SyChip SN3020
IEEE802.15.4/ZigBee
Smart Energy Module

User Manual
and Datasheet

Version: 1.0

February 3, 2011

Confidential Information

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1 System Descriptions

1.1 Applications

SyChip's SN3020 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 SN3020 module operates in the 2.4 GHz unlicensed ISM frequency band for worldwide deployment.

1.2 Module Summary

- Dimensions: *27.20 x 14.75 x 2.90* mm^3

- 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

- Antenna: on-module

- Host Interface: SPI, UART

- Meter interface: I2C, GPIO

- ADC ports: 6 x 14-bit

- RoHS compliant

- MSL JEDEC level 3

1.3 Block Diagram
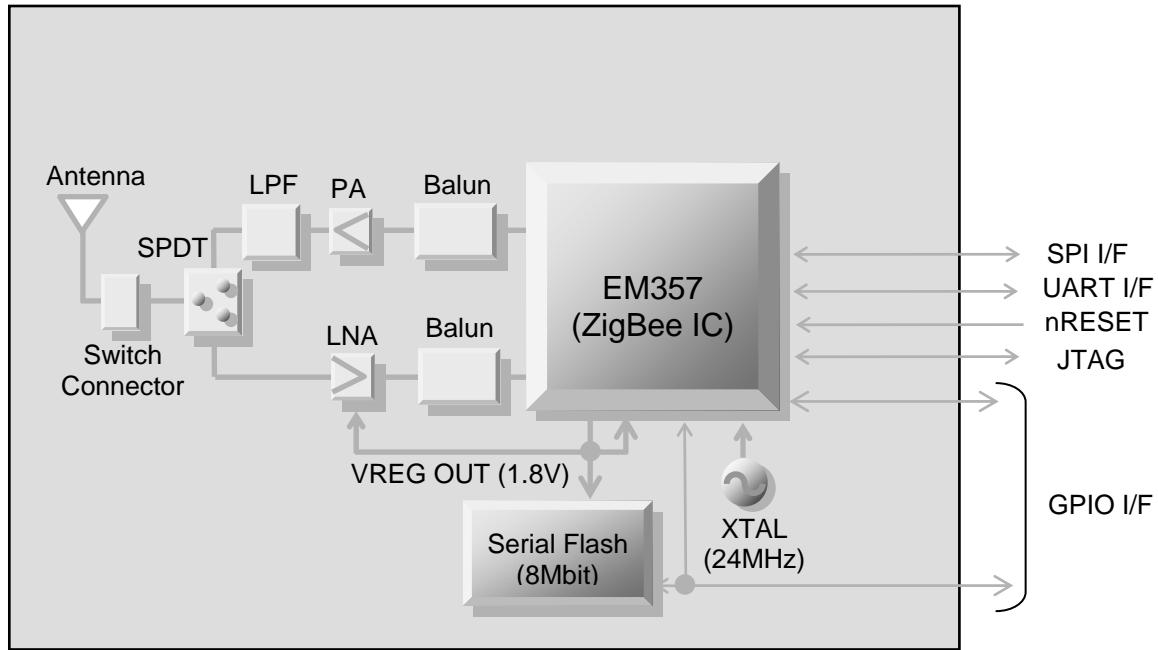
Figure 1 SN3020 Module Block Diagram

1.4 Acronyms
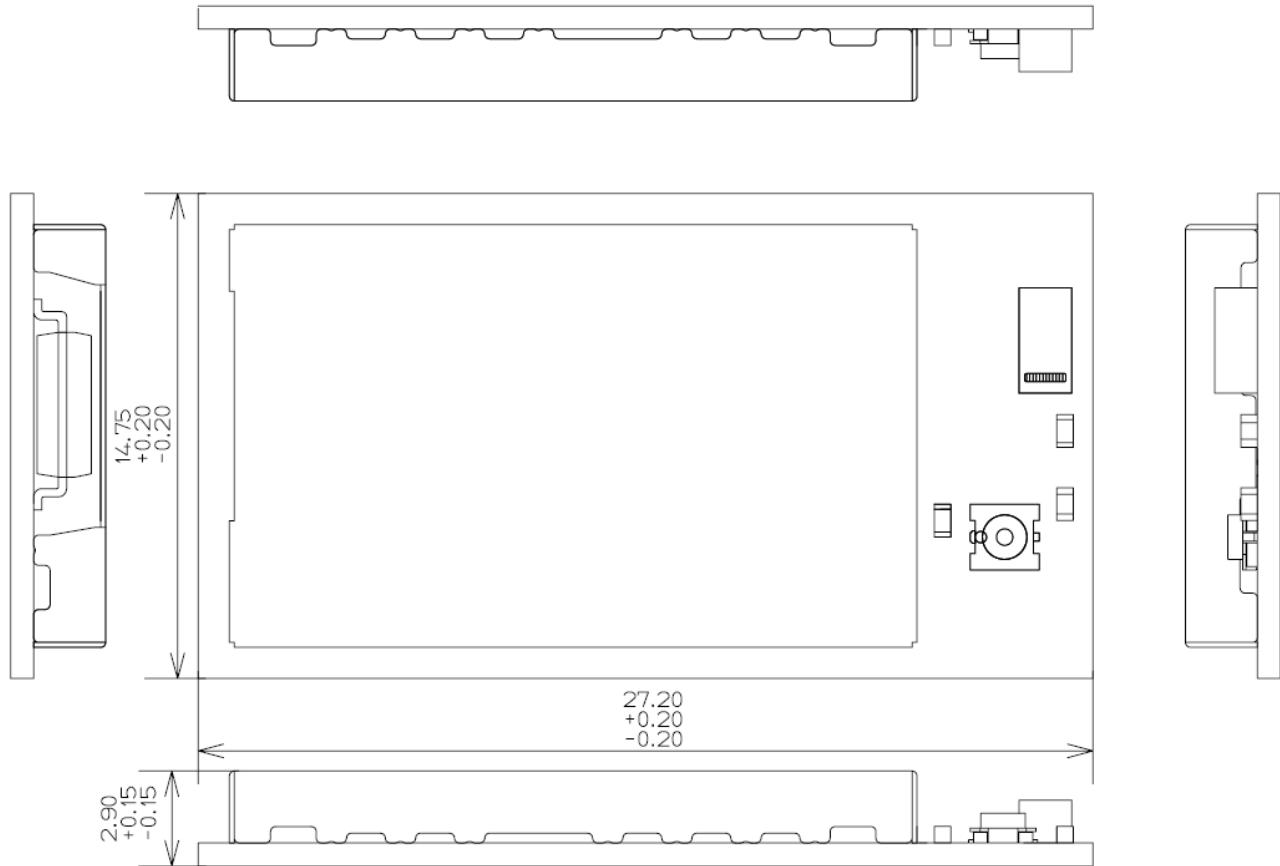
ADC   Analog to Digital Converter

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
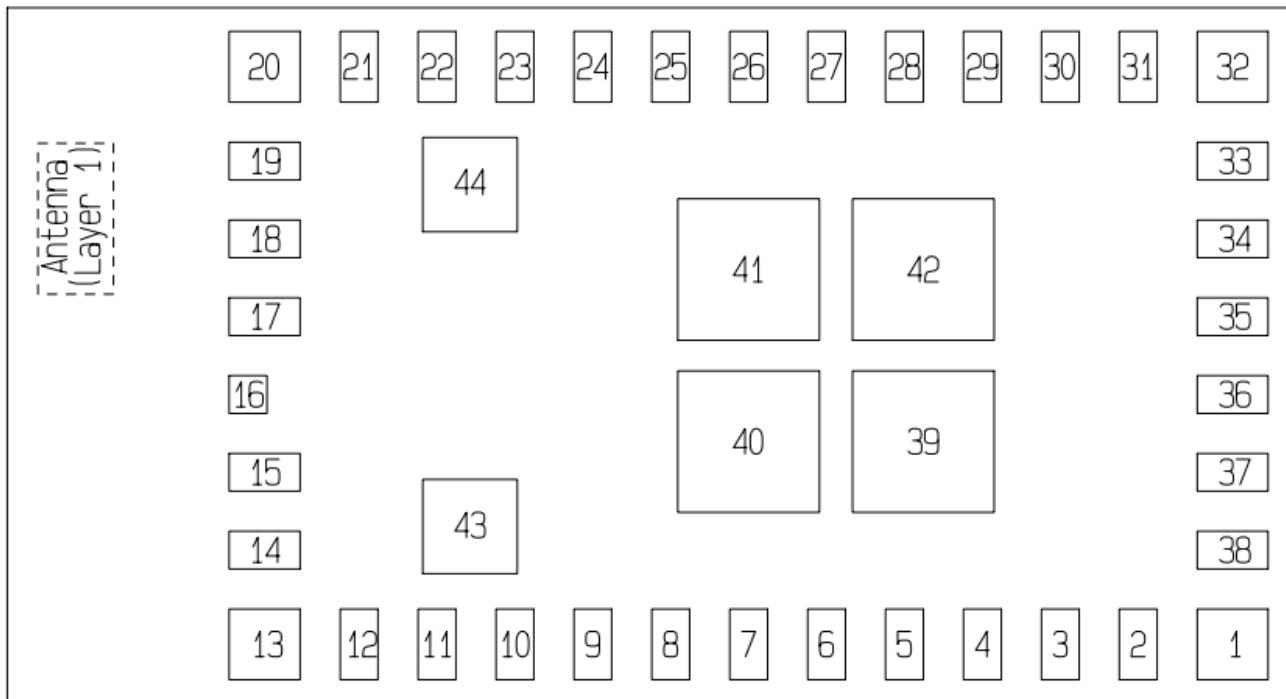
Parameter	Typical	Units
Dimension (LxWxH)	27.20 x 14.75 x 2.90	mm
Dimension tolerances (LxWxH)	±0.20 x ±0.20 x ±0.15	mm

2.2   Module top and side view
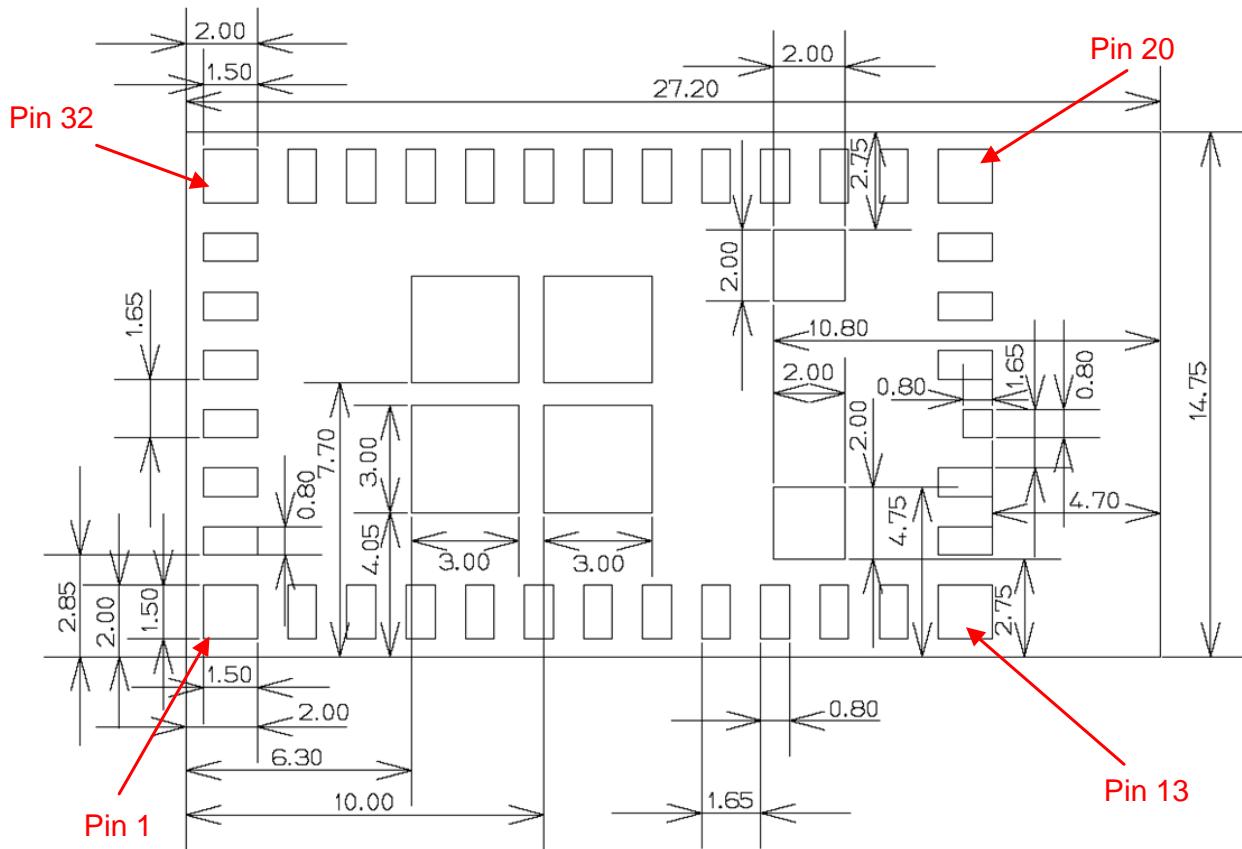
Figure 2 Module Top and Side View

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	Reserved	I/O	Not connected in SN3020.
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	**SPI port 1 clock,** 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 **Boot control, must be left open or pulled high during the reset to enable the normal firmware boot process.**

Pin #	Pin name	I/O	Description
34	**SC1MISO(s)/ 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)/ 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 Serial Wire port OUTPUT signal, or JTAG data out
37	**SC1nSSEL/PB4**	**I/O**	**SPI port 1 slave select, or** programmable I/O control available to the host,
38	PC3/JTDI	I/O	Programmable I/O control available to the host, or 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 Internal RC oscillator on Processor, radio, peripherals off		1.2		μA
Standby mode	VCC = 3.0V, TAMB = 25°C Processor on Radio and peripherals off		12		mA
Receive mode	VCC = 3.0V, TAMB = 25°C Radio receive chain on		35		mA
Transmit mode (+20dBm)	VCC = 3.0V, TAMB = 25°C Radio transmit chain on		175		mA
Serial controller current	For each controller at maximum data rate		0.2		mA
General purpose timer current	For each timer at maximum clock rate		0.25		mA
General purpose ADC current	At maximum sample rate, DMA enabled		1.1		mA

3.2 Digital IO Specification

VCC = 3.0V, TAMB = 25°C, NORMAL MODE[1] 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 threshold	Schmitt input threshold going from high to low	V_{SWIL}	0.42 x V_{CC}		0.5 x V_{CC}	V

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[1] NORMAL MODE as defined by Ember for EM357.

High Schmitt switching threshold	Schmitt input threshold going from low to high	V_{SWIH}	0.62 x V_{CC}		0.8 x V_{CC}	V
Output voltage for logic 0	I_{OL} = 4mA (8mA) for standard (high current) pads	V_{OL}	0		0.18 x V_{CC}	V
Output voltage for logic 1	I_{OH} = 4mA (8mA)for standard (high current) pads	V_{OH}	0.82 x 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

VCC = 3.0V, TAMB = 25°C, NORMAL MODE measured at 50Ω 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 [2]		20		dBm
Adjacent channel rejection		24		dB
Alternate channel rejection		42		dB
Carrier frequency error	-40		+40	ppm

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[2] 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_{op}	Operating temperature	-40	85	°C
T_{st}	Storage temperature	-40	85	°C
Vbatt	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
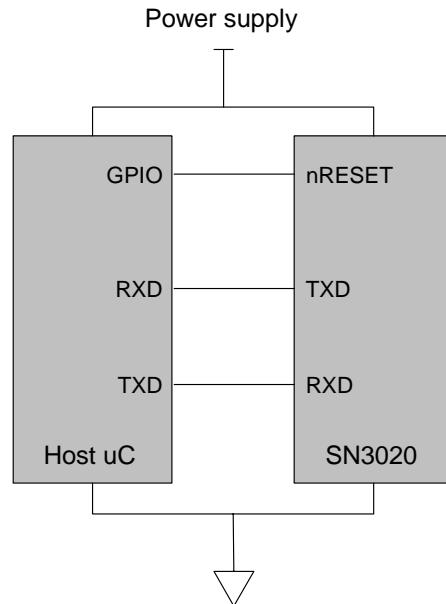
Symbol	Parameter	Min	Typ	Max	Units
Vbatt	Power supply	2.4	3.0	3.4[3]	V
T_{op}	Operating temperature	-40		85	°C

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[3] This value is handled by Firmware to meet FCC regulation for modular approval.

6 Application Information

6.1 Reference connection for UART host interface
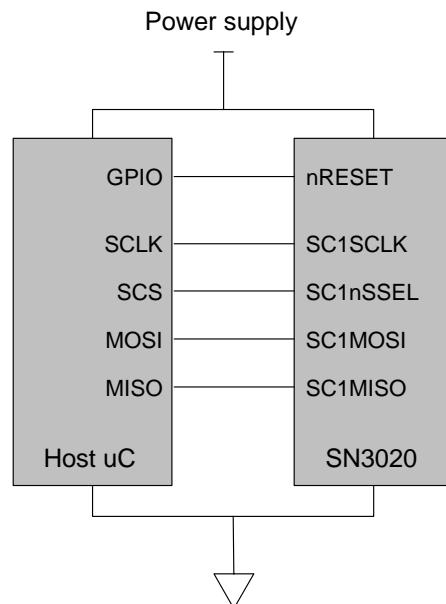
Figure 5 illustrates the connections between SN3020 module and the host MCU via UART interface. A level shifter may be needed if the host UART interface level does not match with SN3020.


Figure 5 UART Host Interface Reference Diagram

6.2 Reference connection for the SPI host interface

Figure 6 illustrates the connections between SN3020 module and the host MCU via SPI interface.

Figure 6 SPI Host Interface Reference Diagram

6.3 Recommended host (customer) circuit board PCB pattern
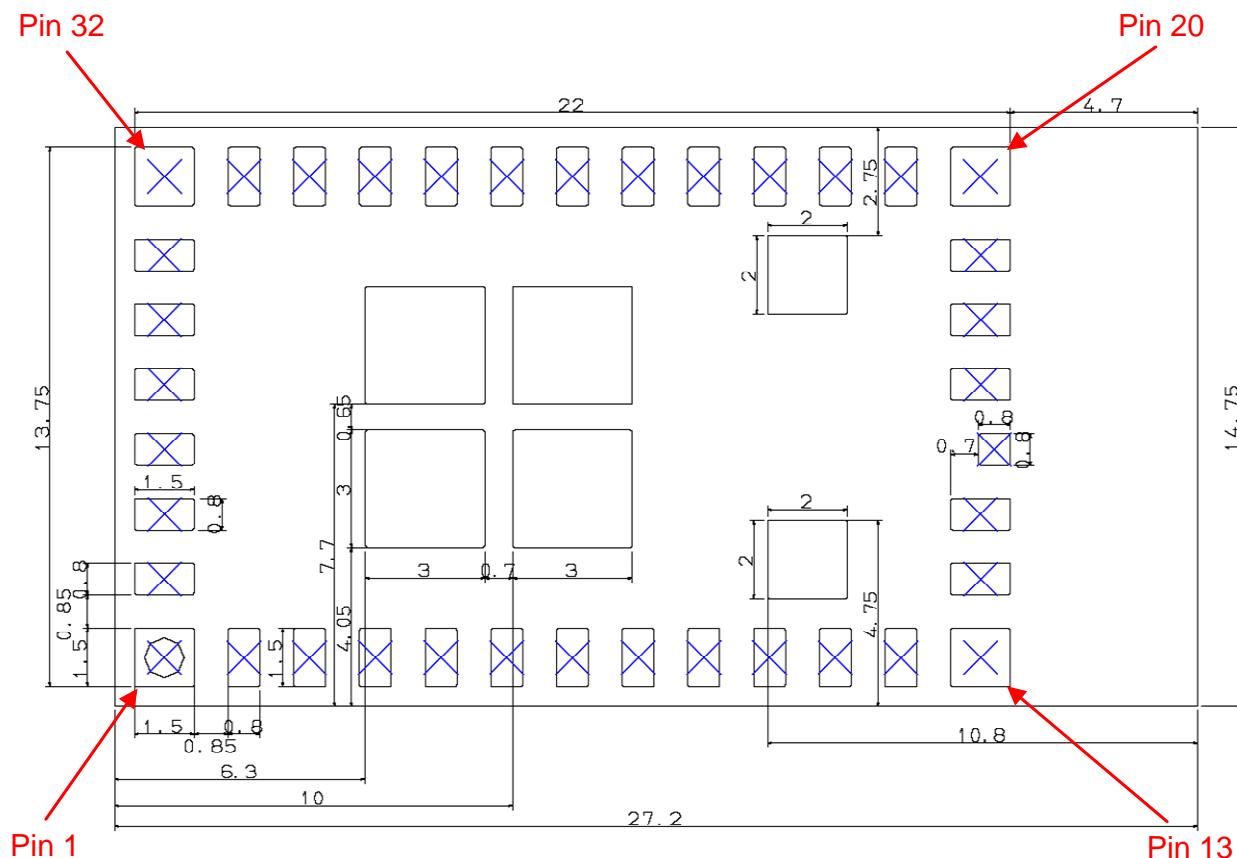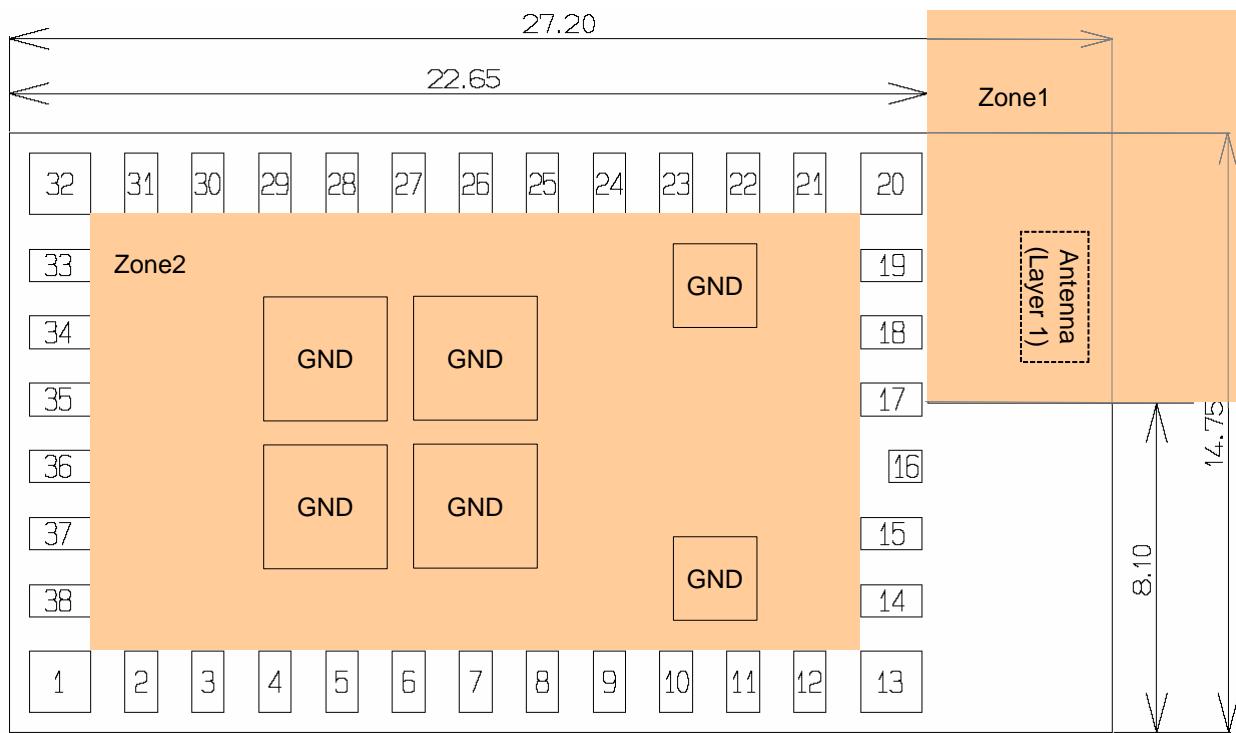
Figure 7 Recommended Host (customer) PCB Pattern

6.4 Host PCB layout recommendations

The SN3020 module has an 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
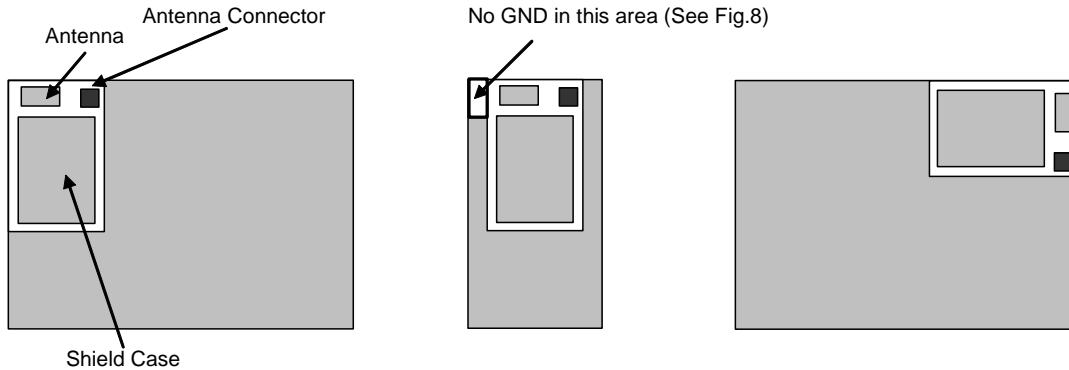
Notes:

1. Due to the surface mount antenna on the module, the area in 'Zone1' <u>on all layers</u> of the customer circuit board should be free of any metal objects. Specifically, there should be no ground plane, traces, or metal shield case.

2. The area in 'Zone2' on the <u>top layer</u> of the customer circuit board should have ground only with no signal traces.
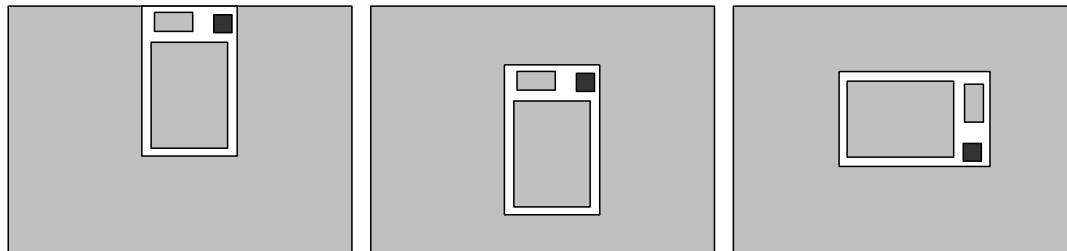
6.5   Module Location

For optimum EIRP, customer is advised to use the recommended module location on their respective PCB.

6.5.1 Location in x-y plane

Antenna Connector

Antenna

No GND in this area (See Fig.8)

Shield Case
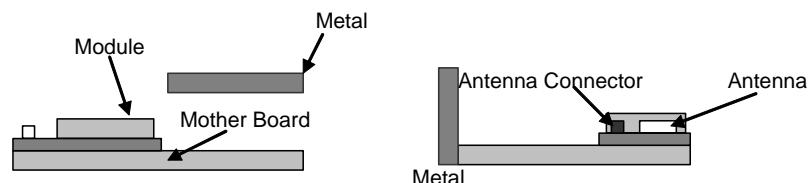
Figure 9 Recommended Locations in xy-plane
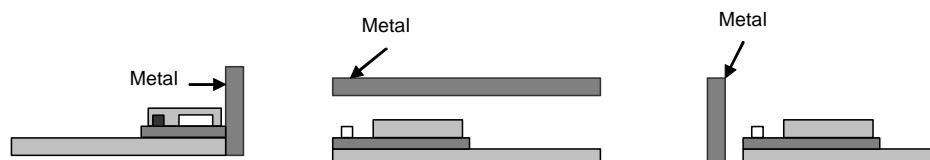
Figure 10 Locations Not Recommended in xy-plane

6.5.2 Location in z-plane

Metal

Module

Mother Board

Antenna Connector

Antenna

Metal

Figure 11 Recommended Locations in z-plane

Metal

Metal

Metal

Metal

Figure 12 Locations Not Recommended in xy-plane

7   Assembly Information
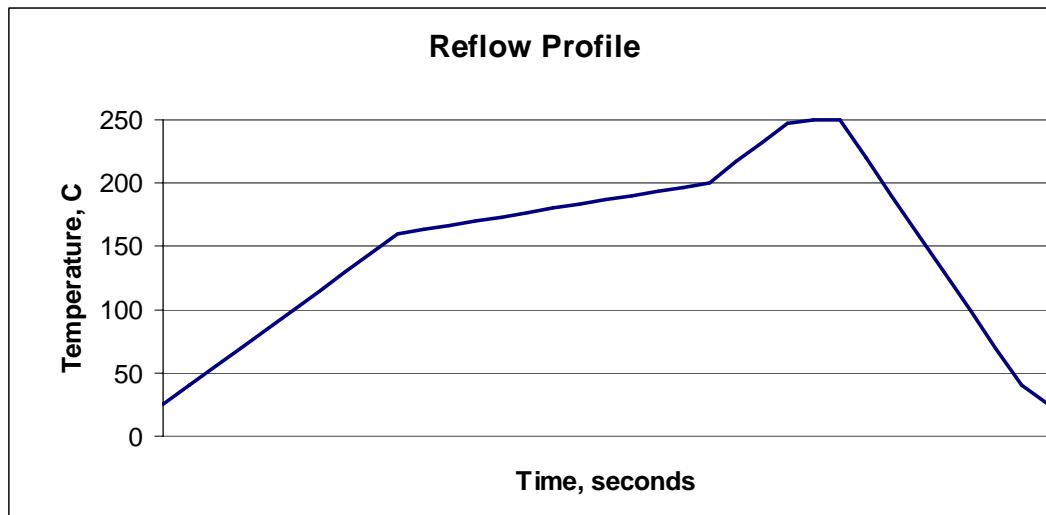
7.1   Lead-free soldering reflow profile

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 13 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)

DIMENSIONS		
Ao	15.20 ±0.10	
Bo	27.70 ±0.10	NOTES:
Ko	3.40 ±0.10	
W	44.00 ±0.30	ALL DIMENSIONS IN MILLIMETRES
P	20.00 ±0.10	10 SPROCKET HOLE PITCH CUMULATIVE TOLERANCE ± 0.20 MATERIAL: CONDUCTIVE POLYSTYRENE
T	0.30 ±0.05	CAMBER NOT TO EXCEED 1.0mm IN 250mm
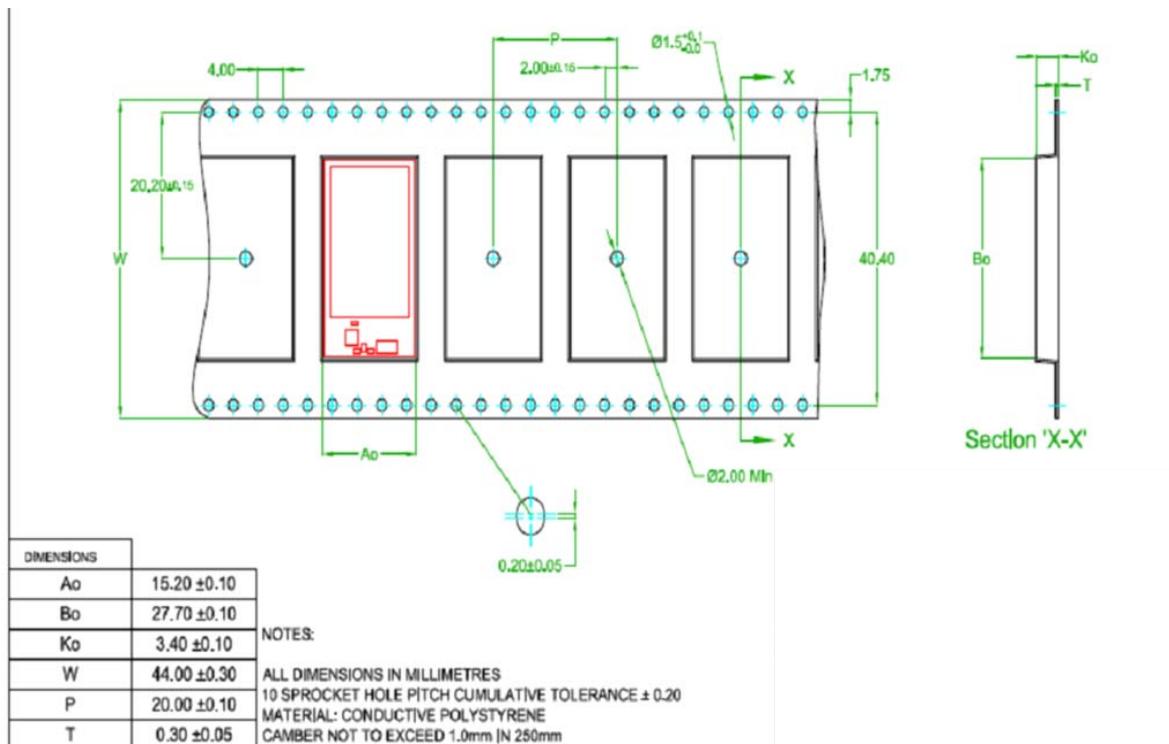
Figure 14 Tape Dimensions

(2) Dimensions of reel

TBD

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)
D	Certification Information

9 Ordering Information

Table 9 Ordering Information

Product	SyChip Model Number	SyChip Part Number
Evaluation kit	SN3020EVK	88-00143-85
Module	SN3020	88-00143-00/01*

- -01 is for engineering sample quantities in cut tape (Ex. 5~50 pieces)
- -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 Regulatory Information

SN3020 has obtained the certifications described below.

11.1 FCC Notice (USA)

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

The FCC requires the user to be notified that any changes or modifications not expressly approved by SyChip, Inc. may void the user's authority to operate the equipment. While an application of the SN3020 module in a product is not required to obtain a new FCC authorization for the module, this does not preclude the possibility that some other form of authorization or testing may be required for that end product.

This device using the integrated antenna has been tested to comply with FCC CFR Part 15. The device meets the requirements for modular transmitter approval as detailed in the FCC public notice DA00.1407.transmitter given the following considerations:

- Maximum output power level for the channels as defined by IEEE 802.15.4 [1] must be set to the value below using emberSetRadioPower or equivalent under NORMAL mode as specified in [2].
  - o For channels 11 to 24, the value of -11
  - o For channel 25, the value of -17
  - o For channel 26, the value of -27
- Duty cycle of 67% allowed.
- The firmware disables power out if the source voltage is greater than 3.4V.
- VBATT must be between 2.4V – 3.4V.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures: reorient or relocate the receiving antenna, increase the separation between the equipment and receiver, connect the equipment into an outlet on a circuit different from that to which the receiver is connected, or consult the dealer or an experienced radio/TV technician for help.

11.1.1 FCC Labeling Requirements

When integrating the SN3020 into a product the FCC labeling requirements must be met. This includes a clearly visible label on the outside of the finished product specifying the SN3020 FCC identifier (FCC ID:QPU3020) as well as the notice above. The exterior label can use wording such as "Contains Transmitter Module FCC ID:QPU3020" or "Contains FCC ID:QPU3020" although any similar wording that expresses the same meaning may be used.

11.1.2 RF Exposure

This module has been certified for remote and base radio applications and is not intended to be operated within 20cm of the body. If the module will be used for portable applications, the device must undergo SAR testing.

The following statement must be included as a CAUTION statement in manuals for the products to alert users on FCC RF exposure compliance:

"WARNING: To satisfy FCC RF exposure requirements for mobile transmitting devices, a separation distance of 20cm or more should be maintained between the antenna of this device and persons during operation. To ensure compliance, operations at closer distances than this are not recommended."

11.2 IC Notice (Canada)

The term "IC" before the certification/registration number only signifies that the Industry Canada technical specifications were met.

Le terme "IC" devant le numéro de certification /d'enregistrement signifie seulement que les spécifications techniques Industrie Canada ont été respectées.

This device complies with Health Canada's Safety Code 6 / IC RSS-210. The installer of this device should ensure that RF radiation is not emitted in excess of the Health Canada's requirement. Information can be obtained at: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php

Cet appareil est conforme avec Santé Canada Code de sécurité 6 / IC RSS-210. Le programme d'installation de cet appareil doit s'assurer que les rayonnements RF n'est pas émis au-delà de l'exigence de Santé Canada. Les informations peuvent être obtenues: http://www.hc-sc.gc.ca/ewh-semt/pubs/radiation/radio_guide-lignes_direct-eng.php

The host device should be properly labeled to identify the module within the host device. The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains transmitter module IC:4523A-SN3020

where 4523A-SN3020 is the module's certification number.

11.3 CE Notice (Europe)

This device has been tested and certified for use in the European Union.

If this device is used in a product, the OEM has responsibility to verify compliance of the final product to the EU standards. A Declaration of Conformity must be issued and kept on file as described in Annex II of the Radio and Telecommunications Terminal Equipment Directive.

The 'CE' mark must be placed on the OEM product per the labeling requirements of the Directive. Given that the operating frequency band is not harmonized by a few European countries, the restriction or alert sign must be placed along side the 'CE' mark as shown below. As of the date of this document, only France has a restriction. The restriction is that, if the radio is operated outdoors in the 2450-2483.5 MHz band, the power must be limited to 10 mW instead of 100 mW. The OEM must account for this and the product must have the alert mark. It does not require country notifications, however.

CE ①

12 Technical Support Contact

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USA
Tel: (972) 202-8900
Fax: (972) 633-0327

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

13 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