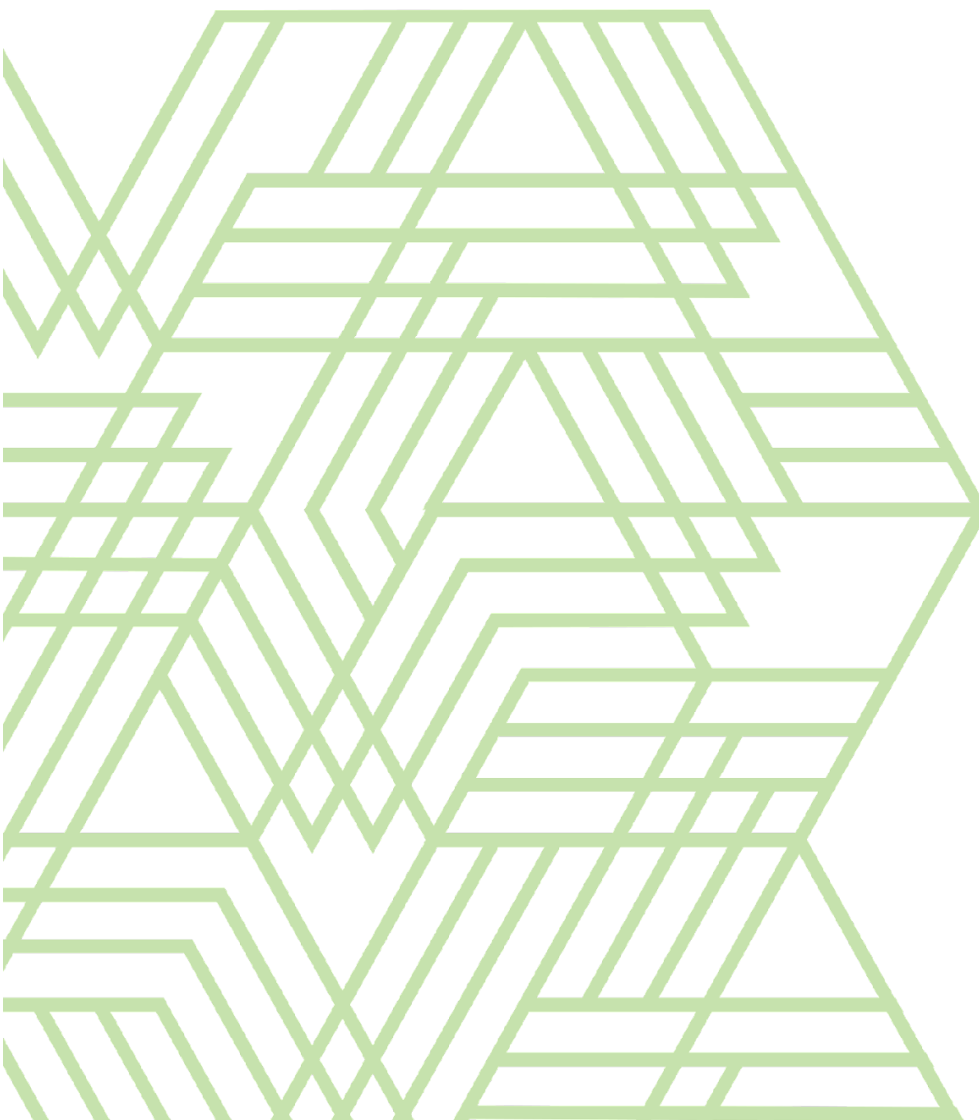


# ATM3330e PV Remote Control

## User Guide

**SUMMARY:** This document describes the features and usage of the ATM3330e based Photovoltaic (PV) Bluetooth LE Remote Control Reference Design. The Remote Control is powered by a PV cell and is available in battery-free configuration.



Atmosic™

Doc. No. ATM3330e-UGPVR-C-P052

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## Acronyms and Abbreviations

Acronyms	Definition
ADPCM	Adaptive Differential Pulse-Code Modulation
HSC	Hybrid Supercapacitor
IMA	Interactive Multimedia Association
IR	Infrared
LE	Low Energy
OTA	Over-The-Air
PMU	Power Management Unit
PV	Photovoltaic
RCU	Remote Control Unit
RDK	Reference Design Kit
RPB	Reference Design Programming Board
SDK	Software Development Kit
SoC	System-on-Chip
UHD	Ultra High-Definition

# 1. Overview

The ATM3330e PV Remote Control Unit (RCU) is a Bluetooth LE TV Remote Control reference design that demonstrates the low power consumption of the Atmosic ATM3330e Bluetooth LE SoC, and how the addition of a PV cell to a remote control can reduce or eliminate the need for batteries in the device.

This document covers the features, operation, performance, and update procedure of the ATM3330e PV RCU.

The ATM3330e PV RCU supports HSC configuration to harvest energy to store in the device. The remote control reference design stores harvested energy in a hybrid supercapacitor that can also be recharged via a USB connector on the device.

The ATM3330e SoC solution combines an ultra-low power Bluetooth LE 5.3 solution with an integrated PMU that supports the direct connection of PV cells.

The direct connection of a PV cell to the ATM3330e PMU has multiple benefits, both reducing the overall cost of adding energy harvesting and improving the efficiency of harvested energy usage. In addition, the low power consumption of the ATM3330e means less energy needs to be harvested, so a smaller PV cell can be used in the design, further reducing both the cost and area required for the PV cell.

The ATM3330e PV RCU is designed to operate at indoor light levels with excess harvested energy stored in the hybrid supercapacitor.

The ATM3330e PV RCU is Android 12 compatible and has been verified to work with the [ADT-3](#) and [onn](#). Android TV Developer Kit from Google and the UHD Streaming Device.

The Atmosic PV RCU is provided for demonstration and evaluation purposes only and is not for commercial sale. See [References](#) section for related information.

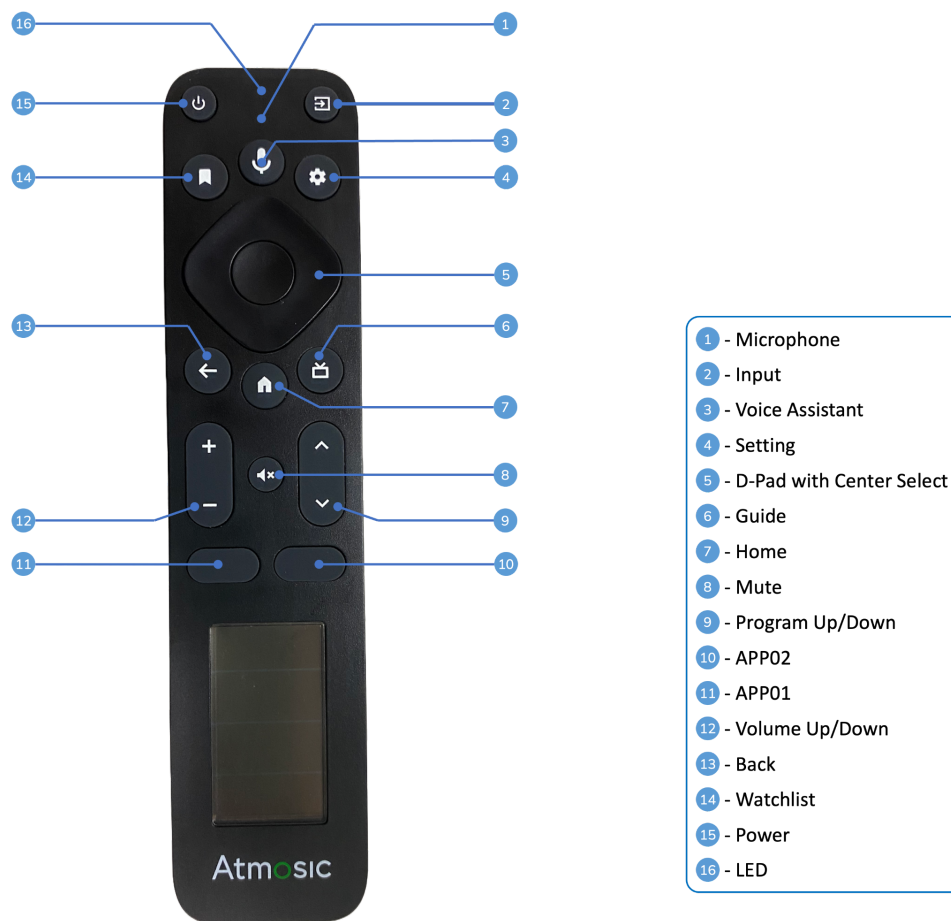
Reference Design	SoC Package	SoC Part Number	Reference Design Part Number
ATM3330e PV Remote Control with Hybrid Supercapacitor	56-pin 7x7 mm QFN	ATM3330E-5DCAQN	ATMRC-3330E-HSC-3

*Table 1 - ATM3330e PV Remote Control Part Number*

## 2. PV Remote Control Unit (RCU)

The ATM3330e PV RCU is shown in [Figure 1](#). The PV cell on the front is an AM-1454 amorphous silicon PV cell from Panasonic. The Remote Control also supports the following features:

- Android 12 TV
- Google Voice over Bluetooth LE (version 0.4e/1.0)
- 8 kHz/16-bit IMA ADPCM voice encoder
- NEC IR Transmission Protocol
- 20 keys (5x4 matrix)



*Figure 1 - ATM3330e PV Remote Control, Front*

The battery-free configuration integrates two 50 F hybrid supercapacitors (see [References](#) section for more information). The internal hardware of the Remote Control is shown in [Figure 2](#). The hybrid supercapacitors can be accessed by removing the back cover.



Figure 2 - ATM3330e PV Remote Control with Back Cover Removed

The main configuration of the ATM3330e with hybrid supercapacitors is shown in [Figure 3](#). More information about the 50 F hybrid supercapacitors can be found in the [References](#) section.

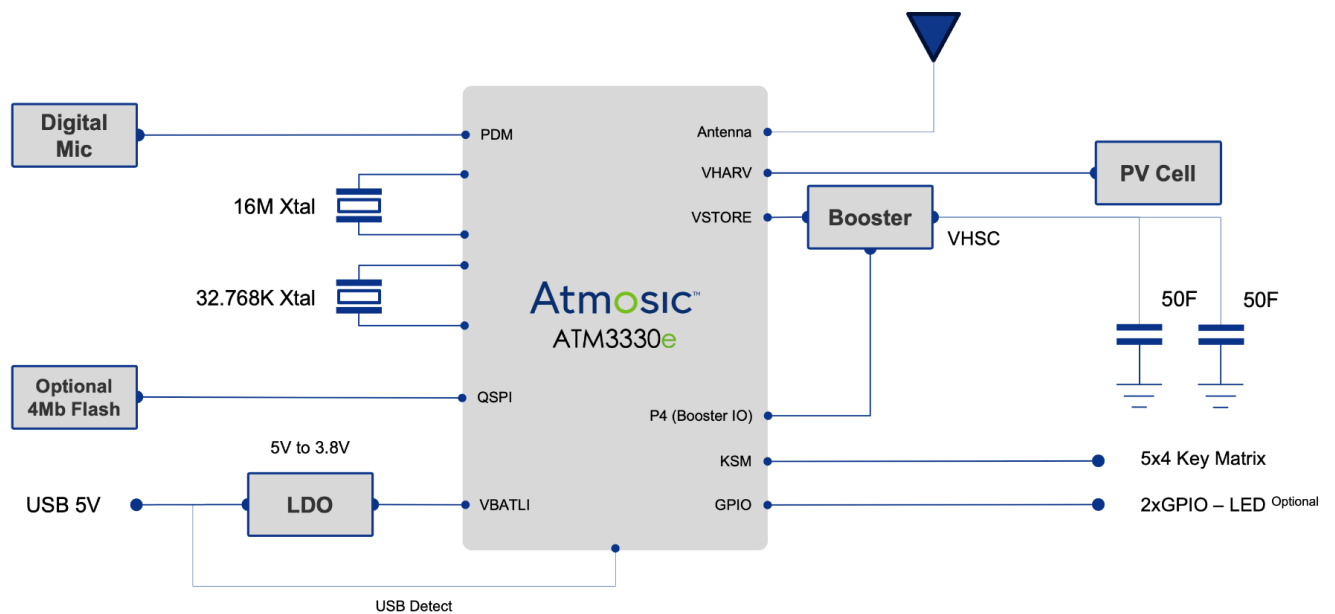


Figure 3 - ATM3330e PV Remote Control Block Diagram

The ATM3330e PV RCU supports three boost options of energy harvesting for different applications as described in [Figure 4](#).

- Boost option 1: Inductive boost from Vharv (ATMRC-3330E-HSC-3-IB-VH)
- Boost option 2: 2-diode boost from Vstore (ATMRC-3330E-HSC-3-DB-VS)
- Boost option 3: 2-diode boost from Vharv (ATMRC-3330E-HSC-3-DB-VH)

The different boost topologies require different firmware configurations to support and the Vhar (Harv\_out) range needs to be adjusted according to the PV cell selected.

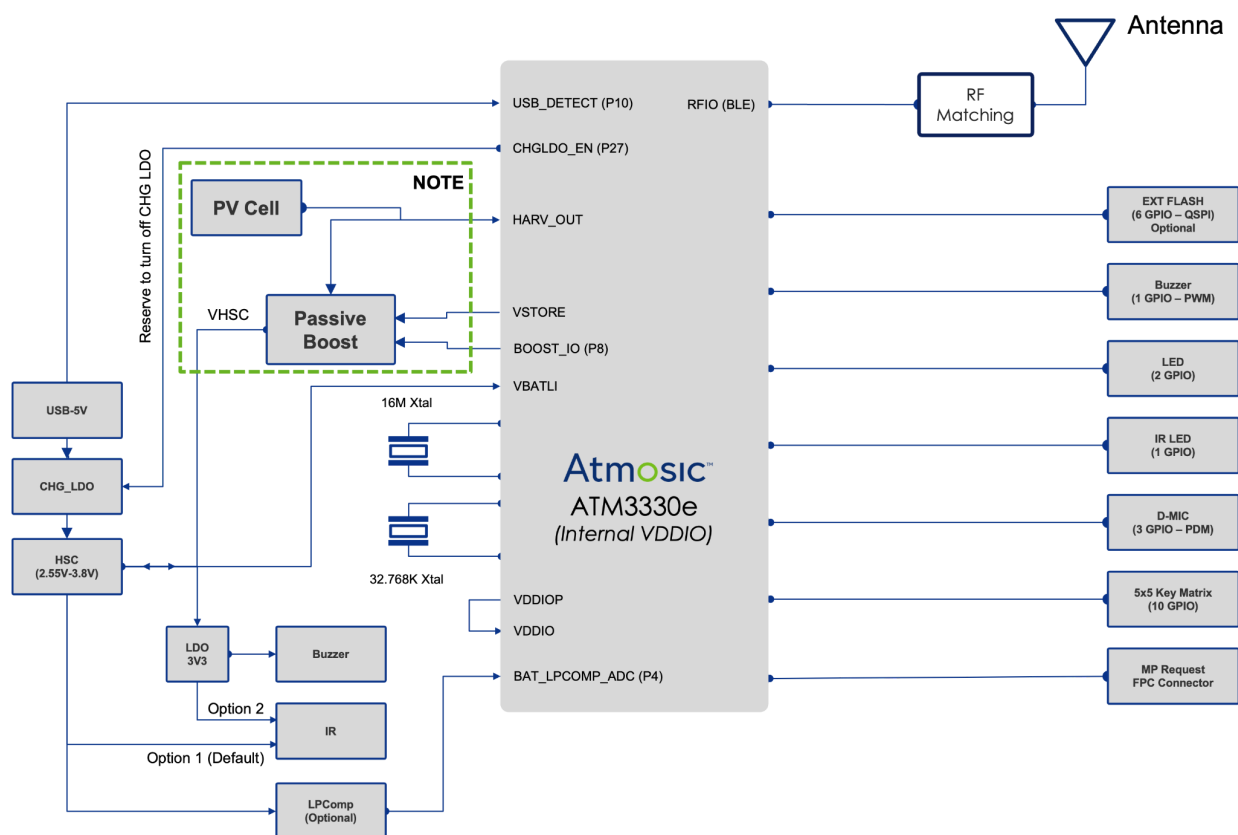
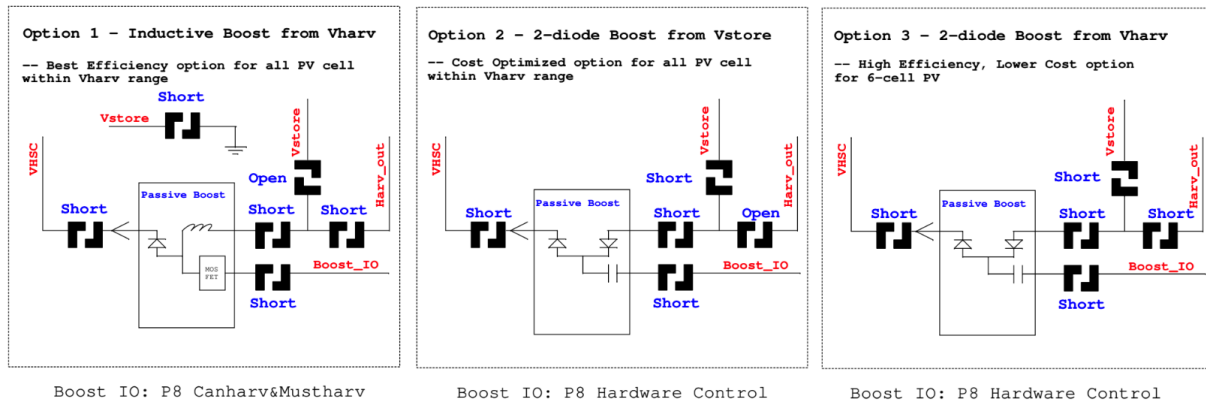


Figure 4 - ATM3330e PV Remote Control Block Diagram (Internal VDDIO)



Different boost circuits depending on the type of PV cell & efficiency



Note: Open is no connection, Short is connection

Figure 5 - ATM3330e PV Remote Control Boost Option Block Diagram

### 3. Android TV Device Support

The Atmosic PV RCU has been tested and verified with the ADT-3 and onn. Android TV devices. The Android TV devices are not provided with the Atmosic PV RCU and are available separately. Refer to the [References](#) section for more information about the Android TV devices.

## 4. Remote Control Operation

### 4.1 General Operation

The state machine for the Remote Control is depicted in [Figure 6](#). Upon power-up, the Remote Control will automatically enter the pairing state if it has not already been paired. If previously paired, it will attempt to reconnect and enter hibernation if it cannot connect in 1.28 seconds. From the pairing state, it will time out after 60 seconds if the pairing is not completed. A keypress on the Remote Control is required to exit the hibernation state and restart the reconnection or pairing process.

Once connected, the Remote Control has a default connection interval of 10 ms with a slave latency setting of 99.

The ATM3330e PV RCU has a voltage monitoring function that operates continuously except when the Remote Control is in the SoC Off state. If the voltage of the HSC is higher than the VBAT\_BOOST voltage level (see [Table 2](#)), the system will enable

external boost charger operation. If the voltage of the HSC is higher than VBAT\_OV, the system will stop the boost charger operation.

If the voltage falls below BRWNOUT\_THR\_VBATLI (see [Table 2](#)), the Remote Control will enter SoC Off and will not be operable again until it reaches WAKEUP\_THR\_VBATLI via USB charging.

When the USB cable is plugged in for charging, a hardware reset disables all Remote Control functionality until the USB cable is unplugged.

The critical voltage levels are shown in [Table 2](#).

	Option 1	Option 2	Option 3
VBATLI Charging Related Thresholds	ATMRC-3330E-HSC-3-IB-VH	ATMRC-3330E-HSC-3-DB-VS	ATMRC-3330E-HSC-3-DB-VH
VBAT_OV	3.8 V	3.8 V	3.8 V
VBAT_BOOST	Invalid	3V	Invalid
WAKEUP_THR_VBATLI	3.1V	3.1V	3.35 V
BRWNOUT_THR_VBATLI	2.8V	2.8V	3.25 V

*Table 2 - Critical VBATLI Voltage Level*

#### 4.1.1 SDK Build Options for Boost Options

To generate FW based on SDK (VER:5.5.0 with patch, or later), please set BOARD according to different boosting circuits. The make option uses BOARD to select each boost option.

```
make run_all BOARD=<board option>
```

Boost Option	Boosting Circuit	Board Option
Option 1	Inductive boost from Vharv	ATMRC_3330e_HSC_3_IB_VH
Option 2	2-diode boost from Vstore	ATMRC_3330e_HSC_3_DB_VS
Option 3	2-diode boost from Vharv	ATMRC_3330e_HSC_3_DB_VH

*Table 3 - Make Options in SDK for Different Boost Options*

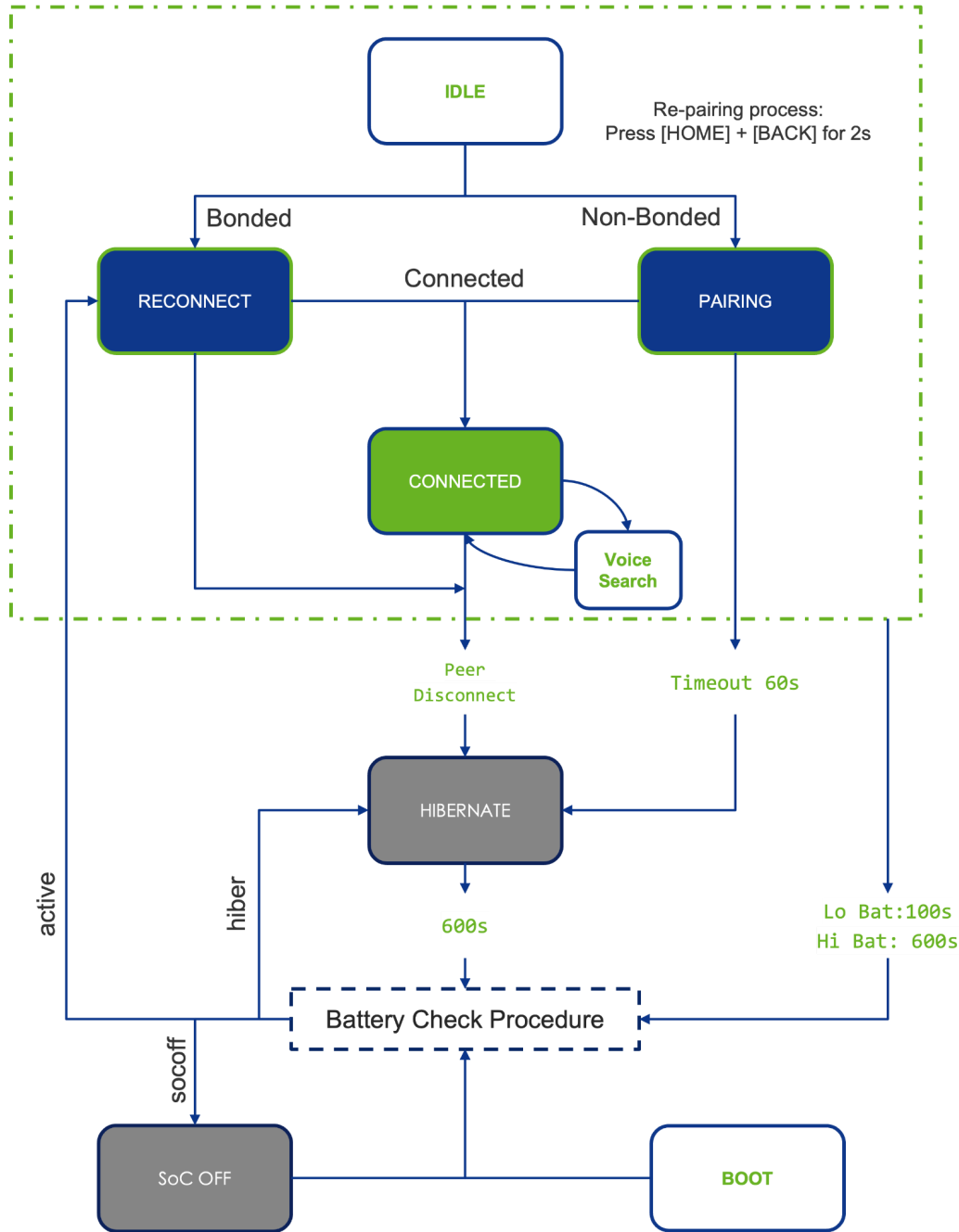


Figure 6 - Remote Control State Machine

## 4.2 Pairing the Remote Control

The Atmosic PV RCU is compatible with both the [ADT-3](#) and [onn](#). Android TV devices. To pair the remote, use the connect a Bluetooth device option in the Settings menu of the Android TV device. Use the Remote Control already paired to the Android TV

device to select the Atmosic RCU device and begin the pairing process. If the Atmosic RCU device is not found, it may either already be paired with another device such as a phone, or another TV device, or in the hibernate state. Press the OK and VoIDn keys simultaneously for two seconds on the Atmosic PV RCU to enter pairing mode. The green LED blinks to indicate pairing is in progress.

If pairing is not completed in 60 seconds after exiting idle/hibernation, the Atmosic PV RCU will enter the Hibernate state, and press the OK and VoIDn keys simultaneously for two seconds again to start the re-pairing process.

To pair with another TV device, delete the Atmosic PV RCU from the list of Bluetooth devices in the Settings>connected devices>previously connected menu of the Android TV device.

## 4.3 Default Parameters

### 4.3.1 Advertising Parameters

The remote control uses two advertisement sets, one for reconnecting advertisements and another for pairing advertisements:

- pairing advertisement interval: 40 ms
- reconnect: send HIGH DUTY directed advertisement duration 1 second

### 4.3.2 Connection Parameters

By default the remote control will operate with the following parameters after connection:

- Connection Interval: 10 ms
- Slave latency: 99
- Connection Timeout: 3 seconds

### 4.3.3 Device Information Parameters

By default the remote will operate with the following parameters:

- Device name: Atmosic RCU
- Tx power: 0 dBm

## 4.4 LED Indicator

The Remote Control supports LED indicators for the operating states listed in [Table 4](#).

Operating State	LED Behavior
USB cable in and charging	Red LED on
USB cable in and charging battery voltage over 3.6 V	Green LED on
Pairing	Green LED blinking at 250 ms interval
Reconnecting	Green LED blinking at 100 ms interval
Remote key press (connected)	Green LED on for 100 ms

*Table 4 - LED Indicator Description*

## 4.5 USB Type-C Connector

The USB Type-C connector is used to charge the hybrid supercapacitor as shown in [Figure 7](#), it is not necessary to remove the back cover for charging.

When plugging in the USB cable, it will trigger a hardware reset to the Remote Control and then enter hibernation. The solid red LED is displayed until the hybrid supercapacitor is charged to a voltage over 3.6 V and the green LED turns on.



*Figure 7 - USB Type-C connection for Charging*

## 5. Power Consumption Measurement

This section introduces how to do the power consumption measurement of the Remote Control reference design and how to configure the dummy (DM) pads to meet different boost options requirements.

### 5.1 Application Options for Energy Boost

The ATM3330e PV RCU can support applications with different energy boost options as below:

- Application 1 - Inductive boost, bypass PMU, Panasonic 4 cell PV.
- Application 2 - two diode boost, Panasonic 4 cell PV.
- Application 3 - Inductive boost, bypass PMU, specific PV cell(Single Cell PV, for example).

Application option 1 and 4 share the same DM connections.

	DM5	DM6	DM17	DM21	DM22	DM26	DM27	DM28	DM29	DM30
<b>Application 1</b>	0	1	1	1	1	0	1	1	0	0
<b>Application 2</b>	1	1	0	0	0	1	0	0	1	1
<b>Application 3</b>	0	1	1	1	1	0	1	1	0	0

*Table 5 - DM(dummy) Pad Selections for Different Application Options*

By default setting, the PV RCU is Application 1. There are some DM pads on the ATM3330e PV RCU board for selecting different energy boost options. “1” means 0 ohm short on this dummy pad and “0” means open on this dummy pad.

### 5.2 VBATLI Current Consumption Measurement

The ATM3330e PV RCU current consumption can be measured by the following steps:

- 1) Desolder PV cell from J2 pin1 and pin2 as [Figure 8](#) shown. The ATM3330e PV RCU current consumption should be measured without harvesting function.
- 2) Desolder DM13 to disconnect VBATLI from HSC, detailed as shown in [Figure 9](#).
- 3) Solder 2 fly-wires onto DM13 pin1 and GND (J2 pin2), respectively. Then connect the fly-wires with a DC power analyzer for further analysis of current consumption, as shown in the following [Figure 10](#).

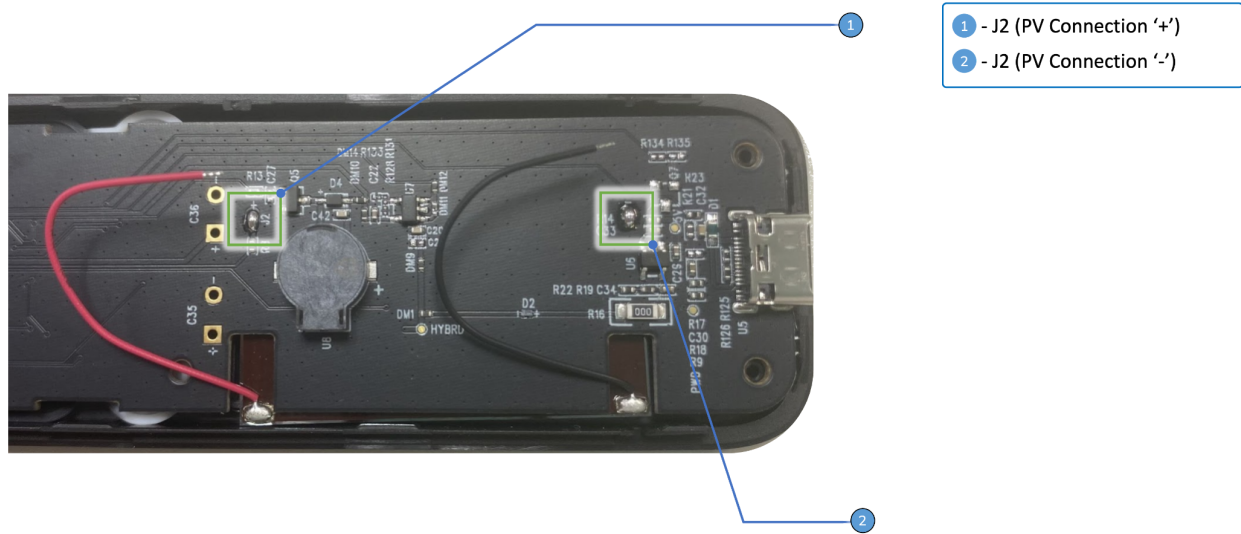


Figure 8 - Desolder PV for Current Consumption Measurement

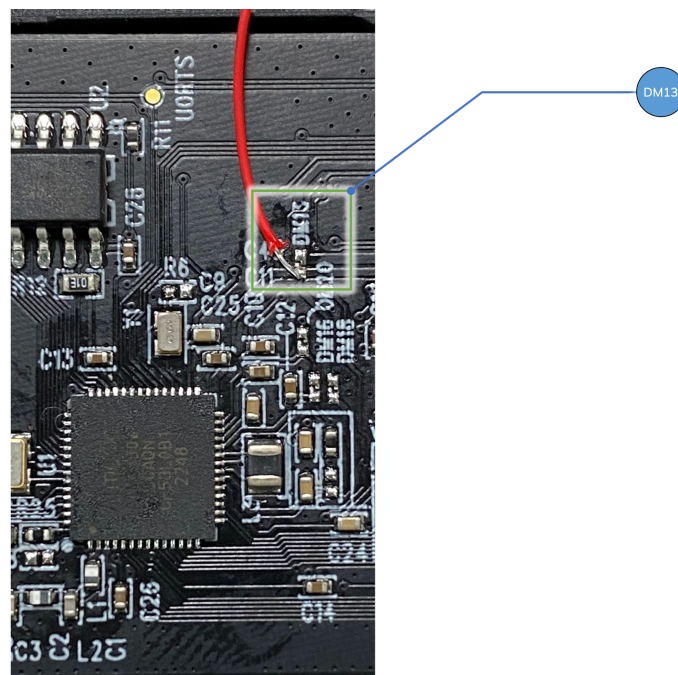


Figure 9 - Desolder DM13 to Disconnect VBATLI from HSC

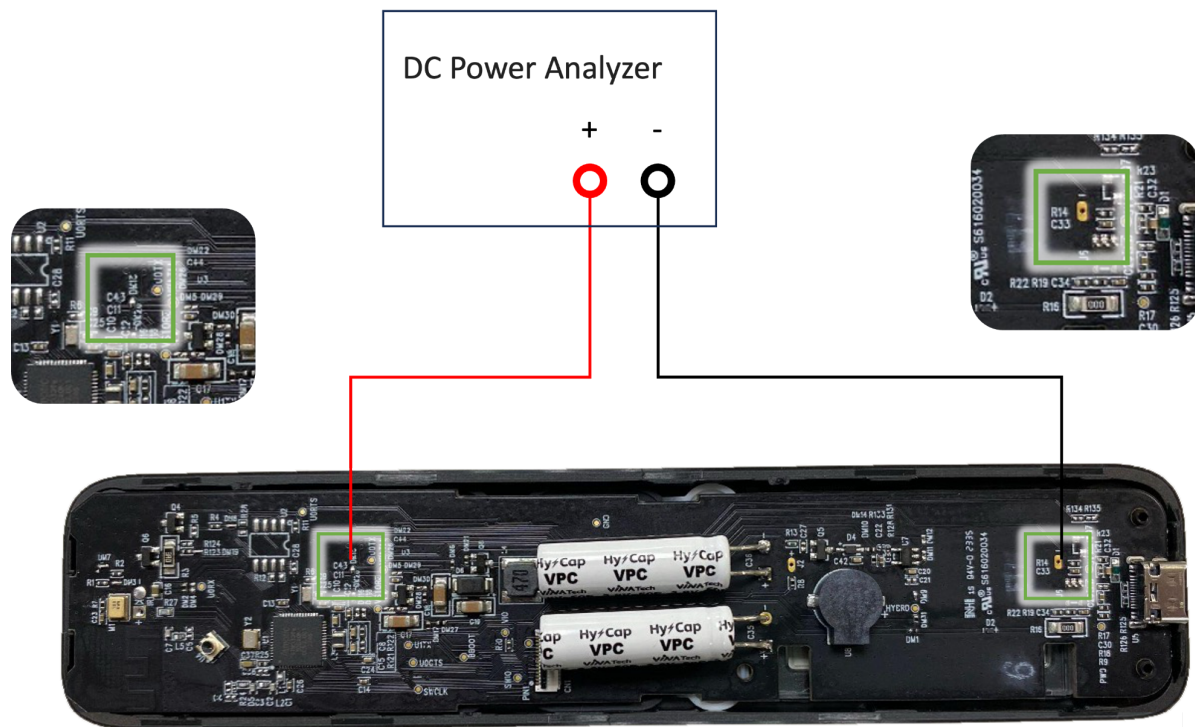


Figure 10 - Connection of Remote Control to DC Power Analyzer for System Current Measurements

## 6. Updating the Remote Firmware

It is recommended that any firmware updates be done OTA with the Atmosic Mobile Application. Hardwired methods of upgrading the firmware are also available, but require removal of the unit's back housing. For additional information, contact Atmosic support.

### 6.1 OTA Update via Mobile App

The Atmosic DevTools App supports OTA upgrading of the remote firmware and is available on both Android and iOS. It can be downloaded from Google Play or Apple APP Store.

Before upgrading, the Remote Control must be put into pairing mode. See [Pairing the Remote Control](#) section of this document for details.

For detailed instructions, please refer to the Firmware Update OTA section of the appropriate User Guide listed in the [References](#) section.



## 6.2 Firmware Update Using Reference Design Programming Board (RPB)

The ATM3330e PV RCU reference design has one connector which can be used for flash programming and as a debug interface. To support the debug and programming function, additional required hardware available from Atmosic is listed below. See [Figure 11](#) for a depiction of how this additional hardware is connected to the PV RCU.

Please refer to the ATM33 RDK Firmware Update section in the **Reference Design Programming Board User Guide** (listed in [References](#) section) for detailed firmware update procedure.

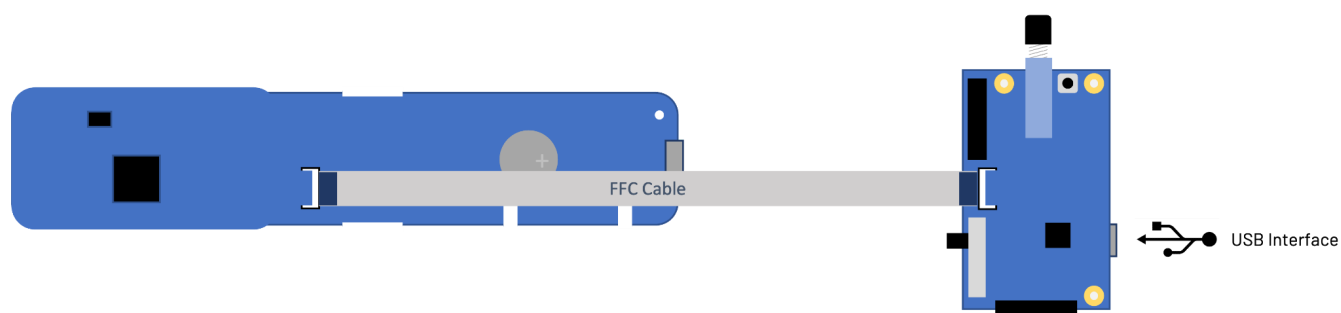


Figure 11 - Connection for Firmware Programming and Debug

## References

Title	Document Number
ATM33/e Series OTA Update Service User Guide	ATM33_e-UGOTA
DevTools Mobile App User Guide	ATM-UGDTMA
RF Test Tool User Guide	ATM-UGRF
SDK User Guide	ATM-UGSDK
Reference Design Programming Board User Guide	ATM-UGRPB
Hardware	Kit Part Number
ATM3330e PV Remote Control Reference Design Battery Free Configuration	ATMRC-3330e-HSC-3
Reference Design Programming Board	ATMRPB-FJ
Devices	Description / Link
ADT-3 Android TV device	Android TV Guide (androidtv-guide.com) - <a href="#">ADT-3</a>
onn. Android TV device	onn. Android TV 4K UHD Streaming Device with Voice Remote Control & HDMI Cable
Component	Description / Link
VINATech 50 F Hybrid Supercapacitor	<a href="#">Datasheet</a> - contact VINATech for additional information ( <a href="mailto:matthewchoi@vinatech.com">matthewchoi@vinatech.com</a> or <a href="mailto:tdickson@vinatechusa.com">tdickson@vinatechusa.com</a> )

## Revision History

Date	Version	Description
December 5, 2023	0.52	Reference design version has been updated to V3.
July 24, 2023	0.51	Format change, no content change.
June 9, 2023	0.50	Initial version created.



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