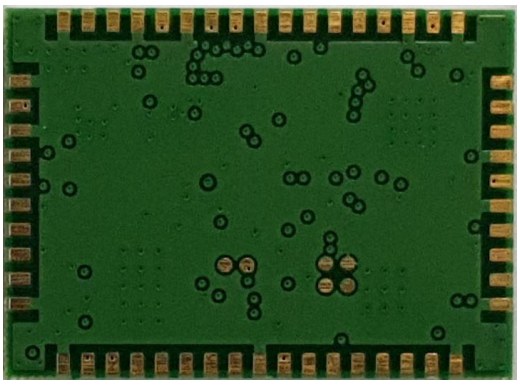
SEONG JI / SFM20R3

DATA SHEET Rev.04



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1. Approval Revision Record

NO	REASON	RECORD OF REVISION	Date	Remark
1	REV 00	WSSFM20R3 Initial Releases	2017-05-19	-
2	REV 01	Hardware connection for RF regulatory certification		
3	REV 02	TELEC certification updated of WiFi RF Output Power	2018-02-01	-
4	REV 03	Added “ESD Warning”	2018-07-19	-
5	REV 04	Changed manufacture(Wisol → SEONGJI)	2018-08-30	-

2. Scope

- Description

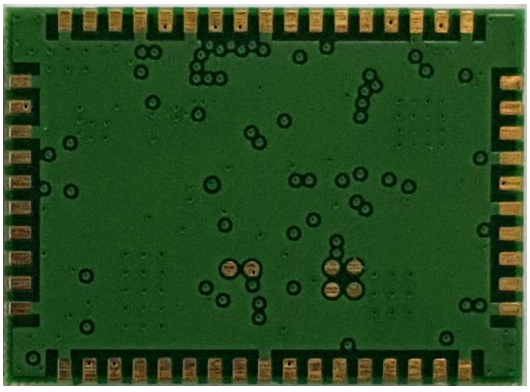
  - Sigfox Configuration 2 RC3
  - WIFI (2.4GHz) : Supports 802.11 b/g/n.
  - BLE : Support version BT4.2.
  - NFC : Type 2 near field communication (NFC-A) tag with wakeup-on-field and touch to-pair capabilities.
  - GPS : Supports GPS and GLONASS.
  - Accelerometer : ±2g/±4g±/8g dynamically selectable full-scale.

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

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

3. Numbering of product

3-1. Product



3-2. Part No.

W	S	**S**	**F**	**M**	**2**	**0**	**R**	**3**	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	2	3	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)		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
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. WiFi

7-3-1. Electrical Specification

Parameter		Min	Typ.	Max	Unit
Target Power for TX					
2.4GHz	Tx mode, Cont.Tx@11M		220		mA
	Tx mode, Cont.Tx@54M		160		mA
	Tx mode, Cont.Tx@HT20 MCS7		160		mA
	Rx mode, Cont. Rx@11M		77		mA
	Rx mode, Cont. Rx@54M		77		mA
	Rx mode, Cont. Rx@HT20 MCS7		77		mA

Note: The above mentioned values have been obtained according to our own measuring methods and may very depend on the circuit, in which the component is actually incorporated. Therefore, you are kindly requested to test the performance of the component actually in your set.

7-3-2. Receiver Specification

Conditions: VCC=3.3V, Temp=25℃

Parameter	Conditions	Min	Typ.	Max	Unit
Minimum Receiver Sensitivity in 802.11b mode					
1Mbps	PER<8%, Packet size = 1024bytes	-	-95	-80	dBm
2Mbps		-	-91	-80	dBm
5.5Mbps		-	-84	-76	dBm
11Mbps		-	-84	-76	dBm
Minimum Receiver Sensitivity in 802.11g mode					
6Mbps	PER<10%, Packet size = 1024bytes	-	-89	-82	dBm
9Mbps		-	-88	-81	dBm
12Mbps		-	-87	-79	dBm
18Mbps		-	-85	-77	dBm
24Mbps		-	-82	-74	dBm
36Mbps		-	-79	-70	dBm
48Mbps		-	-74	-66	dBm
54Mbps		-	-72	-65	dBm
Minimum Receiver Sensitivity in 802.11n mode					
HT20, MCS7	PER<10%	-	-70	-64	dBm
Maximum Input Signal Level					
802.11b mode	PER<8%	-10	-	-	dBm
802.11g mode	PER<10%	-20	-	-	dBm
802.11n mode	PER<10%	-20	-	-	dBm
Adjacent channel rejection (ACR) in 802.11b mode					
1Mbps	PER<8%, Packet	35	-	-	dB

2Mbps	size = 1024bytes	35	-	-	dB
5.5Mbps		35	-	-	dB
11Mbps		35	-	-	dB
Adjacent channel rejection (ACR) in 802.11g mode					
6Mbps	PER<10%, Packet size = 1024bytes	16	-	-	dB
9Mbps		15	-	-	dB
12Mbps		13	-	-	dB
18Mbps		11	-	-	dB
24Mbps		8	-	-	dB
36Mbps		4	-	-	dB
48Mbps		0	-	-	dB
54Mbps		-1	-	-	dB
Adjacent channel rejection (ACR) in 802.11n mode					
MCS0	PER<10%	16	-	-	dB
MCS7		-2	-	-	dB

7-3-3. Transmitter Specification

The WiFi output power of the SFM20R3 module is set as the below table value.
The output power set in the SFM20R3 module is RF regulatory certification based on the SEONGJI reference board and the external antenna (INNO-LINK: INNO-EWFSWS-151).
Refer to "WiFi RF Output Power Control" for power control method to increase output power by using internal antenna or chip antenna which is lower efficiency than SEONGJI reference antenna.
If the output power set in the SFM20R3 module is changed, WiFi RF regulatory certification of the product is required.

Conditions: VCC=3.3V, Temp=25℃

Parameter	Conditions	Frequency	Min	Typ.	Max	Unit
Output Power in 802.11b mode, CCK						
1~11Mbps	As specified in IEEE802.11	2412	11.0	13.5	16.0	dBm
		2436	10.0	12.5	15.0	dBm
		2462	9.5	12.0	14.5	dBm
		2484	10.0	12.5	15.0	dBm
Output Power in 802.11g mode, OFDM						
6M~54Mbps	As specified in IEEE802.11	2412	11.0	13.5	16.0	dBm
		2436	10.0	12.5	15.0	dBm
		2462	9.5	12.0	14.5	dBm
		2484	10.0	12.5	15.0	dBm
Output Power in 802.11n mode, HT20, OFDM						
MCS0~7	As specified in IEEE802.11	2412	11.0	13.5	16.0	dBm
		2436	10.0	12.5	15.0	dBm
		2462	9.5	12.0	14.5	dBm
		2484	10.0	12.5	15.0	dBm
Spectrum mask						

Margin to 802.11b/g/n all mode	Maximum output power	0	-	-	dBr
Modulation Accuracy in 802.11b mode					
1Mbps	As specified in IEEE802.11	-	-	35	%
2Mbps		-	-	35	%
5.5Mbps		-	-	35	%
11Mbps		-	-	35	%
Modulation Accuracy in 802.11g mode					
6Mbps	As specified in IEEE802.11	-	-	-5	dB
9Mbps		-	-	-8	dB
12Mbps		-	-	-10	dB
18Mbps		-	-	-13	dB
24Mbps		-	-	-16	dB
36Mbps		-	-	-19	dB
48Mbps		-	-	-22	dB
54Mbps		-	-	-25	dB
Modulation Accuracy in 802.11n mode					
HT20, MCS7	Full packet	-	-	-27	dB
Frequency Tolerance					
802.11b/g/n	Operating Temp.	-25	0	25	ppm

*Output power can be changed according to the antenna characteristics used in mass production but the SEONGJI module is set to the power value shown in the table above.

7-4. GPS

7-4-1. 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

7-4-2. 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

7-5. NFC

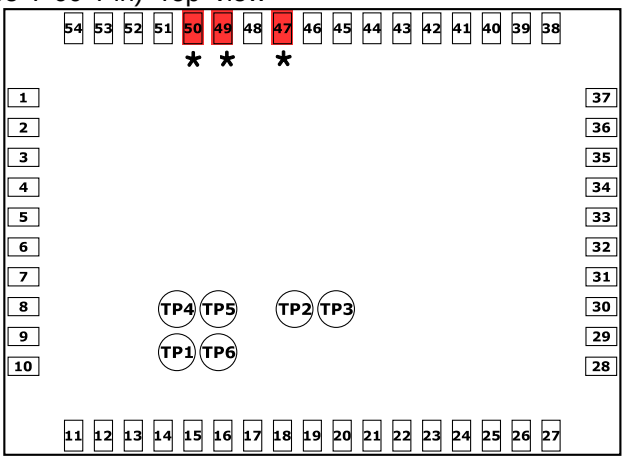
7-5-1. Electrical Specification

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	STATE_LINK_WIFI	22	I2C0_SCL_DBG	43	GND
2	STATE_WORK_WIFI	23	STATE0	44	NFC2
3	VDD_WIFI_EN	24	WKUP	45	NFC1
4	GND	25	STATE_CPU_SFX	46	GND
5	GPS_RF	26	STATE_RF_SFX	47	DL_EN/INT_WIFI *
6	GND	27	GND	48	NRST_WIFI
7	VDD_MAIN_3P0	28	GND	49	UART0_RX_WIFI *
8	V_BCKP_GPS	29	VDD_SFX_EN	50	UART0_TX_WIFI *
9	VDD_GPS	30	NRST_SFX	51	VDD_WIFI
10	GND	31	SWDCLK	52	GND
11	GND	32	SWDIO	53	WIFI_RF
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 WiFi 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	STATE_LINK_WIFI	O	WiFi Link state, 0: unlinked 1: linked
2	STATE_WORK_WIFI	O	WiFi working state, 0: not working 1: working
3	VDD_WIFI_EN	O	WiFi power enable
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	DL_EN/INT_WIFI	I	WiFi Download enable , active high **It must be connected to an external connector or TP for use in RF regulatory certifications.**
48	NRST_WIFI	I	WiFi Reset , do not connect
49	UART0_RX_WIFI	I	WiFi Download **It must be connected to an external connector or TP for use in RF regulatory certifications.**
50	UART0_TX_WIFI	O	WiFi Download **It must be connected to an external connector or TP for use in RF regulatory certifications.**
51	VDD_WIFI	P/O	WiFi Power output
53	WIFI_RF	RF	WiFi RF In/Out
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 SFM20R module, you must have the following hardware connections to control each RF block and download the test-firmware.

- **WiFi control and firmware download**

The specified test-firmware must be downloaded to the internal flash memory of the SFM20R module and controlled using the AT command to RF certification proceed. Hardware pin47, pin49 and pin50 must be connected to an external connector or test-point.

- **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. WIFI status PIN

- STATE_LINK_WIFI : TBD
- STATE_WORK_WIFI : WIFI Scan State (0: not working 1: working)

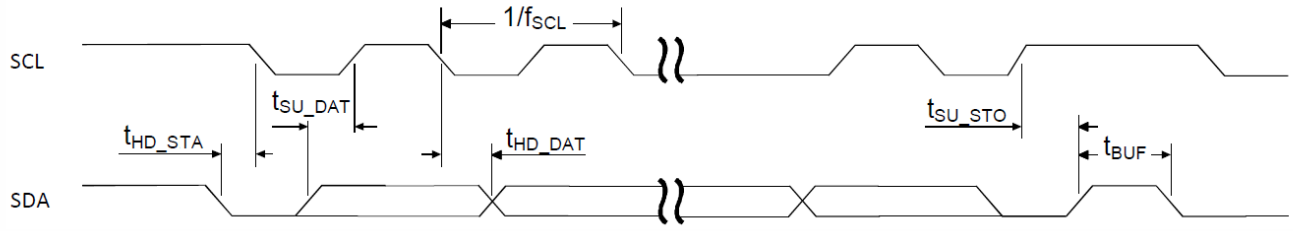
8-2-3. Sigfox status PIN

- STATE_CPU_SFX : Sigfox CPU activity indicator
- STATE_RF_SFX : Sigfox Radio activity indicator

8-2-4. 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

8-2-5. I2C Slave for debug

- upto 400Khz

8-2-6. 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)

8-2-7. GPIOs

- support 4 GPIO
  STATE0
  WKUP
  AIN1
  AIN0

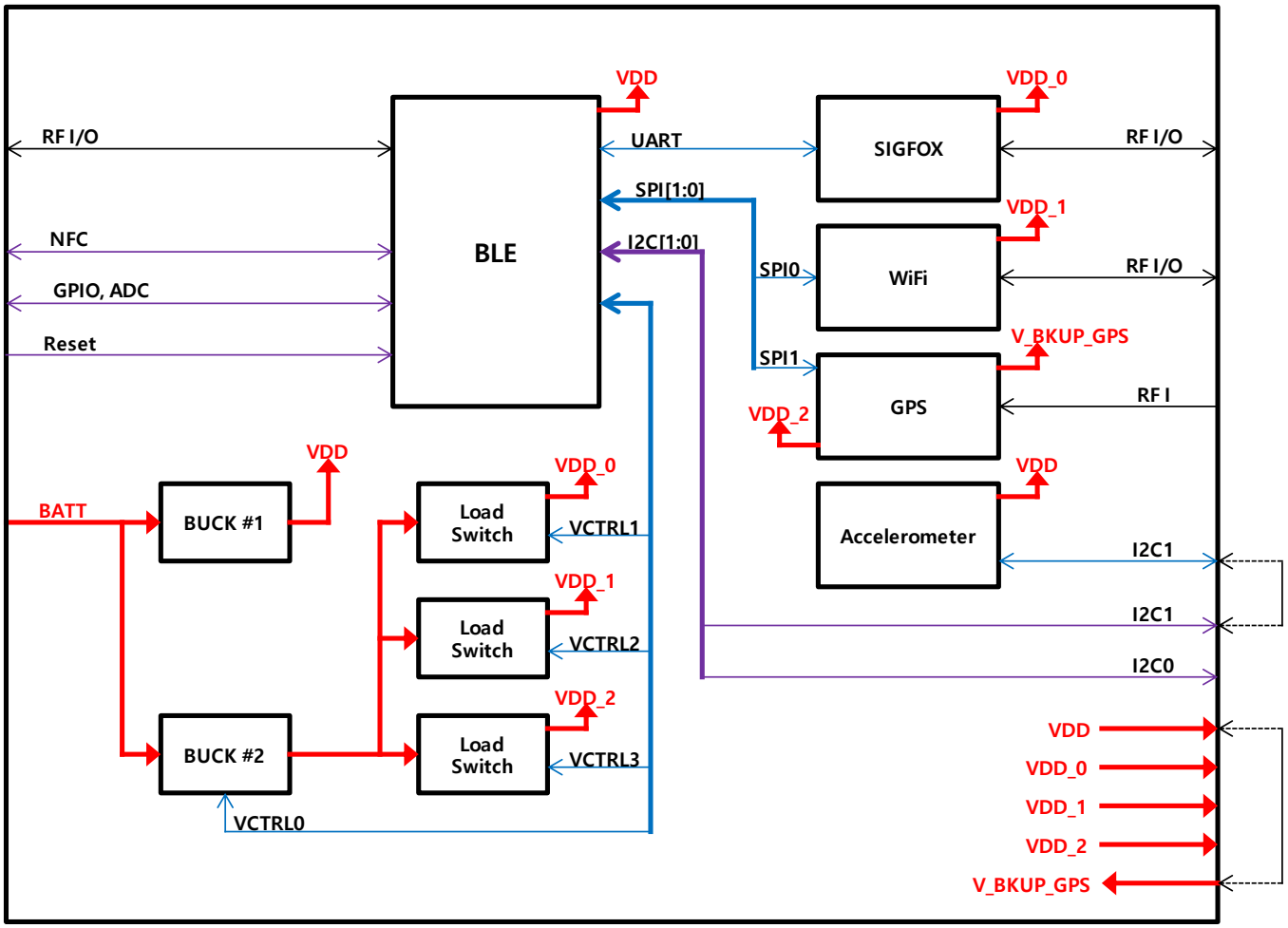
8-2-8. NFC

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

8-2-9. Reset Pin

- Chip reset input. Active low.

9. Block Diagram



10. Power Modes

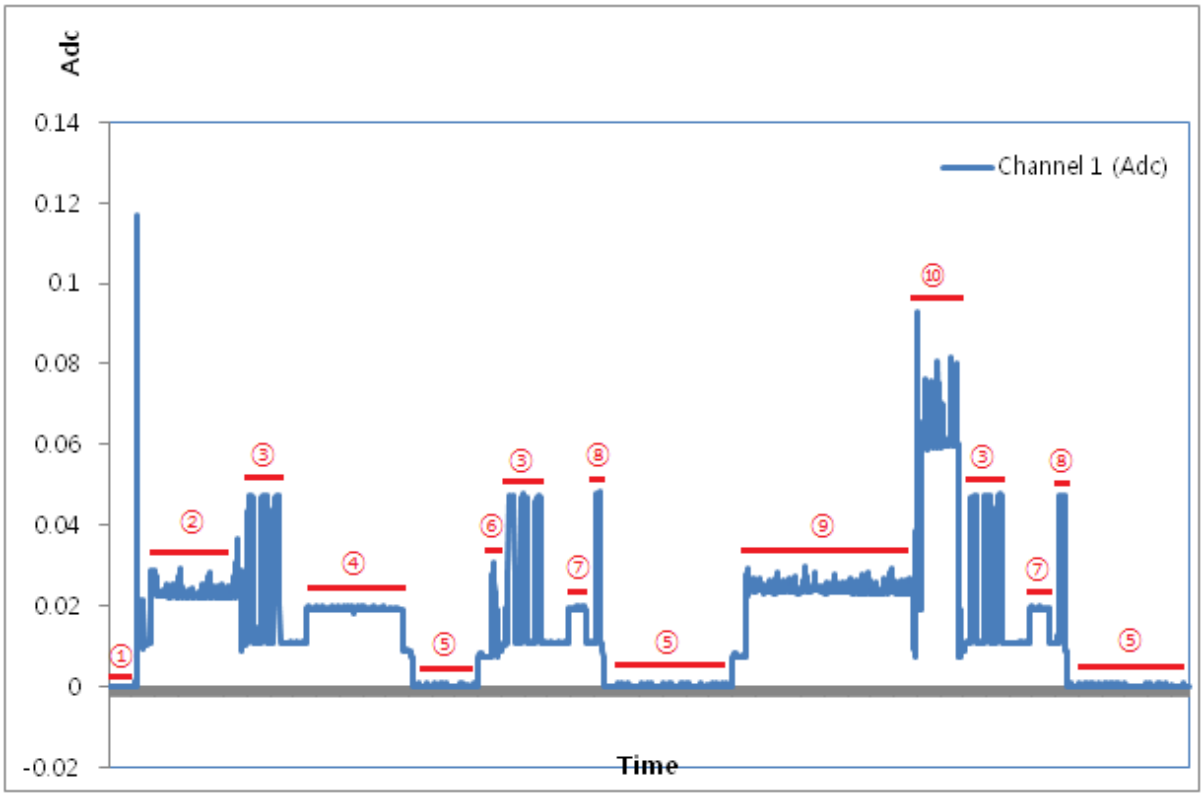
10-1. Test condition

Time Interval : 250ms
Measurement : DC Current
Range(Adc) : 0.1A

Test Result

Power Off (Deep Sleep)	GPS	WIFI	Sigfox			BLE (Sleep)
			Tx	Rx	OOB	
avg 5uA	avg 23mA	avg 70mA	45mA	avg 20mA	45mA	avg 40uA
①	② ⑥ ⑨	⑩	③	④ ⑦	⑧	⑤

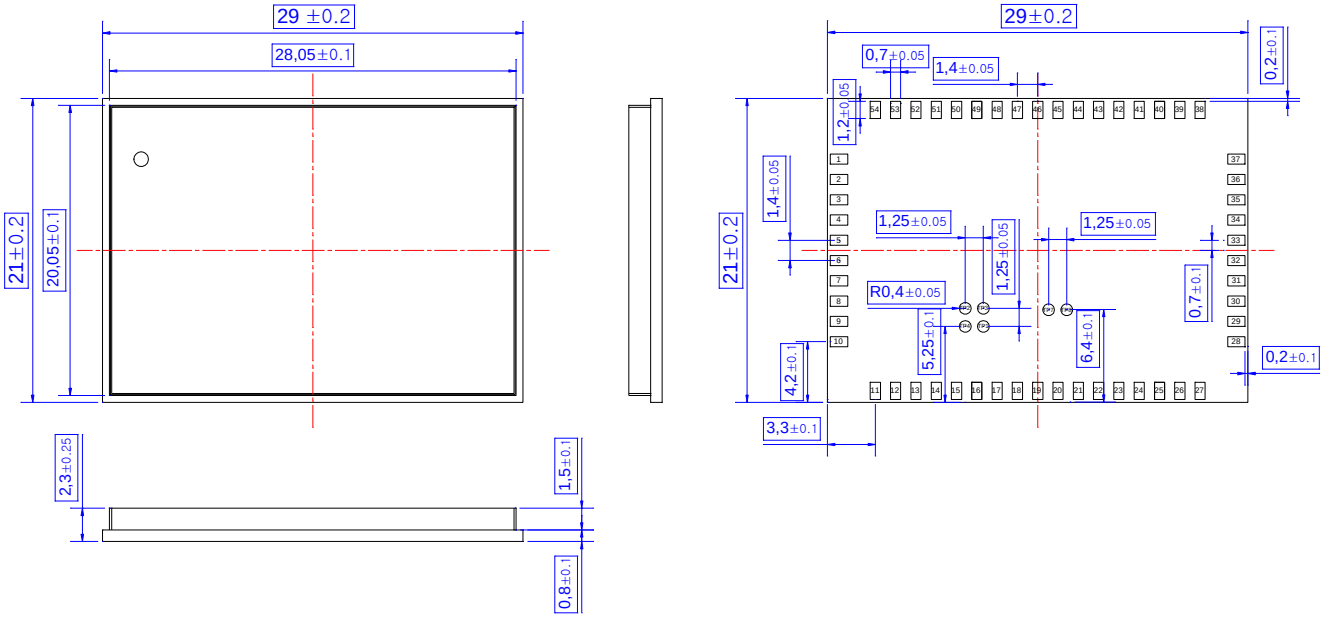
Test Graph



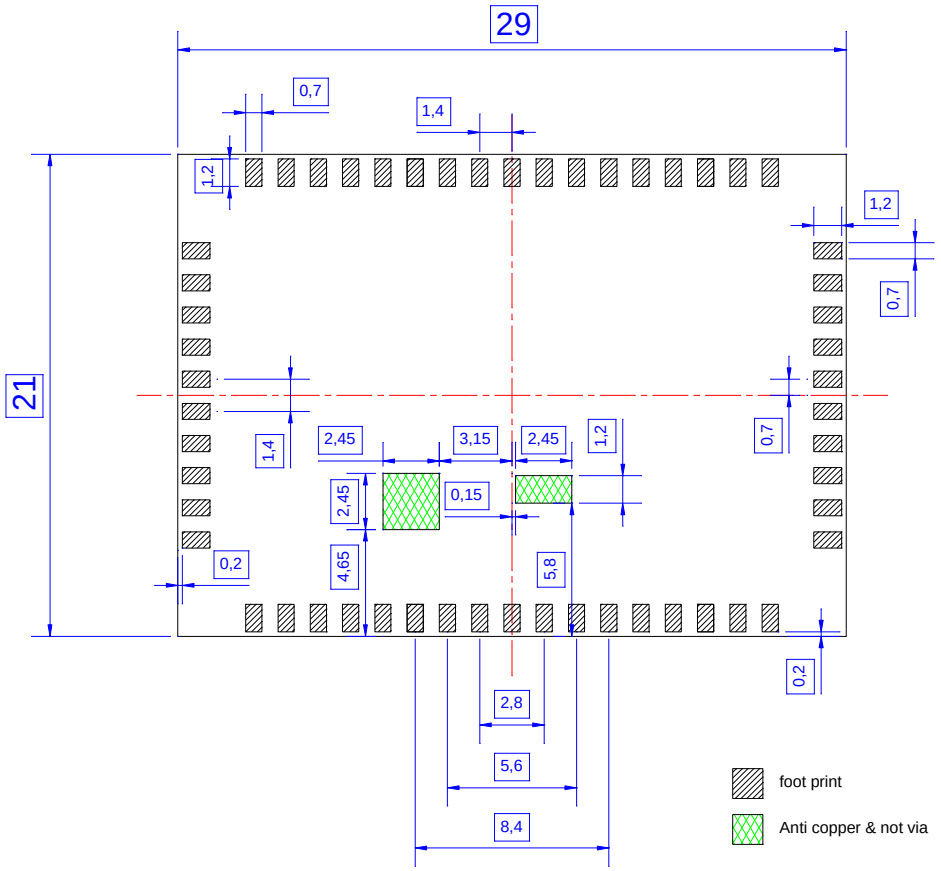
② : GPS cold start
④ : Sigfox Rx time out
⑥ : GPS hot start
⑨ : GPS not fixed

11. Dimensions & drawing

11-1. Design dimension

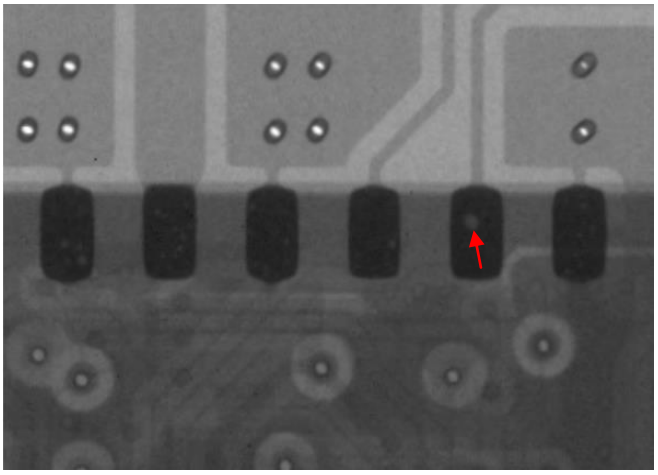
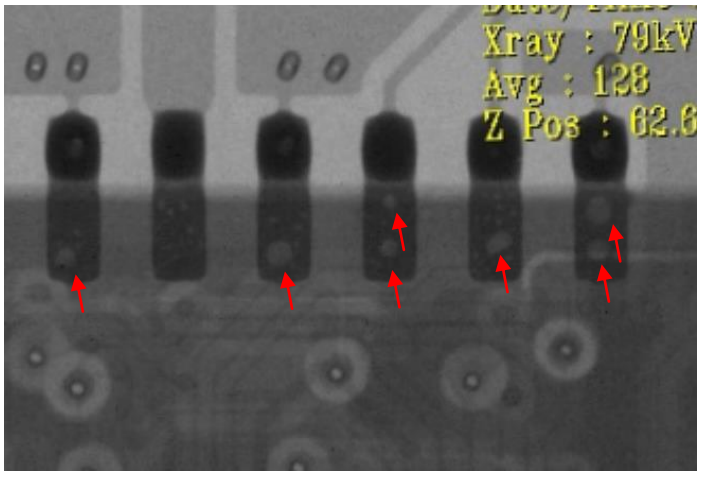


11-2. Recommend Foot print



- **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.

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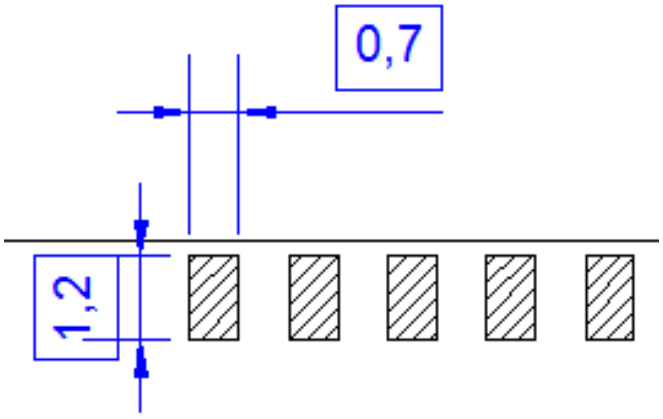
<td> 
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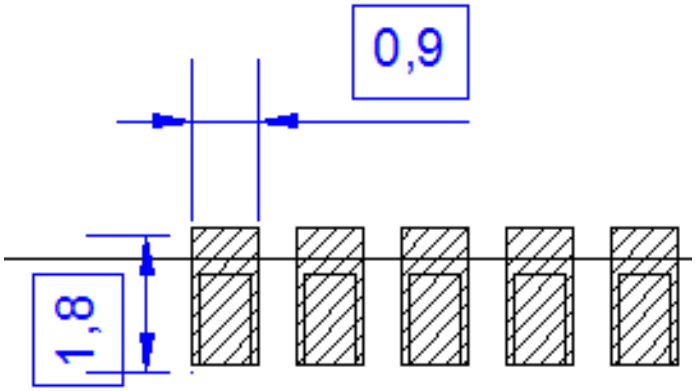
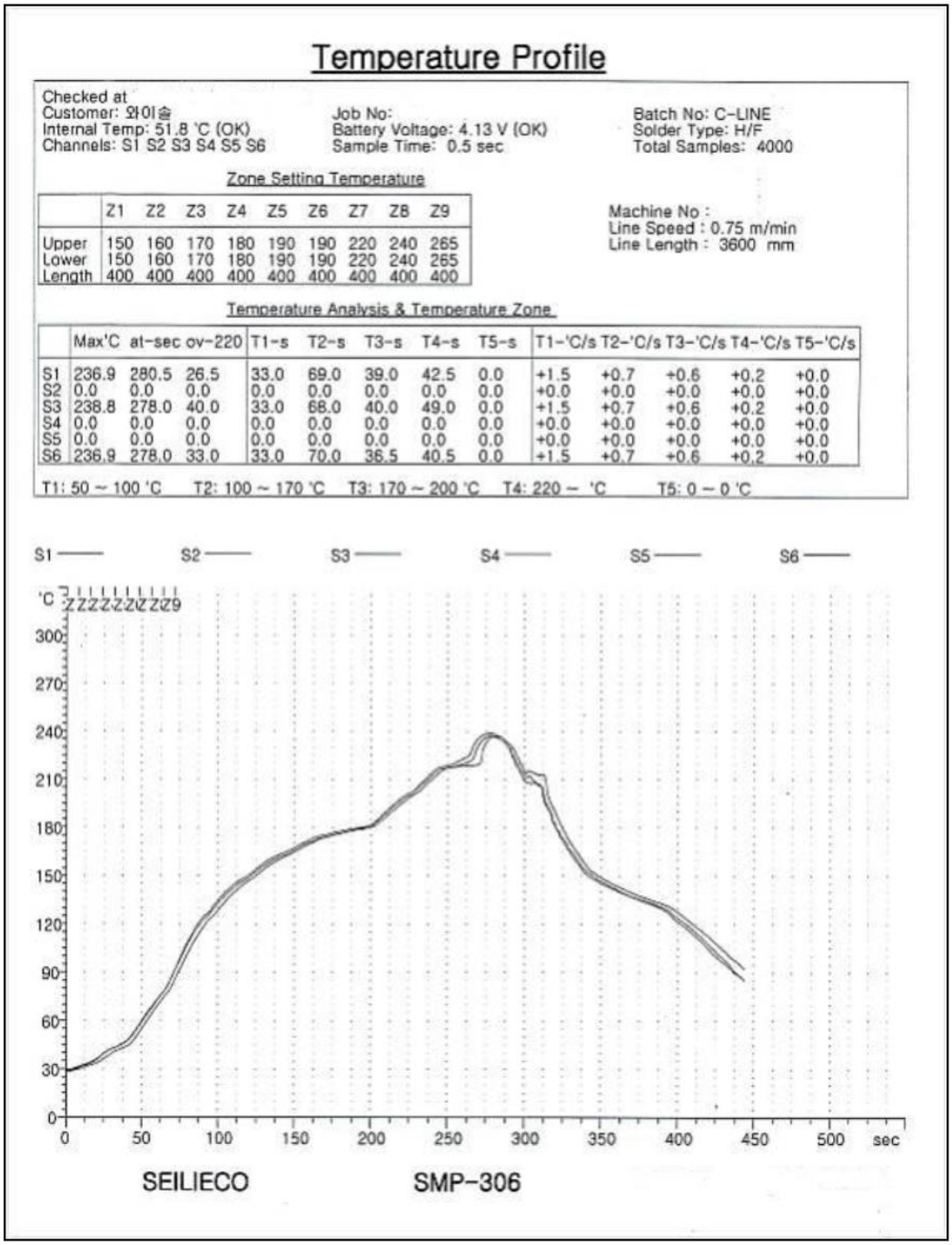
<td> 
</td>
</tr>
<tr>
<td>[Foot print size : 0.7 x 1.2mm]</td>
<td>[Foot print size : 0.9 x 1.8mm]</td>
</tr>
</table>

12. Reflow profile

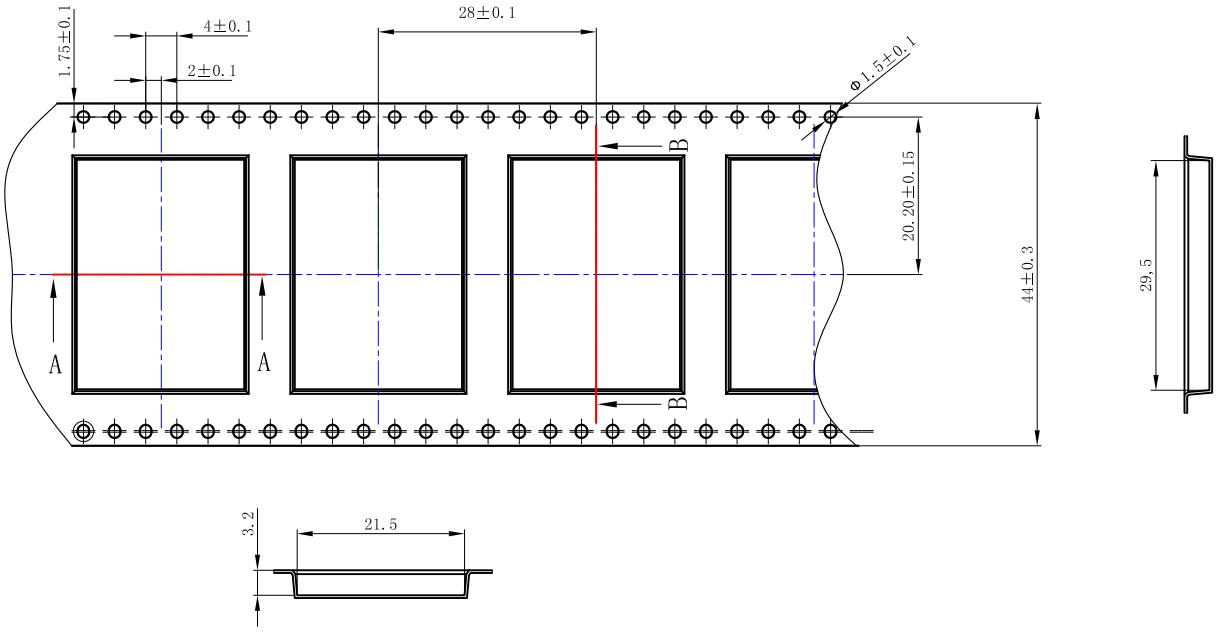
<Reflow profile of Module>



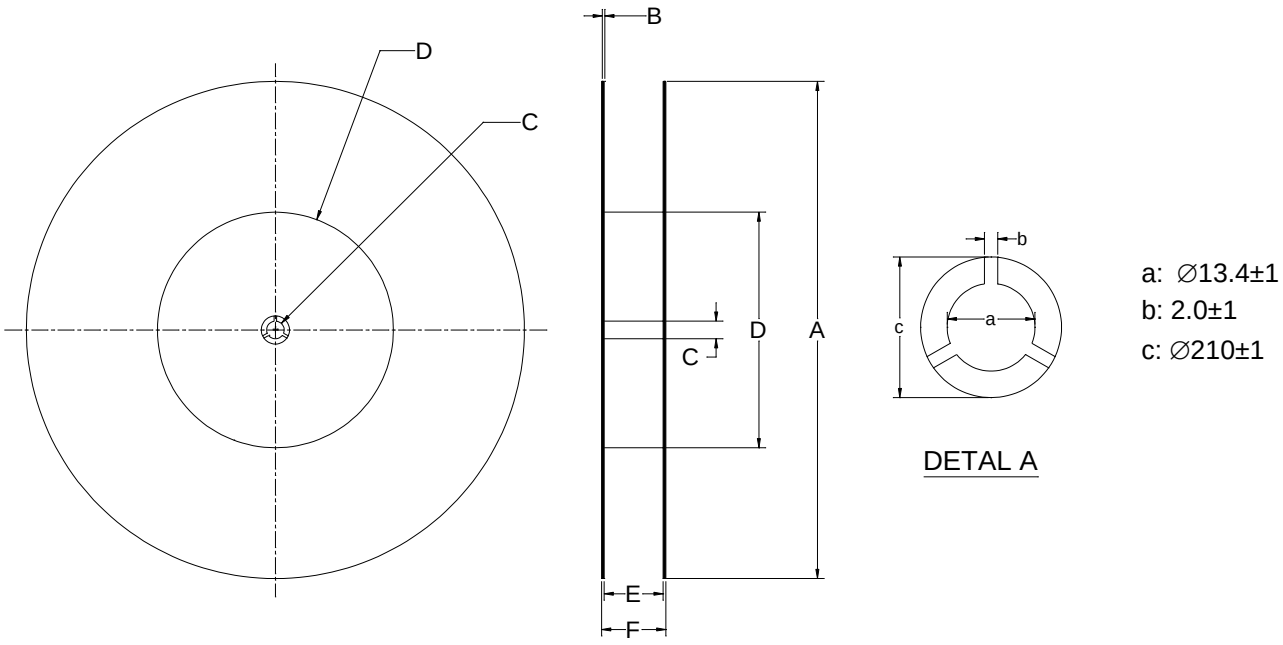
	Preheat	Soak	Ramp	PEAK
SPEC	50~100℃	100~170℃	220℃ ↑	240℃
	1~2℃/sec	60~100sec	30~50sec	±5℃
result of measurement	1.5	69	44	237.5
	OK	OK	OK	OK

13. Package

13-1. Dimension of Tape



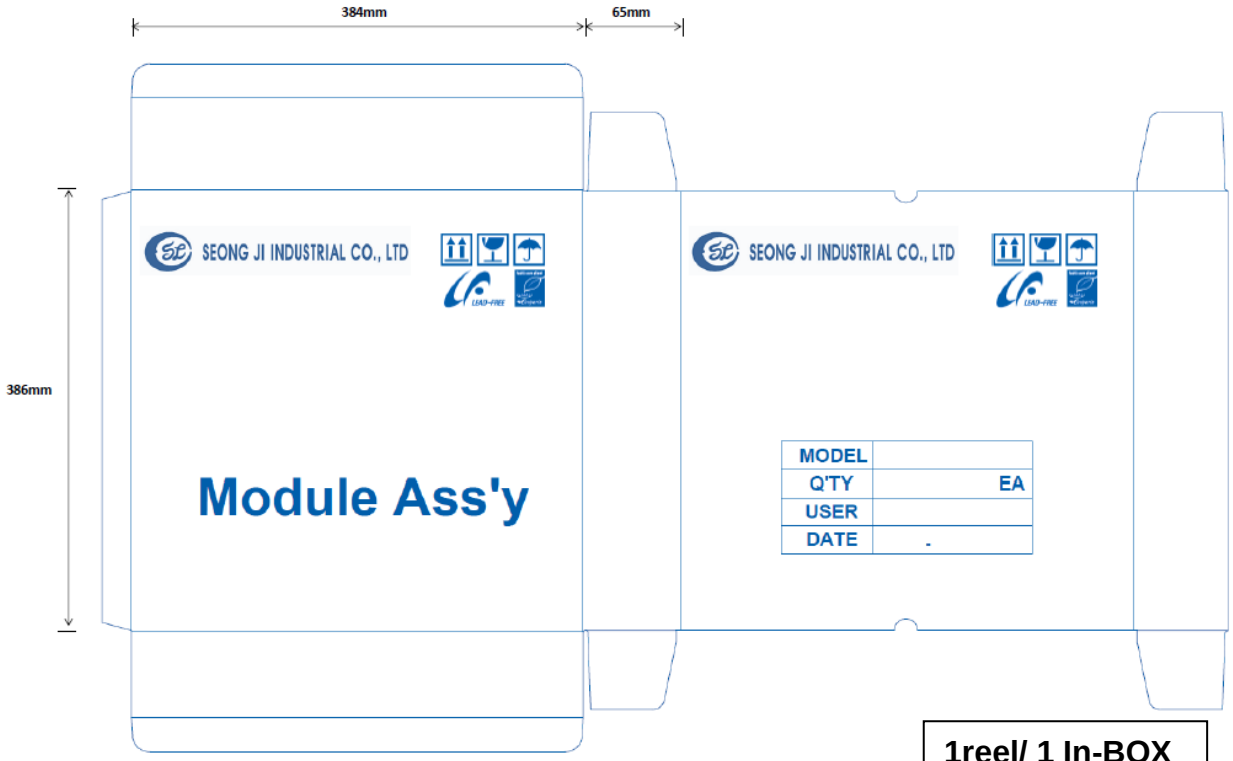
13-2. Dimension of Reel



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



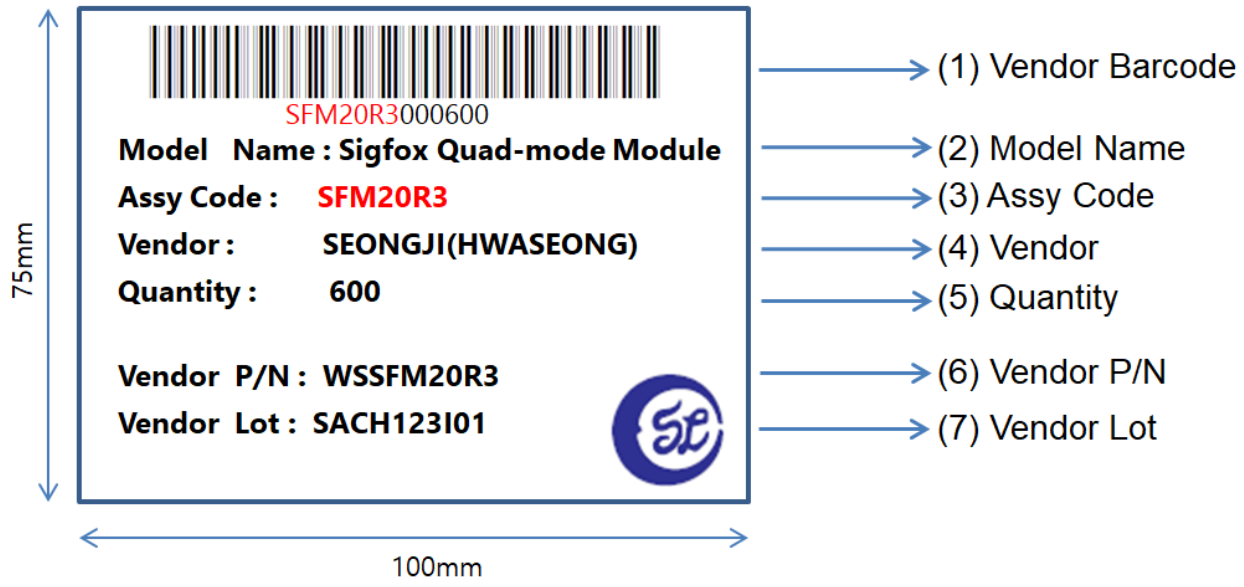
1reel/ 1 In-BOX

13-4. OUT BOX

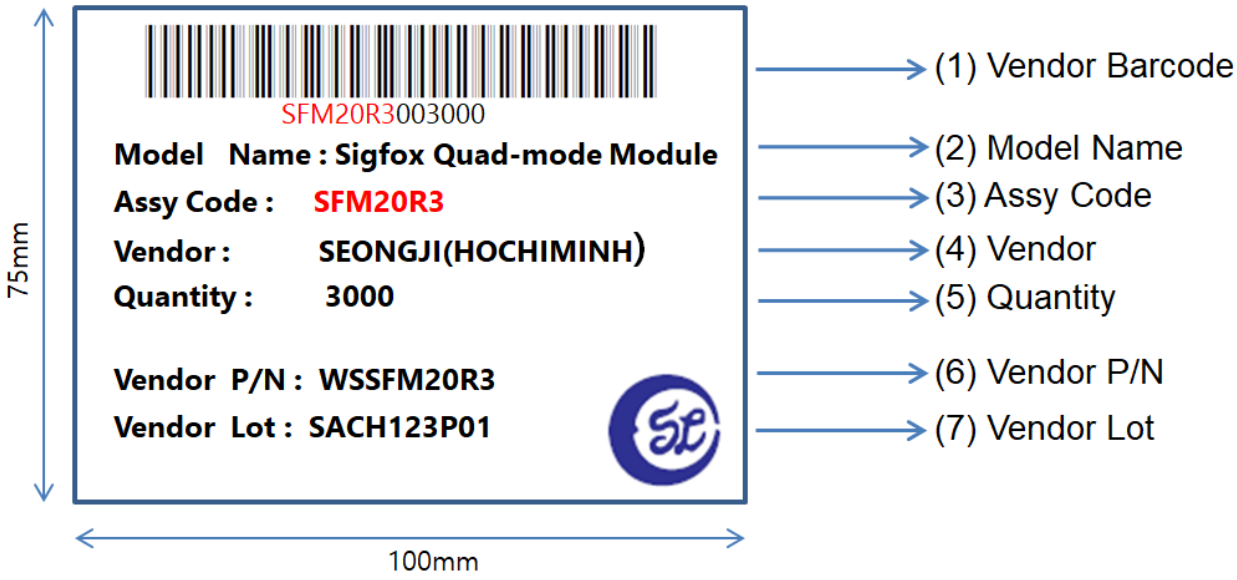
387 x 240 x 390

5 In-BOX/ 1 Out-BOX

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.

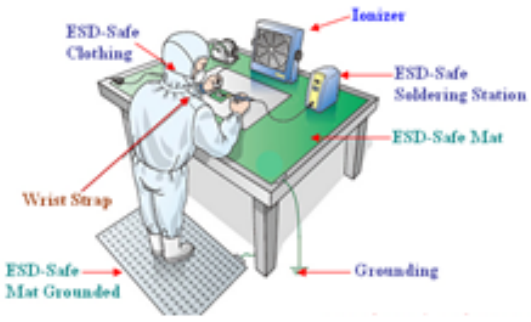
Product ESD specification:
- HBM ±2kV

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.