

# SyChip SN3021 IEEE802.15.4/ZigBee Smart Energy Module

## User Manual and Datasheet

**Version: 1.2**

**February 21, 2012**

*Confidential Information*

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# 1 System Descriptions

## 1.1 Applications

SyChip's SN3021 module is a standard-based wireless transceiver targeting the Smart Energy market with low power consumption, high transmit power (20 dBm typ.) and high receiver sensitivity (-103 dBm). It is based upon the IEEE 802.15.4 wireless network specification. The module can be used to develop applications supporting the ZigBee PRO Smart Energy application profile. The SN3021 module operates in the 2.4 GHz unlicensed ISM frequency band for worldwide deployment.

## 1.2 Module Summary

- Dimensions:  $27.20 \times 14.75 \times 2.90$  mm<sup>3</sup>
- Ember EM357 high-performance, integrated ZigBee/802.15.4 chipset
- Supply voltage: 2.4V to 3.4V
- Data logging memory: 8 Mbits serial flash
- Security: 128-bit AES
- External antenna launch pad
- Host Interface: SPI, UART
- Meter interface: I2C, GPIO
- ADC ports: 6 x 14-bit
- RoHS compliant
- MSL JEDEC level 3

### 1.3 Block Diagram

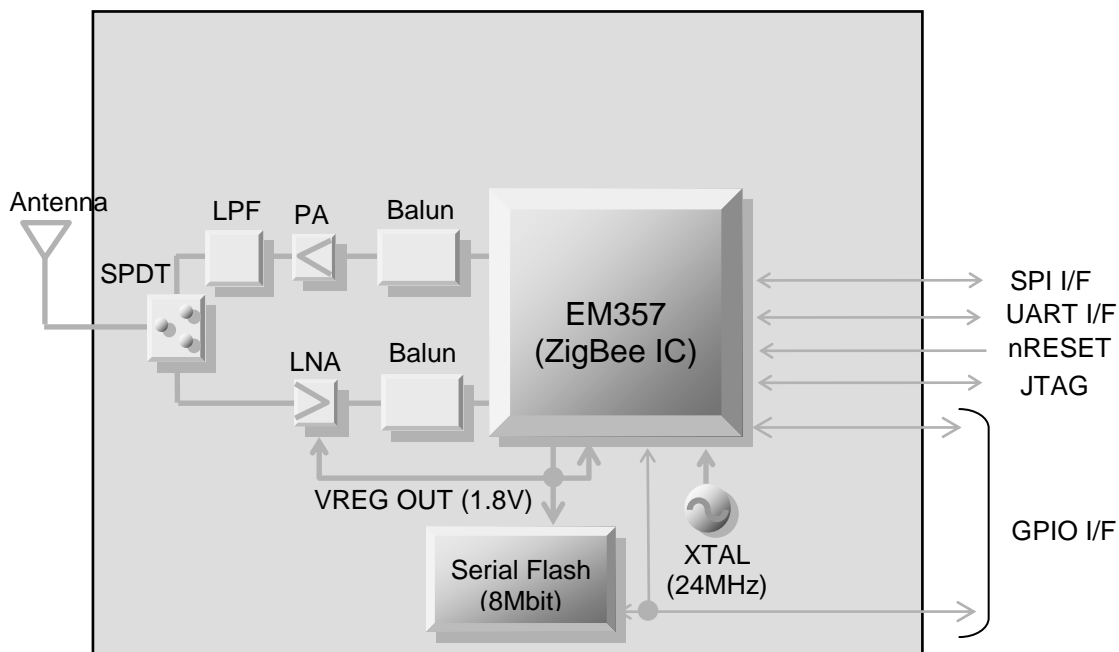


Figure 1 SN3021 Module Block Diagram

### 1.4 Acronyms

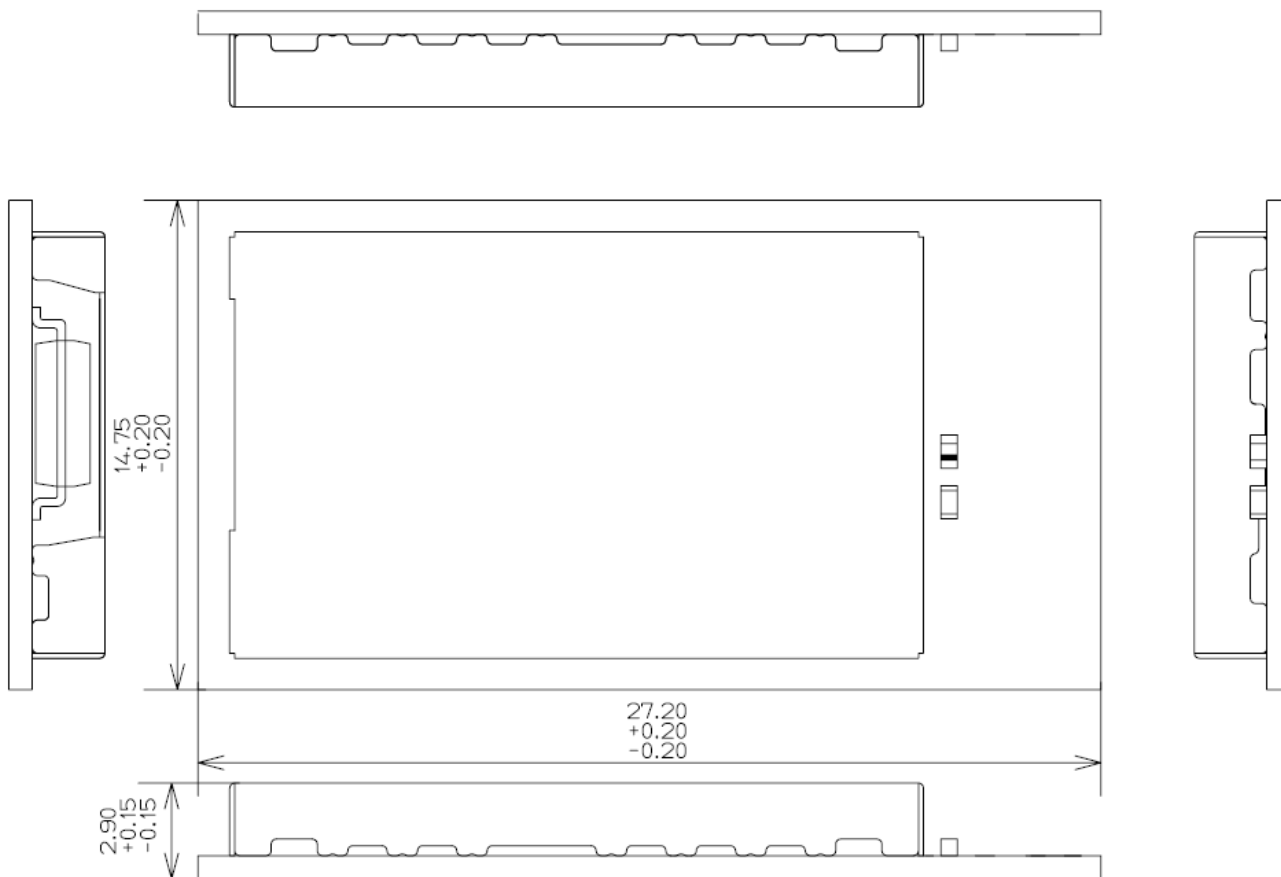
|      |   |
|------|---|
| ADC  | Analog to Digital Converter                 |
| AMR  | Automatic Meter Reading                     |
| GPIO | General-Purpose Input-Output                |
| I2C  | Intelligent Interface Controller            |
| ISM  | Industrial, Scientific and Medical          |
| MAC  | Medium Access Control                       |
| MSL  | Moisture Sensitivity Level                  |
| PER  | Packet Error Rate                           |
| ROHS | Restriction of Hazardous Substances         |
| SPI  | Serial Peripheral Interface                 |
| UART | Universal Asynchronous Receiver-Transmitter |
| WPAN | Wireless Personal Area Network              |

## 2 Mechanical Specifications

### 2.1 Module Dimension

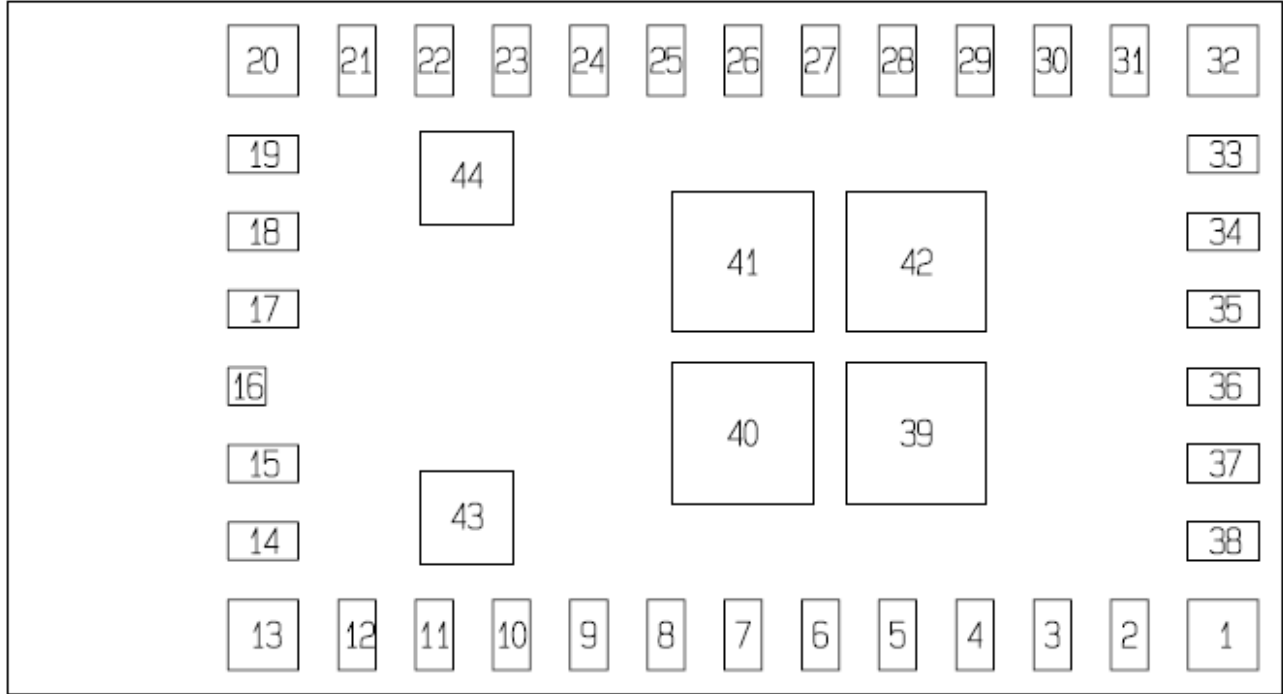
| Parameter                    | Typical                              | Units |
|------------------------------|--------------------------------------|-------|
| Dimension (LxWxH)            | 27.20 x 14.75 x 2.90                 | mm    |
| Dimension tolerances (LxWxH) | $\pm 0.20$ x $\pm 0.20$ x $\pm 0.15$ | mm    |

### 2.2 Module top and side view



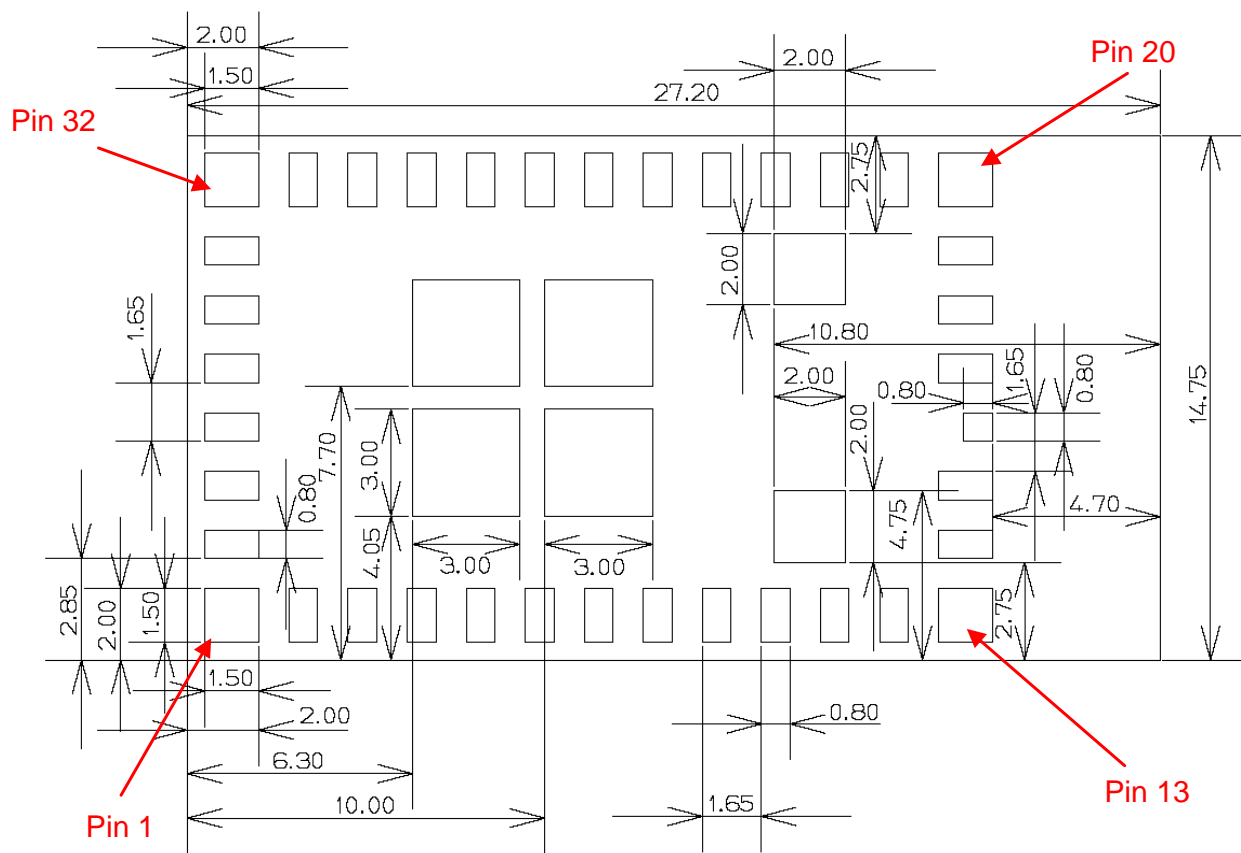
**Figure 2 Module Top and Side View**

### 2.3 Module bottom view



**Figure 3 Module Bottom View**

**2.4 Detailed mechanical data (top view)**



**Figure 4 Detailed Mechanical Data (top view)**



## 2.5 Module Pin-out

**Table 1 Module Connector Signal Description**

| Pin # | Pin name      | I/O | Description  |
|-------|---------------|-----|--|
| 1     | GND           | -   | Ground   |
| 2     | Reserved      | O   | Internal serial flash on/off control (active low), for debugging use only                      |
| 3     | PC4/JTMS      | I/O | Programmable I/O control available to the host, or JTAG mode select                            |
| 4     | PB0/IRQA      | I/O | Programmable I/O control available to the host, or an interrupt input                          |
| 5     | Reserved      | O   | Internal serial flash nCS, for debugging use only  |
| 6     | PB6/ADC1/IRQB | I/O | Programmable I/O control available to the host, or ADC input, or an interrupt input            |
| 7     | PC1/ADC3      | I/O | Programmable I/O control available to the host, or an ADC input                                |
| 8     | SWCLK/JTCK    | I   | JTAG/Serial Wire debugging port clock  |
| 9     | PC0/JRST/IRQD | I/O | Programmable I/O control available to the host, or an interrupt input, or the JTAG reset input |
| 10    | GND           | -   | Ground   |
| 11    | PB5/ADC0      | I/O | Programmable I/O control available to the host, or an ADC input                                |
| 12    | GND           | -   | Ground   |
| 13    | GND           | -   | Ground   |
| 14    | GND           | -   | Ground   |
| 15    | GND           | -   | Ground   |

| Pin # | Pin name           | I/O | Description   |
|-------|--------------------|-----|---|
| 16    | Antenna            | I/O | External antenna feed   |
| 17    | GND                | -   | Ground  |
| 18    | Reserved           | O   | Used internally as the LNA on (active low), for debugging use only  |
| 19    | nRESET             | I   | Module reset signal (Internal pull-up)  |
| 20    | GND                | -   | Ground  |
| 21    | GND                | -   | Ground  |
| 22    | PA3                | I/O | Programmable I/O control available to the host,   |
| 23    | GND                | -   | Ground  |
| 24    | PC6/OSC32B         | I/O | Programmable I/O control available to the host, or 32.768kHz crystal  |
| 25    | PC7/OSC32A         | I/O | Programmable I/O control available to the host, or 32.768kHz crystal  |
| 26    | SC1SCLK/PB3        | I/O | <b>SPI port 1 clock</b> , or programmable I/O control available to the host,  |
| 27    | Reserved           | O   | Used internally as the serial flash MOSI, for debugging use only  |
| 28    | Reserved           | O   | Used internally as the serial flash MISO, for debugging use only  |
| 29    | VBATT              | PI  | Module power supply   |
| 30    | Reserved           | O   | Used internally as the serial flash clock, for debugging use only   |
| 31    | PA4/ADC4           | I/O | Programmable I/O control available to the host, or ADC input  |
| 32    | GND                | -   | Ground  |
| 33    | PA5/ADC5/nBOOTMODE | I/O | Programmable I/O control available to the host, or ADC input, or <b>Boot control, must be left open or pulled high during the reset to enable the normal firmware boot process.</b> |

| Pin # | Pin name                                 | I/O | Description  |
|-------|--|-----|--|
| 34    | SC1MISO(s)/<br>SC1MOSI(m)/TXD/PB1/SC1SDA | I/O | SPI port 1 MISO (slave)/ MOSI (master) signal, UART TXD signal, I2C port 1 DATA signal, or programmable I/O control available to the host. |
| 35    | SC1MOSI(s)/<br>SC1MISO(m)/RXD/PB2/SC1SCL | I/O | SPI port 1 MOSI (slave)/ MISO (master) signal, UART RXD signal, I2C port 1 CLK signal, or programmable I/O control available to the host.  |
| 36    | PC2/JTDO/SWO                             | I/O | Programmable I/O control available to the host, or<br>Serial Wire port OUTPUT signal, or<br>JTAG data out                                  |
| 37    | SC1nSSEL/PB4                             | I/O | SPI port 1 slave select, or<br>programmable I/O control available to the host,   |
| 38    | PC3/JTDI                                 | I/O | Programmable I/O control available to the host, or<br>JTAG data in   |
| 39    | GND                                      | -   | Ground   |
| 40    | GND                                      | -   | Ground   |
| 41    | GND                                      | -   | Ground   |
| 42    | GND                                      | -   | Ground   |
| 43    | GND                                      | -   | Ground   |
| 44    | GND                                      | -   | Ground   |

## 3 DC Electrical Specifications

### 3.1 Typical Power Consumption

Table 2 Typical Power Consumption

| Item                             | Condition   | Values |      |     | Units |
|----------------------------------|---|--------|------|-----|-------|
|                                  |   | Min    | Typ  | Max |       |
| Sleep mode                       | VCC = 3.0V, TAMB = 25°C<br>Internal RC oscillator on<br>Processor, radio, peripherals off |        | 1.2  |     | μA    |
| Standby mode                     | VCC = 3.0V, TAMB = 25°C<br>Processor on<br>Radio and peripherals off                      |        | 10   |     | mA    |
| Receive mode                     | VCC = 3.0V, TAMB = 25°C<br>Radio receive chain on   |        | 35   |     | mA    |
| Transmit mode<br>(+20dBm)        | VCC = 3.0V, TAMB = 25°C<br>Radio transmit chain on  |        | 160  |     | mA    |
| Serial controller current        | For each controller at maximum<br>data rate   |        | 0.2  |     | mA    |
| General purpose timer<br>current | For each timer at maximum clock<br>rate   |        | 0.25 |     | mA    |
| General purpose ADC<br>current   | At maximum sample rate, DMA<br>enabled  |        | 1.1  |     | mA    |

### 3.2 Digital IO Specification

VCC = 3.0V, TAMB = 25°C, NORMAL MODE<sup>1</sup> unless otherwise stated

Table 3 Digital IO Specification

| Item                               | Condition  | Symbol     | Values               |     |                     | Units |
|------------------------------------|--|------------|----------------------|-----|---------------------|-------|
|                                    |  |            | Min                  | Typ | Max                 |       |
| Input current for logic 0          |  | $I_{IL}$   |                      |     | -0.5                | μA    |
| Input current for logic 1          |  | $I_{IH}$   |                      |     | 0.5                 | μA    |
| Low Schmitt switching<br>threshold | Schmitt input<br>threshold going<br>from high to low | $V_{SWIL}$ | $0.42 \times V_{CC}$ |     | $0.5 \times V_{CC}$ | V     |

<sup>1</sup> NORMAL MODE as defined by Ember for EM357.

|                                  |  |                   |                      |  |                      |    |
|----------------------------------|--|-------------------|----------------------|--|----------------------|----|
| High Schmitt switching threshold | Schmitt input threshold going from low to high               | $V_{SWIH}$        | $0.62 \times V_{CC}$ |  | $0.8 \times V_{CC}$  | V  |
| Output voltage for logic 0       | $I_{OL} = 4\text{mA}$ (8mA) for standard (high current) pads | $V_{OL}$          | 0                    |  | $0.18 \times V_{CC}$ | V  |
| Output voltage for logic 1       | $I_{OH} = 4\text{mA}$ (8mA) for standard (high current) pads | $V_{OH}$          | $0.82 \times V_{CC}$ |  | $V_{CC}$             | V  |
| Output Source Current            | Standard current pad   | $I_{OHS}$         |                      |  | 4                    | mA |
| Output Sink current              | Standard current pad   | $I_{OLS}$         |                      |  | 4                    | mA |
| Output Source Current            | High current pad   | $I_{OHH}$         |                      |  | 8                    | mA |
| Output Sink current              | High current pad   | $I_{OLH}$         |                      |  | 8                    | mA |
| Total output current             |  | $I_{OH} + I_{OL}$ |                      |  | 40                   | mA |

## 4 RF Specifications

$V_{CC} = 3.0\text{V}$ ,  $T_{AMB} = 25^\circ\text{C}$ , NORMAL MODE measured at  $50\Omega$  terminal load connected to the RF connector

Table 4 RF Specifications

| Parameter   | Min  | Typ  | Max  | Units |
|---|------|------|------|-------|
| Frequency range                                       | 2400 |      | 2500 | MHz   |
| Receiver sensitivity                                  |      | -103 |      | dBm   |
| Maximum input signal level                            | -20  |      |      | dBm   |
| Transmitter power at the maximum setting <sup>2</sup> |      | 20   |      | dBm   |
| Adjacent channel rejection                            |      | 24   |      | dB    |
| Alternate channel rejection                           |      | 42   |      | dB    |
| Carrier frequency error                               | -40  |      | +40  | ppm   |

<sup>2</sup> Ember RF output power programmed to -12 by emberSetRadioPower [2] or equivalent under NORMAL mode

## 5 Environmental Specifications

### 5.1 Absolute maximum ratings

Table 5 Absolute Maximum Rating

| Symbol            | Description                         | Min       | Max | Units |
|-------------------|-------------------------------------|-----------|-----|-------|
| T <sub>op</sub>   | Operating temperature               | -40       | 85  | °C    |
| T <sub>st</sub>   | Storage temperature                 | -40       | 85  | °C    |
| V <sub>batt</sub> | Power supply                        | -0.3      | 3.6 | V     |
| RFin              | RF input power                      |           | 10  | dBm   |
| MSL               | Moisture Sensitivity Level          | 3         |     |       |
| RoHS              | Restriction of Hazardous Substances | Compliant |     |       |

### 5.2 Operation conditions

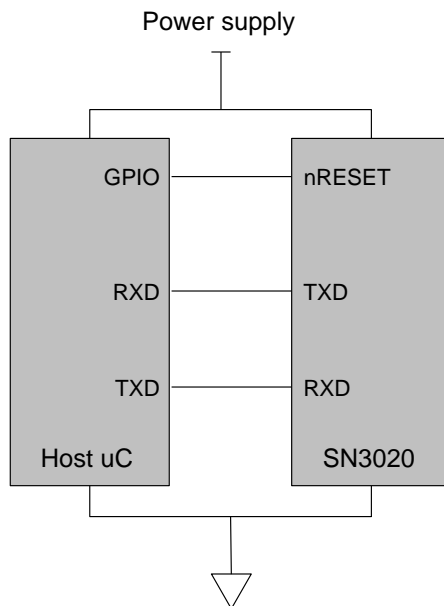
Table 6 Recommended Operating Conditions

| Symbol            | Parameter             | Min | Typ | Max | Units |
|-------------------|-----------------------|-----|-----|-----|-------|
| V <sub>batt</sub> | Power supply          | 2.4 | 3.0 | 3.4 | V     |
| T <sub>op</sub>   | Operating temperature | -40 |     | 85  | °C    |

## 6 Application Information

### 6.1 Reference connection for UART host interface

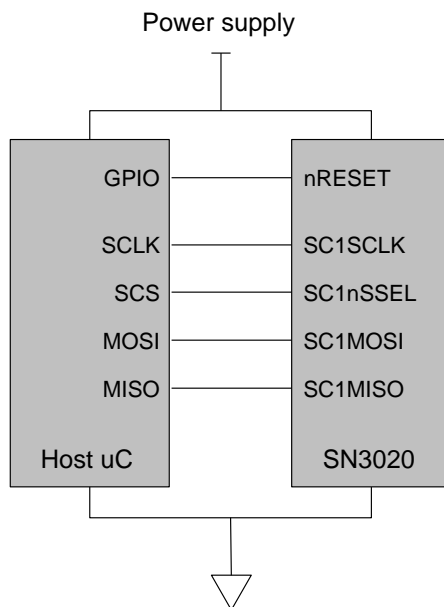
Figure 5 illustrates the connections between SN3021 module and the host MCU via UART interface. A level shifter may be needed if the host UART interface level does not match with SN3021.



**Figure 5 UART Host Interface Reference Diagram**

## 6.2 Reference connection for the SPI host interface

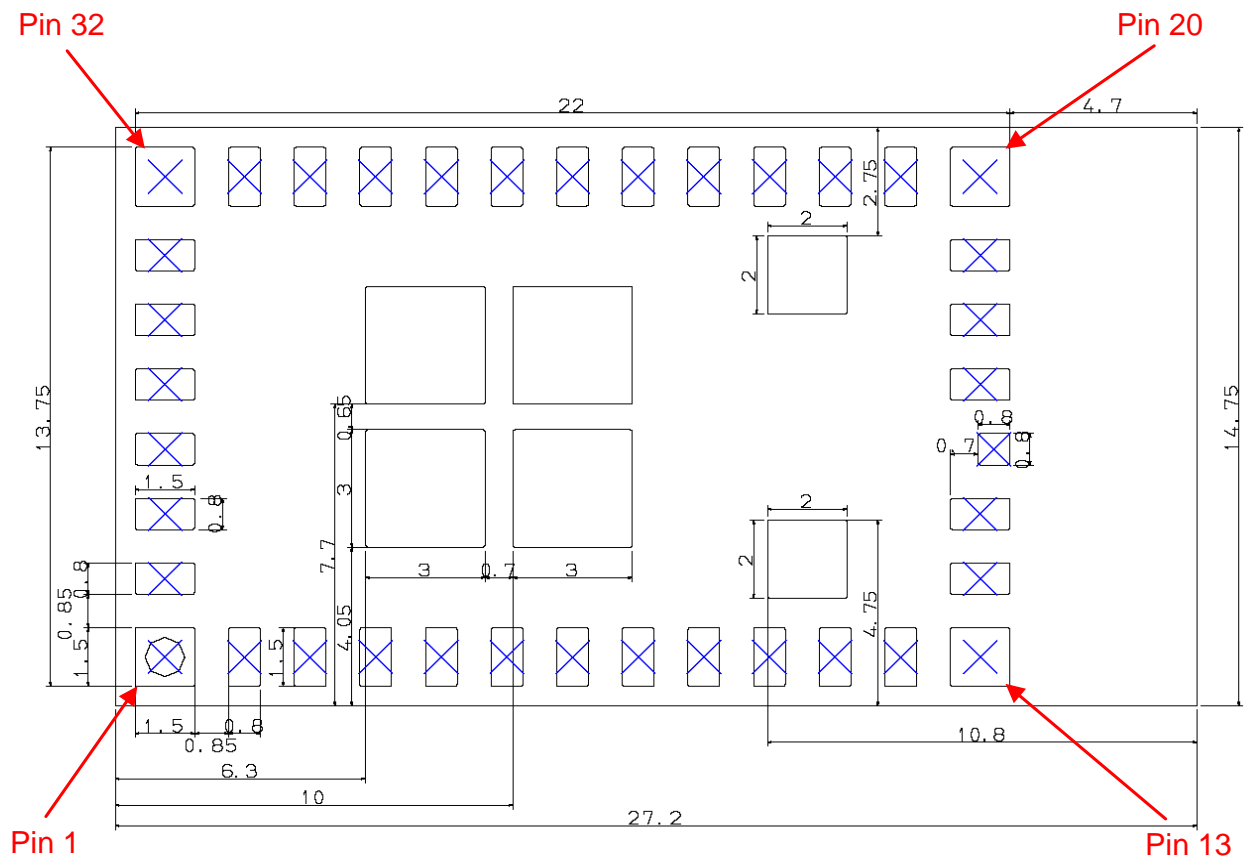
Figure 6 illustrates the connections between SN3021 module and the host MCU via SPI interface.



**Figure 6 SPI Host Interface Reference Diagram**



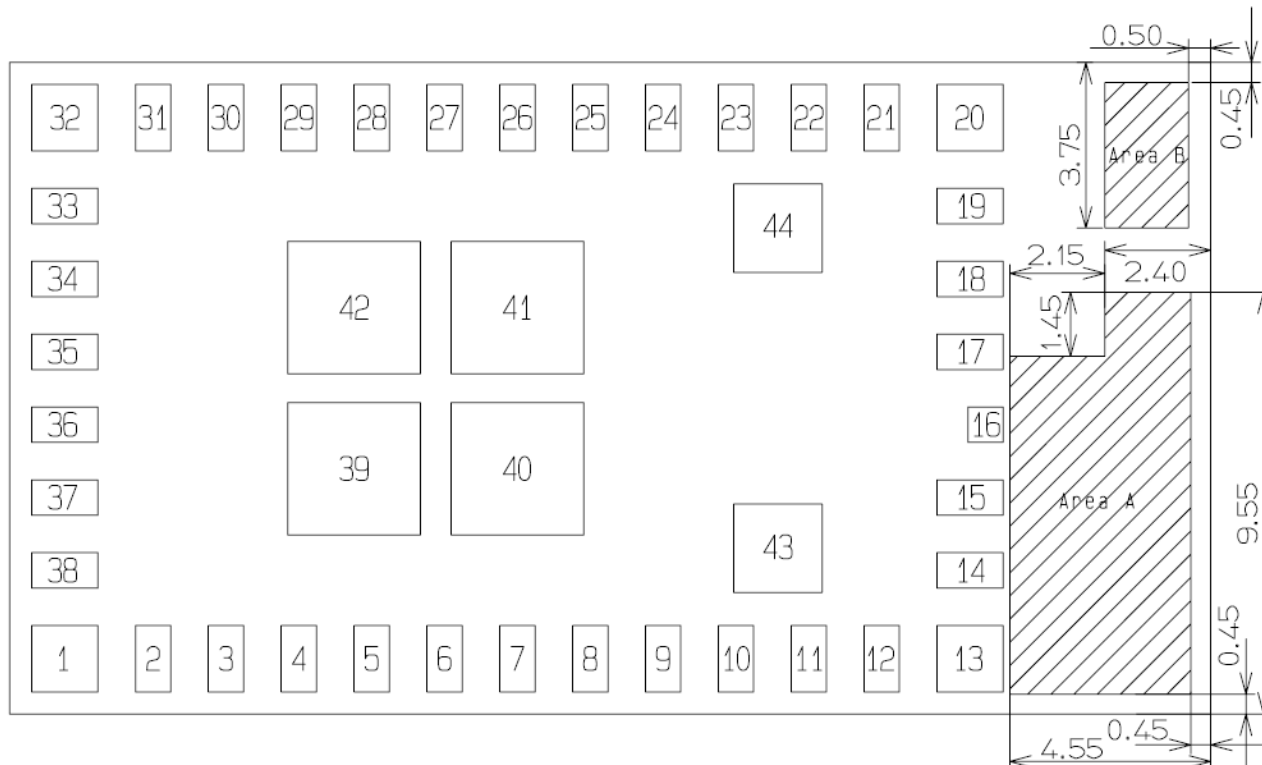
### 6.3 Recommended host (customer) circuit board PCB pattern



**Figure 7 Recommended Host (customer) PCB Pattern**

### 6.4 Host PCB layout recommendations

The SN3021 module has an footprint of onboard antenna. therefore it requires some special host PCB layout underneath the module such that the radio can achieve its best RF performance. Refer to Figure 8 for the requirements.



**Figure 8 Recommended Host Circuit Board Design underneath the Module**

**Notes:**

1. We recommend to use a filled via to pull RF signal out from RF pad (i.e. Pin 16).
2. If you don't use a filled via, RF trace from Pin 16 should go though "Area A" and "Area B" as little as possible.

## 7 Assembly Information

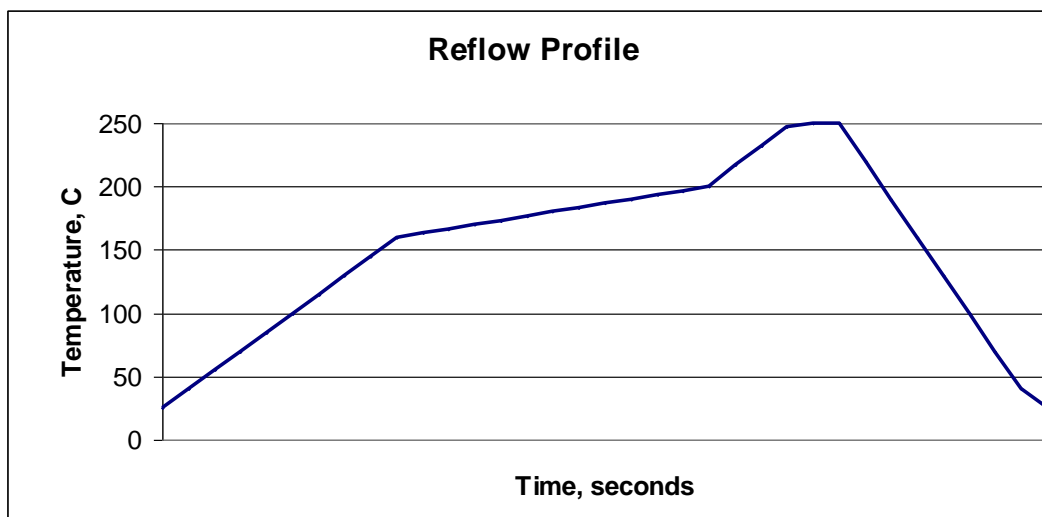
### 7.1 Lead-free soldering reflow profile

The lead-free solder reflow profile is recommended in the table & graph below. The profile is used to attach the module to its host PCB.

The module is designed to withstand 2 reflows. Opposite side reflow is prohibited due to the module weight.

**Table 7 Reflow Profile Recommendation**

|   |                |
|---|----------------|
| Ramp up rate                                | 3°C/second max |
| Maximum time maintained above 217°C         | 120 seconds    |
| Peak temperature                            | 250°C          |
| Maximum time within 5°C of peak temperature | 20 seconds     |
| Ramp down rate                              | 6°C/second max |



**Figure 9 Reflow Profile Pattern**

## 8 Package Information

### 8.1 Tape and reel specification

The product will be shipped in tape and reel package.

#### (1) Dimensions of tape (Plastic tape)

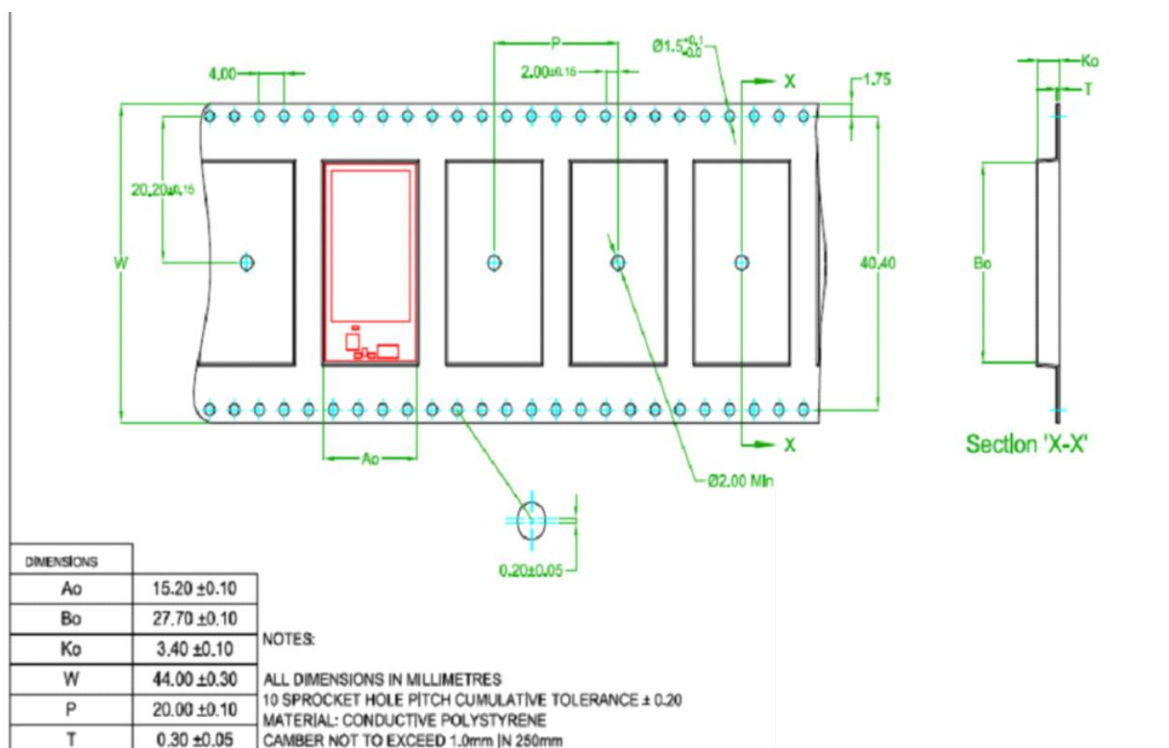


Figure 10 Tape Dimensions

## 8.2 Module Marking

The module will be marked using a label suitable for reflow soldering.

**Table 8 Module Marking**

| Item | Description  |
|------|--|
| A    | Pin 1 ID   |
| B    | Model Name   |
| C    | MFG barcode in human readable form (includes module type, date code and serial number) |

## 9 Ordering Information

**Table 9 Ordering Information**

| Product        | SyChip Model Number | SyChip Part Number |
|----------------|---------------------|--------------------|
| Evaluation kit | SN3021EVK           | 88-00144-85        |
| Module         | SN3021              | 88-00144-00        |

- -00 is for full production reel (950 pcs/reel)

## 10 RoHS Declaration

Given supplier declarations, this product does not contain substances that are banned by Directive 2002/95/EC or contains a maximum concentration of 0.1% by weight in homogeneous materials for

- Lead and lead compounds
- Mercury and mercury compounds
- Chromium (VI)
- PBB (polybrominated biphenyl)
- PBDE (polybrominated biphenyl ether)

And a maximum concentration of 0.01% by weight in homogeneous materials for

- Cadmium and cadmium compounds

## 11 Technical Support Contact

SyChip, LLC

2805 Dallas Parkway, Suite 400

Plano, TX 75093

USA

Tel: (972) 202-8900

Fax: (972) 633-0327

Note: SyChip, LLC is an operating unit within Murata Wireless Solutions

## 12 References

[1] IEEE Standard 802.15.4 – 2003 Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)

[2] Ember, “EmberZNet API Reference: For the EM35x SoC Platform”, 120-3022-000G, October 28 2010

## 13 Disclaimer:

Please read this notice before using the SN3021 product.

1. Please note that the only warranty that SyChip LLC (“SyChip”) provides regarding the products is its conformance to the specifications provided herein. Accordingly, SyChip shall not be responsible for any defects in products or equipment incorporating such products, which are caused under the conditions other than those specified in this specification.

SYCHIP HEREBY DISCLAIMS ALL OTHER WARRANTIES REGARDING THE PRODUCTS, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE, THAT THEY ARE DEFECT-FREE, OR AGAINST INFRINGEMENT OF INTELLECTUAL PROPERTY RIGHTS. YOU AGREE TO INDEMNIFY AND DEFEND SYCHIP AND ITS AFFILIATES AGAINST ALL CLAIMS, DAMAGES, COSTS AND EXPENSES THAT MAY BE INCURRED, INCLUDING WITHOUT LIMITATION, ATTORNEY FEES AND COSTS, DUE TO THE USE OF PRODUCTS.

2. The product is designed and manufactured for general applications, and not for any particular application, so testing and use of the product shall be conducted at your own risk and responsibility. Specifically, please observe the following:

- i) Please conduct validation and verification of the products in actual condition of mounting and operating environment before commercial shipment of the equipment.
- ii) Please pay attention to minimize any mechanical vibration or shock, not to drop the product or a substrate that contains the product during transportation.
- iii) Since the application of static electricity or overvoltage may cause a defect in the product or deterioration of its reliability, caution must be taken against exposure to any static electricity generated by electrified items such as work benches, soldering irons, tools, carrying containers, etc.
- iv) Caution shall be taken to avoid overstress to the product during and after the soldering process.
- v) Since the applied soldering method may deteriorate the reliability, thorough evaluation is recommended.
- vi) In case the product is to be used in equipment or electric circuit that requires high safety or reliability function or performance, sufficient reliability evaluation checks for safety shall be performed before commercial shipment and moreover, due consideration to install a protective circuit is strongly recommended at customer's design stage. Please provide an appropriate fail-safe function on your product to prevent any damages that may be caused by the abnormal function or the failure of our product.

Notwithstanding the foregoing, the product shall not be used in any application listed below which requires especially high reliability for the prevention of such defect as may directly cause damage to the third party's life, body or property.

- Aircraft equipment
- Aerospace equipment
- Undersea equipment
- Power plant control equipment
- Medical equipment
- Transportation equipment (vehicles, trains, ships, etc.)
- Traffic signal equipment
- Disaster prevention / crime prevention equipment
- Application of similar complexity and/or reliability requirements to the applications listed in the above.

3. SyChip's warranty as provided in Clause 1 above that the products comply with descriptions expressly specified in the specifications shall be effective for a period of six (6) months from the date of delivery. SyChip shall not be liable for any defects that occur in dry packed products that are installed more than six (6) months after shipment.

SyChip's liability under this warranty shall be limited to products that are returned during the warranty period to the address designated by SyChip and that are determined by SyChip not to conform to such warranty. If SyChip elects to repair or replace such products, SyChip shall have reasonable time to repair such products or provide replacements. Repaired products shall be warranted for the remainder of the original warranty period. Replaced products shall be warranted for a new full warranty period.

For avoidance of doubt, SyChip shall not be liable for any defects that are caused by neglect, misuse or mistreatment by an entity other than SyChip including improper installation or testing, or for any products that have been altered or modified in any way by an entity other than SyChip. Moreover, SyChip shall not be liable for any defects that result from your or third party's design, specifications or instructions for such products.

4. Testing and other quality control techniques are used to the extent SyChip deems necessary. Unless mandated by government requirements, SyChip does not necessarily test all parameters of each product.

5. End of Life - Please note that we may discontinue the manufacture of products, due to reasons such as, but not limited to, end of supply of materials and/or components from our suppliers.





## Стандарт Электрон Связь

Мы молодая и активно развивающаяся компания в области поставок электронных компонентов. Мы поставляем электронные компоненты отечественного и импортного производства напрямую от производителей и с крупнейших складов мира.

Благодаря сотрудничеству с мировыми поставщиками мы осуществляем комплексные и плановые поставки широчайшего спектра электронных компонентов.

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