CERTIFICATE OF COMPLIANCE

Certificate Number	20210607-E341165
Report Reference	E341165-20210607
Issue Date	2022-01-14
Issued to:	Enphase Energy Inc 1420 N. McDowell Blvd. Petaluma, CA 94954-6515
This is to certify that representative samples of	Grid Support Utility Interactive Inverter Model IQ8D-72-E-US
	Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.
Standard(s) for Safety:	UL 1741, Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741, Second Edition, dated January 28, 2010, with revisions through September 16, 2020. Including the requirements in UL 1741 Supplement SA, sections as noted in the Technical considerations. IEEE 1547-2003, IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems. IEEE 1547.1-2005, IEEE Standard for Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems. CSA C22.2 No. 107.1, General Use Power Supplies, Edition 3, Issue Date 09/2001
Additional Information:	See the UL Online Certifications Directory at www.ul.com/database for additional information

This *Certificate of Compliance* is provided as a courtesy to help our customers communicate product compliance information, as documented in our UL Follow-Up Services procedure. This Certificate of Compliance does not provide authorization to apply the UL Mark. Only the UL Follow-Up Services Procedure provides authorization to apply the UL Mark.

Only those products bearing the UL Mark shall be considered as being UL Certified and covered under UL's Follow-Up Services. Look for the UL Certification Mark on the product.

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Components 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 it's intended purpose. Compliance testing was conducted on samples of the products according to the test methods in the following sections of UL 1741 with compliant results:

Certified functions. Cross Reference table – UL 1741 SA to SRD	Source Requirement Document(s)	Test Standard(s) and Section(s)	Report Date
ANTI-ISLANDING PROTECTION - UNINTENTIONAL ISLANDING WITH GRID SUPPORT FUNCTIONS ENABLED	Electric Rule No. 21 Hh.1a	UL 1741 SA 8	2021-06-07
LOW/HIGH VOLTAGE RIDE THROUGH	Electric Rule No. 21 Table Hh.1	UL 1741 SA 9	2021-06-07
LOW/HIGH FREQUENCY RIDE THROUGH	Electric Rule No. 21 Table Hh.2	UL 1741 SA10	2021-06-07
RAMP RATES	Electric Rule No. 21 Table Hh.2k	UL 1741 SA 11	2021-06-07
RECONNECT BY "SOFT START"	Electric Rule No. 21 Hh.2k	UL 1741 SA 11	2021-06-07
SPECIFIED POWER FACTOR	Electric Rule No. 21 Hh.2i	UL 1741 SA 12	2021-06-07
DYNAMIC VOLT/VAR OPERATIONS	Electric Rule No. 21 Hh.2J	UL 1741 SA 13	2021-06-07
FREQUENCY-WATT	Electric Rule No. 21 Hh.2.L	UL 1741 SA 14	2021-06-07
VOLT-WATT	Electric Rule No. 21 Hh.2.m	UL 1741 SA 15	2021-06-07
DISABLE PERMIT SERVICE	Electric Rule No. 21 Hh.8.a	UL 1741 SA 17	2021-06-07
LIMIT ACTIVE POWER	Electric Rule No. 21 Hh.8.a	UL 1741 SA 18	2021-06-07

Testing conducted to the requirements of UL 1741 SA corresponds to the minimum requirements for CA Rule 21, 2015. An enumeration of functions tested, including complete ratings, and available certified settings for the Grid Support functions, are recorded in the appendix to this document. Test data and detailed results of compliance testing are retained in the complete UL Report for this product.

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Report Reference E341165-20210607
Issue Date 2022-01-14

Appendix

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 SA17	--	Pass
LIMIT ACTIVE POWER	UL 1741 SA18	Adjustable	Pass

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Inverter Firmware Version:		
UL 1998 (grid support)	Date	Version/Revision
YES	2021-05-21	v2.27.03
YES	2022-01-10	v2.40.01

Inverter Ratings - Output	
Output phase configuration	3 Phase, 4 Wire
Nominal (line to line) output voltage (V ac)	208/120Y
Operating voltage range (V ac)	208/120Y
Normal out frequency (Hz)	60
Rated output current (A ac)	3
Rated output power, (kW)	633

Other ratings:	
Max. output fault current (A) / duration (ms)	5.32 A / 1.6 ms
Max. utility backfeed current to PV input (A)	0.002
Line Synchronization Characteristics / In-rush current	Method 2 / 0.490
Enclosure Ratings	UL Type 6
Max. Branch Circuit overcurrent protection (A ac)	20
Maximum Air Ambient (°C)	60

INTERCONNECTION INTEGRITY TEST CATEGORIES:	
C62.42.2 Ring Wave Surge Category	B
C62.42.2 Combination Wave Surge Category	B
C37.90.1 RF Immunity - compliance	Yes
C37.90.2 Communication circuit - compliance	N/A

Products Listed on this certificate have been tested and complied with the requirements in UL 1741 SA8 - *UNINTENTIONAL ISLANDING WITH GRID SUPPORT FUNCTIONS ENABLED*

Summary of SA8 - *UNINTENTIONAL ISLANDING* testing results			
	100%	66%	33%
Maximum Clearing time (ms)	84	210	247
Minimum Clearing time (ms)	58	60	63

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Products Listed on this certificate have been tested and complied with the Must Trip and Ridethrough limits within the stated +/- MSA limits.

Manufacturers stated accuracy of Voltage measurement L-L	*MSAv L-L*	1.00%	%Vnom
Manufacturers stated accuracy of Voltage measurement L-N	*MSAv L-N*	1.00%	%Vnom
Manufacturer's stated accuracy of time response (for Voltage trips) stated in percent, with fixed minimum limits	% based limits		
	0.033	Minimum accuracy (sec)	
	5.000	Time setting below which minimum accuracy applies (Sec)	
	1.00%	Percent (%) accuracy above minimum time setting.	

Magnitude and time Limits - Utility interconnection voltage magnitude limits, Ride Through time limits and trip times:

Nominal voltage	Single / Split phase					
UL 1741 SA9:	Magnitudes (% of nominal)		Ride Through (Seconds) (+)		Must Trip (Seconds)	
Boundary designation (++)	Min	Max	Min	Max	Min	Max
HV3	106%	122%	0.000	0.000	0.100	0.500
HV2	104%	120%	0.300	19.800	0.160	20.000
HV1	102%	120%	0.800	299.800	1.000	300.000
LV1	70%	98%	0.300	299.800	0.500	300.000
LV2	50%	96%	0.100	149.800	0.200	150.000
LV3	48%	94%	0.600	29.800	0.100	30.000
LV4	0%	0%	0.000	0.000	0.000	0.000

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Report Reference	E341165-20210607
Issue Date	2022-01-14

Products Listed on this certificate have been tested and complied with the Must Trip and Ridethrough limits within the stated +/- MSA limits.

Manufacturers stated accuracy of frequency measurement	*MSA Hz*	0.10	Hz
Manufacturer's stated accuracy of time response (for Frequency trips) stated in percent, with fixed minimum limits	% based limits		
	0.033	Minimum accuracy (sec)	
	5.000	Time setting below which minimum accuracy applies (Sec)	
	1.00%	Percent (%) accuracy above minimum time setting.	

Magnitude and time Limits - 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	0.00	0.00	0.000	0.000	0.000	0.000
HF2	60.10	66.00	0.000	0.000	0.100	1000.0
HF1	60.10	66.00	0.3	999.0	0.5	1000.0
LF1	50.00	59.90	0.3	999.0	0.5	1000.0
LF2	49.90	57.00	0.000	0.000	0.100	1000.0
LF3	0.00	0.00	0.000	0.000	0.000	0.000

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Products Listed on this certificate have been tested and complied with the Normal and Soft Start Ramp rate requirements.

SA11 Ramp Rate test ratings (RR/SSRR)		
Minimum **normal** ramp-up rate	1.00%	%Irated/SEC
Maximum **normal** ramp-up rate	100.0%	%Irated/SEC
Minimum **soft start** ramp-up rate	0.10%	%Irated /SEC
Maximum **soft start** ramp-up rate	100.0%	%Irated /SEC

Products Listed on this certificate have been tested and complied with the tests for verification of adjustable power factor.

SA12 SPF Specified Power Factor (INV3)	
Minimum Inductive (Underexcited) Power Factor (<0)	-85.00%
Minimum Capacitive (Overexcited) Power Factor (>0)	85.00%

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Products Listed on this certificate have been tested and complied with the tests for verification of Volt/Var performance across their rated range of adjustment.

SA13 Volt/Var Mode (VV) extent of curve range settings				
Reactive Power Settings		Qmax Values - Minimums	Qmin Values - Maximums	Units
Reactive power production setting	Q_1	0.00	0.53	PU VAR
Reactive power absorption setting at the left edge of the deadband	Q_2	-0.53	0.53	PU VAR
Reactive power absorption setting at the right edge of the deadband	Q_3	-0.53	0.53	PU VAR
Reactive power absorption setting	Q_4	-0.53	0.00	PU VAR
Voltage Settings		V - Minimum	V - Maximum	Units
The voltage at Q_1	V_1	0.80	0.98	%Vnom
The voltage at Q_2	V_2	0.90	1.00	%Vnom
The voltage at Q_3	V_3	1.00	1.10	%Vnom
The voltage at Q_4	V_4	1.02	1.19	%Vnom

Products Listed on this certificate have been tested and complied with the tests for verification of Frequency-Watt performance across their rated range of adjustment.

SA14 Frequency-Watt (FW) extent of curve range settings				
Curtailment function Settings		Over Frequency	Under Frequency	Units
Low end of the adjustment range	F_{start_min}	60.017	58.000	Hz
High end of the adjustment range	F_{start_max}	62.000	60.000	Hz
Minimum slope of frequency droop	HIGH_kof-min	0.017	0.008	f_{PU}/W_{PU} change
Maximum slope of frequency droop	HIGH_kof-max	0.083	0.083	f_{PU}/W_{PU} change

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Products Listed on this certificate have been tested and complied with the tests for verification of Volt-Watt performance across their rated range of adjustment.

SA15 Volt-Watt (VW) extent of curve range settings			
Curtailment function Settings			Units
Low end of the adjustment range (begin function)	V_{start_min}	1.01	PU (Vnom)
High end of the adjustment range (begin function)	V_{start_max}	1.09	PU (Vnom)
Low end of the adjustment range (end function)	V_{stop_min}	1.03	PU (Vnom)
High end of the adjustment range (end function)	V_{stop_max}	1.15	PU (Vnom)

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Harmonics measurements at 33%, 66% and 100% of rated output

Odd Orders, Measured maximums. Harmonic levels across all phases (Amperes)				Compliance Limit
33%	66%	100%	ORDER	(Amperes)
0.0242	0.0341	0.0369	I-THD	0.1520
1.00871	2.03977	3.03870	1	3.04000
0.00367	0.02316	0.02949	3	0.12160
0.00489	0.01013	0.00601	5	0.12160
0.00939	0.00518	0.00651	7	0.12160
0.00067	0.00377	0.00245	9	0.12160
0.00999	0.00563	0.00803	11	0.06080
0.00339	0.00516	0.00491	13	0.06080
0.00207	0.00396	0.00083	15	0.06080
0.00569	0.00311	0.00317	17	0.04560
0.00500	0.00549	0.00377	19	0.04560
0.00124	0.00235	0.00144	21	0.04560
0.00452	0.00713	0.00246	23	0.01824
0.00605	0.00566	0.00374	25	0.01824
0.00215	0.00367	0.00171	27	0.01824
0.00396	0.00376	0.00389	29	0.01824
0.00342	0.00230	0.00419	31	0.01824
0.00246	0.00087	0.00358	33	0.01824
0.00396	0.00218	0.00456	35	0.00912
0.00328	0.00300	0.00426	37	0.00912

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Harmonics measurements at 33%, 66% and 100% of rated output – Cont'd.

Even Orders, Measured maximums. Harmonic levels across all phases (Amperes)				Compliance Limit
33%	66%	100%	ORDER	(Amperes)
0.00381	0.00489	0.00483	2	0.03040
0.00390	0.00458	0.00480	4	0.03040
0.00324	0.00403	0.00271	6	0.03040
0.00379	0.00432	0.00355	8	0.03040
0.00311	0.00334	0.00337	10	0.03040
0.00291	0.00368	0.00270	12	0.01520
0.00326	0.00335	0.00355	14	0.01520
0.00265	0.00280	0.00244	16	0.01520
0.00219	0.00270	0.00200	18	0.01140
0.00255	0.00260	0.00273	20	0.01140
0.00170	0.00195	0.00170	22	0.01140
0.00136	0.00166	0.00123	24	0.00456
0.00191	0.00166	0.00196	26	0.00456
0.00077	0.00092	0.00094	28	0.00456
0.00082	0.00110	0.00092	30	0.00456
0.00125	0.00095	0.00140	32	0.00456
0.00028	0.00004	0.00061	34	0.00456
0.00053	0.00048	0.00067	36	0.00228
0.00069	0.00026	0.00091	38	0.00228
0.00054	0.00026	0.00076	40	0.00228

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DC Injection:

DC injection measurements at 33%, 66% and 100% of rated output

Calculated Limit in Amperes (DC).	Output level for test	Measured Values - DC current on AC line (ALL values in Amperes)		
		Phase A	Phase B	Phase C
0.015	33%	0.00294	0.00003	0.00001
0.015	66%	0.00278	0.00063	0.00003
0.015	100%	0.00484	0.00206	0.00007

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