

GS780MIZ Module OEM / Integrator Installation Manual Data Sheet

GS780M-DS-00001

Preliminary

GainSpan® 802.15 Bluetooth® BLE Module

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Introduction

The low-power GS780MIZ module adds low-power **Bluetooth**[®] low energy technology (BLE), version 4.2, connectivity to devices intended for portable applications.



The module offers extended communication range in single-mode BLE operation with reduced power consumption for extended battery life. You can operate the GS780MIZ in either standalone mode with application software running on the module, or connected to a microcontroller running the application software and communicating through a UART or SPI interface. The module operates in the 2.4 to 2.485 GHz frequency range using spread-spectrum, frequency-hopping, full-duplex modes, and will meet FCC/IC (US/Canada), CE/ETSI(Europe), and TELEC(Japan) regulatory certification requirements.

The GS780MIZ module reduces RF design and certification times to facilitate quick time-to-market. The small form factor and adaptable RF technology, trading off sensitivity, interference and power, permit you to build products customized to your application requirements. At the GS780MIZ core are,

- Renesas RL78/G1D
- program and data flash and SRAM memory
- Bluetooth low energy technology v4.2 single-mode master/slave RF with on-chip oscillator
- flexible MCU/RF power management modes
- real-time clock, watchdog and interval timers
- A/D converter
- 3-wire serial I/O (CSI), UART, and I²C communication interfaces



NOTE: The module is Bluetooth low energy technology v4.2-qualified by Bluetooth SIG but does not support long data packets and the latest privacy encryption, which are optional features of the

Features

<i>16-bit RL78 CPU Core</i>	32 MHz CPU with 1MB address space.	<i>A/D converter</i>	8-channel, 8/10-bit resolution
<i>On-Chip RF Transceiver</i>	Bluetooth low energy technology v4.2 with 2.4 GHz ISM band, GFSK modulation, TDMA/TDD frequency hopping.	<i>I/O Interfaces</i>	<ul style="list-style-type: none"> • 2x 7/8-bit CSI/SPI • 2x 7/8/9-BIT UART • 2x I2C master • 1x I2C multi-master • GPIO: 23 ports
<i>Program Flash Memory</i>	256KB ROM, approx. 110KB stack	<i>Power functions</i>	<ul style="list-style-type: none"> • Power-on reset • Selectable low voltage detector
<i>Data Flash Memory</i>	8KB	<i>Package Type, Pin Count</i>	30-pin
<i>RAM</i>	20KB, approx. 8KB stack	<i>Certifications and Compliance</i>	FCC, IC, TELEC, CE/ETSI (planned)
<i>DMA Controller</i>	4 programmable channels, 8/16-bit	<i>Standby function</i>	Reduced current: HALT, STOP, SNOOZE modes.
<i>Real-time clock</i>	99-year calendar, alarm and constant period interrupt.	<i>Low Power Technology</i>	Automatically optimizes power consumption based on range.
<i>Extended-Function Timers</i>	Eight 16-bit independent timers, with two high-accuracy timers. Eight 12-bit interval timers with interrupt.	<i>Safety Functions</i>	IEC60730- and IEC61508-compliant: <ul style="list-style-type: none"> • Flash memory CRC • RAM parity error • RAM guard • SFR guard • Invalid memory access • Frequency detection • A/D test
<i>Watchdog timer</i>	Detect infinite program loop.		

References

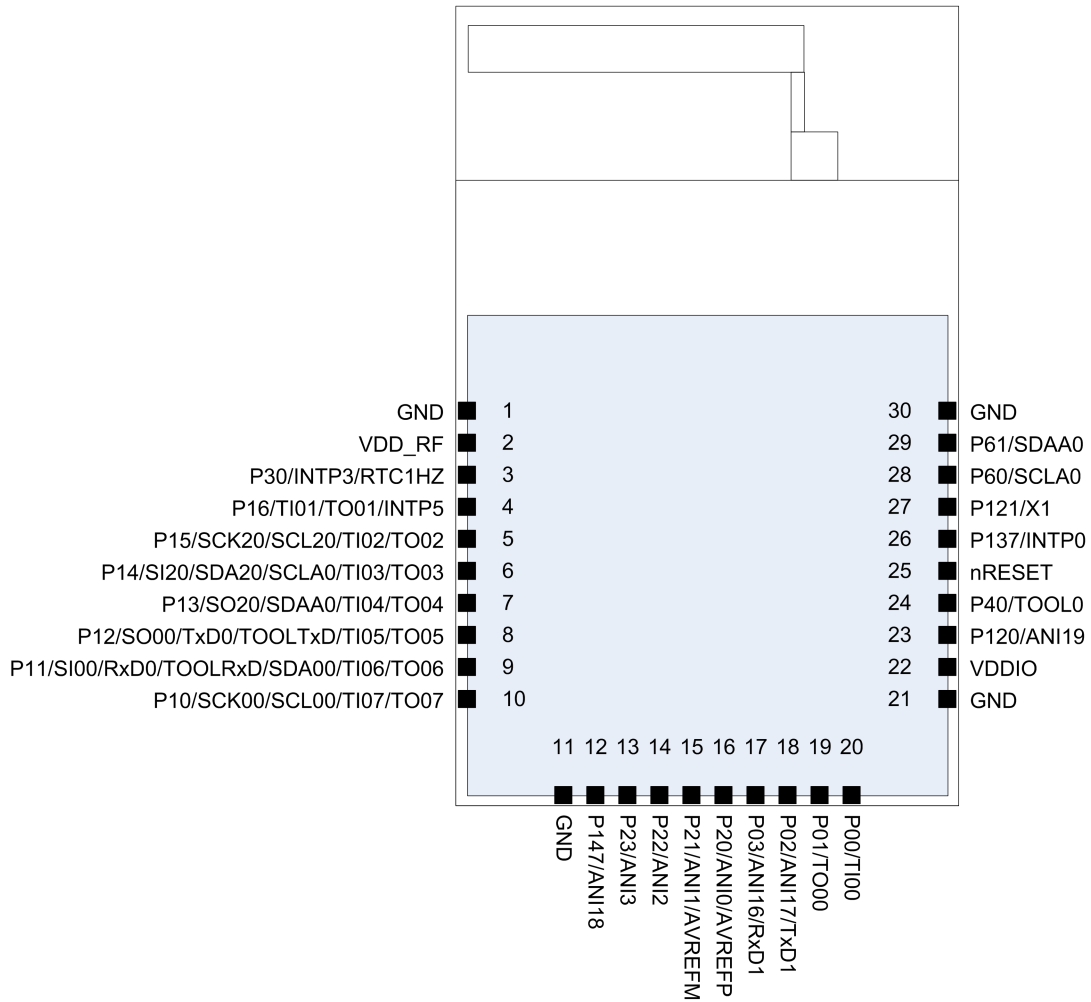
- [Renesas RL78/G1D microcontroller documentation](#)
- [Bluetooth SIG](#)

Specifications

Pin Count	30 pins
Package	solder down module; edge pins
RF Output Power (typical)	GS780MIZ: 0 dBm
Rx Sensitivity	GS780MIZ: -91 dBm
Operating Frequency	2.4 GHz
RF Protocol	IEEE 802.15.1, Bluetooth low energy technology v4.2
Antenna	Ceramic
Operating Temperature	-40° to +85°C
Encryption	AES128
Certifications and Compliance	planned: FCC, IC, TELEC, CE/ETSI
Safety functions	WDT, TRAP instruction, Flash memory CRC, RAM parity error detection, Invalid memory access detection, Frequency detection, RAM and SFR guard, A/DC test
MCU Core	Renesas RL78, 16-bit
Frequency	32 MHz
Memory	Internal Flash: 256KB program flash (approximately 110KB used for stack) 8KB data flash RAM: 20KB (8KB approximately used for stack)
External interrupt	3 channels
DMA	4 channels
I/O Interfaces	SPI, UART, simple I ² C, multi-master I ² C, GPIO, PWM, 10-bit A/D
Host Connections	SPI, UART
Timers	8 16-bit channels 4 channel PWM output, 7 channel multi PWM output
Real-time clock	1 channel
Outline Dimensions	GS780MIZ: 12.5mm x 17mm x 2.2mm
Operating Voltage	1.8-3.6V

Pin Assignments

Device Pin-out



Module Pin Descriptions

Pin no.	Pin name	Port	On Reset	Description
1	GND	–	–	Ground
2	VDD RF	–	–	Supply for RF
3	P30	3	Input port	I/O
	INTP3			External Interrupt Input 3
	RTC1HZ			Real-time clock: correction clock (1 Hz) output
4	P16	1	Input port	I/O
	TI01			External count clock/capture 01
	TO01			Timer Output 01
	INTP5			External Interrupt Input 5
5	P15			I/O
	SCK20			Clock I/O of SPI CSI20
	SCL20			Clock Output SPI CSI20
	TI02			External count clock/capture 02
	TO02			Timer Output 02
6	P14			I/O
	SI20			Data Input SPI CSI20
	SDA20			Data I/O I2C20
	SCLA0			Data Output I2CA0
	TI03			External count clock/capture 03
	TO03			Timer Output 03
7	P13			I/O
	SO20			Data Output SPI CSI20
	DSAA0			Data I/O I2CA0
	TI04			External count clock/capture 04
	TO04			Timer Output 04
8	P12			I/O
	SO00			Data Output SPI CSI00
	TxD0			Data Output UART0
	TOOLTxD			Output UART Flash Memory Programming
	TI05			External count clock/capture 05
	TO05			Timer Output 05

Pin no.	Pin name	Port	On Reset	Description
9	P11			I/O
	SI00			Data Input SPI CSI00
	RxD0			Data Input UART0
	TOOLRxD			Input UART Flash Memory Programming
	SDA00			Data I/O IIC00
	TI06			External count clock/capture 06
	TO06			Timer Output 06
10	P10			I/O
	SCK00			Clock I/O of SPI CSI00
	SCL00			Clock Output SPI CSI00
	TI07			External count clock/capture 07
	TO07			Timer Output 07
11	GND	–	–	Ground
12	P147	14	Analog input port	I/O
	ANI18			A/D converter analog input
13	P23			I/O
	ANI3			A/D converter analog input
14	P22			I/O
	ANI2			A/D converter analog input
15	P21	2	Analog input port	I/O
	ANI1			A/D converter analog input
	AVREFM			Analog Reference Minus
16	P20			I/O
	ANI0			A/D converter analog input
	AVREFP			Analog Reference Plus
17	P03		Analog input port	I/O
	ANI16			A/D converter analog input
	RxD1			Data Input UART1
18	P02	0	Analog input port	I/O
	ANI17			A/D converter analog input
	TxD1			Data Output UART1
19	P01		Input port	I/O
	TO00			Timer Output 00
20	P00			I/O
	TI00			External count clock/capture 00
21	GND	–	–	Ground

Pin no.	Pin name	Port	On Reset	Description
22	VDDIO	–	–	Supply for Digital IO
23	P120	12	Analog input port	I/O
	ANI19			A/D converter analog input
24	P40	4	Input port	I/O
	TOOL0			Programming Pin
25	nRESET	–	–	Active-low system reset input
26	P137	13	Input port	Input
	INTP0			External Interrupt Input 0
27	P121	12	Input port	I/O
	X1			General Purpose Input
28	P60	6	Input port	I/O
	SCLA0			Data Output I2CA0
29	P61	6	Input port	I/O
	SDAA0			Data Input I2CA0
30	GND	–	–	Ground

Port Functions

Port	Function
0	4-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting at input port. Input of P01 and P03 can be set to TTL input buffer. Output of P00, P02, and P03 can be set to N-ch open-drain output (VDD tolerance). P02 and P03 can be set to analog input.
1	7-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting at input port. Input of P10, P11, and P13 to P16 can be set to TTL input buffer. Output of P10 to P15 can be set to N-ch open drain output (VDD tolerance).
2	4-bit I/O port. Input/output can be specified in 1-bit units. Can be set to analog input.
3	Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting at input port.
4	Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting at input port.
6	2-bit I/O port. Input/output can be specified in 1-bit units. N-ch open-drain output (6V tolerance).
12	For only P120, input/output can be specified. For only P120, use of an on-chip pull-up resistor can be specified by a software setting at input port. P120 can be set to analog input. P121 is input-only.
13	P137 1-bit input-only port.
14	2-bit I/O port. Input/output can be specified in 1-bit units. Use of an on-chip pull-up resistor can be specified by a software setting at input port. P147 can be set to analog input.

Electrical Characteristics

Recommended Operating Conditions

Characteristic	Value
Supply voltage	
Maximum voltage rating	
Power consumption	
Maximum 3.3V output current draw	

Absolute Maximum Specifications [TBD]

Characteristic	Value

Digital I/O Pin Specifications [TBD]

Characteristic	Value

[TBD: POWER CONSUMPTION SPEC, RADIO CHARACTERISTICS SPEC]

RL78/G1D

Refer to [Renesas RL78/G1D Datasheet](#) for details about the electrical characteristics listed in the following table.

Section	Characteristic/Title	Renesas Datasheet Page Number
2.1	Absolute Maximum Ratings	11
2.2	Operating Voltage	13
2.3	Oscillator Characteristics	14
2.4	DC Characteristics	15
2.5	Current Consumption	19
2.6	AC Characteristics	25
2.7	Peripheral Functions Characteristics	29
2.7.1	Serial array unit	29
2.7.2	Serial interface IICA	54
2.8	Analog Characteristics	58
2.9	RF Transceiver Characteristics	65
2.10	RAM Data Retention Characteristics	72
2.11	Flash Memory Programming Characteristics	72
2.12	Special Flash Memory Programming Communication (UART)	72
2.13	Timing of Entry to Flash Memory Programming Modes	73

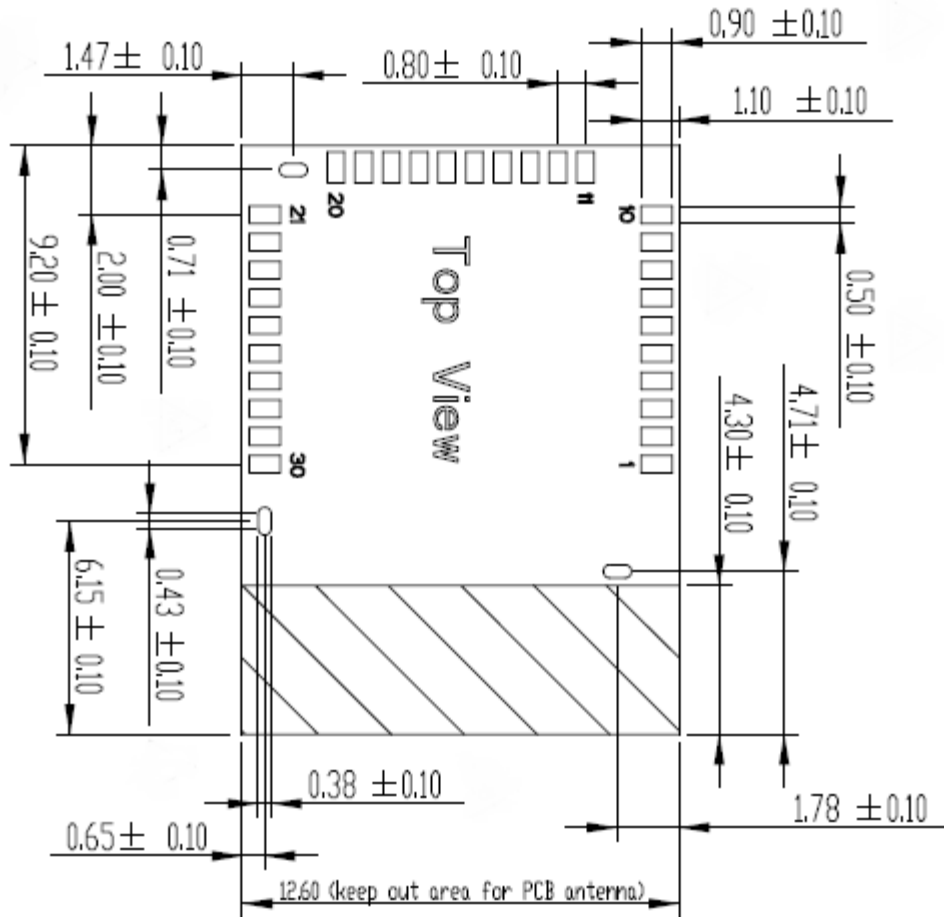


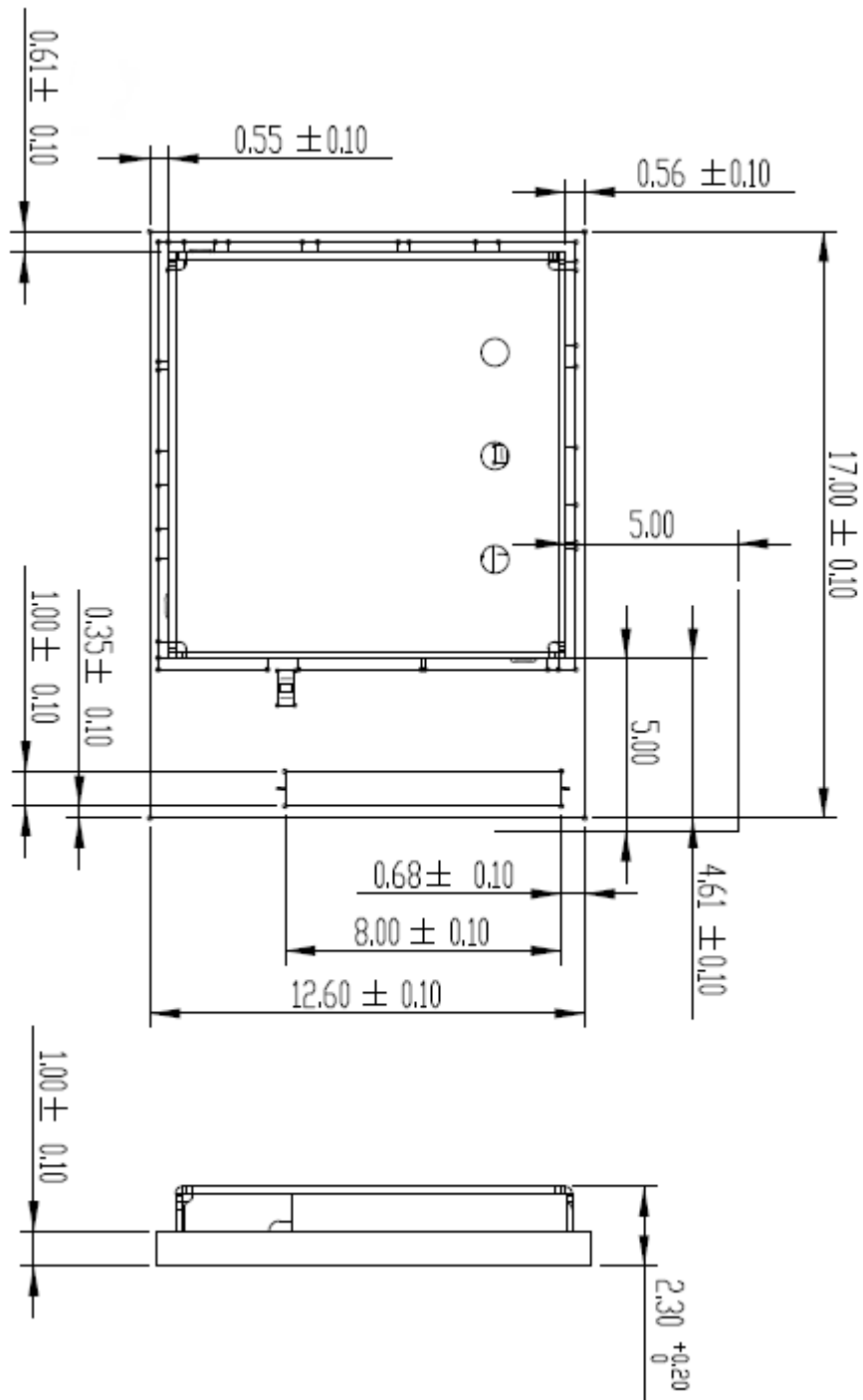
NOTE: Document section, title, and page number refer to Renesas document R01DS0258EJ0110 Rev.1.10, dated Sep 25, 2015.

Packaging and Layout Guidelines

Recommended PCB Footprint and Dimensions

The following figures show the module dimensions and recommended footprint. The first figure shows the recommended PCB antenna keep-out area. The second figure shows the GS780MIZ package dimensions. (Refer to the [notes](#) following the figures for additional mechanical recommendations.)





**NOTES:**

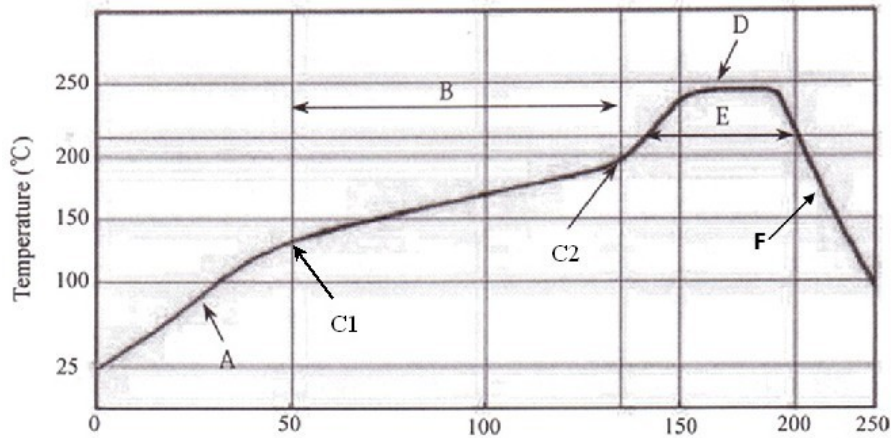
1. All Dimensions are in millimeters (mm).
2. For Boards using Ceramic Antenna, we recommend:
 - Have Only Air on BOTH sides of antenna.
 - Hang Antenna over edge of base board (best);
 - Or, cut notch in base board under antenna area:
 - 5mm beyond module edge on each side is good.
 - full module width is minimum.
 - No metal or FR4 encircling antenna area.
 - Antenna at edge of base board, not interior of base board.
 - Nothing conductive near antenna (e.g. battery, display, wire).
3. Module solder pads on footprint should be the same size as the pads on the module. The three RF shield mounting holes have exposed metal. These areas must not have metal on the customer board.
4. For best RF performance, we recommend:
 - Using power (PWR) or GND planes from module back to power supply.
 - Isolating PWR/GND from high frequency or high current components. For example, a notch in GND plane to isolate from host uC.
 - Using at least three vias when either power or GND changes layers. This applies particularly at the module GND pins and at the VDD_RF pin.
 - Providing a 10 uF capacitor at the VDD_RF pin and using three vias both sides of the capacitor.
 - Keep high speed signals away from RF areas of module.
5. For area under module, other than the antenna area, we recommend two options:
 - No metal of any kind under module “not on any layer.”
 - Having full GND plane under module (layer 1 or layer 2) with no “HOT” vias under module (over 100KHz), and may route signals below GND plane. Also, no metal traces are to be present in the circle, around shield and alignment holes. This option is best for 2-layer boards. If GND is on layer 1, use thermal relief pads for the GND pins of the module footprint.
6. If any metal is present on layer 1, extra thick solder mask under the module is required.
7. In performing SMT or manual soldering of the module to the base board, first align the row of pins from #11 through #20 onto the base board, then match the other two rows.

In addition to the guidelines, note the following suggestions:

1. External bypass capacitors for all module supplies should be as close as possible to the module pins.
2. Never place the antenna very close to metallic objects.
3. External monopole antennas need a reasonable ground plane area for antenna efficiency.
4. Do not use a metallic or metalized plastic for the end product enclosure when using on-board antenna.
5. If the module is enclosed in a plastic case, have reasonable clearance from plastic case to on-board antenna.

Surface Mount Assembly

The figure shows the reflow profile, and the recommended reflow parameters are summarized in the following table.




Preheat	
Temperature Ramp up rate for (A) ²	1.5~3.5 oC/s
Pre-heat time (B) ³	80 to 130 seconds
Pre-heat starting temperature (C1)	125 to 135 oC
Pre-heat ending temperature (C2)	180 to 200 oC
Heating	
Peak Temperature range (D)	240 to 250 oC
Melting time ⁴ that is the time over 220 oC (E)	50 to 75 seconds
Cool Down Ramp (F)	>2 oC/s

**NOTES:**

1. Perform adequate test in advance as the reflow temperature profile varies according to the conditions of the parts and boards, and the specifications of the reflow furnace.
2. Max number of reflow supported is two.
3. Temperature uniformity inside the IR reflow oven must be tightly controlled and multiple thermocouples should be used. The locations should also include multiple points INSIDE the module RF shield. The temperature profile of all thermocouples must meet the requirements of the above table.
4. Pay close attention to "Melting Time over 220oC". Sufficient time is needed to completely melt all solder.
5. Be careful about rapid temperature rise in preheat zone because it can cause excessive slumping of the solder paste.
6. If the preheat is insufficient, large solder balls tend to be generated. Conversely, if performed excessively, fine balls and large balls will generate in clusters at a time.
7. If the temperature is too low, non-melting tends to be caused in the area with large heat capacity after reflow.
8. Be careful about sudden rise in temperature because it may increase the slump of solder paste.
9. Be careful about slow cooling because it can cause the positional shift of parts and a decline in joining at times.
10. A no clean flux should be used during the SMT process.

Moisture Conditions

The modules are shipped in sealed trays with the following conditions indicated on the label:

	CAUTION This bag contains MOISTURE-SENSITIVE DEVICES	LEVEL 3
		<small>if Blank, see adjacent bar code label</small>

1. Calculated shelf life in sealed bag: 12 months at $< 40^{\circ}\text{C}$ and $< 90\%$ relative humidity (RH)

2. Peak package body temperature: **250** $^{\circ}\text{C}$
if Blank, see adjacent bar code label

3. After bag is opened, devices that will be subjected to reflow solder or other high temperature process must

a) Mounted within: **168** hours of factory
if Blank, see adjacent bar code label
conditions $\leq 30^{\circ}\text{C}/50\%$

b) stored at $< 10\%$ RH

4. Devices require bake, before mounting, if:

a) Humidity indicator card is $> 10\%$ when read at $23 \pm 5^{\circ}\text{C}$

b) 3a or 3b not met

5. If baking is required, devices may be baked for 48 hours at $125 \pm 5^{\circ}\text{C}$

Note: If device containers cannot be subjected to high temperature or shorter bake times are desired, reference IPC/JEDEC J-STD-033 for bake procedure

Bag Seal Date: _____
if Blank, see adjacent bar code label

Note: Level and body temperature defined by IPC/JEDEC J-STD-020

FCC Statement:

Federal Communication Commission Interference Statement

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 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.
- Consult the dealer or an experienced radio/TV technician for help.

FCC Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

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.

IMPORTANT NOTE:

FCC Radiation Exposure Statement:

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

The module is limited to OEM installation only.

OEM Integrators shall be responsible for ensuring that the end-user has no manual / instructions to remove or install the module.

IMPORTANT NOTE:

This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.

USERS MANUAL OF THE END PRODUCT:

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the FCC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied.

The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

If the labelling area is small than the palm of the hand, then additional FCC part 15.19 statement is required to be available in the users manual: This device complies with Part 15 of 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.

LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains TX FCC ID: YOPGS780MIZ ".

If the labelling area is larger than the palm of the hand, then the following FCC part 15.19 statement has to also be available on the label: This device complies with Part 15 of 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 installation is limited to mobile installation only.

A separate approval is required for all other operating modes not covered in this filing.

IC Statement:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

IMPORTANT NOTE:

IC Radiation Exposure Statement:

This equipment complies with IC RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator & your body.

Cet équipement est conforme aux limites d'exposition aux rayonnements IC établies pour un environnement non contrôlé.

Cet équipement doit être installé et utilisé avec un minimum de 20 cm de distance entre la source de rayonnement et votre corps.

IMPORTANT NOTE:

This module is intended for OEM integrator. The OEM integrator is responsible for the compliance to all the rules that apply to the product into which this certified RF module is integrated. Additional testing and certification may be necessary when multiple modules are used.

Any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment.

USERS MANUAL OF THE END PRODUCT:

In the users manual of the end product, the end user has to be informed to keep at least 20cm separation with the antenna while this end product is installed and operated. The end user has to be informed that the IC radio-frequency exposure guidelines for an uncontrolled environment can be satisfied.

The end user has to also be informed that any changes or modifications not expressly approved by the manufacturer could void the user's authority to operate this equipment. 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.

LABEL OF THE END PRODUCT:

The final end product must be labeled in a visible area with the following " Contains IC: 9154A-GS780MIZ ".

The Host Model Number (HMN) must be indicated at any location on the exterior of the end product or product packaging or product literature which shall be available with the end product or online.