xEV Smart Charging Experience PRD

Product Requirements Document

Electric Vehicle Connected Services

(Feature Bundle 5)

Version 1.15

09/04/2019

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1 Change Control

Version	Author	Changes	Release Date
1	VPOWERS5, ASANANIK	Initial Release	8/17/2018
1.1	VPOWERS5, ASANANIK	Master Reset updates with input from Pankaj; updated stakeholder table; updates to Charge Schedule Updates and data elements for Charge Schedules and Departure Times	
1.2	VPOWERS5, ASANANIK	Added new requirements: - 7-day schedule - Duration - Departure times per location - Charge alert sent to analyze power draw variation - Stop/Start charge commands	8/31/2018
1.3	VPOWERS5, ASANANIK	DC Fast Charging requirements added, ISO Charge Station schedule/power schedule elements added, removed reqt. that Stop Charge command will last until end of charge window, updated stakeholders, updated power draw requirements & added power de-rate capability section	9/13/2018

1.4	VPOWERS5, ASANANIK	Added new requirements after meeting with HPCM/EPE team:
		• User will not be able to VIEW Smart Charge & Departure Settings (can view these as PCT, but not SC)
		• User will be able to VIEW "what happens now" or "what will happen if you plug in right now" (status @ smart charging location)
		  ○ Next Charging Window (start/end time)
		  ○ Target SOC
		• User will NOT be able to EDIT Smart Charging Charge nor Departure settings in-vehicle
		• Stop Charge Command – Utility provider or grid may issue on demand grid event and stop/pause charge
			9/21/2018

1.5	VPOWERS5, ASANANIK	Updates per FB5 CCS settings Updates to Charge Schedule Updates, Departure Time Updates, Stop Charge Command, User Involvement New requirements after meeting with HPCM/EPE team: • Stop Charge command will be a global command – applies to SC, PCT, and Charge Now. • Smart Charging shall have 2 Departure Times per day per location	9/27/2018

1.6	VPOWERS5, ASANANIK	Added to list of actors Details added to Stop Charge & Start Charge Revisions from TDR review HMI requirements specifically called out	10/5/2018
1.7	VPOWERS5, ASANANIK	Updated Smart Charging settings sent from cloud Corrected stakeholder list Requirement #s added Power De-Rate removed from scope Start & Stop commands removed from scope Clarified distinctions between “schedule”, “windows”, and “smart charging settings” New reqt: Smart Charging will be available for BEVs only and globally where FNV2 architecture is supported, unless regionally limited New reqt: At Job 1 and for controllable launch, Smart Charging will only be available to a specified sub-set of VINs Clarified reqts. around editing location target SOC and minimum SOC Added legal requirements	10/18/2018
1.8	VPOWERS5, ASANANIK	Stakeholder list moved to Sharepoint Jeremy HMI notifications document incorporated into PRD Stop duration removed from scope User *can* select 100% as minimum SOC global value Smart Charging is only available in normal mode and not in manufacturing or transport mode Vehicle will store 7 days of Smart Charging settings per location Separate user consent pop-up for Smart Charging not required in-vehicle Assumptions added, new formatting for reqt. ID, stakeholder list moved to Sharepoint, additional safety, reliability, and	11/02/2018

		performance requirements added based on Technical Design Review feedback	
1.9	VPOWERS5	Specified specific values to be deleted during Master Reset & Brand Connect Reset Vehicle shall charge to maximum value between target SOC and minimum SOC Added error notification to HMI notifications section for when user tries to set a target SOC below their minimum SOC Updated CCS Entity Type # and ID # Rephrased legal requirement #43 for deleting location – interface must exist, but user-deletion capability does NOT need to exist in-vehicle Removed reqt #20 ability to delete SC locations – *user shall be able to view and delete all or any Smart Charging locations via HMI* Removed deletion of Smart Charging location from HMI notifications section	11/21/2018
1.10	VPOWERS5 MGRAY129	Revised Minimum SOC requirements – minimum SOC and minimum Target SOC values that user can select to be determined by UX team. Removed below requirements: **###R_F_SC_00035### Minimum SOC > 50%** Min SOC level cannot be adjusted to less than 50% **###R_F_SC_00036### Minimum SOC increments** Min SOC level can be set in increments of 10% starting from 50% and up to 100%. **###R_F_SC_00038### Target SOC > 50%** Target SOC level cannot be adjusted to less than 50% **###R_F_SC_00039### Target SOC increments** Target SOC level can be set in increments of 10% starting from 50% and up to 100% Removed mention of Target SOC one- time edits as it is moving from SC specific to global feature.	12/6/2018
1.11	VPOWERS5	Vehicle will not store target SOC per location per day; only target SOC per location.	12/14/2018

		One-time edits for Target SOC and Departure times are moving from SC specific requirements to global requirements, affecting Preferred Charge Times and charge programming.	
1.12	VPOWERS5	One-time edits removed from scope	1/28/2019
1.13	VPOWERS5	Preferred Charge Times not in effect in Smart Charging is ON	4/01/2019
1.14	VPOWERS5	Added Departure Times requirements #47, 48, and 49 and removed reference to BUAllow in CCS function (reqt #45) Added assumption for Smart Charging fleet experience Revised HMI notifications table based on HMI *P31a_15P_ChageSettings_D_042619* spec Added CVBOP (Connected Vehicle Business Operation Portal) section - requirements forthcoming Removed requirements #31 "auto" minimum SOC and suggested minimum SOC value Removed section 9.2 – Begin Charge Revised Master Reset table	8/01/2019
1.15	VPOWERS5	Clarified CCS requirement – Smart Charging will turn off when vehicle data, location sharing, vehicle connectivity, driving characteristics, or remote controls is turned off Revised reqt ###R_F_SC_00005### HMI Smart Charging landing page Removed reqt ###R_F_SC_00013### SC Onboarding after feature is ON Revised reqt ###R_F_SC_00014### Minimum SOC Removed both of the Smart Charging Activation messages from section 21 – HMI Notifications	

2 Executive Summary

2.1 Purpose of this document

The purpose of this document is to detail the **in-vehicle** requirements for the xEV Smart Charging feature. Smart Charging takes the decision-making burden off users by using a machine-learning algorithm that automatically makes charging decisions for the user based on routines and preferences. The Smart Charging feature will be available to all Ford and Lincoln BEVs starting in CY2020/MY2021; it can be deployed globally.

The Smart Charging experience for China may need to be tailored based on limitations pertaining to tracking and recording Chinese nationals GPS data.

2.2 Current charging experience

Currently, EV owners can use the FordPass/Lincoln Way App to check current and projected charge programming information as well as set up preferred charge times. Preferred Charge Times allow users to select times during which charging will take place at their saved locations based on user-dictated schedules and low-cost energy time ranges.

Preferred Charge Times puts the decision-making burden on the user; Smart Charging removes this burden and aims to eliminate range anxiety while also making the charging experience a smooth and simple one.

2.3 Future charging experience

Smart Charging aims to create a seamless charging experience. A machine-learning algorithm determines charging times and locations based on a user's daily routine and preferences, and sends these settings to the vehicle. This feature saves users time and money all while keeping them charged to the necessary amount. Additionally, through integration with utility providers and grid services, the algorithm navigates pricing trends and wait times delivering a "don't make me think" value proposition to users.

Smart Charging is one of five new EV features aimed at making Ford EVs more competitive in the market. The other features are:

- Locate & Pay
- Plug & Charge
- Trip Planner
- Charge Station Availability
- Cloud Based POIs

2.4 Scope of this Document

The scope of this document is to define the Smart Charging experience as it relates to changes to the *in-vehicle* modules.

2.5 Business objectives

In transitioning from Preferred Charge Times to Smart Charging, the following business objectives shall be achieved:

1. Support in utility and automotive industry effort to use BEVs as a grid resource
2. Enhance EV user experience and minimize user travel anxiety relative to battery capacity
3. Increase FordPass and FordPay adoption
4. Support Ford brand value and trust in the market

5. Support MVP build milestone for CX727 in North America and the EU

2.6 Assumptions

No.	Description
A1	To utilize the Smart Charging feature, the user has a FordPass/LincolnWay account
A2	EV Customers will use FordPass and LincolnWay for their connected experience
A3	Users must be fully authorized to their vehicle to access Smart Charging. This means the user has met the following conditions: • User has installed and created a valid login account for the Ford owner mobile app • User has registered an eligible vehicle VIN (define as a VIN which is known to have a TCU installed and has sent a provisioning message to NGSDN) • User has completed the authorization process for the eligible VIN At Job 1, Smart Charging will only be available to a sub-set of eligible VINs.
A4	Designs and concepts of UI/UX shown in PRD are not finalized content. UI/UX team to define the right experience
A5	The FordPass team will determine how the experience will differ on the web and the mobile app. For the purpose of this document, any reference to "FordPass" could mean via any of the defined FordPass channels
A6	The user experience for this feature will be consistent across FordPass, HMI and web
A7	Payment & Subscriptions are not required for the Smart Charging feature
A8	Smart Charging will be available per-VIN and not per-user
A9	The Smart Charging experience is dependent on the type of station for which the vehicle is charging. At DC fast charge station, vehicle will always charge immediately.
A10	Smart Charging can expand with the 100% connectivity initiative as connected features are deployed in more regions.
A11	Smart Charging will not have fleet applications for CX727 launch, but will for P702

2.7 Constraints

No.	Description
C1	Smart Charging is a BEV-only feature

C2	Smart Charging will be available globally to registered owners, unless country-specific regulations prohibit the use of the feature
C3	There must be modem connectivity for Smart Charging to work

2.8 Dependencies

No.	Description
D1	Mobile app availability (for download) will depend on mobile application store (Apple Store and Google Play)
D2	Detailed logical functions related to the requirements in this PRD are captured in the FS
D3	All vehicles have at least FNV2 architecture

2.9 Stakeholder Overview

The Smart Charging stakeholder list can be located here.

3 Product Detail

The high-level data flow between the vehicle, cloud, and mobile app is shown below. The smart charging algorithm is hosted in the cloud – optimal charging settings will be sent from the cloud to the vehicle. Trip and charge information from the vehicle feeds to the cloud and serve as inputs into the algorithm; the algorithm continually refines charge schedule settings to evolve with routine and preference changes over time. The user will have the ability to turn on and turn off Smart Charging via FordPass/Lincolnway or the HMI.

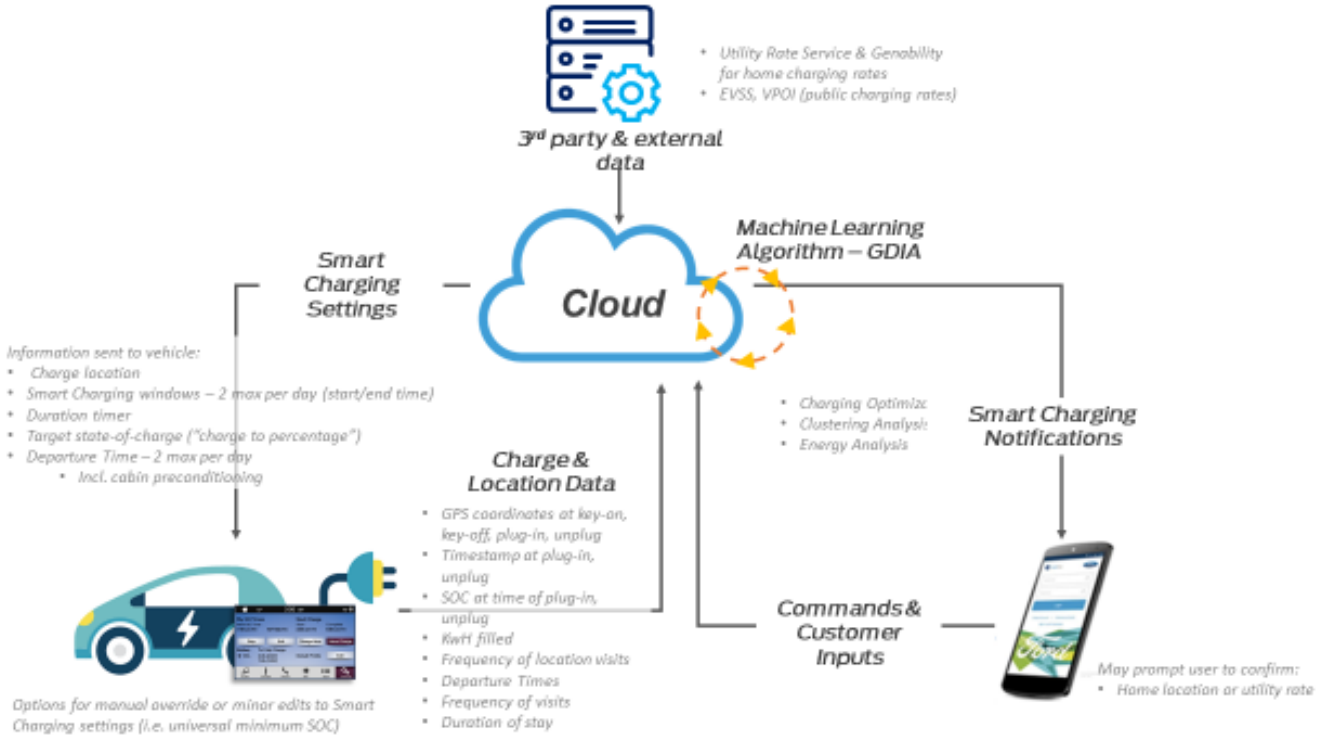


Figure 1 Smart Charging – Data Flow

2.2 Architecture overview

Below is a view of the Smart Charging architecture; the main pieces are the mobile app, the cloud, and the vehicle.

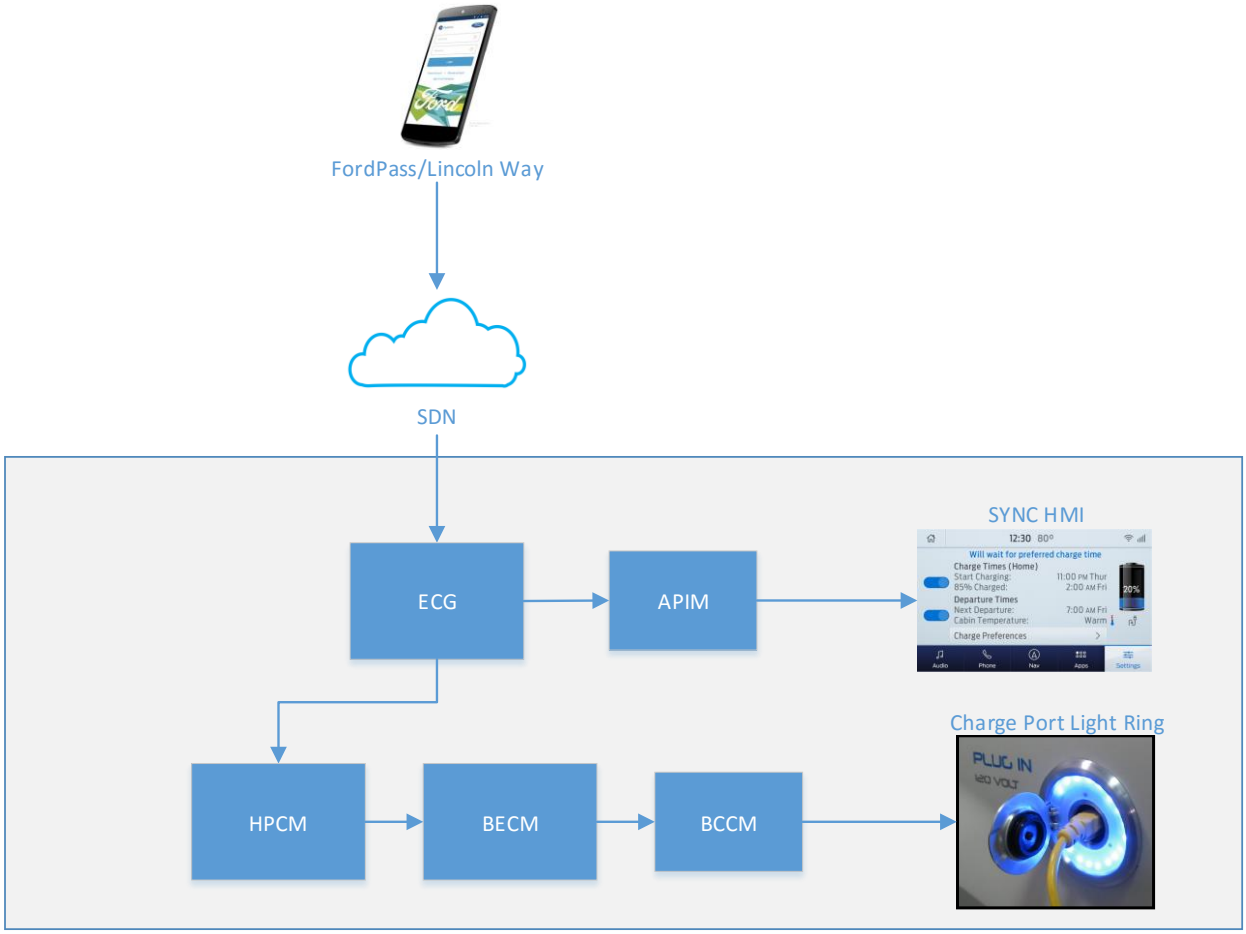


Figure 2 Smart Charging – Architecture Overview

3.1 Actors

Below is a list of actors used throughout this document. The relationship between these actors will be detailed in the remaining sections.

Actor	Vehicle/Cloud	Team Responsible	Description
ECG	Vehicle	ECG team	The Enhanced Central Gateway is an Ethernet enabled component with excess computing capability to house and /or bridge next generation technology.
SDN	Cloud	CVP&P	The Service Delivery Network processes the data provided by the TCU/ECG and converts it into the appropriate format for delivery to a given User Interface or 3rd Party Provider.

SCA-V	Cloud	GDIA	A sub-group of the Global Data Insights and Analytics practice, SCA-V houses the smart charging algorithm. It is responsible for recalculating the smart charging settings based on user routine learning and publishes new settings to be sent to the vehicle.
VPOI	Cloud	VPOI	Vehicle Point of Interest – cloud application that provides EV saved and unsaved locations and preferred charge time profiles. Also interfaces with 3rd party charge station providers to retrieve charge station info. Syncs with HPCM when user makes changes via FP/LW
BCCM	Vehicle	EPE	The Battery Charge Control Module is the High Voltage charge controller on BEVs and PHEVs. This module regulates AC power for basic charging of the main traction battery on PHEVs and BEVs.
BECM	Vehicle	EPE	The Battery Energy Control Module monitors the condition and SOC between cells
OBCC	Vehicle	EPE	The Off-Board Charge Control module is responsible for communication with AC or DC Fast Charging stations using the ISO 15118-2 standard protocol.
HPCM	Vehicle	EPE	Hybrid Powertrain Control Module – in-vehicle module that holds Departure Times and Charge Settings
SYNC/APIM	Vehicle	SYNC team	Center stack user interface inside the vehicle

3.2 Acronyms & Definitions

Acronym	Definition
EVSE	Electric Vehicle Supply Equipment – more colloquially known as EV charging stations
AC Charging Station	Alternate current charging stations; available as Level 1 (110V) or Level 2 (220V). In-car converter translates AC to DC (direct current)
DC Fast Charging Station	Direct current fast charging stations; available as Level 3. AC current is converted to DC before entering the vehicle
Windows	The suggested or preferred charging start and end times sent from the cloud to the vehicle. The window is developed in the cloud and is an input for the actual vehicle schedule.

Schedules	The actual start and end times the vehicle charges based on the windows, battery SOC, external conditions, etc.
GDPR	General Data Protection Regulation – this is a regulation in EU law on data protection and privacy for all individuals within the EU. It was implemented in May 2018.

4 High Level Journey

Below is the high-level Smart Charging journey – based on a machine-learning algorithm that identifies charging behaviors and daily routines, optimal charging settings are sent from the cloud to the vehicle. The user will only need to plug in their vehicle while the cloud's machine learning algorithm collects data and adapts the charge schedule settings based on the user's routine.

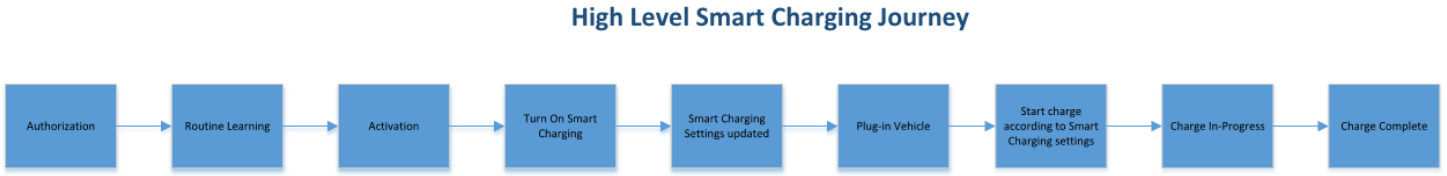


Figure 3: High Level Smart Charging Journey

5 Feature Modeling

5.1 Operation Modes and States

The below state chart models the state-based and mode behavior of the Smart Charging feature.

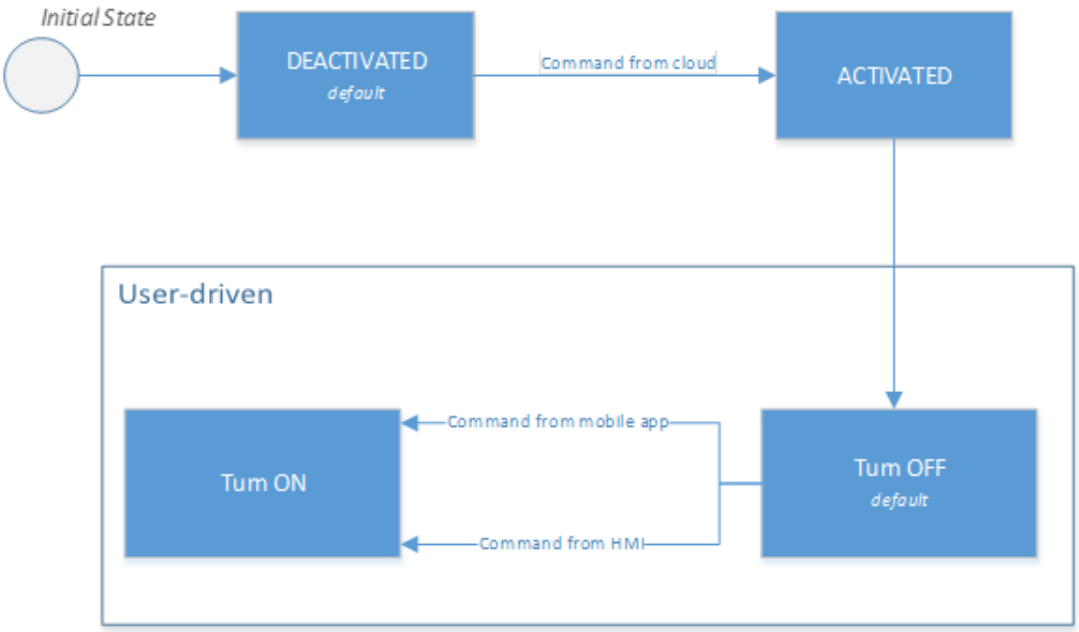


Figure 4: Smart Charging State Chart

6 Smart Charging Activation

6.1 Activate/Deactivate Smart Charging Feature

For Job 1 launch in CY2020, Smart Charging shall only be available for a subset of VINs. While Smart Charging functionality will be available for all Ford and Lincoln CY2020/MY2021 BEVs, the feature will be activated or unhidden only for a sub-set. The default is deactivated.

###R_F_SC_00001### Activation for qualifying VINs

Smart Charging as a feature shall only be activated for a set number of VINs. The default is deactivated.

###R_F_SC_00002### Activation command

Activation command shall be sent from the cloud to qualifying vehicles

###R_F_SC_00003### Activation state

Vehicle shall track state of Smart Charging Activation

###R_F_SC_00004### Normal Mode

Smart Charging is only available when the Vehicle Life cycle is set to NORMAL mode. In other modes (TRANSPORT OR MANUFACTURING), Smart Charging shall be deactivated.

6.1.1 Use Case

###UC_F_SC_00001### SC Feature Activation

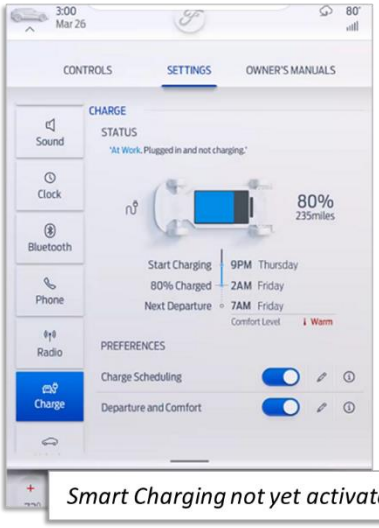
Purpose		Allow cloud to activate Smart Charging for specific vehicles
Actors		Vehicle, Cloud
Precondition		CCS settings are turned on Smart Charging is deactivated for vehicle
Main Flow	M1	Cloud activates Smart Charging
	M2	Cloud sends request to vehicle to activate Smart Charging
	M3	Vehicle successfully activates Smart Charging
	M4	Vehicle sends acknowledgement to cloud that Smart Charging is activated
Post-condition	P1	Smart Charging is activated

7 Onboarding

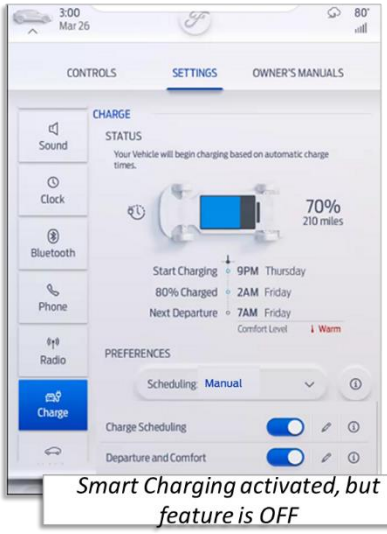
7.1 Smart Charging Activation

###R_F_SC_00005### Smart Charging activation

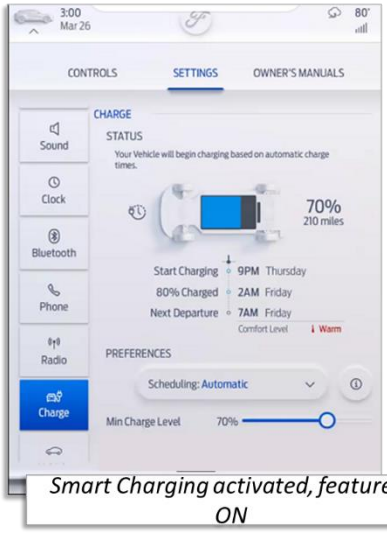
After Smart Charging has been activated for the specific VIN, the user shall be informed the feature is now available for use. This is shown through an automatic (Smart Charging) and manual (Preferred Charge Times) toggle.



Smart Charging not yet activated



Smart Charging activated, but feature is OFF



Smart Charging activated, feature is ON

7.2 Turn ON Smart Charging

###R_F_SC_00006### Turn on SC via mobile app

If Smart Charging is activated for the specified VIN, the user shall be able to turn on the feature from FordPass or Lincoln Way

###R_F_SC_00007### Turn on SC via HMI

If Smart Charging is available for the specified VIN, the user shall be able to turn on the feature from the HMI

###R_F_SC_00008### default SC state

By default, Smart Charging shall be turned off

###R_F_SC_00009### Preferred Charge Times after SC ON

Turning on Smart Charging will not erase previously set Preferred Charge Times stored on the vehicle

###R_F_SC_000010### Preferred Charge Times updates after SC ON

User shall *not* be able to update saved locations with Preferred Charge Times once Smart Charging is ON

###R_F_SC_00011### SC storage on vehicle

Smart Charging settings shall be stored on the vehicle

###R_F_SC_00012### SC successfully turned ON

Once successfully turned ON, result shall display on both platforms (HMI or mobile app)

7.2.1 via HMI

The process for turning on Smart Charging via the HMI is shown below:

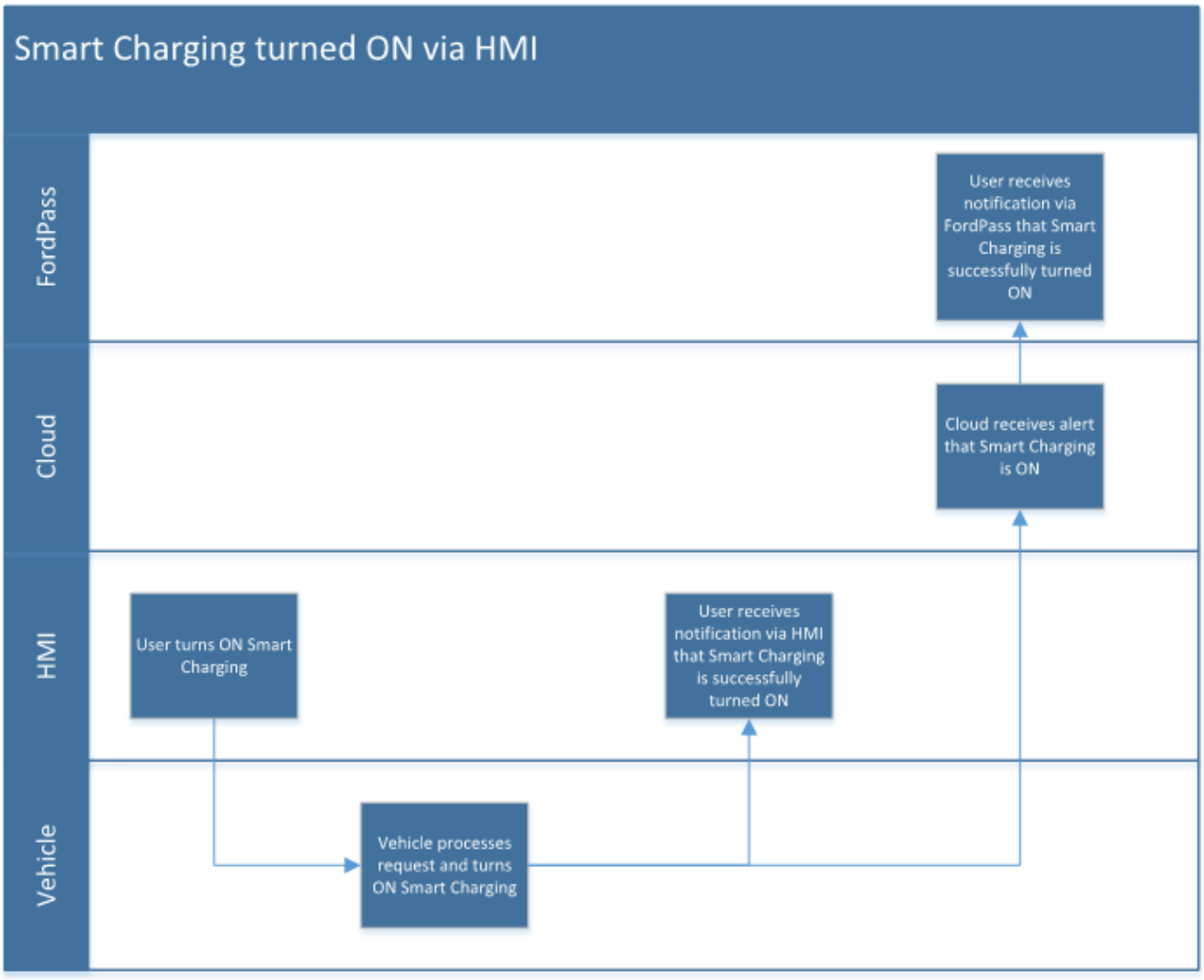


Figure 5 Turning ON Smart Charging via HMI

7.2.2 via mobile app

The process for turning on Smart Charging via mobile app is shown below:

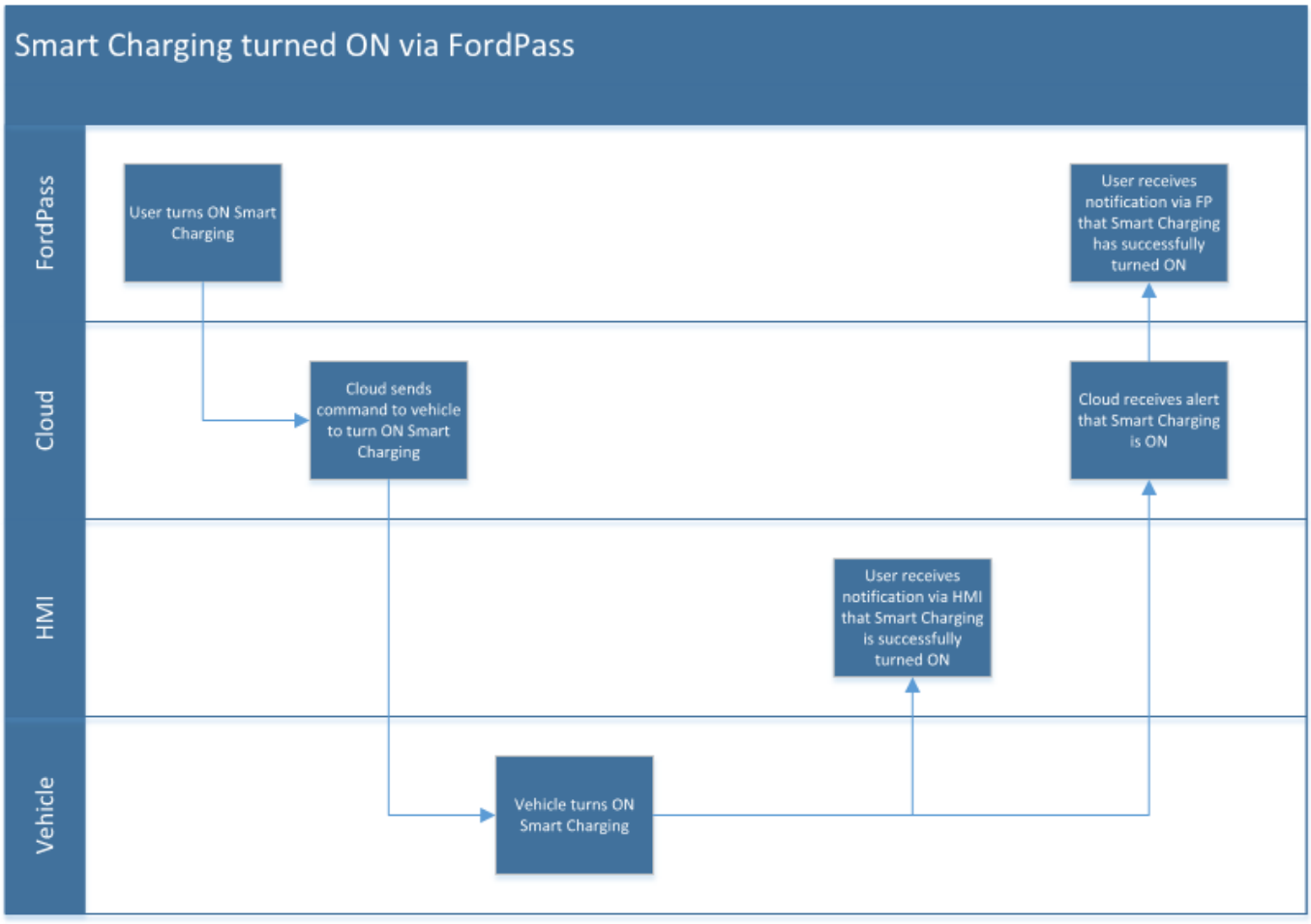


Figure 6 Turning ON Smart Charging via FordPass

7.2.3 Use Case

###UC_F_SC_00002### SC Feature ON

Purpose		Allow user to turn ON Smart Charging feature
Actors		User, Vehicle, Cloud
Precondition		User has authorized vehicle User registered for FP/LW CCS settings are turned ON Smart Charging is activated for vehicle Smart Charging is OFF
Main Flow	M1	User turns ON Smart Charging via mobile app
	M2	Cloud sends request to vehicle to turn ON Smart Charging

Alternative Flow 1	A1-1	User turns ON Smart Charging via HMI
Post-condition	P1	Vehicle turns ON Smart Charging
	P2	Vehicle sends acknowledgement to cloud that Smart Charging is ON
	P3	User is notified Smart Charging has successfully turned ON (mobile app & HMI)

7.3 Post turning-on Smart Charging

~~###R_F_SC_00013### SC Onboarding after feature is ON~~

~~There shall be an HMI experience familiarizing the user with the functionality of the feature (cf. HMI Notifications)~~

###R_F_SC_00014### Minimum SOC

The user can set a minimum SOC via the HMI (cf. Other Available Settings – HMI)

8 Smart Charging Machine Learning Algorithm

8.1 Routine Learning

The vehicle sends trip and charge data (i.e. location lat/long, plug-in time, battery SOC at time of plug-in, charge begin/end times, etc.) are sent to the cloud for processing immediately after the vehicle is authorized. This data is fed to the cloud's machine learning logic to be applied to the Smart Charging feature.

8.2 Smart Charging & HMI view

As route data is gathered, the Cloud will define new charge settings. The Clouds machine learning logic will continually refine settings – based on routine and driving patterns in addition to external conditions like traffic, charger availability, etc. - which are sent to and stored on the vehicle. The smart charging algorithm in the cloud will dictate how often settings are sent to the vehicle.

###R_F_SC_00015### 7-day storage

The vehicle shall store 7-days of Smart Charging settings – except for target SOC - per Smart Charging location

###R_F_SC_00016### unable to view SC windows via HMI

Users *shall not* be able to view their weekly or forecasted Smart Charging windows via HMI

###R_F_SC_00017### able to view SC status via HMI

If user is at a smart charging location, user *shall* be able to view the status of their charging at that location via HMI

###R_F_SC_00018### able to view SC schedule via HMI

If user is at a smart charging location, user *shall* be able to view that location's charging schedule (start/end time) and target SOC

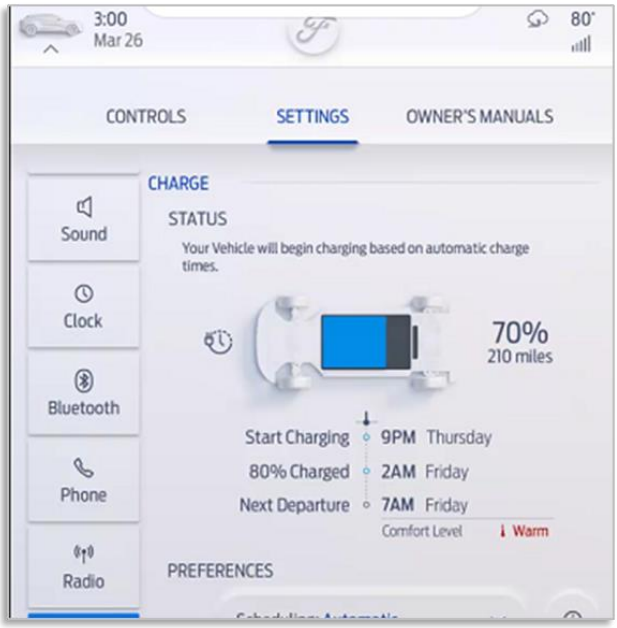


Figure 7 Mock FB5 charging status screen if at a Smart Charging location

###R_F_SC_00019### unable to edit SC windows via HMI

User *shall not* be able to edit their smart charging windows for any smart charging location via HMI

###R_F_SC_00020### deleting a location

If Smart Charging location is deleted, Smart Charging shall be turned OFF

8.2.1 Command for Charge Settings Updates

###R_F_SC_00021### SC settings update

A command shall be sent from the SDN to the vehicle to sync the latest smart charging settings on the vehicle

8.2.2 Smart Charging Settings

The Smart Charging format will be in some ways similar to that of Preferred Charge Times. However, Smart Charging requires additional data elements, which will be sent by the cloud to the vehicle, where these values will be stored.

###R_F_SC_00022### Smart Charging locations

The vehicle shall hold 5 max. Smart Charging locations (in addition to 10 Preferred Charge Time locations)

###R_F_SC_00023### Day-specific settings

The vehicle shall maintain the ability to store day-specific settings, with the exception of target SOC.

###R_F_SC_00024### Settings per location

Smart Charging settings **shall be per location** and will include:

a. Charge location (GPS lat/long, etc)
b. Smart Charging windows, 2 max windows per day (start and end windows)
c. Target SOC ("charge to % level")
d. Start duration-based charge time – this is location specific (not tied to a day of the week)
e. Maximum power - max power vehicle can draw from EVSE mains

A duration window is a length of time for which the vehicle can charge when at a specified location. For example, a user takes advantage of 1 hour of free charging at the gym every week, but not always on the same day. The duration window allows the vehicle to capture that free hour of charge by assigning a duration of 60 mins. to the gym rather than a start/end time and day requirement. In such cases, the Smart Charging time windows could be set to 24 hours.

8.3 Departure Times Updates & HMI view

As route data is gathered, the Cloud will also define new Smart Charging-specific departure times. The Cloud's machine learning logic will continually refine departure times, in addition to smart charging settings, which will be sent to and stored on the vehicle. Smart Charging does not affect the existing functionality of Departure Times (two global Departure Times per day).

8.3.1 Command for Departure Times Updates

The existing command for Departure Time updates will be used for Smart Charging.

###R_F_SC_00047### Departure Times View - HMI

The user shall be able to *view* Smart Charging-set Departure Times on the vehicle HMI.

###R_F_SC_00048### Departure Times editing functionality removed - HMI

The below functionality shall be removed when Smart Charging is ON

- Global on/off toggle
- Clear all
- Editing functionality

There shall be an HMI experience educating the user as to why there is no Departure Times editing functionality when Smart Charging is ON.

###R_F_SC_00049### Departure Times within Charge Settings Tile - HMI

When Smart Charging is ON, the Departure Times line item below preferences (including global on/off) in the Charge Settings Tile shall be removed

8.4 Charging Logic

The logic for determining when the vehicle actually charges will be based on existing signals within the vehicle. Smart Charging will *not* impact this existing logic when determining if the vehicle needs to charge outside its windows to reach target SOC, or if it will not reach the desired target SOC.

8.5 Use Case

###UC_F_SC_00003### SC Departure Times

Purpose		Allow cloud to update vehicle with Smart Charging settings & Departure Times
Actors		Vehicle, Cloud
Precondition		User has authorized vehicle User registered for FP/LW CCS settings are turned on Smart Charging is activated for vehicle Smart Charging is ON
Main Flow	M1	Cloud sends Smart Charging Settings & Departure Times to vehicle
	M2	Vehicle syncs latest settings
	M3	Vehicle sends acknowledgement to cloud that Smart Charging Settings & Departure Times have successfully synced
Post-condition	P1	Cloud is informed vehicle has successfully synced latest Smart Charging Settings & Departure Times

9 Charging Experience

9.1 Plug In

###R_F_SC_00025### SC Settings used when SC ON

If Smart Charging is turned ON and the user is at a Smart Charging location, the Smart Charging settings shall be used

###R_F_SC_00026### SC interaction with PCT

If Smart Charging is ON and the user is not at a Smart Charging location, but is at a saved location with previously set Preferred Charge Times, the Preferred Charge Time windows shall *not* be used. The vehicle will immediately start charging upon plug-in

###R_F_SC_00027### SC interaction with Charge Now

If the user is not at a Smart Charging location nor at a saved location with Preferred Charge Times, the vehicle will immediately start charging upon plug-in

###R_F_SC_00028### SC ON when at a non-Smart Charging location

If the vehicle is at a non-Smart Charging location, Smart Charging shall remain turned on

Shown below is the plug-in process for when Smart Charging is turned on.

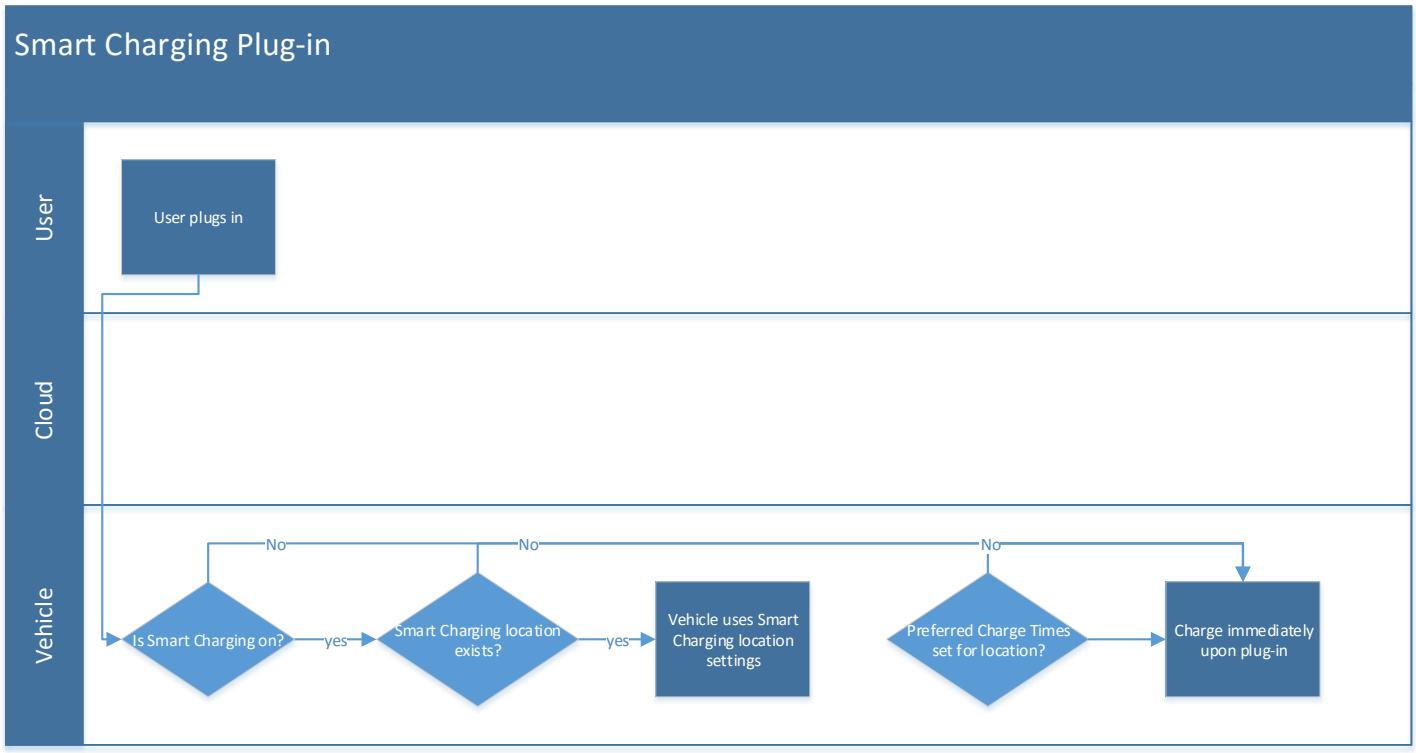


Figure 8 Smart Charging – User Plugs In

9.1.1 Use Case

###UC_F_SC_00004### SC Charging Experience

Purpose		User expects vehicle to charge accordingly
Actors		User, Vehicle, Cloud
Precondition		User has authorized vehicle User registered for FP/LW CCS settings are turned on Smart Charging is activated for vehicle Smart Charging is ON
Main Flow	M1	User charges at Smart Charging Location
Alternative Flow 1	A1-1	User charges at a non-Smart Charging Location
Post-condition	P1	Vehicle charges according to Smart Charging settings or charges immediately upon plug-in

9.1.2 Smart Charging and Digital Charging Schedules

Some digital charging stations will send a charging schedule to the vehicle.

###R_F_SC_00029### EVSE Schedule

If available, the vehicle shall pick up the default schedule provided by the EVSE and send it to the cloud. The information contained in this schedule is:

a. EVSE ID
b. Time interval points (displayed as seconds from NOW or 0)
c. Max power points per time interval points

The figure below shows how vehicle charging may be impacted according to output levels set by digital stations or ISO-151182 schedules (cf. OBCC IFS for more details).

Hours	12	1	2	3	4	5	6	7	8
SC Settings				CHARGING	(HPCM)				
EVSE Schedule (600V)	1000KWH	1000KWH	1000KWH	1000KWH	500KWH	500KWH	500KWH	1000KWH	1000KWH
FP/LW							80%		

Figure 9 ISO Charge Schedule vs. Smart Charging Settings

9.2 Charging In-Progress

Charge status alerts will not be impacted if Smart Charging is turned on. Considerations such as how long the charge is taking, voltage, and current output levels of the charge station will feed into the algorithm as they are sent from the vehicle to the cloud.

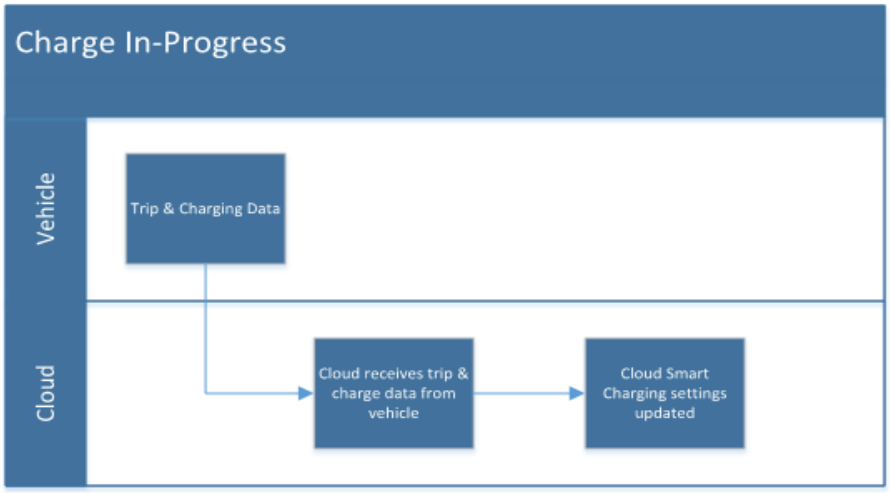


Figure 10 Smart Charging – Charge in Progress

9.3 Charge Complete

Charge complete alerts will be not impacted if Smart Charging is turned on.

10 User Involvement

Some users can choose to be more or less involved with the smart charging feature and can change their level of involvement via user preferences.

10.1 Minimum SOC

The Minimum SOC is a “safety net” that provides comfort to potentially skeptical users; it is a minimum “charge to” percentage for the Smart Charging settings.

###R_F_SC_00030### Global minimum SOC

Users *can* indicate a universal minimum SOC. The user can set and adjust this minimum.

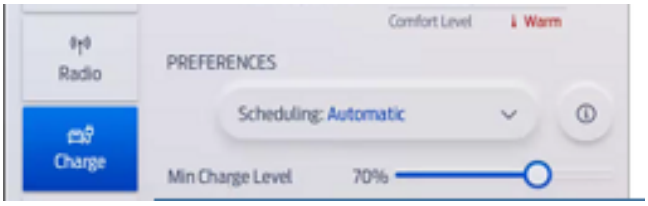


Figure 11 Illustrative Minimum SOC HMI setting

10.1.1 via HMI

###R_F_SC_00032### Minimum SOC change in-vehicle

If a user changes their minimum SOC via HMI, then the vehicle shall charge to and display whichever is the higher value between target SOC and user-set minimum SOC.

$$IF\ target\ SOC \geq minimum\ SOC,$$

$$THEN\ no\ change$$

$$IF\ target\ SOC < minimum\ SOC,$$

$$THEN\ change\ target\ SOC = minimum\ SOC$$

10.1.2 via mobile app

###R_F_SC_00033### Minimum SOC change via app

If user changes minimum SOC via mobile app, then the cloud shall notify the vehicle of the new setting

10.1.3 Use Case

###UC_F_SC_00005### Minimum SOC

Purpose		User wants to change minimum SOC via HMI
Actors		User, Vehicle, Cloud
Precondition		User has authorized vehicle User registered for FP/LW CCS settings are turned on

		Smart Charging is activated for vehicle Smart Charging is ON
Main Flow	M1	User updates Minimum SOC preference via HMI
	M2	Vehicle checks if SC settings have already been synced to vehicle – settings have been synced
Alternate Flow - 1	A2-1	Vehicle checks if SC settings have already been synced to vehicle – no settings have been synced
Post-condition	P1	Vehicle charges to and displays whichever value is higher – target SOC for given location or user-set minimum SOC
	P2	Vehicle sends minimum SOC settings to cloud

11 Turn OFF Smart Charging

###R_F_SC_00034### SC OFF via app

Users shall be able to turn off Smart Charging from FordPass or Lincoln Way

###R_F_SC_00035### SC OFF via HMI

Users shall be able to turn off Smart Charging from the HMI

###R_F_SC_00036### SC OFF on both platforms

Once successfully turned OFF, result shall display on both platforms (HMI or mobile app)

11.1 via HMI

The process for turning off Smart Charging via the HMI is shown below:

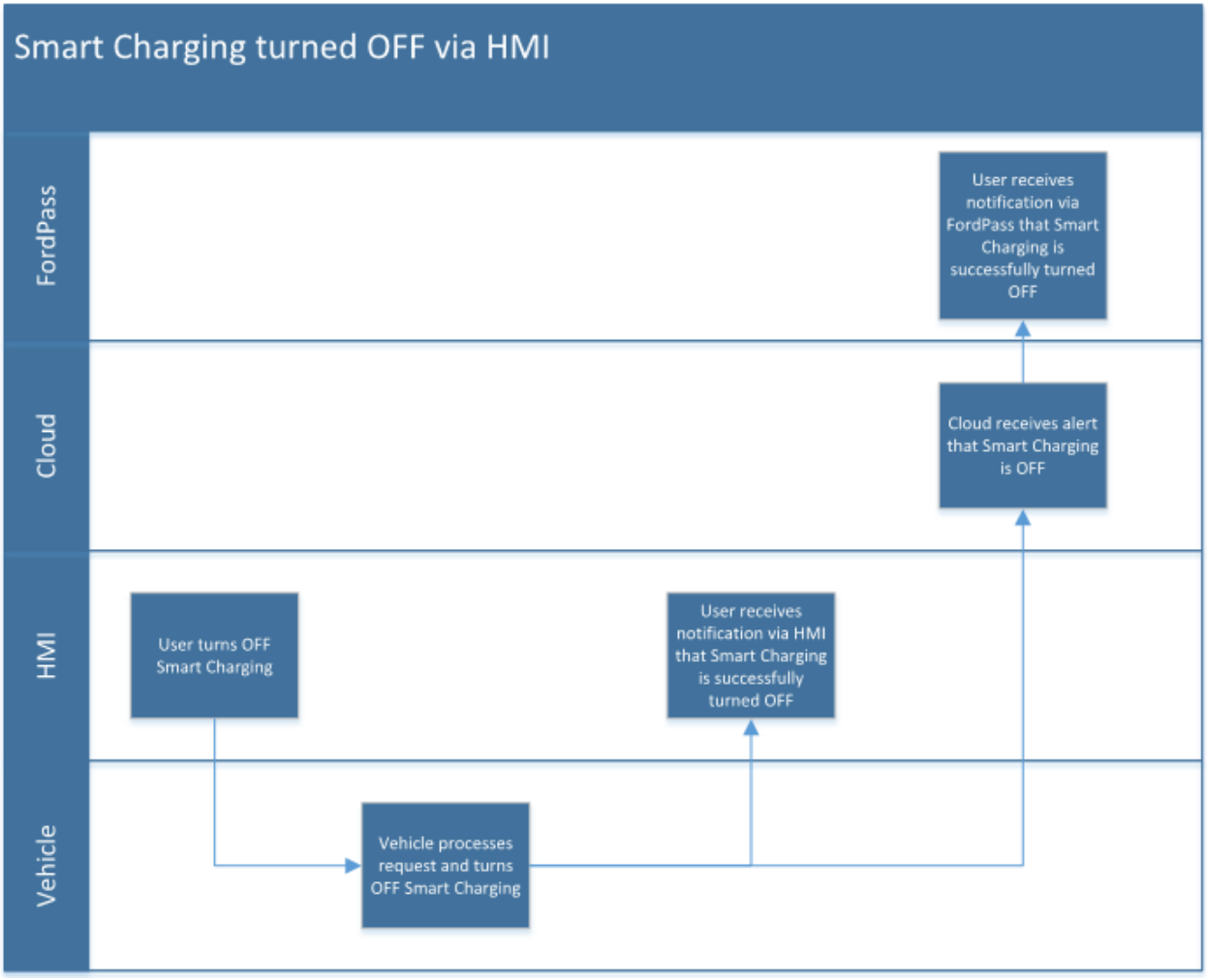


Figure 12 Smart Charging – Disabling Smart Charging via HMI

11.2 via mobile app

The process for turning off Smart Charging via the mobile app is shown below:

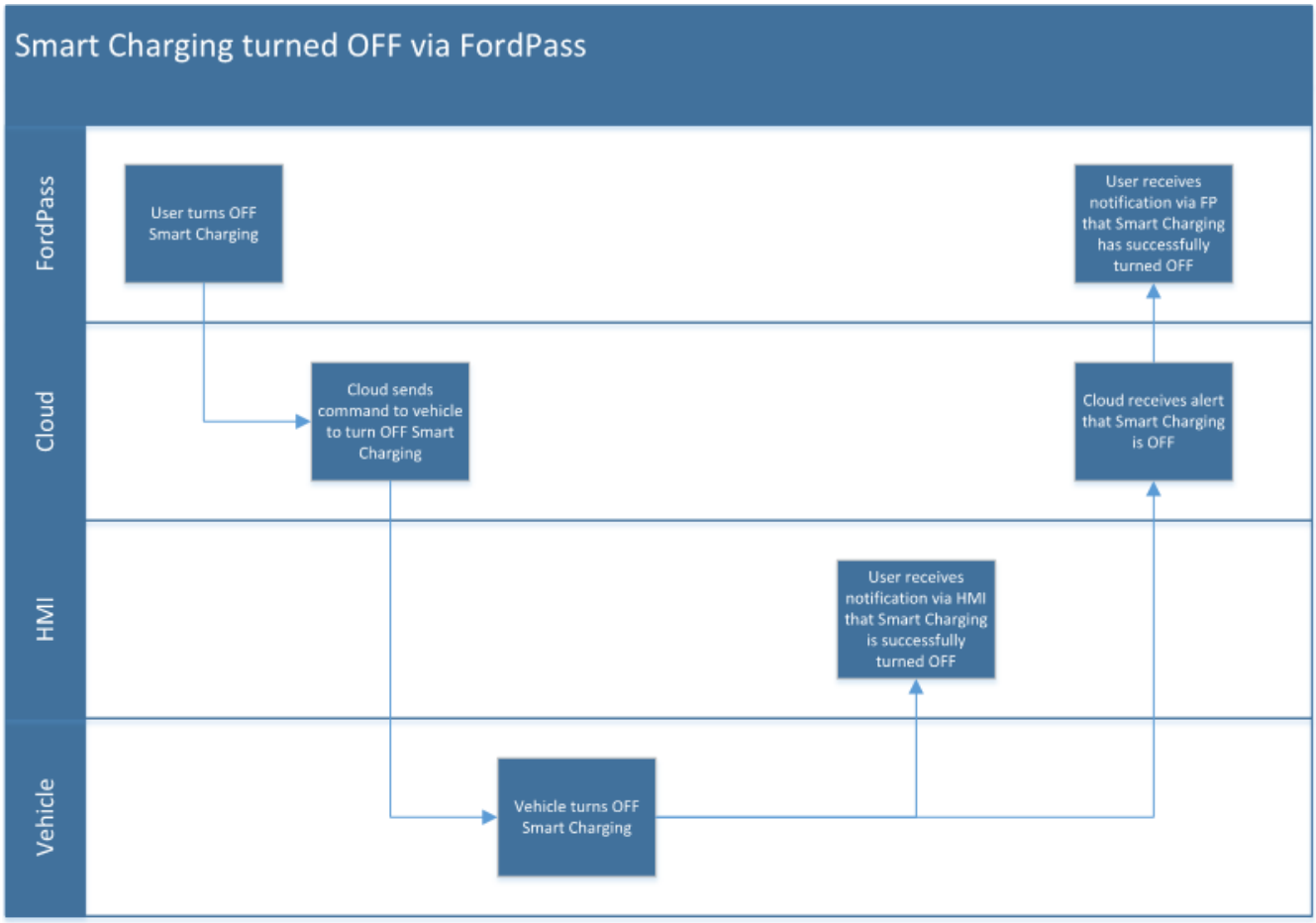


Figure 13 Smart Charging – Disabling Smart Charging via FordPass

11.3 Use Case

###UC_F_SC_00007### Turn OFF Smart Charging

Purpose		Allow user to turn OFF Smart Charging feature
Actors		User, Vehicle, Cloud
Precondition		User has authorized vehicle User registered for FP/LW CCS settings are turned on Smart Charging is activated for vehicle Smart Charging is ON
Main Flow	M1	User turns OFF Smart Charging via mobile app
	M2	Cloud sends request to vehicle to turn OFF Smart Charging
Alternative Flow 1	A1-1	User turns OFF Smart Charging via HMI
Post-condition	P1	Vehicle turns OFF Smart Charging

	P2	Vehicle sends acknowledgement to cloud that Smart Charging is OFF
	P3	User is notified Smart Charging has successfully turned OFF (mobile app & HMI)

12 Legal & Compliance Requirements

###R_F_SC_00037### deleting SC location command

The cloud shall send a separate delete Smart Charging location command if needed.

13 Performance Requirements

N/A

14 Security Requirements

Captured in Cyber Security Threat Model

15 Reliability Requirements

N/A

16 Safety Requirements

Smart Charging functions are covered under Quality Management (i.e. *risk associated with a hazardous event is not unreasonable and does not therefore require safety measures in accordance with ISO 26262*)

17 Operational Requirements

17.1 CVBOP – TBD

###R_F_SC_00046### XYZ

18 Master Reset

Master Reset Matrix				
OPTIONS FOR RESET	**Master Reset from vehicle**	**"Brand" Connect Reset– *user selects "yes" when prompted with option to erase EV data from vehicle***	**"Brand" Connect Reset– *user selects "no" when prompted with option to erase EV data from vehicle***	**Last user removes vehicle from Mobile App**
Trigger	Vehicle	Vehicle	Vehicle	SDN
What is reset in VEHICLE?	Smart Charging turned OFF Activation Status remains ON Resetting of SC-specific settings: *SC locations, SC windows, SC minimum SOC, SC target SOCs, duration values, max power*	Smart Charging turned OFF Activation Status remains ON Resetting of SC-specific settings: *SC locations, SC windows, SC minimum SOC, SC target SOCs, duration values, max power*	Smart Charging turned OFF Activation Status remains ON SC-specific settings retained on the vehicle	Smart Charging turned OFF Activation Status remains ON Resetting of SC-specific settings: *SC locations, SC windows, SC minimum SOC, SC target SOCs, duration values, max power*
What is reset in CLOUD?	Smart Charging turned OFF Activation Status remains ON Resetting of SC-specific settings: *SC locations, SC windows, SC minimum SOC, SC target SOCs, duration values, max power*	Smart Charging turned OFF Activation Status remains ON Resetting of SC-specific settings: *SC locations, SC windows, SC minimum SOC, SC target SOCs, duration values, max power*	Smart Charging turned OFF Activation Status remains ON	Smart Charging turned OFF Activation Status remains ON Resetting of SC-specific settings: *SC locations, SC windows, SC minimum SOC, SC target SOCs, duration values, max power*

Master Reset Recovery Matrix				
Who can restore?	Any previously authorized user	Any previously authorized user	Any previously authorized user	Any previously authorized user
user says yes to restore **What is restored?**	Nothing (post – MVP cloud may re-sent schedule to mobile app and car)	Nothing (post – MVP cloud may re-sent schedule to mobile app and car)	SC-specific settings on the vehicle	Nothing (post – MVP cloud may re-sent schedule to mobile app and car)
user says no to restore **What is restored?**	Nothing	Nothing	Nothing	Nothing

19 Module Swap

###R_F_SC_00044### re-authorization

If changes are made to the vehicle, or the ECG is swapped, the cloud shall re-authorize the vehicle

###R_F_SC_00045### consistency between module swaps

User settings and preferences shall remain consistent between module swaps

20 Customer Connectivity Settings (CCS)

Customer Connectivity Settings (CCS) allows users to enable/disable vehicle connectivity, geo-location or location sharing, vehicle data sharing, and remote control sharing. If one of the below CCS entities is disabled, then alerts pertaining to that entity are not sent to the cloud. The below table shows the various impacts to Smart Charging should CCS be *disabled* by the user.

Smart Charging impact if Customer Connectivity Settings (CCS) disabled	
Driving Characteristics	SC is not available; info related to charge date, start/end time, timestamp for plug/unplug are required
Vehicle Connectivity	SC is not available; alerts are required to be sent from TCU to SDN
Location Sharing	SC is not available; GPS coordinates are required during charging
Vehicle Data	SC is not available; Departure Times require temperature settings
Remote Controls	SC is not available; charge scheduling information is required
User/Vehicle Identification	SC is available
Microphone	SC is available

###R_F_SC_00047### CCS requirement

If driving characteristics, vehicle connectivity, location sharing, vehicle data, or remote controls is turned off, then Smart Charging will turn off, as well.

20.1 Use Case

###UC_F_SC_00008### Turn OFF a CCS

Purpose		Smart Charging feature response to user disabling of certain connectivity settings (CCS)
Actors		User, Vehicle, Cloud
Precondition		User has authorized vehicle User registered for FP/LW CCS – either vehicle data, vehicle connectivity, location sharing, driving characteristics, or remote controls - settings are turned on Smart Charging is activated for vehicle Smart Charging is ON
Main Flow	M1	User turns OFF any single or combination of the following CCS – vehicle data, vehicle connectivity, location sharing, driving characteristics, remote controls
	M2	Vehicle sends alert to cloud that it has turned OFF Smart Charging
Post-condition	P1	User is notified Smart Charging has successfully turned OFF (mobile app & HMI)

21 HMI Notifications

Below is an illustrative table for Smart Charging notifications via in-vehicle HMI:

Reason for Message	Trigger	In-Vehicle status/notification (center stack HMI)	Sample Copy	Responses/Next Actions	Notes
Agreed Messages					
~~Smart Charging Activated~~ ~~**user has not set up Preferred Charge Times in past 6 mo**~~	~~Cloud~~	~~Toggle~~ ~~Close~~	~~Great news - you could benefit from Smart Charging! If you enable this feature Ford will manage your charging at your common charging locations based on your daily needs. All you need to do is plug in, and we will ensure your range needs are met, while also providing you with the most cost efficient charging experience. Would you like to enable Smart Charging?~~	~~Toggle: User can choose to turn on Smart Charging directly within activation notification~~ ~~Close: prompt closes~~	~~After this message is sent, the Smart Charging feature should now be available in the vehicle HMI~~
~~Smart Charging Activated~~ ~~**user has active Preferred Charge Times**~~	~~Cloud~~	~~Toggle~~ ~~Close~~	~~Great news – you could benefit from Smart Charging. Instead of creating and editing your own Preferred Charge Times, we create them for you based on your daily needs and charging behavior. Would you~~	~~Toggle: User can choose to turn on Smart Charging directly within activation notification~~ ~~Close: prompt closes~~	~~Same as above~~

			~~like to enable Smart Charging?~~		
CCS Notifications	On/off state of CCS	Manage Close	Turning On Automatic Scheduling requires enablement of certain connectivity settings. These can be enabled via your connectivity menu.	Manage: user is directed to Connectivity menu Close: Close pop-up; user cannot turn on Smart Charging	CCS screen flow and requirements can be found in CCS SPSS

22 References

Doc ID	Reference Document
1	Customer Connectivity Settings (CCS) PRD
2	FB5 core feature set PRD
3	OBCC IFS for details on EVSE Power Schedule
4	Smart Charging Stakeholder List