



Pacific Gas and Electric Company

SPAN PowerUp, Dynamic Service Rating and SPAN Drive Testing

Program DR Optimization & Transformation

Project DRET Lab Test smart panel on Load Management functions.

Line of Business or Department Load Management Solution Design

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Document Change History

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1.0 Executive Summary

PG&E Applied Technical Services (ATS) tested three components of SPAN technology - SPAN PowerUp, SPAN Dynamic Service Rating, and SPAN Drive throttling - in order to assess each specific functionality. Generally, all functions were found to work as intended, and no major deficiencies were discovered during testing.

1.1 Technology Definitions

- SPAN Installer App and SPAN Home App –the applications for setting up and monitoring the SPAN system.
- SPAN PowerUp – a UL 3141 certified Power Control System (PCS) and UL 916 certified Energy Management System (EMS) embedded within SPAN Panel.
- SPAN Dynamic Service Rating (DSR) -- A temporary service rating that can be set by utility partners to temporarily lower the panel service rating, thus triggering SPAN PowerUp to manage the concurrent load at a lower limit than normal operating capacity of the panel.
- SPAN Drive – A Level 2 electric vehicle charger designed for real time coordination with home loads.

1.2 Summary Findings

1. PowerUp:
 - a. When current on either leg of SPAN Panel exceeds 80% of the nominal service rating, the SPAN PowerUp algorithm begins accumulating virtual heat to emulate the service conductor behavior. Once this virtual heat accumulates beyond a trigger threshold, PowerUp pauses or throttles circuits using either software or relays according to the user's priorities.
 - b. The rate of accumulation increases exponentially as current increases from 80-100%.
 - i. At just above 80%, control actions may not occur for hours.
 - ii. At or above 100%, control actions take place within seconds.
 - c. PowerUp operates locally with no dependency on cloud communications, other than for the customer to modify preferences
 - d. PowerUp will not control "always-on" circuits unless no other circuits are available for control and the current has been (a) high for several hours or (b) exceeds the nominal service rating.
 - e. The customer receives a notification when PowerUp events start and end. Certain appliances will automatically turn on when the circuit is restored.
 - i. When a circuit that powers this type of appliance is being managed, it could cause a continual cycle of turning on/off the circuit /appliances.
 - ii. This condition will lead to a continual/repetitive notification to the customer.
 - iii. SPAN implements timing constraints to mitigate short cycling and allow devices (e.g. HVAC, water heating) to serve the customer before being turned off again.
 - iv. As tested, customers received notifications each time the last device was restored and then shed again.
2. Dynamic Service Rating:
 - a. A DSR event can be scheduled through the web-based system.



- b. The panel receives the DSR event and implements the same load management behavior as PowerUp, based on the temporary DSR setpoint rather than the nominal service rating.
3. SPAN Drive charge throttling:
 - a. Paired with a SPAN Panel and its built-in PowerUp function, SPAN Drive charging current is managed based on the condition of the total house load to ensure the service rating setpoint is not exceeded.
 - b. The charging current showed oscillating behavior as it was adjusted before reaching the desired setpoint (see Figure 7.2-4 Close up plot of box D from Figure 7.2-1). Charging fluctuations occurred when an adjustment was made.

1.3 Summary Recommendations

1. SPAN Installer App and SPAN Home App:
 - Consider a capability to transfer circuit label modification from the SPAN Home App to the SPAN Installer App
 - Consider a capability to save a panel configuration and return to the previous panel configuration
 - Consider a capability to return to the default PowerUp priority.
2. Dynamic Service Rating:
 - The current customer notification seems to imply power shutoff. Revise the message accordingly.
 - Consider a capability to edit DSR events and create a recurring DSR event in the web-based tool.
 - DSR events cannot be scheduled to overlap, otherwise the preceding event terminates the following event. A warning message should be generated when an operator creates this condition.
3. SPAN Drive charge throttling:
 - Consider eliminating the oscillating behavior.

2.0 Objective

1. Evaluate SPAN Installer App and SPAN Home App.
2. Test SPAN Panel PowerUp Function.
3. Test Dynamic Service Rating with PowerUp Function.
4. Test SPAN Drive with PowerUp Function.

3.0 Test Setup

In SPAN Panel, behind each breaker position there is a contactor that is software controlled. These contactors enable disconnecting load through SPAN Home App. In an event that a SPAN Drive is available, the charging current will be adjusted before any of other loads in SPAN Panel will be managed.



SPAN Panel Unit Under Test

Unit Under Test	SPAN Panel MAIN 32 S/N NT-2219-C1EJT
Mounting	wall-mounted

The device under test is a SPAN Drive that is attached to SPAN Panel Gen2 S/N NT-2219-C1EJT. SPAN Drive is a level 2 home Electric Vehicle Supply Equipment (EVSE) that allows for dynamic charging of an EV.



SPAN Drive Unit Under Test

Unit Under Test	SPAN DRIVE:LEVEL 2 EV Charging for home charging DT-2245_C1JNF
Connector type	J1772
Mounting	wall-mounted
Max Power	48A (11.52kW)
Dimensions	17.9 x 5.9 x 3.1in (455 x 150 x 80mm)
AC Voltage (nominal)	208-240V single-phase

4.0 User Interface

4.1 SPAN Installer App

The SPAN Installer App is how SPAN Panel is initially set up by the installer. The Installer needs to complete each step in the SPAN Installer App.

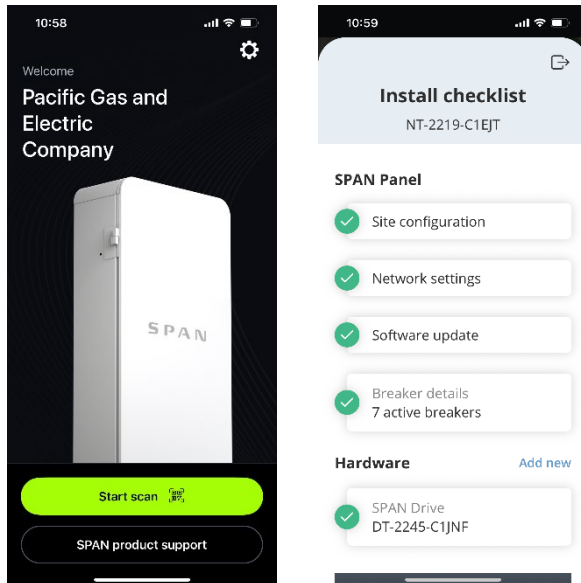


Figure 4.1-1 SPAN Installer App: startup screen.

4.2 SPAN Home App

The SPAN Home App is how the customer monitors and interacts with SPAN Panel, and SPAN Drive.

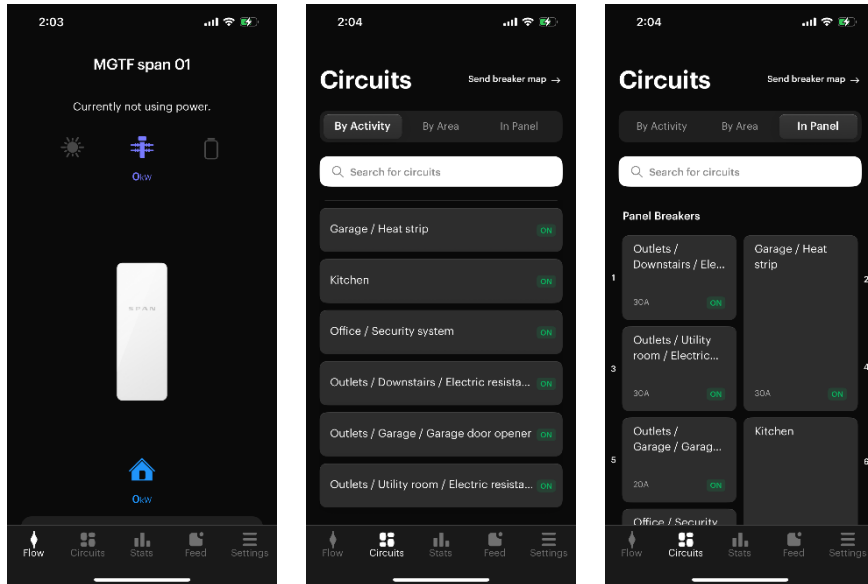


Figure 4.2-1 SPAN Home App main page: showing power consumption.

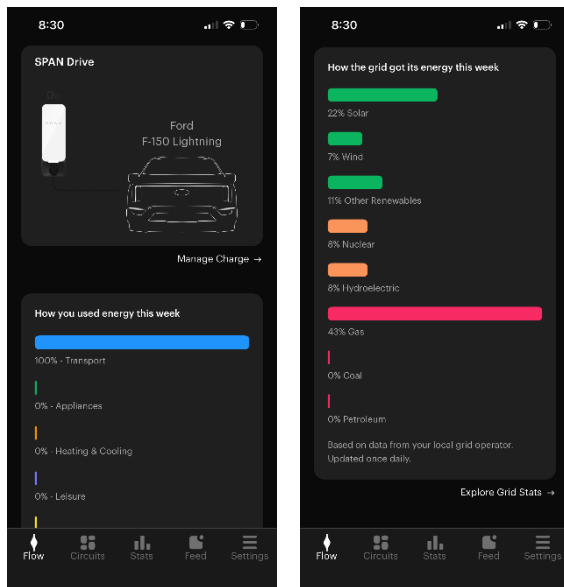


Figure 4.2-2 SPAN Home App main page: showing SPAN Drive Status, Home Energy Usage Statistics, and Grid Energy Usage Statistic.

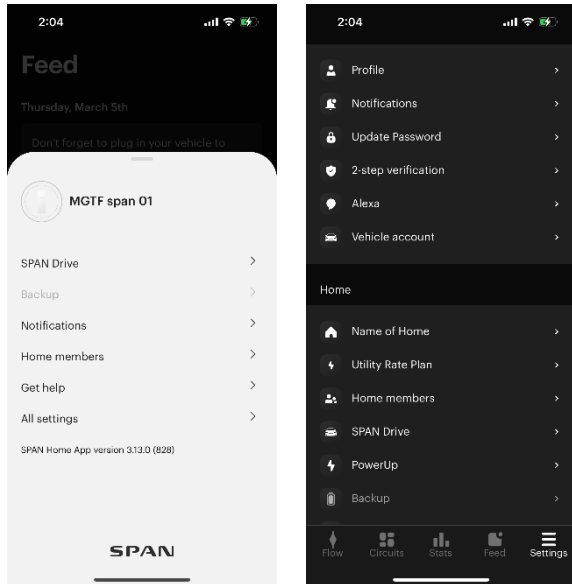


Figure 4.2-3 SPAN Home App “Settings” and “All Settings” page

4.3 Circuit Label

Circuit label can be accessed on the SPAN Installer App and SPAN Home App. In the SPAN Installer App on the “Breaker details” page, the installer needs to provide the panel configuration including the breaker size, pole configuration and circuit information.

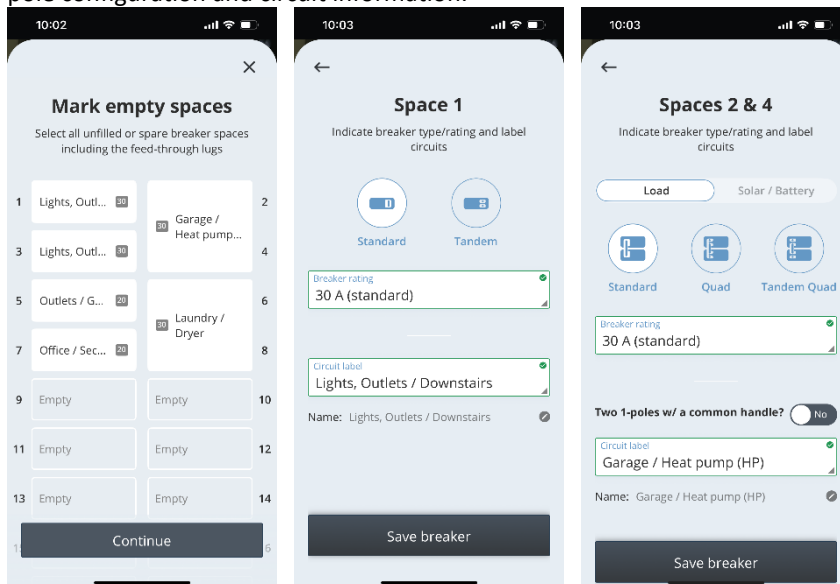


Figure 4.3-1 SPAN Installer App: Breaker details page.

The Installer can specify the circuit label for each breaker. The label can include circuit type information, location and Hardware/Appliances powered by the circuit. The installer is required to complete either “Circuit Type” or “Location” or “Hardware & Appliances” information.

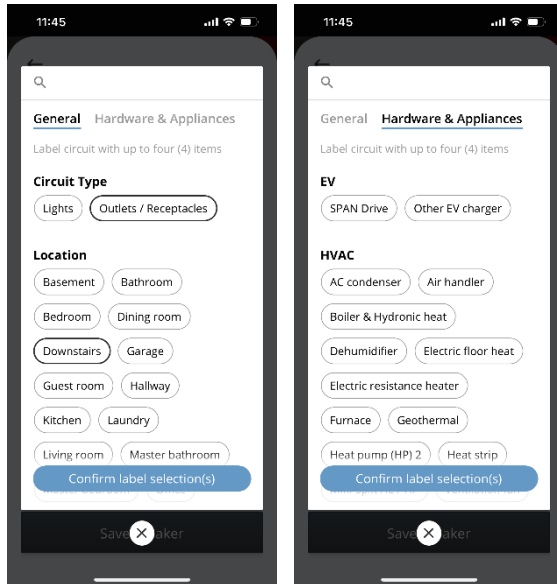


Figure 4.3-2 SPAN Installer App: Circuit Label.

The circuit label entered by the Installer will be transferred to the SPAN Home App as shown below.

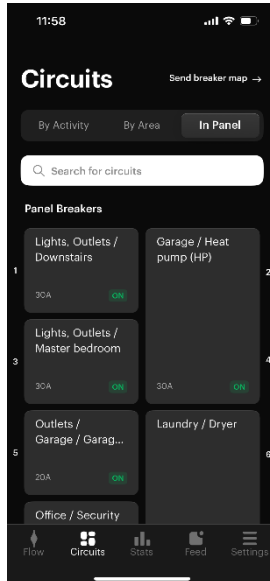


Figure 4.3-3 SPAN Home App: Panel Circuits Detail.

The customer can modify the circuit information, which includes circuit label, location and hardware/appliances powered by the circuit. However, the circuit label in the SPAN Installer App will not be updated based on the customers' modifications.

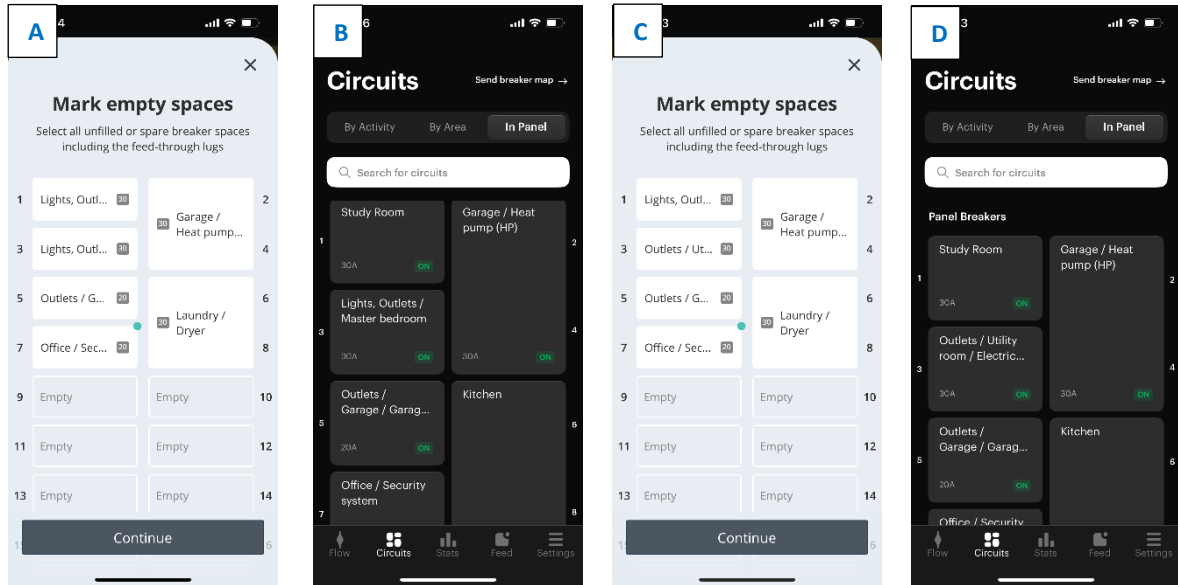


Figure 4.3-4 SPAN Installer App and SPAN Home App breaker details.

A: Initial panel configuration in SPAN Installer App.

B: panel configuration in the SPAN Home App (customer modified ckt# 1 and 6/8).

C: Panel configuration shown in the SPAN Installer App. Update made in B is not reflected in C. Ckt# 3 was modified from Master bedroom to Utility room, and electric resistance heater was added.

D: Panel configuration shown in the SPAN Home App. Update made in B for ckt# 1 and 6/8 are retained. Update made in C for ckt# 3 also reflected in D.

On Step C, when the breaker 6/8: Laundry/Dryer breaker was selected, a warning message appears. The Circuit description in the warning message does not match with what is shown in the SPAN Installer App.

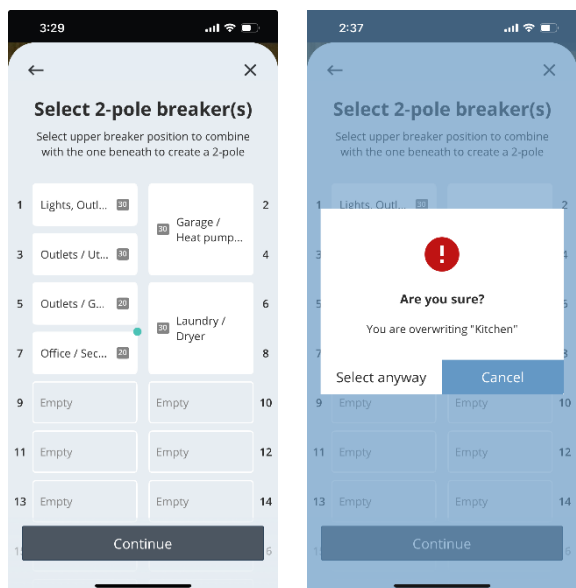


Figure 4.3-5 SPAN Installer App breaker detail mismatch.

4.4 PowerUp

A customer can access the PowerUp priority by going to Settings -> All settings -> PowerUp. The default PowerUp priority is based on the circuit labels entered in the SPAN Installer App. Modification made in the SPAN Home App will only change the text label on the circuit, but the circuit PowerUp priority order will remain the same. See below for example:

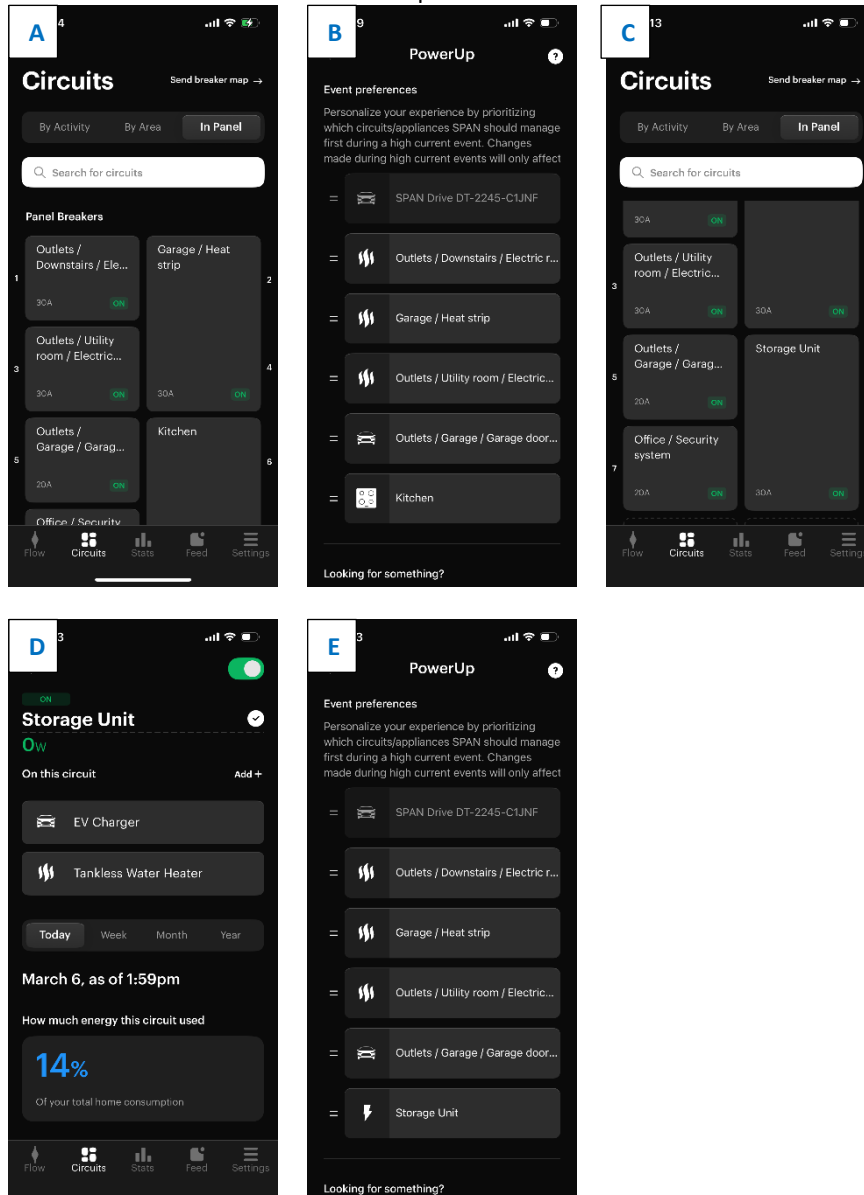


Figure 4.4-1 SPAN Home App, SPAN Breaker details.

A: Initial panel configuration in SPAN Home App.

B: Default PowerUp priority, showing ckt#6/8: Kitchen as the lowest priority.

C: Customer made modification on the circuit label for ckt#6/8 to Storage Unit

D: Customer add EV Charger and Tankless Water Heater appliance to ckt#6/8: Storage Unit.

E: Default PowerUp priority, showing ckt#6/8: Storage Unit as the lowest priority. The label/text is updated, but the order does not change.

PowerUp default priority is based on appliance type. PowerUp implements a 1:1 mapping from appliance type to shed priority. First to shed appliance types are large loads that are tolerant to interruption first (e.g. EVs, electric water heaters). If a circuit has multiple appliance types assigned, then SPAN sets priority based on the lowest shed priority type. For example, if an EV were to share a circuit with the kitchen lights, the priority of the kitchen lights would govern. The default PowerUp priority order can be found in Appendix 9.2 Default PowerUp Priority.

SPAN Drive is the first device that PowerUp will try to manage. For other hardware/appliances, although a hardware/appliance is listed higher on the PowerUp Priority order, it does not mean that it will be managed first in all cases. PowerUp skips circuits using less than 4A to focus on the circuits driving high current events. PowerUp also includes “minimum on time” protection to prevent a circuit from shedding if it recently was controlled.

4.5 Always-on Circuit

The Installer can specify the ‘always-on’ breakers at the last page of “Breaker Details” in the SPAN Installer App. The always-on breakers will be marked with a green dot.

The customer can modify the ‘always-on’ breaker by modifying the ‘always-on’ Circuits page in the SPAN Home App. The modification made by the customer will be transferred back to the SPAN Installer App.

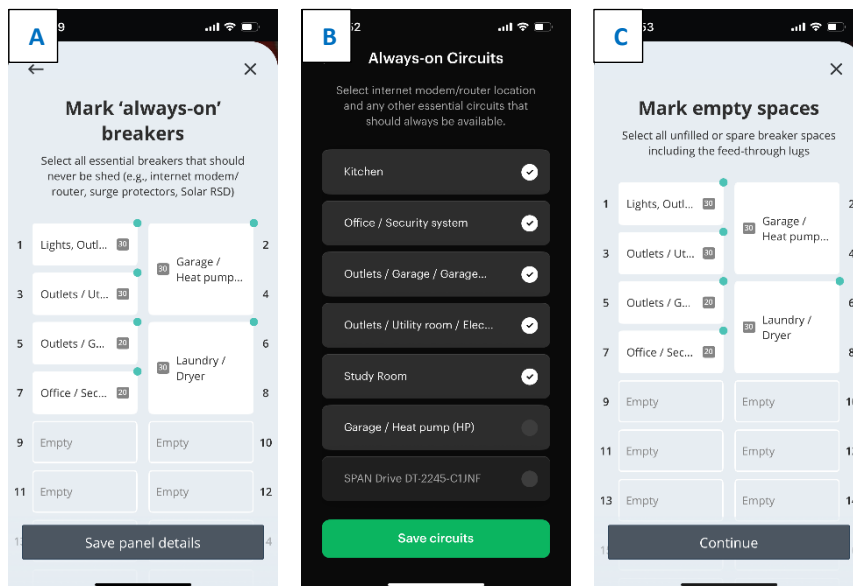


Figure 4.5-1 “Always-on” breakers in the SPAN Installer App. “Always-on” Circuits in the SPAN Home App.
A: Initial ‘always-on’ breakers in SPAN Installer App.
B: Customer removed ckt#2 “Garage/Heat Pump (HP)” from the Always-on Circuit list in SPAN Home App.
C: The green dot marker was removed from ckt#2 in the SPAN Installer App.

4.6 SPAN Drive

SPAN Home App, once a SPAN Drive is connected, provides the user with options to “charge now” or “charge on schedule”.

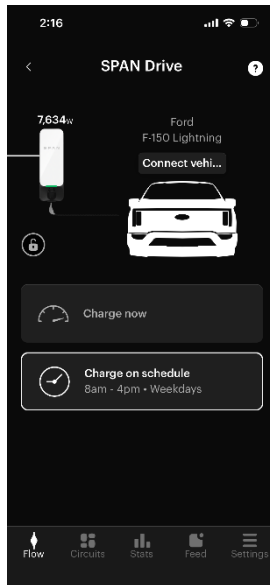


Figure 4.6-1 SPAN Drive page in SPAN Home App.

4.7 Dynamic Service Rating (DSR)

Dynamic Service Rating can be set through a web-based interface (fleetmanager.app.span.io) that allows utility partners to add and view one or more SPAN Panels with the purpose of monitoring or applying temporary service limits to each panel’s power consumption, while maintaining the PowerUp priority and always-on circuit that is set by the customer. ATS tested DSR with a single SPAN Panel.

The screen shot below shows how to select a SPAN Panel and apply a temporary service rating to the panel. Once this power limit is exceeded, various load management functions take effect at the Panel level in accordance with the homeowner’s PowerUp priority and always-on circuit setting.

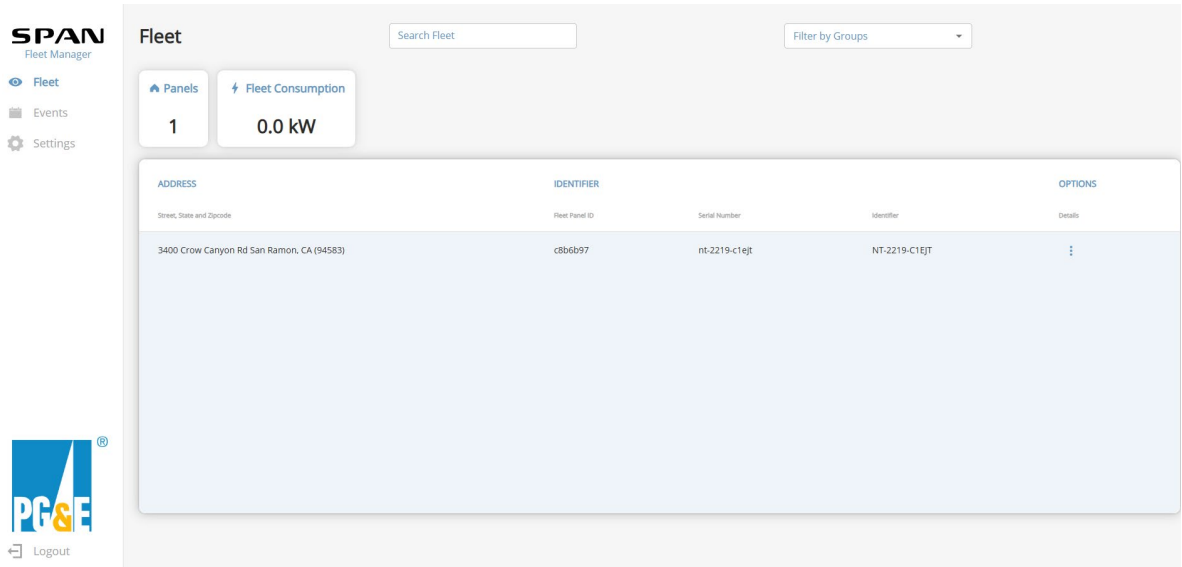


Figure 4.7-1 Dynamic Service Rating homepage.

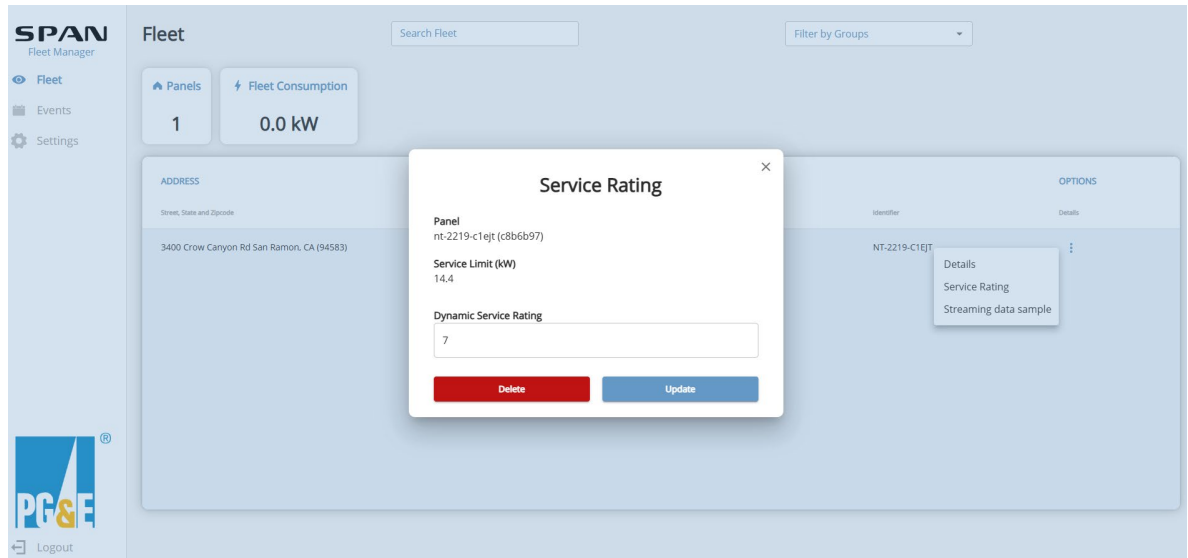


Figure 4.7-2 Temporary service rating setup dialog box.

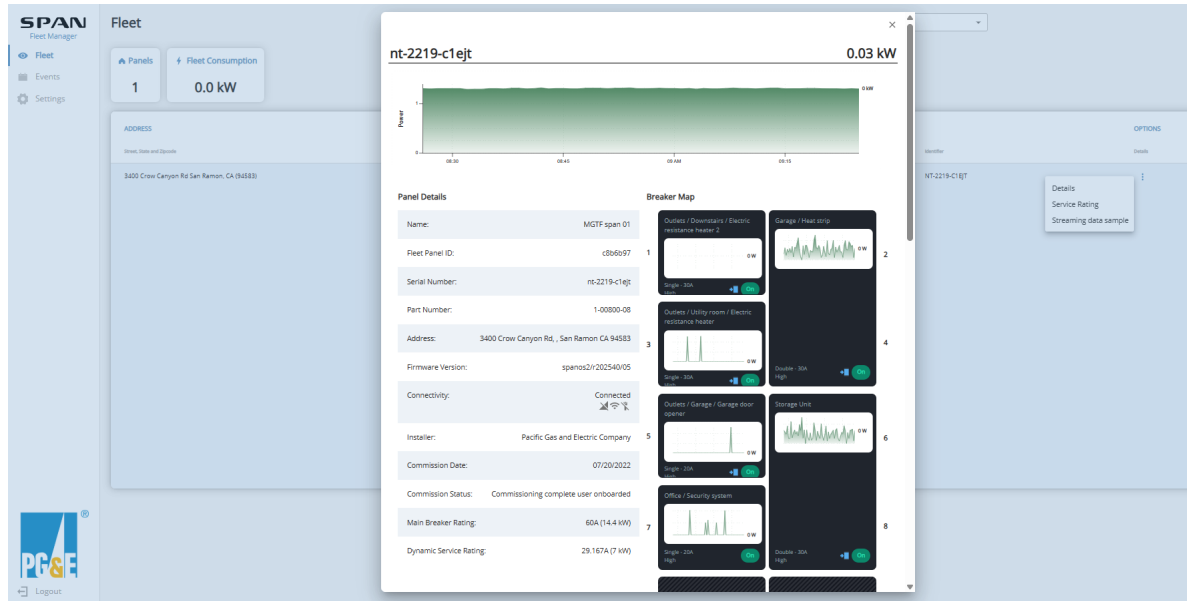


Figure 4.7-3 Dynamic Service Rating, “Details” page.

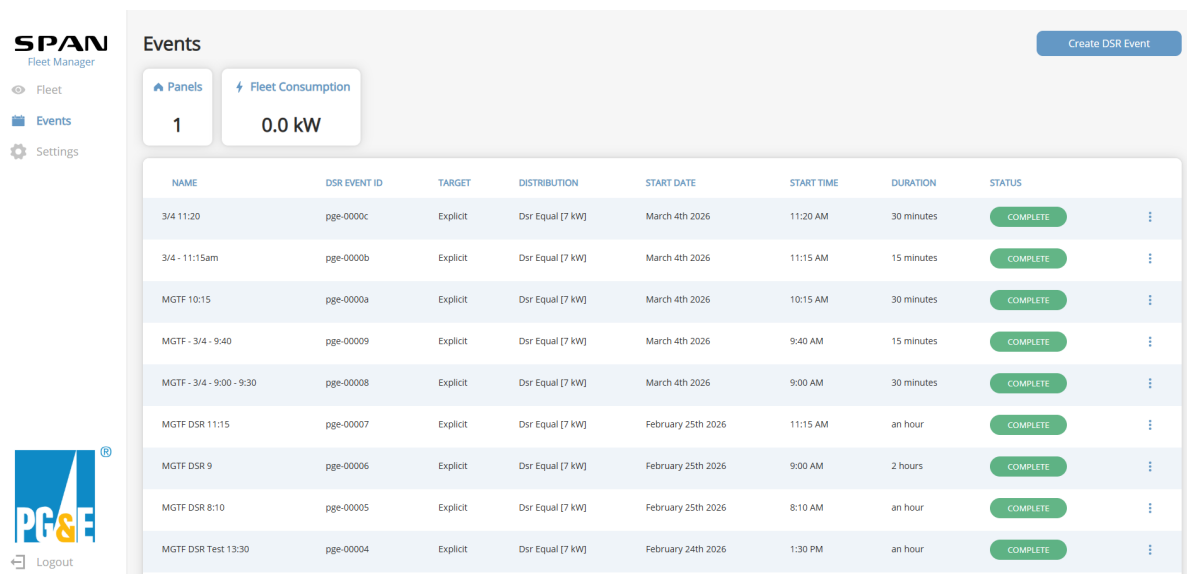


Figure 4.7-4 Dynamic Service Rating, “Events” page.

A Dynamic Service Rating event can be scheduled in advance through the “Events” Page. At the time of test, below are some of the limitation of the schedule feature:

- A recurring regular schedule cannot be set. The event needs to be scheduled one at a time.
- Once created, an event cannot be modified. An event needs to be deleted, and a new event needs to be created if changes are necessary.
- “Duplicate” function is not supported although listed as an option.
- Available duration (in minutes): 1, 2, 3, 4, 5, 10, 15, 20, 30, 45, 60, 90, 120, 150, 180, 240 and 300.
- Available advance notifications lead time (in minutes): 1, 2, 3, 4, 5, 10, 15, 20, 30, 45, 60, 90, 120, 150, 180, 240 and 300.

The created DSR event should not overlap with each other. When overlap occurs, the DSR event will not take place as intended.

MGTF DSR 9	pge-00006	Explicit	Dsr Equal [7 kW]	February 25th 2026	9:00 AM	2 hours	COMPLETE	⋮
MGTF DSR 8:10	pge-00005	Explicit	Dsr Equal [7 kW]	February 25th 2026	8:10 AM	an hour	COMPLETE	⋮

Figure 4.7-5 DSR Event ID: PGE-00005 is scheduled to start at 8:10 for 1 hour. Event ID: PGE-00006 is scheduled to start at 9:00 for 2 hours.

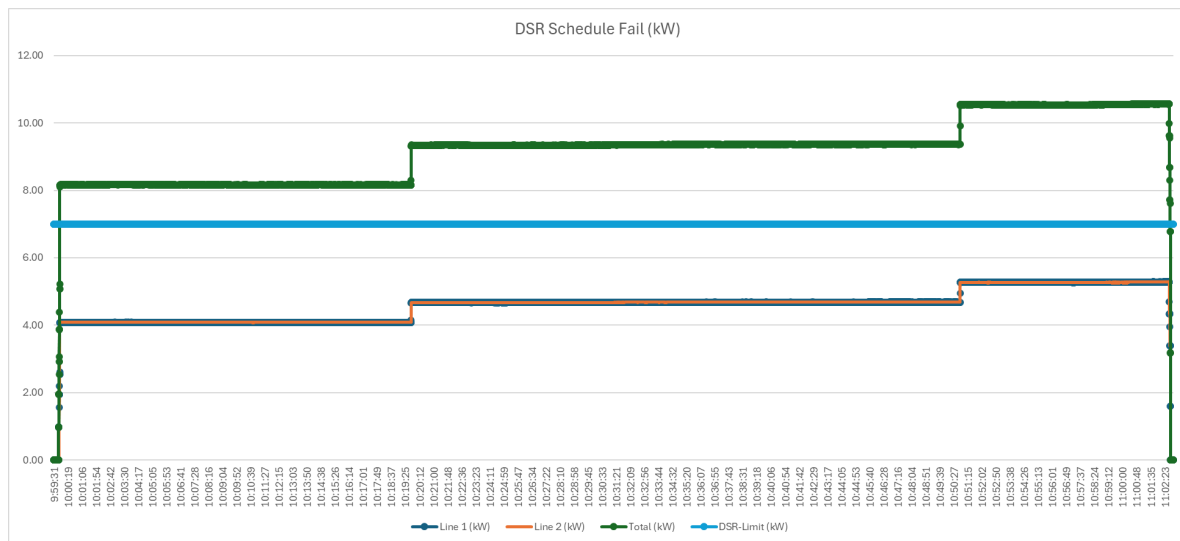


Figure 4.7-6 Total kW is above the DSR Limit of 7kW from 9:55AM – 11:02AM.

Event ID: PGE-00006 did not take place as intended. When PGE-00005 ended at 9:10AM, it also terminated PGE-00006 event.

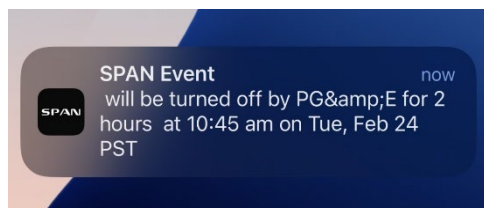


Figure 4.7-7 DSR Customers advance notification.

Customers will receive advance notification based on the time selected in the web-based tool. The message in the notification seems to communicate a power outage rather than limiting power. PG&E is also misspelled in the notification.

5.0 PowerUp Tests Results



Figure 5.0-1 PowerUp notification when PowerUp event starts and ends.

The customers will receive notification when the PowerUp event starts and ends.

There are some appliances that will automatically turn on when the circuit is restored, such as space heaters, lights, network equipment etc. When these types of appliances are being managed and cause SPAN Panel exceeds the DSR limit, the circuit will be managed (turn off) to keep the total power below the DSR limit. After a certain period, the circuit will be restored which will put the total power above the DSR limit again. The circuit will be managed (turn off) for a second time to keep the total power below the DSR limit. This sequence will lead to turning on/off cycle of the appliances during the duration of the DSR event and the customer will receive a notification each time PowerUp event starts and ends. During testing, ATS use “Electric Resistance Heater” as the appliance type powered by the managed circuit. In this scenario, ATS received PowerUp notifications every 25 minutes.

5.1 Scenario 1

SPAN PowerUp is tested under this configuration:

- Main OCPD: 60A
- DSR: N/A
- All circuit is marked as “Always-on” circuit, except SPAN Drive.
- EV load is 0 (not charging).

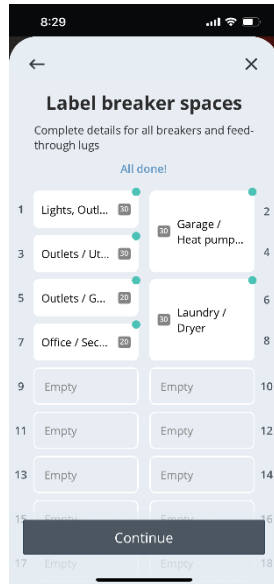


Figure 5.1-1 Scenario 1 Panel Configuration

Test-Id	Current		Power			Site Configuration				Manage Time (s)
	LINE A (A)	LINE B (A)	LINE A (kW)	LINE B (kW)	Total (kW)	Main OCPD (A)	Main OCPD (A) 80%	Main OCPD (A)	Main OCPD (kW) 80%	
167	25	60	3	7.2	10.2	60	48	14.4	11.52	22
168	23	58	2.76	6.96	9.72	60	48	14.4	11.52	NA (stays on, 41m test duration)
169	24	59	2.88	7.08	9.96	60	48	14.4	11.52	NA (stays on, 20m test duration)
170	53	53	6.36	6.36	12.72	60	48	14.4	11.52	NA (stays on, 21m test duration)
172	58	58	6.96	6.96	13.92	60	48	14.4	11.52	NA (stays on, 25m test duration)
171	60	60	7.2	7.2	14.4	60	48	14.4	11.52	22

Table 5.1-1 PowerUp Scenario 1 Test Result Summary

PowerUp will start managing a circuit when any of the lines' current is equal to the main OCPD rating. When all circuit is marked as "always-on", PowerUp will not turn off any circuit if any of the lines' current is greater or equal to 80% of the Main OCPD.

5.2 Scenario 2

SPAN PowerUp is tested under this configuration:

- Main OCPD: 60A
- DSR: N/A
- Managed Circuit:



- Ckt#2 Garage/Heat Pump
- SPAN Drive.
- EV load is 0 (not charging).

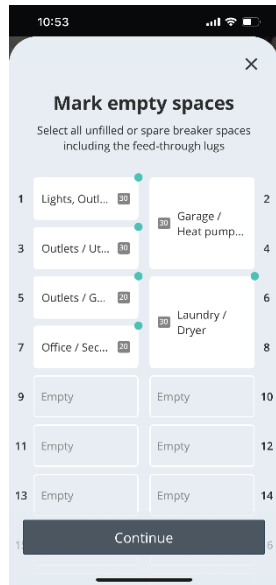


Figure 5.2-1 Scenario 2 Panel Configuration

Test-Id	AMP CALC		Power		Site Configuration						Manage Time (s)
	LINE A	LINE B	LINE A (kW)	LINE B (kW)	Total (kW)	Main OCPD (A)	Main OCPD (A) 80%	Main OCPD (kW)	Main OCPD (kW) 80%	Max Line (A) / Main OCPD (A) (%)	
107	60	60	7.2	7.2	14.4	60	48	14.4	11.52	100%	20
108	54	54	6.48	6.48	12.96	60	48	14.4	11.52	90%	1418 (23m, 38s)
109	48	48	5.76	5.76	11.52	60	48	14.4	11.52	80%	NA (stays on, 30m test duration)
110	42	42	5.04	5.04	10.08	60	48	14.4	11.52	70%	NA (stays on, 30m test duration)
173	23	58	2.76	6.96	9.72	60	48	14.4	11.52	97%	964 (16m, 4s)
180											
181	24	59	2.88	7.08	9.96	60	48	14.4	11.52	98%	23
183	28	53	3.36	6.36	9.72	60	48	14.4	11.52	88%	1291 (21m, 31s)
174	58	58	6.96	6.96	13.92	60	48	14.4	11.52	97%	1137 (18m, 57s)
176	60	60	7.2	7.2	14.4	60	48	14.4	11.52	100%	19



Test-Id	AMP CALC		Power		Site Configuration						Manage Time (s)
	LINE A	LINE B	LINE A (kW)	LINE B (kW)	Total (kW)	Main OCPD (A)	Main OCPD (A) 80%	Main OCPD (kW)	Main OCPD (kW) 80%	Max Line (A) / Main OCPD (A) (%)	
175	35	60	4.2	7.2	11.4	60	48	14.4	11.52	100%	16

Table 5.2-1 PowerUp Scenario 2 Test Result Summary

PowerUp will start managing ckt#2 when any of the lines' current is greater or equal to 80% of the Main OCPD. The higher the ratio between line current to the main OCPD rating, the faster the circuit will start to be managed.

6.0 Dynamic Service Rating (DSR) with PowerUp Tests Results

6.1 Scenario 1

SPAN Dynamic Service Rating with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: 7kW (29.17A)
- Balanced load condition.
- Managed Circuit:
 - Ckt#2 Garage/Heat Pump.
 - SPAN Drive.
- EV load is 0 (not charging).
- Measure ckt#2 manage start time.

Test-id	Breaker #2 (Garage – HP) (A)	L1 (A)	L1 (Power, kW)	L2 (A)	L2 (Power, kW)	Total Power	DSR Limit (A)	DSR Limit (Power, kW)	Total Power / DSR Limit (%)	Manage Time (s)
153	3	32	3.84	32	3.84	7.68	29.17	7.00	110%	2782 (46m, 22s)
152	5	34	4.08	34	4.08	8.16	29.17	7.00	117%	1272 (21m, 12s)
151	5.5	34.5	4.14	34.5	4.14	8.28	29.17	7.00	118%	1257 (20m, 57s)
150	6	35	4.2	35	4.2	8.4	29.17	7.00	120%	865 (14m, 25s)
164	6	35	4.2	35	4.2	8.4	29.17	7.00	120%	1200 (20m)
146	7	36	4.32	36	4.32	8.64	29.17	7.00	123%	24
140	10	39	4.68	39	4.68	9.36	29.17	7.00	134%	15

Table 6.1-1 Dynamic Service Rating with PowerUp Scenario 1 Test Result Summary

PowerUp will start managing ckt#2 when total power is above the DSR limit. The higher the ratio between total power to the DSR limit, the faster the circuit will start to be managed.

An anomaly is observed in test-id 150. Test-id 150 and 164 have the same load condition, it is unclear why test-id 150 start managing ckt#2 after 865 seconds, while test-id 164 start managing ckt#2 after 1200 seconds. Test-id 160 and 162 (Scenario 2) has the same load magnitude, but a different circuit label. The manage time is similar to test-id 164 as expected.

6.2 Scenario 2

SPAN Dynamic Service Rating with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: 7kW (29.17A)
- Balanced load condition.
- Managed Circuit:
 - Ckt#2 Garage/Heat Strip.
 - SPAN Drive.
- EV load is 0 (not charging).
- Measure when ckt#2 manage start time.

Test-id	Breaker #2 (Garage – Heat Strip) (A)	L1 (A)	L1 (Power, kW)	L2 (A)	L2 (Power, kW)	Total Power	DSR Limit (A)	DSR Limit (Power, kW)	Total Power / DSR Limit (%)	Manage Time (s)
160	6	35	4.2	35	4.2	8.4	29.17	7.00	120%	1188 (19m, 48s)
161	7	36	4.32	36	4.32	8.64	29.17	7.00	123%	22
162	6	35	4.2	35	4.2	8.4	29.17	7.00	120%	1147 (19m, 7s)
163	10	39	4.68	39	4.68	9.36	29.17	7.00	134%	19

Table 6.2-1 Dynamic Service Rating with PowerUp Scenario 2 Test Result Summary

PowerUp will start managing ckt#2 when total power is above the DSR limit. The higher the ratio between total power to the DSR limit, the faster the circuit will start to be managed. Regardless the type of appliance powered by ckt#2, it does not impact when the circuit will start to be managed.

6.3 Scenario 3

SPAN Dynamic Service Rating with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: 7kW (29.17A)
- Un-balanced load condition.
- Managed Circuit:
 - Ckt#2 Garage/Heat Strip.
 - SPAN Drive.
- EV load is 0 (not charging).

- Measure when ckt#2 manage start time.

Test-id	L1 (A)	L1 (Power, kW)	L2 (A)	L2 (Power, kW)	Total Power (kW)	DSR Limit (A)	DSR Limit (Power, kW)	Total Power / DSR Limit (%)	Trip Time (s)
165	38	4.56	10	1.2	5.76	29.17	7.00	82%	NA (stays on, 30m test duration)
166	48	5.76	23	2.76	8.52	29.17	7.00	122%	27
188	46.75	5.61	22	2.64	8.25	29.17	7.00	118%	963 (16m, 3s)
189	44.75	5.37	20	2.4	7.77	1.11	7.00	111%	1514 (25m, 14s)

Table 6.3-1 Dynamic Service Rating with PowerUp Scenario 3 Test Result Summary

PowerUp will start managing ckt#2 when total power is above the DSR limit. The higher the ratio between total power to the DSR limit, the faster the circuit will start to be managed.

Test-id 165 is a condition where L1 current is greater than the calculated current based on the DSR limit ($7\text{kW} / 240\text{V} = 29.17\text{A}$). However, since the total power is less than the DSR Limit, PowerUp will not be activated in this condition.

6.4 Scenario 4

SPAN Dynamic Service Rating with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: 7kW (29.17A)
- Balanced load condition.
- Managed Circuit:
 - Ckt#2 Garage/Heat Strip.
 - SPAN Drive.
- EV load is 0 (not charging).
- Measure ckt#2 restoration time.

Test-id	Breaker #2		Before PowerUp			After PowerUp			Restore Time (s)
	Load(A)	Load Description	Amp	Power (kW)	Total Power / DSR Limit (%)	Amp	Power (kW)	Total Power / DSR Limit (%)	
156	10	Garage / Heat Pump	34	8.16	117%	24	2.88	41%	901 (15m, 1s)
155	15	Garage / Heat Pump	36	8.64	123%	21	4.32	36%	901 (15m, 1s)



Test-id	Breaker #2		Before PowerUp			After PowerUp			Restore Time (s)
	Load(A)	Load Description	Amp	Power (kW)	Total Power / DSR Limit (%)	Amp	Power (kW)	Total Power / DSR Limit (%)	
154	18	Garage / Heat Pump	36	8.64	123%	18	2.16	31%	900 (15m, 1s)
157	18	Garage / Heat Strip	36	8.64	123%	18	2.16	31%	180 (3m)
158	15	Garage / Heat Strip	36	8.64	123%	21	4.32	36%	180 (3m)
159	10	Garage / Heat Strip	34	8.16	117%	24	2.88	41%	189 (3m 9s)

Table 6.4-1 Dynamic Service Rating with PowerUp Scenario 4 Test Result Summary

Circuit restoration time depends on the circuit label (type of appliance) entered in the SPAN Installer App. Different type of appliance will have a different restoration time. ATS only tested 2 different appliance label: Heat Pump and Heat Strip.

6.5 Scenario 5

SPAN Dynamic Service Rating with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: 7kW (29.17A)
- Balanced load condition.
- Managed Circuit:
 - Ckt#1: Outlets/Downstairs/Electric Resistance Heater.
 - Ckt#2 Garage/Heat Pump.
 - SPAN Drive: EV load is 0 (not charging).
- Ckt#2 Garage/Heat Pump is higher in the PowerUp priority to Ckt#1 Outlets/Downstairs/Electric Resistance Heater.
- Perform 2hour test, observe which circuit is being managed.

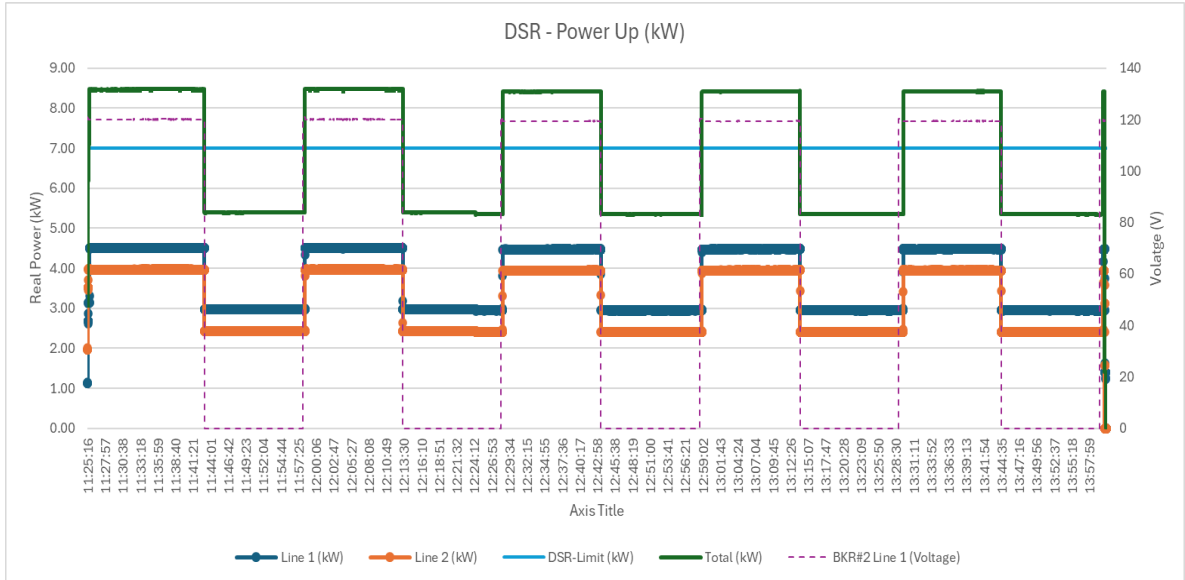


Figure 6.5-1 Power (kW) and Voltage (V) vs. Time plot .

PowerUp always managed Ckt#2 during the DRS event.

7.0 SPAN Drive with PowerUp Tests Results

7.1 Scenario 1

SPAN Drive with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: N/A
- Un-balanced load condition.
- Managed Circuit: Ckt#2 Garage/Heat Pump and SPAN Drive.

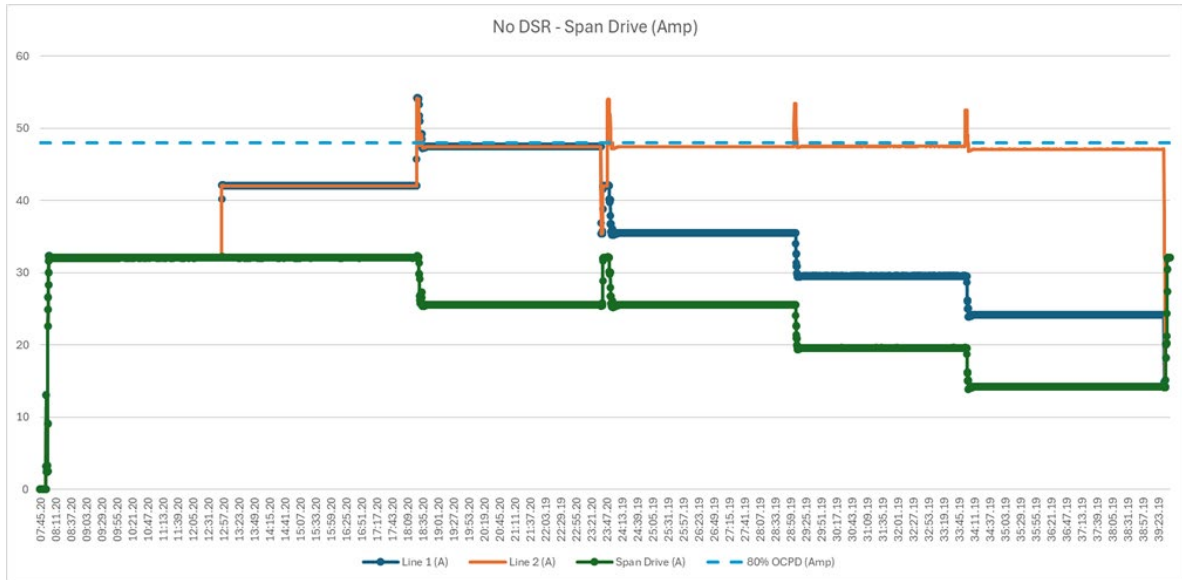


Figure 7.1-1 Current (A) vs. Time plot, SPAN Drive with PowerUp load management.

SPAN Drive charging current is managed such that none of the line current will be greater than 80% of the main OCPD rating.

7.2 Scenario 2

SPAN Drive with PowerUp is tested under this configuration:

- Main OCPD: 60A (14.4kW)
- DSR: 7kW (29.17A)
- Un-balanced load condition.
- Managed Circuit: Ckt#2 Garage/Heat Pump and SPAN Drive.

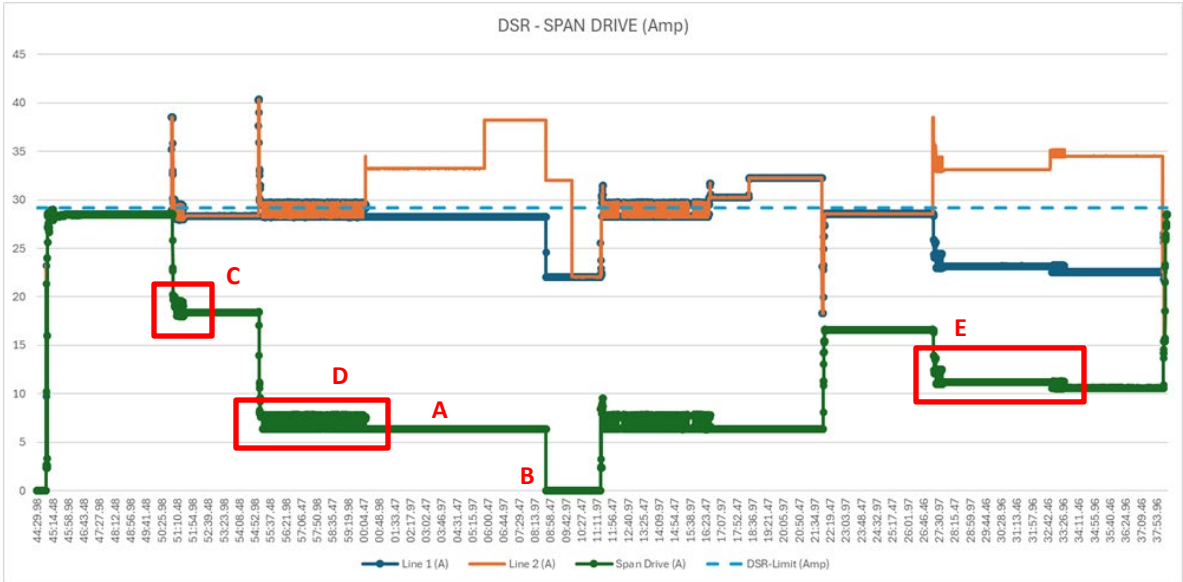


Figure 7.2-1 Current (A) vs. Time plot, SPAN Drive with active DSR and PowerUp load management.

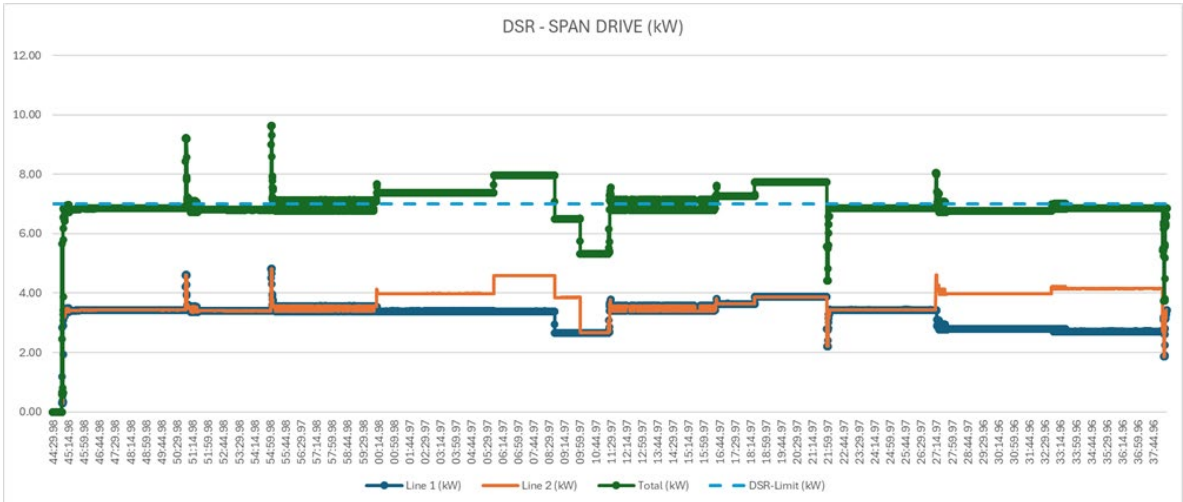


Figure 7.2-2 Real Power (kW) vs. Time Plot, SPAN Drive with active DSR and PowerUp load management.

Figure 7.2-1 and Figure 7.2-2 are generated from the same test. Since DSR limit is real power limit, SPAN Drive charging current is managed such that the total kW will be less than the DSR limit. Any of the line current is allowed to be above the calculated the DSR current limit, as long as the total kW is less than the DSR limit.

A in Figure 7.2-1 shows the allowable minimum charging current: 6.35A. The charging current can't be lower than 6.35A. If the total kW is still above the DSR limit when the charging current is already at 6.35A, the charging current will be set to 0A after certain period of time as shown in B in Figure 7.2-2.

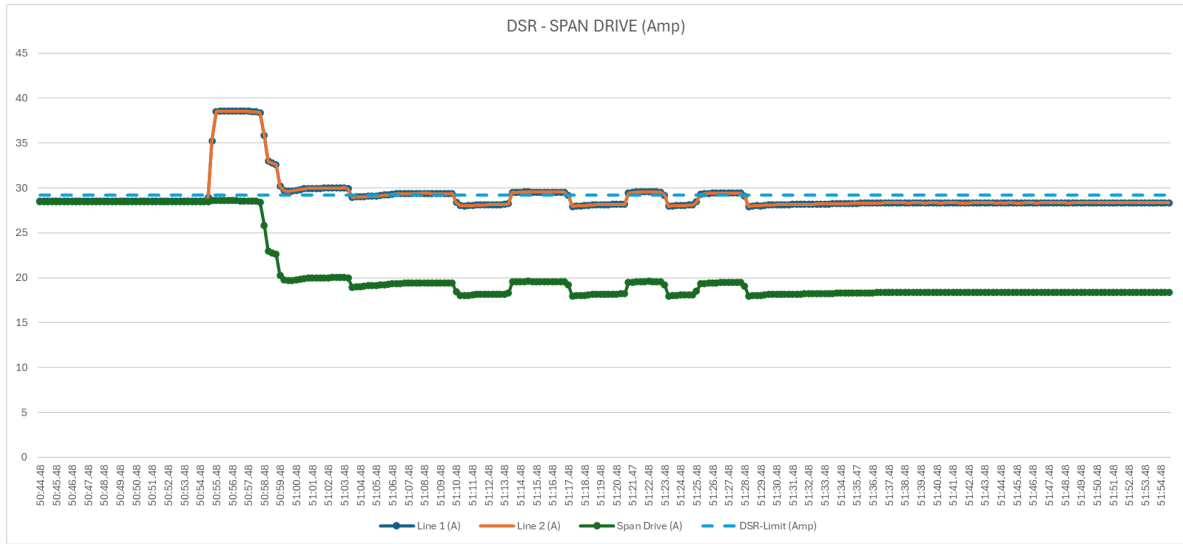


Figure 7.2-3 Close up plot of box C from Figure 7.2-1. Charging fluctuations when adjustment is made.

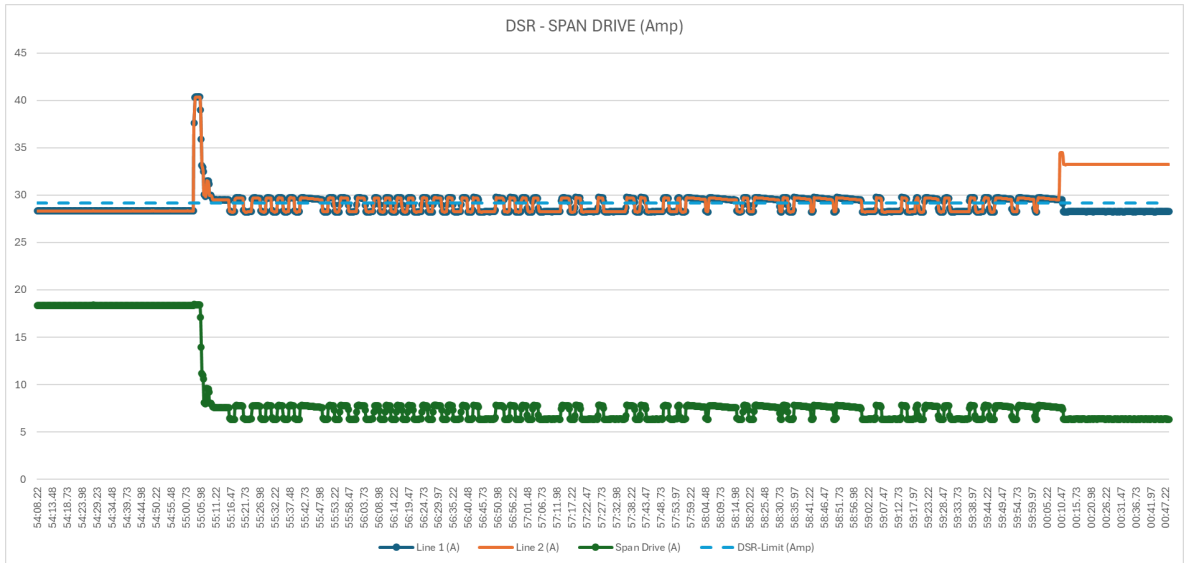


Figure 7.2-4 Close up plot of box D from Figure 7.2-1. Charging fluctuations when adjustment is made.

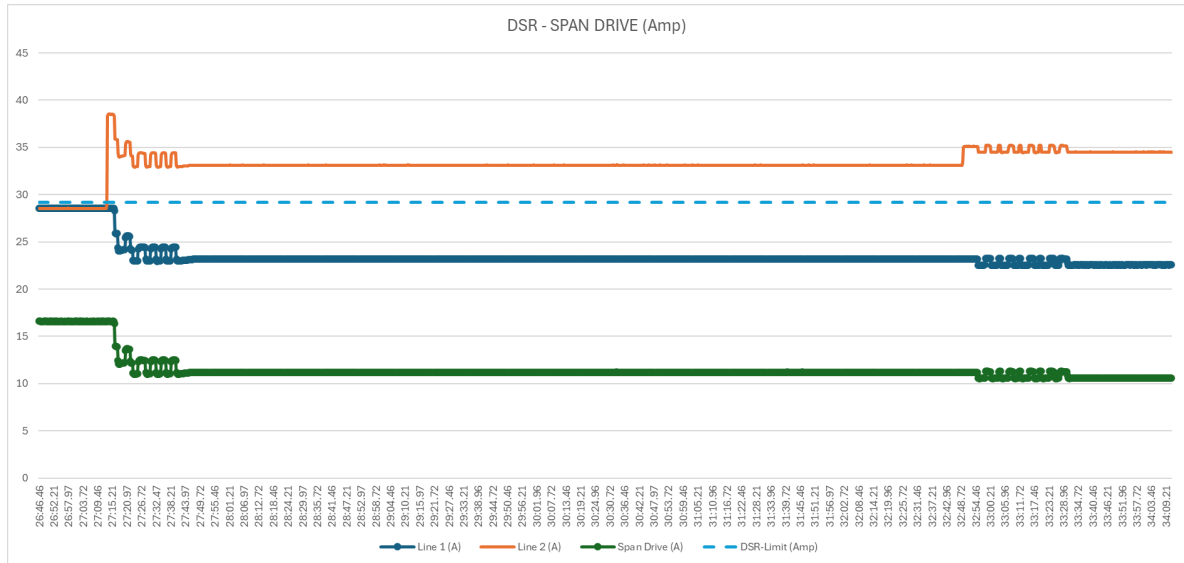


Figure 7.2-5 Close up plot of box E from Figure 7.2-1. Charging fluctuations when adjustment is made.

The charging current is fluctuating +/- 1.3A when adjustment is made. When the charging current is adjusted to the minimum value (6.3A), it fluctuates for 3 minutes and 51 seconds (Figure 7.2-4) until the charging current stabilize.

8.0 Review of SPAN and SPAN Drive Certifications

The team did a review of SPAN Drive’s stated certification in accordance with SPAN’s public web interface. The team did a review of SPAN and SPAN Drive’s stated certification in accordance with SPAN’s public web interface.

SPAN listed certifications	Notes a general explanation of those certifications
UL 67	Panel board specific standard. See appendix for details.
UL 916	UL 916 is a safety standard for energy management equipment (EME) and associated sensing devices from Underwriters Laboratories (UL). The standard applies to equipment that is rated 600 volts or less and is intended to be installed in accordance with the National Electrical Code, NFPA 70. EME is used to control electrical loads by responding to sensors or transducers, sequencing, or cycling loads through preprogrammed data logic circuits. The equipment can also monitor devices that respond to signals from a utility company over power lines or as radio signals.
UL 869A	UL 869A is a standard that sets requirements for service equipment, including panelboards and switchboards, that are designed to be installed in accordance with the National Electrical Code (NEC)
NEC compliant	

SPAN Drive listed certifications	Notes a general explanation of those certifications
UL 2594	UL 2594 is a safety standard that covers electric vehicle (EV) supply equipment, rated a maximum of 250 V ac, with a frequency of 60 Hz, and intended to provide power to an electric vehicle with an on-board charging unit.
UL 2231	UL 2231 is a safety standard that covers personnel protection systems for electric vehicle supply circuits.
ENERGY STAR®	Products that earn the ENERGY STAR label are independently certified to meet strict standards for energy efficiency set by the EPA.



9.0 Appendix

9.1 UL 67 Description

UL 67: UL 67 is also applicable for residential electrical panel.

Below is the scope description from UL:

1 Scope

1.1 These requirements cover panelboards to be employed in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements cover panelboards for the intended to provide the primary function of control and protection of electrical circuits.

1.3 These requirements do not cover:

a) Distribution equipment which sole function is the automatic or nonautomatic transferring of one or more load conductor connections from one power source to another. Reference the Standard for Transfer Switch Equipment, **UL 1008**.

b) Factory wired assemblies of industrial control equipment intended to control industrial processes. Reference the Standard for Industrial Control Panels, **UL 508A**.

c) Distribution equipment containing only one circuit subdivision, unless also provided with a meter socket. See 1. Reference the Standard for Molded-Case Circuit Breakers, Molded-Case Switches and Circuit-Breaker Enclosures, **UL 489**.

d) Distribution equipment intended to serve as a means for distributing power required to operate mobile or temporarily installed equipment. Reference the Standard for Power Outlets, **UL 231**.

e) Factory wired assemblies of controllers, timers, temperature regulating equipment and such, intended for control of equipment for use with swimming pools, hot tubs, and/or spas. Reference the Standard for Electric Spas, Equipment Assemblies, and Associated Equipment, **UL 1563**.

f) Factory wired assemblies intended for the control of Architectural and Floating Fountains. Reference the Standards for Motor-Operated Water Pumps, **UL 778**, Underwater Luminaires and Submersible Junction Boxes, **UL 676** and Industrial Control Panels, **UL 508A**.

g) Portable power distribution equipment. Reference the Standard for Portable Power-Distribution Equipment, **UL 1640**.

h) Panelboards with converter and/or inverter functions, intended for use as distribution equipment in recreational vehicles. Reference the Standard for Power Converters/Inverters and Power Converter/Inverter Systems for Land Vehicles and Marine Crafts, **UL 458**.



9.2 Default PowerUp Priority

Default priorities for SPAN Panel MAIN 32

Priority	Appliance type (selected by installer)
1	SPAN Drive
2	Other EV charger
3	Machinery
4	Snow melt
5	Tank electric resistance water heater
6	Heat strip
7	Electric resistance heater
8	Electric floor heat
9	Steam shower
10	Hot tub
11	Sauna
12	Air handler
13	Furnace
14	Pool heater
15	Pump
16	Other water heater
17	Dryer
18	AC condenser
19	Heat pump (HP)
20	Mini-split AC / HP
21	Geothermal
22	Other HVAC
23	Spare
—	Types not listed here - highest breaker rating first, then lowest breaker space number first
Last - 6	Range
Last - 5	Oven
Last - 4	Oven & Range



Last - 3	Elevator
Last - 2	Subpanel
Last - 1	SPAN Panel
Last	Surge protector