

ATM32xx EVK Energy Harvesting

User Guide

SUMMARY: This document provides the user of an ATM3 Energy Harvesting Evaluation Kit with the setup and basic usage instructions for evaluating the Atmosic Energy Harvesting solution.



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Acronyms and Abbreviations

Acronyms	Definition
ATM32xx	ATM3202 ATM3221
EVB	Evaluation Board
EVK	Evaluation Kit
PV	Photovoltaic
RF	Radio Frequency
SDK	Software Development Kit
SMA	Subminiature version A
SoC	System-on-Chip
TEG	Thermal

1. Overview

The Atmosic ATM3 series SoC can be powered by harvesting energy from sources such as PV, TEG, RF or mechanical actuation. Harvesting can be employed in completely batteryless configurations or can also be used with a battery (standard or rechargeable) to extend its lifetime.

This guide explains how to use either a PV cell or RF source to power up the ATM32xx EVB with or without a battery in the system. Please refer to the **ATM32xx Energy Harvesting Application Note** (available on the Atmosic Support Website) for more information about energy harvesting operation and performance. See [References](#) section for more information.

EVK	SoC Package	SoC Part Number	Kit Part Number
Evaluation Kit for ATM3202	40-pin 5x5 mm QFN	ATM3202SR	ATMEVK-M3202-02
Evaluation Kit for ATM3221	64-pin 6x6 mm DR_QFN	ATM3221SR	ATMEVK-M3221-02

Table 1 - Supported ATM3 SoCs and EVKs

This guide applies to EVB listed in [Table 1](#). For documentation covering other revisions of the EVB, please contact the Atmosic support team. For information on EVB descriptions, please refer to **ATM2/ATM3 Evaluation Kit User Guide**.

ATM32xx EVB is pre-configured with a flash application to transmit scannable beacons every second and enter a low power state between advertisements. The pre-configured application can be optimized for RF or PV harvesting for different battery options, selected by the on-board DIP switch.

The ATM32xx EVK comprises of the following (shown in [Figure 1](#) and [Figure 2](#)):

- (a) 1 Evaluation Board: ATM3202 EVB or ATM3221 EVB;
- (b) 1 Interface Board;
- (c) 1 2.4-GHz whip antenna: ANT-916-CW-HWR-SMA ([data sheet](#));
- (d) 1 900-MHz whip antenna: GW.15.2113 ([data sheet](#));
- (e) 1 USB-A to micro-B cable
- (f) 1 USB-A to mini-B cable;
- (g) 1 Panasonic PV cell: AM-1454 ([data sheet](#))
- (h) 1 CR2032 Battery

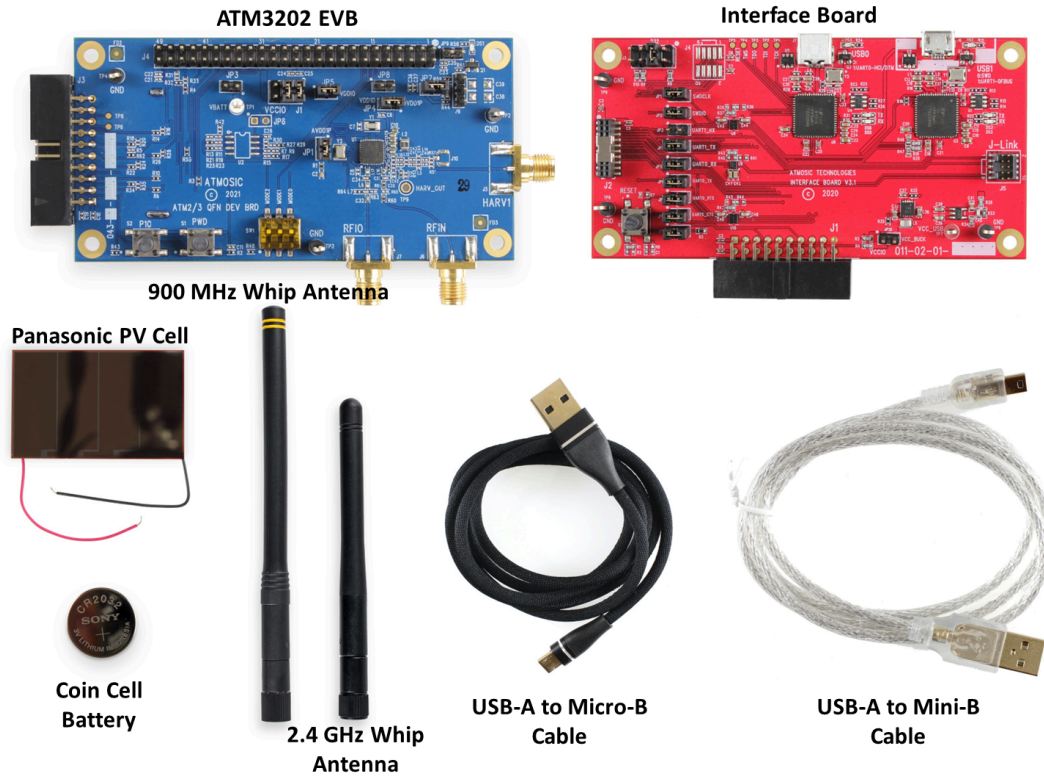


Figure 1 - Items Included in the ATM3202 EVK

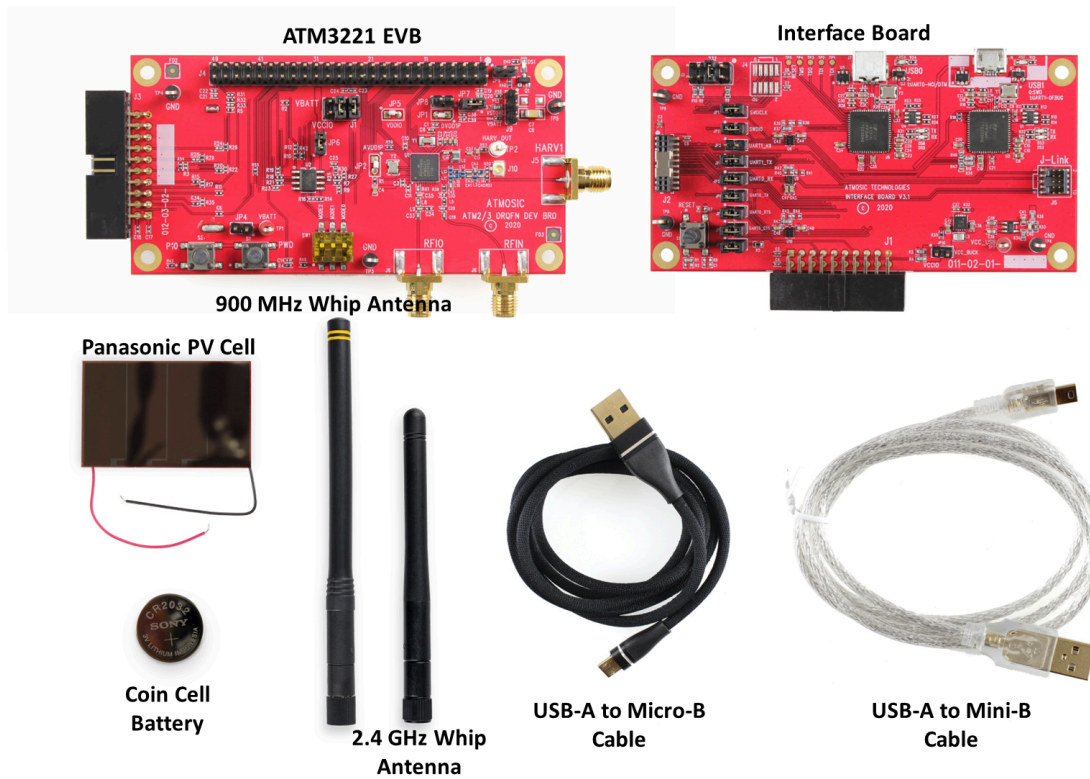


Figure 2 - Items Included in the ATM3221 EVK

2. EVB Connections

[Figure 3](#) and [Figure 4](#) show the locations of specific features needed to operate the ATM3202 and ATM3221 EVBs, respectively.

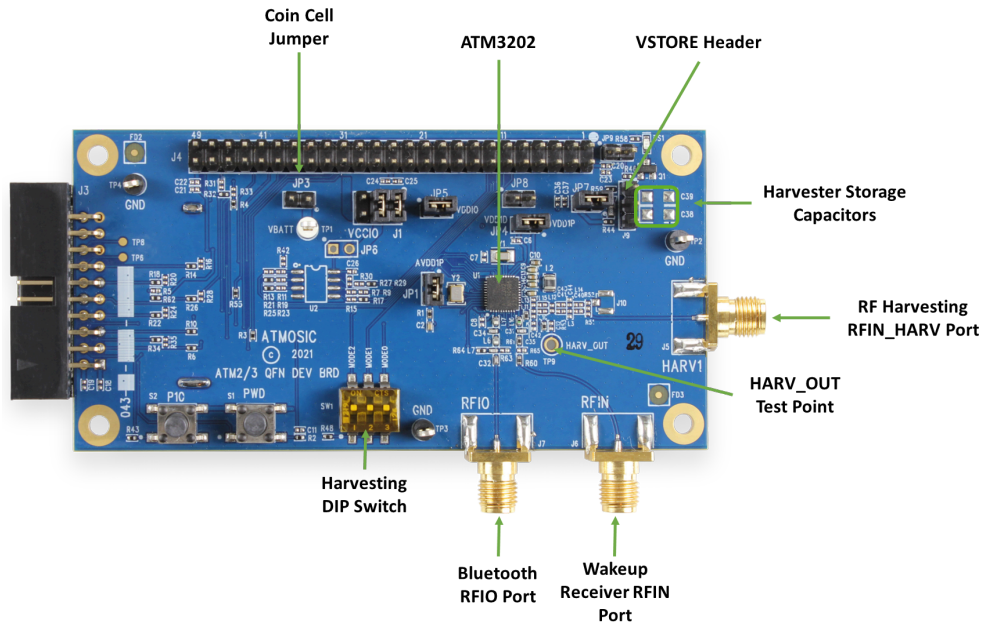


Figure 3 - ATM3202 EVB

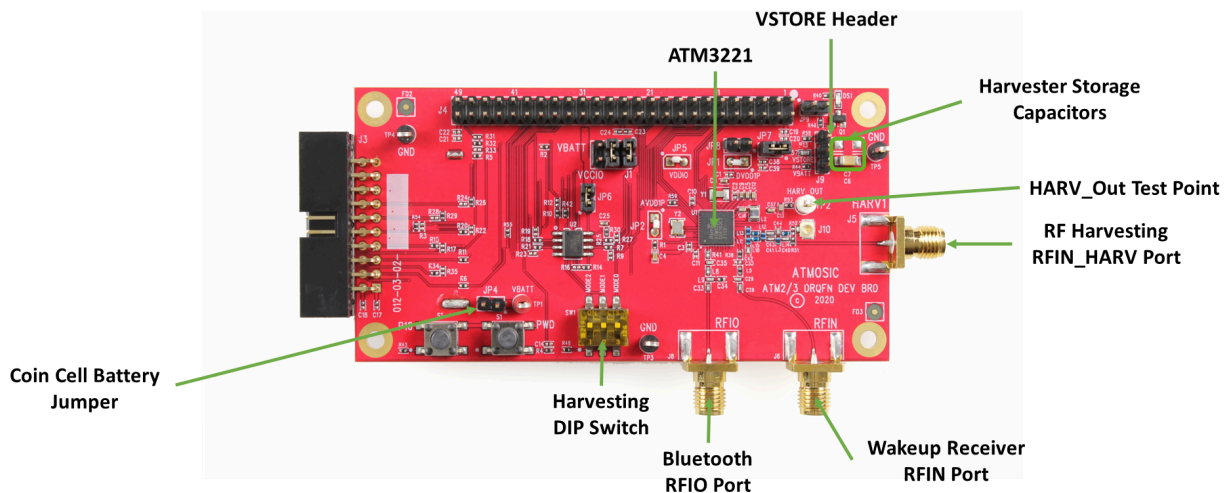


Figure 4 - ATM3221 EVB

The RFIN_HARV SMA connector is the input port for RF harvesting, while the HARV_OUT test point is the input port for non-RF energy harvesting. The 2.4-GHz whip antenna is connected to the RFIO SMA connector.

The DIP switches to select battery option and harvesting type are shown in [Figure 5](#). MODE0 can be used to select RF or non-RF harvesting settings (ie. PV harvesting). The **ON** marking on top is the direction for logical high, indicating RF setting; square dot at bottom left corner is the direction for logical low, indicating the non-RF setting. MODE1 can be used to select the battery options. **ON** indicates a system with regular battery or no battery, otherwise indicates a system with rechargeable battery. MODE2 is currently not programmed. If the device is in operation when the DIP switch position is changed, the EVB must be power cycled before the setting change will take effect, see [Power Cycling the EVB](#) section.

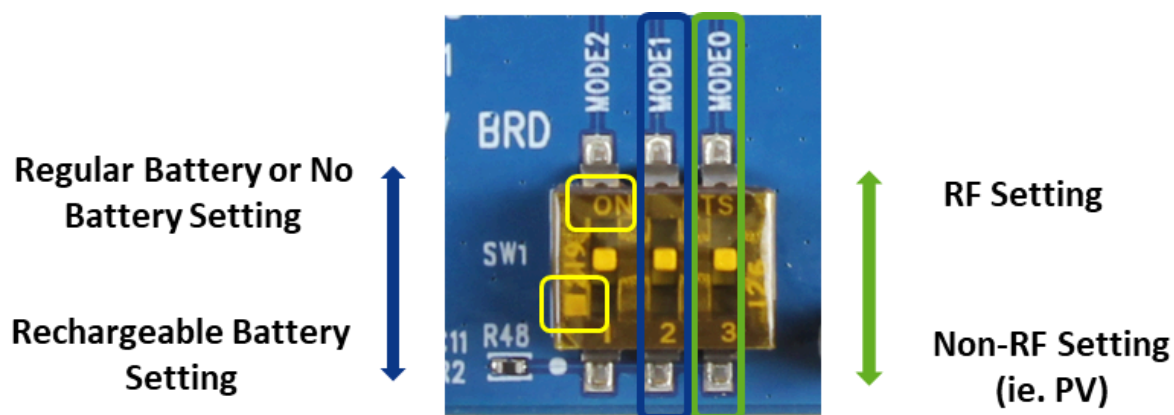


Figure 5 - DIP Switch Marking

The default jumper settings are suitable for a system with no battery. To evaluate the system with a battery, users need to insert the battery to the battery holder at the back of EVB and modify the jumps shown in [Table 2](#). Also see [Figure 6](#) and [Figure 7](#) for battery jumper locations of the ATM3020 EVB and ATM3321 EVB respectively.

EVB	Battery to be evaluated	DIP Switch MODE1 Battery Type	Jumper JP3 or JP4	Jumper J9
ATM3202	CR2032	HIGH: Standard battery	JP3: Position 1-2	J9: Disconnect 2-3
	ML2032	LOW: Rechargeable battery	JP3: Position 1-2	J9: Position 2-3
ATM3221	CR2032	HIGH: Standard battery	JP4: Position 1-2	J9: Disconnect 2-3
	ML2032	LOW: Rechargeable battery	JP4: Position 1-2	J9: Position 2-3

Table 2 - Battery Jumper Settings

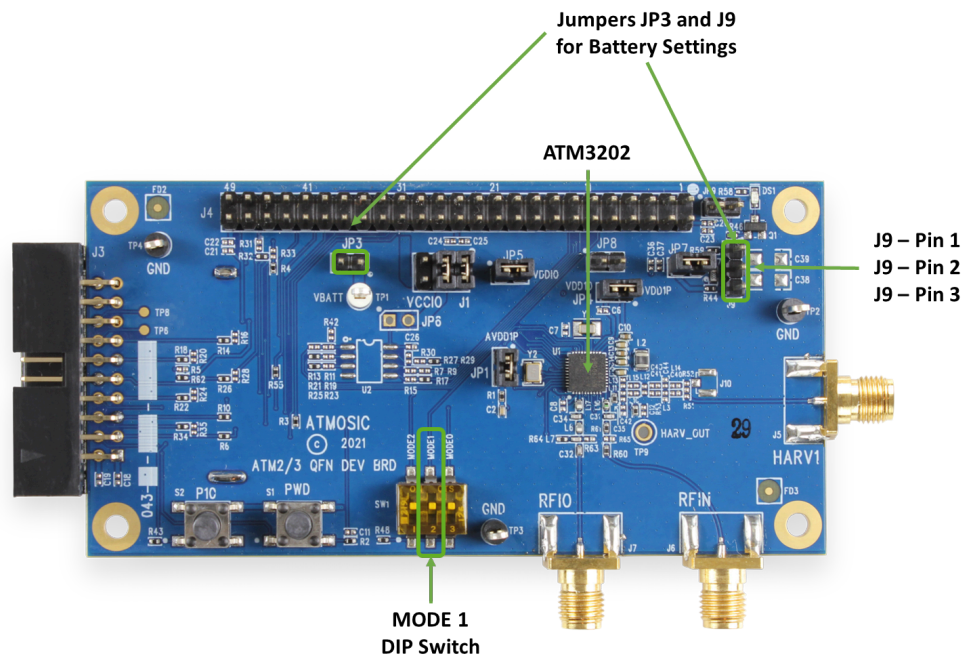


Figure 6 - ATM3202 EVB Battery Jumpers and Dip Switch Location

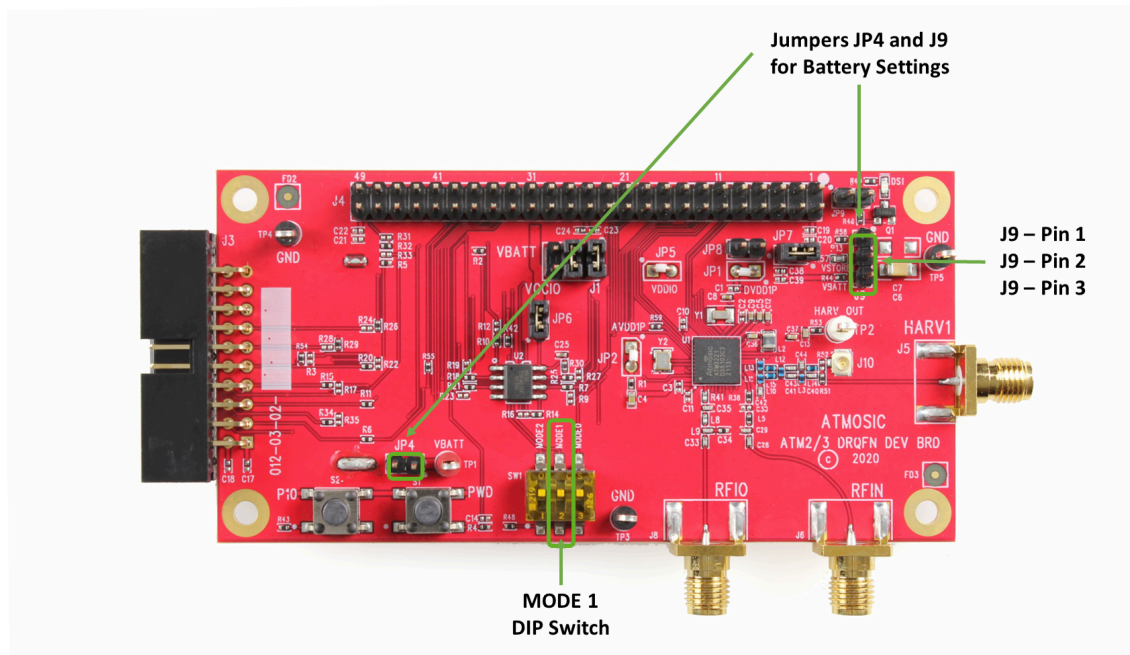


Figure 7 - ATM3221 EVB Battery Jumpers and Dip Switch Location

For more information on the related software settings for battery and harvesting options, please refer to the README file in the SDK:
platform/atm3/ATM32xx-xXx/examples/README.

The rest of the document uses the default configuration, system with no battery, to showcase the harvesting setup and behavior.

2.1 Power Cycling the EVB

The Powerdown (PWD) button should NOT be used for power cycling the board. This function is only supported when an external I/O supply is used.

Instead, the following steps should be taken to power cycle the EVB:

- 1) Remove any harvesting source by disconnecting or covering the PV cell (PV configuration) or turning off the RF source (RF configuration)
- 2) Wait at least 10 seconds for power rails to discharge
- 3) Reconnect the desired harvesting source to EVB

3. Setup for RF Harvesting

When evaluating RF harvesting, the MODE0 DIP switch should be set high for optimal RF performance. The EVB can harvest power from the RF Source Transmitter board (See [Set up the RF Source Transmitter Board](#) section) without a battery, and eventually has enough harvested energy to power up the chip to send beacons (see [Advertisement Beacons Detection](#) section).

The RF Source Transmitter board is not included in the Evaluation Kit and is available separately from Atmosic.

3.1 Set up the RF Source Transmitter Board

The RF Source Transmitter board has two main chips on it. One is Si446x which is used to transmit RF power to charge the EVB. The other is ATM32xx Bluetooth LE chip which is used to communicate with the EVK if desired (see [Dynamic RF Source Control](#) section). The RF Source Transmitter board is powered from a 5 V adapter. A 900-MHz whip antenna (with two yellow stripes) should be attached to the RFIO SMA port as well as the RFIN_HARV port of ATM32xx EVB, as shown in [Figure 8](#). Please align the two antennas for optimal performance.

The RF Source Transmitter board also enables Bluetooth LE communication via an Atmosic ATM2 device integrated onto the board. A Bluetooth LE antenna connection at the Bluetooth LE RFIO port is required.

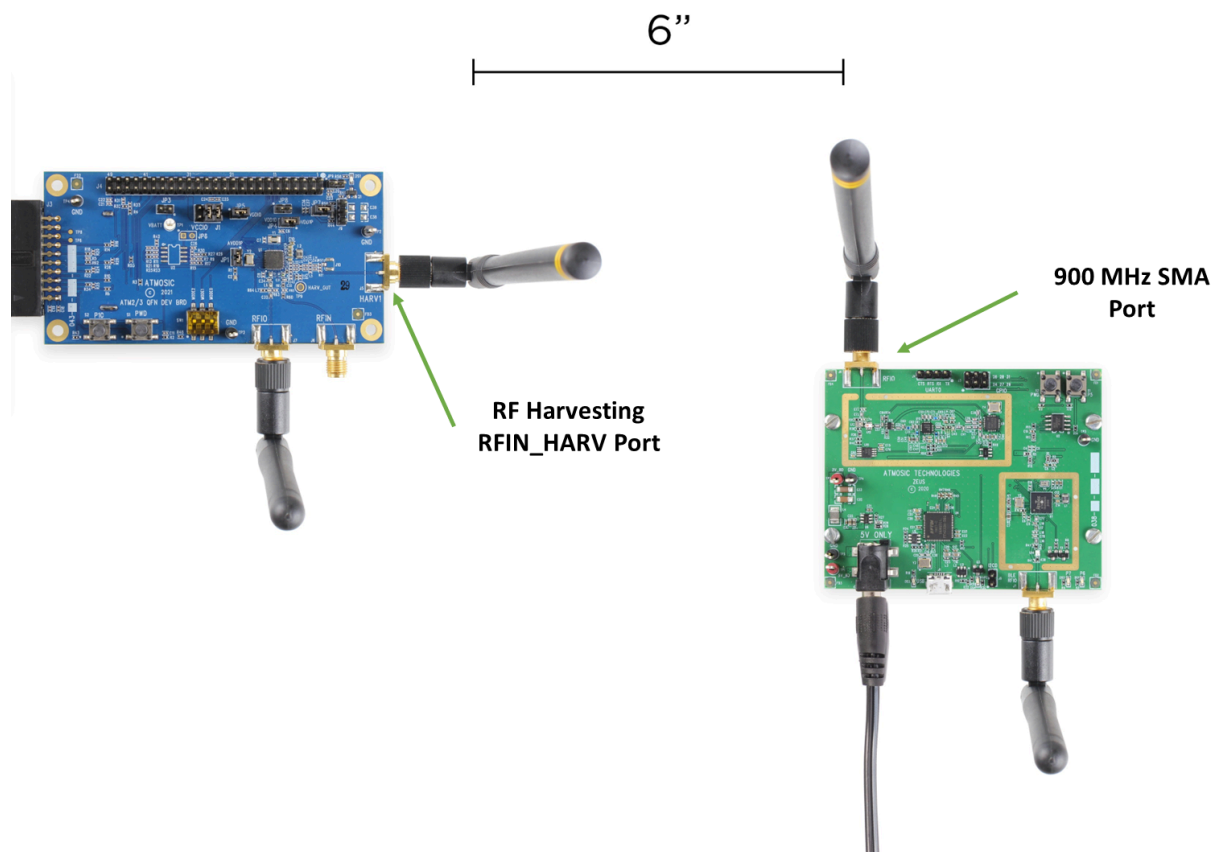


Figure 8 - EVK Setup with Transmitter Board

The RF Source Transmitter board transmits a 100% duty cycle at 915-MHz signal at 29 dBm by default and supports a variety of duty cycle, frequency, and output power level settings. For more information about RF Source Transmitter board setup and configuration, please refer to the **RF Source Transmitter Board User Guide**.

Note: Do not continuously operate the transmitter board at full TX power while its antenna is closer than 6 inches to the harvesting antenna of the EVB. Please also disconnect the transmitter board when not in use.

3.2 Advertisement Beacons Detection

When the EVB receives enough harvested energy to power up the chip and sends beacons, the advertisement beacons can be detectable with any Bluetooth LE sniffer application. As an example, Atmosic DevTools App (available by searching for Atmosic DevTools in Google Play or Apple Apps Store) is used and the screenshot is shown in [Figure 9](#).

The scan response of the beacon shows ATM3 RF. With a batteryless system, if the EVB is 20 inches away from the transmitter board which operates at default continuous mode, it will start beaconing within 5 seconds.

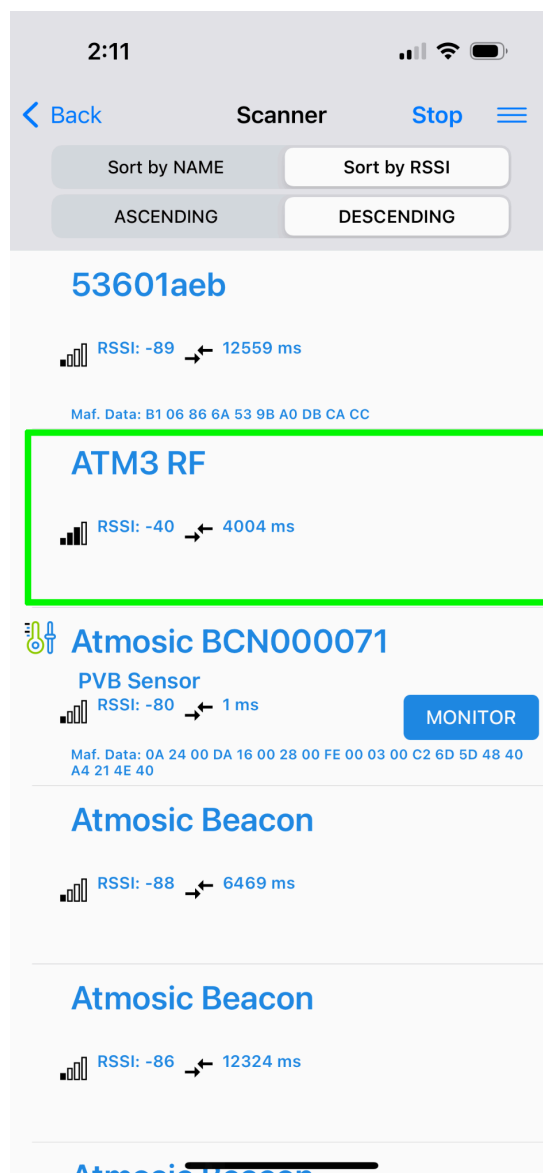


Figure 9 - EVB Detected by Atmosic DevTools

3.3 Dynamic RF Source Control

It is possible for EVB to communicate with the RF Source Transmitter Board, dynamically controlling it based on the energy status of the storage device.

The corresponding EVK application example is available in the Atmosic SDK: `platform/atmX/ATMXXxx-xXx/examples/RFsource_adv`. Please execute the following command to compile and load the application:

```
make CFG_DYN_HARV=1 run_all
```

When Dynamic RF Source Control feature is enabled, the VSTORE voltage is measured periodically (every second by default). When the voltage is higher than the configured upper threshold (3.0 V default), the EVB will send a BLE advertisement packet with a specific ADV payload called Start-RF. When the VSTORE voltage falls below the configured lower threshold (2.0 V default) the EVB will send a packet with the Stop-RF ADV payload.

The RF Source Transmitter Board is configured to always scan and look for these specific payload advertisements. It will start or stop transmitting RF power according to which payload (Start-RF or Stop-RF) it receives.

For power optimization, the user can modify the voltage thresholds and measurement interval based on the storage element capacity and the expected harvesting power.

To modify the VSTORE thresholds, please add the following CFLAGS in the makefile, type `make clean` and `make CFG_DYN_HARV=1 run_all` to compile and load the application.

```
CFLAGS += -DVSTORE_HVT=3.0 -DVSTORE_LVT=2.0
VSTORE_HVT: High voltage threshold of VSTORE.
VSTORE_LVT: Low voltage threshold of VSTORE.
```

To modify the time interval for VSTORE voltage measurement, please modify in the example file: `RFsource_adv.c` (unit in 10 ms):

```
#define ITVL_MEAS_V_CS 100
```

The EVK beacon interval can be modified in `rfa_param_adv.h` located at `platform/atmX/ATMXXxx-xXx/examples/RFsource_adv/src/bt`:

```
#define ADV0_INTERVAL_MIN_MS 1000  
#define ADV0_INTERVAL_MAX_MS 1000
```

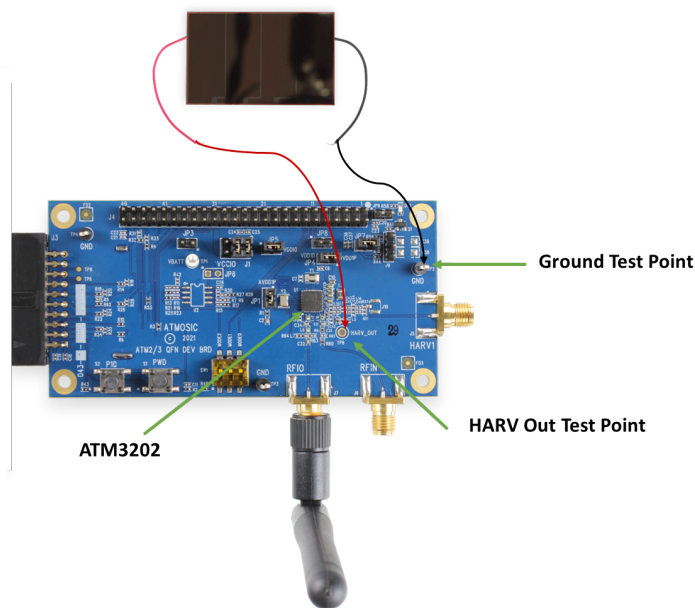
4. Setup for PV Harvesting

When using a PV cell as the harvesting source to the EVB, MODE0 DIP switch should be set low for optimal performance.

The EVB can harvest power from the PV cell without a battery, and eventually has enough harvested energy to power up the chip to send beacons.

4.1 Set up the PV cell

Connect the positive terminal of the PV cell to the HARV_OUT test point and its negative terminal to any GND test point as shown in [Figure 10](#). For demonstration and evaluation purposes, a PV cell by Panasonic is suitable for indoor environments and is included in the EVK.



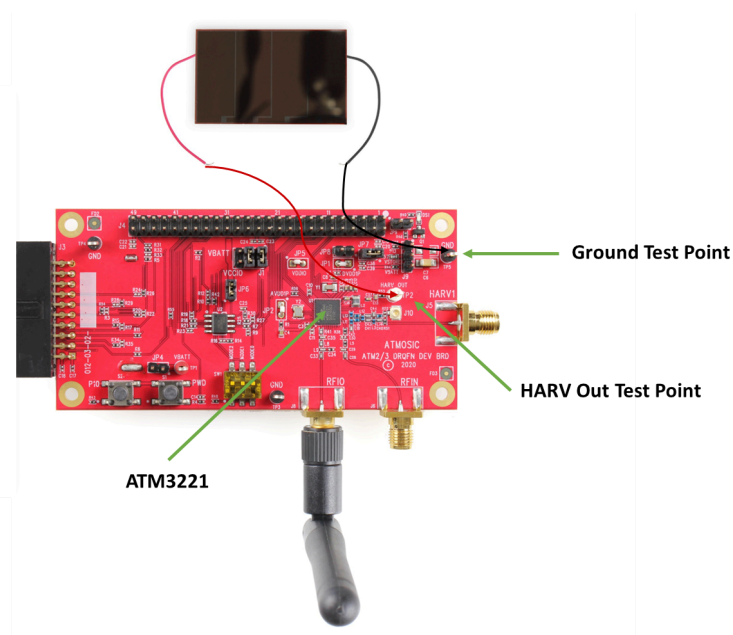


Figure 10 - EVK Setup with PV Cell

4.2 Advertisement Beacons Detection

The advertisement beacons are detectable with any Bluetooth LE sniffer application. As an example, Atmosic DevTools App (available on Google Play or Apple App Store by searching for Atmosic DevTools) is used and the screenshot is shown in [Figure 11](#). The scan response of the beacon shows ATM3 SOLAR. With a batteryless system, under typical indoor office lighting of > 200 lux, the EVB will start beaconing within 10 seconds.

References

Title	Document Number
ATM32xx EVK Energy Harvesting Application Note	ATM32xx-ANHV
ATM2/ATM3 Evaluation Kit User Guide	ATM2_ATM3-UGEVK
ATM2/ATM3 EVK Power Consumption Evaluation User Guide	ATM2_ATM3-UGPCE
RF Source Transmitter Board User Guide	ATM-UGTB
Component	Link
2.4-GHz whip antenna: ANT-916-CW-HWR-SMA	data sheet
900-MHz whip antenna: GW.15.2113	data sheet
Panasonic PV cell: AM-1454	data sheet

Revision History

Date	Version	Description
February 21, 2024	0.62	Updated title and footer. No content change.
April 6, 2023	0.61	Updated Advertisement Beacons Detection section. Changed format.
April 4, 2023	0.60	Major updates to include latest versions of the EVB and configurations.
June 15, 2022	0.58	Updated Figure 2 - Items included in the ATM32xx Evaluation Kit (EVK) , Figure 4 - DIP Switch Marking. Added Figure 6 - ATM3201-043 EVB Setup for Rechargeable Battery,
December 17, 2021	0.57	Updated Connecting to the EVB . Corrected typos.
September 29, 2021	0.56	Updated Overview and section Setup with RF Sources and EVK application.
April 14, 2021	0.55	Updated format, no content change.
March 30, 2021	0.54	Updated Overview , Power Cycling the EVB , Figure 5 - ATM3201 EVB Setup for Rechargeable Battery , Figure 6 - ATM3221 EVB Setup for Rechargeable Battery.
December 2, 2020	0.53	Corrected typos.
November 23, 2020	0.52	Changed name to ATM32xx, updated various sections.
July 2, 2020	0.51	Updated various sections.
March 6, 2020	0.50	Initial version created.



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