

CERTIFICATE OF COMPLIANCE

Certificate Number 20221130-E210376
Report Reference E210376-20221130
Issue Date 2022-11-30

Issued to: SMA Solar Technology AG
Sonnenallee 1
34266 Niestetal GERMANY

**This is to certify that
representative samples of**

STATIC INVERTERS, CONVERTERS AND
ACCESSORIES FOR USE IN INDEPENDENT POWER
SYSTEMS

Permanently-connected, utility Interactive, 3-phase inverter,
Models: SHP 125-US-21, SHP 150-US-21, SHP 165-US-
21, SHP 172-US-21 and SHP FLEX-US-21. (which are
intended for DC input from photovoltaic modules)

Have been investigated by UL in accordance with the
Standard(s) indicated on this Certificate.



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Standard(s) for Safety: UL1741 Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources.

UL 62109-1, Safety of power converters for use in photovoltaic power systems – Part 1: General requirements

IEEE 1547, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems.


IEEE 1547.1, IEEE Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.

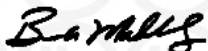
CSA C22.2 No. 62109-1 Safety of power converters for use in photovoltaic power systems - Part 1: General requirements.

CSA C22.2 No. 62109-2 Safety of power converters for use in photovoltaic power systems - Part 2: Particular requirements for inverters.

Additional Information: See the UL Online Certifications Directory at www.ul.com/database for additional information

Only those products bearing the UL Certification Mark should be considered as being covered by UL's Certification and Follow-Up Service.

The UL Recognized Component Mark generally consists of the manufacturer's identification and catalog number, model number or other product designation as specified under "Marking" for the particular Recognition as published in the appropriate UL Directory. As a supplementary means of identifying products that have been produced under UL's Component Recognition Program, UL's Recognized Component Mark: , may be used in conjunction with the required Recognized Marks. The Recognized Component Mark is required when specified in the UL Directory preceding the recognitions or under "Markings" for the individual recognitions.



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Recognized components are incomplete in certain constructional features or restricted in performance capabilities and are intended for use as components of complete equipment submitted for investigation rather than for direct separate installation in the field. The final acceptance of the component is dependent upon its installation and use in complete equipment submitted to UL LLC.

Look for the UL Certification Mark on the product.

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Permanently-connected, Grid Support Utility Interactive inverters.

This description covers the SMA Solar Technology AG Model: SHP 125-US-21, SHP 150-US-21, SHP 165-US-21, SHP 172-US-21 and SHP FLEX-US-21.
(which are intended for DC input from photovoltaic modules) inverters.

The Certificate is valid for the HP-Version V03.15.22 (FPGA V3.08.05.R) and V03.16.22 (FPGA V5.03.00.R).

USL - Evaluated to the requirements of the UL Standard for Safety of power converters for use in photovoltaic power systems – Part 1: General requirements, UL 62109-1 First Edition, Dated July 18, 2014.

Additionally evaluated to the requirements in UL 1741 Supplement SA (Second Edition, dated January 28, 2010, and revision dated February 15, 2018)– Grid Support Utility Interactive Inverters and Converters, Second Edition, dated September 7, 2016, which also fulfills the Source Requirement Documents of California Public Utilities Commission Rule 21 for grid support utility interactive inverters: the Generating Facility Interconnections of PG&E (Pacific Gas and Electric Company, Cal. P.U.C. Sheet No. 36812-E), SCE (Southern California Edison, Cal. PUC Sheet No. 60550-E) and SDG&E (San Diego Gas & Electric Company, Cal. P.U.C. Sheet No. 28143-E) and HECO SRD-UL-1741-SA-V1.1, 2017-09-22.

Additionally evaluated to the requirements in IEEE 1547 INTERCONNECTING DISTRIBUTED RESOURCES WITH ELECTRIC POWER SYSTEMS- Edition 1 - Revision Date 2014/05/16 and IEEE 1547.1 IEEE STANDARD CONFORMANCE TEST PROCEDURES FOR EQUIPMENT INTERCONNECTING DISTRIBUTED RESOURCES WITH ELECTRIC POWER SYSTEMS - Edition 1 - Revision Date 2015/03/26

Additionally evaluated to the Certification Requirement Decision dated October 22, 2019, Supplement SA sections SA17 and SA18 Subject: Grid Support Utility Interactive Interoperability Optional Functions: Prevent Enter Service and Limit Active Power (CA Rule 21, Phase 3, functions 2 and 3).

CNL - Additionally evaluated to CSA C22.2 NO. 62109-1 SAFETY OF POWER CONVERTERS FOR USE IN PHOTOVOLTAIC POWER SYSTEMS - PART 1: GENERAL REQUIREMENTS - Edition 1 - Issue Date 2016/07/01 and CSA C22.2 NO. 62109-2 SAFETY OF POWER CONVERTERS FOR



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USE IN PHOTOVOLTAIC POWER SYSTEMS - PART 2: PARTICULAR REQUIREMENTS FOR INVERTERS- Edition 1 - Issue Date 2016/07/01

The following is valid for models : SHP 125-US-21, SHP 150-US-21, SHP 165-US-21, SHP 172-US-21 and SHP FLEX-US-21 with Firmware Processor Version HP-Version V03.15.22 (FPGA V3.08.05.R) and V03.16.22 (FPGA V5.03.00.R).

Additionally Evaluated to the requirements of the Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741, Third Edition, dated September 28, 2021. Including the requirements in UL 1741 Supplement B (SB). Additionally evaluated to the Source Requirement Documents of HECO SRD V2.0.

IEEE 1547, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems.

IEEE 1547.1, IEEE Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems.

IEEE 1547-2018 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

IEEE 1547a-2020 IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces - Amendment 1: To Provide More Flexibility for Adoption of Abnormal Operating Performance Category III, Dated 2020-03-09

IEEE 1547-2018 - Errata to

IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, IEEE Standards Coordinating Committee 21, IEEE Std 1547-2018, Revision of IEEE Std 1547-2003, Correction Sheet, Dated 2018-06-04



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IEEE 1547.1-2020 IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces

IEEE 1547-2018 - Errata to

IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces, IEEE Standards Coordinating Committee 21, IEEE Std 1547-2018, Revision of IEEE Std 1547-2003, Correction Sheet, Dated 2018-06-04

This description covers the SMA Solar Technology AG Models SHP 125-US-21, SHP 150-US-21, SHP 165-US-21, SHP 172-US-21 and SHP FLEX-US-21 inverters.

USL - Evaluated to the requirements of the Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741,

Products covered by this certificate provide functionality in compliance with UL 1741 Supplement A (SA) when used in a UL Listed end product which has been evaluated by UL for its intended purpose.

Compliance testing was conducted on samples of the products according to the test methods in UL 1741 with compliant results, and product ratings were reviewed for fulfillment of the requirements in the following SRDs:



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Test Name	IEEE 1547.1-2020 (UL1741SB) Section	Fixed / Adjustable	Pass / Fail
PRIORITY OF RESPONSES	5.2	Adjustable	Pass
TEMPERATURE STABILITY	5.3	Adjustable	Pass
TEST FOR OVERVOLTAGE TRIP	5.4.2	Adjustable	Pass
TEST FOR UNDERVOLTAGE TRIP	5.4.3	Adjustable	Pass
LOW-VOLTAGE RIDE-THROUGH TESTS	5.4.4	Adjustable	Pass
TEST FOR VOLTAGE DISTURBANCES WITHIN CONTINUOUS OPERATING REGION	5.4.5	Adjustable	Pass
HIGH-VOLTAGE RIDE-THROUGH TESTS	5.4.7	Adjustable	Pass
TEST FOR OVERFREQUENCY TRIP	5.5.1	Adjustable	Pass
TEST FOR UNDERFREQUENCY TRIP	5.5.2	Adjustable	Pass
TEST FOR LOW-FREQUENCY RIDE-THROUGH	5.5.3	Adjustable	Pass
TEST FOR HIGH-FREQUENCY RIDE-THROUGH	5.5.4	Adjustable	Pass
TEST FOR RATE OF CHANGE OF FREQUENCY (ROCOF)	5.5.5	Adjustable	Pass
TEST FOR VOLTAGE PHASE-ANGLE CHANGE RIDE-THROUGH	5.5.6	Adjustable	Pass
NORMAL RAMP RATE	N/A	Adjustable	Pass
ENTER SERVICE	5.6	Adjustable	Pass
PROTECTION FROM ELECTROMAGNETIC INTERFERENCE (EMI)	5.8.1	Adjustable	Pass
SURGE WITHSTAND PERFORMANCE TEST	5.8.2	Adjustable	Pass
LIMITATION OF DC INJECTION FOR INVERTERS	5.9	Fixed	Pass



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Detailed Testing Summary (continued)			
Test Name	IEEE 1547.1-2020 (UL1741SB) Section	Fixed / Adjustable	Pass / Fail
UNINTENTIONAL ISLANDING	5.10	Adjustable	Pass
OPEN PHASE TEST	5.11	Fixed	Pass
CURRENT DISTORTION	5.12	Adjustable	Pass
LIMIT ACTIVE POWER	5.13	Adjustable	Pass
TEST FOR CONSTANT POWER FACTOR (P.F.) MODE	5.14.3	Adjustable	Pass
TEST FOR VOLTAGE-REACTIVE POWER (VOLT-VAR) MODE	5.14.4	Adjustable	Pass
TEST FOR VOLTAGE-REACTIVE POWER (VOLT-VAR) MODE (VREF TEST)	5.14.5	Adjustable	Pass
TEST FOR VOLTAGE—REACTIVE POWER (VOLT-VAR) MODE WITH AN IMBALANCED GRID	5.14.6	Adjustable	Pass
TEST FOR ACTIVE POWER-REACTIVE POWER MODE (WATT-VAR)	5.14.7	Adjustable	Pass
TEST FOR CONSTANT REACTIVE POWER (VAR) MODE	5.14.8	Adjustable	Pass
TEST FOR VOLTAGE-ACTIVE POWER (VOLT-WATT) MODE	5.14.9	Adjustable	Pass
TEST FOR VOLTAGE-ACTIVE POWER (VOLT-WATT) MODE WITH AN IMBALANCED GRID	5.14.10	Adjustable	Pass
TEST FOR FREQUENCY-DROOP (FREQUENCY-POWER OR FREQUENCY-WATT) CAPABILITY—ABOVE NOMINAL FREQUENCY	5.15.2	Adjustable	Pass
TEST FOR FREQUENCY-DROOP (FREQUENCY-POWER OR FREQUENCY-WATT) CAPABILITY—BELOW NOMINAL FREQUENCY	5.15.3	Adjustable	Pass
TEST FOR PRIORITIZATION OF DER RESPONSES	5.16.1	Adjustable	Pass
LOAD REJECTION OVERVOLTAGE (LROV) TEST	5.17.2	Adjustable	Pass



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Detailed Testing Summary (continued)

Test Name	IEEE 1547.1-2020 (UL1741SB) Section	Fixed / Adjustable	Pass / Fail
PERSISTENCE OF DER PARAMETER SETTINGS	5.19	Adjustable	Pass
INTEROPERABILITY	6	Adjustable	Pass



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Detailed Testing Summary	Test Standard(s) and Section(s)	Fixed / Adjustable	Pass / Fail
UNINTENTIONAL ISLANDING WITH GRID SUPPORT FUNCTIONS ENABLED	UL 1741 SA 8	Adjustable	Pass
HIGH VOLTAGE RIDE-THROUGH DURATION	UL 1741 SA 9.1	Adjustable	Pass
HIGH VOLTAGE RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA 9.2	Adjustable	Pass
HIGH VOLTAGE MUST TRIP CLEARING TIMES	UL 1741 SA 9.2	Adjustable	Pass
LOW VOLTAGE RIDE-THROUGH DURATION	UL 1741 SA 9.1	Adjustable	Pass
LOW VOLTAGE RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA 9.2	Adjustable	Pass
LOW VOLTAGE MUST TRIP CLEARING TIMES	UL 1741 SA 9.2	Adjustable	Pass
HIGH FREQUENCY RIDE-THROUGH DURATION	UL 1741 SA10.1	Adjustable	Pass
HIGH FREQUENCY RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA10.2	Adjustable	Pass
HIGH FREQUENCY MUST TRIP CLEARING TIMES	UL 1741 SA10.2	Adjustable	Pass
LOW FREQUENCY RIDE-THROUGH DURATION	UL 1741 SA10.1	Adjustable	Pass
LOW FREQUENCY RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA10.2	Adjustable	Pass
LOW FREQUENCY MUST TRIP CLEARING TIMES	UL 1741 SA10.2	Adjustable	Pass
NORMAL RAMP RATE	UL 1741 SA 11.2	Adjustable	Pass
"SOFT START" RAMP RATE	UL 1741 SA 11.4	Adjustable	Pass
SPECIFIED POWER FACTOR	UL 1741 SA 12	Adjustable	Pass
VOLT/VAR MODE (Q(V))	UL 1741 SA 13	Adjustable	Pass
FREQUENCY-WATT (FW)	UL 1741 SA 14	Adjustable	Pass
VOLT-WATT (VW)	UL 1741 SA 15	Adjustable	Pass
DISABLE PERMIT SERVICE	UL 1741 SA 17	Adjustable	Pass



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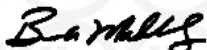
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LIMIT ACTIVE POWER	UL 1741 SA 18	Adjustable	Pass
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UL1741 SA Boundary	IEEE 1547.1-2020 Shall Trip
High Voltage 3 (HV3)	Not applicable
High Voltage 2 (HV2)	Over Voltage 2 (OV2)
High Voltage 1 (HV1)	Over Voltage 1 (OV1)
Low Voltage 1 (LV1)	Under Voltage 1 (UV1)
Low Voltage 2 (LV2)	Under Voltage 2 (UV2)
Low Voltage 3 (LV3)	Not applicable
Low Voltage 4 (LV4)	Not applicable

Frequency regions comparison between UL1741SA and IEEE1547.1-2020:

UL1741 SA Boundary	IEEE 1547.1-2020 Shall Trip
High Frequency 3 (HF3)	Not applicable
High Frequency 2 (HF2)	Over Frequency 2 (OF2)
High Frequency 1 (HF1)	Over Frequency 1 (OF1)
Low Frequency 1 (LF1)	Under Frequency 1 (UF1)
Low Frequency 2 (LF2)	Under Frequency 2 (UF2)
Low Frequency 3 (LF3)	Not applicable



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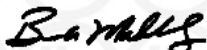
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Inverter Firmware Version:		
UL 1998	Date	Version/Revision
Compliant	2022-09-07	3.15.22 (FPGA V3.08.05.R)
Compliant	2022-09-07	3.16.22 (FPGA V5.03.00.R)

Inverter Ratings - Output	All models, with individual differences as shown
Output phase configuration	3-Phase Delta
Nominal (line to line) output voltage V ac	480 / 600 / 630 / 660
Operating voltage range V ac	422 - 759
Line Synchronization Characteristics	Method 2
Normal out frequency Hz	60
Rated output current (A ac)	151
Rated output power, (kW)	125 / 150 / 165 / 172
Max. Branch Circuit overcurrent protection (A ac)	250
Maximum Air Ambient (°C)	60

Other ratings:	
Max. utility backfeed current to PV input (A)	0A
Line Synchronization Characteristics / In-rush current	Method 2
Limits of accuracy of voltage measurement	2 %
Limits of accuracy of frequency measurement	+/- 0.1 Hz
Manufacturers stated accuracy of time response for voltage trips	+/- 0.1 % at nominal trip time
Manufacturers stated accuracy of time response for frequency trips	+/- 0.1 % at nominal trip time
*Enclosure Ratings	4x

INTERCONNECTION INTEGRITY TEST CATEGORIES:	
C62.42.2 Ring Wave Surge Category	B / 5.87 kV / 0.5 kA
C62.42.2 Combination Wave Surge Category	B / 6.27 kV / 3.06 kA
C37.90.1 RF Immunity - compliance	Yes
C37.90.2 Communication circuit - compliance	Yes



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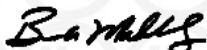


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<u>Magnitude and time Limits</u> - Utility interconnection voltage magnitude limits, Ride Through time limits and trip times:						
Nominal voltage	/ Single/Split phase / Single/Split phase					
UL 1741 SA9:	Magnitudes (% of nominal)		Ride Through (Seconds) (+)		Must Trip (Seconds)	
Boundary designation (++)	Min	Max	Min	Max	Min	Max
HV3	79.42	120.00	1	30	0.1	59
HV2	79.42	120	1	30	0.1	59
HV1	79.42	110	1	30	0.1	60
LV1	37.36	100	1	30	0.1	60
LV2	37.36	100	1	30	0.1	60
LV3	37.36	100	1	30	0.1	60

<u>Magnitude and time Limits</u> - Utility interconnection Frequency magnitude limits, Ride Through time limits and trip times:						
Nominal Frequency	60 Hz					
UL 1741 SA10:	Magnitudes (Frequency)		Ride Through (Seconds) (+)		Must Trip (Seconds)	
Boundary designation	Min	Max	Min	Max	Min	Max
HF3	-	-	-	-	-	-
HF2	50.0	66.0	10	999.0	0.1	1000.0
HF1	50.0	66.0	10	999.0	0.1	1000.0
LF1	44.0	60.0	10	999.0	0.1	1000.0
LF2	44.0	60.0	10	999.0	0.1	1000.0
LF3	-	-	-	-	-	-



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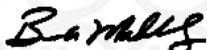
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Frequency-Droop Category III:			
Nominal Frequency	60Hz		
Parameter	Default Settings	Ranges of allowable Settings	
		Min	Max
db _{OF} , db _{UF} (Hz)	0.036	0.017	1.0
k _{OF} , k _{UF}	0.05	0.02	0.05
T _{response} (small signal) (s)	5.0	0.20	10.0

SA11 Ramp Rate test ratings (RR)		
Minimum normal ramp-up rate	0.2	%I _{rated} /SEC
Maximum normal ramp-up rate	20	%I _{rated} /SEC
Minimum soft start ramp-up rate	0.1	%I _{rated} /SEC
Maximum soft start ramp-up rate	20	%I _{rated} /SEC

SA12 SPF Specified Power Factor (INV3)	
Minimum Inductive (Underexcited) Power Factor (<0)	-0.8
Minimum Capacitive (Overexcited) Power Factor (>0)	+0.8

SA13 Volt/Var Mode (VV) extent of curve range settings				
		Q _{max} Values - Maximums	Q _{min} Values - Minimums	Units
Reactive power production setting	Q ₁	60	15	%VAR
Reactive power absorption setting at the left edge of the deadband	Q ₂	0	0	%VAR
Reactive power absorption setting at the right edge of the deadband	Q ₃	0	0	%VAR
Reactive power absorption setting	Q ₄	-60	-15	%VAR



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Functional in the following priority modes: [] active power priority [X] reactive power priority (RPP)

		Maximum	Minimum	Units
The voltage at Q ₁	V ₁	97.83	92.00	%Vnom
The voltage at Q ₂	V ₂	100.00	96.00	%Vnom
The voltage at Q ₃	V ₃	104.00	100.00	%Vnom
The voltage at Q ₄	V ₄	108.00	102.17	%Vnom

SA14 Frequency-Watt (FW) extent of curve range settings

Settings	Frequency		Power level	
	Low end of the adjustment range of the start of the curtailment function	F _{start_min}	60.1	100 %
High end of the adjustment range of the start of the curtailment function	F _{start_max}	62.0	100 %	%Watts
Low end of the adjustment range of the endpoint of the curtailment function	F _{stop_min}	60.78	0 %	%Watts
High end of the adjustment range of the endpoint of the curtailment function	F _{stop_max}	65.5	0 %	%Watts

SA15 Volt-Watt (VW) extent of curve range settings

Settings	Volts		Power level	
	Low end of the adjustment range of the start of the curtailment function	V _{start_min}	103 %	100%
High end of the adjustment range of the start of the curtailment function	V _{start_max}	103 %	100 %	%Watts
Low end of the adjustment range of the endpoint of the curtailment function	V _{stop_min}	106%	0 %	%Watts
High end of the adjustment range of the endpoint of the curtailment function	V _{stop_max}	110 %	0 %	%Watts



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