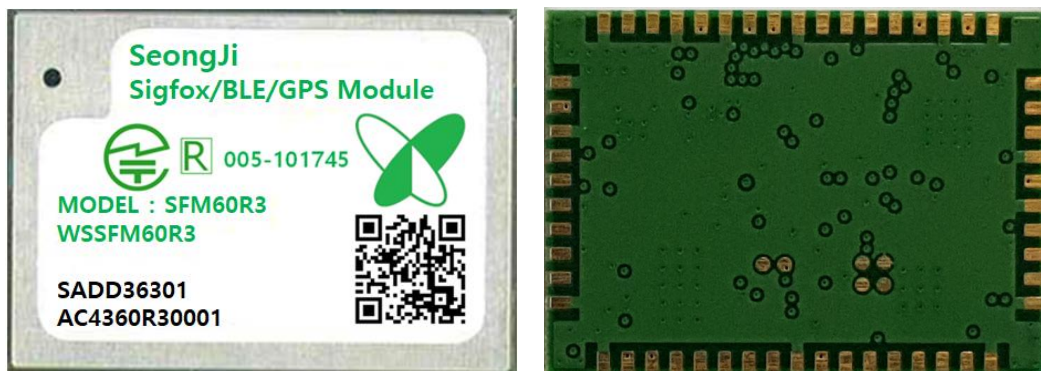


# SEONG JI / SFM60R3

DATA SHEET Rev.04



**SEONG JI INDUSTRIAL CO.,LTD**

54-33, DongtanHana1(i)-gil, Hwaseong-si, Gyeonggi-do, 18423, KOREA

<http://www.seongji.co.kr>

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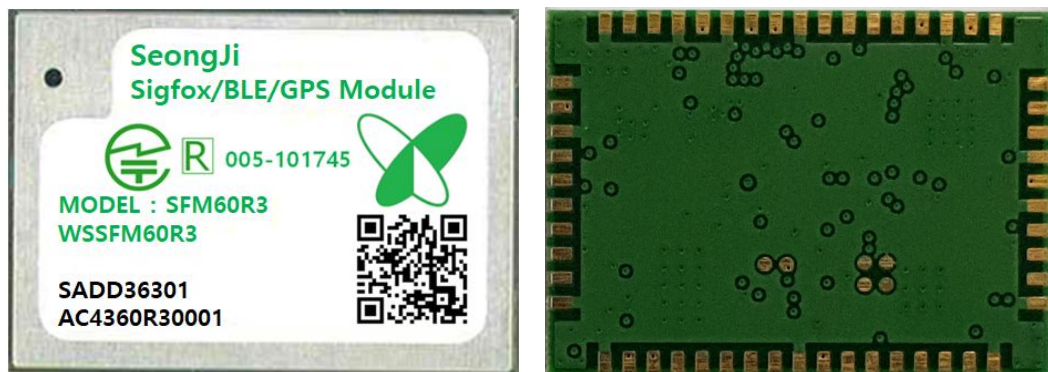
## 2. Scope

- Description
  - Sigfox Configuration 6 RC3
  - BLE : Support version BT4.2.
  - NFC : Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch to-pair capabilities.
  - GPS : Supports GPS and GLONASS.
  - Accelerometer :  $\pm 2g/\pm 4g/\pm 8g$  dynamically selectable full-scale.
- Type : SMD Type
- PBA Size : 29mm(W) x 21mm(L) x 2.3mm(H)

This module has completed SIGFOX P1 verification and TELEC RF regulatory certification.

## 3. Numbering of product

### 3-1. Product



### 3-2. Part No.

W	S	<b>S</b>	<b>F</b>	<b>M</b>	<b>6</b>	<b>0</b>	<b>R</b>	<b>3</b>	A	P
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)

No.	EXPLANATION
(1),(2)	Wireless Solution
(3),(4)	Application (SF:Sigfox)
(5)	Type (M:Module)
(6),(7)	Group model numbering
(8), (9)	Region Code
(10), (11)	Application Type(Firm Ware Type) AP(API version)

3-3. Lot. No.

<b>S</b>	<b>A</b>	<b>C</b>	<b>J</b>	<b>A</b>	<b>6</b>	<b>3</b>	<b>0</b>	<b>1</b>
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)

①	Sigfox Module																																																																								
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⑧⑨	A Serial Number (1serial: 1,100ea)																																																																								

#### 4. Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
VCC	Module input voltage	5.5	V
OT	Operating Temperature	-30 to +85	°C
ST	Storage Temperature	-40 to +125	°C

#### 5. DC Characteristics

Symbol	Parameter	Min	Typ.	Max	Unit
VCC	Module input voltage	3.2	3.3	5.0	V

#### 6. I/O Specifications

Symbol	Parameter	Min	Typ.	Max	Unit
VCC	supply voltage		3.0	3.3	V
VIH	High level input voltage	2.1			V
VIL	Low level input voltage			0.9	V

## 7. RF Specifications

### 7-1. Sigfox

#### 7-1-1. Electrical Specification

Symbol	Parameter	Min	Typ.	Max	Unit
Current	Tx Current(@ "15" setting)		65		mA
	Tx Current(@ "14" setting)		54		mA
	Rx Current		16		mA

#### 7-1-2. Receiver, Transmitter Specification

Conditions: VCC=3.3V, Temp=25℃

Parameter		Min	Typ.	Max	Unit
RF Frequency	Tx		923.2		MHz
	Rx		922.2		MHz
Tx output power(at "15" setting)			13.7		dBm
Tx output power(at "14" setting)			12.2		dBm
Frequency Error Tolerance(+25℃)		-2.5	-	+2.5	ppm
2 <sup>nd</sup> Harmonics(conducted)		-	-37	-35	dBm
3 <sup>rd</sup> Harmonics(conducted)		-	-41	-35	dBm
Rx Sensitivity(@600bps, GFSK)		-	-127	-	dBm
Rx Spurious Emission(30MHz~12.75GHz)		-	-	-54	dBm

\* Because of output power variation of modules the maximum output power can be over 14dBm, so we recommend to set 14 as default output setting.

**7-2. BLE**
**7-2-1. Electrical Specification**

Parameter		Min	Typ.	Max	Unit
Target Power for TX					
BLE	Tx mode, Cont.Tx		14		mA
	Rx mode		13		mA

**7-2-2. Receiver, Transmitter Specification**

Conditions: VCC=3.3V, Temp=25℃

Parameter		Min	Typ.	Max	Unit
RF Characteristics					
RF Frequency Range		2.402	-	2.480	GHz
Output Power [TRM-LE/CA/01/C]		-0.5	3.5	7.5	dBm
In Band Emission[TRM-LE/CA/03/C] ±2MHz offset ±3MHz offset				-20 -30	dBm
Modulation Characteristics [TRM-LE/CA/05/C]	Delta F1 Avg.	225	-	275	KHz
	Delta F2 Max.	185	-	-	KHz
	Delta F2 Avg/F1 Avg	0.8	-	-	-
Carrier Frequency Offset and Drift [TRM-LE/CA/06/C]	Initial Center Frequency Tolerance	-50	-	50	KHz
	Fn  Max.	-150	-	150	KHz
	F0 -Fn  Max.	-	-	50	KHz
	F1 – F0	-	-	20	KHz
	Fn = Fn-5  max.	-	-	20	KHz
Receiver Sensitivity [PER<30.8%, 1500packets]		-	-93.5	-70	dBm
Maximum input lever [PER<30.8%, 1500packets]		-10	0		dBm



### 7-3. GPS

#### 7-3-1. Module Specification

Conditions: VCC=3.3V, Temp=25℃

Frequency	L1, 1575.42MHz
GPS Sensitivity	
Tracking	-158 dBm
Navigation	-157 dBm
Acquisition (Cold start)	-143 dBm
C/N0 <sup>2</sup>	- 37
Time To First Fix <sup>2</sup>	
Hot Start	< 1s
Cold Start	< 35s

#### 7-3-2. EVB Specification

-With external GPS LNA module(SAW filter + LNA)

Frequency	L1, 1575.42MHz
GPS Sensitivity <sup>1</sup>	
Tracking	-160 dBm
Navigation	-159 dBm
Acquisition (Cold start)	-145 dBm
C/N0 <sup>2</sup>	- 39
Time To First Fix <sup>2</sup>	
Hot Start	< 1s
Cold Start	< 35s

<sup>1</sup> Demonstrated with a SFMG2XAB002 (SAW+LNA)

<sup>2</sup> All satellites at -130 dBm

## 7-4. NFC

## 7-4-1. Electrical Specification

Parameter	Min	Typ.	Max	Unit
RF Input Frequency		13.56		MHz
ISO-14443A				
Carrier modulation index	95			%
Data Rate		106		Kbps
Modulation sub carrier frequency		13.56 /16		MHz
NFC Reader	Min	Typ.	Max	Unit
ACR122U (ACS) <sup>1</sup> reading range	40			mm
Dragon (DUAL I) <sup>2</sup> reading range	50			mm

1.Measurement NFC reader

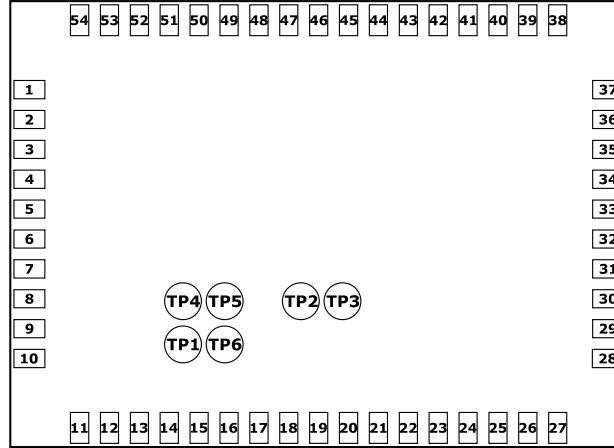
<sup>1</sup>ACR122U: <http://www.acs.com.hk/en/products/3/acr122u-usb-nfc-reader/>

<sup>2</sup>Dragon: <http://duali.com/eng/nfc-product/nfc-reader/nfc-desktop-readers.html>

2. Demonstrated with a reference antenna included in the EVK.

## 8. Pin Description

### 8-1. Interface PIN(SMD Type : 60 Pin) Top view



NO	PIN NAME	NO	PIN NAME	NO	PIN NAME
1	NC	22	I2C0_SCL_DBG	43	GND
2	NC	23	STATE0	44	NFC2
3	GPIO0	24	WKUP	45	NFC1
4	GND	25	STATE_CPU_SFX	46	GND
5	GPS_RF	26	STATE_RF_SFX	47	GPIO1
6	GND	27	GND	48	GPIO2
7	VDD_MAIN_3P0	28	GND	49	NC
8	V_BCKP_GPS	29	VDD_SFX_EN	50	NC
9	VDD_GPS	30	NRST_SFX	51	NC
10	GND	31	SWDCLK	52	GND
11	GND	32	SWDIO	53	NC
12	NRST_GPS	33	VDD_SFX	54	GND
13	I2C1_SDA_ACC	34	NRST	TP1	NC (VDD USB For GPS)
14	I2C1_SCL_ACC	35	GND	TP2	NC (USB DM For GPS)
15	I2C1_SCL_BLE	36	SIGFOX_RF	TP3	NC (USB DP For GPS)
16	I2C_SDA_BLE	37	GND	TP4	NC (GND for GPS)
17	VDD_GPS_EN	38	GND	TP5	NC
18	BATT	39	AIN1	TP6	NC
19	GND	40	AIN0		
20	2ND_POW_EN	41	GND		
21	I2C0_SDA_DBG	42	BLE_RF		

\* In case of RF regulatory certification, connect to external connector or Test-point to download test firmware. For details, refer to "8-2-1 Hardware connection for RF Regulatory Certification".

## 8-2. Interface PIN description

NO.	PIN NAME	TYPE	DESCRIPTION
1	NC		No connection should be made to this pin
2	NC		No connection should be made to this pin
3	GPIO0	I/O	General Purpose Input Output
4,6,10,11,19, 27,28,35,37,38, 41,43,46,52,54	GND	P	Ground
5	GPS_RF	RF	GPS RF Input
7	VDD_MAIN_3P0	P/O	3.0V Main power
8	V_BCKP_GPS	P/I	GPS backup power
9	VDD_GPS	P/O	GPS Power
12	NRST_GPS	I	GPS Reset , do not connect
13	I2C1_SDA_ACC*		Accelerometer Side, connect pin16(I2C1_SDA_BLE)
14	I2C1_SCL_ACC*		Accelerometer Side, connect pin15(I2C1_SCL_BLE)
15	I2C1_SCL_BLE*		BLE(CPU) Side, connect to pin14(I2C1_SCL_ACC)
16	I2C1_SDA_BLE*		BLE(CPU) Side, connect to pin13(I2C1_SDA_ACC)
17	VDD_GPS_EN	O	GPS power enable
18	BATT	P/I	Supply 3.3V ~ 5.0V
20	2ND_POW_EN	O	Secondary DCDC power enable
21	I2C0_SDA_DBG*		Module Debugging port for I2C. <b>It must be connected to an external connector or TP for use in RF regulatory certifications.</b>
22	I2C0_SCL_DBG*		Module Debugging port for I2C. <b>It must be connected to an external connector or TP for use in RF regulatory certifications.</b>
23	STATE0	O	Indicate module(BLE) state
24	WKUP	I	Module Wake-up from sleep state
25	STATE_CPU_SFX	O	Sigfox CPU state
26	STATE_RF_SFX	O	Sigfox RF state
29	VDD_SFX_EN	O	Sigfox power enable
30	NRST_SFX	I	Sigfox Reset , do not connect
31	SWDCLK*	I	BLE SWD clock input for debug and programming. <b>It must be connected to an external connector or TP for use in RF regulatory certifications.</b>
32	SWDIO*	I/O	BLE SWD I/O for debug and programming. <b>It must be connected to an external connector or TP for use in RF regulatory certifications.</b>
33	VDD_SFX	P/O	Sigfox Power output
34	NRST	I	BLE Reset , Main reset , active low

36	SIGFOX_RF	RF	Sigfox RF In/Out
39	AIN1	I/O	Analog input, General purpose I/O
40	AIN0	I/O	Analog input, General purpose I/O
42	BLE_RF	RF	BLE RF In/Out
44	NFC2	I/O	NFC antenna connection , General purpose I/O
45	NFC1	I/O	NFC antenna connection , General purpose I/O
47	GPIO1	I/O	General Purpose Input Output
48	GPIO2	I/O	General Purpose Input Output
49	NC		No connection should be made to this pin
50	NC		No connection should be made to this pin
51	NC		No connection should be made to this pin
53	NC		No connection should be made to this pin
TP1	NC		Internal connection
TP2	NC		Internal connection
TP3	NC		Internal connection
TP4	NC		Internal connection
TP5	NC		Internal connection
TP6	NC		Internal connection

- To use internal accelerometer sensor, connect pin 13 to pin 16 and pin 14 to pin 15.
- Slave address of internal accelerometer is 0x18(7bit)
- External I<sup>2</sup>C devices can be connected to pin 15 and 16.

#### 8-2-1. Hardware connection for RF Regulatory Certification

When performing RF certification on products using the SFM60R module, you must have the following hardware connections to control each RF block and download the test-firmware.

##### - Sigfox, BLE, GPS control

There is no need to download a test-firmware and one of the two below must be connected to an external connector or test-point to control the RF block.

##### [Case 1]

The SWD(pin31 and pin32) port can be used to control Sigfox, BLE and GPS.  
However, JTAG equipment such as J-link is required.

##### [Case 2]

The I2C(pin21 and pin22) port can be used to control Sigfox, BLE and GPS.  
However, I2C to USB converter is required.

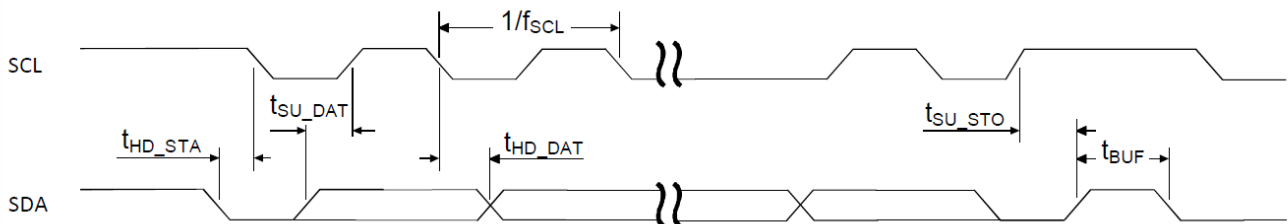
#### 8-2-2. Sigfox status PIN

- STATE\_CPU\_SFX : Sigfox CPU activity indicator
- STATE\_RF\_SFX : Sigfox Radio activity indicator

#### 8-2-3. I2C Master for external sensors

- The TWI master is compatible with I2C operating at 100 kHz and 400 kHz.

Symbol	Description	Min.	Typ.	Max.	Units
$f_{TWI,SCL,100k}$	SCL clock frequency, 100 kbps		100		kHz
$f_{TWI,SCL,400k}$	SCL clock frequency, 400 kbps		400		kHz
$t_{TWI,SU\_DAT}$	Data setup time before positive edge on SCL – all modes	300			ns
$t_{TWI,HD\_DAT}$	Data hold time after negative edge on SCL – all modes	500			ns
$t_{TWI,HD\_STA,100k}$	TWI master hold time for START and repeated START condition, 100k	10000			ns
$t_{TWI,HD\_STA,400k}$	TWI master hold time for START and repeated START condition, 400k	2500			ns
$t_{TWI,SU\_STO,100k}$	TWI master setup time from SCL high to STOP condition, 100k	5000			ns
$t_{TWI,SU\_STO,400k}$	TWI master setup time from SCL high to STOP condition, 400k	1250			ns
$t_{TWI,BUF,100k}$	TWI master bus free time between STOP and START conditions, 100k	5800			ns
$t_{TWI,BUF,400k}$	TWI master bus free time between STOP and START conditions, 400k	2100			ns



TWI timing diagram, 1 byte transaction

#### 8-2-4. I2C Slave for debug

- upto 400Khz

#### 8-2-5. Two-pin Serial Wire Debug (SWD) interface

- The debug and trace system offers a flexible and powerful mechanism for non-intrusive debugging. The main features of the debug and trace system are:
  - . Two-pin Serial Wire Debug (SWD) interface
  - . Flash Patch and Breakpoint Unit (FPB) supports:
    - . Two literal comparators
    - . Six instruction comparators
  - . Data Watchpoint and Trace Unit (DWT)
    - . Four comparators
  - . Instrumentation Trace Macrocell (ITM)
  - . Embedded Trace Macrocell (ETM)

#### 8-2-6. GPIOs

- support 7 GPIO
  - STATE0
  - WKUP
  - AIN1
  - AIN0
  - GPIO0
  - GPIO1
  - GPIO2

\* GPIO01 is used as bootstrap pin. Do not connect to GND.

#### 8-2-7. NFC

- Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch to-pair capabilities

#### 8-2-8. Reset Pin

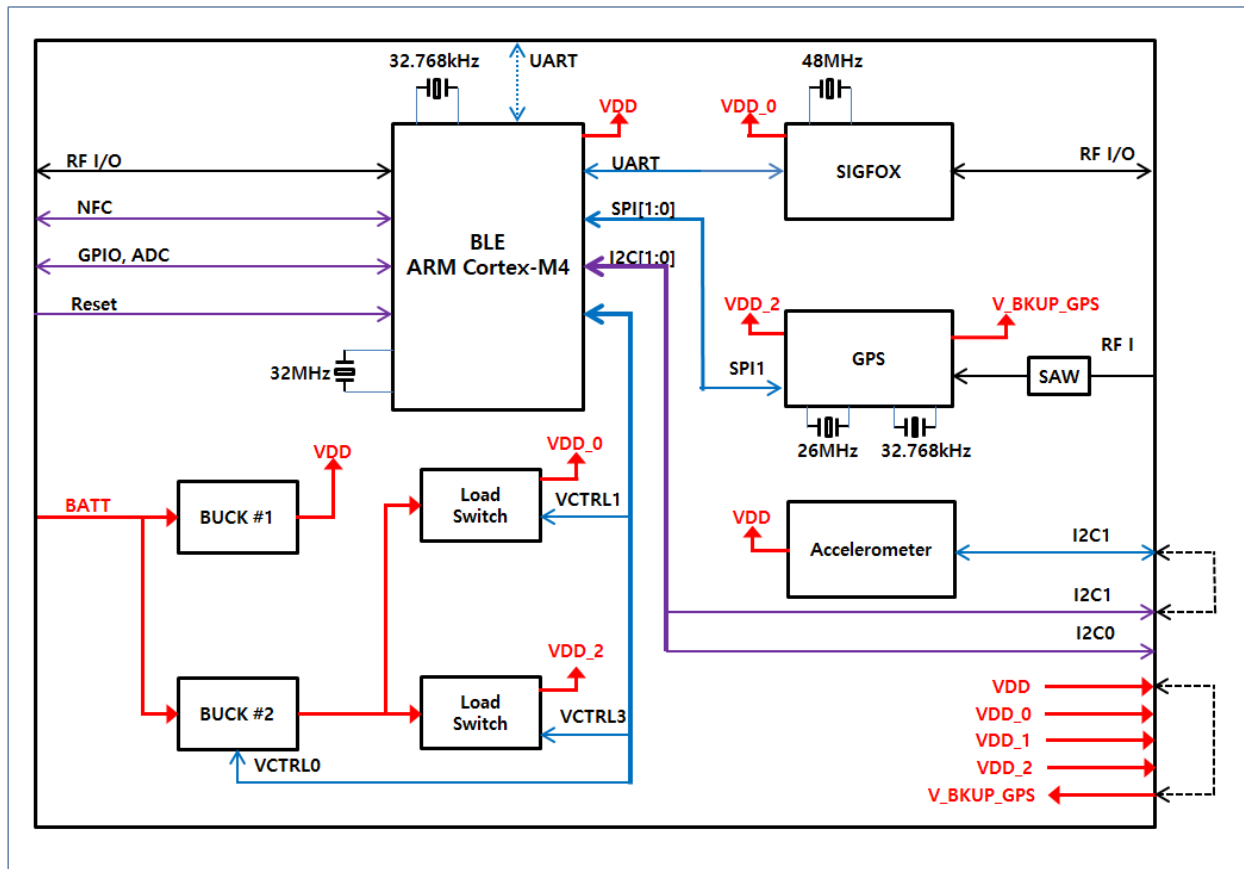
- Chip reset input. Active low.

### 8-3. SFM60R and SFM20R Pin Comparison Table

NO	SFM60R- Pin Name	SFM20R- Pin Name	NO	SFM60R- Pin Name	SFM20R- Pin Name
1	NC	STATE_LINK_WIFI	31	SWDCLK	SWDCLK
2	NC	STATE_WORK_WIFI	32	SWDIO	SWDIO
3	GPIO0	VDD_WIFI_EN	33	VDD_SFX	VDD_SFX
4	GND	GND	34	NRST	NRST
5	GPS_RF	GPS_RF	35	GND	GND
6	GND	GND	36	SIGFOX_RF	SIGFOX_RF
7	VDD_MAIN_3P0	VDD_MAIN_3P0	37	GND	GND
8	V_BCKP_GPS	V_BCKP_GPS	38	GND	GND
9	VDD_GPS	VDD_GPS	39	AIN1	AIN1
10	GND	GND	40	AIN0	AIN0
11	GND	GND	41	GND	GND
12	NRST_GPS	NRST_GPS	42	BLE_RF	BLE_RF
13	I2C1_SDA_ACC	I2C1_SDA_ACC	43	GND	GND
14	I2C1_SCL_ACC	I2C1_SCL_ACC	44	NFC2	NFC2
15	I2C1_SCL_BLE	I2C1_SCL_BLE	45	NFC1	NFC1
16	I2C_SDA_BLE	I2C_SDA_BLE	46	GND	GND
17	VDD_GPS_EN	VDD_GPS_EN	47	GPIO1	DL_EN/INT_WIFI
18	BATT	BATT	48	GPIO2	NRST_WIFI
19	GND	GND	49	NC	UART0_RX_WIFI
20	2ND_POW_EN	2ND_POW_EN	50	NC	UART0_TX_WIFI
21	I2C0_SDA_DBG	I2C0_SDA_DBG	51	NC	VDD_WIFI
22	I2C0_SCL_DBG	I2C0_SCL_DBG	52	GND	GND
23	STATE0	STATE0	53	NC	WIFI_RF
24	WKUP	WKUP	54	GND	GND
25	STATE_CPU_SFX	STATE_CPU_SFX	TP1	NC (VDD USB For GPS)	NC (VDD USB For GPS)
26	STATE_RF_SFX	STATE_RF_SFX	TP2	NC (USB DM For GPS)	NC (USB DM For GPS)
27	GND	GND	TP3	NC (USB DP For GPS)	NC (USB DP For GPS)
28	GND	GND	TP4	NC (GND for GPS)	NC (GND for GPS)
29	VDD_SFX_EN	VDD_SFX_EN	TP5	NC	NC
30	NRST_SFX	NRST_SFX	TP6	NC	NC



## 9. Block Diagram



## 10. Power Modes

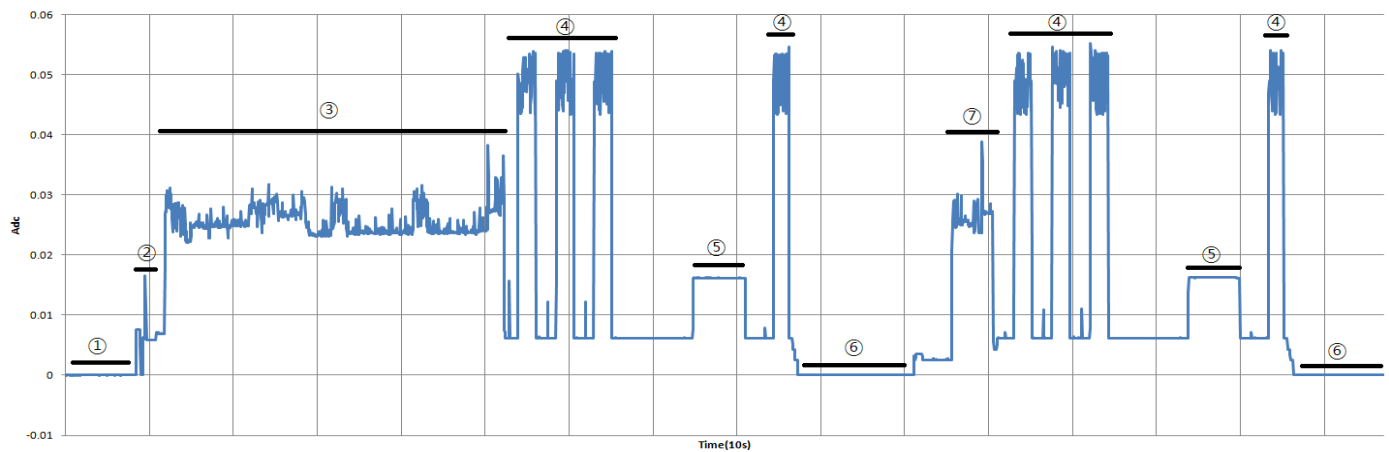
### 10-1. Test condition

Time Interval : 40ms

Measurement : DC Current

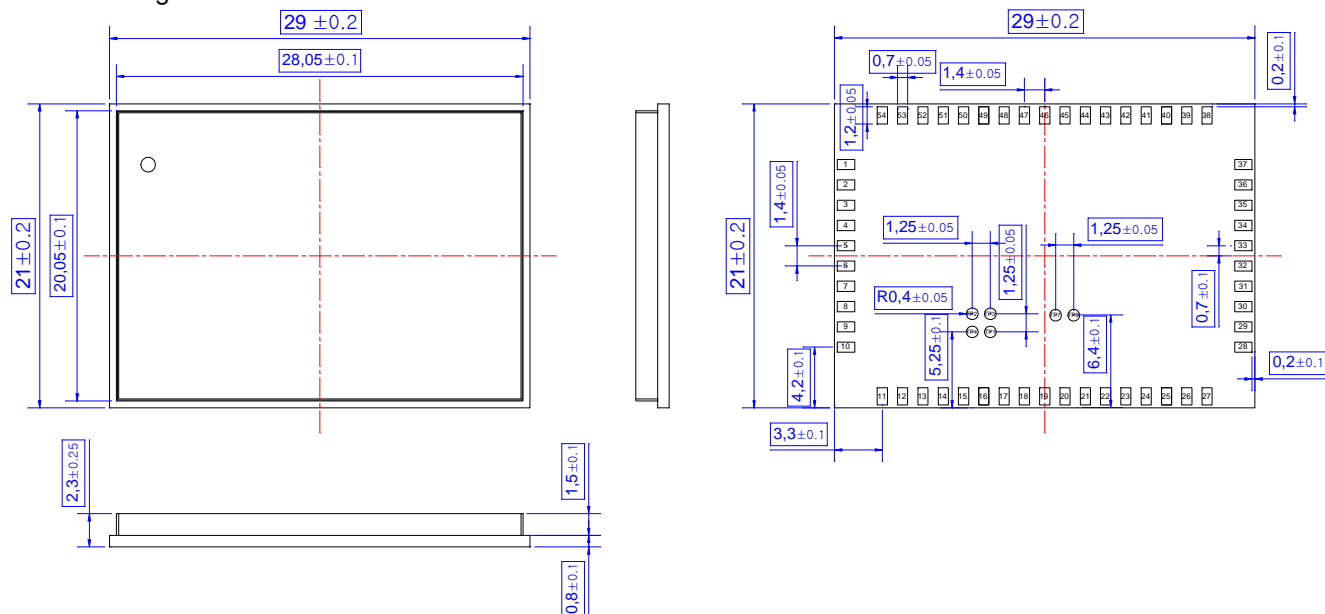
Range(Adc) : 1A

Power Off (DeepSleep)	Power On	GPS (ublox)	Sigfox		Sleep * use V_BCKP_GPS : 15uA
			Tx	Rx	
average 5uA	average 4mA	average 23mA	average 50mA	average 18mA	average 40uA
①	②	③ ⑦	④	⑤	⑥

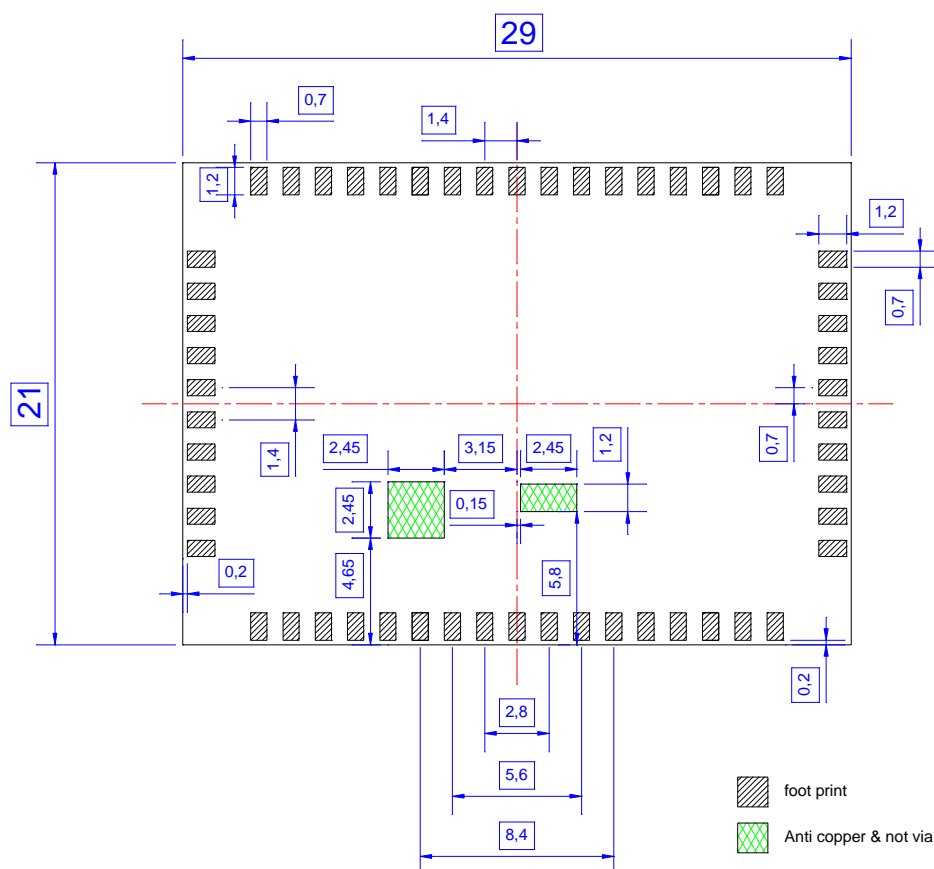


## 11. Dimensions & drawing

### 11-1. Design dimension



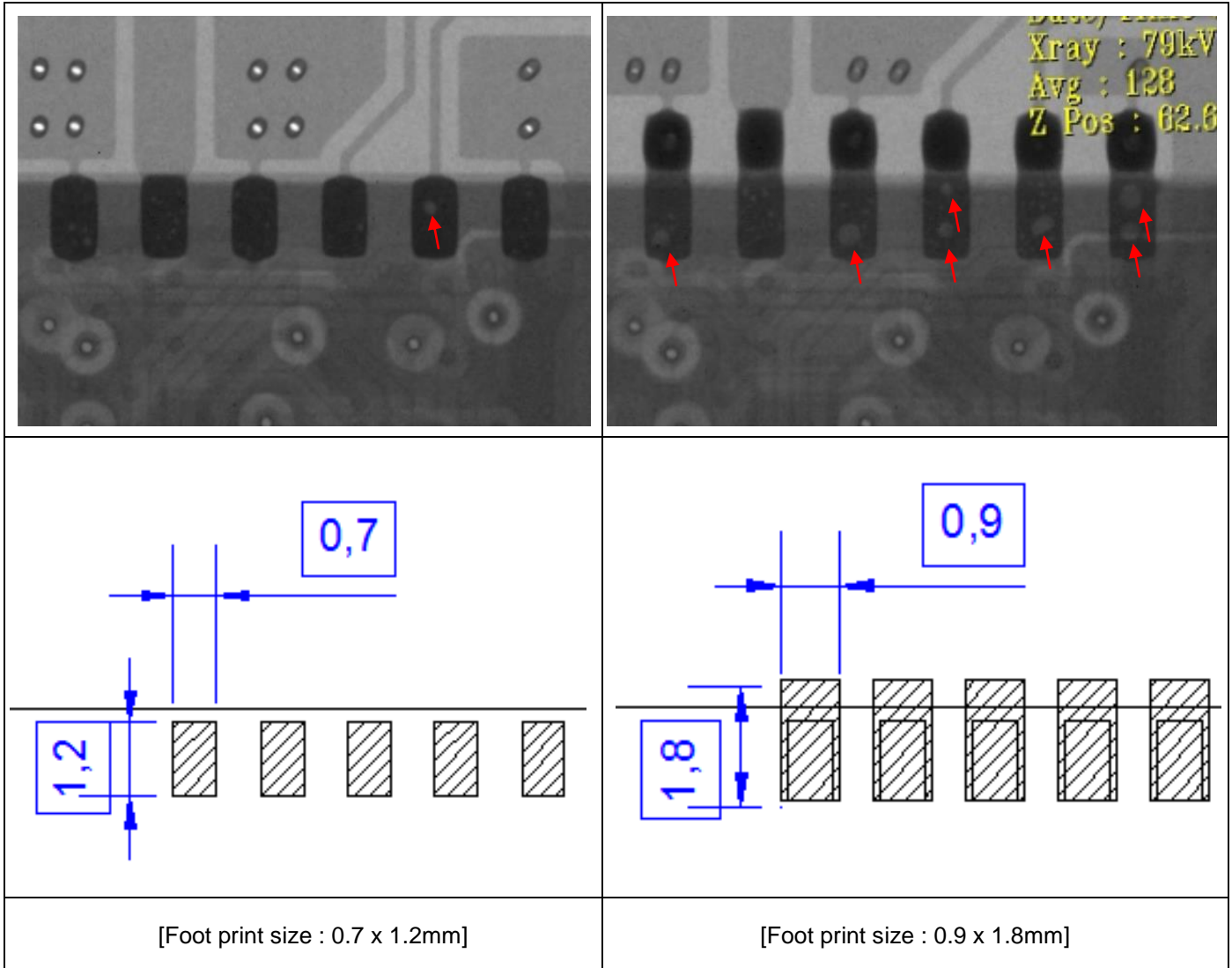
### 11-2. Recommend Foot print



### - X-ray by Foot print size

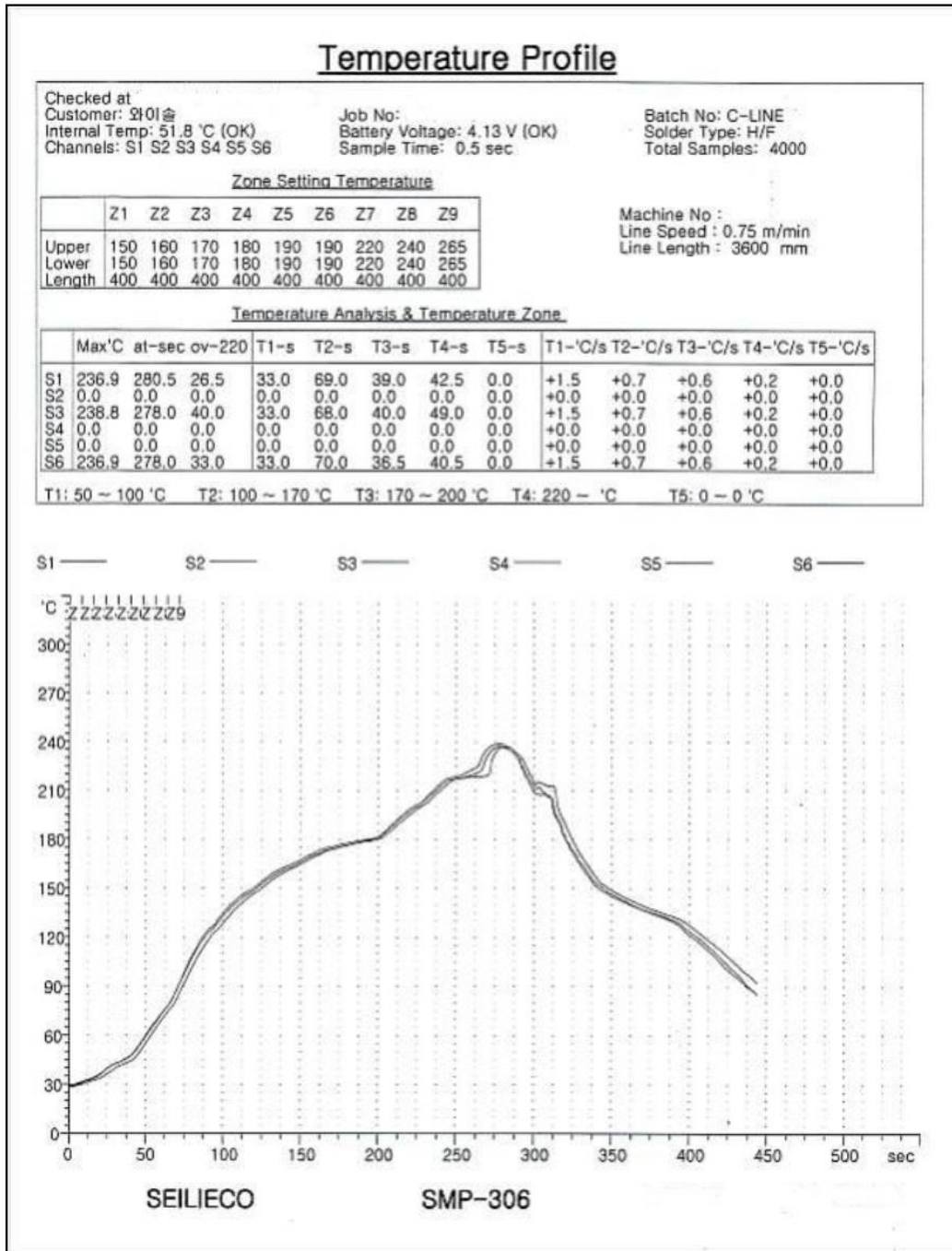
The foot print size was designed 0.7x1.2mm and 0.9x1.8mm then the SMD was performed.

It is not a big difference, but it can be seen that the design with 0.7x1.2mm has better soldering performance with less Void as seen in the X-ray below. The disadvantage is that manual soldering is not possible, so it may be better to design 0.9x1.8mm for development stage. However, we recommend a foot print of 0.7 x 1.2mm for mass production.



## 12. Reflow profile

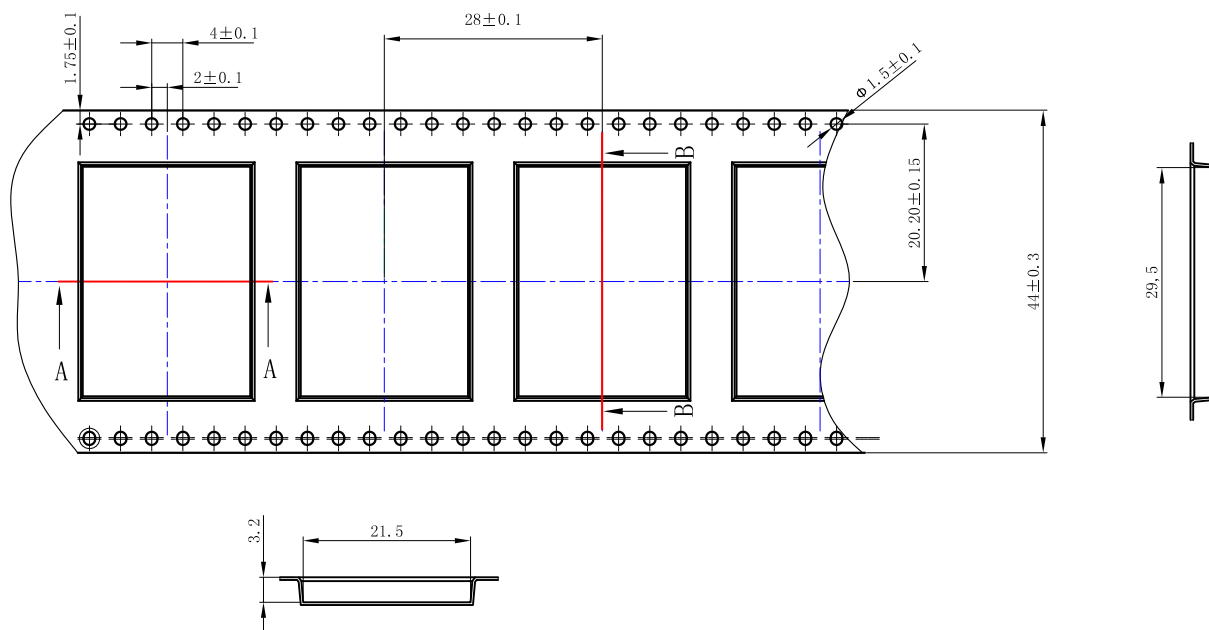
<Reflow profile of Module>



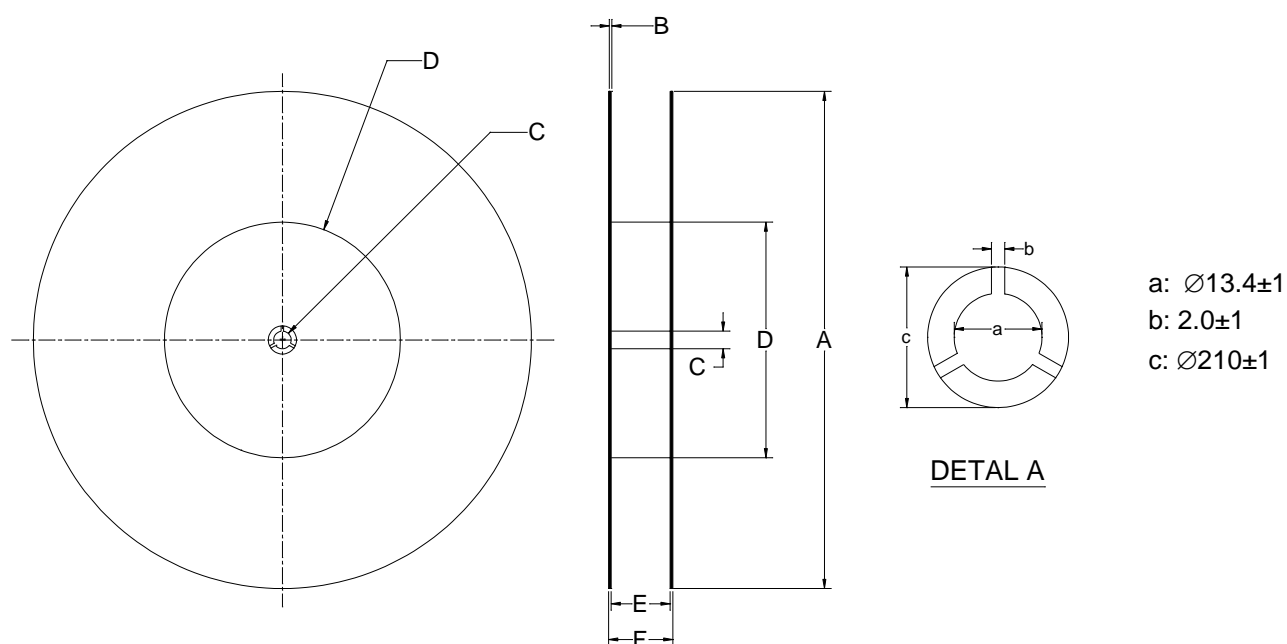
SPEC	Preheat	Soak	Ramp	PEAK
	50~100°C	100~170°C	220°C ↑	240°C
	1~2°C/sec	60~100sec	30~50sec	±5°C
result of measurement	1.5	69	44	237.5
	OK	OK	OK	OK

### 13. Package

### 13-1. Dimension of Tape



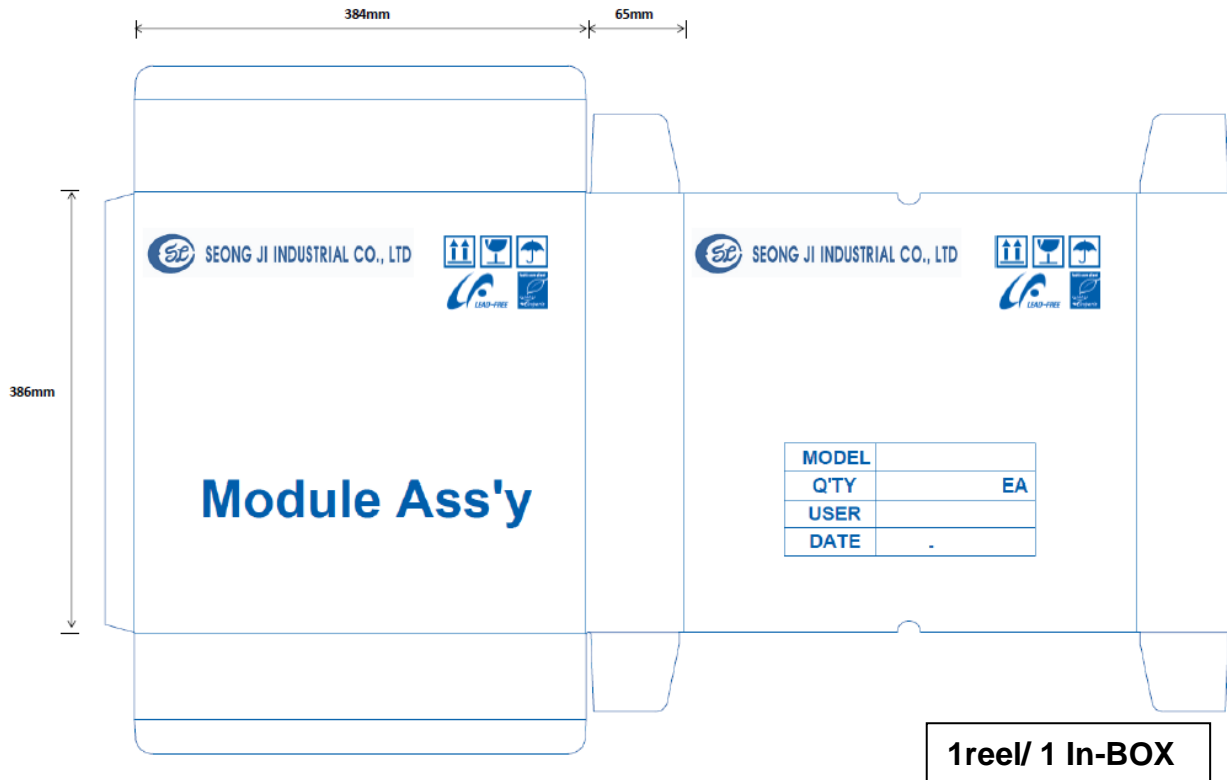
### 13-2. Dimension of Reel



A	B	C	D	E	F
380 ± 1 mm	2 ± 1 mm	13.4 ± 1 mm	180 ± 1 mm	45 ± 1 mm	49 ± 1 mm

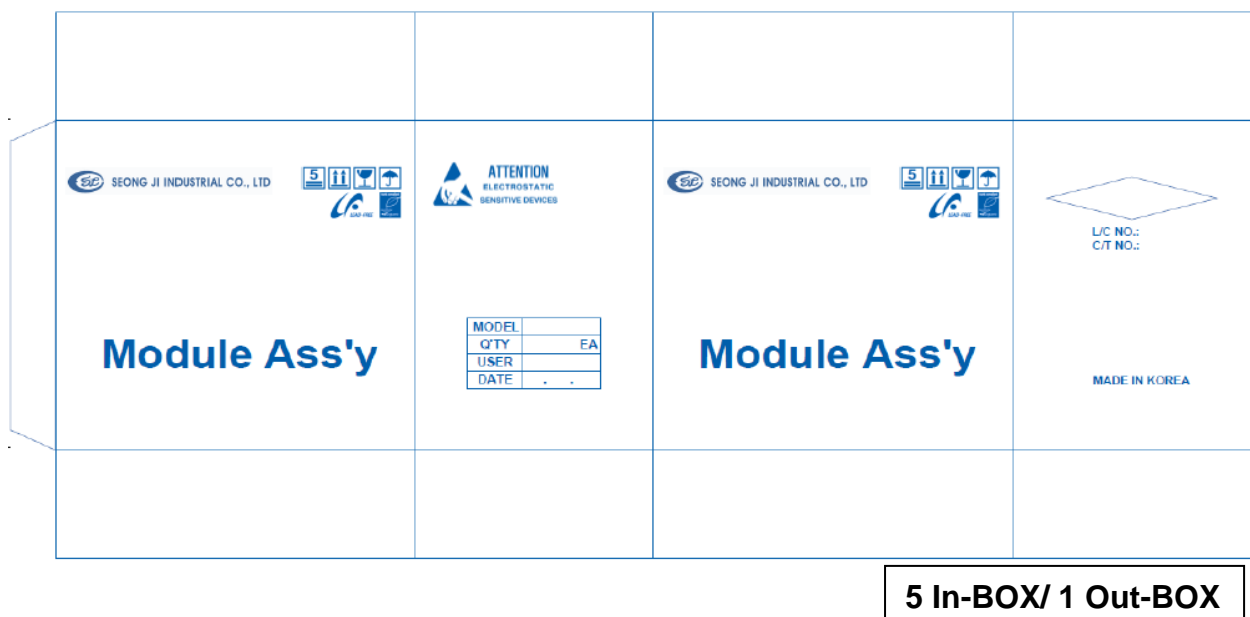
### 13-3. IN BOX

**384 x 65 x 386**

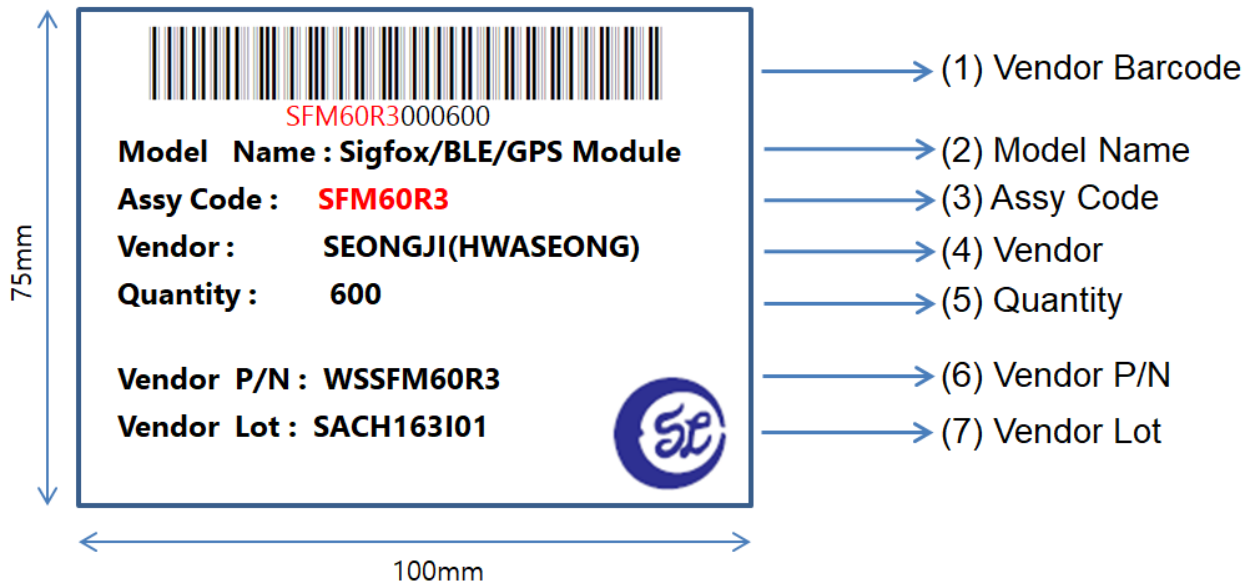


### 13-4. OUT BOX

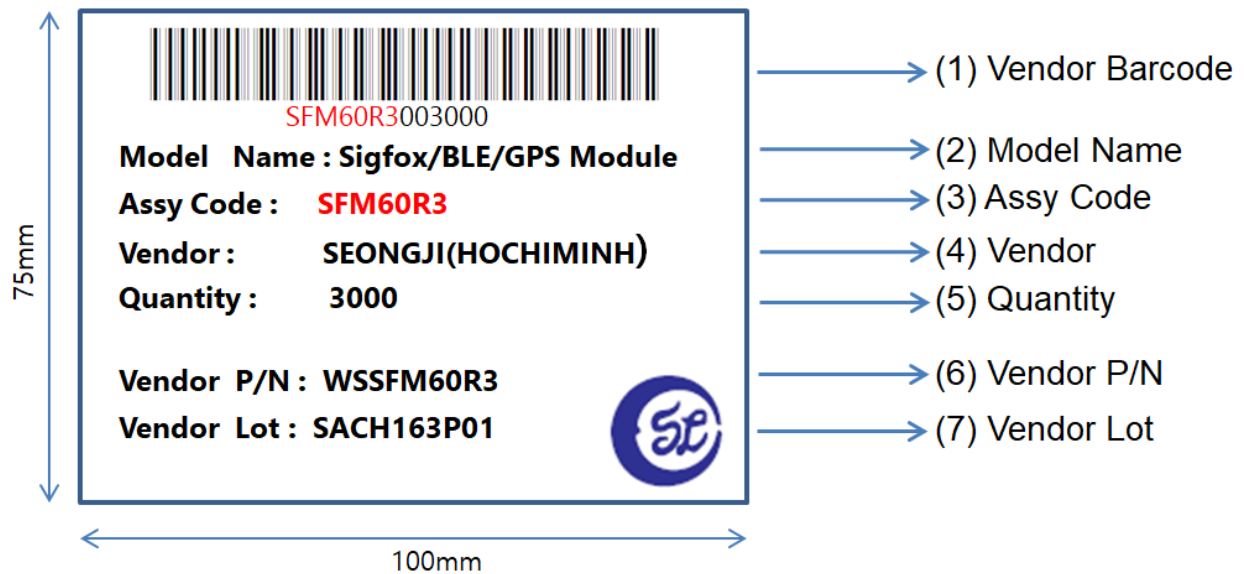
**387 x 240 x 390**



13-5. IN BOX Label



13-6. OUT BOX Label





## ESD Warning



This modules are ESD sensitive devices, appropriate precautions should be taken during the module assembly in the final product. Mechanical impact and harsh tools must be avoided during the module assembly in the final product.

Product ESD specification:

- HBM  $\pm 2\text{kV}$

The following precautions must be taken:

- Do not open the protective conductive packaging until you have use the following, and are at an approved anti-static work station.



- Use a conductive wrist strap attached to a good earth ground.

- If working on a prototyping board, use a soldering iron or station that is marked as ESD-safe.
- If possible, use SMT equipment(reflow) when making prototype boards.
- Use an approved anti-static mat to cover your work surface.



- Always discharge yourself by touching a grounded bare metal surface or approved anti-static mat before picking up an ESD - sensitive electronic component.