



Prüfbericht - Nr.: <i>Test Report No.:</i>	60418398 001	Auftrags-Nr.: <i>Order No.:</i>	168271986	Seite 1 von 59 <i>Page 1 of 59</i>
Kunden-Referenz-Nr.: <i>Client Reference No.:</i>	2173023	Auftragsdatum: <i>Order date:</i>	07.02.2020	
Auftraggeber: <i>Client:</i>	EAST Group Co., Ltd. No.6 Northern Industry Road, Songshan Lake Sci.& Tech. industrial zone, Dongguan City, Guangdong province, China			
Prüfgegenstand: <i>Test item:</i>	Grid-connected PV Inverter			
Bezeichnung / Typ-Nr.: <i>Identification / Type No.:</i>	EA2KSI, EA2.5KSI, EA3KSI, EA3KSI-D,EA3.68KSI, EA4KSI, EA4.6KSI, EA5KSI, EA6KSI, EA7KSI			
Auftrags-Inhalt: <i>Order content:</i>	N/A			
Prüfgrundlage: <i>Test specification:</i>	UL 1741:2010 R2.18			
Wareneingangsdatum: <i>Date of receipt:</i>	N/A			
Prüfmuster-Nr.: <i>Test sample No.:</i>	Engineering samples			
Prüfzeitraum: <i>Testing period:</i>	07 15, 2020 to 09 20, 2020			
Ort der Prüfung: <i>Place of testing:</i>	EAST Group Co., Ltd.			
Prüflaboratorium: <i>Testing laboratory:</i>	TÜV Rheinland (Shanghai) Co., Ltd.			
Prüfergebnis*: <i>Test result*:</i>	Pass			
geprüft von / tested by:		kontrolliert von / reviewed by:		
(11.05.2020) Billy Chen		(11.05.2020) John Dai		
Datum <i>Date</i>	Name / Stellung <i>Name / Position</i>	Unterschrift <i>Signature</i>	Datum <i>Date</i>	Name / Stellung <i>Name / Position</i>
				
Sonstiges/ Other:				
1. NRTL certificate. 2. Inverter software version: MDSP: V016, MCU: V016				
Zustand des Prüfgegenstandes bei Anlieferung: <i>Condition of the test item at delivery:</i>		Prüfmuster vollständig und unbeschädigt <i>Test item complete and undamaged</i>		
*Legende: 1 = sehr gut 2 = gut 3 = befriedigend 4 = ausreichend 5 = mangelhaft P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage N/A = nicht anwendbar N/T = icht getestet *Legend: 1 = very good 2 = good 3 = satisfactory 4 = sufficient 5 = poor P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested				
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. <i>This test report relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any safety mark.</i>				
V04				



Test item particulars		
Description	Grid-connected PV Inverter	
Trademark.....		
Factory	EAST Group Co., Ltd.	
Model and/or type reference	EA2KSI, EA2.5KSI, EA3KSI, EA3KSI-D,EA3.68KSI, EA4KSI, EA4.6KSI, EA5KSI, EA6KSI, EA7KSI	
DC Nominal Voltage	600V	
DC Operating range	90-600V	
MPPT DC Voltage range.....	90-550V	
DC Max. Current.....	11A	
Max. DC Short Circuit Current	12A	
AC Nominal Voltage	220/240V	
AC Operating range.....	N/A	
Grid connection type.....	Single phase	
AC Max. Current	See model list	
Max. Output Overcurrent Protection	See model list	
AC Max. Continuous output Power.....	See model list	
Grid Frequency	60 Hz	
Adjustable Voltage Frequency	See model list	
AC Power Factor	0.8Cap.~0.8Ind.	
Installation mode	Fixed	
Software/Firmware tested within the unit	MDSP	V014
	MCU	V014
Pollution degree.....	III	
Overvoltage category	IV	
Rated ambient temperature	-25 to +60 °C	
Enclosure index / type	Type 4X	
Equipment mobility	Fixed	
Protection class of equipment.....	I	
Mass of equipment (lb)	See model list	
Overall size (W x H x D, in.)	See model list	
Possible test case verdicts:		
- test case does not apply to the test object	N/A	
- test object does meet the requirement	P (Pass)	
- test object does not meet the requirement	F (Fail)	
Testing	WMT at EAST	
Date(s) of performance of tests.....	See cover page	

List of Attachments:

1. CDF (14 pages)
2. Test Package-1 UL 1741 (40 pages)
3. Photos (9 pages)

Product Description

The equipment is single phase utility-interactive type PV inverter which will be installed and connected to the grid network after installation.

It contains filters for smoothing the output voltage and for EMC, switching and control circuits. Electronic circuits has be mounted on a number of PCBs interconnected by appropriate connectors and wires. Power board including electronics components has be mounted on the heat sink to earthing by metal screw and spring washer.

There are included a RS485 and two RJ45 communication ports which are connected to the monitors to monitor the status of the inverter by proprietary software.

The PV input combine with 1 or 2 string MPPT tracer and PV input terminals. AC output direct connected to grid and the protective earthing are provided by dedicated earthing terminals. Grid is protected combination with a two series of relays as redundant build for ensure the inverter can independent disconnected from gird while a relay was fault.

During fault condition defined in this standard, after the DSP receives the abnormal signal from the relevant protective detection circuit, the relays will operate to disconnect the PV inverter line and neutral from grid automatically.

The master DSP and slaver DSP has capacity independent disconnected from grid, when any grid fault had happened.

operation conditions.

Block Diagram:

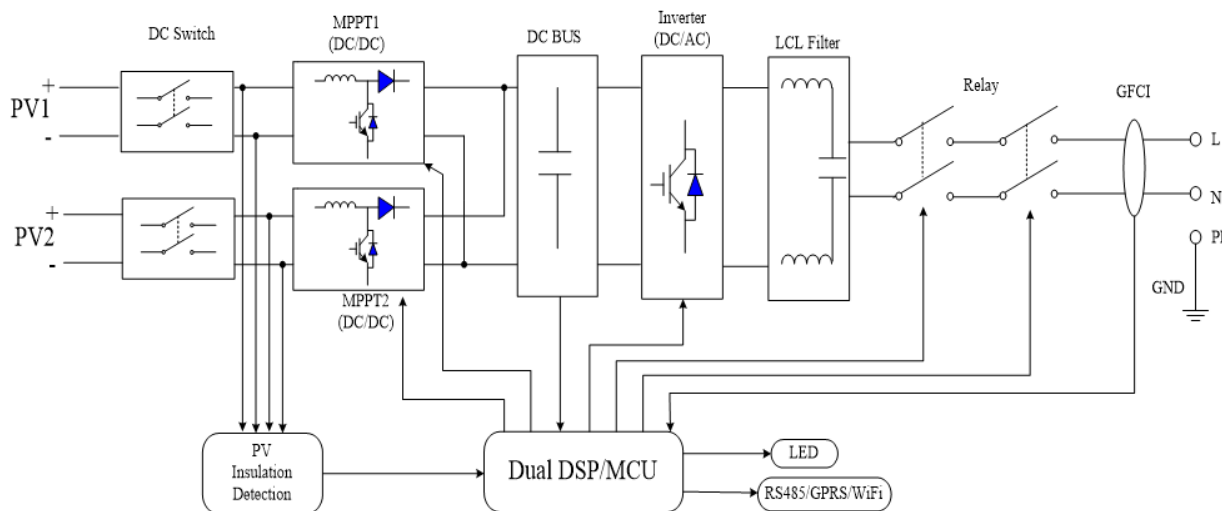


Figure 1. Block diagram

Model Difference:

The models EA2KSI, EA2.5KSI, EA3KSI are identical to hardware and software, except the output power are different has be adjusted by software.

The Models EA3KSI-D, EA3.68KSI, EA4KSI, EA4.6KSI, EA5KSI, EA6KSI and EA7KSI are same as the hardware and software, except the output power are different has be adjusted by software and internal cooling fan within EA6KSI.

The model EA7KSI is same as EA6KSI, except the components are different at below table 1.

The models EA2KSI, EA2.5KSI, EA3KSI and models EA3KSI-D, EA3.68KSI, EA4KSI, EA4.6KSI, EA5KSI, EA6KSI, EA7KSI are same as software and hardware, excepted the component are different with below table 1:

Model Components	EA2KSI, EA2.5KSI, EA3KSI	EA3KSI-D, EA3.68KSI, EA4KSI EA4.6KSI, EA5KSI, EA6KSI	EA7KSI
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Max. input current	11A	11Ax2	
Output current sensor	HLSR 20-P/LEM	HLSR 32-P/LEM	
MPPT string	1	2	
Boost induct	580uH(11A)*1	580uH(11A)*2	
BUS capacitor	1200uF(315V)*4	1200uF(315V)*6	1500uF(315V)*6
IGBT/MOSFET	IKW40N65H5*5, IKW40N120H3*2	IKW40N65H5*6, IKW40N120H3*2	IKW50N65H5*6, NGTB50N120FL2WG*2
Power board size	262mm*216mm	322mm*231.5mm	
Overall size (WxDxH) [mm]	308x116.5x353	370x126.5x420	

Model list:

MODEL LIST 1		EA2KSI	EA2.5KSI	EA3KSI	EA3KSI-D	EA7KSI
INPUT(PV)	V _{MAX} PV [Vdc]	600				
	I _{sc} PV [A]	12			2x12	
	MPP Voltage Range V _{MPP} [Vdc]	90-550				
	Max. PV Input Current [A]	11			11x2	
	MPP Full Power Voltage Range [Vdc]	200-480	250-480	300-480	150-480	350-480
	Input PV Operating Voltage Range [Vdc]	90-600				
	Start PV Voltage [Vdc]	120				
	Backfeed Current [A]	0				
	Overvoltage Category (OVC)	OVC II				
GRID CONNECTION	Rated Output Voltage Ur [Vac]	220/240				
	Normal Operating Voltage Range Un [Vac]	180-280				
	Rated Output Frequency F _{NETZ} [Hz]	60				
	Normal Operating Frequency Range Fn [Hz]	55 - 65				
	Rated Output Power P _E [W]	2000	2500	3000	3000	7000
	Max. Output Current I _{max} [A]	9.1/8.3	11.4/10.4	13.6/12.5	13.6/12.5	31.8/29.2
	Power Factor cosφ [λ]	0.8 cap-0.8ind adjustable (default: 1)				
	Efficiency max. η _{max} [%]	97.8				
	Night Power Consumption [W]	< 0.5				
	THD [V / I] (100% full power)	< 3%				
	Acoustic Noise [dB]	< 40				
Overvoltage Category (OVC)	OVC III					
SYSTEM	Type of inverter	Non-transformer				
	Firmware [DSP/MCU]	MDSP: V016, MCU: V016				
	Separated by	Transformerless				

MPPT strings	1	2
MPPT tracking	1	2
Protective Class	1	
Enclosure Protection (IP)	IP65	
Operating Temperature Range [°C]	-25-60 (> 45 °C derating)	
Pollution degree (PD)	PD3 for outside, PD2 for inside	
Altitude [m]	4000 (> 2000 derating power)	
Weight [kg]	< 9	< 11.5
Size (WxDxH) [mm]	308x116.5x353	370x126.5x420
Note:		

MODEL LIST 2		EA3.68KSI	EA4KSI	EA4.6KSI	EA5KSI	EA6KSI
INPUT(PV)	V _{MAX} PV [Vdc]	600				
	I _{SC} PV [A]	2x12				
	MPP Voltage Range V _{MPP} [Vdc]	90-550				
	Max. PV Input Current [A]	11x2				
	MPP Full Power Voltage Range [Vdc]	200-480		230-480	250-480	300-480
	Input PV Operating Voltage Range [Vdc]	90-600				
	Start PV Voltage [Vdc]	120				
	Backfeed Current [A]	0				
	Overvoltage Category (OVC)	OVC II				



GRID CONNECTION	Rated Output Voltage U _r [Vac]	220/240				
	Normal Operating Voltage Range U _n [Vac]	180-280				
	Rated Output Frequency F _{NETZ} [Hz]	60				
	Normal Operating Frequency Range F _n [Hz]	55 - 65				
	Rated Output Power P _E [W]	3680	4000	4600	5000	6000
	Max. Output Current I _{max} [A]	16.7/15.3	18.2/16.7	20.9/19.2	22.7/20.8	27.3/25
	Power Factor cosφ [λ]	0.8 cap-0.8ind adjustable (default: 1)				
	Efficiency max. η _{max} [%]	97.8				
	Night Power Consumption [W]	< 0.5				
	THD [V / I] (100% full power)	< 3%				
	Acoustic Noise [dB]	< 40				
Overvoltage Category (OVC)	OVC III					
SYSTEM	Type of inverter	Non-transformer				
	Firmware [DSP/MCU]	MDSP: V016, MCU: V016				


Separated by	Transformerless
MPPT strings	2
MPPT tracking	2
Protective Class	1
Enclosure Protection (IP)	IP65
Operating Temperature Range [°C]	-25-60
Pollution degree (PD)	PD3 for outside, PD2 for inside
Altitude [m]	4000 (> 2000 derating power)
Weight [kg]	< 11.5
Size (WxDxH) [mm]	370x126.5x420
Note:	

Nameplate:

EAST



PV Inverter: Utility-Interactive	
Model	EA2KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A
d.c.Isc PV	12A
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	8.3A
a.c.Rated Output Power	2000W
a.c.Max. Apparent Power	2000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II (DC)
Ambient Temperature	-25 °C~60 °C



 Protection Class I 
 EA2KSI 201909060001



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PV Inverter: Utility-Interactive	
Model	EA2.5KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A
d.c.Isc PV	12A
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	10.4A
a.c.Rated Output Power	2500W
a.c.Max. Apparent Power	2500VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II (DC)
Ambient Temperature	-25 °C~60 °C


 Protection Class I 
 EA2.5KSI 201909060001



EAST

PV Inverter: Utility-Interactive	
Model	EA3KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A
d.c.Isc PV	12A
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	12.5A
a.c.Rated Output Power	3000W
a.c.Max. Apparent Power	3000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II(DC)
Ambient Temperature	-25 °C ~60°C



EAST

PV Inverter: Utility-Interactive	
Model	EA3KSI-D
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A*2
d.c.Isc PV	12A*2
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	12.5A
a.c.Rated Output Power	3000W
a.c.Max. Apparent Power	3000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II(DC)
Ambient Temperature	-25 °C ~60°C



EAST

PV Inverter: Utility-Interactive	
Model	EA3.68KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A*2
d.c.Isc PV	12A*2
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	15.3A
a.c.Rated Output Power	3680W
a.c.Max. Apparent Power	3680VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II(DC)
Ambient Temperature	-25 °C ~60°C



EAST

PV Inverter: Utility-Interactive	
Model	EA4KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A*2
d.c.Isc PV	12A*2
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	16.7A
a.c.Rated Output Power	4000W
a.c.Max. Apparent Power	4000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II(DC)
Ambient Temperature	-25 °C ~60°C



EAST

PV Inverter: Utility-Interactive	
Model	EA5KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A*2
d.c.Isc PV	12A*2
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	20.8A
a.c.Rated Output Power	5000W
a.c.Max. Apparent Power	5000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II (DC)
Ambient Temperature	-25 °C ~60 °C



Protection Class I



EAST

PV Inverter: Utility-Interactive	
Model	EA6KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A*2
d.c.Isc PV	12A*2
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	25.0A
a.c.Rated Output Power	6000W
a.c.Max. Apparent Power	6000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II (DC)
Ambient Temperature	-25 °C ~60 °C



Protection Class I



EAST

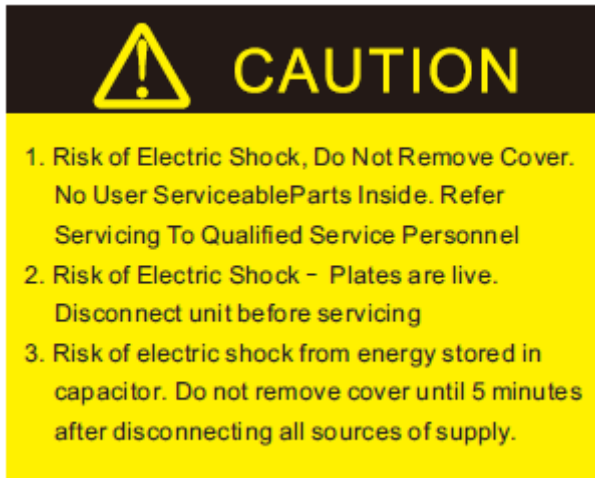
PV Inverter: Utility-Interactive	
Model	EA7KSI
d.c.Max.Input Voltage	600Vd.c.
d.c.MPPT Voltage Range	90~550Vd.c.
d.c.Max.Input Current	11A*2
d.c.Isc PV	12A*2
a.c.Rated Output Voltage	240Va.c.
a.c.Rated Output Frequency	60Hz
a.c.Max.Output Current	29.2A
a.c.Rated Output Power	7000W
a.c.Max. Apparent Power	7000VA
Power Factor Range	0.8 cap.~0.8 ind.
Enclosure	NEMA Type 4X
Overvoltage Category	III(AC), II (DC)
Ambient Temperature	-25 °C ~60 °C



Protection Class I

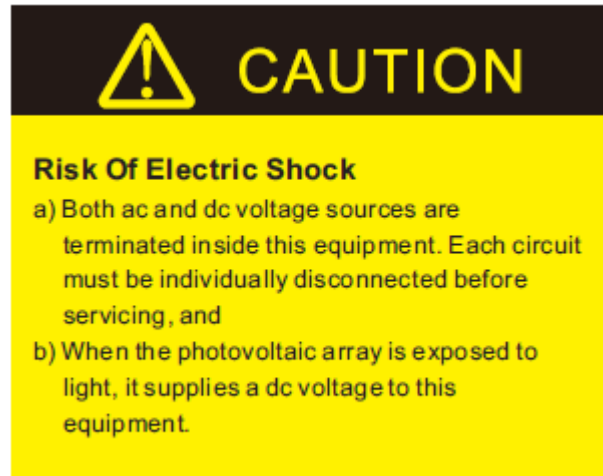


Warning Label:



CAUTION

1. Risk of Electric Shock, Do Not Remove Cover. No User Serviceable Parts Inside. Refer Servicing To Qualified Service Personnel
2. Risk of Electric Shock - Plates are live. Disconnect unit before servicing
3. Risk of electric shock from energy stored in capacitor. Do not remove cover until 5 minutes after disconnecting all sources of supply.



CAUTION

Risk Of Electric Shock

- a) Both ac and dc voltage sources are terminated inside this equipment. Each circuit must be individually disconnected before servicing, and
- b) When the photovoltaic array is exposed to light, it supplies a dc voltage to this equipment.

Summary of Testing:


cl 42	Maximum-Voltage measurements
cl 43	Temperature
cl 44	Dielectric Voltage-Withstand Test
cl 45	Output Power Characteristics
cl 47.2	Output overload test
cl 47.3	Short-circuit test
cl 47.4	DC input miswiring test
cl 47.6	Component Short/open
c. 47.7	Load transfer test
cl 47.8	Loss of Control circuit
cl 48	Grounding Impedance Test
c. 49	Overcurrent Protection Calibration Test
cl 57	Capacitor Voltage Determination Test.

UL 1741: 2010 (Revision 2018)			
Clause	Requirement — Test	Result — Remark	Verdict
3.1	Components		--
3.1.1	Components comply with component standards	See table 3.1	P
3.1.2.	A component is not required to comply with a specific requirement that: a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or b) Is superseded by a requirement in this standard.	Non approved components, such as DC capacitors, voltage chokes, sense transformer, were tested according to requirements of this standard	P
3.1.3	Component used in accordance with its specified rating established for the intended conditions of use	Voltage, current and temperature ratings verified for this application	P
3.1.4	Components used within their specifications	Considered	P
4	General		--
4.1	Rated voltages of 50 volts or less, operate as intended in both grounded and ungrounded circuits	Rated above 50V	N/A
4.2	Converters	PV DC to AC inverter	P
5	Frame and Enclosure		--
5.1	General	metal enclosure evaluated in this report	P
5.1.1	Enclosure house all current-carrying parts and provides protection as require in this standard		P
5.1.2	The frame or chassis shall not be relied upon to carry current during normal operation	Metal enclosure grounded	P
	<i>Exception: As provided in the Exception to 20.12</i>		N/A
5.1.3	Dial or nameplate that is a part of the enclosure	Nameplate label attached to enclosure	P
5.1.4	Enclosure, other than a Type 1, complies with Environmental Rated Enclosures, Section 5.9, or		N/A
	Meet the requirements for the respective Type of UL 50 (UL 50E)	Type 4X enclosure, passed hose down test	P
5.1.5	Sheet-metal and Machine screws		P
5.1.6	Sheet-metal screws mounting internal components	Winding components and printed circuit boards mounted to bottom of the chassis	P
5.2	Access Covers		P
5.2.1	Covers in a unit used as a load center	The cover be locked by screws.	P
5.2.2	Door or cover giving access to a fuse complies with the requirements for doors and covers of UL508	DC fuses inside DC cabinet behind the door.	P
5.3	Cast metal enclosures	Sheet metal enclosure	N/A
5.3.1	The thickness of cast metal meet Table 5.1, or		N/A
	Compression test, see section 60		N/A
5.4	Sheet metal enclosures		P
5.4.1	Thickness of a sheet-metal meet Table 5.2, or	Metal Thickness > 1.5 mm	P

UL 1741: 2010 (Revision 2018)			
Clause	Requirement — Test	Result — Remark	Verdict
	Compression test, see section 60	Meet the thickness requirement	N/A
5.4.2	Supporting Frames	Enclosure consists of main frame, 4 sides, top and bottom.	P
5.4.3	Construction does not have supporting frames		N/A
5.5	Nonmetallic Enclosures	Metal enclosure	N/A
5.5.1	Polymeric enclosure or parts complies with UL 746C or UL 50		N/A
5.5.2	Electrical instrumentation forming part of an enclosure		N/A
5.5.3	Exceptions to requirement of 5.5.1		N/A
5.5.4	Nonmetallic enclosure connecting to rigid conduit system, complies with UL 50		N/A
5.6	Openings covered by glass	No opening with glass	N/A
5.6.1	Glass covering an opening secured in place and provide mechanical protection for the enclosed parts		N/A
5.6.2	Glass type and dimensions for an opening:		N/A
5.7	Openings for wiring system connections		N/A
5.7.1	Threads for the connection of conduit		N/A
5.7.2	Clamps and fasteners for the attachment of conduit or equivalent		N/A
5.7.3	Knockout in sheet-metal enclosure secured and removable without undue deformation of the enclosure		N/A
5.7.4	Knockout surface, size, and location		N/A
5.7.5	Spacing between an uninsulated live part and a bushing installed in a knockout		N/A
5.7.6	Spacing for enclosure not provided from the factory with conduit openings or knockouts		N/A
5.7.7	Plates or plugs for unused conduit openings or other holes in the enclosure		N/A
5.7.8	Opening in an environmental rated enclosure is closed with components having the applicable environmental ratings as specified in Table 5.5		N/A
5.8	Openings for ventilation		P
5.8.1	Enclosure constructed to protect the unit against the emission of flame, molten metal, flaming or glowing particles, or flaming drops from the enclosure	Ventilation opening with fans mounted at bottom of back panel outside of 4X enclosure.	P
5.8.2	Ventilation Openings in enclosure bottoms	At the bottom outside the enclosure	P
	Construction of the bottom of the enclosure		N/A
5.8.3	Openings in enclosure tops		N/A
	Openings in the top, dimensions and shapes		N/A
5.8.4	Openings in enclosure sides		P

UL 1741: 2010 (Revision 2018)			
Clause	Requirement — Test	Result — Remark	Verdict
	Louver not more than 305 mm (12 inches) long		P
	Area of an opening covered by louvers not exceed 0.129 m ² (200 square inches)		P
5.8.5	Expanded metal mesh and screens		N/A
	The thickness of perforated sheet steel and sheet steel employed for expanded-metal mesh used to cover an opening in the enclosure:		N/A
	The diameter of the wires of screen:		N/A
5.8.6	Barriers used with ventilation openings		N/A
	Distance of ventilation openings to arcing parts:		N/A
	Barrier Dimensions:		N/A
	Thickness of sheet-metal barriers:		N/A
5.9	Environmental rated enclosures		P
5.9.1	Enclosure construction meets the requirements of marked Type		P
5.9.2	An environmental type connections	NEMA type 4X	P
5.9.3	Type 3, 3R, and 3S enclosures comply with the Rain and Sprinkler Tests, Section 61		N/A
5.9.4	Type 2 enclosures		N/A
5.9.5	Type 3 enclosures		N/A
5.9.6	Type 3R enclosures		N/A
5.9.7	Type 3S enclosures		N/A
5.9.8	Type 4, 4X, 6, 6P, or 11 enclosures	Complied with hose down and corrosion test – refer to test package	P
5.9.9	Type 12 enclosures		N/A
5.9.10	Type 12K enclosures		N/A
5.9.11	Type 13 enclosures		N/A
5.9.12	Gaskets comply with the Gasket Tests, UL 50 (UL 50E)	Certified gasket used	P
5.9.13	Component, used with type designated enclosure:		N/A
	a) Evaluated for its intended use with the enclosure;		N/A
	b) Installation accessories for complies provided;		N/A
	c) Installation instructions provided;		N/A
	d) Information of the components marked accordingly		N/A
5.9.14	Size of drain holes, as specified in Table 5.9		N/A
6	Protection Against Corrosion		P
6.1	Iron and steel parts shall be protected against corrosion	By painting material suitable for NEMA 4X enclosure.	P
7	Mechanical Assembly		--

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Clause	Requirement — Test	Result — Remark	Verdict
7.1	Unit assembled not adversely affected by the vibration		P
7.2	Switch, fuseholder, or lampholder securely mounted and prevented from turning or shifting in its mounting panel	Certified switch used	P
7.3	Additional means, other than friction, used for 7.2		P
8	Mounting		--
8.1	Provision made for securely mounting a unit in position	Rack mounted See the user manual.	P
8.2	Keyhole slots for mounting screws		N/A
8.3	Use of Castors		N/A
9	Protection of Users - Accessibility of Uninsulated Live Parts		--
9.1	The part that is accessible to the user	No live parts can access by the user.	N/A
9.2	Dimensions of openings in an enclosure		N/A
9.3	Test probe applied to openings in an enclosure		N/A
9.4	Test probe applied with a max. force of 4.4 N (1 pound)		N/A
9.5	With reference to 9.2, the minor dimension of an opening is equal to the diameter of the largest cylindrical probe that is able to be inserted through the opening.		N/A
9.6	Test pin not touch any uninsulated hazardous live parts		N/A
9.7	Test probe and test pin applied to all openings		N/A
9.8	Removable covers without the use of tool		N/A
10	Protection of Service Personnel		--
10.1	Service personal protection while the unit is energized	Warning label shown: No service while is live	P
10.2	Live parts arranged and covers located to reduce the risk while covers are being removed and replaced		P
10.3	Uninsulated live parts and moving parts prevent from unintentional contact by service personnel		P
10.4	Guarding of Live parts located on back side of door		P
10.5	Components that require examination, resetting, adjustment, servicing, or maintenance while energized		P
10.6	Protection against inadvertent contact with adjacent uninsulated live parts while adjustments made with a screwdriver or similar tool when the unit is energized		P
10.7	Protection or marking for live heat sinks, relay frames, and similar components		P
10.8	Protection against access to moving parts	Refer to clause 10.3	P
10.9	Mounting control components or means used		P
11	Electric Shock		--
11.1	Voltage of accessible live part involves a risk of electric shock or not, Table 11.1		P

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Clause	Requirement — Test	Result — Remark	Verdict
11.2	Stored energy		P
11.2.1	Voltage and capacitance between capacitor terminals that are accessible	The voltage drop down to 30V after 267 seconds.	P
11.2.2	Part involving a potential of more than 40 kV peak		N/A
11.2.3	<p>Stored energy in capacitors, limit: 20 joules</p> <p>Exception No. 1:</p> <p>a) A tool is required to remove a panel to reach the capacitor or accessible uninsulated portions of the associated circuit,</p> <p>b) The time required to discharge the capacitor is within the limitations specified in 11.2.1 and is less than 5 minutes, and</p> <p>c) The unit is marked as specified in 64.11.</p> <p>Exception No. 2:</p> <p>b) When a momentary type switch is used, the capacitor or capacitor bank shall be discharged to levels in accordance with Table 11.2 within 1 minute.</p>	<p>Take Exception No.1. The voltage of bus capacitors drop down to 30V after 123 secs.</p> <p>Warning label provided</p> 	P
11.2.4	Equipment connecting to a controlled conductor of PV source or output circuits and has devices that may store energy comply with 92.1.10 and provide the markings and instructions in accordance with 96.3 and 97.4.		P
12	Switches and Controls		--
12.1	AC or DC switches rated for the controlled circuits	Certified switches used	P
12.2	Primary-circuit switches controlling inductive loads having a power factor less than 75 percent	No such device	N/A
12.3	Switch used to connect a load to various sources or potentials, rated for such use	Complied.	P
12.4	Pilot-duty rating for switch or other device controlling a relay coil, solenoid coil, or similar coil load	No such device	N/A
12.5	Device rated for across-the-line motor starting of an alternating current motor	No such device	N/A
12.6	Multi-pole snap in switches	No such device	N/A
12.7	A 240-volt or 250-volt snap switch used in a circuit involving more than 120V to ground, rated for such use	No such device	N/A
12.8	Switch not disconnect grounded conductor of a circuit	No switch on grounded conductor	P
12.9	Bypass switch complies with the Standard for Automatic Transfer Switches, UL 1008 unless exception applied	No such device	N/A
12.10	Exception to 12.9, solid-state switch, or mechanical or electromechanical switch	IGBT tested with the unit	P
12.11	Upper "ON" position of vertically operated switches or circuit breakers	PV DC disconnect handle "ON" at upper position	P
13	Disconnect Devices		--
13.1	General		P
13.1.1	A disconnect device required by the NEC shall be evaluated to the requirements in this section.	Certified DC and AC disconnect provided	P
13.1.2	A disconnect device shall open all conductors of the circuit to which it is connected that are not solidly grounded.		P

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Clause	Requirement — Test	Result — Remark	Verdict
13.1.3	System Disconnecting Means: A device serving the function of the NEC-required system disconnecting means shall:		P
	a) Consist of a manually operated switch or a circuit breaker,	On the front panel	P
	b) Employ an operating handle that is accessible from outside of the enclosure or located behind a hinged cover not requiring a tool for opening, and		P
	d) Be marked in accordance with 63.26	Marked	P
13.1.3 .1	Equipment Disconnecting Means: A device serving the function of the NEC-required equipment disconnecting means shall:		P
	a) Consist of a manually operated switch or a circuit breaker,		P
	b) Employ an operating handle that is capable of from outside of being operated without exposing the operator to inadvertent contact with live parts, and		P
	c) Be marked in accordance with 63.26 to indicate its function.		P
13.2	Provision for locking		P
13.2.1	Isolating and disconnecting devices shall have provision for being locked in the “Off” position	Complied.	P
14	AC Output Connections		--
14.1	Stand-alone inverters	The unit is grid-tie type inverter.	N/A
14.1.1	The ac output of a stand-alone inverter provided with (a) or (b), or both:	Not stand alone inverter	N/A
	a) Receptacles which comply with 14.1.2		N/A
	b) Provision for connection of a fixed wiring system in accordance with Supply Connections, Section 16		N/A
14.1.2	Inverters provided with ac output receptacle:		N/A
	a) the receptacle is of the grounding type		N/A
	b) ac output conductor, white/silver terminal, bonded to the ground		N/A
	c) provided with an equipment-grounding connection		N/A
	d) receptacle installed in raised covers secured solely by a single screw		N/A
14.1.3	Ground-fault circuit-interrupter comply UL 943		N/A
14.2	Utility-interactive inverters		P
14.2.1	Have provision for connection of a wiring system complying with Supply Connections, Section 16	Terminals provided for field connection	P
14.2.2	General-use ac output receptacle not provided on a utility-interactive inverter unless it is internal to the unit and accessible for service personnel use only	No general use receptacle	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
14.2.3	Inverter with ac output shall comply with the following:		P
	a) The installation instructions complies with 65.2, and		P
	b) The output circuit not bonded to the enclosure		P
15	Receptacles		--
15.1	General-use receptacle in inverter is grounding type	No receptacle	N/A
15.2	Receptacles supplied from the output ac circuit of inverter:		N/A
	a) White or silver terminals of the receptacle grounded,		N/A
	b) Equipment-grounding terminal of the receptacle is conductively connected to equipment grounding means,		N/A
	c) Installed in a raised cover complies with NEC 70		N/A
16	Supply Connections		--
16.1	General		P
16.1.1	Has provision for connection of a wiring system consisting of:	Fixed wiring terminals provided for DC input and AC output connections	P
	a) Wiring terminals or wiring leads, and		P
	b) A means for connection of cable or conduit,		P
	Or, exceptions applied		N/A
16.1.3	Wiring terminal or leads shall be rated and sized for field wiring conductor per NEC 70		P
16.2	Wiring terminals		P
16.2.1	Wiring terminal shall comply with the requirement in 16.1.3 for a wire of each metal for which it is marked	Certified terminal blocks for ac, MC4 connector for DCs.	P
16.2.2	Factory-installed pressure terminal connector provided		N/A
16.2.3	Wiring terminal secured in position by means other than friction between surfaces		P
16.2.4	Exceptions to 16.2.2 a) to e)		N/A
16.2.5	Terminal block or insulating base for support of a pressure terminal connector comply with UL 1059		P
16.2.6	Size of wire-binding screws at a field-wiring terminal not smaller than No. 10 (4.8 mm diameter)		N/A
16.2.7	Wire-binding screws thread into metal		P
16.2.8	Terminal plate tapped for a wire-binding screw shall be of metal not less than 1.27 mm (0.050 inch) thick		P
16.2.9	Two or more full threads in the metal of terminal plate		P
16.2.10	Terminal for connection of a grounded conductor of ac circuit identified as described in 63.15		P
16.3	Wiring leads		N/A
16.3.1	Field wiring lead size a) to c)	No wire leads	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
16.3.2	Field wiring lead type a) to c)		N/A
16.3.3	Field-wiring lead withstand Strain Relief Test, Section 50 a) to b)		N/A
16.3.4	Field-wiring lead provided for connection to an external line-voltage circuit		N/A
16.3.5	The free end of field-wiring lead not used is insulated		N/A
16.3.6	Field-wiring lead for connection of a grounded conductor of ac circuit identified as described in 63.15		N/A
16.4	Wiring compartments		P
16.4.1	Location of wiring compartment	A wiring compartment shall be provide for final installation	P
16.4.2	Sharp edges and corners		P
16.4.3	Volume of wiring compartment		P
16.5	Openings for conduit or cable connection		P
16.5.1	For fixed unit, openings or knockouts provided	Certified water tied gland used	P
16.6	Openings for class 2 circuit conductors		N/A
16.6.1	Insulating bushing supplied for opening for the entry of a conductor or conductors of a Class 2 circuit		N/A
16.6.2	Bushings of rubber or rubber type material provided in accordance with 16.6.1 for Type 1 enclosures	Not type 1 enclosure	N/A
17	Wire-Bending Space		--
17.1	Wire-bending space requirement for permanently connected unit employing pressure terminal connectors	A wiring compartment shall be provide for final installation	P
17.2	The conductor size:		P
17.3	Wire-bending space for field installed conductors provided opposite any:		P
	a) Pressure wire connector, and		P
	b) Opening or knockout for conduit or wireway in gutter		P
17.4	Wire-bending space for opposite wire-terminal, as specified in table 17.1		P
17.5	Wire-bending space for adjacent wire-terminal, as specified in table 17.2		P
17.6	For conductor restricted by a barrier or other means		N/A
17.7	For a unit not provided from the factory with a conduit opening or knockout	Water proof grand used	N/A
17.8	Distance measurement for 17.3 – 17.5		N/A
17.9	Suitable width of a wiring gutter in which one or more knockouts are provided		N/A
18	Equipment Grounding		P
18.1	General		P

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Clause	Requirement — Test	Result — Remark	Verdict
18.1.1	There shall be means for grounding all dead metal parts	Metal enclosure grounded	P
18.1.2	Equipment grounding means provided for each wiring system for the following circuits:		P
	a) Each dc input circuit,	For use with DC input floating system in the manual.	N/A
	b) Each ac input circuit,	No AC input	N/A
	c) Each ac output circuit, and	AC output	P
	d) Each battery circuit	No battery circuit	N/A
18.1.3	Equipment-grounding means for a fixed unit		P
18.1.4	Equipment-grounding terminal or lead connected to the frame or enclosure by positive means	Grounding terminal provided and proper marked	P
	The head of a screw or bolt, other than a double-nut secured bolt or screw, used to secure a terminal or lead, shall not be accessible from outside of the enclosure		P
18.1.5	Equipment-grounding connection shall penetrate a nonconductive coating		P
18.1.6	Equipment-grounding means is not subject to inadvertent removal during servicing		P
18.1.7	Free end of an equipment-grounding lead shall be insulated unless the lead is not capable of contacting live parts when the lead is not used in the field		P
18.1.8	Equipment grounding leads or equipment grounding terminals provided for each input and each output circuit	No ground lead provided. Enclosure bonded together properly. Passed the grounding test.	P
	- free length, not less than 152mm (6"), and color		N/A
	- equipment grounding terminal marking		P
	- current rating		P
18.1.9	Equipment-grounding conductor not spliced internally		P
18.1.10	Equipment-grounding connection not carry current unless an electrical malfunction occurs		P
18.1.11	Soldering lug, screwless (push-in) connector, a quick-connect connector, or other friction-fit connector not used as equipment-grounding means		P
18.1.12	Equipment-grounding terminal rated for securing a conductor size based on the size of the overcurrent protection device to be employed		P
18.1.13	Color and symbol for wire-binding screw, pressure wire connector, or stud-and-nut type terminal		P
18.2	Grounding Electrode Terminal		N/A
18.2.1	Grounding electrode terminal provided for service entrance equipment, or equipment containing the main dc or ac bonding connection	Not service entrance equipment	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
18.2.2	Grounding electrode terminals connection and access		N/A
19	AC Output Circuit Grounded Conductor		--
19.1	Circuit grounding to ac output circuit of stand-alone inverter	Not stand-alone inverter	N/A
19.2	Utility-interactive inverter not have direct/solid electrical connection between output ac conductor and enclosure		P
19.3	Grounded conductor for each ac output circuit		P
19.4	The conductor connected by a bonding jumper between the grounded conductor and:		P
	a) The enclosure of a metal-enclosed unit, or		P
	b) For a nonmetallic enclosed unit, the metal chassis that is bonded to the equipment grounding conductor or terminal	Metal enclosure	N/A
19.5	The size of the bonding jumper specified in table 19.1		N/A
20	Internal Bonding for Grounding		-
20.1	Grounding of all exposed dead metal parts, if risk exists	All dead metal parts reliably bonded to ground	P
20.2	Bonding of all uninsulated metal parts that involve a risk of electric shock or electrical energy-high current levels where they are accessible by user or inadvertent contact by serviceman		P
	Exceptions, a) – g)		N/A
20.3	Bonding by metal-to-metal piano-type hinge for doors	Paint removed and plated for Screw holes	P
20.4	Continuity of the grounding system relies on the dimensional integrity of a nonmetallic material		N/A
20.5	Materials used for bonding: copper, a copper alloy, etc.	a copper alloy	P
20.6	Positive means for connections in bonding path	Paint removed	P
20.7	Grounding Impedance Test, section 48, and bonding means penetrates nonconductive coatings	Grounding impedance test performed with positive result	P
20.8	Min. two threads in metal for single screw, or more screws used		P
20.9	Bonding Conductor Test, Section 52, for bonding clamping devices	No such clamping devices	N/A
20.10	Size and/or test for bonding conductor or strap		P
20.11	More than one size branch-circuit overcurrent device involved, rating of the overcurrent device		N/A
20.12	The bonding connection not carry current other than current resulting from an electrical malfunction	No current goes though the grounding connections in normal conditions	P
	Exception for LVLE circuits, etc.		N/A
21	Internal Wiring		--
21.1	General		P

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Clause	Requirement — Test	Result — Remark	Verdict
21.1.1	Rating and type of internal wiring	Certified wires used.	P
21.1.2	Insulating tubing or sleeving not used as insulation other than for a short length		N/A
21.1.3	Stranded conductors used and protected where wiring extends to a hinged door or other part that is subject to movement		N/A
21.2	Protection of wiring		P
21.2.1	Internal wiring not accessible from outside the enclosure		P
21.2.2	Wires are away from sharp edge, burr, fin, moving part, etc., which may damage the conductor insulation	Away from sharp edge	P
21.2.3	Mounting screws and nuts' sharp edges not damage wiring and their ends not projected more than 4.8 mm (3/16 inch) into the wireway		P
21.2.4	A hole through which insulated wires pass in a sheet metal wall internal to the overall enclosure of a unit provided with smooth, rounded surfaces		P
21.3	Electrical connections	(Need some more description in this section)	P
21.3.1	A splice or connection shall be mechanically secure and shall make reliable electrical contact	AC wires outlet DC used MC 4 mating connectors.	P
21.3.2	A soldered connection shall be made mechanically secure before being soldered	DC wires with connectors/lugs screwed to PCB.	P
21.3.3	A stranded internal wiring connection reduces the potential for loose strands of wire	Stranded internal wirings with crimped connectors or lugs	P
21.3.4	An open-end spade lug secured by a screw or nut secured by additional means	No open end lugs	N/A
21.3.5	Quick-connect terminal comply with UL 310 or investigated per the relevant tests of UL 310	No quick connect terminal	N/A
21.3.6	Use of Aluminum conductors		N/A
21.3.7	Splice provided with insulation equivalent to that of the wires involved unless permanent spacings are maintained between the splice and other metal parts		N/A
22	Live Parts		--
22.1	Current-carrying part shall be of silver, copper, copper alloy, aluminum, or the equivalent	Copper or Aluminum wires used also specified in the manual	P
22.2	Uninsulated live parts secured so they do not turn or shift in position where such displacement results in a reduction of spacings below the minimum values	AC/DC Busbar and terminals secured to enclosure or chassis by screw	P
23	Separation of Circuits		--
23.1	Factory wiring		P
23.1.1	Insulated conductors of different circuits separated by barriers or segregated and separated or segregated from uninsulated live parts connected to different circuits	AC output wires and DC input wires at different wire compartments	P

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Clause	Requirement — Test	Result — Remark	Verdict
23.1.2	Types of different circuits:	Isolation transformer used for control circuits and Opt coupler used (meet d), e) and f))	P
23.1.3	Means of segregation of insulated conductors	Wires separated by clamping and routing	P
23.2	Field wiring		P
23.2.1	Separation of field installed conductors from other circuits		P
	a) Factory installed conductors	DC MC4 connectors field connect with mating parts	P
	b) Uninsulated live parts	AC wires outlet	P
	c) Field Installed conductors of any other circuits		P
23.2.2	Separation of a field-installed conductor from another field-installed conductor and from an uninsulated live part connected to another circuit		P
23.2.3	Openings in the enclosure for field wiring		P
23.3	Separation barriers		N/A
23.3.1	Barrier used for separation between the wiring of different circuits shall be:		N/A
	a) Grounded metal or 0.71 mm (0.028 inch) minimum thick insulating material, and		N/A
	b) Supported so that it is unable to be readily deformed or displaced to defeat its purpose.		N/A
23.3.2	Barrier used for separation between field wiring of one circuit and field or factory wiring or uninsulated live parts of another circuit not spaced more than 1.6 mm (1/16 inch) from the surface that serves to provide separated compartments		N/A
24	Spacings		--
24.1	General	See table 24, 25 for details	P
24.1.1	The spacings meet the requirement of Table 24.1	T24.1 used for distance between live parts and enclosure wall	P
	Exception to table 24.1 item 1-8		N/A
24.1.2	Uninsulated live parts connected to different circuits investigated as though they are parts of opposite polarity and on the basis of the highest voltage involved		P
24.1.3	The spacing at a field wiring terminal is to be measured with wires representative of field wiring in place and connected to the terminals as in actual service	Measured with field DC and AC cables connected	P
24.1.4	Spacing measurement for multi-component unit	600Vdc DC +,- circuits, 240Vrms AC circuits	P
24.1.5	Spacings for fuse and fuseholder with the fuse in place		P
24.1.6	Uninsulated live part is not rigidly secured in position	No such part	N/A
24.1.7	Lock washer is one means of rigidly securing a part	Used for bonding	P

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Clause	Requirement — Test	Result — Remark	Verdict
24.1.8	Spacings to film coated wire are to be investigated as though the wire is an uninsulated live part	No such wire	N/A
24.1.9	Spacings within non safety circuits:		P
	a) Secondary circuits supplied by a transformer winding rated less than 200 volt-amperes or at a potential of 100 volts or less,		P
	b) Battery circuits at a potential of 100 volts or less, or	No battery circuits inside the enclosure	N/A
	c) A circuit derived from a battery rated over 100 volts in which the voltage within the circuit is limited to 100 volts or less by a regulating network	See above	N/A
24.2	Insulating liners and barriers		N/A
24.2.1	Insulating liner or barrier of material:	No liner or barrier used	N/A
	a) Not the sole support for uninsulated live parts involving a risk of fire, electric shock, or electrical energy-high current levels,	No vulcanized fiber or mica used	N/A
	b) Not less than 0.71 mm (0.028 inch) thick, and		N/A
	c) Located so that it is not adversely affected by arcing		N/A
	Other insulating materials used as a barrier or as direct or indirect support of uninsulated live parts		N/A
24.2.2	Insulating tubing complying with UL 224, when the following conditions are met:	No tubing	N/A
	a) The conductor is not subjected to compression, repeated flexing, or sharp bends,		N/A
	b) The conductor or case covered with the tubing is well rounded and free from sharp edges,		N/A
	c) The tubing is used in accordance with the manufacturer's instructions, and		N/A
	d) The conductor or case is not subjected to a temperature or voltage higher than that the tubing rating		N/A
24.2.3	A wrap of thermoplastic tape, complying with UL 510, when all of the following conditions are met:	No tape	N/A
	a) The wrap is no less than 0.33 mm (0.013 inch) thick, is applied in two or more layers, and is used in conjunction with not less than one-half the required through-air spacing,		N/A
	b) The wrap is not less than 0.72 mm (0.028 inch) thick where used in conjunction with less than one-half the required through-air spacing,		N/A
	c) The temperature rating of the tape is not less than the max. temperature observed during the temperature test,		N/A
	d) The tape is not subject to compression,		N/A
	e) The tape is not wrapped over a sharp edge		N/A
25	Alternate Spacings – Clearances and Creepage Distances		--

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Clause	Requirement — Test	Result — Remark	Verdict
25.1	Except in 25.2 and 25.3, UL 840 may be used as an alternative for spacings	Requirements of UL 840 applied, see table 24, 25 for details	P
25.2	The clearances between an uninsulated live part and the walls of a metal enclosure, including fittings for conduit or armored cable, shall meet Table 24.1	T24.1 used	P
25.3	The clearances and creepage distances at field wiring terminals shall comply with Spacings, Section 24	Only DC positive cable and AC 3 phase as field connection, see table 24, 25 for details	P
25.4	Conditions used for applying UL 840:		P
	a) Pollution degree 3, unless otherwise specified	PD 2 internal.	P
	b) Overvoltage Category IV for inverters	OVC IV for AC, II for DC. The certificated SPD be use for reduced the impulse voltage.	P
	c) Pollution degree 2 on PWB		P
	d) CTI of PWB, min. of 100 without investigation	CTI > 100	P
	e) Conformal coating per UL 746C	No conformal coating for PCBAs	N/A
	f) Pollution degree 1 by potting, etc.		N/A
	g) Phase-to-ground rated system voltage	240Vrms used	P
	h) Determination of Ci and Cr per UL 840	1.5kV impulse withstand voltage used for clearances, see table 24, 25	P
26	Insulating Materials		--
26.1	General		P
26.1.1	Polymeric material on which uninsulated live parts is mounted Classed per UL 94 as V-0, V-1, or V-2		P
26.1.2	Vulcanized fiber and Electrical grade vulcanized fiber		P
26.1.3	Polymeric material used to support an uninsulated live part or parts comply UL 746A, UL 746B, and UL 746C		P
26.2	Barriers		P
26.2.1	Insulating barrier of vulcanized fiber, thermoplastic, or other material used in lieu of required spacings shall be:		P
	not less than 0.71 mm (0.028 inch) thick, and		P
	so located or of such material that it is not adversely affected by arcing		P
	Exception to 26.2.1		N/A
26.2.2	Insulation used in lieu of required spacings between a magnet-coil winding and other uninsulated live parts or grounded dead metal parts, meet 26.2.1		N/A
27	Capacitors		--
27.1	Oil-filled capacitors used for EMI elimination or power-factor correction comply with UL 810		P

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Clause	Requirement — Test	Result — Remark	Verdict
27.2	Capacitors connected across ac input/output circuit which is connected to utility comply with UL 60384-14.	Certified X caps and Y caps used, refer to CDF	P
28	Isolated Accessible Signal Circuits		--
28.1	Isolated accessible signal circuit having means for external connections	Certified Photo-couplers used	P
28.2	Signal circuit that extends outside of a unit shall be an isolated circuit and shall be isolated from internal circuits having a voltage involving risk of electrical shock, by:		P
	a) Optical isolator comply with UL 1577		P
	b) Isolation transformer comply with UL 5085		N/A
	c) Capacitor comply with UL 1414		N/A
	d) Electro-mechanical relay comply with UL 508		P
	e) Voltage regulating network		N/A
28.3	The maximum power voltage and current available from an isolated accessible signal circuit, see 29.4 – 29.11		P
28.4	The maximum power available from an isolated accessible signal circuit that employs an overcurrent protection device, specified in Table 28.1.		P
29	Control Circuits		--
29.1	LVLE or LE control circuit is able to be connected to a single-point reference ground	Control circuit digital ground provided	P
29.2	LVLE non-safety circuits require no investigation, PWB and insulated wire used in such circuits shall comply with 21.1.1 and 32.1	Certified V-0 PCB used	P
29.3	Safety control circuit shall be investigated in accordance with the requirements for primary circuits	Isolated transformer and opt-couplers used for control circuit	P
29.4	Voltage and current limited control circuit within the unit, PWB and insulated wire used in such circuits shall comply with 21.1.1 and 32.1	Certified V-0 PCB used	P
	a) The voltage < table 11.1	12Vdc	P
	b) The current	Certified resettable fuses used for fan, and other control circuit. Max. 9A 30V rated fuses used.	P
29.5	The maximum current measurement, reference to 29.4(b)		P
29.6	The voltage measurement, reference to 29.4(a)		P
29.7	Limited current control circuit which is not limited as to available short-circuit current by the construction of a transformer, and the circuit includes one or more resistors, a fuse, a nonadjustable manual-reset protective device, or a regulating network		P
29.8	Fuse or circuit-protective device used to limit the current in accordance with 29.7, rated or set at not more than the values specified in Table 29.1		P

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Clause	Requirement — Test	Result — Remark	Verdict
29.9	Fuse or circuit-protective device connected to the primary of a transformer to limit the current in accordance with 29.7, equivalent to that specified in 29.8 as determined by conducting the Overcurrent Protection Calibration Test, Section 49		P
	Exception: The Overcurrent Protection Calibration Test, Section 49, does not apply when the combination of a fuse or overcurrent protective device and a transformer complies with UL 1585		N/A
29.10	Regulating network used to limit the current in accordance with 29.7, the current under any condition of load, including short circuit, does not exceed the values indicated in 29.4(b)		N/A
29.11	Regulating networks used to limit the voltage or current		N/A
	a) Comply with 29.13, and		N/A
	b) Critical components comply with UL 991, etc.		N/A
29.12	In a circuit of the type described in 29.7, the secondary winding of the transformer, the fuse or circuit protective device, or the regulating network, and all wiring up to the point at which the current and voltage are limited		N/A
29.13	Regulating network, reference to 29.11 a), comply with the following tests in accordance with the method described in UL 991:	Not regulating network	N/A
	a) Transient Overvoltage Test,		N/A
	b) Ramp Voltage Test,		N/A
	c) Electromagnetic Susceptibility Tests,		N/A
	d) Electrostatic Discharge Test,		N/A
	e) Thermal Cycling Test,		N/A
	f) Humidity Test, and		N/A
	g) Effects of Shipping and Storage Test		N/A
29.14	The following test parameters are to be used in the investigation of a regulating network covered by 29.13		N/A
	a) Electrical supervision of critical components applies,		N/A
	b) Audibility is usable as a trouble indicator for an electrical supervision circuit,		N/A
	c) A field strength of 3 volts per meter is to be used for the Radiated EMI Test, and		N/A
	d) Exposure Class H5 is to be used for the Humidity Test		N/A
30	Overcurrent Protection		--
30.1	General		P
30.1.1	Renewal overcurrent protective device, etc. accessible:		P
	a) From outside of the enclosure, or		N/A
	b) Behind a hinged cover		P

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Clause	Requirement — Test	Result — Remark	Verdict
30.1.2	Location of Plug-type and extractor-type fuseholder	Not plug type	N/A
30.1.3	Use of Plug-type and extractor-type fuseholder		N/A
30.1.4	Suitable rated fuse and fuseholder used		P
30.1.5	Fuseholder type, cartridge, plug, or extractor, etc.		P
30.1.6	Plug-type fuseholder, Type S construction		N/A
30.1.7	Appliance protector comply with UL 1077 and used within the designed short-circuit interrupting rating	Not Appliance protector	N/A
30.1.8	Circuit breaker in the input or output circuit shall open all ungrounded conductors of the circuit		P
30.1.9	Marking for interchangeable overcurrent protection fuse		P
30.1.10	Overcurrent protective device not connected in the grounded (neutral, in an ac circuit) side of the supply circuit unless the protective device simultaneously disconnects the grounded and ungrounded conductors of the supply circuit	On PV + and PV - inputs	P
30.1.11	Temperature or current-sensitive devices		N/A
30.1.12	Overcurrent protection employing solid-state component circuitry used for protection of control circuits comply with the calibration and interrupt requirements in UL 489		N/A
30.1.13	Labels or marking for units having overcurrent protective devices connected directly to input or output terminals		N/A
30.2	Control circuit overcurrent protection		P
30.2.1	Control circuit that extends from the unit to a remote control panel, status panel, or a similar component	Communicate through RS485/RJ45.	P
30.2.2	The overcurrent protective device, circuit breaker or fuse		P
	a) Rated for branch-circuit overcurrent protection, or		P
	b) In compliance with 30.1.6		P
	Marking for protective fuse, in accordance with 64.6		N/A
30.2.3	Class 1 power-limited circuit, accordance with NEC 70	Not class 1 circuit	N/A
30.2.4	An external control circuit derived from the secondary of a transformer other than that described in 30.2.3		N/A
30.2.5	Transformer used to supply a control circuit provided with overcurrent protection in the primary circuit		N/A
30.3	Output ac power circuit overcurrent protection		P
30.3.1	AC output power circuit provided with overcurrent protection for all ungrounded conductors, circuit breaker or a fuse rated for use as branch circuit protection	External circuit breaker mentioned in the user manual. AC disconnect provided, handle on the front door.	P
30.3.2	The rating of the overcurrent protection for fixed wiring unit not exceed the ampacity of the conductors intended to be connected to the unit		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
30.3.3	Overcurrent protection provided for each attachment-plug receptacle		N/A
30.4	Battery circuits		N/A
30.4.1	Overcurrent protection provided for unit intended for connection to a battery circuit	PV inverter only.	N/A
30.4.2	The overcurrent protective device shall be dc rated and for branch-circuit protection in accordance with NEC 70		N/A
30.4.3	The protective device located adjacent to the battery connecting means ahead of any component which is able to malfunction under short-circuit conditions		N/A
30.4.4	The rating of the overcurrent protective device shall be based on the ampacity of the conductors intended to be connected between the unit and battery		N/A
31	DC Ground Fault Detector/Interrupter		--
31.1	Inverters or charge controllers with direct photovoltaic inputs from a grounded photovoltaic array or arrays provided with a ground-fault detector/interrupter (GFDI)	No GFDI - Not to connect to a grounded photovoltaic array. 1741 CRD and CSA 107.1-16 PV R isolation and leakage current tested. Refer to test package.	N/A
31.2	GFDI shall sense the ground fault, interrupt the ground fault current path and provide an indication of the fault when the ground faults exceed the currents, Table 31.1		N/A
31.3	No automatic reclosure after tripped in 31.2		N/A
31.4	Automatic reclosure when power is restored, in accordance with Utility Disconnect, section 40		N/A
31.5	GFDI incorporates solid-state components		N/A
31.6	GFDI rendered by malfunction of components		N/A
31.7	Components subjected to the following test in accordance with the methods described in UL 991:		N/A
	a) Transient Overvoltage Test,		N/A
	b) Ramp Voltage Test,		N/A
	c) Electromagnetic Susceptibility Tests,		N/A
	d) Electrostatic Discharge Test,		N/A
	e) Thermally Cycling Tests,		N/A
	f) Humidity Test, and		N/A
	g) Effects of Shipping and Storage Test		N/A
31.8	For the tests specified in 31.7:		N/A
	a) Electrical supervision of critical components applies,		N/A
	b) Audibility is usable as a trouble indicator for an electrical supervision circuit,		N/A
	c) A field strength of 3 volts per meter is to be used for the Radiated EMI Test, and		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
	d) Exposure class H5 is to be used for the Humidity Test		N/A
31.9	Integral GFDI or separate device not inlkd to any main photovoltaic disconnect and operation of the main photovoltaic disconnect shall not affect the normal grounding of the system		N/A
31.10	Integral GFDI or photovoltaic inverter operating with separate GFDI marked in accordance with 64.16		N/A
32	Printed-Wiring Boards		--
32.1	PWB in a unit comply with UL 796, classified per UL 94 The use of a material Classed V-2 requires the use of an enclosure without openings	Certified PCB used	P
33	External Transformers		--
33.1	A manufacturer-specified external isolation transformer, see 2.1.29, shall comply with the Standard for Dry-Type General Purpose and Power Transformers, UL 1561, or the Standard for Transformers, Distribution, Dry-Type – Over 600 Volts, UL 1562, whichever applies.		N/A
33.2	Product that measures the utility voltage and frequency through a manufacturer-specified external isolation transformer that is also used to export power to the EPS		N/A
33.3	Product, not covered by 32.2, that uses a manufacturer-specified external isolation transformer provided with instructions in accordance with 65.2.8		N/A
34	Protection against Risk of Injury to Persons – General		--
34.1	Protection provided when operation, maintenance, or foreseeable misuse of a unit involves a risk of injury	Protection guard provided	P
34.2	Factors in judging exposed moving parts	Moving parts enclosed. Fans inside metal enclosure.	P
34.3	Means of protection and evaluation	UL certified fans. Locked rotor tested with component certified.	P
35	Enclosures and Guards		--
35.1	Parts capable of resulting in a risk of injury enclosed	All live parts enclosed behind the doors.	P
35.2	Openings in a guard or enclosure around a moving part		P
35.3	No sharp constitution of risk of injury to persons in normal maintenance or use		P
35.4	Guards or portions of an enclosure acting as a guard for a part that involves a risk of injury to persons, be:		P
	a) Unable to operate with the guard removed,		N/A
	b) Secured using fasteners require a tool for remover, or		P
	c) Provided with an interlock		N/A
36	Moving Parts		--
36.1	Rotating member, breakage of which results in a risk of injury to persons, enclosed or guarded	Fans inside the enclosure	P

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Clause	Requirement — Test	Result — Remark	Verdict
36.2	Rotating or moving part that involves a risk of injury to persons when it becomes disengaged provided with a positive means to retain it in place		P
37	Switches and Controls		N/A
37.1	When unintentional operation of a switch involves a risk of injury to persons, the actuator of the switch located or guarded so that such operation is unforeseeable	Disconnected switch control outside of the enclosure of switch box, the actuator inside the enclosure and not accessible.	P
37.2	Actuator of a switch guarded by recessing ribs, barriers, or similar component		P
38	Mounting		P
38.1	Manufacturer provide the hardware with the unit, if mounting instructions furnished with a unit specified that mounting hardware is not readily available commercially		P
39	Output Power Characteristics and Utility Compatibility – General		--
39.1	Stand-alone inverters comply with 45.2.1 and with the harmonic voltage distortion requirements in 45.4.1	Not standalone inverter	N/A
39.2	Utility-interactive inverters comply with the applicable tests in Utility Interaction Section 40		P
40	Utility Interaction		--
40.1	A utility-interactive inverter or interconnection system equipment (ISE) shall comply with IEEE 1547, and IEEE 1547.1, excluding the requirements for Interconnection Installation Evaluation, Commissioning Tests, and Periodic Interconnection Tests	Inverter tested to Tested to IEEE 1547 and IEEE 1547.1 and did not including this report.	P
40.2	Utility-interactive inverters and interconnection system equipment (ISE) provided with field adjustable trip limits and trip times for voltage and frequency, when:	Trip limits and trip times tested according to standard IEEE 1547 2014 and IEEE 1547.1A 2015. Can be adjusted on field within the requirement.	P
	AC output rating is more than 30kW	125kW	P
	AC output rating is not more than 30kW		N/A
40.3	Field adjustable control accessible to service personnel only	Panel adjustable control is within the requirement by UL 1741, Rule 21 and Rule 14	P
40.4	Installation manual described the trip limit and time adjustment ranges in addition to the default factory settings	Provided manual	P
40.5	Units with field adjustable trip points provided with a means to display or indicate the programmed trip limits, trip times and reconnect time delay		P
40.6	Each combination of microprocessor model, manufacturer and firmware/software version used in the production of a utility-interactive inverter or interconnection system equipment (ISE) shall be evaluated in accordance with 40.1	Evaluated and tested – refer to test package	P

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Clause	Requirement — Test	Result — Remark	Verdict
	Exception: For units with firmware/software that is in compliance with UL 1998, subsequent firmware/software revisions may be entitled to a limited reevaluation in accordance with 40.1 as determined by the subsequent UL 1998 evaluation of the revised firmware or software		P
41	Performance – General		--
41.1	Inverters and Converters subjected to the tests applied	Tested according to clauses 42 – 61 as applicable	P
41.2	Testing voltage of power sources per table 41.1	See test package	P
41.3	Simulated utility source used for tests	See test setup in test package	P
41.4	Actual utility used as simulated utility source	Simulated utility used in testing	N/A
41.5	Input and output overcurrent protection is to be installed	Not installed	N/A
41.6	Specific defined input sources	Simulated DC source used in testing instead of battery system	P
42	Maximum-Voltage Measurements		--
42.1	The maximum voltage determined for:	DC: 850-1500VDC AC: 247-690VAC, 3-phase	P
	a) the dielectric voltage-withstand test		P
	b) the minimum spacings, Cl, and Cr		P
42.2	Connector or comparable part connected and disconnected during the test		N/A
42.3	Peak value of the voltage or the rms or average values	Refer to test package	P
43	Temperature		--
43.1	Maximum temperature measurement, table 43.1	Temperatures within limits, see test package for details	P
43.2	Maximum surface temperature measurement, table 43.2		P
43.3	Temperature measurement correction, table 43.3	Tested at ambient 30, 40, 45, 50 and 60°C (max. rating)	P
43.4	Temperatures stable conditions		P
43.5	Unit tested and operated in normal conditions		P
43.6	Unit intended for mounting in more than one position or in a confined location	Only one mounting position and tested	P
43.7	Thermocouples used for temperature measurement	Thermocouples used	P
43.8	Thermocouple junction held securely in the surface of the material being tested		P
43.9	Coil and winding temperatures by thermocouples located on exposed surfaces		P
43.10	The temperature of a winding using the change-of-resistance method		N/A
43.11	Localized component heating occurs in products that reduce output power with an increase in temperature	De-rating at 45°C ambient	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
44	Dielectric Voltage-Withstand Test		--
44.1	Immediately following the temperature test or with the unit at normal operating temperature, between:	(see test package)	P
	<ul style="list-style-type: none"> the input circuit and dead metal parts, 	DC circuits and PE or enclosure: 1414Vdc+2x600Vdc=2614Vdc Tested at 2614 Vdc	P
	<ul style="list-style-type: none"> the output circuit and dead metal parts, and 	AC circuits and PE or enclosure: 1000Vac+240 x 2 Vac=1480Vac Tested at 1480Vdc	P
	<ul style="list-style-type: none"> the input and the output circuits, 	Not tested due to DC/AC not isolated	N/A
	<ul style="list-style-type: none"> secondary circuit and dead metal parts, 		P
	<ul style="list-style-type: none"> terminals of capacitors 	Not tested	N/A
44.2	Test equipment and application of the test voltage	1 min for each test	P
44.3	Low-voltage control circuit or a sensor circuit		P
45	Output Power Characteristics		--
45.1.1	Simulated utility source, if used, in accordance with 41.3		P
45.2	Output Ratings		--
45.2.1	Stand-alone inverter or converter, output voltage: $\pm 10\%$	Not standalone inverter	N/A
45.2.2	Utility-interactive inverter, capable of operating at rated output current $\pm 10\%$	Complied.	P
45.2.3	AC module: within $\pm 10\%$ rated output power & current	Utility-interactive	P
45.2.4	Lower output rating at higher ambient temperature	See test package	P
45.3	Input range		P
45.3.1	Utility-interactive inverter or converter, input range vary		P
45.4	Harmonic distortion		P
45.4.1	Stand-alone inverter, voltage harmonics < 15%		P
46	Utility Compatibility		P
46.1	Utility-interactive inverter and ISE met IEEE 1547 and IEEE 1547.1 with exception specified in 40.1	Tested to Tested to IEEE 1547 2014 and IEEE 1547.1A 2015	P
47	Abnormal Tests		--
47.1	General		P
47.1.1	Unit not emit flame or molten metal or become a risk of fire, electric shock, or injury to persons		P
47.1.2	Each followed with Dielectric Voltage-Withstand Test		P
47.1.3	Risk of fire, electric shock, or injury to persons if:		P
	a) Emission of flame, molten metal, glowing or flaming particles through any openings in the product,		P
	b) Charring, glowing, or flaming of the supporting surface, tissue paper, or cheesecloth,		P


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Clause	Requirement — Test	Result — Remark	Verdict
	c) Ignition of the enclosure,		P
	d) Creation of any openings in the enclosure that results in accessibility of live parts, or		P
	e) Opening of the 3-ampere fuse connected to ground		P
47.1.4	During the tests, unit is placed on a softwood surface covered with white tissue paper	Placed as final installation	N/A
47.1.5	The input and output circuits connections during tests		P
47.1.6	Enclosure connected to ground via a 3A fast acting fuse		P
47.1.7	Duration of each test, until ultimate results, etc.		P
47.2	Output overload test		P
47.2.1	Following the temperature test, Section 43:		P
	a) stand-alone inverter, see 47.2.3		N/A
	b) utility-interactive inverter, see 47.2.4		P
47.2.2	Firmware or Software controlling the temperature limits, disabled or evaluated for reliability per UL 1998		P
47.2.3	Increase the output load by 10% step		P
47.2.4	Adjusting the utility voltage for max. output current		P
47.3	Short-circuit test		P
47.3.1	For dc battery circuit and the ac output circuit: L-N or L-L	No batteries	P
47.3.2	When shorting the unit, the source to be disconnected	Short between line to lines: Inverter turns off and disconnects itself from grid, no damages occur to the unit, when the short was removed, the unit returned to work normally. MC4 connector used for PV, mated, can't be shorted without matching parts.	P
47.3.3	Fault current and duration measured immediately after the short is applied	Measured, see test package	P
47.3.4	Repeat to total of four times for each application	Tested 4 times	P
47.3.5	For 3-phase output, shorts applied from phase to phase and from phase to neutral or ground		P
47.3.6	For unit with external isolation transformers, the short is to be applied before and after the external transformer	No external isolation transformer in testing	N/A
47.3.7	The location of the applied short not direct the output short-circuit test current through the 3A ground fuse		P
47.4	DC input miswiring test		P
47.4.1	DC input connected in reverse (wiring + to -)	Tested, refer to test package	P
47.4.2	Simulated input source, max. input voltage and limited the current to 1.5 times rated		P
47.5	Ventilation test	Tested, refer to test package	P

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Clause	Requirement — Test	Result — Remark	Verdict
47.5.1	Forced ventilation with fan motors investigated for the locked-rotor condition		P
47.5.2	Forced ventilation with fan motors not investigated for the locked-rotor condition		P
47.5.3	Unit having filters, guards, or screens over input ventilation openings, with 50% and 100% blocked		P
47.6	Component short- and open-circuit		P
47.6.1	Capacitors, diodes, solid-state devices, etc. – SC / OC		P
47.6.2	Max. backfeed current not exceed the marked		N/A
47.7	Load transfer test		N/A
47.7.1	Bypass switch continued to operate normally	No bypass switch	N/A
47.7.2	Bypass ac source displaced 120° or 180°, the load is to be adjusted to draw maximum rated ac power		N/A
47.7.3	Inverter employing a bypass switch having a control preventing switching between two ac sources out of synchronization		N/A
47.8	Loss of Control Circuit		P
47.8.1	Utility-interactive inverter or ISE ceased export power upon the loss of control circuit power		P
47.8.2	Single fault is placed to disables the power to the control circuit when the unit working normally		P
48	Grounding Impedance Test		--
48.1	Impedance limit: 0.1ohm		P
48.2	Measured voltage with current 25A		P
49	Overcurrent Protection Calibration Test		--
49.1	Max. time to open, Table 49.1	None in this evaluation	N/A
49.2	Continuously adjustable resistive load used to get the specified current in Table 49.1		N/A
49.3	More than one secondary winding or taps		N/A
50	Strain Relief Test		--
50.1	Wiring lead for field-wiring connection, pull force of:		N/A
	a) 89 N (20 lbf) for 1 minute applied to a lead extending from the enclosure, and		N/A
	b) 44.5 N (10 lbf) for 1 minute applied to a lead within a wiring compartment		N/A
50.2	Input or output cord: 155.7N (35 lbf) for 1 minute		N/A
51	Reduced Spacings on Printed Wiring Boards Tests		--
51.1.1	Printed wiring board traces of different potential having reduced spacings:	No reduced spacing	N/A
	a) Dielectric Voltage-Withstand Test, Section 51.2, or		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
	b) Shorted Trace Test, Section 51.3		N/A
51.2	Dielectric voltage-withstand test		N/A
51.2.1	Withstand for 1 minute of voltage per clause 44.1		N/A
51.2.2	Power-dissipating component parts, electronic devices, and capacitors connected between traces, removed		N/A
51.3	Shorted trace test		N/A
51.3.1	Reduced traces short-circuited, one location at a time		N/A
	a) The overcurrent protection associated with the branch circuit to the unit shall not open, and		N/A
	b) A wire or a printed wiring board trace shall not open		N/A
52	Bonding Conductor Test		--
52.1	Bonding circuit, including conductor, terminations, etc.		N/A
	a) current equals to 135% and 200% of branch-circuit overcurrent-protective device, Table 52.1		N/A
	b) limited-short-circuit test, Table 52.2		N/A
52.2	Power factor of 0.9 – 1.0 and voltage of test circuit		N/A
52.3	Followed by Grounding Impedance Test, Section 48		N/A
53	Voltage Surge Test		--
53.1	GFDI preconditioning: 93 ±2%, 32.0±2.0°C for 168h or 48h per outdoor or indoor use	No GFDI	N/A
53.2	Surge voltage impulses test:		N/A
	a) Ten applications of a 6 kV surge impulse at 60 second intervals		N/A
	b) Ten applications of a 3 kV surge impulse at 60 second intervals. The ground-fault detector shall not trip		N/A
53.3	The unit in the “on” condition with no load connected		N/A
53.4	The surge generator as specified		N/A
53.5	Followed by Calibration Test, Section 54		N/A
54	Calibration Test		--
54.1	The operating time of GFDI, meet Table 54.1	No GFDI	N/A
	a) As received in a 25±3.0°C ambient,		N/A
	b) Immediately following conditioning 48h in 85±5 % at 32±2.0°C,		N/A
	c) After 4 hours in 40±2.0°C ambient,		N/A
	d) After 5 cycles of thermal shock consisting of 4h at:		N/A
	40±2.0°C followed by 4h at 0±2.0°C for general use equipment, or		N/A
	66±2.0°C followed by 4 hours at -35±2°C for outdoor use equipment, and		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
	e) At 25±3.0°C		N/A
54.2	GFDI current relaying device with an indicated delay		N/A
54.3	Tolerance band of the above mentioned delay		N/A
54.4	Testing while the device is still in the test environment		N/A
54.5	Unit tested three times under each test condition		N/A
54.6	A field pick up current adjustment is to be set at its maximum value		N/A
54.7	Repeat the GFDI by connecting to 55% of ac voltage and 80% of dc voltage, when power from a control power source is required to operate the device		N/A
54.8	No tripping if less than 85% of pickup current trip limit		N/A
55	Overvoltage Test		--
55.1	GFDI intended to be continuously connected to a source of control voltage: 110% voltage tested without damage	No GFDI	N/A
55.2	Followed by the Dielectric Voltage-Withstand Test, Section 44		N/A
56	Current Withstand Test		--
56.1	GFDI, high fault current condition followed by Calibration Test, Section 54	No GFDI	N/A
56.2	High fault current condition created by any number of turns in the sensor "window" producing the required ampere turn value		N/A
57	Capacitor Voltage Determination Test		--
57.1	Unit operated at a dc voltage equal to peak value of the ac input circuits, and at the maximum rated DC input	Refer to test package	P
58	Stability		--
58.1	a) 10 degrees in the direction of least stability	Rack mounted	N/A
	b) Placed on a plane inclined at an angle of 10 degrees from the horizontal, or		N/A
	c) Externally-applied horizontal force of 20 percent of unit weight or 22.7 kg (50 pounds), whichever is less		N/A
58.2	10 degrees from the horizontal supporting surface		N/A
58.3	Location of externally-applied horizontal force, 58.1 c)		N/A
59	Static Load		--
59.1	Force equal to three times the weight of the unit and not less than 89 N (20 lbf) applied	Rack mounted. Tested, the mounting bracket passed the loading test.	P
59.2	The force applied through the center of unit gravity for one minute		P
60	Compression Test		--

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Clause	Requirement — Test	Result — Remark	Verdict
60.1	Thinner enclosure tested	Enclosure thickness meet the requirement in 5.1-5.3	N/A
60.2	A force of 445 N (100 pounds) applied by a 12.7mm square flat steel face		N/A
61	Rain and Sprinkler Tests		--
61.1	General	Complied to Hose Down test	N/A
61.1.1	Unit is fitted with supply connection		N/A
61.1.2	Unit in multiple mounting orientations		N/A
61.1.3	The rain and sprinkler tests sequence, Table 61.1		N/A
61.1.4	No water entering the unit or not wet safety parts		N/A
61.2	Rain test		N/A
61.2.1	Rain tested per environment rating		N/A
61.2.2	Water spray apparatus, water pressure: 34.5 kPa (5 psi)		N/A
61.2.3	Unit with gasket		N/A
61.3	Sprinkler test		N/A
61.3.1	Sprinkler tested per environment rating		N/A
61.3.2	Outdoor ground-mounted unit or wall-mounted unit		N/A
61.3.3	Unit position in front of a standard water spray head water pressure: 138 kPa (20 psi)		N/A
62	Rating – Details		N/A
62.1	Unit rated as shown in Table 62.1	All specified in installation manual and some in nameplate	N/A
63	Marking – Details		-
63.1	Permanent marking required in suitable type	Certified material used for labeling	P
	Pressure-sensitive label complying with UL 969		P
63.2	Unit plainly and permanently marked and visible with:		P
	a) The manufacturer's name, trademark, etc.	"EAST"	P
	b) A distinctive catalog number or the equivalent,	Model number on Marking label	P
	c) The electrical ratings, and	On label attached on surface	P
	d) The date or other dating period of manufacture not exceeding any three consecutive months	Serial number on label	P
63.3	Marked with "Utility-Interactive", "Interconnection System Equipment", or the equivalent	Marked "Utility Interactive Inverter"	P
63.4	Marked with "This unit or system is provided with fixed trip limits and shall not be aggregated above 30 kW on a single Point of Common Connection"	No utility support functions.	N/A
63.5	DC Ground-Fault Detector/Interrupter within unit or not	With field adjustable trip limits	N/A
63.6	Production of particular factory, if more than one	No GFDI in unit	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
63.7	Symbols of dc, ac, phase, etc.	Single factory	N/A
63.8	Symbols provided as part of the Important Safety Instructions	Marked	P
63.9	The operating positions of a handle, knob, etc.	Provided in manual	P
63.10	Wiring terminals marking, if any confusing		P
63.11	Field-wiring terminals marked with wire type to be connected, "Copper Only" etc.	Marked for DC connection, AC circuit breaker provided marking	P
63.12	Equipment-grounding conductor identification	 for used.	P
63.13	Ambient temperature, and reduced output power rating	No derating.	P
63.14	Symbol for equipment-grounding conductor:	Grounding symbol by grounding bar	P
	a) Provided in the important Safety Instructions		P
	b) Similar symbol used for bonding point to ground	See manual	P
63.15	Terminal for grounded conductor	Internal bonding not marked	N/A
63.16	Terminal marked "Grounding Electrode Terminal"	Grounding symbol marked next to terminal	P
63.17	Terminal for field wiring connections marked with tightening torque	No such terminal	N/A
63.18	Remote battery supply, marked the polarity of the connections between the battery supply and the unit	Information provided in manual	P
63.19	Particular voltage marked for multiple-voltage output unit for permanent connection to the branch circuit	Marked with "+" and "-" next to DC terminals	P
63.20	ON and OFF positions of disconnect control devices	Labeled adjusted to DC switch.	P
63.21	The above information described in 66.4(G) provided		P
63.22	Non-LVLE clock, timing device, etc. marked to indicate that the circuit remains energized while the unit is off	Instruction in manual	P
63.23	Unit containing a field-wiring lead intended to be connected to a wire binding screw located in the field-wiring compartment, marked clearly the use of the lead	No such lead, only DC and AC terminals	N/A
63.24	Low-voltage Class 2 field-wiring leads not color coded, identified	No such lead	N/A
63.25	Stand-alone unit having grounding type receptacles for the output ac current connections marked with "One side of the output circuit is bonded to the inverter frame. Connect the grounding electrode terminal to a grounding electrode in accordance with the local codes"	No receptacle	N/A
63.26	Disconnect device, switch, or breaker for the output ac and dc power circuits, identified	Provided	P
63.27	Small sized field installed conductor for use with the field connection pressure terminal marked with "Use – max. AWG wire only for field connector" or the equivalent	No pressure terminal	N/A
63.28	Total voltage harmonic distortion more than 30%, marked for stand-alone inverters	Utility-interactive inverter	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
63.29	Enclosure, other than Type 1, permanently marked	Marked	P
63.30	Marking to indicate that rain tight or wet location hubs that comply with UL 514B, are to be used	Bottom section as conduit hub	N/A
63.31	Separable conduit hub and closure fitting marked with the manufacturer's name or trademark and the catalog number or equivalent	No such separable parts	N/A
63.32	Type 2 or 3R enclosure has knockouts for conduit in the sides or back and in which the equipment to be installed is not known marked to indicate the area in which live parts are to be installed	Type 4X	N/A
63.33	Type 4X enclosure intended for indoor use only marked "4X Indoor Use Only" in letters not less than 4mm high	Type 4X	P
63.34	Marking provided to instruct the installer to fill the opening with a Type 12 conduit fitting		N/A
64	Cautionary Markings		--
64.1	"CAUTION", "WARNING", or "DANGER" used	Warning/Caution/Danger label provided	P
64.2	"CAUTION", "WARNING", or "DANGER" in letters not less than 3.2 mm high. The remaining letters shall not be less than 1.6 mm high		P
64.3	Location of cautionary marking shall be:		P
	a) on a part that is not removable without impairing the operation of the unit, and		P
	b) Visible and legible to the operator during the normal operation of the unit		P
64.4	Live heat sink or other part marked with "CAUTION - Risk of Electric Shock - Plates (or other word) are live. Disconnect unit before servicing"	No touchable heat sink. Enclosure grounded	N/A
64.5	Inverter having an isolation transformer, capacitor, or a dc sensor having a high-speed disconnect switch shall be marked "CAUTION - For Proper Circuit Isolation" etc.	No such device in EUT	N/A
64.6	Access Cover without hinge marking with "CAUTION -" and the following or equivalent: "Risk of Electric Shock, Do Not Remove Cover. No User Serviceable Parts Inside. Refer Servicing To Qualified Service Personnel"	Marked	P
64.7	Fuse rating marking, and "WARNING - For Continued Protection Against Risk Of Fire, Replace Only With Same Type And Ratings Of Fuse"	Marked next to DC fuseholders	P
64.8	Inverter marked with "CAUTION" and "Risk Of Electric Shock -" and the following or the equivalent:	Marked on outside enclosure	P
	a) "Both ac and dc voltage sources are terminated inside this equipment. Each circuit must be individually disconnected before servicing," and		P
	b) "When the photovoltaic array is exposed to light, it supplies a dc voltage to this equipment."	Not for connecting to PV	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
64.9	Unit exceeds the temperature limits marked externally where readily visible after installation with the word "CAUTION" and the following or the equivalent: "Hot surfaces - To reduce the risk of burns - Do not touch"	Temperatures within limits	N/A
64.10	Unit provided with single-pole circuit breakers in the input or output circuit marked internally with "CAUTION" and "To reduce the risk of electric shock and fire - Do not connect to a circuit operating at more than 150 volts to ground"	No such single-pole circuit breaker	N/A
64.11	Removable panel covering capacitor marked with "CAUTION - Risk of electric shock from energy stored in capacitor" and "Do not remove cover until _ minutes after disconnecting all sources of supply"	Marked	P
64.12	Unit marked "CAUTION - Risk of electric shock and/or electric energy-high current levels" and "Disconnect and discharge (identify capacitor) before removing panel as follows"	Discharge time measured	N/A
64.13	Ungrounded dead metal part marked with "CAUTION" and "Not grounded - Involve a risk of electric shock. Test before touching"	All dead metal parts bonded to enclosure	N/A
64.14	With reference to Exception No. 3 to 11.2.3, marking provided "CAUTION - Risk of electric shock or electrical energy-high current levels" and "High-energy electric charge is stored in capacitor and associated circuitry. Test before touching"	See above	N/A
64.15	Units with GFDI marked with "CAUTION" and "Risk of Electric Shock. Normally Grounded Conductors May Be Ungrounded and Energized When a Ground-Fault Indicated"	No GFDI within unit	N/A
65	Equipment Information and Instructions		--
65.1	Separation of information		P
65.1.1	Operating and operator-servicing instructions shall be separated from servicing instructions	Separated	P
65.1.2	Service Instruction with "Warning - These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the operating instructions unless you are qualified to do so"	Specified in manual, no service while energized	P
65.2	Operating and installation instructions		P
65.2.1	The operating and installation instructions include sufficient information for the purposes	Provided in manual	P
65.2.2	The important safety instructions shall appear before the battery installation procedures and maintenance	Important safety instruction within the first part of the manuals	P
65.2.3	The installation instructions shall indicate that the wiring methods in accordance with the NEC 70, are to be used	Specified in manual	P
65.2.4	Enclosure marked Type 4, 4X, 6, or 6P provided with instructions for installation of a watertight conduit, etc.	Type 4X	P

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Clause	Requirement — Test	Result — Remark	Verdict
65.2.5	Installation instructions provided with an enclosure intended for field assembly of the bonding means	Provided in manual	P
65.2.6	When hub or fitting not provided or installed on Type 4 or 4X enclosure, instructions identifying the specific hub or fitting and installation instructions	Type 4X	N/A
65.2.7	Instructions for hubs to be connected to the conduit before the hub is connected to the polymeric enclosure	No hub	N/A
65.2.8	Instructions for manufacturer-specified external isolation transformer to specify the manufacturer, model, electrical ratings, and environmental ratings, etc.	No such transformer	N/A
66	Important Safety Instructions		P
66.1	The headings "IMPORTANT SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" not less than 4.8mm high or emphasized to distinguish them from the rest of the text. Upper case letters in the instructions shall not be less than 2.0mm high, and lower case letters not be less than 1.6mm high	"IMPORTANT SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" > 5mm high	P
66.2	No substitute for the words "CAUTION," "WARNING," or "DANGER" in the text of the instructions		P
66.3	The important safety instructions described in items A - S in 66.4, as appropriate, provided with each unit. The information contained in items C - S is able to be marked on the unit or in the instruction manual	Relevant information provided in the manual	P
66.4	The important safety instructions shall include instructions for the following items A – S, as applicable. "IMPORTANT SAFETY INSTRUCTIONS" and "SAVE THESE INSTRUCTIONS" shall precede the list. The word "WARNING", "CAUTION", and "DANGER" entirely in upper case letters		P
MANUFACTURING AND PRODUCTION TESTS			
67	Dielectric Voltage-Withstand Test		P
67.1	Each unit tested in production line, the potential:	Considered	P
	a) From input and output wiring, including connected components, to accessible dead metal parts that are able to become energized, and	Specified in CDF	P
	b) From input and output wiring to accessible low-voltage, limited-energy metal parts, including terminals		P
67.2	Potential and Frequency of test voltage, Table 67.1	Specified in CDF	P
67.3	Use of DC equivalent	Considered and test voltage specified in CDF	N/A
67.4	Testing of a unit in heated or unheated condition	Unheated condition to be applied	P
67.5	Test performed on a complete, fully assembled unit		P
67.6	Unit employing solid-state components		N/A
67.7-10	Test equipment used for the test	To be verified in first factory inspection	N/A

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Clause	Requirement — Test	Result — Remark	Verdict
67.11	The unit switches are in the on position during tests	To be verified in factory inspection	N/A
68	Utility Voltage and Frequency Variation Test		--
68.1	Each utility-interactive inverter tested per Table 68.1	Specified in CDF	P
68.2	Field adjustable trip points confirmed in accordance with the manufacturer's installation instructions		P
68.3	No full power required, the simulated utility source conditions, etc.		P
CHARGE CONTROLLERS			
69	Introduction – General		N/A
	Permanently connected charge controllers in PV system		N/A
70	Construction – General		--
70.1	Identification of the grounded conductor		N/A
70.2	Shunt provided in accordance with the Exception to 70.1		N/A
70.3	Controls for the adjustment of the state-of-charge of a battery accessible for qualified service personnel only		N/A
70.4	Temperature compensating monitoring within charge controller		N/A
70.5	Polymeric material in a charge controller: min. relative thermal index of 90°C		N/A
71	Performance – General		--
71.1	Charge controller tested as described in 72.1 – 76.4.		N/A
71.2	Installation of charge controller use in PV control panel		N/A
71.3	Installation of charge controller to be used in PV module wiring compartment		N/A
	Prior to testing, 20 cycles of the Temperature Cycle Test per UL 1703		N/A
	When performing the tests, the charge controller without an electrical enclosure in an ambient of 60°C minimum or as rated by the manufacturer		N/A
71.4	The input dc voltage for testing: 125%		N/A
72	Normal Operations		--
72.1	Not exceed by more than +10%, input and output, etc.		N/A
72.2	Not exceed its rated voltages		N/A
	An on/off and constant voltage charge controller shall not have an output voltage at the battery terminals or at load terminals that exceeds its rated value by more than +10% after the first minute of operation		N/A
72.3	Power sources connection for testing: 125% of rating		N/A
72.4	Load adjustment for testing operation		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
72.5	Connection of charge controller not function with open-circuited battery terminals		N/A
73	Temperature		--
73.1	Polymeric materials temperature not exceed the relative thermal index rating of the material per UL746B		N/A
74	Temperature Compensation		--
74.1	Charge controller provided with integral temperature compensation		N/A
74.2	The temperature sensor input is to be open-circuited and then short-circuited, one at a time		N/A
75	Connection Sequence		--
75.1	Charge controller remains within rated values		N/A
75.2	Charge controller marked with a connection sequence		N/A
75.3	Charge controller not marked with a prescribed connection sequence		N/A
75.4	Battery voltage disconnected and reconnected during normal operation. Measure voltages, currents at the PV input, load output, and battery terminals		N/A
76	Abnormal Tests		--
76.1	General		N/A
76.1.1	Charge controller shall comply with 47.1.1		N/A
76.1.2	Shorting of the battery output terminals under load		N/A
76.2	Input and output faults		N/A
76.2.1	Short-circuited the photovoltaic input to the charge controller, under rated load		N/A
76.2.2	Short-circuited the output of the charge controller, under rated load		N/A
76.3	Charge controller miswiring		N/A
76.3.1	Connection order and polarity, Table 76.1 (A – H)		N/A
76.3.2	Simulated array source used		N/A
76.3.3	Result of the test, no reverse polarity voltage present		N/A
76.3.4	No additional external overcurrent protection in the test circuit		N/A
76.4	Low-Voltage Disconnect		N/A
76.4.1	Charge controller operated in a stable, controlled manner in charge and discharge of a battery load		N/A
76.4.2	Charge controller with low-voltage disconnect connected to a source providing the charge controller's rated input, a battery or simulated battery load, and a rated load		N/A
	The battery source adjusted to 25 percent, 50 percent, 75 percent, and 100 percent of the rated battery voltage		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
	The load is adjusted so that the charge controller cycles in accordance with the charge controller design from battery charge to battery discharge state		N/A
	Adjustable charge set-points are to be set to their closest tolerance so that the charge controller cycles during the battery charge		N/A
77	Marking – Cautionary Markings		--
77.1	Charge controller requires a specific connection method marked with "CAUTION: Risk of fire and shock, connect ___ terminals prior to the connection of ___ terminals"		N/A
78	Marking – Details		N/A
78.1	Charge controller marked with Details, Section 63, and Cautionary Markings, Section 64		N/A
78.2	Charge controller intended to be installed in the wiring compartment of a photovoltaic module		N/A
78.3	Charge controller with a temperature compensating set-point adjusted by service personnel, marked with set-point details		N/A
78.4	Charge controller with internal temperature compensating means marked "CAUTION: Internal Temperature Compensation. RISK OF FIRE, USE WITHIN ___ m (ft) of BATTERIES" or "RISK OF FIRE, MOUNT IN CONTACT WITH BATTERIES"		N/A
78.5	Charge controller marked with min. interrupting rating of the overcurrent protective device to be used for short-circuit protection		N/A
79	Important Safety Instructions		--
79.1	The installation instructions shall identify the conductor or the terminal described in 70.1		N/A
79.2	The installation instructions shall specify the type and chemical composition of the battery to be used		N/A
79.3	Charge controller for field installation shall be provided with a wiring diagram or installation instructions that specify the method of installation including the connection method and wire size range in accordance with Article 690 of NEC 70		N/A
79.4	The installation instructions for charge controller to be installed in the wiring compartment of PV module shall specify the manufacturer and model of the PV module		N/A
79.5	The installation instructions for a charge controller shall describe the maximum overcurrent protection to be provided in accordance with Article 690 NEC 70		N/A
79.6	The installation instructions for a charge controller with an internal temperature compensating means shall indicate where the controller is to be used with respect to the batteries (See 78.4) and the risks associated with the improper installation		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
79.7	The installation instructions for a charge controller with service personnel adjustable temperature compensating set-points shall describe the battery chemistry and types for each set point. The instructions shall detail the risks associated with improper settings		N/A
AC MODULES			
80	Introduction – General		--
80.1	Additional requirement for AC modules		N/A
81	Construction – General		--
81.1	AC module is utility interactive, and not be capable of stand-alone operation		N/A
81.2	The PV panel or module of ac module comply with the requirements of UL 1703		N/A
81.3	All components across the dc input circuit of ac module shall be rated for 125 percent of rated crystalline silicon PV module open-circuit voltage		N/A
81.4	For amorphous silicate or thin film PV modules, the components across the line shall be rated for the PV module open-circuit voltage regardless of temperature		N/A
81.5	AC disconnection means such as a terminal, connector, or similar means shall be provided		N/A
81.6	Polymeric materials shall have a relative thermal index in accordance with UL 746B, not less than the temperature measured during the normal temperature test and not less than 90°C		N/A
81.7	Connectors employed external to the module shall comply with the material and conditioning requirements in UL 1703, in addition to UL 498. Connection shall not be of a NEMA configuration		N/A
81.8	Equipment grounding for a dc input circuit specified in 18.1.2 does not apply to an ac module		N/A
81.9	Gasket provided as part of the protective housing used on ac module enclosure shall comply with UL 1703		N/A
82	Performance – General		--
82.1	One sample of ac module shall comply with Dielectric Voltage-Withstand Test, Section 44, after being conditioned with the Temperature Cycling and Humidity Cycling Tests in UL 1703		N/A
82.2	Adhesive Securement Test, see Section 83		N/A
82.3	The Temperature Test, Section 43, is to be conducted in an ambient of 40°C (104°F) or greater		N/A
82.4	The entire ac module assembly shall be subjected to Rain and Sprinkler Tests, Section 61		N/A
	Following by Dielectric Voltage-Withstand Test, Section 44		N/A
83	AC Module Inverter Securement Test		--

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Clause	Requirement — Test	Result — Remark	Verdict
83.1	AC module inverter secured to the back of PV module with adhesive, see 83.3 – 83.7		N/A
83.2	AC module inverter secured to the back of PV module with means other than adhesive, see 83.4 – 83.7		N/A
83.3	Three separate specimens for testing:		N/A
	• One AC module that is in as-received condition		N/A
	• One subjected to the Temperature Cycle Test		N/A
	• And one subjected to the Humidity Cycling Test		N/A
83.4	Result of the test, the force shall not:		N/A
	a) Separate the enclosure from the substrate or superstrate, or		N/A
	b) Fracture the enclosure, substrate, or superstrate		N/A
83.5	Tests performed in the most severe orientation		N/A
83.6	A shear force of 47.5 N (35 lb/ft) or 4 times the weight of the complete inverter assembly, whichever is greater, applied to the top most outer portion of the enclosure furthest from the mounting surface in the direction parallel to the adhesive or similar attachment bond		N/A
83.7	The force is to be applied for at least one minute		N/A
84	Rating – General		--
84.1	AC module inverter that is provided integral to the PV module not required to provide dc input ratings		N/A
85	Marking – Details		--
85.1	The output of AC module shall be marked with the maximum parallel combination of modules that it is intended for		N/A
85.2	AC module shall be marked “to be connected only to a dedicated branch circuit” or the equivalent. AC module shall be marked with the maximum size		N/A
85.3	Marking of branch circuit overcurrent protection size		N/A
86	Important Safety Instructions		--
86.1	The important safety instructions shall include a statement indicating that the AC module shall be connected only to a dedicated branch circuit		N/A
RAPID SHUTDOWN EQUIPMENT AND SYSTEMS			--
87	General		--
87.1	Section 87-97, amend the general requirements in Sections 4 through 68		N/A
87.2	Sections 87 through 97 to define requirements for PVRSE and PVRSS to reduce the level of electric shock and energy hazards for emergency responders. These sections apply to the NEC 690.12 requirements		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
87.3	These requirements evaluate controlled conductors that may have a connection to ac circuits, such as inverter output circuits.		N/A
87.4	These controlled circuits are not required to be completely isolated		N/A
87.5	The PVRSE and PVRSS shall comply with the functional safety points as follows:		N/A
	a) Loss of control signal results in the PV system conductors being in a controlled state.		N/A
	b) When all power sources are removed, the PV system conductors shall revert to a controlled state.		N/A
	c) PVRSS and PVRSE that relies on electronic control to initiate rapid shutdown shall be tested to the functional safety requirements of Section 92.		N/A
	d) Attenuation devices shall be evaluated for the loss of continuity of any input or output connection (including the circuit being controlled).		N/A
88	Protection of Emergency Personnel		--
88.1	The requirement apply to PVRSE and PVRSS intended to reduce hazards from electric shock and energy hazards to emergency personnel or first responders.		N/A
88.2	A PVRSS shall maintain controlled conductors at a limit of not more than 30 Vdc, 8A (for dc circuits) or 15 Vac, 8A (for ac circuits) within the time limit specified in the ratings; both DC and AC not exceed 240 VA (volt-amperes) in the controlled state.		N/A
88.3	An uninsulated live part involving a risk of electric shock or electrical energy at high current levels shall be located, guarded, or enclosed to protect against unintentional contact		N/A
88.4	A complete system that performs PVRSS functionality shall:		N/A
	a) Include at least one initiator as defined in 2.2.4,		N/A
	b) Be marked as described in 96.1, and		N/A
	c) Include the information required in 97.1 in the installation instructions.		N/A
88.5	If the component relies on electronic control, the component shall be tested to the applicable requirements for functional safety in Sections 92 and 94.		N/A
88.6	PVRSS and PVRSE with electronic controls shall comply with one of, or a combination of the functional safety based approaches described in Section 92 as necessary to evaluate the intended functionality of the PVRSS.		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
88.7	Mechanical and electro-mechanical PVRSE devices shall comply with the requirements in 92.1.3, the environmental stress testing in Section 94, and shall be evaluated to the applicable requirements of at least one of the following standards		N/A
	a) The Standard for Industrial Control Equipment, UL 508,		N/A
	b) The Outline of Investigation for Manual Disconnect Switches Intended for Use in Photovoltaic Systems, UL 508I,		N/A
	c) The Standard for Enclosed and Dead-Front Switches, UL 98,		N/A
	d) The Outline of Investigation for Open-Type Switches, UL 98A,		N/A
	e) The Outline of Investigation for Enclosed and Dead-Front Switches for Use in Photovoltaic Systems, UL 98B,		N/A
	f) The Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, UL 489,		N/A
	g) The Standard for Circuit Breakers For Use in Communications Equipment, UL 489A, or		N/A
	h) The Outline of Investigation for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures For Use With Photovoltaic (PV) Systems, UL 489B.		N/A
88.8	A PVRSS that includes and relies upon multiple distributed switching devices or equipment shall be evaluated considering the effect of individual equipment failures. The evaluation shall include, but not be limited to:		N/A
	a) The possibility that failure of one component to operate may cause operational failures in other system equipment or components,		N/A
	b) The worst case configuration (e.g. maximum number of switching elements allowed per power supply),		N/A
	c) The effects of conducted or radiated EMI on electronic controls as part of a functional safety evaluation required by Section 92, and		N/A
	d) Environmental effects on switch transition timing.		N/A
88.9	Failures as noted in 88.8 shall be assessed during testing of systems, as to their impact upon the ability of the overall system to operate as intended.		N/A
88.10	Functional self-test requirements:		N/A
	a) A PVRSS shall be provided with a means or a method by which correct operation of the product is verified and it may be automatic through a manual initiator.		N/A
	b) A PVRSS self-test function used to monitor and mitigate the failure of critical components shall be automatic and comply with 92.1.9.		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
88.11	PVRSE (inverter(s), converter(s) and other device(s)) that are rated to provide PVRSS functionality shall be evaluated to the applicable requirements in Section 93, and in all possible operating modes.		N/A
88.12	PVRSE rated as a component of a PVRSS or that provide a complete PVRSS function shall be marked according to Section 96 and instructions provided according to Section 97.		N/A
88.13	PVRSS that incorporate voltage sensitive devices such as, but not limited to, semiconductor switches and mechanical contactors, shall comply with Section 93, conditions in Section 92.2 and the functional safety evaluation in Section 94.		N/A
88.14	For PVRSS that incorporate multiple distributed switching devices intended to operate together in a series configurations, the individual switching devices shall be rated for interruption of the voltage and current for the PVRSS function they perform,		N/A
	Exception No. 1		N/A
	Exception No. 2		N/A
88.15	PVRSE that is intended for mounting on PV modules shall comply with the requirements in Sections 81 – 86		N/A
	Exception: not for AC line		N/A
88.16	Upon loss of control power, a PVRSS shall either continue to operate normally with full functionality or it shall initiate a shutdown by placing the conductors in a controlled state complying with Section 93.1.		N/A
88.17	A PVRSS that relies upon electronic functions, low voltage logic circuitry, or wireless communication for the initiation of PVRSS functions shall comply with the appropriate PVRSS Radiated EMI test in Section 94.		N/A
88.18	PVRSS or PVRSE that also includes AFCI shall be evaluated together to ensure compatibility.		N/A
88.19	PVRSS that uses an attenuation device(s) to control conductors shall maintain compliance with 88.2 while applying conditions in 87.5 and Section 92.		N/A
88.20	PVRSE and PVRSS shall be rated and evaluated for compliance in accordance with Table 88.1 based upon their intended application and installation location.		N/A
89	Electrical Isolation Systems (EIS)		--
89.1	PVRSE that uses contactors or relays for isolation of controlled conductors shall contain electrical or electronic arc suppression devices on any contacts to minimize the radiated and conducted radio frequency (RF) signature of arcs created when those contacts open.		N/A
90	Initiators		--
90.1	An initiator for PVRSS functions shall be clearly identifiable for the function it performs.		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
	a) The position of the initiators “ON” or OFF”		N/A
	b) The manually operable initiator shall require manual resetting		N/A
	c) An input designed to receive an external initiation signal from emergency devices shall require manual resetting		N/A
	d) the initiation system shall have those devices or inputs connected in such a manner that activation of any one of the devices or inputs will result in initiating the PVRSS.		N/A
	e) If a status indicator light is provided, it shall indicate not later than specified response time from the initiation of the rapid shutdown and only after the PVRSS function properly occurs.		N/A
91	PVRSS that Includes Disconnect Functionality		--
91.1	PVRSS that includes PVRSE shall comply with the additional following requirements:		N/A
	a) The PVRSE shall comply with requirements for an electrically tripped or power operable disconnect device from one of the standards listed in 88.7.		N/A
	b) The manual switching device shall allow disconnection by either manual operation or by initiator.		N/A
	c) The manual switching device shall not allow manual closure (connection) while the initiator is activated (conductors placed in the controlled state).		N/A
	d) The manual switching device shall be able to determine the status of the initiator at all times.		N/A
	e) The combination PVRSE or PVRSS and the disconnect function shall comply with all applicable sections for PVRSE and PVRSS in this standard		N/A
92	PVRSS and PVRSE Functional Safety		--
92.1.1	PVRSS or PVRSE that use electronic controls, communication and/or firmware shall be subjected to a risk assessment for functional safety.		N/A
92.1.2	Standards listed in Table 92.1 shall be used along with the requirements in Section 94 to evaluate the PVRSE and if evaluating an entire PVRSS, each PVRSE of the PVRSS.		N/A
92.1.3	All PVRSE, including mechanical devices, shall consider conditions noted in Section 92.2 and environmental stress testing in Section 94.		N/A
92.1.4	The rapid shutdown function of the PVRSS or PVRSE shall not be affected by the appropriate environmental stresses described in Table 94.1.		N/A
92.1.5	An entire PVRSS can be evaluated as a combination.		N/A
92.1.6	PVRSE may be evaluated individually when the interaction with other devices is considered in the evaluation and explained in the manufacturer’s instructions.		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
92.1.7	Devices using electronic controls for the rapid shutdown function under evaluation shall have a FMEA performed as described in the standards listed in Table 92.1.		N/A
92.1.8	Devices that also use firmware/software for the PVRSS and PVRSE function shall include a risk assessment considering the interaction of the firmware and circuit as performed in UL 1998 or other standards listed in Table 92.1.		N/A
92.1.9	Critical components shall be evaluated in accordance with UL 991 or the equivalent functional safety standard listed in Table 92.1. The self-test system shall recognize the fault or failure and it shall initiate a shutdown as described in Section 93.1.		N/A
92.1.10	Inverters or other devices that have not been evaluated as part of a PVRSS shall be tested to verify that controlled input and output ports comply with 88.2 limits when the external source is removed as tested in Section 93.		N/A
92.2	Conditions to be addressed for a PVRSS/PVRSE		--
92.2.1	A functional safety evaluation shall address the following: a) Stated and intended functionality of the product. 1) Only PVRSS related functions and systems need to meet functional safety requirements as stated in this standard. 2) Auxiliary equipment and functions which may be provided with a PVRSS/PVRSE		N/A
	b) Effects of system or device failure, inaction, improper installation and component failures, such as: 1) Single point failure of components and equipment 2) Ground faults 3) Short and open circuits, 4) Incorrect installation wiring, 5) Loss of control signal or power 6) Improper sequencing and synchronization of controls		N/A
	c) Humidity, water or dust exposure during normal operating conditions based on installation location and enclosure protection.		N/A
	d) External environmental stresses listed in Table 94.1.		N/A
	e) Electrical ratings, overvoltage, undervoltage, ride-through as described in Section 93.3, short circuit current, power quality as listed in Table 94.1.		N/A
	f) The interconnection of multiple devices and how distance between devices or the number of devices impacts the result of environmental stresses listed in Table 94.1.		N/A
93.1	Operational tests for PVRSS/PVRSE verification of levels – controlled conductors		--
93.1.1	The intent of this test is to validate PVRSS/PVRSE functionality and measure the available voltage, current, and power on controlled conductors at the rated rapid shutdown time limit		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
93.1.2	After activation of a PVRSS, the following conditions shall apply: a) The terminals shall not present voltage greater than 30 Vdc or 15 Vac (rms), measured between any two conductors and any conductor and ground		N/A
	b) Not more than 240 VA continuous power, and no more than 8.0 A average current		N/A
	c) The “circuit voltage” in the above equation shall be the open circuit voltage present in the circuit at the rated rapid shutdown time limit after the initiation of disconnection.		N/A
93.2	Verification testing of PVRSS at rated extremes		--
93.2.1	The following verification tests shall be conducted. a) A device under test (DUT) powered by ac and Grid Support Compatible shall be tested using the range specified in Section 93.3.		N/A
	b) A DUT powered by a dc input shall also be tested at the minimum and maximum operating voltage levels for the controlled circuits as per its ratings.		N/A
	c) A DUT shall have each type of available control power removed individually and all types simultaneously, with a result that the DUT shall do one of the following: 1) Continue to operate normally with all critical functions available, 2) Initiate shutdown, placing Controlled Conductors in a controlled state complying with Section 93.1.		N/A
	d) Units that use batteries as a control power source shall be tested using batteries of a type that can be used in the DUT.		N/A
93.3	Power supply grid support ride through		--
93.3.1	VRSE/PVRSS that receive operating power from the ac utility shall be identified as grid support compatible and marked in accordance with 96.4.		N/A
93.3.2	PVRSS or PVRSE described in 93.3.1 is tested to Sections SA9 and SA10 to determine that the device or system does not activate within the ride-through region.		N/A
93.3.3	PVRSS or PVRSE as described in 93.3.1 shall be capable of performing its intended function within each of the voltage and frequency regions in Sections SA9 and SA10.		N/A
93.3.4	The PVRSS shall be tested at the most severe rated ride through conditions based on the units PVRSS ratings.		N/A
93.4	Inverters rated as PVRSE		--

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Clause	Requirement — Test	Result — Remark	Verdict
93.4.1	The DUT is to be connected to a PV input source (PV array or PV simulator) and an ac output source (utility or utility simulator). a) To be rated on the ac output as PVRSE, the simulated utility ac source shall be disconnected. b) To be rated on the PV input as PVRSE, the DUT shall comply with both of the following two tests and be marked in accordance with 96.2.		N/A
93.4.2	Stand-alone or Multimode inverters may be rated as PVRSE on one or more input/outputs. a) If applicable, the ac source(s) shall be at the nominal rated ac voltage for the DUT +/- 2%. b) DUT complying with these tests for any set of terminals shall be marked according to 96.2 for those terminals.		N/A
93.5	Other equipment rated as PVRSE		N/A
93.5.1	a) To be rated on the output as PVRSE		N/A
	b) To be rated on the input as PVRSE, the DUT shall comply with both of the following two tests. 1) The output source or load is to be disconnected and simultaneously the input source shall also be disconnected. The voltage on the input terminals of the DUT shall meet the requirements of 93.1.2(a). 2) After the input terminal voltage has stabilized at the maximum rated input source voltage +0/-2% the input source shall be disconnected.		N/A
94	Functional Safety Evaluation and Environmental Stress Testing For PVRSS/PVRSE		--
94.1	Shall comply with the limits in 88.2 on its dc or ac input or output terminals upon the loss of control circuit power when tested in accordance with 94.2.		N/A
94.2	The DUT is to be connected to its rated input and output circuits, and its rated control circuit supply voltages if supplied separately. The circuit voltages shall be within +/- 2% of rated. A single fault is to be placed in the control system such that it disables the power to the PVRSS control circuit.		N/A
94.3	Additional fault testing shall be performed as identified in 92.1.7 through 92.1.9.		N/A
94.4	Equipment evaluated to this section shall have the appropriate environmental stress test applied as listed in Table 94.1 and the rapid shutdown function verified.		N/A
94.5	The method used to verify the correct function during a stress condition will depend on the PVRSS or PVRSE device being tested.		N/A
94.6	Inverters performing a rapid shutdown function on the PV input conductors and/or ac output conductors by reacting to a loss of ac grid shall be evaluated to the appropriate environmental stress tests listed in Table 94.1. The alternate test methods listed in Table 94.1 for IEEE1547/IEEE1547.1 can be used.		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
94.7	The following conditions are to be used with Table 94.1: (1)-(10)		N/A
95.1	A PVRSS system or component, used solely for the purpose of rapid shutdown, shall be rated in accordance with Table 62.1.		N/A
	Marking		N/A
96.1	Only a complete PVRSS may be marked “photovoltaic rapid shutdown system.” Only PVRSE may be labeled “photovoltaic rapid shutdown system equipment.” The term “PHOTOVOLTAIC” may be replaced with “PV.”		N/A
96.2	Only PV systems equipment that has been found to comply with the relevant PVRSS and or PVRSE requirements to perform rapid shutdown functions may be marked with the following wording or equivalent:		N/A
96.3	Equipment described in 11.2.4 and 92.1.10 shall be marked on or near each port identified with the following markings: “PVRSS Controlled Conductor Connection Port – refer to instructions for conditions of use.”		N/A
96.4	Only PVRSS and PVRSE complying with Section 93.3 may be marked as follows; “grid support interactive compatible.”		N/A
96.5	Products evaluated as PVRSS or PVRSE shall include the relevant markings of Table 62.1 and Section 63, 96.1 – 96.4 in the installation instructions required in 97.14.		N/A
96.6	For products with power supply grid support ride through, documentation shall include the minimum ride through times for each region from the testing of Sections SA9 and SA10.		N/A
97	Installation Instructions		N/A
97.1	The installation instructions provided with the product shall include all the relevant items of 97.2 – 97.14 and shall be consistent with the evaluation performed on the product.		N/A
97.2	PVRSS and PVRSE shall comply with the relevant parts of Sections 65.2 and 66.		N/A
97.3	The installation instructions shall indicate whether the equipment qualifies as a PV Rapid Shutdown System (PVRSS) or as PV Rapid Shutdown Equipment (PVRSE).		N/A
97.4	Equipment described in 11.2.4 and 92.1.10 shall include instructions to ensure correct use of equipment with other connected devices, including:		N/A
	a) The Port is not controlled, but has been evaluated for connection to controlled conductors,		N/A
	b) Electrical characteristics of the port,		N/A
	c) Characteristics (pertinent to the PVRSS system) of the conductors that can be connected to the port, and		N/A
	d) Expected behavior of the electrical circuit during PVRSS initiation.		N/A

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Clause	Requirement — Test	Result — Remark	Verdict
97.5	In relation to 65.2(d), the installation instructions shall describe the method(s) of initiating Rapid shutdown function and shall be marked in accordance with Section 690.56(C) of the NEC (NFPA 70).		N/A
97.6	The installation instructions shall instruct the installer to provide signage complying with Section 690.56(C) of the NEC (NFPA 70). The installation instructions shall state whether: a) All conductors are controlled, or		N/A
	b) Only conductors leaving the footprint of the array are controlled.		N/A
97.7	PVRSE shall have the following warning in the instruction manual:		N/A
97.8	This equipment shall be installed and operated in an environment within the ratings and limitations of the equipment as published in these installation instructions.		N/A
97.9	All PVRSS and PVRSE shall be provided with installation instructions necessary for proper installation of the system including but not limited to details such as minimum control wire size, and maximum control wire length.		N/A
97.10	For PVRSE that will be mounted behind a PV module, no portion of the PVRSE enclosure will be less than 12.7 mm (1/2 in) from the module substrate, then the instructions for installing the PVRSE shall be specific enough to assure this distance is maintained.		N/A
97.11	The installation instructions shall provide system test or commissioning procedure(s) for validation of proper PVRSS operation, including compliance with the rated rapid shutdown time limit.		N/A
97.12	Installation instructions shall have revision control and revision level shall be marked on the document.		N/A
97.13	PVRSS and PVRSE that have complied with the requirements of Section 93.3 for grid support shall be provided with installation instructions that detail that the product is compatible with grid support functions and any limitations on the grid support functionality.		N/A
97.14	PVRSS will have the following warning in the instruction manual:		N/A

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Clause	Requirement - Test	Result	Verdict
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Table 3.1	List of Critical Components				P
object/part No.	manufacturer/ trademark	type/model	technical data	standard	mark(s) of conformity ¹⁾
Refer to CDF					
1) an asterisk indicates a mark which assures the agreed level of surveillance.					

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Item #	Requirement – test	Results - Remarks					Verdict
24	TABLE: clearance and creepage distance measurements					P	
Item #	clearance cl and creepage distance dcr at/of:	U ac (Vrms)	U dc (V)	required cl (mm)	cl (mm)	required dcr (mm)	dcr (mm)
Control board							
1	Opto-coupler U33 two side	--	600	1.5	8.5	6.0	8.5
2	Opto-coupler U28 two side	--	600	1.5	8.5	6.0	8.5
3	Opto-coupler U1 two side	--	600	1.5	8.5	6.0	8.5
4	LED2 to C61 on PCB	--	600	1.5	6.1	6.0	6.1
5	CON 4 Live parts to comm.	--	600	1.5	7.4	6.0	7.4
6	CON 4 Comm. Pins to LED3	--	600	1.5	6.1	6.0	6.1
Unit							
7	Boost induction to metal base	--	600	1.5	6.3	6.0	6.3
8	Inverter induction to metal base	--	600	1.5	3.0	6.0	3.0
Main board							
9	IGBT live part surface to earthing	--	600	1.5	6.3	6.0	6.3
11	R229 to earthing on PCB	--	600	1.5	6.6	6.0	6.6
11	PV1- to earthing on PCB	--	600	1.5	8.2	6.0	8.2
12	PV2+ to earthing on PCB	--	600	1.5	8.2	6.0	8.2
13	R89 to earthing on PCB	--	600	1.5	6.7	6.0	6.7
14	R380 to earthing on PCB	--	600	1.5	6.0	6.0	6.1
15	H3, H4 to Live parts on PCB	--	600	1.5	6.1	6.0	6.1
16	L to N on PCB	240	--	1.5	4.0	2.5	4.0
17	PV- to PV+ on PCB	--	600	1.5	4.2	3.2	4.2
18	Transformer (T1) primary winding to secondary winding	--	600	1.5	6.5	6.0	6.5
Note:							
<ol style="list-style-type: none"> 1. Pollution degree II on PCB with coating, PCB IIIb. 2. UL 62109-1 clause 7.3.7.1.2 item b) DC circuit - Overvoltage II, AC circuit - Overvoltage IV. 3. UL 840 used for spacing on the printed circuit board. 4. The SPD be use for reduce the impulse voltage to 2.5kV, the clearance require has be reduced to 1.5mm reference to the UL 840. 							

=====**End of Report**=====