Tesla, Inc.

3500 Deer Creek Road

Palo Alto, California, 94304

Product: AC Powerwall, Model #: 1092170, 2012170 and 3012170

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:

G100 Issue 2 – Amendment 2

Engineering Recommendation G100 Issue 2 2022 Amendment 2
Technical Requirements for Customers' Export and Import Limitation Schemes

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

5/15/2023 (mm/dd/yyyy)

Mehran Zamani

Date

Grid Staff Compliance Engineer

Manufacturer's CLS Product Information

This form is available in a Microsoft Word version from the ENA's website.

G100/2 - Form B - Compliance Verification Report for Customer Export or Import Limitation Schemes

This form shall be used by the **Manufacturer** to demonstrate and declare compliance with the requirements of EREC G100. The form can be used in a variety of ways as detailed below:

1. For **Fully Type Tested** status

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

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

   The **Manufacturer** can use this form to obtain **Type Tested** status for one or more **Components** which are used in a **CLS** by registering this form with the relevant parts completed with the Energy Networks Association (ENA) Type Test Register.

3. One-off Installation

   The **Installer** can use this form to confirm that the **CLS** has been tested to satisfy the requirements of this EREC G100. This form shall be submitted to the **DNO** before commissioning.

A combination of (2) and (3) can be used as required, together with Form C where compliance of the **CLS** is to be demonstrated on site.

Note:

If the **CLS** is **Fully Type Tested** and registered with the Energy Networks Association (ENA) Type Test Register, Form C shall include the **Manufacturer**'s reference number (the Type Test Register system reference), and this form does not need to be submitted.

Where the **CLS** is not registered with the ENA Type Test Register or is not **Fully Type Tested** this form (all or in parts as applicable) shall be completed and provided to the **DNO**, to confirm that the **CLS** has been tested to satisfy all or part of the requirements of this EREC G100.

CLS Designation		Export limiting Scheme	
Manufacturer name		Tesla, Inc.	
Address		47400 Kato Rd, Fremont, CA 94538 USA	
Tel	408-876-1303	Web site	www.tesla.com
E:mail	mzamani@tesla.com		
Installer's name			
Address			

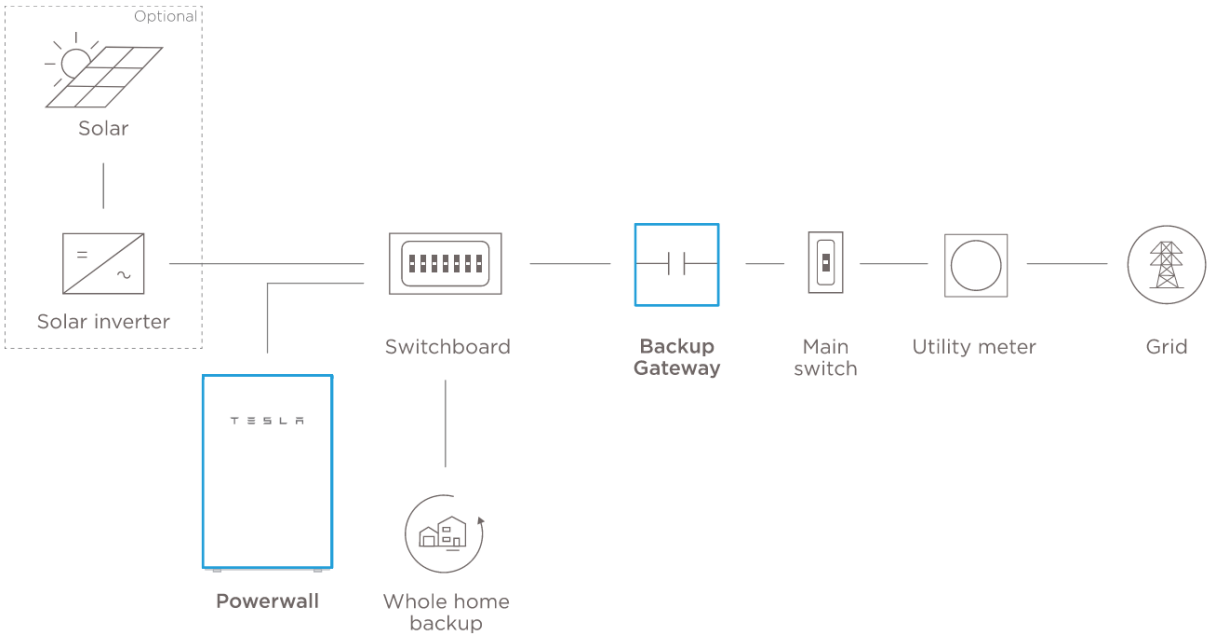
Tel		Web site	
E:mail			

Export/Import capabilities

Export	Y	Import	NA

Description of Operation

EREC G100 section 4.2 requires a description of the **CLS**, and schematic diagram, to be provided to the **Customer**. Please provide that description and the diagram here.



Tesla Powerwall is a state-of-the-art battery system intended for residential and light commercial applications. There are two components of the Tesla Powerwall: the Powerwall and the Backup Gateway. Powerwall 2 AC (PN: 1092170-XX-Y, 2012170-XX-Y, 3012170-XX-Y) is an assembly that consists of lithium-ion battery cells, an isolated DC/DC converter, an integrated AC inverter and a liquid thermal management system. The battery cells inside Powerwall are the components closest to being a conventional battery; however, the installer or user is never exposed to these cells since they are electrically and physically isolated from contact by maintenance personnel or homeowners.
For backup applications, the Backup Gateway (PN: 1152100 -XX-Y) is used to isolate Powerwall from the grid and facilitate the powering of backed up loads. The Gateway is connected to the Powerwall via communication cables and thus functions together with the Powerwall as a complete system. Within the Backup Gateway enclosure is a microprocessor controlled power contactor, inclusive of line- and load-side voltage sensing and current measurement. In addition, the Backup Gateway contains a meter in which the CTs that measure the site net load connect to.

Tesla Powerwall is managed by a software platform that allows the system to provide grid services, economic returns, and energy security while maintaining system limits. System limits can vary depending on the connection of the Powerwall, the electrical infrastructure on site, and the interconnection of the system. Power Control System (PCS) is a term used by Tesla to refer software controls of production sources (Solar & Battery) to maintain system limits. PCS software can limit the power of a Powerwall system to safely interconnect with a variety of home electrical system ratings. As a result, PCS can help avoid expensive electrical upgrades, complicated load relocation, or a reduction in system performance.

Power Control System (PCS) methodology and implementation can be used to manage a system to enforce the following limits:

- Site Limit: To prevent excess Import/Export through the site meter to/from the utility connection. Tesla PCS software curtails both battery and/or solar, and compensates by having Powerwall charge or discharge to prevent exceeding the configured limits
- Conductor Limit: To prevent excess current through specific monitored and controlled conductors. Tesla PCS software both curtails battery and/or solar, and compensates by having Powerwall charge or discharge to prevent exceeding the configured limits
- Panel Limit: To prevent excess current experienced by a virtual panel, fed by a sum of site, solar, and batteries. Tesla PCS software curtails battery and/or solar to prevent exceeding the configured limits

Tesla PCS software manages the output of the battery and controlled solar in a best effort approach to prevent exceeding each of the configured limits.

NOTE: Solar curtailment in grid-connected systems is only possible with compatible Tesla solar products.

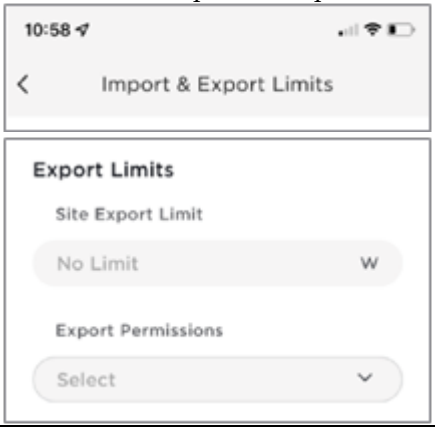
NOTE: Site, Conductor, and Panel Limits are all types of PCS. These terms are distinct and specific features of Tesla's overall suite of PCS controls.

Tesla uses Site Limit feature to comply with G100 CLS requirements.

Every system has a Site meter which monitors energy flow to and from the grid. The Site Limit feature allows the installer to set Site Export limits to ensure the system does not exceed the amount of power that can be exported per site requirements. As described below, Site Export limits can be set to restrict export to a numerical value (e.g. can only export up to 10 kW).

Site Export Permissions: Site Export Permissions determine whether Powerwall (the battery) and/or Solar can export to the grid. Site Export Permissions are determined by the utility, the permit, and the interconnect agreement. Installer can configure the site export while commissioning.

Site Export Limits
For systems that can export to the grid, there may be a limit on how much power the site is allowed to export. In this case a Site Export Limit can be set to comply with that power limit. The Site Export Limit is set on the Import & Export Limits page in the Setup App.



Once the system is commissioned with the site limits set, the limits cannot be changed by installer/end-user and Tesla support is needed.

Communications Media

Document the provisions made for the use of various communication media, and both the inherent characteristics and the design steps made to ensure security and reliability.

Tesla PCS software controls the entire energy storage site and communicates over CAN bus at 10Hz. Backup Gateway is a part of a Powerwall system and contain current sensor(s) per phase as needed, to act as a site and/or solar meter, which measure the grid and uncontrolled power production sources.

Backup Gateway communicates to Powerwall at 250k Baud rate over the CAN.

Cyber Security

Confirm that the **Manufacturer** or **Installer** of the **CLS** has provided a statement describing how the **CLS** has been designed to comply with cyber security requirements, as detailed in section 4.7.

The Tesla Energy Cybersecurity Program is modelled after the NISTIR 7628 framework, which itself is modelled after the following publications:

• NIST 800-53, Revision 3, Recommended Security Controls for Federal Information Systems and Organizations, August 2009

• NERC CIP 002, 003-009, Version 5

• Catalog of Control Systems Security: Recommendations for Standards Developers, Department of Homeland Security, March 2010

• ISA99 / IEC62443

Power Quality Requirements

Where the **CLS** includes the power electronics that controls generation or loads (as opposed to the power electronics being included in **Devices** that are subject to their own power quality compliance requirements) please submit the harmonic and disturbance information here as required by EREC G5 and EREC P28.

Powerwall 2 is compliant with EREC G99 and EREC G98(less than 16A)

2. Power Quality – Harmonics:

For **Power Generating Module**s 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, and measurements for the 2nd – 13th harmonics should be provided. 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. For three phase **Power Generating Module**s, measurements for all phases should be provided.
For **Power Generating Module**s of **Registered Capacity** of greater than 75 A per phase (ie 50 kW) the installation shall be designed in accordance with EREC G5.

The rating of the **Power Generating Module** (per phase) should be provided below, and the Total Harmonic Distortion (THD) and Partial Weighted Harmonic Distortion (PWHD) should be provided at the bottom of this section.

Power Generating Module tested to BS EN 61000-3-12

Power Generating Module rating per phase (rpp)	**5**	kVA	Harmonic % = Measured Value (A) x 23/rating per phase (kVA)
Single or three phase measurements (for single phase measurements, only complete L1 columns below).	1 Phase		

Harmonic	At 45-55% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured Value (MV) in Amps			Measured Value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.004	--	--	0.017	--	--	8%	8%
3	0.164	--	--	0.652	--	--	21.6%	Not stated
4	0.029	--	--	0.114	--	--	4%	4%
5	0.080	--	--	0.319	--	--	10.7%	10.7%
6	0.024	--	--	0.095	--	--	2.67%	2.67%
7	0.234	--	--	0.929	--	--	7.2%	7.2%
8	0.006	--	--	0.025	--	--	2%	2%
9	0.145	--	--	0.575	--	--	3.8%	Not stated
10	0.003	--	--	0.010	--	--	1.6%	1.6%
11	0.066	--	--	0.261	--	--	3.1%	3.1%
12	0.002	--	--	0.009	--	--	1.33%	1.33%
13	0.106	--	--	0.420	--	--	2%	2%
THD1	-	--	--	1.635	--	--	23%	13%

PWHD2	-	--	--	2.440	--	--	23%	22%
Harmonic	At 100% of **Registered Capacity**						Limit in BS EN 61000-3-12	
	Measured value (MV) in Amps			Measured value (MV) in %				
	L1	L2	L3	L1	L2	L3	1 phase	3 phase
2	0.013	--	--	0.053	--	--	8%	8%
3	0.259	--	--	1.025	--	--	21.6%	Not stated
4	0.042	--	--	0.165	--	--	4%	4%
5	0.308	--	--	1.223	--	--	10.7%	10.7%
6	0.032	--	--	0.127	--	--	2.67%	2.67%
7	0.247	--	--	0.979	--	--	7.2%	7.2%
8	0.010	--	--	0.041	--	--	2%	2%
9	0.185	--	--	0.735	--	--	3.8%	Not stated
10	0.005	--	--	0.021	--	--	1.6%	1.6%
11	0.162	--	--	0.641	--	--	3.1%	3.1%
12	0.003	--	--	0.010	--	--	1.33%	.33%
13	0.166	--	--	0.659	--	--	2%	2%
THD[3]	1.635	--	--	2.578	--	--	23%	13%
PWHD[4]	2.440	--	--	4.940	--	--	23%	22%

3. Power Quality – Voltage fluctuations and Flicker:

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

The standard test impedance is 0.4 Ω for a single phase **Power Generating Module** (and for a two phase unit in a three phase system) and 0.24 Ω for a three phase **Power Generating Module** (and for a two phase unit in a split phase system). Please ensure that both test and standard impedance are completed on this form. If the test impedance (or the measured impedance) is different to the standard impedance, it must be normalised to the standard impedance as follows (where the **Power Factor** of the generation output is 0.98 or above):

d max normalised value = (Standard impedance / Measured impedance) x Measured value.

Where the **Power Factor** of the output is under 0.98 then the X 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 needs to comply with the particular requirements set out in the testing notes for the technology under test.

The test date and location must be declared.

Test start date	12 Sep 2022	Test end date	12 Sep 2022
Test location	Tesla, Inc: 47400 Kato Rd Fremont CA USA		

	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	1.01 %	0.23%	0%	1.01%	0.23%	0%	0.13	0.11
Normalised to standard impedance	-	-	-	-	-	-	-	-
Normalised to required maximum impedance	-	-	-	-	-	-	-	-
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	0.4	Ω	Xl	0.27	Ω

Standard Impedance	R	0.24 * 0.4 ^	Ω	Xl	0.15 * 0.25 ^	Ω
Maximum Impedance	R	8.08	Ω	Xl	5.05	Ω

* Applies to three phase and split single phase **Power Generating Module**s. Delete as appropriate.

^ Applies to single phase **Power Generating Module** and **Power Generating Module**s using two phases on a three phase system. Delete as appropriate.

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.

The % DC injection ("as % of rated AC current" below) is calculated as follows:

% DC injection = Recorded DC value in Amps / Base current

where the base current is the **Registered Capacity** (W) / Vphase. The % DC injection should not be greater than 0.25%.

Test power level	10%	55%	100%
Recorded DC value in Amps	-0.0221	-0.0381	-0.0424
as % of rated AC current	0.10	0.18	0.20
Limit	0.25%	0.25%	0.25%

Fail Safe

CLS internal failure: please submit here the description of the internal **Fail Safe** design and operation. Please also document how it has been demonstrated, including the non-volatile recording of times and numbers of state 2 operations, and confirm the overall response of the **CLS** to this internal failure.

Tesla PCS is implemented after review of system risks to ensure that the PCS controls, when combined with traditional design methodology and overcurrent protection, will ensure safe and effective system operation. Tesla has reviewed the behavior of all parts of the system to ensure a proper response even during a loss of communication or a hardware failure.

Additionally Tesla Powerwall PCS software is certified under UL 1741 PCS as secondary overcurrent protection with maximum open loop response time of 1.9 seconds.
(i.e., PCS software curtails the controlled devices to follow the site limits within 2 seconds)

Backup Gateway communicates with controlled device (AC Powerwall) via CAN Protocol.

If an individual Powerwall fails in multi-Powerwall system, then that Powerwall is bypassed due to a parallel connection and does not affect the operation of other components which would continue to limit the system to the export limit which has been set.

Communication and power supply failures between **Components** and **Devices**. Please document here compliance with EREC G100 section 5.5.

Component/Device number/description	Communication failure test	Power supply failure test

Powerwall 2 (Inverter)	Remove/Interrupt Communication wires (CAN +ve and CAN –ve) between Backup Gateway and AC Powerwall. Results in State-3 operation within 5 seconds. After resetting, the system restores operation in State-1	12V-GND to ACPW removed Inverter shutdown immediately. Results in State-3 operation within 5 seconds. After resetting, the system restores operation in State-1
Backup Gateway (Energy meter-CLS)	--	Power supply removed, Inverter shutdown immediately. Results in State-3 operation within 5 seconds. After resetting, the system restores operation in State-1

Operational Tests

In accordance with EREC G100 section 5.6 undertake the tests A and B to confirm correct operation in state 1 and state 2, that transition into state 3 occurs as required, and that behaviour in state 3 is also as required.

Test A

Nominal Export Limit (for type tests this will be at maximum, minimum and one intermediate setting) in Amp: 16A, 32A,60A, 80A, 100A	16A
Nominal Import Limit (for type tests this will be at maximum, minimum and one intermediate setting) in Amp:	NA

No	Starting level	Step value	**CLS** registers change in level?	**CLS** and/or **Component** and/or **Device** initiates correct response of ≥ 5%?	Duration of step in test	Correct state 1/ state 2 operation
1	16	16.8	Yes, Register in State 2 excursion	Yes	58	State 1

2	16	17.6	Yes, Register in State 2 excursion	Yes	58	State 1
3	16	19.2	Yes, Register in State 2 excursion	Yes	58	State 1
4	-	-	-	-	-	-
5	-	-	-	-	-	-
6	-	-	-	-	-	-
Test B						
Nominal Export Limit:16A, 32A,60A,80A,100A						16A
Nominal Import Limit:						NA
No	Starting level	Step value	**CLS** registers change in level?	**CLS** and/or **Component** and/or **Device** initiates correct response of ≥ 5%?	Duration of step in test	Correct state 3 operation
7	16	16.8	Yes, Register in State 3	Yes	62	State 3
8	-	-	-	-	-	-

State 3 Reset

These tests are to demonstrate compliance with section EREC G100 4.5.2.

Please document how the reset from state 3 to state 1 has been demonstrated. Please include how the reset is achieved.

Please confirm that for **CLSs** to be installed in **Domestic installations** three (3) resets causes lockout or that for non-domestic installations lockout can only be reset after four hours. Please explain how lockout is reset.

Following the communication failure tests, once injected fault is removed- system resets itself and enters state-1 operation.

In the event of single excursion into state 2 operation that persists for more than 1 minute- Tesla Powerwall will enter into state 3 operation immediately.

If state-3 is locked out, it can be reset my Tesla or Installer's via remote control.