## Tesla, Inc. 3500 Deer Creek Road Palo Alto, California, 94304, U.S.A.



Product: AC Powerwall, Model #: 1092170

# **Manufacturers Declaration of Conformity**

Tesla Inc. certify and declare under their sole responsibility that the above-referenced product(s), is in conformity with the following specifications applied:

G99 Issue 1 – Amendment 3

Engineering Recommendation G99 Issue 1 - Amendment 3 16 May 2018 – Requirements for the connection of generation equipment in parallel with public distribution networks on or after 27 April 2019

Products must be installed and operated with reference to the instructions in the Product Manual

The following Notified Body; Intertek 3933 US Route 11, Cortland, New York, 13045, USA has issued a positive Statement of Opinion based on test report number 103852302CRT-001a.

J. M.S.		
	06/19/2019	(mm/dd/yyyy)
Jonathan McCormick	Date	

Sr. Manager, Regulatory Compliance Engineering





Company:	Tesla	Test Engineer:	Gaurav Joglekar	hodokos	01/16/2019- 02/21/2019	
Project #	G103852302	Project Engineer	Dipesh Patel	Pipesh	2/25/2019	
Model:	1092170-xx-y	Reviewer:	Steven Pasternack	the Partie	2/28/2019	
Product Name:	AC Powerwall					
Standard(s):  G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May 2019						

## Form A2-3: Compliance Verification Report for Inverter Connected Power Generating Modules

This form should be used by the **Manufacturer** to demonstrate and declare compliance with the requirements of EREC G99. The form can be used in a variety of ways as detailed below:

#### 1. To obtain Fully Type Tested status

The **Manufacturer** can use this form to obtain **Fully Type Tested** status for a **Power Generating Module** by registering this completed form with the Energy Networks Association (ENA) Type Test Verification Report Register.

### 2. To obtain Type Tested status for a product

This form can be used by the **Manufacturer** to obtain **Type Tested** status for a product which is used in a **Power Generating Module** by registering this form with the relevant parts completed with the Energy Networks Association (ENA) Type Test Verification Report Register.

#### 3. One-off Installation

This form can be used by the **Manufacturer** or **Installer** to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99. This form must be submitted to the **DNO** as part of the application.

A combination of (2) and (3) can be used as required, together with Form A2-4 where compliance of the **Interface Protection** is to be demonstrated on site.

#### Note:

Within this Form A2-3 the term **Power Park Module** will be used but its meaning can be interpreted within Form A2-3 to mean **Power Park Module**, **Generating Unit or Inverter** as appropriate for the context. However, note that compliance must be demonstrated at the **Power Park Module** level.

If the **Power Generating Module** is **Fully Type Tested** and registered with the Energy Networks Association (ENA) Type Test Verification Report Register, the Installation Document (Form A3-1 or A3-2) should include the **Manufacturer's** reference number (the Product ID), and this form does not need to be submitted.

Where the **Power Generating Module** is not registered with the ENA Type Test Verification Report Register or is not **Fully Type Tested** this form (all or in parts as applicable) needs to be completed and provided to the **DNO**, to confirm that the **Power Generating Module** has been tested to satisfy all or part of the requirements of this EREC G99.

PGM technology Inverter with Battery Storage		orage		
Manufacturer name		Tesla Inc		
		3500 Deer Creek		
Address		Palo Alto, CA 94304		
Tel	(650) 391-7144	Web site www.tesla.com		
E:mail	jmccormick@tesla.com			
Registered Capacity		5kW		



Company:	Tesla	Test Engineer:	Gaurav Joglekar	hodopos	01/16/2019- 02/21/2019
Project #	G103852302	Project Engineer	Dipesh Patel	Dipesh	2/25/2019
Model:	1092170-xx-y	Reviewer:	Steven Pasternack	the Porter	2/28/2019
Product Name:	AC Powerwall				
Standard(s):  G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May 2019					

There are four options for Testing: (1) **Fully Type Tested**, (2) Partially **Type Tested**, (3) one-off installation, (4) tested on site at time of commissioning. The check box below indicates which tests in this Form have been completed for each of the options. With the exception of **Fully Type Tested PGMs** tests marked with \* may be carried out at the time of commissioning (Form A4).

Tested option:	1. Fully Type Tested	2. Partially Type Tested	3. One-off Man. Info.	4. Tested on Site at time of Commiss ion-ing
Fully Type Tested - all tests detailed below completed and evidence attached to this submission	Yes	N/A	N/A	N/A
1. Operating Range	N/A	N/A	N/A	N/A
2. PQ – Harmonics		N/A	N/A	N/A
3. PQ - Voltage Fluctuation and Flicker		N/A	N/A	N/A
4. PQ – DC Injection ( <b>Power Park Modules</b> only)		N/A	N/A	N/A
5. Power Factor (PF)*		N/A	N/A	N/A
6. Frequency protection trip and ride through tests*		N/A	N/A	N/A
7. Voltage protection trip and ride through tests*		N/A	N/A	N/A
8. Protection – Loss of Mains Test*, Vector Shift and RoCoF Stability Test*		N/A	N/A	N/A
9. <b>LFSM-O</b> Test*		N/A	N/A	N/A
10. Protection – Reconnection Timer*		N/A	N/A	N/A
11. Fault Level Contribution		N/A	N/A	N/A
12. Self-monitoring Solid State Switch		N/A	N/A	N/A
13. Wiring functional tests if required by para 15.2.1 (attach relevant schedule of tests)*		N/A	N/A	N/A
14. Logic Interface (input port)*		N/A	N/A	N/A

<sup>\*</sup> may be carried out at the time of commissioning (Form A.2-4).

Document reference(s) for Manufacturers' Information: NA



01/16/2019-Tesla Test Engineer: Gaurav Joglekar Company: 02/21/2019 Project # G103852302 2/25/2019 Project Engineer Dipesh Patel Steven 1092170-xx-y the Perter Model: Reviewer: 2/28/2019 Pasternack Product Name: AC Powerwall G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May Standard(s): 2019

**Manufacturer** compliance declaration. - I certify that all products supplied by the company with the above **Type Tested Manufacturer's** reference number will be manufactured and tested to ensure that they perform as stated in this document, prior to shipment to site and that no site **Modifications** are required to ensure that the product meets all the requirements of EREC G99.

Note that testing can be done by the Manufacturer of an individual component or by an external test house.

Where parts of the testing are carried out by persons or organisations other than the **Manufacturer** then that person or organisation shall keep copies of all test records and results supplied to them to verify that the testing has been carried out by people with sufficient technical competency to carry out the tests.



1092170-xx-y

Model:

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Total Quality. Assure	ed.			
Company:	Tesla	Test Engineer:	Gaurav Joglekar	lipolekas
Project #	G103852302	Project Engineer	Dipesh Patel	Dipesh

Product Name: AC Powerwall G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May Standard(s): 2019

Reviewer:

Steven

Pasternack

the Parties

01/16/2019-

02/21/2019

2/25/2019

2/28/2019

## A2-3 Compliance Verification Report –Tests for Type A Inverter Connected Power Generating Modules – test record

1. Operating Range: Two tests should be carried with the Power Generating Module operating at Registered Capacity and connected to a suitable test supply or grid simulation set. The power supplied by the primary source shall be kept stable within ± 5 % of the apparent power value set for the entire duration of each test sequence.

Frequency, voltage and Active Power measurements at the output terminals of the Power Generating Module shall be recorded every second. The tests will verify that the Power Generating **Module** can operate within the required ranges for the specified period of time.

The Interface Protection shall be disabled during the tests.

In case of a PV Power Park Module the PV primary source may be replaced by a DC source.

In case of a full converter Power Park Module (eg wind) the primary source and the prime mover Inverter/rectifier may be replaced by a DC source.

Test 1  Voltage = 85% of nominal (195.5 V),  Frequency = 47 Hz,  Power Factor = 1,  Period of test 20 s	Measured voltage: 195.56V Measured Frequency: 47.001Hz Measured Power Factor: 0.99 Time period: 20sec
Test 2  Voltage = 85% of nominal (195.5 V),  Frequency = 47.5 Hz,  Power Factor = 1,  Period of test 90 minutes	Measured voltage: 195.65V Measured Frequency: 47.5Hz Measured Power Factor: 0.99 Time period: 90 minutes
Test 3  Voltage = 110% of nominal (253 V)., Frequency = 51.5 Hz, Power Factor = 1, Period of test 90 minutes	Measured voltage: 252.96V Measured Frequency: 51.5Hz Measured Power Factor: 0.99 Time period: 90 minutes
Test 4  Voltage = 110% of nominal (253 V),  Frequency = 52.0 Hz,  Power Factor = 1,  Period of test 15 minutes	Measured voltage: 253.07V  Measured Frequency: 52.01Hz  Measured Power Factor: 0.99  Time period: 15 minutes



Company:	Tesla	Test Engineer:	Gaurav Joglekar	yoglekas	01/16/2019- 02/21/2019	
Project #	G103852302	Project Engineer	Dipesh Patel	Dipesh	2/25/2019	
Model:	1092170-xx-y	Reviewer:	Steven Pasternack	the Porter	2/28/2019	
Product Name:	AC Powerwall					
Standard(s):  G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May 2019						

#### 2. Power Quality - Harmonics:

For **Power Generating Modules** of **Registered Capacity** of less than 75 A per phase (ie 50 kW) the test requirements are specified in Annex A.7.1.5. These tests should be carried out as specified in BS EN 61000-3-12 The results need to comply with the limits of Table 2 of BS EN 61000-3-12 for single phase equipment and Table 3 of BS EN 610000-3-12 for three phase equipment.

**Power Generating Modules** with emissions close to the limits laid down in BS EN 61000-3-12 may require the installation of a transformer between 2 and 4 times the rating of the **Power Generating Module** in order to accept the connection to a **Distribution Network**.

For **Power Generating Modules** of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC G5.

Power Generating Module rating per phase (rpp)		5.8	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)		
Harmonic #	Harmonic # At 45-55% of Registered Capacity		100% of Registered Capacity		Limit in BS EN 61000-3-12	
	Measured Value MV in Amps	%	Measured Value MV in Amps	%	1 phase	3 phase
2	0.0025	0.01	0.0045	0.02	8%	8%
3	0.1571	0.62	0.173	0.69	21.6%	Not stated
4	0.0371	0.15	0.0301	0.12	4%	4%
5	0.1744	0.69	0.1427	0.57	10.7%	10.7%
6	0.0402	0.16	0.0261	0.10	2.67%	2.67%
7	0.1543	0.61	0.1089	0.43	7.2%	7.2%
8	0.0105	0.04	0.0142	0.06	2%	2%
9	0.0995	0.39	0.1285	0.51	3.8%	Not stated
10	0.0043	0.02	0.0089	0.04	1.6%	1.6%
11	0.1353	0.54	0.1337	0.53	3.1%	3.1%
12	0.001	0.00	0.0056	0.02	1.33%	1.33%



Company:	Tesla	Test Engineer:	Gaurav Joglekar	yoglekas	01/16/2019- 02/21/2019
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13	0.057	0.23	0.1134	0.45	2%	2%
THD <sup>1</sup>	-	1.60	-	1.59	23%	13%
PWHD <sup>2</sup>	-		-		23%	22%

## 3. Power Quality - Voltage fluctuations and Flicker:

For **Power Generating Modules** of **Registered Capacity** of less than 75 A per phase (ie 50 kW) these tests should be undertaken in accordance with Annex A.7.1.4.3. Results should be normalised to a standard source impedance, or if this results in figures above the limits set in BS EN 61000-3-11 to a suitable Maximum Impedance.

For **Power Generating Modules** of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation must be designed in accordance with EREC P28.

	Starting					Stopping			Running		
	d max	d c		d(t)		d max	d c	d(t)	P st	P lt 2	hours
Measured Values at test impedance	0.00	0.0	0	(	0.00	0.00	0.00	0.00	0.073	0.0	066
Normalised to standard impedance	0.00	0.0	0	(	0.00	0.00	0.00	0.00	0.073	0.0	066
Normalised to required maximum impedance	0.12	0.0	0	(	0.00	0.12	0.00	0.00	0.073	0.0	066
Limits set under BS EN 61000-3-11	4%	3.3	%	3.3%		4%	3.3%	3.3%	1.0	0.	.65
Test Impedance R				0.25	Ω	XI	0.25		Ω		
Standard Impedance R			0.24 * 0.4 ^		Ω	XI	0.15 * 0.25 ^		Ω		

<sup>&</sup>lt;sup>1</sup> THD = Total Harmonic Distortion

<sup>2</sup> PWHD = Partial Weighted Harmonic Distortion



Company:	Tesla	Test Engineer:	Gaurav Joglekar	hodopos	01/16/2019- 02/21/2019			
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Model:	1092170-xx-y	Reviewer:	Steven Pasternack	then Parties	2/28/2019			
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Maximum Impedance F	R	8.08	Ω	XI	5.05	Ω	
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<sup>\*</sup> Applies to three phase and split single phase Power Generating Modules.

For voltage change and flicker measurements the following formula is to be used to convert the measured values to the normalised values where the **Power Factor** of the generation output is 0.98 or above.

Normalised value = Measured value x reference source resistance/measured source resistance at test point

Single phase units reference source resistance is 0.4  $\Omega$ 

Two phase units in a three phase system reference source resistance is 0.4  $\Omega$ 

Two phase units in a split phase system reference source resistance is 0.24  $\Omega$ 

Three phase units reference source resistance is 0.24  $\Omega$ 

Where the **Power Factor** of the output is under 0.98 then the XI to R ratio of the test impedance should be close to that of the Standard Impedance.

The stopping test should be a trip from full load operation.

The duration of these tests need to comply with the particular requirements set out in the testing notes for the technology under test. Dates and location of the test need to be noted below

Test start date	2/22/2017	Test end date	2/22/2017
Test location	Intertek Boxborough		

**4. Power quality – DC injection:** The tests should be carried out on a single **Generating Unit**. Tests are to be carried out at three defined power levels ±5%. At 230 V a 50 kW three phase **Inverter** has a current output of 217 A so DC limit is 543 mA. These tests should be undertaken in accordance with Annex A.7.1.4.4.

Test power level	10%	55%	100%
Recorded value in Amps	-0.0221	-0.0381	-0.0424
as % of rated AC current	0.11	0.18	0.2
Limit	0.25%	0.25%	0.25%

**5. Power Factor**: The tests should be carried out on a single **Power Generating Module**. Tests are to be carried out at three voltage levels and at **Registered Capacity**. Voltage to be maintained within ±1.5% of the stated level during the test. These tests should be undertaken in accordance with Annex A.7.1.4.2.

Voltage	0.94 pu (216.2 V)	1 pu (230 V)	1.1 pu (253 V)	
Measured value	0.99	0.99 0.99		
Power Factor Limit	>0.95	>0.95	>0.95	

<sup>^</sup> Applies to single phase **Power Generating Module** and **Power Generating Modules** using two phases on a three phase system



Company:	Tesla	Test Engineer:	Gaurav Joglekar	hodopos	01/16/2019- 02/21/2019			
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Model:	1092170-xx-y	Reviewer:	Steven Pasternack	the Partie	2/28/2019			
Product Name:	AC Powerwall							
Standard(s):	G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May 2019							

<b>6. Protection – Frequency tests:</b> These tests should be carried out in accordance with the Annex A.7.1.2.3.							
Function	Setting		Trip test		"No trip tests	,33	
	Frequency	Time delay	Frequency	Time delay	Frequency /time	Confirm no trip	
U/F stage 1	47.5 Hz	20 s	47.493	20.04	47.7 Hz 25 s	NO TRIP	
U/F stage 2	47 Hz	0.5 s	47.02	0.519	47.2 Hz 19.98 s	NO TRIP	
					46.8 Hz 0.48 s	NO TRIP	
O/F	52 Hz	0.5 s	51.977	0.506	51.8 Hz 89.98 s	NO TRIP	
					52.2 Hz 0.48 s	NO TRIP	

Note. For frequency trip tests the frequency required to trip is the setting  $\pm$  0.1 Hz. In order to measure the time delay a larger deviation than the minimum required to operate the projection can be used. The "No trip tests" need to be carried out at the setting  $\pm$  0.2 Hz and for the relevant times as shown in the table above to ensure that the protection will not trip in error.

## 7. Protection – Voltage tests: These tests should be carried out in accordance with Annex A.7.1.2.2.

Function	Setting		Trip test		"No trip tests"		
	Voltage	Time delay	Voltage	Time delay	Voltage /time	Confirm no trip	
U/V	0.8 pu (184 V)	2.5 s	184.949V	2.55 sec	188 V 3.50 s	NO TRIP	
					180 V 2.48 s	NO TRIP	
O/V stage	1.14 pu (262.2 V)	1.0 s	261.498V	1.06 sec	258.2 V 2.0 s	NO TRIP	
O/V stage 2	1.19 pu (273.7 V)	0.5 s	276.139V	0.564 sec	269.7 V 0.98s	NO TRIP	



Company:	Tesla	Test Engineer:	Gaurav Joglekar	hodekos	01/16/2019- 02/21/2019				
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Model:	1092170-хх-у	Reviewer:	Steven Pasternack	the Partie	2/28/2019				
Product Name:	AC Powerwall								
Standard(s):	G99 Engineering Recommendation Requirements for the connection of ge 2019	G99 Engineering Recommendation Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May							

Standard(s): Requirements for the connection of generation equipment in parallel with public distribution networks on or after 17 May 2019									
						277.7 V 0.48 s	NO TR		
a larger deviation out at the setting	Note for Voltage tests the Voltage required to trip is the setting $\pm 3.45$ V. The time delay can be measured at a larger deviation than the minimum required to operate the protection. The No trip tests need to be carried out at the setting $\pm 4$ V and for the relevant times as shown in the table above to ensure that the protection will not trip in error.								
8.Protection – L Annex A.7.1.2.4.	oss of Mains	test: These tes	sts sh	ould be	carrie	d out in ac	cordar	nce with	BS EN 62116.
The following sub	set of tests she	ould be recorde	d in t	he follov	ving tal	ole.			
Test Power and imbalance	33% -5% Q Test 22	66% -5% Q Test 12	100% -5% P Test 5			% % Q st 31	66% +5% Test		100% +5% P Test 10
Trip time. Limit is 0.5s	0.04 sec	0.097 sec	97 sec 0.1 sec		0.0	37 sec 0.059 s		9 sec	0.09 sec
Loss of Mains P Annex A.7.1.2.6.	rotection, Vec	tor Shift Stabi	lity t	est. This	s test s	should be d	carried	out in a	ccordance with
	Start Frequency	Change			Confi	rm no trip			
Positive Vector Shift	49.5 Hz	+50 degrees			NO T	RIP			
Negative Vector Shift	50.5 Hz	- 50 degrees			NO T	RIP			
Loss of Mains P A.7.1.2.6.	rotection, RoC	oF Stability te	st: T	his test s	should	be carried	out in	accorda	nce with Annex
Ramp range	Test freque	est frequency ramp: Test Duration Confirm no trip					m no trip		
49.0 Hz to 51.0 H	z +0.95 Hzs	1		2.1 s				NO TF	RIP
51.0 Hz to 49.0 H	z -0.95 Hzs <sup>-1</sup>			2.1 s				NO TF	RIP



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**9. Limited Frequency Sensitive Mode – Over frequency test:** The test should be carried out using the specific threshold frequency of 50.4 Hz and **Droop** of 10%.

This test should be carried out in accordance with Annex A.7.1.3.

**Active Power** response to rising frequency/time plots are attached if frequency injection tests are undertaken in accordance with Annex A.7.2.4.

NA

Alternatively, simulation results should be noted below:

•		1	1	Г
Test sequence at <b>Registered Capacity</b> >80%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00Hz ±0.01Hz	4973.9 W	50 Hz	NA (battery storage internal to the unit)	-
Step b) 50.45Hz ±0.05Hz	4976.3 W	50.45 Hz		-
Step c) 50.70Hz ±0.10Hz	4708.2 W	50.7 Hz		-
Step d) 51.15Hz ±0.05Hz	4214.1 W	51.15 Hz		-
Step e) 50.70Hz ±0.10Hz	4709.6 W	50.7 Hz		-
Step f) 50.45Hz ±0.05Hz	4977.5 W	50.45 Hz		-
Step g) 50.00Hz ±0.01Hz	4975.32 W	50 Hz		
Test sequence at <b>Registered</b> <b>Capacity</b> 40% - 60%	Measured Active Power Output	Frequency	Primary Power Source	Active Power Gradient
Step a) 50.00Hz ±0.01Hz	2478.48 W	50 Hz		-
Step b) 50.45Hz ±0.05Hz	2480.49 W	50.45 Hz		-
Step c) 50.70Hz ±0.10Hz	2241.13 W	50.7 Hz		-



Total Quality. Assure	ed.				
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Step d) 51.15Hz					-

Standard(s):	Requirements for the connect 2019	ion of generation equipme	nt in parallel with pu	blic distribution network	s on or after 17 May		
Step d) 51.15Hz	1752 G W	51 15 Uz		-			
±0.05Hz	1752.6 W	51.15 Hz					
Step e) 50.70Hz ±0.10Hz	2239.17 W 50.7 Hz						
10. Protection – I	Re-connection timer.						
	that the reconnection ency to within the stage			delay of 20 s for	restoration of		
Time delay setting	Measured delay		ks on no reconnection when voltage or frequency ht to just outside stage 1 limits of Table 10.1.				
20SEC	20SEC	At 1.16 pu (266.2 V)	At 0.85 pu (196.1 V)	At 47.4 Hz	At 52.1 Hz		
Confirmation that the <b>Power Generating</b> Module does not re-connect.		No reconnect	No reconnect	No reconnect	No reconnect		
11. Fault level contribution: These tests shall be carried out in accordance with EREC G99 Annex A.7.1.5.							
For <b>Inverter</b> outpu	ut						
Time after fault		Volts	Amps				
20ms		255.72	1.306				
100ms		114.426	0.609				
250ms		72.412	0.3856				
500ms		51.22	0.2728				
Time to trip	0.00247	In seconds					
12. Self-Monitorii	ng solid state switchi	ng: No specified te	st requirements.	Refer to Annex A	.7.1.7.		
It has been verified that in the event of the solid state switching device failing to disconnect the <b>Power Park Module</b> , the voltage on the output side of the switching device is reduced to a value below 50 volts within 0.5 s.  NA (No solid state switching device)							
13. Wiring function	onal tests: If required b	by para 15.2.1.					
Confirm that the commissioning)	relevant test schedul	le is attached (tes	Confirm that the relevant test schedule is attached (tests to be undertaken at time of commissioning)  NA (Type test)				



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14. Logic interface (input port).	
Confirm that an input port is provided and can be used to shut down the module.	Yes
Additional comments. Site Master controller (SMC) or Energy Gateway incorporates this feature command to ACPW to shut down.	and sends