, requirements of consumption current of devices and loader but must ensure not be less than the total of maximum consumption current and the load current of a battery.

e) Efficiency and cos φ factor

Cos φ power factor not be less than 0.8 in the case of the nominal load.

Efficiency should not be less than 75%.

5.1.2.2 Battery charge

a) Output voltage

Equalizing mode: output voltage from 48 VDC to 57 VDC with the load current from 25% to 100% of nominal load current.

Full charge: output voltage from 57 VDC to 65 VDC with load current from 50% to 100% of the nominal current

b) Nominal current

Nominal current depends on each device and battery capacity should be charged, but must be greater than or equal to the load current total of one battery and maximum consumption current of the device

c) Efficiency and cosφ factor

cosφ factor not be less than 0.8

Efficiency should not be less than 80%.

5.1.3 Switching, warning and protecting

5.1.3.1 Switching and metering device

a) Switching

- Switch block make ensure when operating not interrupt power up for the device is operating
- Switching can operate manually or automatically
- Any attempt at switch blocks do not affect the device is powered

b) Metering device

* Meter of the output voltage

Measurement range from 0 V to 75 V must measure the voltage:

- Float Rectifier
- Battery charger, and
- The battery voltage

* Meter of the output current

Measurement range depends on the maximum current of each device, but must measure:

- Out put current of float rectifier;
- Battery charging current

***** Accuracy

Metering device can be either analogue clock or indicators to ensure the accuracy less than or equal to 0.5%

5.1.3.2 Warning and Protecting

All incidents such as AC power loss, low and high out put voltage, low and high in put voltage low, low battery voltage must offer warning signal by audio, indicator lights

a) Float rectifier

- Overvoltage threshold 55 VDC

- Low voltage threshold 44 VDC
- Overload warning when the load current exceeds 110% of the nominal current
- Fuse of outputs protection operates at 120% of the nominal current
- Maximum current limit at 110% of the nominal current

b) Battery charge

- Overvoltage threshold 65 VDC
- Low voltage threshold 44 VDC
- Limit the current from 110% of the nominal current or more
- When the protection threshold voltage of the float rectifier, battery charger allows to interrupt AC input to protect of sources and equipments

5.2 Structure

5.2.1 Structural Characteristics

All blocks must be placed in a continuous cabinet with uniform form, form a power supply unit and complete battery charging.

5.2.1.1 Case

Case must secure, flat surfaces and without protrusions than 3 cm

5.2.1.2 Heat extraction

Case must be designed to be able to efficiently convention of natural gas stream from the bottom to the top of coolant for all the parts in the power cabinet.

5.2.2 Cable and wire

- Cross-section area of the wire must satisfy all requirements of current, the current density is not greater than 3A/mm
- The end of all cables with current must have wrapped termination soldered or clamped so that at the joints without temperatures greater than the wire temperature.
- All cables must be supported appropriately, compact structure. All entrance cables with the AC power must be placed separately from the other cables.

5.2.3 Grounding

All metal parts without current must be grounded through the earth termination

5.3 Environmental conditions

- Working environment temperature: $0 \sim 50^{o}$ C
- Relative humidity $\leq 95\%$

5.4 Testing

a) Each product unit before installing or after repairing, and maintaining must be checked and tested according to the requirements of this standard.

b) Test measurement with the all input voltage range and load current from 0% to 110% of the nominal current

Measuring method

- Use AC and DC voltage instrumentations have suitable scale to measure the input and output voltage level required.
- Use variable resistor load devices with the least load capacity of 100 kW and AC current measurement instrument with suitable scale to measure the load current level required.
- Use the oscilloscope with measurement range to mV to measure ripple and noise
- Insulation

Measuring method: Insulation resistance shall be measured by meter with working voltage to 500V or more

Measurement processing:

+ Between the AC input and the ground
+ Between the DC output and the ground
+ Between the AC input and DC output

- Check the warning function:

+ AC power loss
+ Low input voltage warning
+ High input voltage warning
+ Warning off due to the high output voltage
+ Low output voltage warning
+ Cut warning ...

- Insulation durability test

+ Insulation durability of the transformer, coil ... should be tested by an AC voltage 1.5 kV 50 Hz in one minute
+ Withstand humidity of 95%

- Temperature checking

Measurement methods: Using infrared thermometric devices or contact thermometer to measure the temperature at the required elements

+ For coil, temperature transformer not exceed 50 ^{o} C versus ambient temperature.
+ For silicon diodes or Thyristor, temperature not exceed 70 ^{o} C

6. Technical requirements for power plant -48 VDC with switching technique

6.1 General requirements

6.1.1 Structure

Power System 48 VDC power with switching technique is composed of the following main parts:

- *Rectifier block*: Implement the conversion of input alternating current electrical energy into stable output direct current electrical energy with the nominal voltage of -48 V. Power system may include one or more independent rectifier blocks, and supply DC electrical energy on the DC bus system.

- *Monitor control unit*: Implement installation and adjustment the parameters, function and operation of the rectifier blocks: voltage adjustment, output current limit, control the battery charging and launch mode, system protection modes, incident alerts, displays the system status parameters and support the functions of remote monitoring and control

- *Cabinet frame support and distribution equipment, input and output connections*: Implement cabinet support function to install the rectifier blocks, monitor control unit, input and output distribution, battery connection, switching protection equipment, the connection between the blocks.

6.1.2 Input voltage

The power system must ensure that output targets when the system operating in the input voltage range as follows:

- One phase: voltage range: 187 ~ 264 VAC;
- Three phases: phase voltage range: 320 ~ 456 VAC.

Voltage tolerances between the phases are greater than 10%.

Working voltage range expanding toward high, low side (if any) of the system depends on the type of rectifier blocks have been used and the specific production report

Highest input voltage limit of system can be fully protected, depending on the type of rectifier blocks to be used and specific production report.

6.1.3 Frequency

Power system to meet the out put technical requirements when frequency of the input AC power within the range: 45 ~ 66 Hz.

6.1.4 Input Current

Largest input current limit of the system depends on the largest input current of each specific rectifier block and total of rectifier block in the system.

6.1.5 Power factor

As the power factor of the rectifier blocks used in the power system.

6.1.6 Efficiency

As the source efficiency of the rectifier blocks used in power systems.

6.1.7 Nominal output DC voltage

Nominal output DC voltage is -48 V, positive connect the ground.

6.1.8 Output DC voltage range can be adjusted

Output DC voltage range can be adjusted from 42.0 to 59.5 V.

6.1.9 Output current

Depending on the nominal current limit of each rectifier block and the number of the largest rectifier blocks of the system.

Must be able to adjust the output current value of the system within specific limit.

6.1.10 Power limit

Depending on the nominal power limit of each rectifier block and the number of the largest rectifier blocks in the system.

6.1.11 Protection

- Endure short-circuit: the source system must be able to endure output short-circuit without time limit.
- The source system must have output fuse in the rectifier blocks, the polarity components, battery switches when the batteries are connected to opposite poles.
- Disconnect the battery when the voltage exceeds the low limit.
- Having battery temperature probe
- When the rectifier blocks are faulted, only rectifier blocks off the power, other rectifier blocks are still operating normally
- Having MCB against short circuit at the AC input and DC output

6.1.12 Lightning ground

Source system must have the output ground and against lightning.

All metal parts without current of the system must be grounded through the grounding.

The rectifier blocks must have lighting cutters and filter at AC source input

6.1.13 Warning

Source system must be able to identify, warn, indicate error status of the system. The warning level can be set.

6.1.14 Ability to replace, add the rectifier blocks

The source system must be able to replace hotly and Plug & Play the rectifier blocks.

6.1.15 Environmental conditions

Working temperature range: $-25^{0}C \sim +50^{0}C$

Humidity: $\leq$ 95%

6.2 Technical requirements for each rectifier block

6.2.1 Input

a) Input voltage

Voltage Range:

220 VAC + 20%, -15% (for power systems use one-phase input power), or

380 VAC + 20%, -15% (for power systems using three-phase input power).

Wider voltage range on the high side or the low side, or the wide range for each specific product must be given by manufacturers. In particular, the manufacturer must declare the power level corresponding to the extended voltage range for each specific product.

b) Input power frequency

45 Hz ~ 66 Hz

c) Waveform

Sinusoidal

d) Input Current

Input current of the rectifier block is defined at the nominal high input voltage level. These values must be declared by manufacturer for the corresponding product.

e) Soft start

Time of growth output current to reach the nominal load currents: from 3s to 8s

f) Power factor

> 0.97 when the load is greater than 50% of the nominal output capacity;

> 0.98 when the load equal to 100% of the nominal output capacity.

Power factor decreases when the input voltage exceeds high level of the nominal input voltage range.

g) Efficiency

≥ 0.90 when the load is equal to or greater than 40% of the nominal output capacity

h) Harmonic Distortion

Total harmonic distortion of THD due to equipment must be smaller than 5% when loading with 100% of nominal output capacity.

i) The ability to withstand voltage

The equipment must withstand the test voltage 1500 VAC from input to protective cover in1 minute

6.2.2 Output

Output voltage:

Nominal Output Voltage: -48 VDC, positive connected ground

Output voltage when battery float mode

42.0 V ~ 58.0 V (can be adjusted)

Output voltage when battery equalizing mode:

42.0 V ~ 59.5 V (can be adjusted)

Current limit:

Output current limit range of the rectifier block must be declared by the manufactures for their corresponding products.

Capacity limit:

Capacity of the rectifier block is determined by the current limit in the specific output and input voltage. The current limits and capacity chart have been declared by the manufacture for corresponding product.

Noise:

Psophometricaly weighted noise: < 2 mV effective

Broadband noise: < 10 mV effective (10kHz ~ 100 MHz)

Peak voltage <120 mV pp

NOTE: The above noise level applies to the rectifier blocks with power≥ 6kw. The noise can be smaller for rectifier blocks with smaller capacity and must be specifically declared by the manufacturer

6.2.3 Protection

- Must have protection fuse for inputs and outputs in each rectifier block.
- Power circuit must be cut the circuit when the input AC voltage exceeds the high or low allowed limit

Ability to restore power circuit when the AC input voltage within specified voltage limits

These limits must be declared by the manufacturer for each product.

- There are current limiting circuit spike when connecting rectifier block and the AC voltage bus
- No electrical shock when rectifier block connected to the DC bus
- The output overvoltage: block off when the output voltage higher than specified threshold
- Overcurrent: have ability to withstand the output short circuit current without time limit
- Overheating: have ability to reduce capacity limit when detecting temperature exceeds allowable limits
- Batteries with opposite poles: ability to cut the circuit when detecting battery connects opposite poles

6.2.4 Adjustment

Equipment must be able to perform the requirements of the control and monitor units to adjust:

- Limit the output current as required
- Adjust the output voltage as required
- Cut level of high output voltage
- Cut level of low output voltage
- Turn off the device source when the output voltage exceeds the threshold
- Recovery the device source at the end of the high-voltage state

6.2.5 Warning, Indication

Equipment must be able to detect error warning includes:

-AC input voltage is too high or too low

- Output Voltage too high, too low
- Circuit Fault
- Interrupt the equipment source due to the remote or circuit fault

- Overheating
- Overcurrent

Status indication includes:

- AC power loss
- Error warning
- Device Status
- Disconnect the device source
- Load distribution

6.2.6 Technical requirements

Limits and methods of safety measurement for power plant -48V comply with IEC 60950-1:2001.

Limits and measurement methods of radio disturbance for power plant -48V comply with ISO 7189:2009 (CISPR22: 2006)

Measurement methods of electrostatic discharge immunity for power plant -48V comply with TCVN 8242-4-2:2009 (IEC61000-4-2: 2001)

Measurement methods of Voltage dips, short interruptions and voltage variations immunity tests for power plant -48V comply with TCVN 8241-4-11:2009 (IEC 61000-4-11:2004)

Limits and measurement methods of environmental parameters and their severities tests for power plant -48V comply with TCVN 7921-1:2008 (IEC60721-1: 2002)

Limits and measurement methods of harmonic emissions (equipment input current ≤ 16 A per phase) tests for power plant -48V comply with IEC 61000-3-2

6.3 Technical requirements for monitor control unit

6.3.1 Operating conditions

- Source voltage: 40 ~ 70 VDC, positive connected the ground, if the voltage have other operation then must declared by the manufactures.
- Consumption power: declared by manufacturers
- Protection: must be protected inside by fuse and have ability to against reverse input voltage poles.
- Working environment: Temperature: -25 ~ 70 ^{o}C, relative humidity ≤95%

6.3.2 Interface

- Port connect to the rectifier blocks: Connect signal transmission - receiver with the rectifier blocks must be at least 2kV DC with optical coupling
- Control port over personal computer or notebook: RS 232 standard of type DB9
- Remote monitor port: including all standard types RS 232, RS 485, optical or TCP/IP

6.3.3 Peripheral

- Connector

The monitor control block must have the connectors to the unattended point and peripheral systems

such as:

- Voltage system / battery
- Current sensing of the battery
- Load current sensing
- Heat Sensing
- Switching between battery and load
- Switching off with the low voltage
- The alarm relays (fan error, disconnect source of rectifier block, high voltage cut-off, other warning errors ...)
- Input AC source

Monitor unit for input AC source

The monitored parameters include voltage, current, phase balance, input power frequency.

Monitor unit for battery Cell (optional)

The monitored parameters are voltage, temperature of each battery .

6.3.4 Operation Interface

Control key:

On the control and monitor unit must have control key to set the parameters and functions for source systems.

Instruction screen:

On the control and monitor unit must have instruction screen of voltage and output current, system status, error warning, battery charging mode, the parameter functions are adjusting.

Status indicator lights:

On the control and monitor unit must have LED indicators for system operation status, error warning, error or load distribution mode or source interrupt error of the rectifier block.

Connected Jack for PC or Notebook;

On the control and monitor unit must have connection interfaces for PC or notebook used to setup the mode and working parameter of the system .

Connected Jack to the transmission network: RS 232, RS 485, TCP / IP and optical interface.

6.3.5 Warning

The control monitor block must instruct the warming status of source system -48 VDC through warming sound, and status LED light and display the information on the LCD screen.

The errors should be warmed include:

- Exceed the high limit, low limit of output voltage of the systems
- Exceed the high limit, low limit of output voltage of the rectifier block
- Exceed the low limit of discharge voltage of the battery

- Exceed the high limit of the ambient temperature, battery temperature, temperature of each rectifier block
- Processor bug, the other device bugs
- Exceed the high limit, low limit of voltage and AC input frequency
- Deenergize fault of the rectifier block due to exceeding the high or low voltage threshold.
- Short-circuit fault and output overcurrent
- Battery connection error…

The warning limits can be adjusted through the monitor control unit include:

- Adjust system warning limits
- High Voltage: can be adjusted in the range of 52.0 ~ 66.0 V
- Low Voltage: can be adjusted in the range of 40.0 ~ 54.0 V
- The lowest battery discharge voltage: Can be adjusted in the range of 44.0 ~ 52.0 V

High level of the working environment temperature, battery temperature

- Adjust the warning limit of each rectifier block

High voltage: Can be adjusted in the range of 52.0 ~ 65.0 V

Low Voltage: can be adjusted in the range of 44.0 ~ 54.0 V

High-level of output voltage disconnect source of the rectifier block: can be adjusted in the range of 54.0 ~ 66.0 V.

6.3.6 Controlling and monitoring

The control monitor unit must have functions as follows:

+ Monitoring the status of each rectifier block including:

- Output current
- Working temperature
- Operating software

+ Control the load current and battery charging current: the setting current values must be displayed on the instruction screen at the machine or remote monitor. Step value and the accuracy of current control must be declared by manufacturer

+ Controlling voltage monitoring of the system: the voltage value set in the float mode/ equalizing mode must be displayed on the instruction screen at the machine or remote monitor with accuracy not exceed 0.5%

+ Load current dividing control between the rectifier block with an accuracy of ± 2% compared to the output nominal current of the rectifier blocks

+ Set the warning level, the protective function for the rectifier blocks

+ Rectifier blocks programmed from this setting information

+ Information connection via network: statuses, source system parameters 48V and control signals can be monitored and controlled remotely via software interface and suitable transmission medium

6.4 Technical requirements for source cabinet

6.4.1 Structural requirements

Structure style:

- Rack source cabinet, or a combination support of source modular with rack drawer shape: or designed source cabinets

Support the functions of hot replacement of the rectifier block

Support plug & play function of the rectifier blocks

Support management function, extended battery

6.4.2 Distribution and connection system of power

Input

Cabinet support of power system -48 V must be connected to the a phase or three-phase AC source

Single-phase input AC including 01 phase wire, 01 neutral wire and 01 protection wire.

Three-phase input AC including 03 phase wire, 01 neutral wire and 01 protection wire.

The connector of the AC input source must ensure the electrical insulation and current lead as required, so that the connector temperature is not higher than conductor cable temperature. Current through the connectors is calculated by the sum of the largest input currents of the rectifier blocks in the system.

Output

On the source system cabinet support must have the distribution parts connected to the output DC source, including:

- Connect the device to the load
- Connect to the battery.

Output voltage connection parts must have solid structure, consistent with the current pass through.

Switching and protection

At the AC input, DC output must have the appropriate MCB for switching and short circuit protection

Ground, lightning protection

All metal parts without the current must be grounded through lightning ground

On the source system cabinet support must have the connector for the grounding, suitable lightning ground.

6.4.3 Cables and wires

- Cross-sectional area of all wires must satisfy all requirements of the current pass through, the current density is not greater than $3A/mm^2$

- The end of all cables with lager current intensity must be coated welded or clamped so that the connection area temperature is not greater than the conductor temperature.
- The entire cable must be supported, titled appropriately, compact structure
- All entrance cables with AC source must be separated from the other cables.

Annex A (Reference)

Sample of testing result

A.1 Output voltage

Input		DC Output voltage to input voltage and different load (V)					Ripple mV	Output capacity (W)	Efficiency %
V_{phase}	W	0%	50%	100%	105%	Over 110%			
175									
180									
200									
210									
230									
240									
250									
260									
275									
Nominal Load (A)									

A.2 Warning functions

- Checking the functions

Checking the warming function of system according to requirements at 5.1.3.2 and 6.3.5

A.3 Insulation resistor

	Power - Supply	Charging device	Requirement
AC Input and the ground	…MΩ	…MΩ	≤5 MΩ
DC output and the ground	…MΩ	…MΩ	≤5 MΩ
AC input and DC output	…MΩ	…MΩ	≤5 MΩ

Bibliography

(1) TCN 68-162:1996 “Power plant 48 VDC for telecommunication equipments – Technical requirements”

(2) 48 V Power system and rectifier specification – Rectifier technologies pacific Pty Ltd Australia

(3) Technical specification CDOT – 256 RAX