

SimpleLink™ Wi-Fi® CC3200 Smart Plug User's Guide



General Texas Instruments High Voltage CC3200 Smart Plug User Safety Guidelines

WARNING

Always follow TI's setup and application instructions, including use of all interface components within their recommended electrical rated voltage and power limits. Always use electrical safety precautions to help ensure your personal safety and those working around you. Contact TI's Product Information Center at <http://support/ti.com> for further information.

Save all warnings and instructions for future reference.

Failure to follow warnings and instructions may result in personal injury, property damage, or death due to electrical shock and burn hazards.

The enclosed CC3200 Smart Plug is intended strictly for customer demonstration purposes under the direct control of authorized TI field sales personnel with knowledge of electrical safety risks. In order to minimize risk of personal injury and property damage, at no time shall the CC3200 Smart Plug be operated or otherwise demonstrated by anyone other than a TI authorized field sales representative. The CC3200 Smart Plug should NEVER be left with a customer at any time for their own use or any other evaluation purpose, nor operated in an unintended manner without the direct presence or participation of the authorized TI field sales representative.

The customer should always be reminded that the final application design circuits are solely the responsibility of the customer and at no time allow GERBER plots of the CC3200 Smart Plug printed circuit board layout be provided to customers.

Any other use or application of the CC3200 Smart Plug is strictly prohibited by Texas Instruments.

When demonstrating the CC3200 Smart Plug the following practices and guidelines shall be followed:

1. Work Area Safety:
 - (a) Keep work area clean and orderly.
 - (b) Have qualified observers present anytime circuits are energized.
 - (c) Effective barriers and signage must be present in the area where the CC3200 Smart Plug and its interface electronics are energized, indicating operation and/or presence of high voltages, for the purpose of protecting inadvertent access.
 - (d) All interface circuits including but not limited to power supplies, evaluation modules, instruments, meters, scopes, and other related apparatus used in a development or demonstration environment exceeding $50 V_{\text{RMS}}$ /75-V DC must be electrically located within a protected Emergency Power Off (EPO) protected power strip.
 - (e) Use stable and non-conductive work surface.
 - (f) Use adequately insulated clamps and wires to attach measurement probes and instruments. No freehand testing whenever possible.

2. Electrical Safety:

As a precautionary measure, it is always a good engineering practice to assume that the entire CC3200 Smart Plug may have fully accessible and active high voltages.

- (a) De-energize the CC3200 Smart Plug and all its interface outputs and electrical loads before performing any electrical or other diagnostic measurements. Revalidate that the CC3200 Smart Plug power has been safely de-energized.
- (b) With the CC3200 Smart Plug confirmed de-energized, proceed with required electrical circuit configurations or other CC3200 Smart Plug interface hook-ups, while still assuming the load circuit connected to the CC3200 Smart Plug and accompanying measuring instruments are electrically live.
- (c) Once the CC3200 Smart Plug readiness is complete, proceed with energization as intended.

WARNING

While the CC3200 Smart Plug is energized, never touch any of its electrical circuits or controlled interface loads as they could be at high voltages capable of causing electrical shock hazard.

3. Personal Safety:

- (a) Wear personal protective equipment such as latex gloves or safety glasses with side shields, or protect the EVM in an adequate lucent plastic box with interlocks from accidental touch.

Limitation for safe use:
The CC3200 Smart Plug is intended only for demonstration purposes and not to be used at all as part of a production unit.

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1 Introduction

There is an increasing application requirement for Wi-Fi-enabled energy measurement and control. This increase is manifested in end products like smart plugs, smart receptacles, and in general application spaces such as home appliance, smart grid, and building automation. The goal was to offer a form-factor reference design and application software that could very quickly be turned into a production Smart Plug. The deliverables would also address application requirements in connected energy measurement and any cloud-connected device. Updated information will be posted on the [C3200 Smart Plug product page](#).

2 Requirements

Hardware:

- CC3200 Smart Plug
- Android™ device with Android 4.1 (Jelly Bean, API level 16) or above
- Access point with internet connection

Software:

- Smart Plug Android application in the package
- Exosite account

3 Demo Overview

3.1 *Android Application*

The Smart Plug Android application is a user-friendly tool to interface with the CC3200 Smart Plug. All features mentioned in the introduction can be accessed in this application. The source code of this application is also available for download in the product's wiki page:

http://processors.wiki.ti.com/index.php/CC31xx_%26_CC32xx_Provisioning.

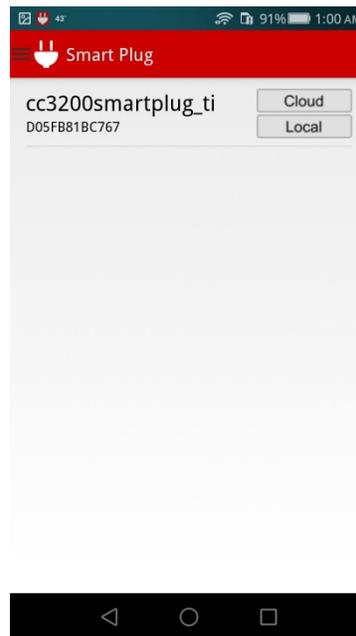


Figure 1. Main Interface

3.2 *Exosite® Website*

Exosite is the cloud service to be used with the CC3200 Smart Plug. The service provides not only the storage for metrology data or an alternative platform to monitor the Smart Plug, but also a communication bridge between the Smart Plug and the Android application. When a mobile device is not in the same local network as the Smart Plug, the user can still access all the readings and most controlling features because the cloud service is doing all the work, making it almost seamless.

4 Smart Plug

The Smart Plug has a very simple look which simplifies the user experience. The main components are:

- **Plug:** On the back side of the Smart Plug, for plugging into a wall outlet.
- **Socket:** For plugging a device in the appliance.
- **Power Indicator:** LED indicator telling whether the Smart Plug is powered or not.
- **Status Indicator:** LED indicator telling the status of the Smart Plug.
- **Provisioning Control Button:** Performs provisioning.
- **Relay Control Button:** Manually controls the relay status of the Smart Plug.
- **Reset Button:** Resets the device forcefully.

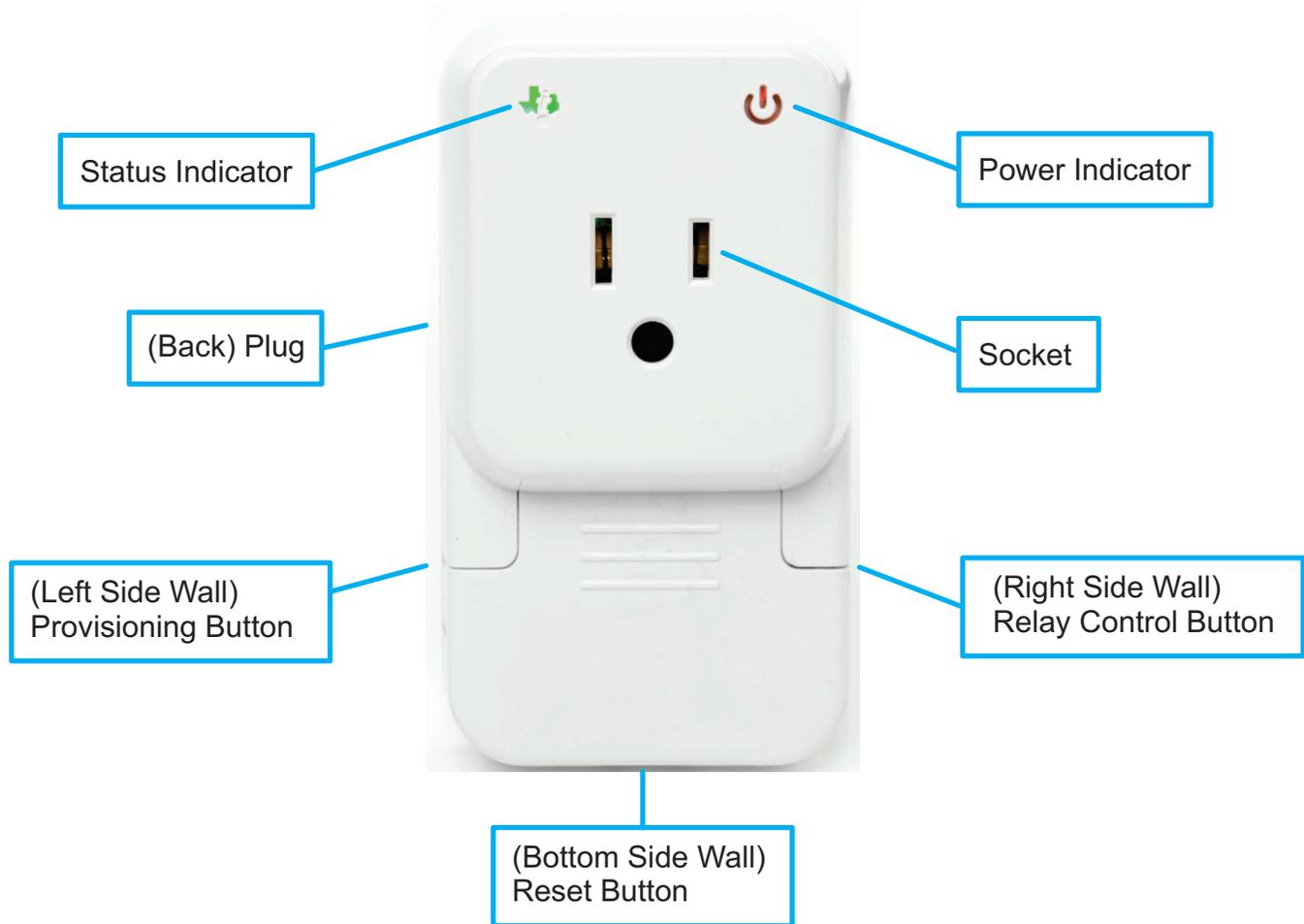


Figure 2. Main Components of Smart Plug

5 Key Components

5.1 Plug

The plug is located on the back side of the Smart Plug. Plug it into a wall outlet to receive power. The device is capable of loading 100 to 240 V and 50- or 60-Hz power supply. If needed, use an adapter to fit your local socket type.

5.2 Socket

Plug the appliance into the socket to read power values. Use an adapter to fit if needed.

5.3 Power Indicator

Power light is represented by a red LED on the top right-hand corner. Being on means the Smart Plug is powered, off otherwise.

5.4 Status Indicator

The status indicator is represented by the three-color green-blue-red LED with a TI logo. This light tells the user the status of the Smart Plug to make sure the device is functioning the way the user intends. [Table 1](#) lists all possible statuses.

Table 1. Status LED Behavior Chart

LEFT LED	BEHAVIOR	STATUS
Red	Flashing slowly, then steady	The device is powering up, then fully powered
	Flashing quickly	Any error indication
Blue	Flashing quickly	The device is in Smart Config mode
	Flashing slowly	Trying to connect to a Wi-Fi network
	Steady	Connected to Wi-Fi with IP address NOTE: If the device is unable to connect to the AP, LED blinks slowly during this period and the <i>Smart Config</i> button can be pressed
Magenta	Steady	Connected to the mobile app
	Flashing	During data transfer NOTE: If the Smart Plug is transferring data to both the cloud and the android app, the cloud's representation dominates.
Green	Steady	Internet connection available or connected to the cloud
	Flashing	During data transfer

5.5 Provisioning Button

On a new Smart Plug, since there is no Wi-Fi profile stored on the device, provisioning becomes important in order for the Smart Plug to connect to the AP of your desire.

The Smart Plug supports three types of provisioning:

Table 2. Smart Plug Provisioning

PROVISIONING METHOD	PROVISIONING BUTTON ACTION	HOW TO USE
Smart Config	Hold for 1 to 3 seconds	Wi-Fi Starter App
AP	Hold for 3 to 10 seconds	Webpage
WPS	Hold for >10 seconds	WPS compatible router

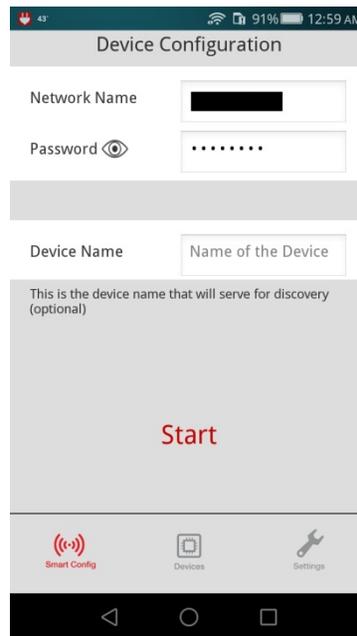


Figure 3. Provisioning by Using Wi-Fi Starter App

For more information about provisioning, visit the CC31xx and CC32xx Provisioning wiki page: http://processors.wiki.ti.com/index.php/CC31xx_%26_CC32xx_Provisioning.

Once the Smart Plug is connected to the AP, the green LED will light up, indicating a successful connection.

5.6 Relay Control Button

Press this button to control the relay status forcefully. This button overrides any scheduled relay from the software. Users will have to re-enter the scheduling if desiring this feature.

5.7 Reset Button

Press this button to reset the device. Please be aware that all existing connections will be terminated. Stored Wi-Fi profiles are not affected.

6 Install Android App

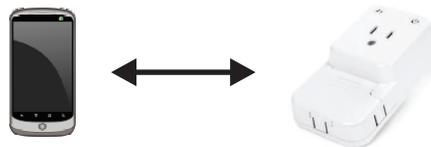
The companion Android app SmartPlug.apk is included in the package. However, since this app is not released on Google Play, users will need to use an alternative way to install the .apk file onto their devices. Please visit this website for instruction on how to install the .apk file: <http://www.cnet.com/how-to/how-to-install-apps-outside-of-google-play/>

7 Network Connection

To read the Smart Plug data, a user may choose to use the Android app or the Exosite website for this task. However, the Android app is capable of monitoring under a local network connection and cloud connection. One convenient feature for this dual connection mode is that the user does not necessarily need an internet connection or a cloud account to bring up the demo. If a local network is the only environment to work with, use the Android app to be the sole monitoring device.

7.1 Local Connection with Android App

When both the Smart Plug and the Android app are located in the same local network, the app can directly monitor the values without any external internet connection.



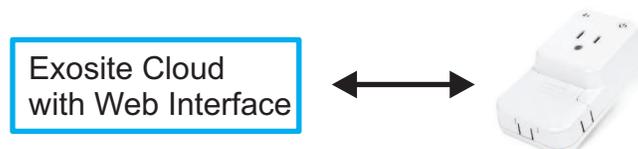
7.2 Cloud Connection With Android App

There are scenarios when the Smart Plug and the Android app are not located in the same local network. In such case, cloud connection becomes very useful because users can monitor the data at anywhere, as long as an internet connection exists. The Android app has Exosite API integrated into it so all data reported to the cloud server can be seen directly on the app.



7.3 Cloud Connection with Exosite Website

Whether or not the user uses the Android app to monitor Smart Plug data, all values are recorded on the Exosite server for users to login through a web browser and see the values.



8 Starting the Demo — Android Application

8.1 Signing in With an Exosite Account

Upon entering the app the first time, the user may sign up or use an existing account. To sign up for a free account, simply provide an email address and a password. For new and existing accounts, passwords must meet these requirements:

- At least six (6) characters
- Contains at least one number
- Contains at least one letter
- Contains at least one non number or capital letter
- Cannot begin or end with spaces
- Must be different from current password

Once signed in, the app will take the user to the main page with a list of devices that is either stored on the cloud or locally. The list may be empty if there are not any known devices added. The user may also choose to skip the sign-in process and proceed directly to the list; however, this will prevent the user from communicating with the device through the Exosite cloud service. Metrology data monitor and other controls are only accessible through local connection.

The main menu can be brought onto the screen by swiping from the left edge of the screen or by touching the application icon at the top of the screen. The menu provides access to all essential functionalities to navigate inside the app easier ([Figure 5](#)).

There are three ways to add a new device:

- Add a Device: Add a device manually by entering relevant information (see [Figure 8](#)).
- mDNS Search: Search for local devices using mDNS (see [Figure 6](#)).
- Sync Devices: If the user has added devices to an Exosite account before, this option will retrieve all of them and list them here.

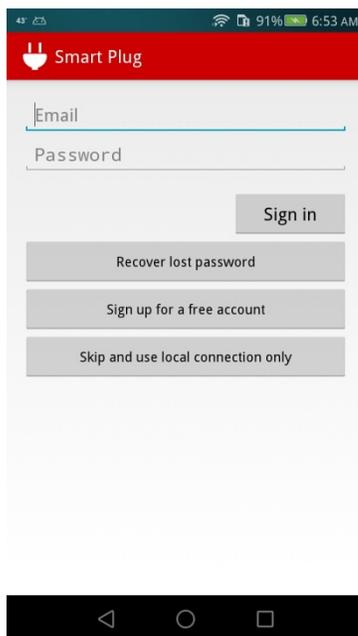


Figure 4. Sign-In Screen

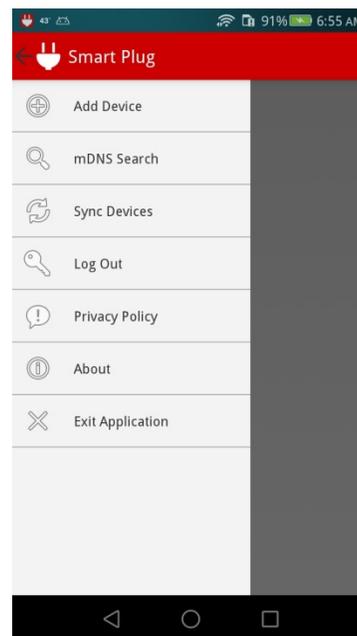


Figure 5. Menu

8.2 Adding a New Device Through mDNS

When the CC3200 Smart Plug and mobile device are in the same local network, mDNS searching is the easiest way to add a new device. mDNS resolves host names to IP addresses within small networks that do not include a local DNS server. It allows the Android device to discover the Smart Plug and ultimately connects to it without manually entering IP addresses.

When a Smart Plug is found within the same network, one of these options will show up:

Table 3. mDNS Options

OPTION	DESCRIPTION
	The device is not in the main list. Click this button to add the device to the list. A confirmation screen will show up, asking the user whether to add this device to the cloud account or not (see Figure 7). This screen will not be shown if the user is not signed into a cloud account.
	This image is not clickable. It indicates that the device is already listed in the app (see Figure 8). Check the main screen to see the device.
	This button will show if the device is already in the main list, but has an unmatched IP address. Click on this to update the IP address.

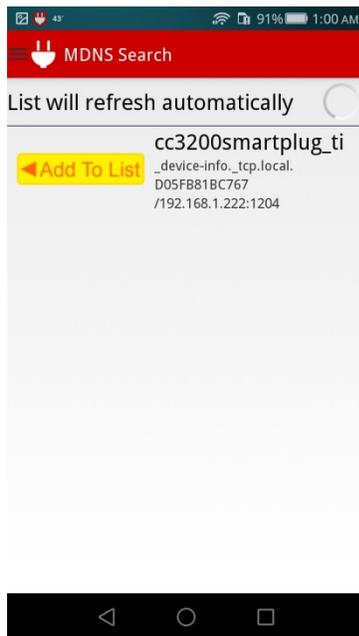


Figure 6. mDNS With Device Found

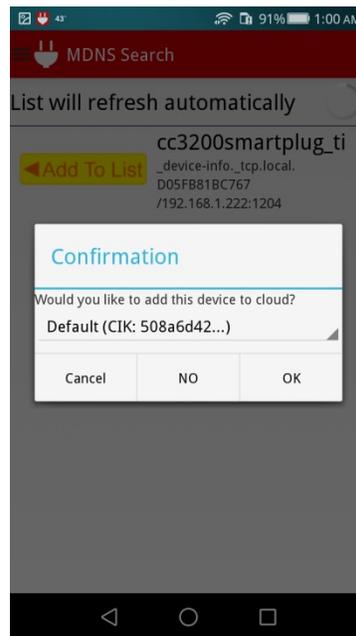


Figure 7. Adding Current Device to Exosite Account



Figure 8. Device is Already Listed

8.3 Adding a New Device Manually

Another way to add a device is by entering all the information manually. This method is particularly useful if the user is adding a Smart Plug that will be used in the future but does not have it running at the moment. [Table 4](#) describes all fields in the page.

Table 4. Adding New Device Setup

FIELD	REQUIRED	DESCRIPTION
Name	Yes	Name of the device
Serial Number (MAC Address)	Yes	MAC address of the device. This is also known as the serial number for the Exosite cloud.
Local Connection Address	—	IP address of the device for local connection
Auto Cloud Connection Only Local Connection Only	—	Connection policy for the device: <ul style="list-style-type: none"> • Auto: Using cloud as the default, but will switch to local connection if the cloud connection is lost • Cloud Connection Only: Forced cloud connection • Local Connection Only: Forced local connection
Portal	—	The portal in the account to which the Smart Plug will be added. No modification is needed if the user has only one portal.
Vendor	—	The name of the vendor. This field is not modifiable due to demonstration purpose. This is required if the user adds the current Smart Plug into the cloud account.
Model	—	The name of the model. This field is not modifiable due to its demonstration purpose. This is also required if the user adds the current Smart Plug into the cloud account.
Local Add Only	—	Enable this check box to add this Smart Plug to the mobile device only. It means the cloud account will not be able to communicate with it. If the user is not signed in, this field makes no difference.



Figure 9. Adding a Device Manually by Entering Information

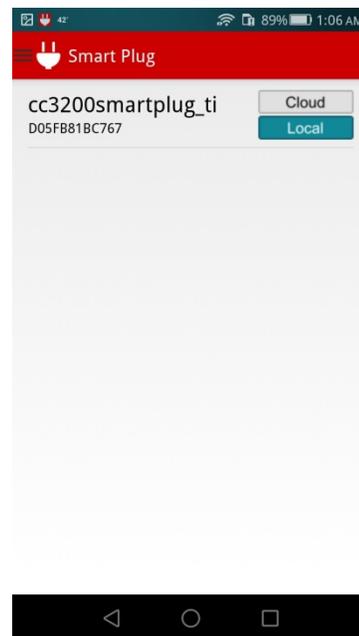


Figure 10. Main List With Smart Plug Running in Local Connection

8.4 Metrology Data Monitoring

One of the main features of the Smart Plug reference design is the monitoring of metrology data. It currently displays the following metrology data:

- Active Power
- Average Power
- Reactive Power
- Apparent Power
- Voltage
- Current
- Frequency
- Power Factor
- Total Energy Consumption

Besides monitoring, it also has the ability to send data to the Smart Plug to improve user experience. Functionality includes the following:

- Device Powering Status
- Scheduling
- Power & Energy Threshold
- Power Saving Status
- 24-Hour Energy Summary
- Calibration
- Enable/Disable Secure Cloud Connection (SSL/TLS)
- Cloud Connection Certificate Update

Refer to the CC3200 Smart Plug design guide for implementation details ([TIDU983](#)).



Figure 11. Device Screen With Cloud Connection Running

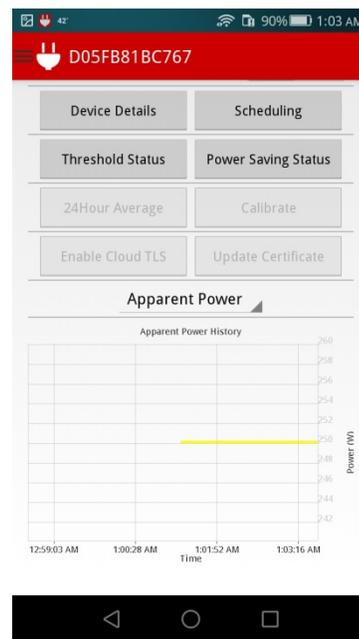
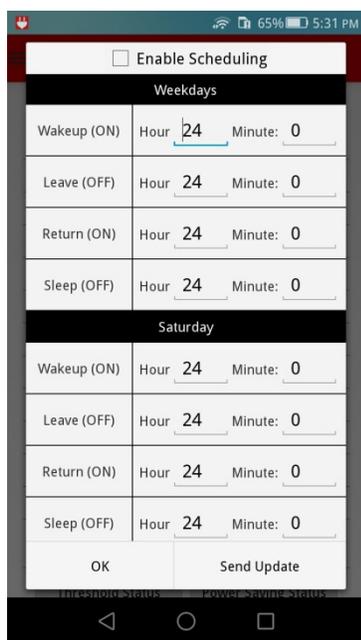
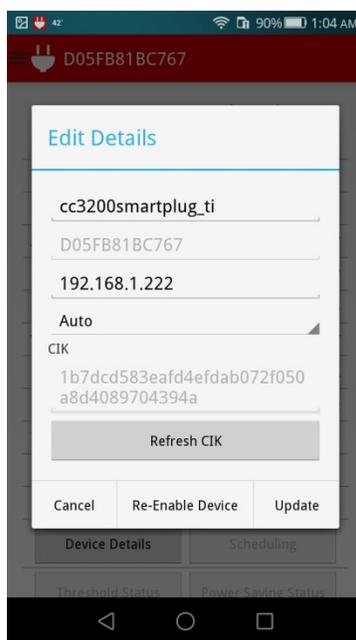
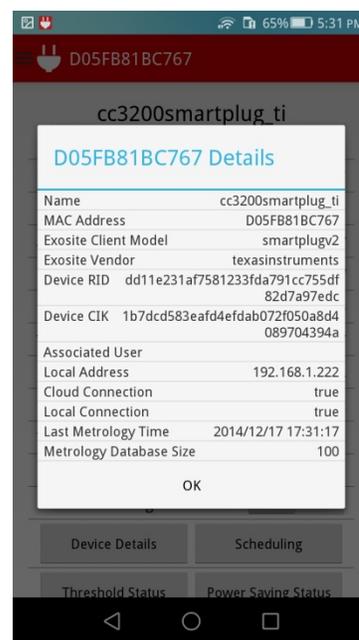


Figure 12. Plotting With Apparent Power Selected

- **Device Powering Status**
This is also known as "relay". This option controls whether or not to supply power to the device plugged into the Smart Plug. Toggling this field will override the Scheduling setting.
- **Scheduling**
Also called "switch table" in the code, this option schedules the relay on weekly bases. The days are divided into three categories: weekdays, Saturday, and Sunday. Each category has four time fields to modify. Users can specify the wake-up time (to turn on), leaving time (to turn off), returning time (to turn on), and sleeping time (to turn off), simulating a daily routine of a typical person (see [Figure 13](#)).
- **Editing Details**
This item is located in the drawer menu on the left side of the screen. The user can make changes to fields as shown in [Figure 14](#). There are currently three connection options: Auto, Cloud Connection Only, and Local Connection Only.
- **Device Details**
A dialog box will pop up when the user clicks on the *Device Details* button (see [Figure 15](#)). This dialog shows all essential information to the user about the Smart Plug, mainly for debugging purposes.
- **Threshold Status**
This sets the threshold values for power and energy. Once a value exceeds the specified threshold value, the corresponding metrology value will start blinking red, and the user will receive email alerts if the Smart Plug is connected to the user's cloud account.
- **Power Saving Status**
The user has the option to enable or disable power saving. Once enabled, the metrology reporting period can be changed to report data every 5 to 60 seconds.


Figure 13. Scheduling Table

Figure 14. Editing Detail

Figure 15. Displaying Device Details

8.5 Local versus Cloud Connection

The followings options can only be changed under a local connection:

- **24-Hour Energy Summary**
The *24-Hour Average* button displays the hourly average energy summary in the past 24 hours.
- **Calibration**
This option calibrates voltage and current readings if the displayed values are not shown correctly. This also displays scale factors and noises information (see [Figure 16](#)).
- **Enable/Disable Secure Cloud Connection (SSL/TLS)**
This is a demonstration to show the ability to communicate with the cloud service with a non-secure connection or with an SSL/TLS connection.
- **Certificate Update**
Certificates come with expiration dates. Once expired, SSL/TLS communication will no longer be working. Having the ability to update the certificate is crucial to make the Smart Plug able to work in the future if the user has not used it for a long time. Click on the button to browse the certificate file to update.

As of right now, only the X509 file extension format is supported (.der extension).

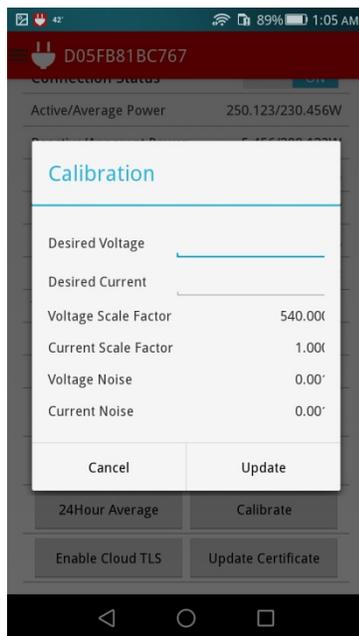


Figure 16. Calibration Screen (Local Connection Only)

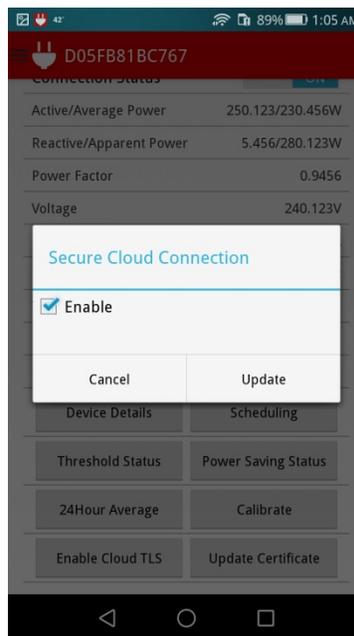


Figure 17. Enable/Disable Cloud Secure Connection (Local Connection Only)

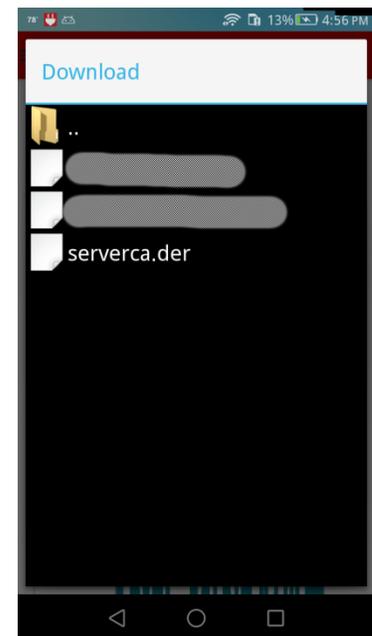


Figure 18. Certificate Update Screen

8.6 Application Termination

Upon pressing the back or home button on the bottom of the screen, the app interface will exit, but the application is still running as a service in the background. Any established communication will sustain and receive metrology updates constantly. To exit the application, select "Exit Application" from the menu (see [Figure 20](#)).

8.7 Troubleshooting and Bug Report

Due to the Android application being used for demonstration purposes and not for end-user distribution, it may contain some bugs. This section briefly describes several problematic scenarios and possible resolutions:

- Cloud Synchronization
 - If the user cannot add a device to the cloud account, contact the local FAE. This device may have been registered by other users before and have not been removed from their account.
 - If a device cannot be deleted (it may show a short message saying "Error"). Manually delete all data by going to *Settings* → *Apps* → *All* → *Smart Plug* → *Clear Data*. This path may vary among different Android devices.
- Application Crash
 - When encountering application crash, a dialog will show up and asks the user to report the bug to the developer. Send the report to the local FAE so TI can improve the robustness of the application.
 - When encountering an application crash, the application may restart automatically. However, application stability is not guaranteed at this point. Exit the application through the "Exit Application" option in the menu and restart.

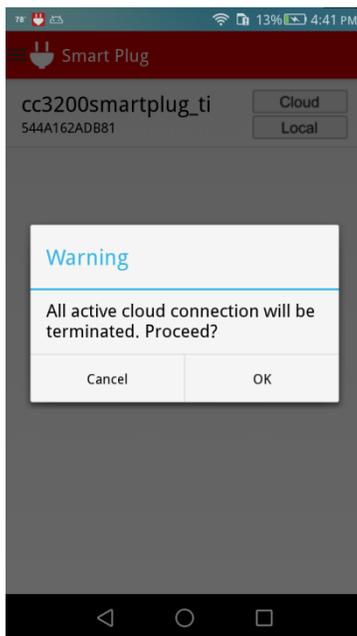


Figure 19. Signed-Out Screen

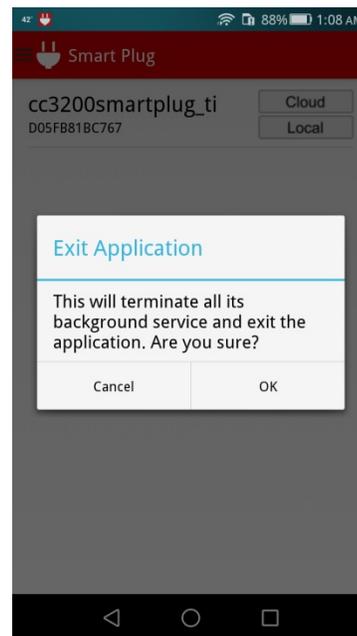


Figure 20. Application Exit

9 Starting the Demo — Exosite Website

An alternative way to monitor the Smart Plug is by using the cloud website. Exosite is the default cloud service provider for Smart Plug. Exosite cloud allows the user to monitor and manipulate the Smart Plug even if user's Android device is not within the same local network of the Smart Plug. Register a free account by using the Android application or through the following link to the TI-Exosite Site: <https://ti.exosite.com/login>.

Once signed in, two columns of information panels and a menu appear on the left side of the screen (see [Figure 21](#)). If the user has any existing device that was added before through the Android application or on the website, the user can see them all in the "Device List" panel on the right. Note that devices listed here may not be all Smart Plugs. This page is essentially a portal to all TI devices, and Smart Plug is one of them. However, the Android application will only display Smart Plug (specifically, Smart Plug V2) devices.

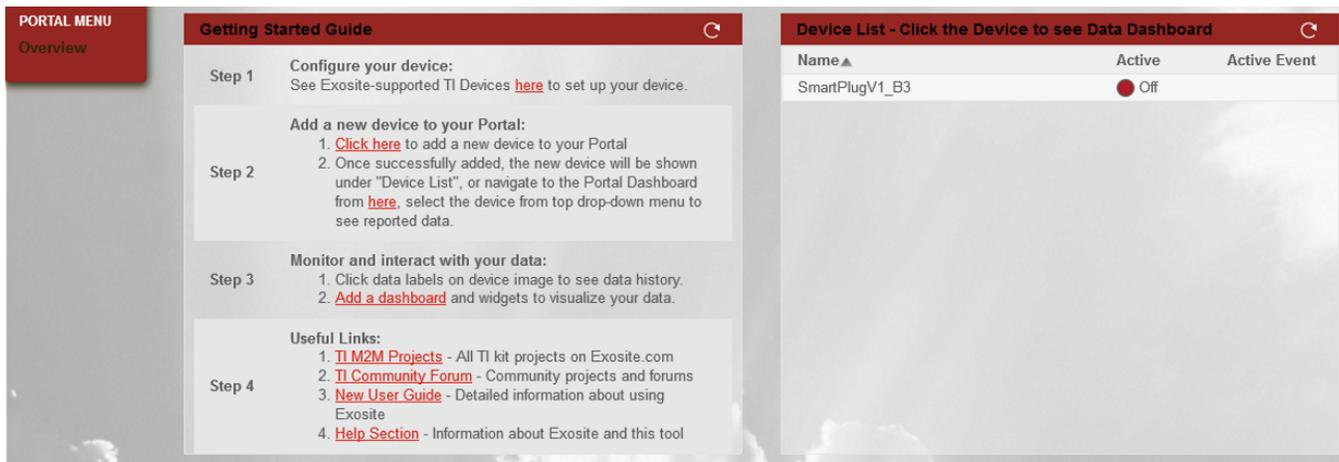


Figure 21. Exosite Start Page

9.1 Adding a New Device

To add a new device, click the link in the Step 2 shown on the left panel in [Figure 21](#).

1. Check "Select a supported device" and choose "Smart Plug V2".
2. Click *Continue*.
3. Enter MAC address and name of the device. The location field is optional.
4. Click *Continue*.

Once the device is successfully added, the user will be given a CIK number as a reference. This number is generated based on the MAC address. If an error appears saying that the device cannot be added, check with the local FAE to make sure the device is not registered to another account.

Going back to the home screen, the new device is in the list on the right. Click on the device name to start monitoring.

9.2 Metrology Data Monitoring

The Exosite cloud webpage provides basic monitoring that closely resembles the Android application. The website is mainly used as an alternative monitoring interface in case an Android device is not available.

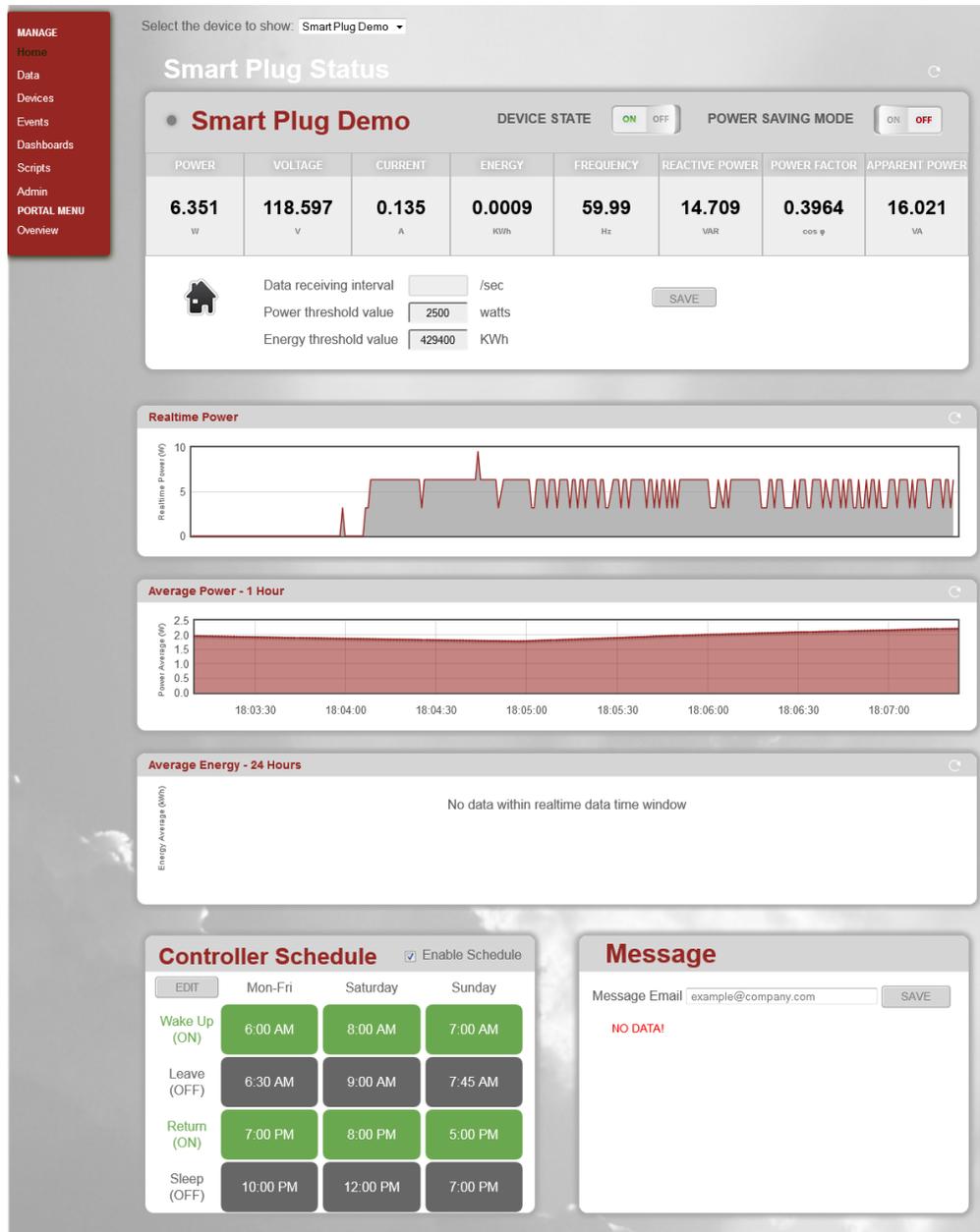


Figure 22. Metrology Data Monitoring Options

9.3 Removing Device from Exosite

If the same Smart Plug needs to be used by someone else in the future, delete the MAC address stored on the cloud to allow the next user to register the same device in his or her account. Only one MAC address can be registered by one user at the same time.

There are two ways to delete the device from the cloud:

1. If the Smart Plug was added to your cloud account via the Android application, you can simply delete the device from the App menu by choosing the "Delete Device" option (see [Figure 23](#)). Synchronization will be done automatically.
2. To delete the device from the cloud website, go to the menu on the left side of the page and click "Devices" → your Smart Plug device. Under the "Delete Device" section, type "confirm" in the box and click "DELETE" (see [Figure 24](#)).

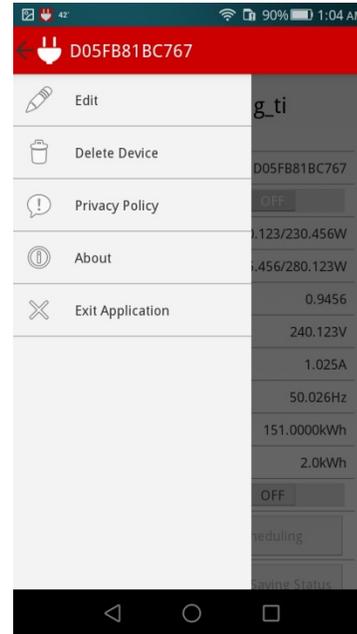


Figure 23. Device Menu in Android

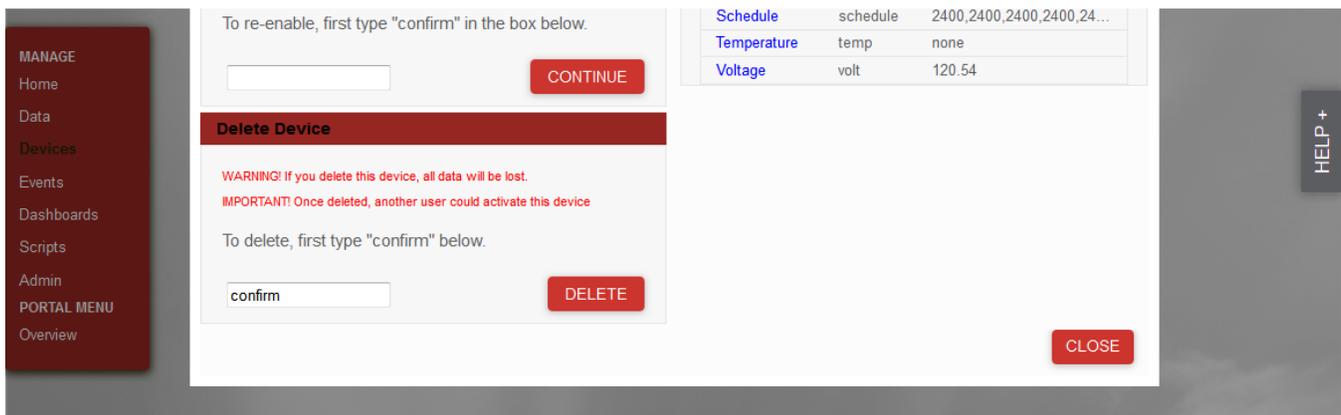


Figure 24. Delete Device from Exosite Website

10 Software Files

To download the software files for this reference design, refer to <http://www.ti.com/tool/TIDC-CC3200smartplug>.

IMPORTANT NOTICE

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