

# USER'S MANUAL

# TWR-RF-SNAP

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Wireless Technology to Control and Monitor Anything from Anywhere™

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TWR-RF-SNAP featuring the Synapse Wireless SM700 IEEE 802.15.4 RF Engine

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# 1 Overview

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The Wireless Mesh Networking Tower Board (TWR-RF-SNAP) is a peripheral Tower System Module. The TWR-RF-SNAP provides wireless mesh networking via the FCC Certified Synapse Wireless SM700 RF Engine. The SM700 is based on the Freescale MC13224 chip which combines a 32-bit ARM7 MCU with an IEEE 802.15.4 radio transceiver.

The TWR-RF-SNAP module can function standalone or within the Tower System. As part of the Tower System, the TWR-RF-SNAP can interface with Tower System controller modules via SPI and can access available Tower System peripheral modules using UART or I2C. The TWR-RF-SNAP also includes a General Purpose Tower Plug-in (TWRPI) socket allowing direct access to a selection of sensor plug-ins via I2C.

A SN132 USB Dongle is also included with the TWR-RF-SNAP. The USB Dongle features the RF100 RF Engine based on a Freescale MC9S08 MCU and the Freescale MC13191 radio. The USB dongle provides a communication portal to a host computer via USB.

The TWR-RF-SNAP can be accessed in Synapse's Portal IDE using either the on-board USB or wirelessly using the included RF100 USB Dongle.

The TWR-RF-SNAP features the following:

- Synapse Wireless SM700. A surface-mount RF Engine powered by the Freescale MC13224.
- Onboard Sensors / Push Buttons / LEDs for user interaction and feedback
- Tower Plug-in (TWRPI) socket for additional sensors
- microUSB connector for powering and providing wired access to the Portal IDE
- Optional battery connector for untethered operation.
- Included SN132 USB Dongle with RF100 RF Engine for wireless access to a host computer

A block diagram for the TWR-RF-SNAP is shown in the figure below.

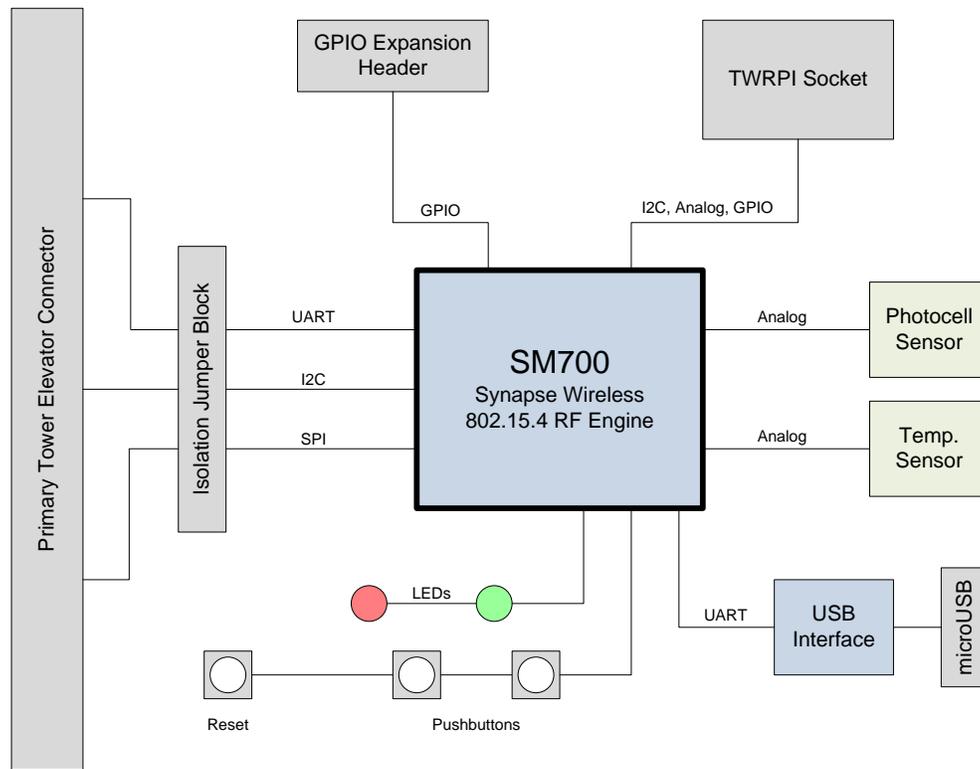


Figure 1 - TWR-RF-SNAP Block Diagram

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An image of the TWR-RF-SNAP with callouts is shown in the figure below.

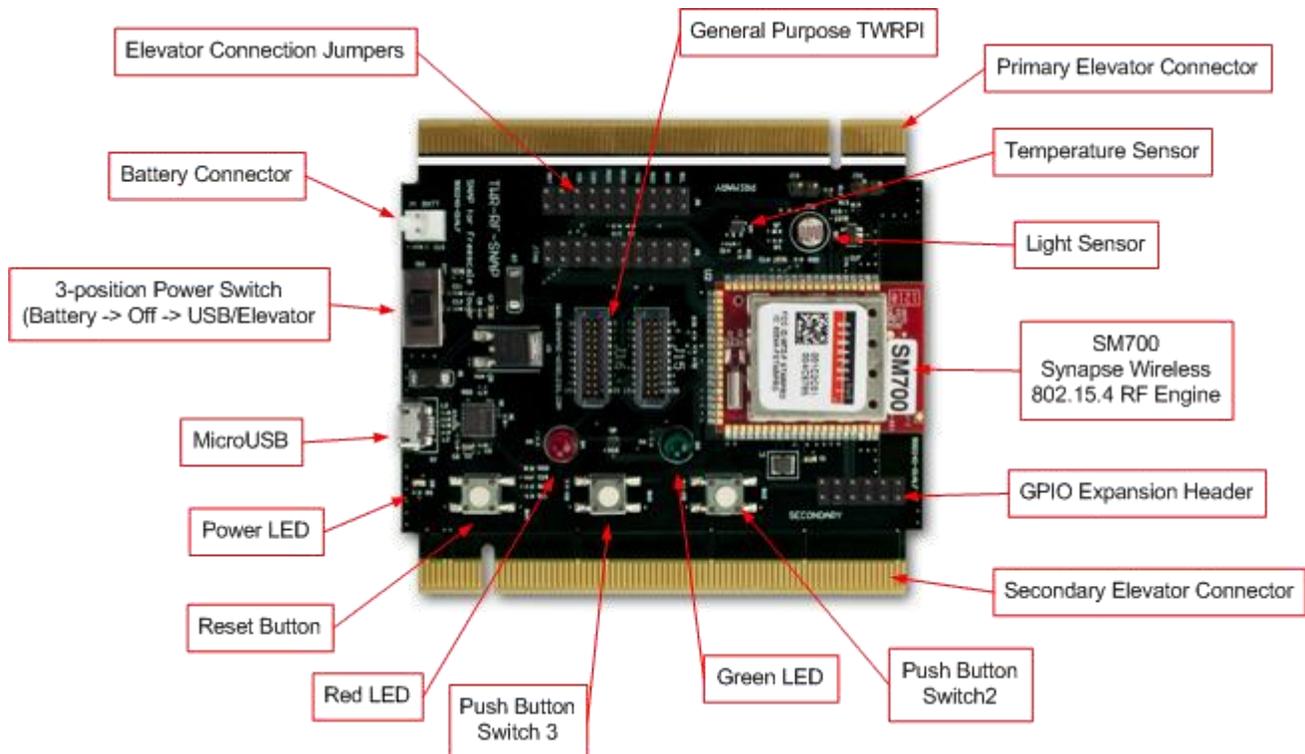


Figure 2 - TWR-RF-SNAP Image

## 2 Reference Documents

The documents listed below should be referenced for more information on the Freescale Tower system and the TWR-RF-SNAP. Refer to <http://freescale.com/tower> for the latest revision of all released Tower documentation.

- *TWR-RF-SNAP Schematics*
- *TWR-RF-SNAP Quick Start Guide*
- *TWR-RF-SNAP Lab Document*

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## 3 Hardware Features

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This section provides more details about the features and functionality of the TWR-RF-SNAP.

### 3.1 Using the TWR-RF-SNAP

#### Options for Powering the TWR-RF-SNAP Module:

The module can be powered using any of the following options:

- 1) USB connector (either via USB AC-power supply or USB port on a PC)
- 2) The Tower Elevator modules (relying on the 5V supply pins)
- 3) The battery connector

Power Switch Settings:

<b><i>Power Switch Position</i></b>	<b><i>Operation</i></b>
Far Left	Draws power from the battery connector
Middle	OFF
Far Right	Draws power from USB Port or Primary Elevator connector

#### Installing into the Tower System:

In addition to functioning standalone, the TWR-RF-SNAP is designed to be used in the Freescale Tower System. When inserted into the Tower System a Tower MCU module can utilize the TWR-RF-SNAP to relay information to additional SNAP nodes, including the provided SN132 USB Dongle. The TWR-RF-SNAP can also access compatible peripheral modules directly using I2C and SPI.

To ensure proper functionality of the TWR-RF-SNAP within the Tower System the Primary Edge connector (marked with the white stripe) must be inserted into the Primary Elevator.

The TWR-RF-SNAP is also compatible with the General Purpose Tower Plug-in modules (or TWRPIs). A TWRPI module can be inserted directly into the available socket on the TWR-RF-SNAP. The TWRPI socket on the TWR-RF-SNAP provides access to I2C, Analog, and GPIO's.

### Controller Module

- Tower MCU/MPU board
- Works stand-alone or in Tower System
- Features integrated debugging interface for easy programming and run-control via standard USB cable

### Secondary Elevator

- Additional and secondary serial and expansion bus signals
- Standardized signal assignments
- Mounting holes and expansion connectors for side-mounting peripheral boards

### Size

- Tower is approx. 3.5" H x 3.5" W x 3.5" D when fully assembled

### Peripheral Module

- Examples include serial interface module, memory expansion module and Wi-Fi®

### Primary Elevator

- Common serial and expansion bus signals
- Two 2x80 connectors on backside for easy signal access and side-mounting board (LCD module)
- Power regulation circuitry
- Standardized signal assignments
- Mounting holes

### Board Connectors

- Four card-edge connectors
- Uses PCI Express® connectors (x16, 90 mm/ 3.5" long, 164 pins)

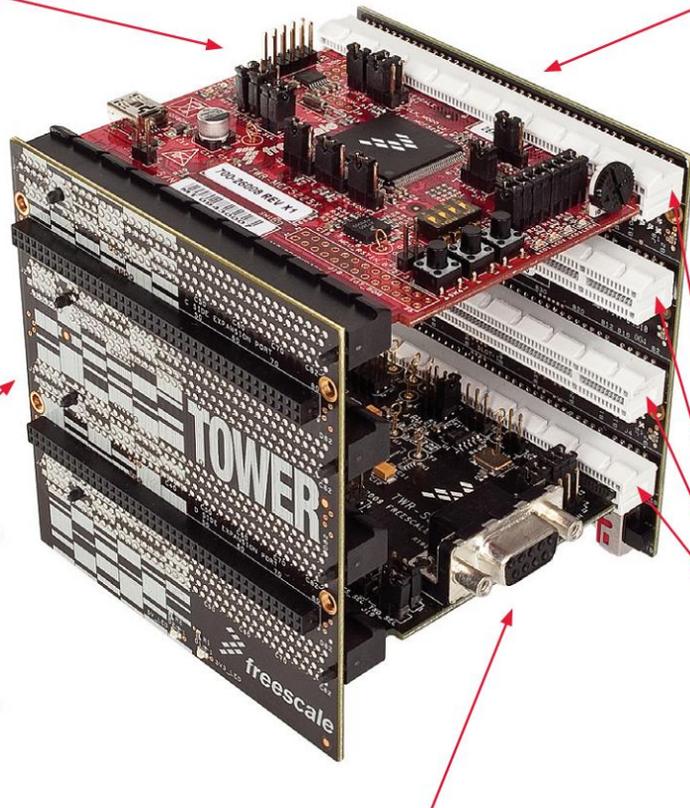


Figure 3 - Freescale Tower System Overview

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## 3.2 IEEE 802.15.4 RF Engine

The TWR-RF-SNAP features the Synapse Wireless SM700 IEEE 802.15.4 RF Engine. The SM700 RF Engine is based on the Freescale MC13224V transceiver platform. The SM700 comes with SNAP® preloaded and ready to perform out of the box. SNAP is Synapse's award-winning, mesh network operating system that provides wireless connectivity for Internet-to-machine and machine-to-machine communications.

### SM700 RF Engine: Synapse Part # SM700PC1

- Powerful 32-bit TDMI ARM7 microprocessor
- Large on-board memory resources
  - Allows for over-the-air SNAPpy script and SNAP OS upgrades
- Accurate 12-bit ADC for precision sensors
- SNAP – Instant-ON mesh network operating system
- Powerful, reliable wireless connection in 2.4GHz license-free band
  - 2.4 GHz RF Frequency (2400 - 2483.5 MHz)
  - 16 RF Channels
- Up to 100mW output power
- -96 dBm Rx sensitivity
- +20dBm Tx output power
- 2.0 to 3.6 Volts Vcc
- Small footprint: 1" x 1.4" (25.4mm x 36.5mm)
- Low power consumption:
  - Transmit mode.....193mA
  - Receive mode.....30mA
  - Hibernate mode.....1.1µA
- Integrated F-antenna
- Over 1.5 miles range
- Available AES 128-bit encryption
- FCC, CE and IC certified

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## 3.3 On-board Sensors, Inputs, and Indicators

The following interfaces are implemented in the TWR-RF-SNAP to allow for user interaction.

### Temperature Sensor:

- Connected to ADC Ch. 1 (physical pin 9 of the SM700) – SNAP GPIO 31
- Low-Power Linear Active Thermistor IC
- Analog output

### Photocell (Light Sensor):

- Connected to ADC Ch. 0 (physical pin 8 of the SM700) – SNAP GPIO 30
- Analog output

### Power Switch:

- Left position – Draws power from the battery connector
- Middle position – OFF
- Right position – Draws power from the tower elevator or USB port

### User LED 1 (Red):

- Connected to TMR0 (physical pin 34 of the SM700) – SNAP GPIO 8
- Activated by setting the pin HIGH

### User LED2 (Green):

- Connected to TMR1 (physical pin 33 of the SM700) – SNAP GPIO 9
- Activated by setting the pin HIGH

### Power LED:

- Green LED (D5) will indicate when power is applied to the board

### Switch 2 (software accessible input):

- Connected to Physical Pin 57 of the SM700 – SNAP GPIO 22
- KBI pin – wake from sleep interrupt capable
- Switch is grounded when pressed

### Switch 3 (software accessible input):

- Connected to Physical Pin 56 of the SM700 – SNAP GPIO 23
- KBI pin – wake from sleep interrupt capable
- Switch is grounded when pressed

### Reset Button:

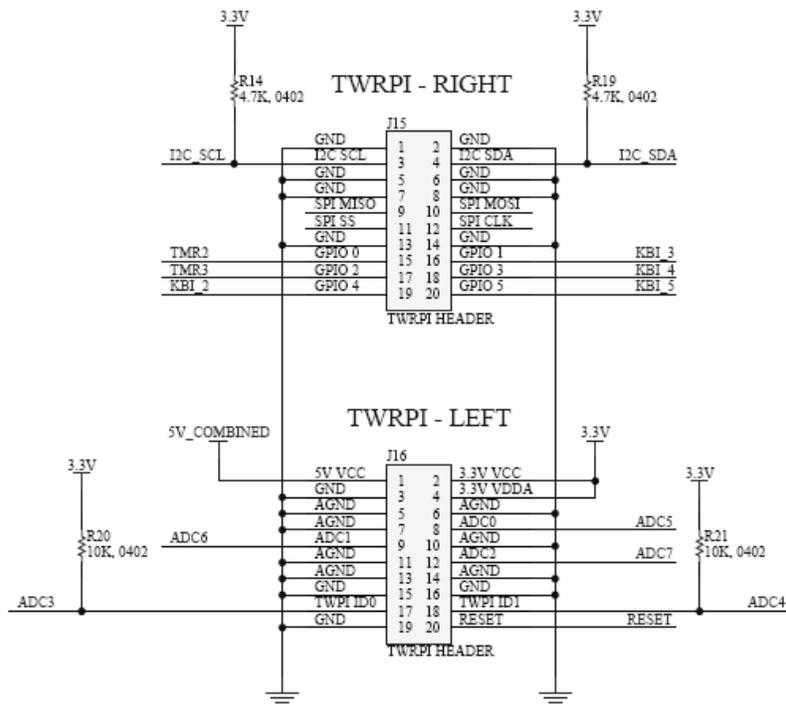
- Push button tied directly to RESET on the SM700 / Reboots the device

## 3.4 Expansion Interfaces

The following interfaces allow for expandability of the TWR-RF-SNAP.

### TWRPI Connector:

- Freescale standard connector for General Purpose Tower Plug-ins (TWRPIs)
- Allows for plug-in of several different sensors – ex. TWRPI-MMA7660 Accelerometer
- Interfaces to sensors via I<sup>2</sup>C and/or ADC (ADC 5-7)
- See figure below for specific pin-out (J15 is the right connector, while J14 is the left connector)



### UART1 (SNAP UART0):

- Connected to Physical Pins 36-37 – SNAP GPIO 14-15
- RX = Pin 37/GPIO\_15, TX = 36/GPIO\_14
- This serial port attaches to edge-connectors (elevator) for communication with other devices within the Tower System

### UART2 (SNAP UART1):

- USB connected to UART2 of the system (Physical Pins 21, 23-25) - SNAP GPIO 21-18
- RTS = Pin\_21/GPIO\_21, CTS= 23/GPIO\_20, RX = 24/GPIO\_19 , TX = 25/GPIO\_18
- Used to upload firmware, factory default the SNAP settings, or erase a script (via Portal)
- Connected to the USB port

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## I2C (SNAP I2C):

- Connected to Physical Pins 28-29 – SNAP GPIO 13-12
- SCL = Pin\_29/GPIO\_12, SDA = Pin\_28/GPIO\_13
- This interface port attaches to edge-connectors (elevator) for communication with other devices within the Tower System as well as the on-board TWRPI socket

## SPI (SNAP SPI):

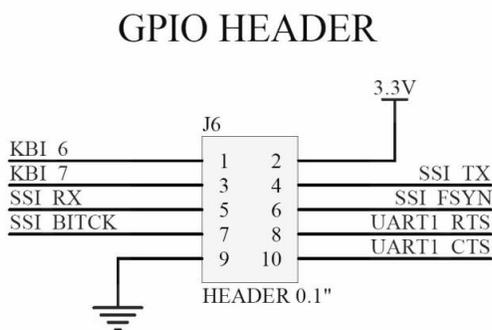
- Connected to Physical Pins 35, 39-41 – SNAP GPIO 7-4
- SCK = Pin\_35/GPIO\_7, MOSI = Pin\_39/GPIO\_6, MISO = Pin\_40/GPIO\_5, SS = Pin\_41/GPIO\_4
- This serial interface bus attaches to edge-connectors (elevator) for communication with other devices within the Tower System

## ADC:

- ADC1 has the capability to use an on-board 2.5V precision voltage reference

## GPIO Expansion Header:

- The GPIO header exposes the following pins for use external to the TWR-RF-SNAP board:



GPIO Header (J6)	Pin Description
1	SNAP GPIO_28 / Keyboard Interrupt 6 (KBI_6)
2	Vcc (3.3V)
3	SNAP GPIO_29 / Keyboard Interrupt 7 (KBI_7)
4	SNAP GPIO_0 / SSI_TX
5	SNAP GPIO_1 / SSI_RX
6	SNAP GPIO_2 / SSI_FSYN
7	SNAP GPIO_3 / SSI_BITCK
8	SNAP GPIO_21 / UART1_RTS (SNAP SW UART0)
9	GND
10	SNAP GPIO_20 / UART1_CTS (SNAP SW UART0)

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### 3.5 SNAP SN132 USB Dongle

The SNAP SN132 USB Dongle is included with the TWR-RF-SNAP. The SN132 features an RF100 RF Engine. It is not only its own free-standing node in the SNAP network, but also provides the PC and Portal software a bridge into the SNAP network. Refer to the lab material associated with the TWR-RF-SNAP module for more about the USB dongle.

#### RF100 RF Engine: Synapse Part # RF100P86

- SNAP – Instant-ON mesh network stack
- Powerful, reliable wireless connection in 2.4GHz license-free band
- Spread spectrum (DSSS) technology surmounts noisy environments
- Optional, Transmit amplifier (18 dBm) for best-in-class range
- Embedded “F” antenna
- Receive amplifier (10 dBm) standard
- Up to 3-mile range (with external antenna)
- Low power modes, down to 2.5  $\mu$ A with internal timer running
- 60k flash, with 20k free for over-the-air uploaded user apps
- FCC Certified on all 16 channels



Figure 4 - SNAP SN132 USB Dongle

The following table describes the how to control the output pins to obtain desired colors. Notice that the LED lines are active LOW.

<i>Desired LED Color</i>	<i>Value of GPIO Pin 0</i>	<i>Value of GPIO Pin 1</i>
Red	Low	High
Green	High	Low
Amber	Low	Low
OFF	High	High

A second green LED is used to indicate that power is being supplied to the module. It cannot be controlled by the user.

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## Software Features

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This section provides more details about the software features and functionality of the TWR-RF-SNAP including the Synapse Wireless Portal IDE and python based SNAPpy scripts.

### 3.6 SNAP / SNAPpy

Synapse's SNAP® technology is an Internet-enabled, auto-forming, multi-hop, mesh network Operating System that is designed to run efficiently on all types of microcontroller; including cost-effective 8-bit microprocessors.

With the SNAP protocol firmware installed, the device automatically forms an ad-hoc radio mesh network with other SNAP devices in range, so each can pass information back and forth, and can relay messages to other SNAP devices that might be out of the original sender's range.

Since SNAP provides a full mesh network, there is no single point of failure: any node can talk directly to any other node that is in range and any node can talk indirectly to any other node via intermediate nodes. SNAP-based networks are self-forming, instant-on, and self-healing.

The SNAP core code handles wireless communications, as well as implementing a Python virtual machine. The subset of Python implemented by the core software is named SNAPpy. Scripts written in SNAPpy (also referred to as Device Images, SNAPpy images or even Snappy Images) can be uploaded into SNAP Nodes serially (or even over the air), and dramatically alter the nodes capabilities and behavior.

The TWR-RF-SNAP comes preloaded with the SNAP firmware, including an initial SNAPpy script that allows the user to interact with the LEDs by pressing the on-board push-buttons. For more information regarding this example SNAPpy script, refer to the TWR-RF-SNAP lab guide.

#### SNAP Highlights:

- Multi-hop mesh
- Auto-forming
- Instant-on
- Peer-to-peer
- SNAPpy application scripts (Python-based programming language)
- Over-the-air programming
- Remote Procedure call architecture
- Processor independence
- Sleepy Mesh – allows for battery operation
- Each node runs autonomously
- No central coordinator since each node can participate in routing
- No single point of failure

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Refer to the SNAP Reference Manual for details regarding the available SNAPpy functions and commands.

## 3.7 Synapse Portal IDE

Portal takes you beyond traditional network commissioning tools by giving you an end-to-end view into your wireless application. Implement the functionality you need one step at a time - dynamically, interactively, wirelessly. As a bridge between the SNAP network and the PC, Portal provides a simple and flexible Python-based interface. Remote nodes can invoke Python functions in Portal using built-in SNAPpy RPC calls.

### Portal Highlights

- Comprehensive administration tool for SNAP networks
- Participates as a full peer on the network
- Syntax-highlighted Python editor for developing SNAPpy scripts
- Invoke (RPC) script functions on any device in network
- Remote nodes can invoke (RPC) scripts within Portal
- Channel analyzer to find ideal channel
- Event Log with timestamps and filtering
- Graphical Data Logger
- Node configuration editor
- Channel scanner to detect new or un-configured nodes
- Connect to SNAP Connect over Internet or TCP/IP LAN

Synapse Portal is a standalone software application that runs on a standard PC. Using a USB or RS232 interface, it connects to any node in the SNAP Wireless Network and becomes a graphical user interface (GUI) for the entire network. Using Portal, you can quickly and easily create, deploy, configure, and monitor SNAP-based network applications. Once connected, the Portal PC has its own unique SNAP Network Address and can participate in the SNAP network as a peer.

The address of each node within the SNAP network can be determined by looking at the last 6 digits of the device's MAC address. This is the node's unique address in a SNAP network.

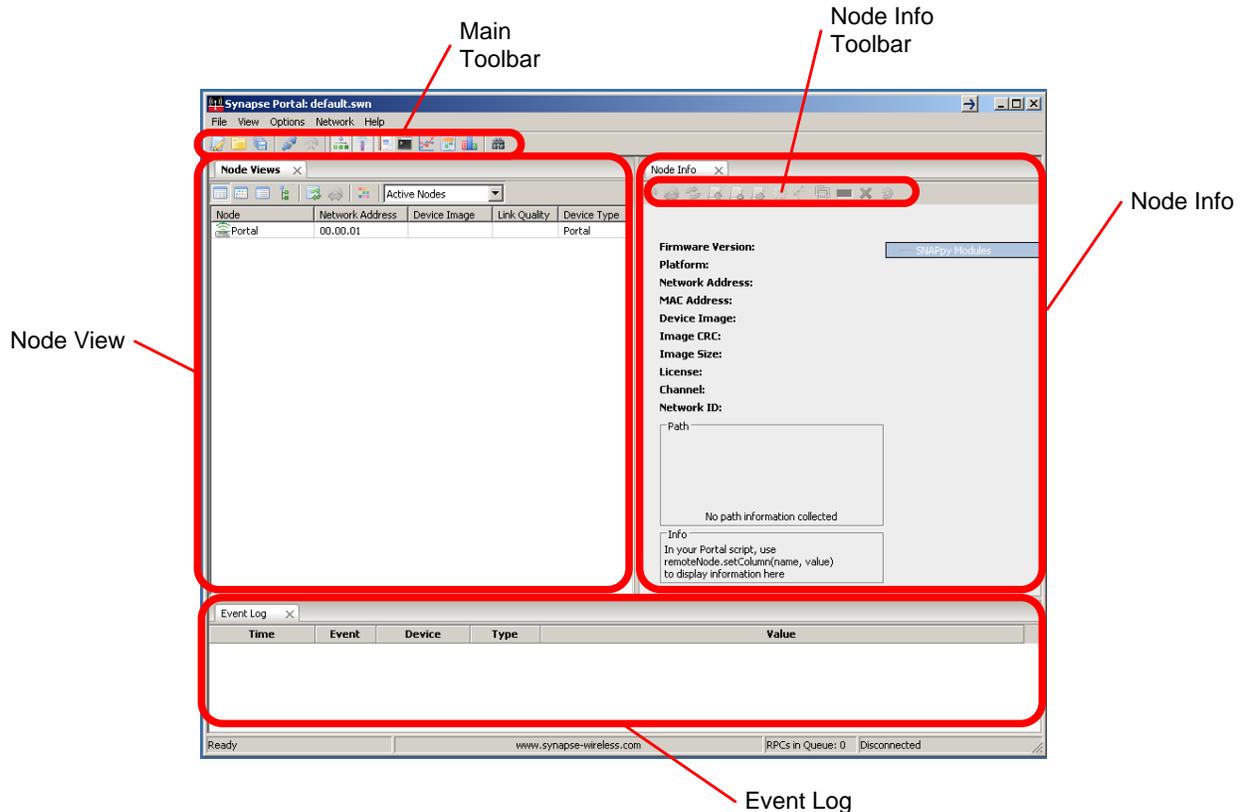
For example: a MAC address of 00:1C:2C:1E:86:03:A2:A6 will use the SNAP address 03.A2.A6. The MAC address is printed on the label of each SNAP device.

For a quick overview of installing the Synapse Portal IDE and the necessary USB drivers refer to the TWR-RF-SNAP Lab Guide.

The Default View of Portal IDE consists of the following key panels and tool bars: Main Toolbar, Node View Panel, Node Info Panel, Node Info Toolbar, and Event Log Panel.

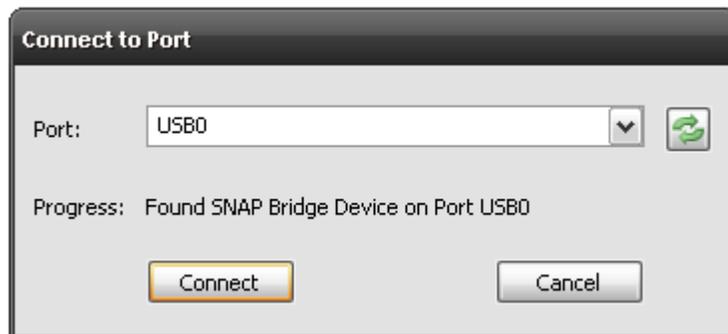
From this user interface you can connect to a SNAP bridge node and start viewing and configuring your SNAP network. The nodes in your network will be displayed in the **Node Views** window as they start

responding to queries made by Portal. Selecting a node by clicking on it in the **Node Views** window will display detailed information about that node over in the **Node Info** window. Finally, the **Event Log** window displays event message about things that have occurred in the system and in the SNAP network. The **Main Toolbar** will provide icons to open existing scripts, create new scripts, connect to a Port Node, and perform a broadcast ping of the network. The **Node Info Toolbar**



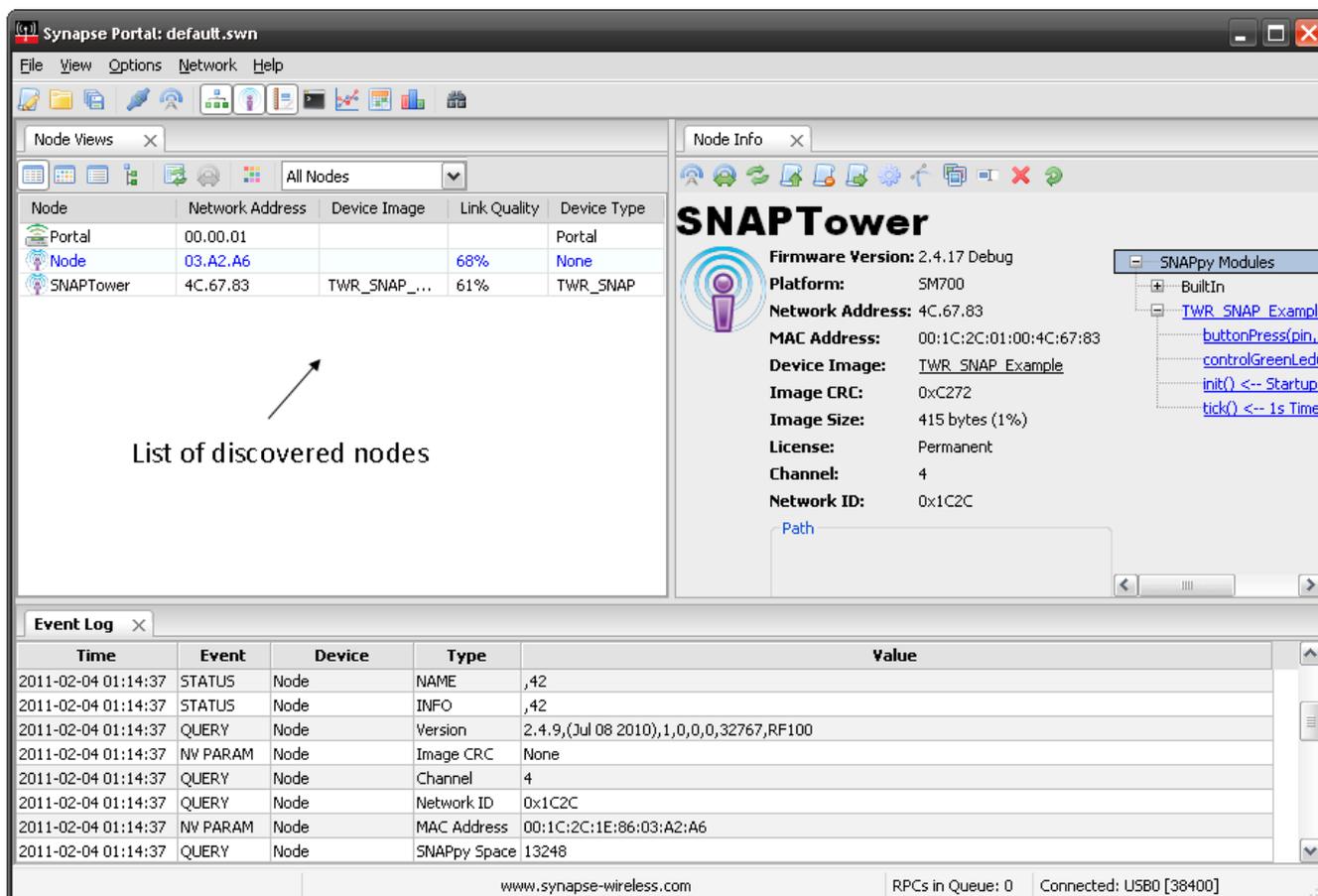
**Figure 5 - Portal IDE Application**

With the SN132 USB Dongle connected to the PC running the Portal IDE and the TWR-RF-SNAP powered externally and within range of the SN132, the application will identify the USB Dongle as an available SNAP Bridge Device on Port USB0.



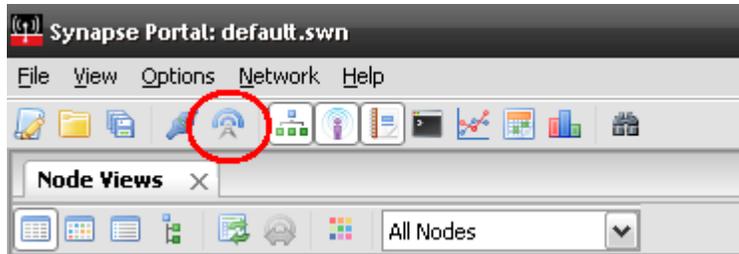
**Figure 6 - SNAP Bridge Device Connect**

The application will then attempt to identify all available Nodes available in the network as seen in the figure below. The TWR-RF-SNAP will be identified as a SNAPTower Node (Device Type: TWR\_SNAP).



**Figure 7 - SNAPTower in Portal**

The Broadcast Ping icon, located in the Main Toolbar, can be used to refresh the identified Nodes in the network. Clicking on this toolbar button will cause Portal to broadcast a special “answer if you hear me” message to all nodes. When the nodes answer, any nodes that Portal did not already know about will be individually queried for additional information. You might use this button if you just added one or more new nodes to your network. Refer to the image below for the location of the Broadcast Ping icon.

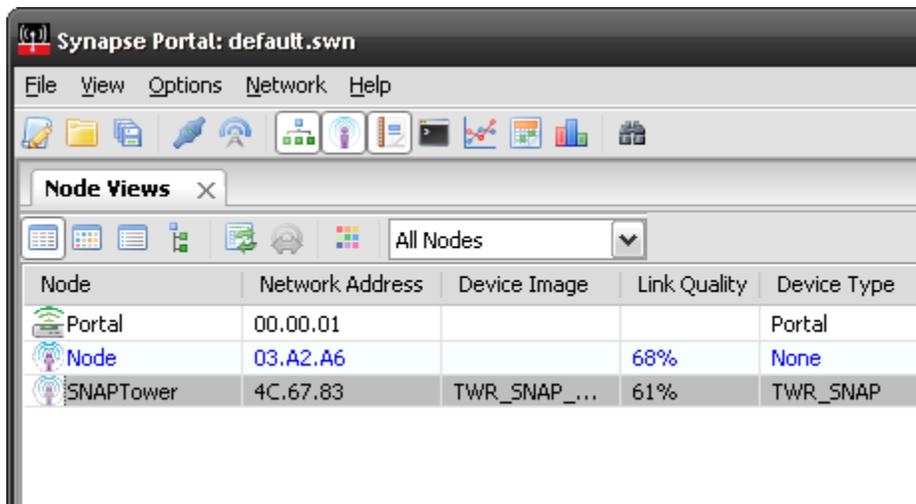


**Figure 8 - Broadcast Ping Icon**

The Node Info panel will contain only information relevant to the Node that is selected or highlighted in the Node View panel.

When referring to the information in the Node Info panel or using the Node Info Toolbar it is important that the correct SNAP Node is first selected in the Node View panel.

For example, to upload a new script to the TWR-RF-SNAP Tower Module, you must first ensure that the SNAPTower Node is selected in the Node Info panel as shown in the image below.



**Figure 9 - SNAPTower Selected in Portal**

Refer to the Synapse Portal Reference Manual for detailed instructions regarding the application.

## 4 Configuration Settings

### 4.1 Jumper / Switch Settings

There are several jumpers provided for isolation, configuration, and feature selection. Refer to the following table for details.

Jumper Options		Setting	Description
J5	TWR-ELEV Connection Jumper	1-2	I2C SCL - Connects I2C_SCL to TWR-ELEV (ELEV_SCL0)
		3-4	I2C SDA - Connects I2C_SDA to TWR-ELEV (ELEV_SDA0)
		5-6	UART RX - Connects UART1_TXD to TWR-ELEV (ELEV_RXD0)
		7-8	UART TX - Connects UART1_RXD to TWR-ELEV (ELEV_TXD0)
		9-10	SPI MISO - Connects SPI_MISO to TWR-ELEV (ELEV_SPI0_MISO)
		11-12	SPI MOSI - Connects SPI_MOSI to TWR-ELEV (ELEV_SPI0_MOSI)
		13-14	SPI CS - Connects SPI_SS to TWR-ELEV (ELEV_SPI0_CS0)
		15-16	SPI CS - Connects SPI_SS to TWR-ELEV (ELEV_SPI0_CS1)
		17-18	SPI CLK - Connects SPI_SCLK to TWR-ELEV (ELEV_SPI0_CLK)
		19-20	RESET - Connects RESET to TWR-ELEV (ELEV_RSTOUT_B)
Switch 1	3-Position Power Switch	Left	Powered via Battery Terminal: Switched towards battery connection
		Center	OFF
		Right	Powered via USB / Tower System : Switched towards USB receptacle
Switch 2	Push Button	Pressed	Switch connects SM700 GPIO 22 to GND when pressed. Pin can be used as an interrupt pin to wake the SM700 from sleep.
Switch 3	Push Button	Pressed	Switch connects SM700 GPIO 23 to GND when pressed. Pin can be used as an interrupt pin to wake the SM700 from sleep.
Switch 4	Push Button	Pressed	Resets the SM700

## 5 Electromechanicals

### 5.1 Elevator Connections

The TWR-RF-SNAP features two expansion card-edge connectors that interface to Elevator boards in a Tower System: the Primary and Secondary Elevator connectors. Table 1 provides the pinout for the Primary and Secondary Elevator Connector. An “X” in the “Used” column indicated that there is a connection from the TWR-MEM to that pin on the Elevator connector. An “X” in the “Jmp” column indicates that a jumper is available that can configure or isolate the connection from the Elevator connector.

**Table 1 - TWR-RF-SNAP Primary Elevator Connector Pinout**

<i>TWR-RF_SNAP Primary Connector</i>									
<i>Pin</i>	<i>Name</i>	<i>Usage</i>	<i>Used</i>	<i>Jmp</i>	<i>Pin</i>	<i>Name</i>	<i>Usage</i>	<i>Used</i>	<i>Jmp</i>
B1	5V	5.0V Power	X		A1	5V	5.0V Power	X	
B2	GND	Ground	X		A2	GND	Ground	X	
B3	3.3V	3.3V Power			A3	3.3V	3.3V Power		
B4	ELE_PS_SENSE	Elevator Power Sense			A4	3.3V	3.3V Power		
B5	GND	Ground	X		A5	GND	Ground	X	
B6	GND	Ground	X		A6	GND	Ground	X	
B7	SDHC_CLK / SPI1_CLK				A7	SCL0	ELEV_SCL0 (ISC_SCL)	X	X
B8	SDHC_D3 / SPI1_CS1_b				A8	SDA0	ELEV_SDA0 (I2C_SDA)	X	X
B9	SDHC_D3 / SPI1_CS0_b				A9	GPIO9 / CTS1			
B10	SDHC_CMD / SPI1_MOSI				A10	GPIO8 / SDHC_D2			
B11	SDHC_D0 / SPI1_MISO				A11	GPIO7 / SD_WP_DET			
B12	ETH_COL				A12	ETH_CRS			
B13	ETH_RXER				A13	ETH_MDC			
B14	ETH_TXCLK				A14	ETH_MDIO			
B15	ETH_TXEN				A15	ETH_RXCLK			
B16	ETH_TXER				A16	ETH_RXDV			
B17	ETH_TXD3				A17	ETH_RXD3			
B18	ETH_TXD2				A18	ETH_RXD2			
B19	ETH_TXD1				A19	ETH_RXD1			
B20	ETH_TXD0				A20	ETH_RXD0			
B21	GPIO1 / RTS1				A21	SSI_MCLK			
B22	GPIO2 / SDHC_D1				A22	SSI_BCLK			
B23	GPIO3				A23	SSI_FS			
B24	CLKIN0				A24	SSI_RXD			
B25	CLKOUT1				A25	SSI_TXD			
B26	GND	Ground	X		A26	GND	Ground	X	
B27	AN7				A27	AN3			
B28	AN6				A28	AN2			

**TWR-RF\_SNAP Primary Connector**

<i>Pin</i>	<i>Name</i>	<i>Usage</i>	<i>Used</i>	<i>Jmp</i>	<i>Pin</i>	<i>Name</i>	<i>Usage</i>	<i>Used</i>	<i>Jmp</i>
B29	AN5				A29	AN1			
B30	AN4				A30	AN0			
B31	<b>GND</b>	<b>Ground</b>	<b>X</b>		A31	<b>GND</b>	<b>Ground</b>	<b>X</b>	
B32	DAC1				A32	DAC0			
B33	TMR3				A33	TMR1			
B34	TMR2				A34	TMR0			
B35	GPIO4				A35	GPIO6			
B36	<b>3.3V</b>	<b>3.3V Power</b>			A36	<b>3.3V</b>	<b>3.3V Power</b>		
B37	PWM7				A37	PWM3			
B38	PWM6				A38	PWM2			
B39	PWM5				A39	PWM1			
B40	PWM4				A40	PWM0			
B41	CANRX0				A41	RXD0	ELEV_RXD0 (UART1_TXD)	<b>X</b>	<b>X</b>
B42	CANTX0				A42	TXD0	ELEV_TXD0 (UART1_RXD)	<b>X</b>	<b>X</b>
B43	1WIRE				A43	RXD1			
B44	SPI0_MISO (IO1)	ELEV_SPI0_MISO (SPI_MISO)	<b>X</b>	<b>X</b>	A44	TXD1			
B45	SPI0_MOSI (IO0)	ELEV_SPI0_MOSI (SPI_MOSI)	<b>X</b>	<b>X</b>	A45	VSS			
B46	SPI0_CS0_b	ELEV_SPI0_CS0 (SPI_SS)	<b>X</b>	<b>X</b>	A46	VDDA			
B47	SPI0_CS1_b	ELEV_SPI0_CS1 (SPI_SS)	<b>X</b>	<b>X</b>	A47	VREFA1			
B48	SPI0_CLK	ELEV_SPI0_CLK (SPI_SCLK)	<b>X</b>	<b>X</b>	A48	VREFA2			
B49	<b>GND</b>	<b>Ground</b>	<b>X</b>		A49	<b>GND</b>	<b>Ground</b>	<b>X</b>	
B50	SCL1				A50	GPIO14			
B51	SDA1				A51	GPIO15			
B52	GPIO5 / SPI0_HOLD (IO3)				A52	GPIO16 / SPI0_WP (IO2)			
B53	USB0_DP_PDOWN				A53	GPIO17			
B54	USB0_DM_PDOWN				A54	USB0_DM			
B55	IRQ_H				A55	USB0_DP			
B56	IRQ_G				A56	USB0_ID			
B57	IRQ_F				A57	USB0_VBUS			
B58	IRQ_E				A58	TMR7			
B59	IRQ_D				A59	TMR6			
B60	IRQ_C				A60	TMR5			
B61	IRQ_B				A61	TMR4			
B62	IRQ_A				A62	RSTIN_b			
B63	EBI_ALE / EBI_CS1_b				A63	RSTOUT_b	ELEV_RSTOUT_B (RESET)	<b>X</b>	<b>X</b>
B64	EBI_CS0_b				A64	CLKOUT0			
B65	<b>GND</b>	<b>Ground</b>	<b>X</b>		A65	<b>GND</b>	<b>Ground</b>	<b>X</b>	
B66	EBI_AD15				A66	EBI_AD14			
B67	EBI_AD16				A67	EBI_AD13			
B68	EBI_AD17				A68	EBI_AD12			
B69	EBI_AD18				A69	EBI_AD11			
B70	EBI_AD19				A70	EBI_AD10			
B71	EBI_R/W_b				A71	EBI_AD9			
B72	EBI_OE_b				A72	EBI_AD8			

*TWR-RF\_SNAP Primary Connector*

<i>Pin</i>	<i>Name</i>	<i>Usage</i>	<i>Used</i>	<i>Jmp</i>	<i>Pin</i>	<i>Name</i>	<i>Usage</i>	<i>Used</i>	<i>Jmp</i>
B73	EBI_D7				A73	EBI_AD7			
B74	EBI_D6				A74	EBI_AD6			
B75	EBI_D5				A75	EBI_AD5			
B76	EBI_D4				A76	EBI_AD4			
B77	EBI_D3				A77	EBI_AD3			
B78	EBI_D2				A78	EBI_AD2			
B79	EBI_D1				A79	EBI_AD1			
B80	EBI_D0				A80	EBI_AD0			
B81	<b>GND</b>	<b>Ground</b>	<b>X</b>		A81	<b>GND</b>	<b>Ground</b>	<b>X</b>	
B82	<b>3.3V</b>	<b>3.3V Power</b>			A82	<b>3.3V</b>	<b>3.3V Power</b>		

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## 5.2 Tower Form-Factor

The TWR-RF-SNAP is designed for the Freescale Tower System as a side mounting peripheral and complies with the electrical and mechanical specification as described in *Freescale Tower Electromechanical Specification*.

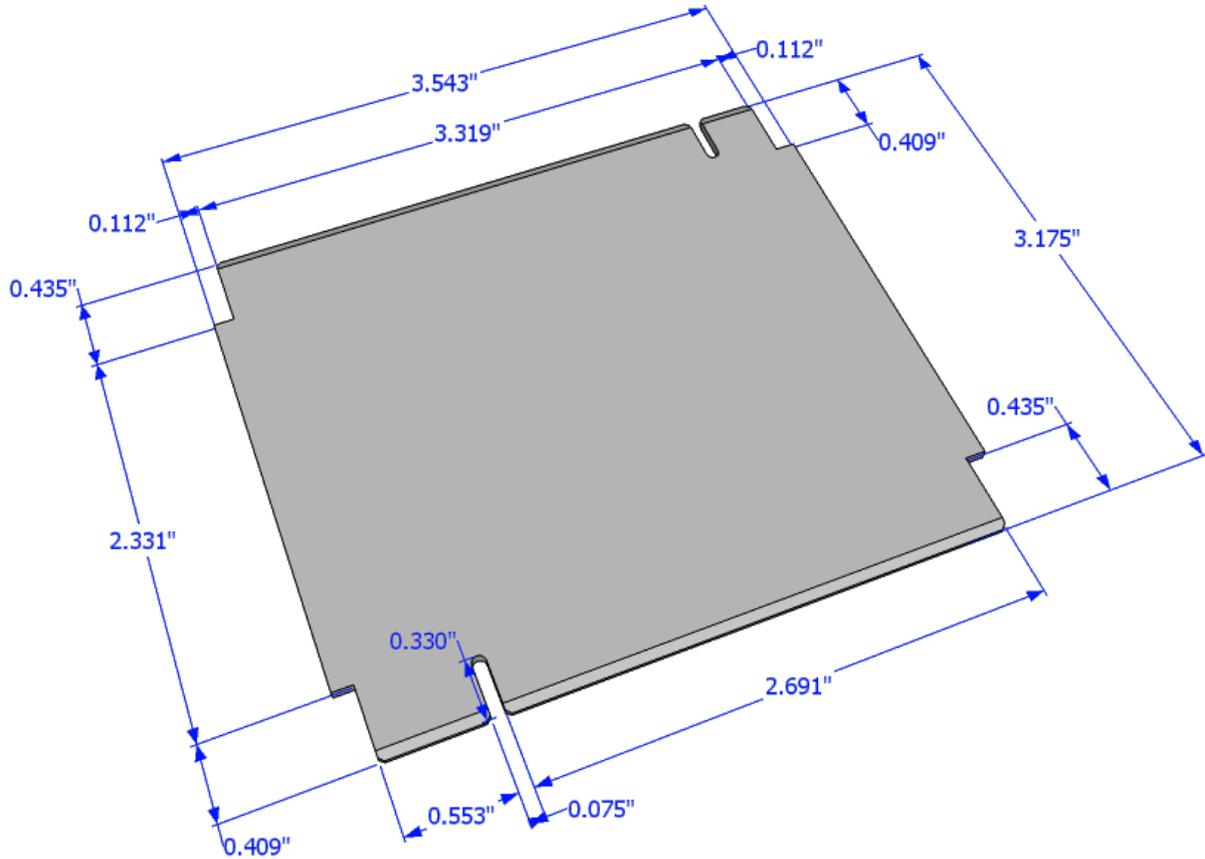


Figure 10 - Tower Board size