

# CERTIFICATE OF COMPLIANCE

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


**Issued to:** SMA Solar Technology AG  
Sonnallee 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.

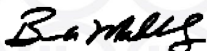
CSA C22.2 No. 62109-1 Safety of power converters for use in photovoltaic power systems - Part 1: General requirements.

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](http://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).

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



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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).

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

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

This description covers the SMA Solar Technology AG Models STP 33-US-41, STP 50-US-41, STP 62-US-41 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:

See also Appendix A for UL 1741 Supplement A (SA)

<b>Certified functions. Cross Reference table – UL 1741 SA to SRD</b>	<b>Source Requirement Document(s)</b>	<b>UL 1741 SA Test Section</b>	<b>Comparable IEEE 1547.1-2020 and UL1741 SB Test Section</b>	<b>Report Date</b>
ANTI-ISLANDING PROTECTION - UNINTENTIONAL ISLANDING WITH GRID SUPPORT FUNCTIONS ENABLED	Electric Rule No. 21 Hh.1a	SA 8	5.10.2	2019- 03-28
LOW/HIGH VOLTAGE	Electric Rule No. 21 Table	SA 9	5.4.4, 5.4.7	2019- 03-28



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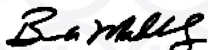
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RIDETHROUGH	Hh.1			
LOW/HIGH FREQUENCY RIDETHROUGH	Electric Rule No. 21 Table Hh.2	SA10	5.5.3, 5.5.4	2019-03-28
RAMP RATES	Electric Rule No. 21 Hh.2k	UL 1741 SA11	N/A	2019-03-28
RECONNECT BY "SOFT START"	Electric Rule No. 21 Hh.2k	UL 1741 SA11	5.6	2019-03-28
SPECIFIED POWER FACTOR	Electric Rule No. 21 Hh.2i	UL 1741 SA12	5.14.3	2019-03-28
DYNAMIC VOLT/VAR OPERATIONS	Electric Rule No. 21 Hh.2j	UL 1741 SA13	5.14.4	2019-03-28
FREQUENCYWATT	Electric Rule No. 21 Hh.2l	UL 1741 SA14	5.15.2	2019-03-28
VOLT-WATT	Electric Rule No. 21 Hh.2.m	UL 1741 SA15	5.14.9	2019-03-28
DISABLE PERMIT SERVICE	Electric Rule No. 21 Hh.8.a	UL 1741 SA 17	5.6	2019-12-16
LIMIT ACTIVE POWER	Electric Rule No. 21 Hh.8.a	UL 1741 SA 18	5.13	2019-12-16

For the purpose of Grid Support Interactive evaluations, this table provides options to use tests from either the UL 1741 SA or IEEE 1547.1 2020 and UL1741SB.

a IEEE 1547-2018 and IEEE 1547.1-2020 do not have a requirement for, or test equivalent to, the UL 1741 SA Normal Ramp Rate which is presently a local requirement per California Rule 21 and/or Hawaii 14H which both require compliance with the Normal Ramp Rate test of SA11.2.

Testing conducted to the requirements of UL 1741 SA corresponds to the minimum requirements for CA Rule 21, 2015. Testing conducted to the requirements of UL 1741 SB corresponds to the minimum requirements for CA Rule 21, 2020 (Including applicable requirements from AL 4032-E (SDGE), AL 4824-E-A (SCE), AL 6635-E (PG&E)). An enumeration of functions tested, including complete ratings, and available certified settings for the Grid Support functions, are recorded in



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the appendix to this document. Test data and detailed results of compliance testing are retained in the complete UL Report for this product.

See also Appendix B: Grid Support Utility Interactive Inverter Worksheet

(+)	Grid Support Function	Source Requirement Document(s)	Test Standard(s) and Section(s)	Comparable IEEE 1547.1-2020 and UL1741 SB Test Section	NRTL Certified Date
	LOW/HIGH VOLTAGE RIDE-THROUGH	SRD 14H V1.1: Part II.C. Table 4 HECO SRD V2.0	UL 1741 SA 9	5.4.4, 5.4.7	2018-11-08
	LOW/HIGH FREQUENCY RIDE-THROUGH	SRD 14H V1.1: Part II.D.1 Table 5 HECO SRD V2.0	UL 1741 SA 10	5.5.3, 5.5.4	2018-11-08
	RAMP RATES	SRD 14H V1.1: Part II.G.1 HECO SRD V2.0	UL 1741 SA 11.2	N/A	2018-11-08
	RECONNECT BY "SOFT START"	SRD 14H V1.1: Part II.G.2 HECO SRD V2.0	UL 1741 SA 11.4	5.6	2018-11-08
	SPECIFIED POWER FACTOR	SRD 14H V1.1: Part II.A.1 HECO SRD V2.0	UL 1741 SA 12	5.14.3	2018-11-08
	DYNAMIC VOLT/VAR OPERATIONS	SRD 14H V1.1: Part II.A.2 Table 2, Figure 2 HECO SRD V2.0	UL 1741 SA 13	5.14.4	2018-11-08
	FREQUENCY-WATT	SRD 14H V1.1: Part	UL 1741 SA 14	5.15.2	2018-11-08



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	II.F Table 7			
	HECO SRD V2.0			
VOLT-WATT	SRD 14H V1.1: Part II.B Table 3, Figure 3	UL 1741 SA 15	5.14.9	2018-11-08
	HECO SRD V2.0			
Anti-Islanding	N/A	UL 1741 SA8	5.10.2	2018-11-08

(+) – Self Certification



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Detailed Testing Summary	Test Standard(s) and Section(s)	Comparable IEEE 1547.1-2020 and UL1741 SB Test Section	Fixed / Adjustable	Pass / Fail
UNINTENTIONAL ISLANDING WITH GRID SUPPORT FUNCTIONS ENABLED	UL 1741 SA 8	5.10.2	Adjustable	Pass
HIGH VOLTAGE RIDE-THROUGH DURATION	UL 1741 SA 9.1	5.4.7	Adjustable	Pass
HIGH VOLTAGE RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA 9.2	5.4.7	Adjustable	Pass
HIGH VOLTAGE MUST TRIP CLEARING TIMES	UL 1741 SA 9.2	5.4.7	Adjustable	Pass
LOW VOLTAGE RIDE-THROUGH DURATION	UL 1741 SA 9.1	5.4.4	Adjustable	Pass
LOW VOLTAGE RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA 9.2	5.4.4	Adjustable	Pass
LOW VOLTAGE MUST TRIP CLEARING TIMES	UL 1741 SA 9.2	5.4.4	Adjustable	Pass
HIGH FREQUENCY RIDE-THROUGH DURATION	UL 1741 SA10.1	5.5.4	Adjustable	Pass
HIGH FREQUENCY RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA10.2	5.5.4	Adjustable	Pass
HIGH FREQUENCY MUST TRIP CLEARING TIMES	UL 1741 SA10.2	5.5.4	Adjustable	Pass
LOW FREQUENCY RIDE-THROUGH DURATION	UL 1741 SA10.1	5.5.3	Adjustable	Pass
LOW FREQUENCY RIDE-THROUGH / MUST TRIP MAGNITUDES	UL 1741 SA10.2	5.5.3	Adjustable	Pass
LOW FREQUENCY MUST TRIP CLEARING TIMES	UL 1741 SA10.2	5.5.3	Adjustable	Pass
NORMAL RAMP RATE	UL 1741 SA 11.2	N/A	Adjustable	Pass
"SOFT START" RAMP RATE	UL 1741 SA 11.4	5.6	Adjustable	Pass
SPECIFIED POWER FACTOR	UL 1741 SA 12	5.14.3	Adjustable	Pass
VOLT/VAR MODE (Q(V))	UL 1741 SA 13	5.14.4	Adjustable	Pass
FREQUENCY-WATT (FW)	UL 1741 SA 14	5.15.2	Adjustable	Pass



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VOLT-WATT (VW)	UL 1741 SA 15	5.14.9	Adjustable	Pass
DISABLE PERMIT SERVICE	UL 1741 SA 17	5.6	Adjustable	Pass
LIMIT ACTIVE POWER	UL 1741 SA 18	5.13	Adjustable	Pass

**Voltage regions equivalencies between UL1741SA and IEEE1547.1-2020/UL1741SB:**

<b>UL1741 SA Boundary</b>	<b>IEEE 1547.1-2020 Shall Trip</b>
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:**

<b>UL1741 SA Boundary</b>	<b>IEEE 1547.1-2020 Shall Trip</b>
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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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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<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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Frequency-Droop Category III:			
Nominal Frequency	60Hz		
Parameter	Default Settings	Ranges of allowable Settings	
		Min	Max
db <sub>OF</sub> , db <sub>UF</sub> (Hz)	0.036	0.017	1.0
k <sub>OF</sub> , k <sub>UF</sub>	0.05	0.02	0.05
T <sub>response (small signal)</sub> (s)	5.0	0.20	10.0

SA11 Ramp Rate test ratings (RR)		
Minimum normal ramp-up rate	0.2	%I <sub>rated</sub> /SEC
Maximum normal ramp-up rate	20	%I <sub>rated</sub> /SEC
Minimum soft start ramp-up rate	0.1	%I <sub>rated</sub> /SEC
Maximum soft start ramp-up rate	20	%I <sub>rated</sub> /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 <sub>max</sub> Values - Maximums	Q <sub>min</sub> Values - Minimums	Units
Reactive power production setting	Q <sub>1</sub>	60	15	%VAR
Reactive power absorption setting at the left edge of the deadband	Q <sub>2</sub>	0	0	%VAR
Reactive power absorption setting at the right edge of the deadband	Q <sub>3</sub>	0	0	%VAR
Reactive power absorption setting	Q <sub>4</sub>	-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 <sub>1</sub>	V <sub>1</sub>	97.83	92.00	%Vnom
The voltage at Q <sub>2</sub>	V <sub>2</sub>	100.00	96.00	%Vnom
The voltage at Q <sub>3</sub>	V <sub>3</sub>	104.00	100.00	%Vnom
The voltage at Q <sub>4</sub>	V <sub>4</sub>	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 <sub>start_min</sub>	60.1	100 %
High end of the adjustment range of the start of the curtailment function	F <sub>start_max</sub>	62.0	100 %	%Watts
Low end of the adjustment range of the endpoint of the curtailment function	F <sub>stop_min</sub>	60.78	0 %	%Watts
High end of the adjustment range of the endpoint of the curtailment function	F <sub>stop_max</sub>	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 <sub>start_min</sub>	103 %	100%
High end of the adjustment range of the start of the curtailment function	V <sub>start_max</sub>	103 %	100 %	%Watts
Low end of the adjustment range of the endpoint of the curtailment function	V <sub>stop_min</sub>	106%	0 %	%Watts
High end of the adjustment range of the endpoint of the curtailment function	V <sub>stop_max</sub>	110 %	0 %	%Watts



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