ATM32xx EVK Energy Harvesting
Quick Start Guide

Revision History

Date	Version	Description
March 6, 2020	0.50	Initial version created.
July 2, 2020	0.51	Updated various sections.
November 23, 2020	0.52	Changed name to ATM32xx, updated various sections.
December 2, 2020	0.53	Corrected typos.
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.
April 14, 2021	0.55	Updated format, no content change.
September 29, 2021	0.56	Updated 1 Overview and section 4 Setup with RF Sources to include Zeus RF Source Transmitter board and EVK application.
December 17, 2021	0.57	Corrected typo. Updated 2 Connecting to the EVB section.

CONFIDENTIAL

©2020-2021, Atmosic Technologies Inc. All rights reserved. Atmosic logo is a registered trademark of Atmosic Technologies Inc. All other trademarks are the properties of their respective holders. This document is subject to change without notice.

Table of Contents

1 Overview 3

2 Connecting to the EVB 4

2.1 Power Cycling the EVB 6

3 Setup with a Battery 6

4 Setup with RF Sources 8

4.1 RF Source Transmitter Board 8

4.2 Zeus RF Source Transmitter 10

4.2.1 EVK Application Download 11

4.2.2 Dynamic RF Source Control 12

5 Setup with PV Source 13

List of Figures

Figure 1 - Items included in the ATM32xx Evaluation Kit (EVK)
Figure 2 - ATM3201 EVB
Figure 3 - ATM3221 EVB
Figure 4 - DIP Switch Marking for ATM3201 (Left) and ATM3221 (Right)
Figure 5 - ATM3201 EVB Setup for Rechargeable Battery
Figure 6 - ATM3221 EVB Setup for Rechargeable Battery
Figure 7 - EVK Setup with Transmitter Board
Figure 8 - EVK Board Detected by ViewTool Hollong Bluetooth LE Sniffer
Figure 9 - EVK Setup with Transmitter Board
Figure 10 - EVK Setup with PV Cell
Figure 11 - EVB Detected by ViewTool Hollong Bluetooth LE Sniffer

CONFIDENTIAL

1 Overview

The Atmosic ATM3 series system-on-a-chip (SoC) can be powered by harvesting energy from sources such as photovoltaic (PV), thermal (TEG), radio frequency (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 Evaluation Board (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.

This guide applies to EVB revision D2x. For documentation covering other revisions of the EVB, please contact the Atmosic support team. For information on EVB revisions and descriptions, please refer to EVK User's Guide for ATMx201/ATMx202.

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 Evaluation Kit (EVK) comprises of the following (shown in Figure 1):

(a) 1 Evaluation Board: ATM3201 EVB or ATM3221 EVB;
(b) 1 Interface Board;
(c) 1 RF Source Transmitter board*
(d) 1 2.4-GHz whip antenna: ANT-916-CW-HWR-SMA (data sheet);
(e) 2 900-MHz whip antenna: GW.15.2113 (data sheet);
(f) 2 USB-A to micro-B cables;
(g) 1 Panasonic PV cell: AM-1454 (data sheet)
(h) 1 Maxell Rechargeable Battery: ML2032 (data sheet)

* **NOTE**: Early versions of the M3 EVK included an RF Source Transmitter Board, however it is no longer provided with the kit and must be ordered separately. Contact your Atmosic sales representative for more information.

CONFIDENTIAL

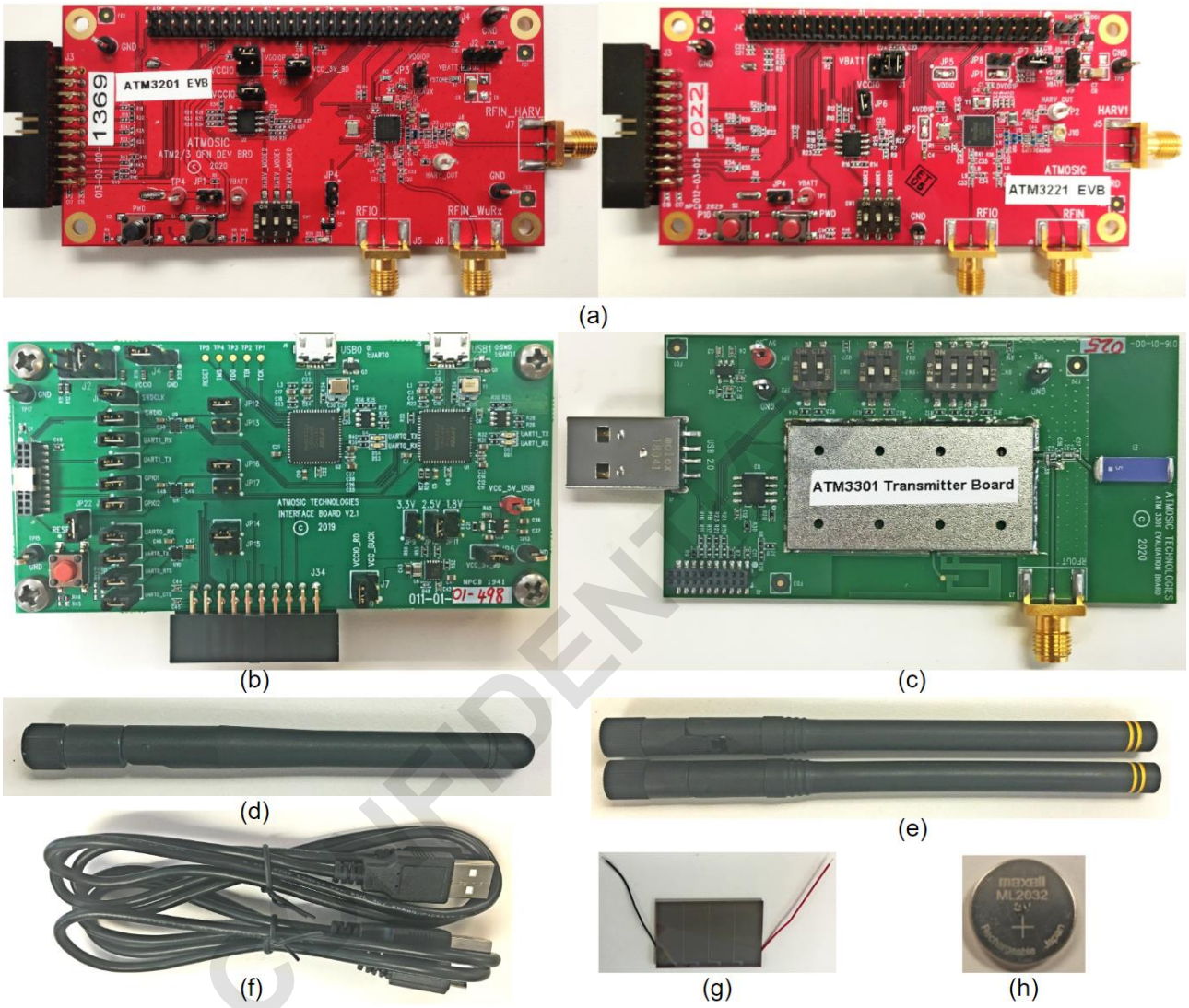

Figure 1 - Items included in the ATM32xx Evaluation Kit (EVK)

2 Connecting to the EVB

Figure 2 and Figure 3 show the locations of specific features needed to operate the ATM3201 and ATM3221 EVBs, respectively.

The RFIN_HARV SMA connector (circled in **blue**) is the input port for RF harvesting, while the HARV_OUT test point (circled in **orange**) is the input port for non-RF energy harvesting. The DIP switches to select battery option and harvesting type are circled in **green** and ground test points are circled in **black**.

The 2.4-GHz antenna is connected to the RFIO SMA port (circled in **yellow**).
The default jumper settings are suitable for a system with no battery. To evaluate the system with a battery, the user needs to insert the battery to the battery holder and modify 2 jumper locations

(circled in cyan and white), which will be discussed in a subsequent section.

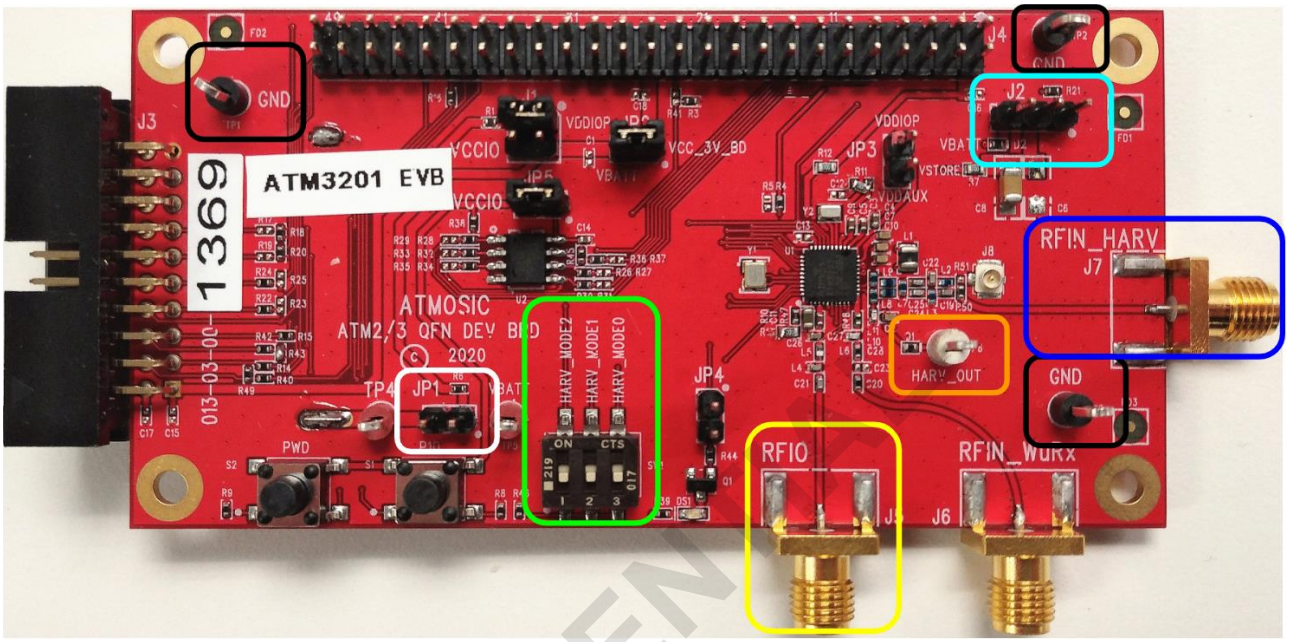

Figure 2 - ATM3201 EVB

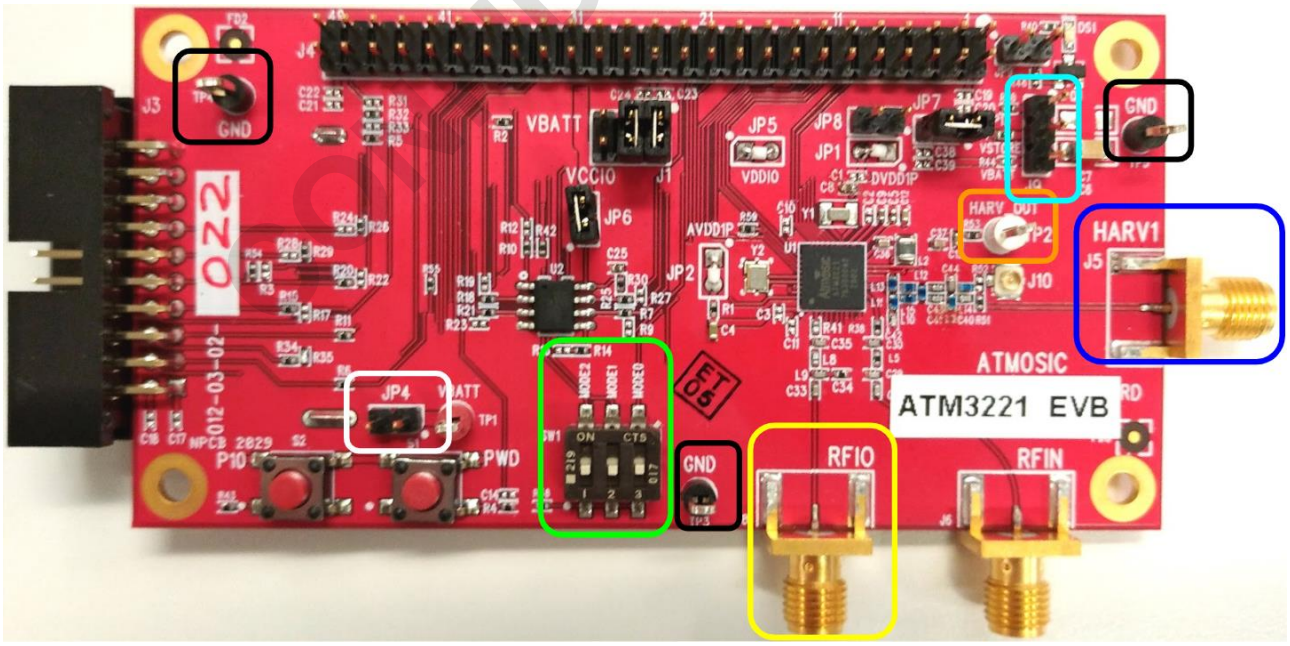

Figure 3 - ATM3221 EVB

Figure 4 shows the DIP Switch markings. Due to limitation of the board space, the switches are marked as HARV_MODEx for ATM3201 (left in Figure 4) and MODEx for ATM3221 (right in Figure 4). They are referred to as MODEx for the rest of this document. MODE0 can be used to select RF or non-RF harvesting settings (ie. PV harvesting). "ON" 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.

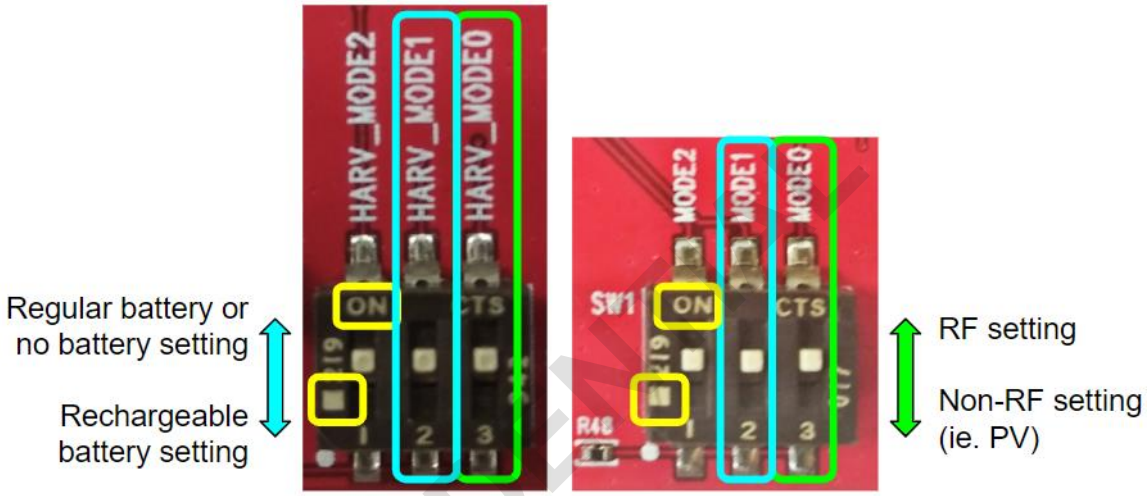

Figure 4 - DIP Switch Marking for ATM3201 (Left) and ATM3221 (Right)

CONFIDENTIAL

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 with a Battery

When evaluating a system with a rechargeable battery, the EVB board should be set up as shown in Figure 5 and Figure 6 for ATM3201 and ATM3221 EVBs respectively. The MODE1 DIP switch (circled in green below) should be set **low**. The jumper circled in cyan should be placed in position

2-3 to connect VSTORE and VBAT through a 560 Ω resistor on board. The ML2032 rechargeable battery is inserted in the battery holder at the back of EVB. The jumper circled in white should be installed to connect to the battery.

When evaluating a system with a regular battery, the MODE1 DIP switch (circled in green below) should be set **high**. A CR2032 battery (not included in EVK) can be inserted in the battery holder at the back of EVB. The jumper circled in white should be installed to connect to the battery.

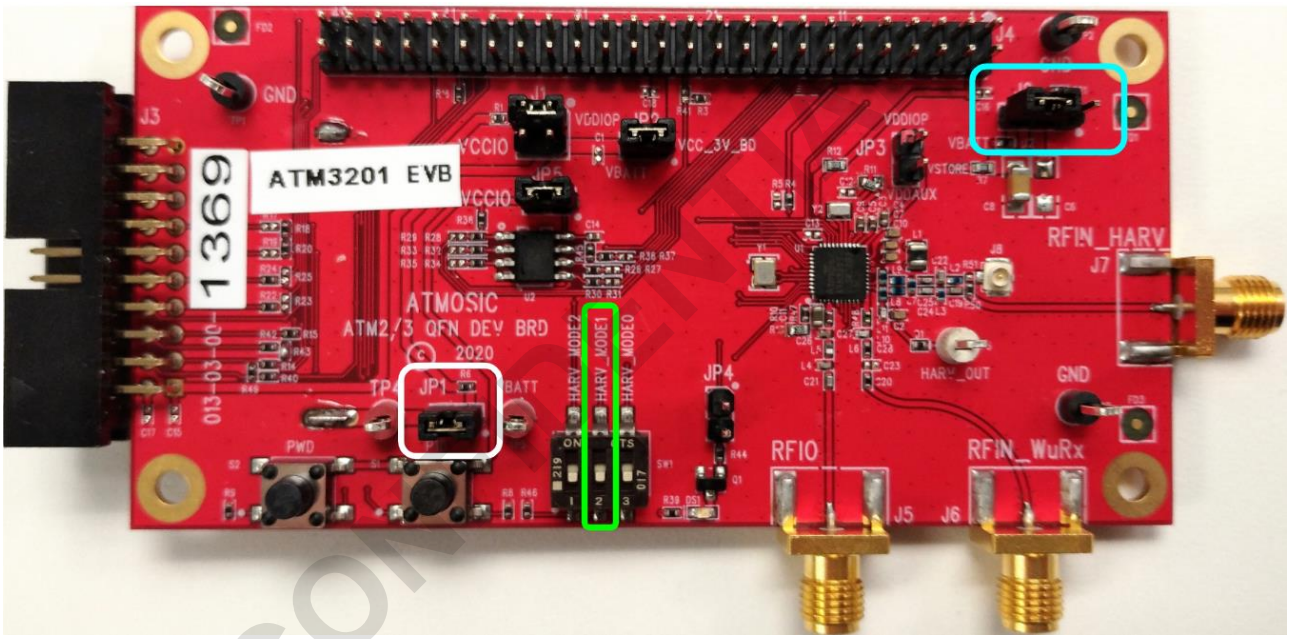

Figure 5 - ATM3201 EVB Setup for Rechargeable Battery

CONFIDENTIAL

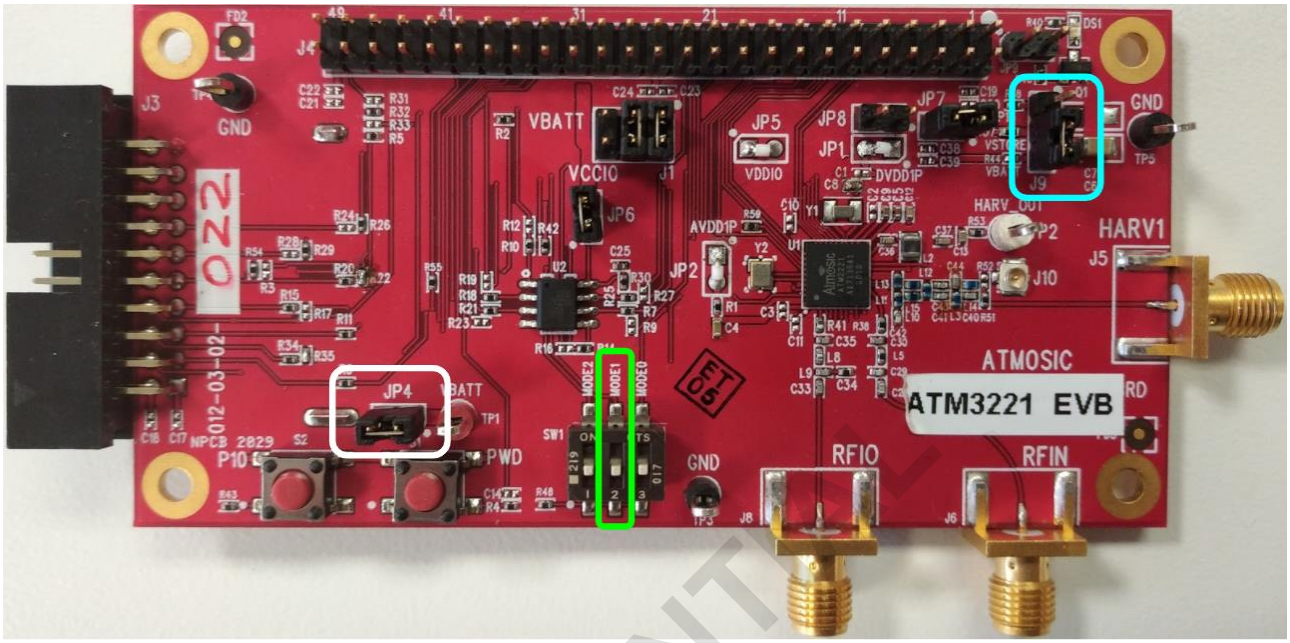

Figure 6 - ATM3221 EVB Setup for Rechargeable Battery

For information on makefile settings that help configure the code for the correct battery configuration, please refer to the README file in platform/atm3/ATM32xx-x1x/examples/ or platform/atm3/ATM32xx-x0x/examples/ directory of the SDK installation.

4 Setup with RF Sources

When evaluating RF harvesting, the MODE0 DIP switch should be set **high** for optimal RF performance. There are two RF Source Transmitter boards available, so follow the instructions based on the RF source being used.

4.1 RF Source Transmitter Board

If you are using a board that looks like the one shown in Figure 1(c), then you only have to plug it into a USB port to start the RF source transmission. A 900-MHz whip antenna should be attached to the RFOUT SMA port of the transmitter board as well as the RFIN_HARV port of ATM32xx EVB, as shown in Figure 7. Please align the two antennas for optimal performance.

The transmitter board transmits a 100% duty cycle 914-MHz GFSK modulated signal at 27 dBm by default. The transmitter board can be configured to transmit with its on-board chip antenna instead of the whip antenna, and it supports a variety of duty cycle, frequency, and output power level settings. Please refer to the *RF Source Transmitter Board User Guide* for more information.

CONFIDENTIAL

Figure 7 - EVK Setup with Transmitter Board

The advertisement beacons are detectable with any Bluetooth LE sniffer application. As an example, a ViewTool Hollong Bluetooth LE Sniffer is used and the screenshot is shown in Figure 8. The scan response of the beacon shows “ATM3 RF”. With a batteryless system, if the EVB is 20 inches away from the transmitter board, it will start beaconing within 5 seconds.

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.

CONFIDENTIAL

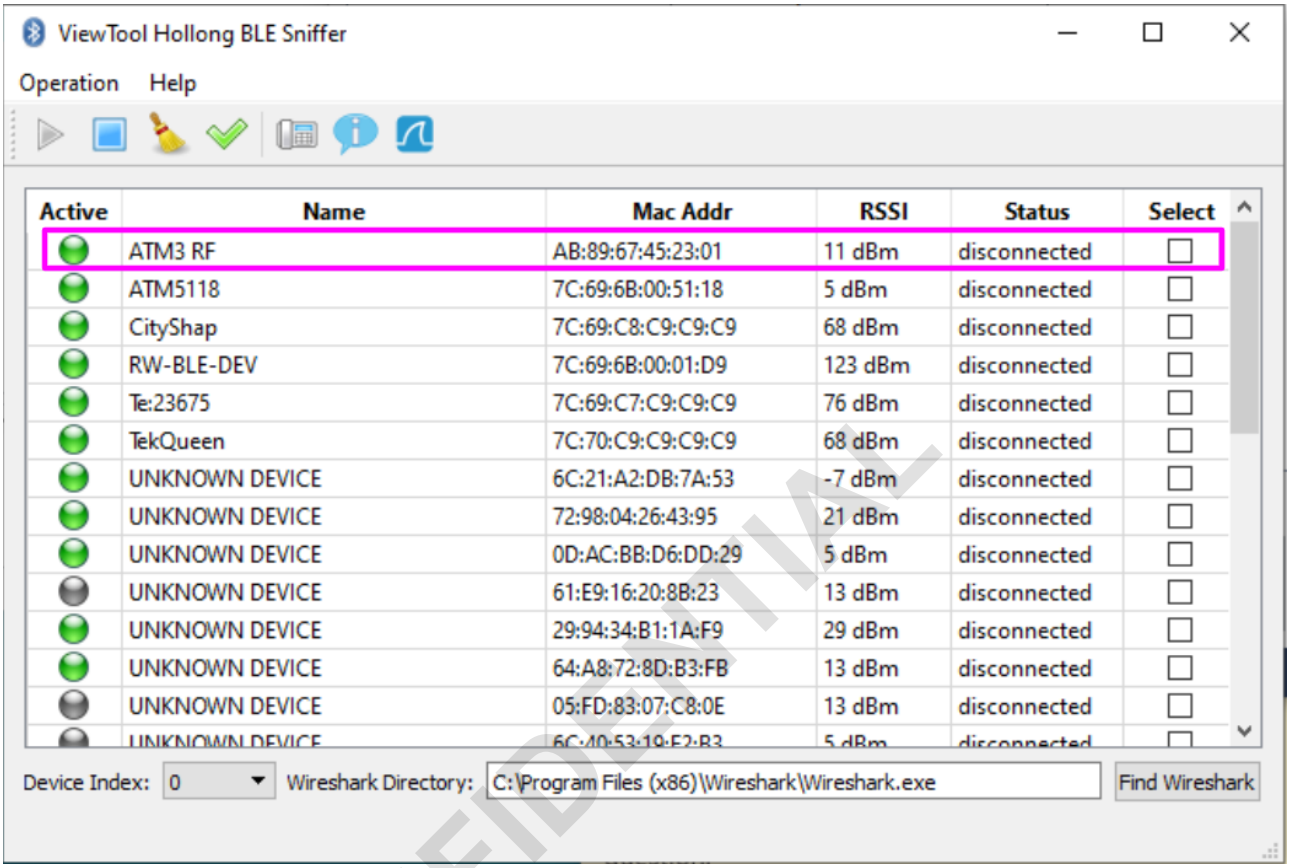

Figure 8 - EVB Detected by ViewTool Hollong Bluetooth LE Sniffer

4.2 Zeus RF Source Transmitter

The Zeus RF Source Transmitter board is not included in the Evaluation Kit and is available separately from Atmosic. Contact your Atmosic representative for ordering information.

The Zeus transmitter board is powered from a 5V adaptor, not the USB connection. 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 9. Please align the two antennas for optimal performance.

The Zeus transmitter board also enables BLE communication via an Atmosic ATM2 integrated onto the board. A Bluetooth LE antenna connection at the Bluetooth LE RFIO port is required.

The Zeus transmitter board transmits a 100% duty cycle 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 Zeus setup and configuration please refer to the Zeus section of the *RF Source Transmitter Board User Guide.*

CONFIDENTIAL

Figure 9 - EVK Setup with Transmitter Board

4.2.1 EVK Application Download

The EVK application that runs with the Zeus RF Source is available in the Atmosic SDK. Look for the RFsource_adv application in the examples folder. From this folder you can load the application that will send out beacons from RF harvested energy by executing the “make run_all” command.

The application also supports dynamic on/off control of the RF Source. This is enabled by executing the following command to compile and load the application with this feature:

make CFG_DYN_HARV=1 run_all

It is also possible to modify the makefile CFLAGS to change the upper threshold and lower VSTORE thresholds. After modifying the CFLAG options in the makefile, type “make clean” and “make CFG_DYN_HARV=1 run_all” to compile and load the application with these new thresholds.

CFLAGS += -DVSTORE_HVT=3.0 -DVSTORE_LVT=2.0

VSTORE_HVT: High voltage threshold of Vstore.
VSTORE_LVT: Low voltage threshold of Vstore.

In the application the time interval to measure Vstore voltage can be changed in RFsource_adv.c:

```
#define ITVL_MEAS_V_CS 100
```

CONFIDENTIAL

The regular beacon's interval can be changed in rfa_param_adv.h:

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

4.2.2 Dynamic RF Source Control

Dynamic RF source control turns on and off the RF source based on the commands from the target device (EVB). The EVB issues these commands to the RF source based on measured voltage on the external storage (Vstore). The Vstore voltage is also measured every second and when the voltage is higher than the upper threshold (3.0 V default), the EVB will advertise a second beacon with a specific payload called "Start-RF" ADV payload. When the Vstore voltage falls below the lower threshold (2.0 V default) the EVB will advertise with the "Stop-RF" ADV payload.

The Zeus board is set 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.

When run with the rechargeable battery these cycles of charging and discharging are very long. To more quickly demonstrate the charging and discharging cycles of dynamic source control, run the EVB battery free and the lower storage capacity will cause the RF source on and off cycles to occur much more quickly.

CONFIDENTIAL

5 Setup with PV Source

When using a PV cell as the harvesting source to the EVB, MODE0 DIP switch should be set **low** for optimal performance. 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 suitable for indoor environments is included in the EVK.

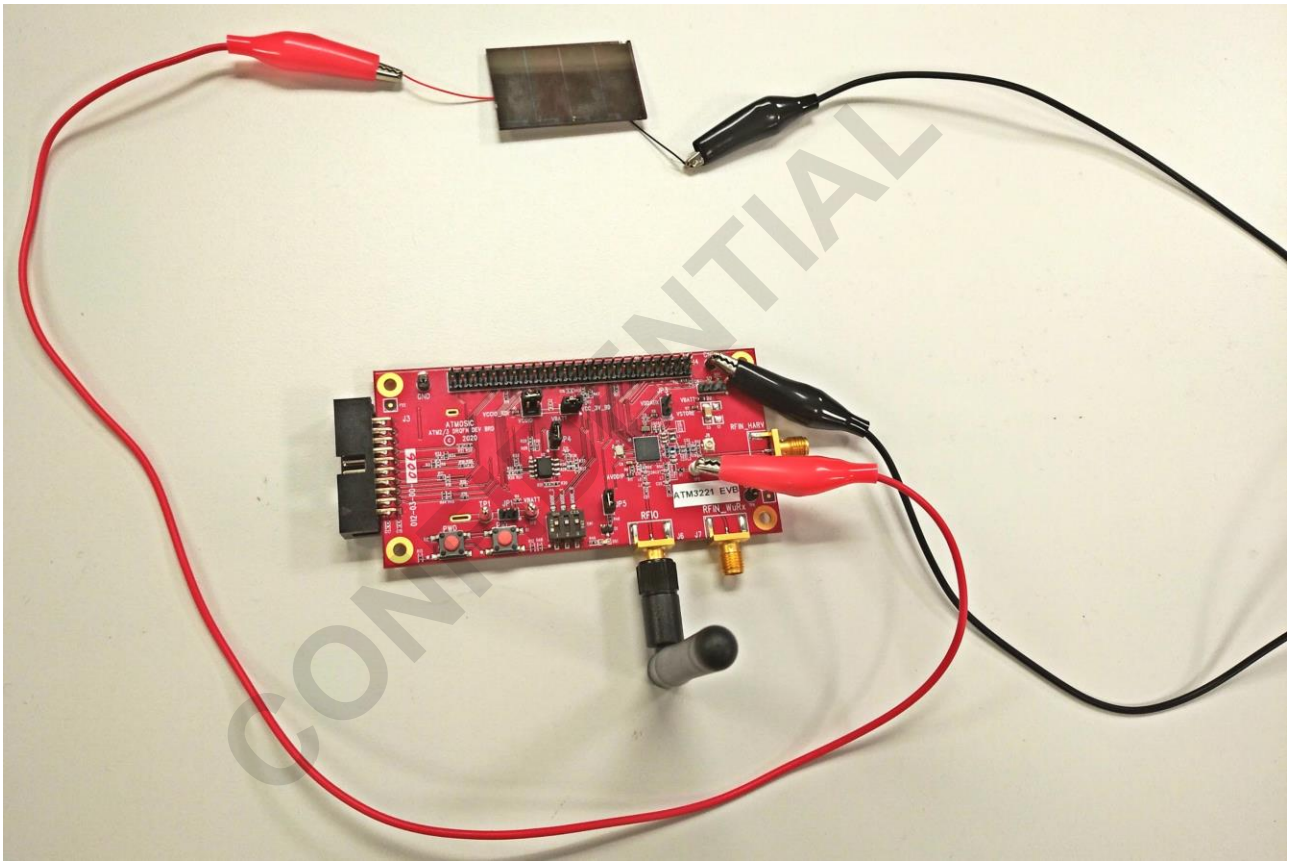

Figure 10 - EVK Setup with PV Cell

The advertisement beacons are detectable with any Bluetooth LE sniffer application. As an example, a ViewTool Hollong Bluetooth LE Sniffer 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.

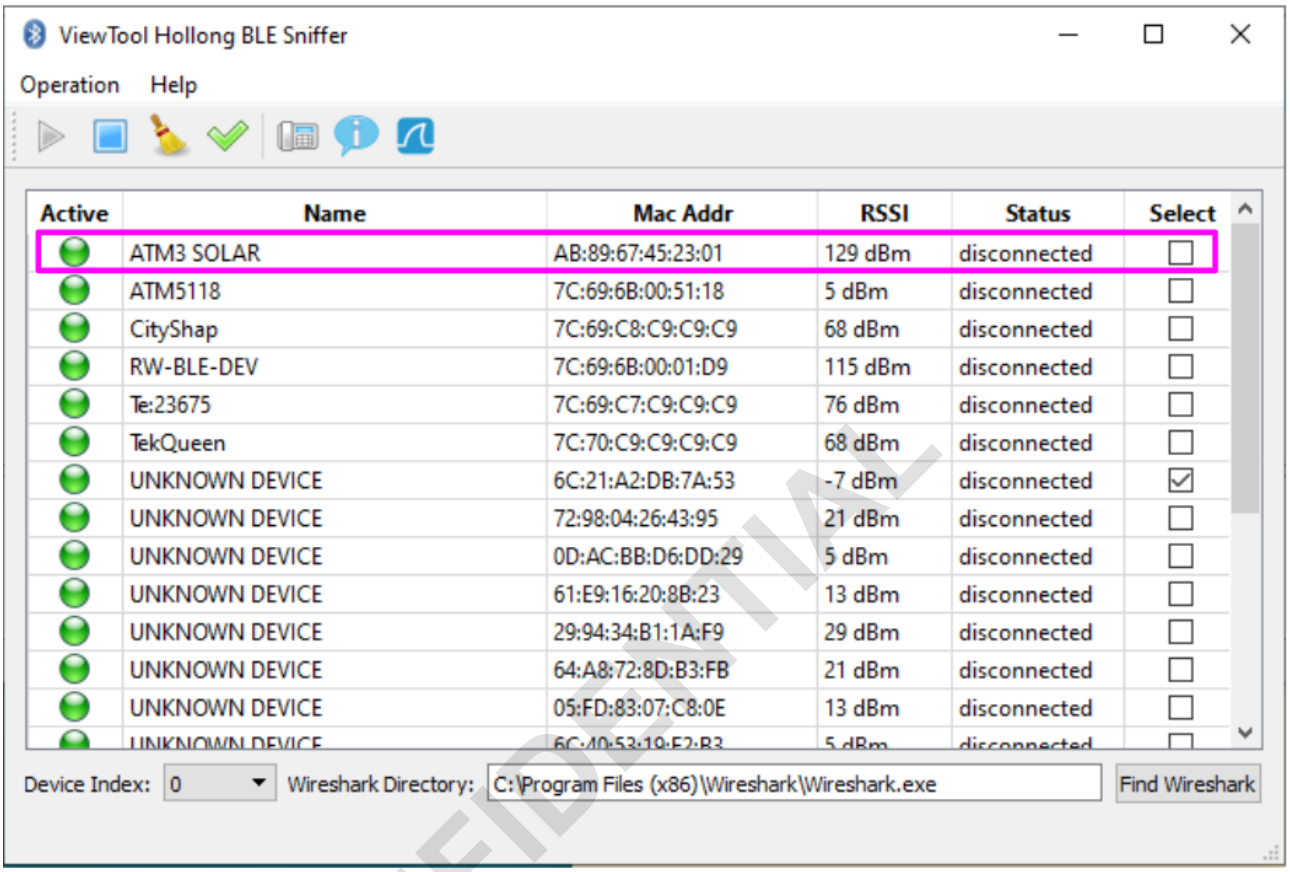

Figure 11 - EVB Detected by ViewTool Hollong Bluetooth LE Sniffer

CONFIDENTIAL

CONFIDENTIAL

ATMOSIC TECHNOLOGIES - DISCLAIMER

This product document is intended to be a general informational aid and not a substitute for any literature or labeling accompanying your purchase of the Atmosic product. Atmosic reserves the right to amend its product literature at any time without notice and for any reason, including to improve product design or function. While Atmosic strives to make its documents accurate and current, Atmosic makes no warranty or representation that the information contained in this document is completely accurate, and Atmosic hereby disclaims (i) any and all liability for any errors or inaccuracies contained in any document or in any other product literature and any damages or lost profits resulting therefrom; (ii) any and all liability and responsibility for any action you take or fail to take based on the information contained in this document; and (iii) any and all implied warranties which may attach to this document, including warranties of fitness for particular purpose, non-infringement and merchantability. Consequently, you assume all risk in your use of this document, the Atmosic product, and in any action you take or fail to take based upon the information in this document. Any statements in this document in regard to the suitability of an Atmosic product for certain types of applications are based on Atmosic's general knowledge of typical requirements in generic applications and are not binding statements about the suitability of Atmosic products for any particular application. It is your responsibility as the customer to validate that a particular Atmosic product is suitable for use in a particular application. All content in this document is proprietary, copyrighted, and owned or licensed by Atmosic, and any unauthorized use of content or trademarks contained herein is strictly prohibited.

Copyright ©2020-2021 by Atmosic Technologies. All rights reserved.

www.atmosic.com