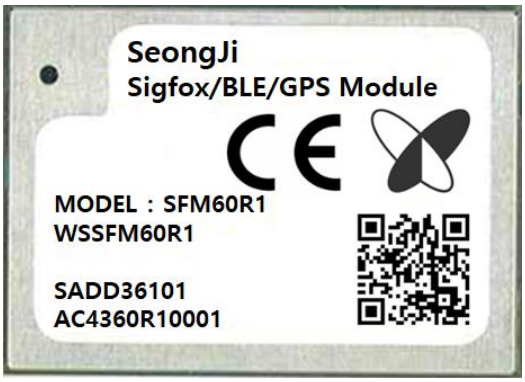
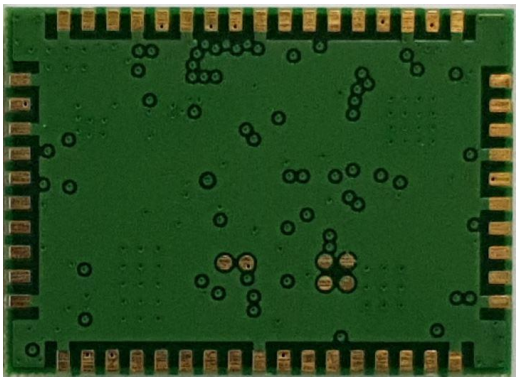
SEONG JI / SFM60R1

DATA SHEET Rev.05





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1. Approval Revision Record

NO	Revision	RECORD OF REVISION	Date	Remark
1	REV 00	WSSFM60R1 Initial Releases	2017-08-15	-
2	REV 01	Hardware connection for RF regulatory certification	2017-10-12	-
3	REV 02	Changed sleep current value CE statement	2018-01-23	-
4	REV 03	BLE support	2018-05-30	-
5	REV 04	Added “ESD Warning”	2018-07-19	-
6	REV 05	Changed manufacture(Wisol →SEONGJI)	2018-08-30	-

2. Scope

- Description

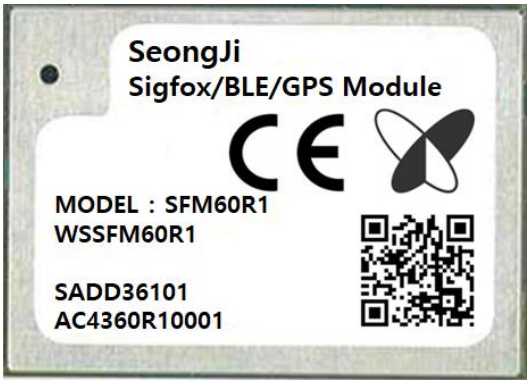
  - Sigfox Configuration 6 RC1
  - BLE : Support version BT4.2.
  - NFC : Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch to-pair capabilities.
  - GPS : Supports GPS and GLONASS.
  - Accelerometer : ±2g/±4g±/8g dynamically selectable full-scale.

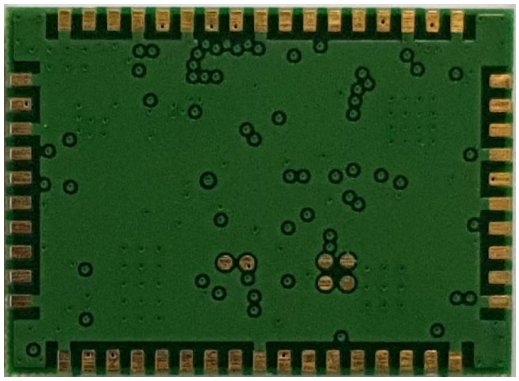
- Type : SMD Type
- PBA Size : 29mm(W) x 21mm(L) x 2.3mm(H)

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

3. Numbering of product

3-1. Product





3-2. Part No.

W	S	**S**	**F**	**M**	**6**	**0**	**R**	**1**	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.

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

①	Sigfox Module
②	Manufacture Area Packing Lot: A / B / C Area: Korea / China / Vietnam
③	Year 2010 = W, 2011 = X, 2012 = Y, 2013 = Z, 2014 = A, 2015 = B, 2016 = C, 2017 = D, 2018 = E, 2019 = F
④	Month 1 = A, 2 = B, 3 = C, 4 = D, 5 = E, 6 = F, 7 = G, 8 = H, 9 = I, 10 = J, 11 = K, 12 = L
⑤	Day 1 = 1, 2 = 2, 3 = 3, 4 = 4, 5 = 5, 6 = 6, 7 = 7, 8 = 8, 9 = 9, 10 = A, 11 = B, 12 = C, 13 = D, 14 = E, 15 = F, 16 = G, 17 = H, 18 = I, 19 = J, 20 = K, 21 = L, 22 = M, 23 = N, 24 = O, 25 = P, 26 = Q, 27 = R, 28 = S, 29 = T, 30 = U, 31 = V
⑥⑦	Model Serial Number (10,11,12,13…)
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	℃
ST	Storage Temperature	-40 to +125	℃

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)		62		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		868.130		MHz
	Rx		869.525		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
2nd Harmonics(conducted)		-	-37	-35	dBm
3nd 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[2]	- 37
Time To First Fix[2]	
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[1]	
Tracking	-160 dBm
Navigation	-159 dBm
Acquisition (Cold start)	-145 dBm
C/N0[2]	- 39
Time To First Fix[2]	
Hot Start	< 1s
Cold Start	< 35s

[1] Demonstrated with a SFMG2XAB002 (SAW+LNA)
[2] All satellites at -130 dBm

7-4. NFC

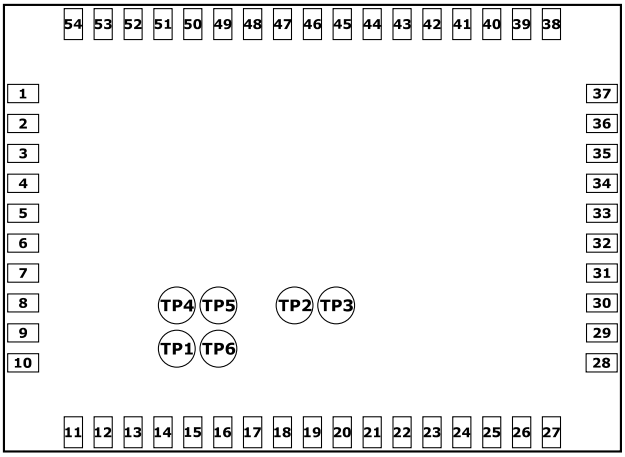
7-4-1. Electrical Specification

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)[1] reading range	40			mm
Dragon (DUAL I)[2] reading range	50			mm

1.Measurement NFC reader
[1]ACR122U: http://www.acs.com.hk/en/products/3/acr122u-usb-nfc-reader/
[2]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. **It must be connected to an external connector or TP for use in RF regulatory certifications.**
22	I2C0_SCL_DBG*		Module Debugging port for I2C. **It must be connected to an external connector or TP for use in RF regulatory certifications.**
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. **It must be connected to an external connector or TP for use in RF regulatory certifications.**
32	SWDIO*	I/O	BLE SWD I/O for debug and programming. **It must be connected to an external connector or TP for use in RF regulatory certifications.**
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^2C 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.

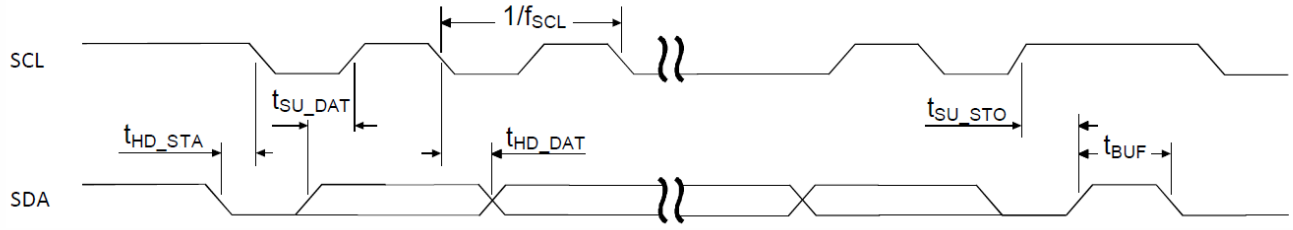
8-2-2. Sigfox status PIN

- 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

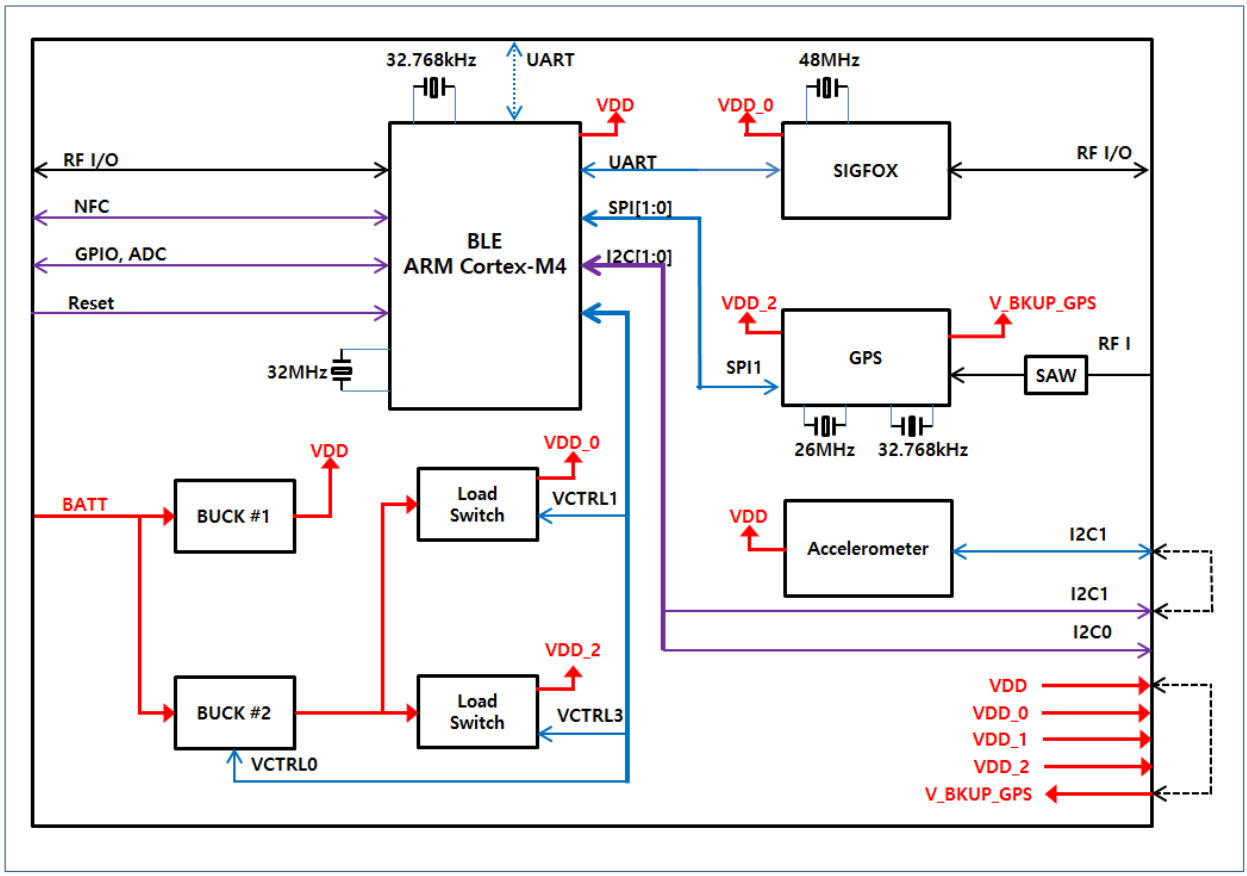
8-2-8. Reset Pin

- 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

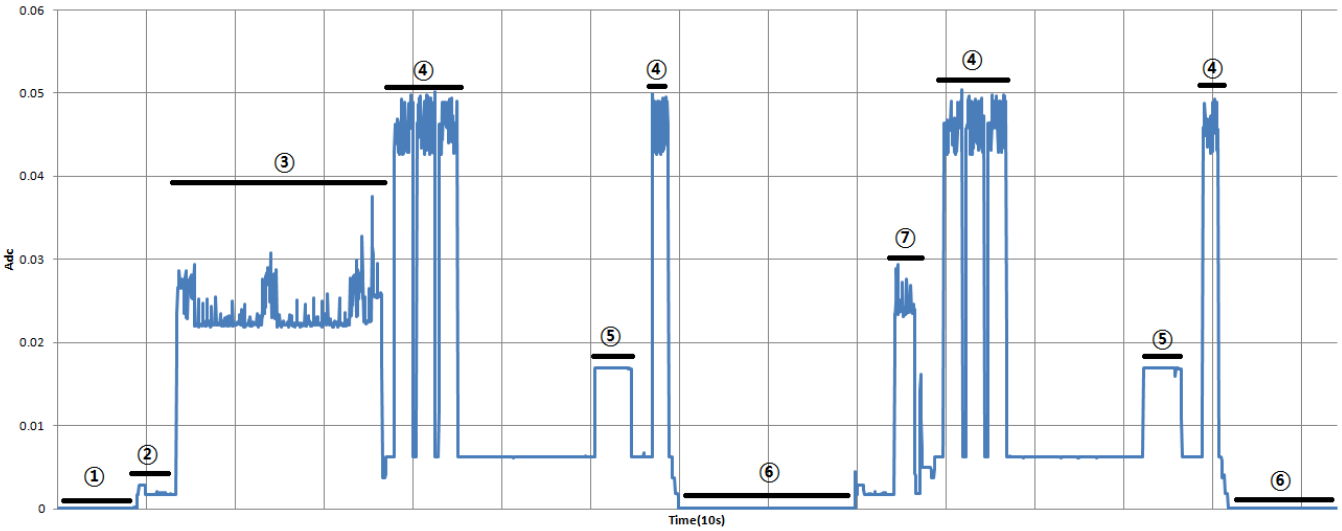


10. Power Modes

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 51mA	average 19mA	average 40uA
①	②	③ ⑦	④	⑤	⑥



11. CE statement

Hereby, SEONG JI INDUSTRIAL CO., LTD declares that the radio equipment type Sigfox/BLE/GPS module is in compliance with Directive 2014/53/EU. The full text of the EU declaration of conformity is available at the providing datasheet or approval sheet.

The antenna(s) must be installed such that a minimum separation distance of at least 20 cm is maintained between the radiator (antenna) and all persons at all times. This device must not be collocated or operating in conjunction with any other antenna or transmitter.

The host manufacturer integrating this module should be assessed total compliance with all essential requirements regarding this radio module.

The host manufacturer has the responsibility that the host device should be compliance when the host device which is equipped this module get power from the battery, the additional Test, TX behavior under Low Voltage Conditions, could be required.

11-1. European Union regulatory compliance

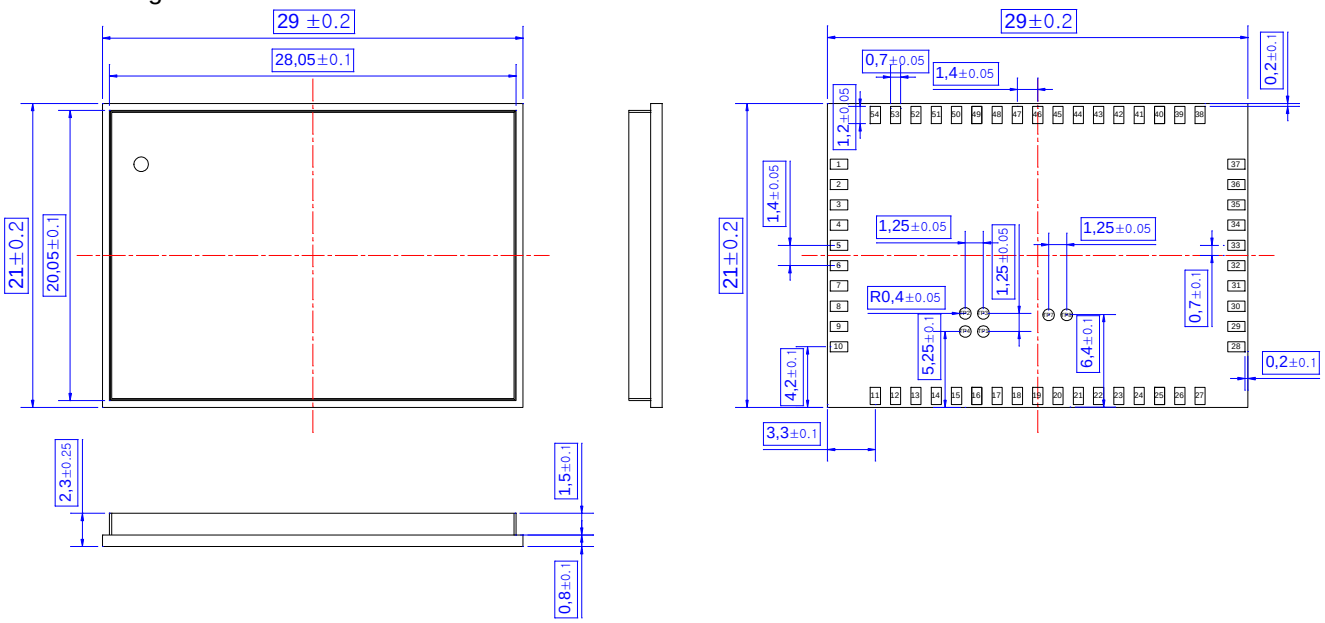
Information about regulatory compliance of the European Union for SFM60R1 module is available in the "SFM60R1 Declaration of Conformity" document.

11-2. Safety compliance

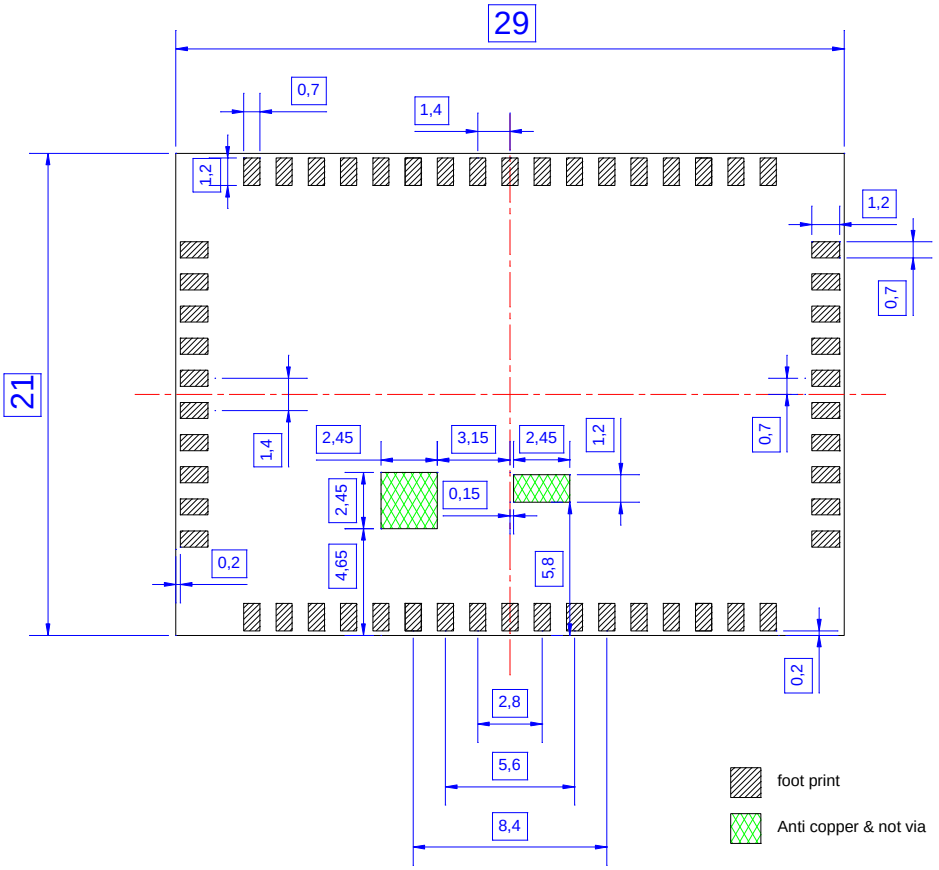
In order to fulfill the safety standard EN 60950-1, the unit must be supplied by a limited power source.

12. Dimensions & drawing

12-1. Design dimension

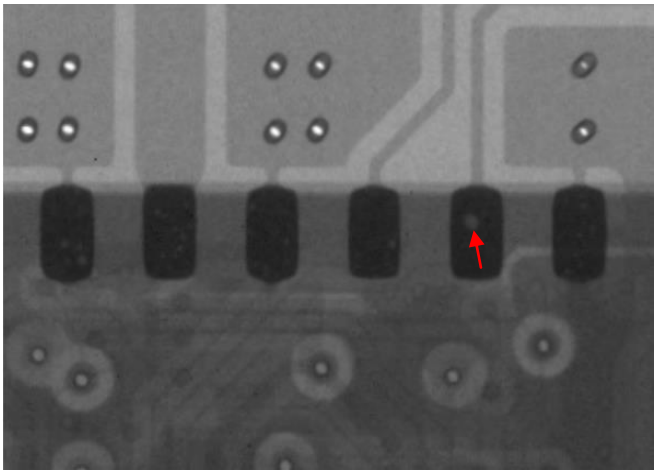
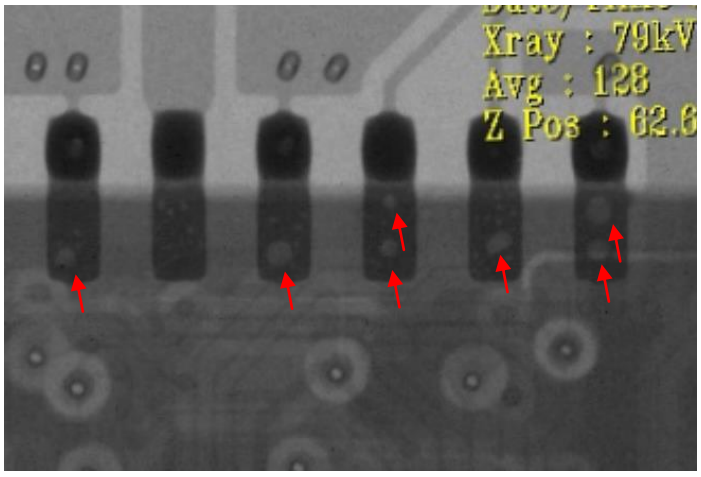


12-2. Recommend Foot print



- **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.

<table>
<tr>
<td>  </td>
<td> 
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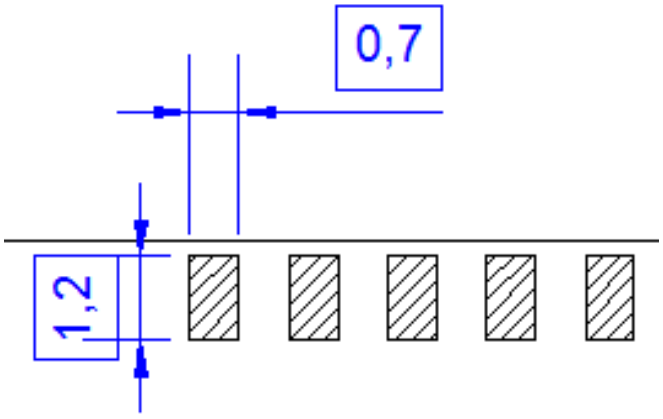
<td> 
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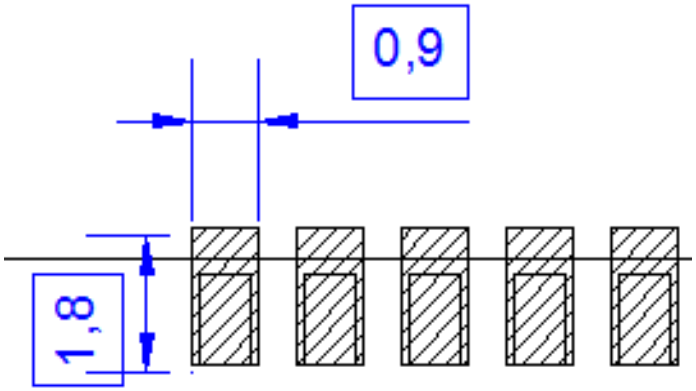
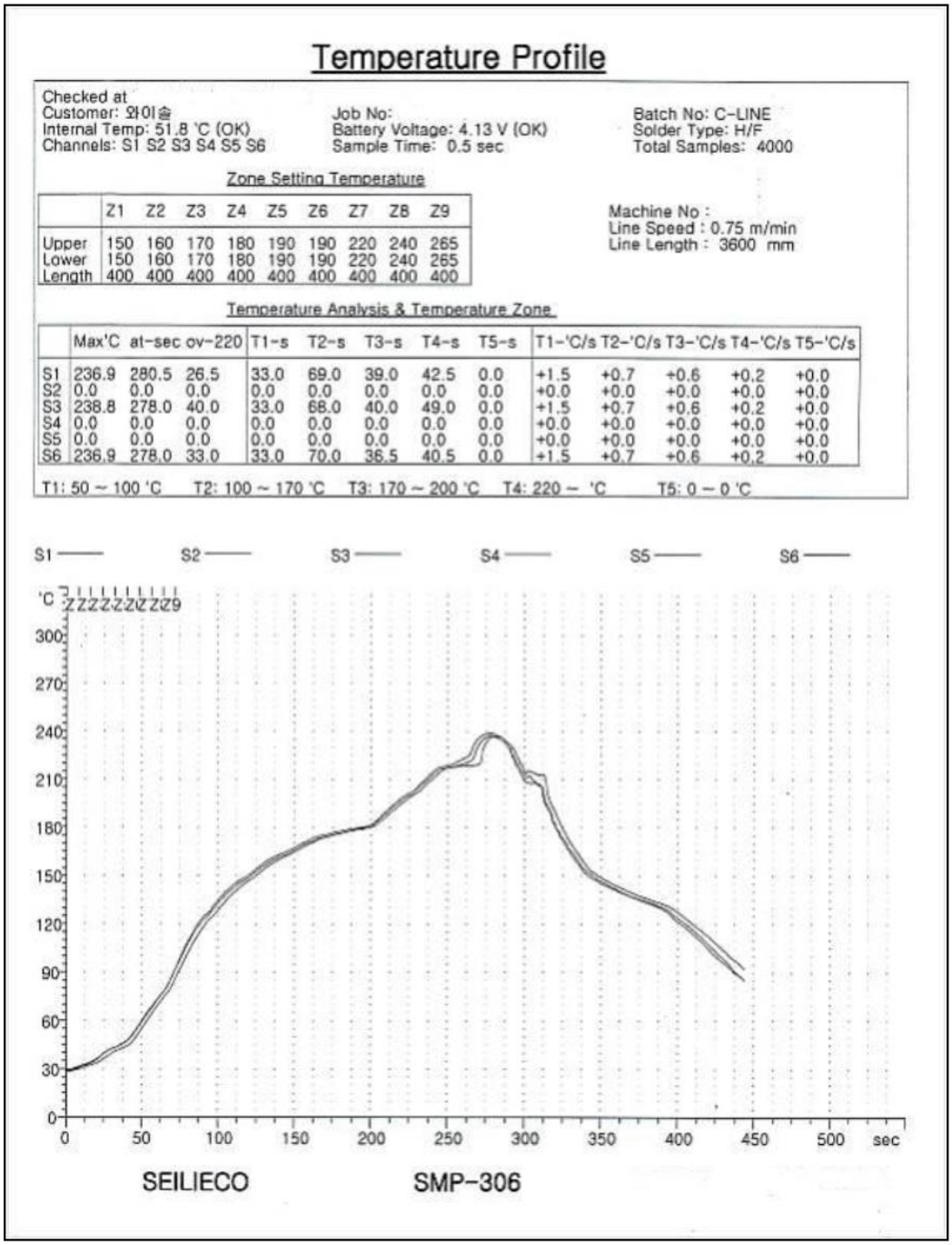
<td> 
</td>
</tr>
<tr>
<td>[Foot print size : 0.7 x 1.2mm]</td>
<td>[Foot print size : 0.9 x 1.8mm]</td>
</tr>
</table>

13. Reflow profile

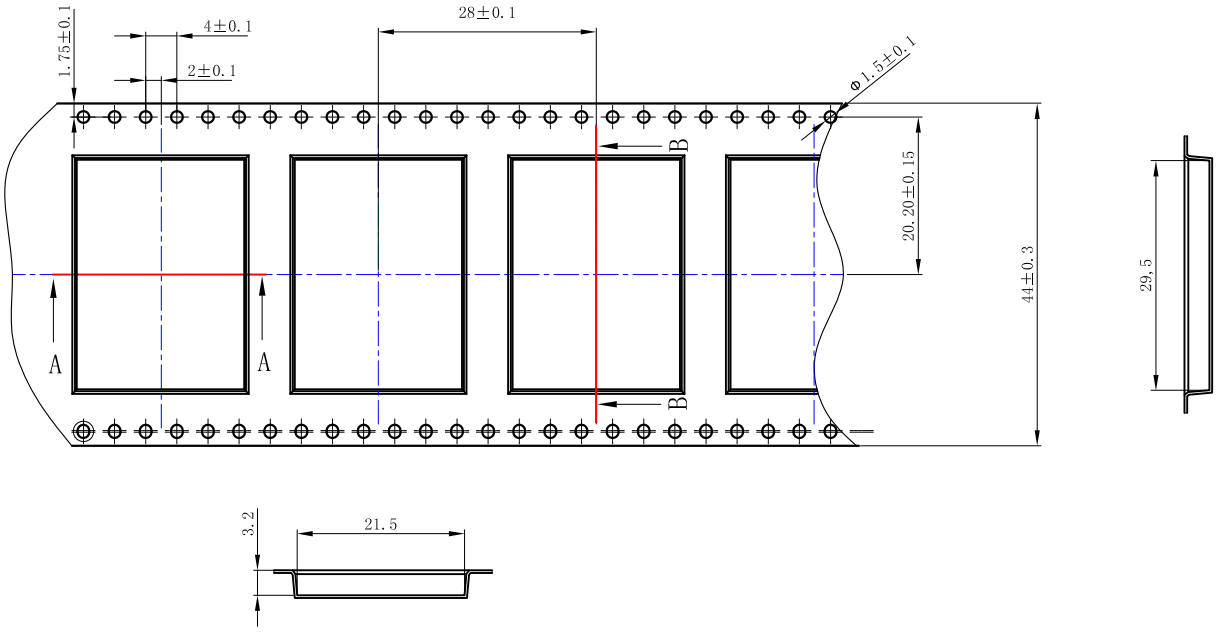
<Reflow profile of Module>



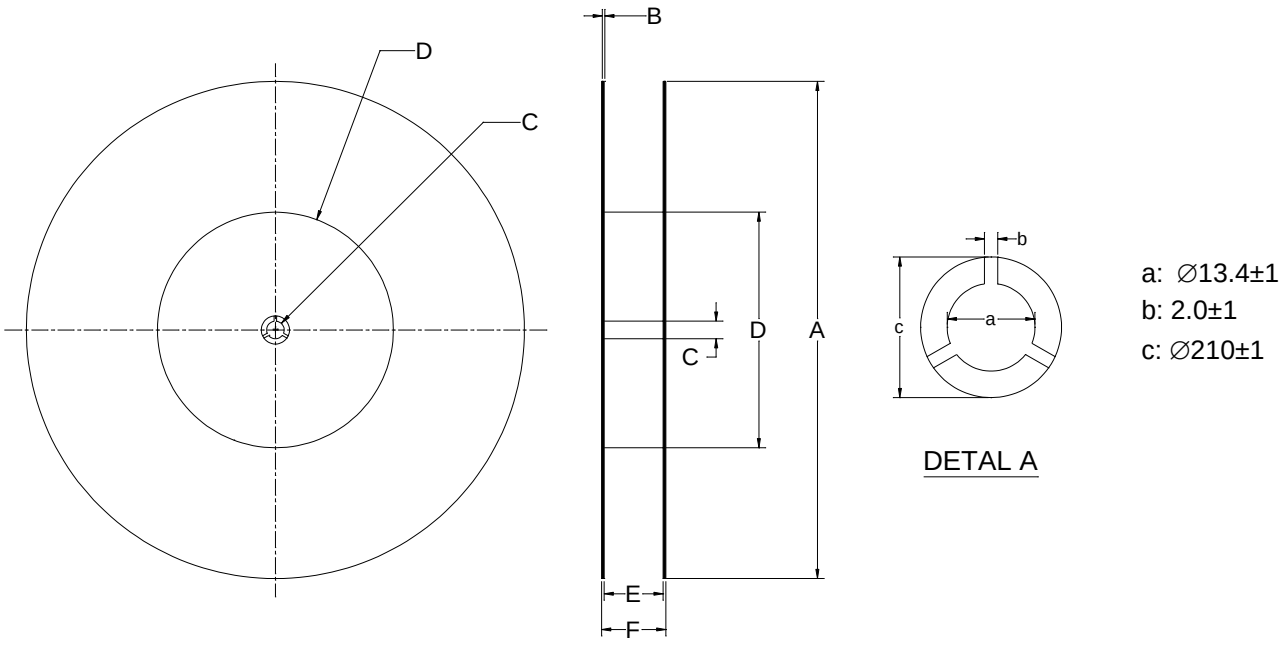
	Preheat	Soak	Ramp	PEAK
SPEC	50~100℃	100~170℃	220℃ ↑	240℃
	1~2℃/sec	60~100sec	30~50sec	±5℃
result of measurement	1.5	69	44	237.5
	OK	OK	OK	OK

14. Package

14-1. Dimension of Tape



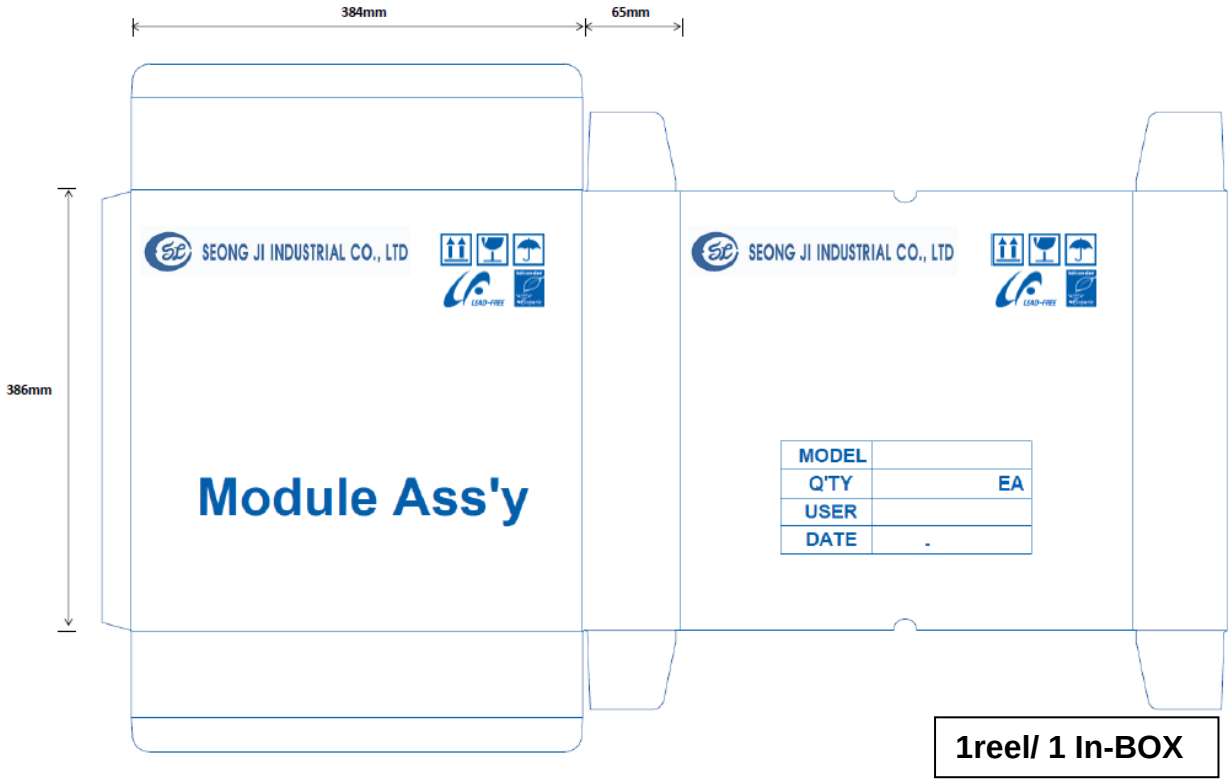
14-2. Dimension of Reel



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

14-3. IN BOX

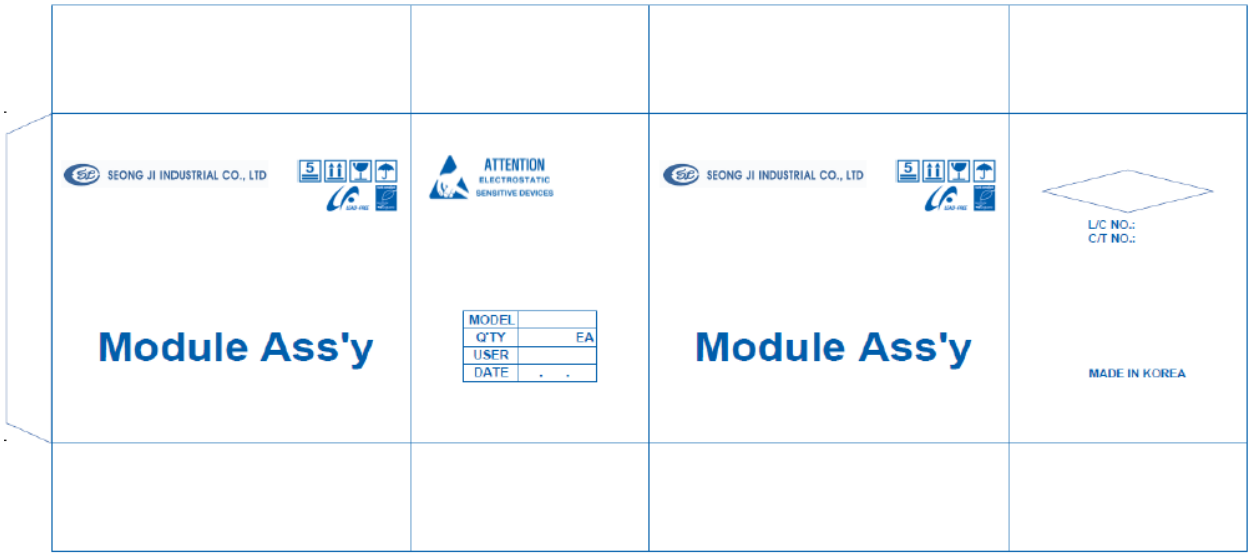
384 x 65 x 386



1reel/ 1 In-BOX

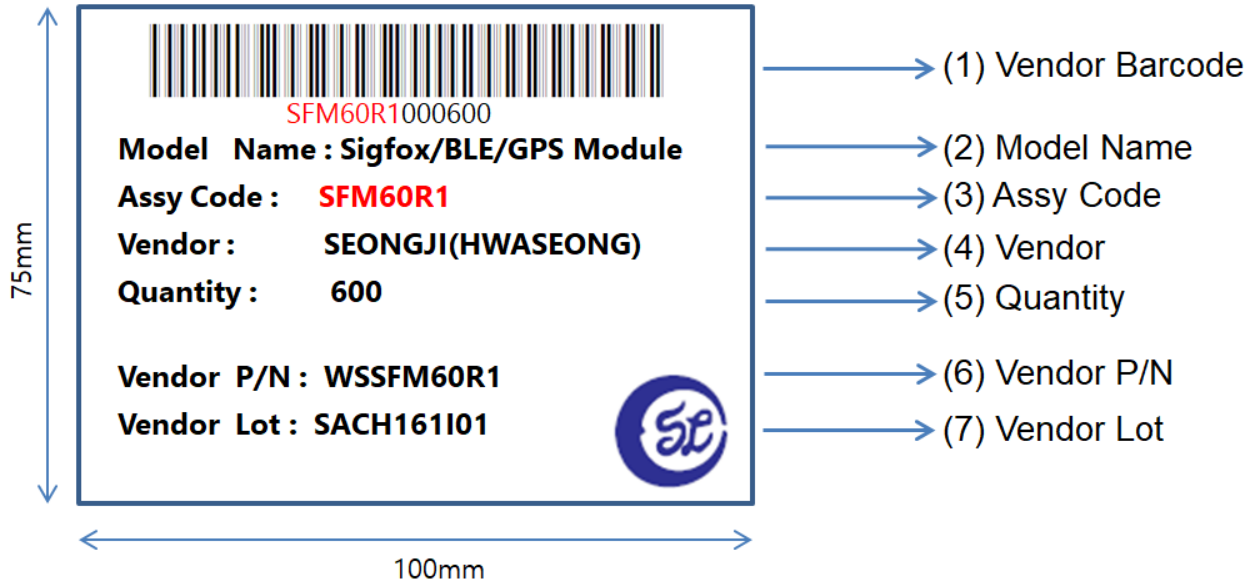
14-4. OUT BOX

387 x 240 x 390

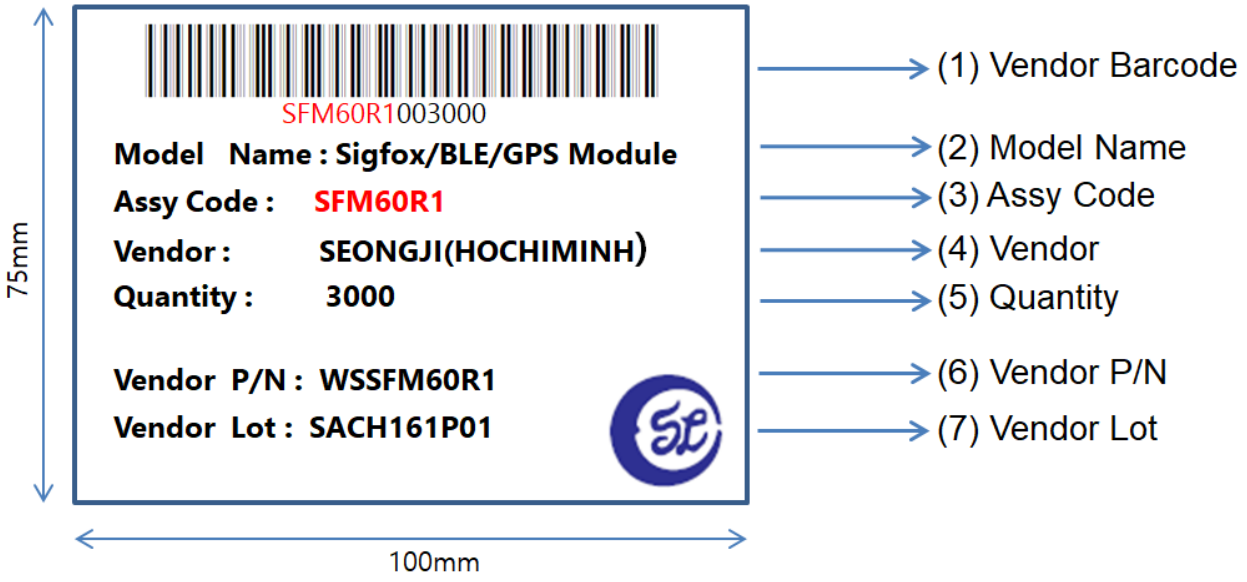


5 In-BOX/ 1 Out-BOX

14-5. IN BOX Label



14-6. 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.

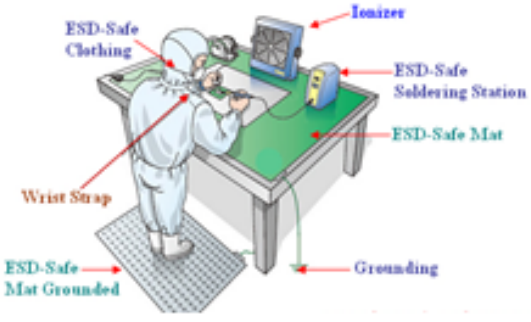
Product ESD specification:
- HBM ±2kV

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.