R6093U
SPECIFICATION Ver1.2

MIBX-R001-1812SC-A290

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1. Functional Description

1.1. Overview

The CruizCore® R6093U is a 3 axis digital gyroscope and accelerometer. It's also working as attitude reference system that among others, can measure 3 axis angular rate, 3 axis acceleration and attitude(yaw is relative to initial orientation) under dynamic conditions. It is a highly compact, light, and fully self-contained module. Internally, the R6093U contains a 3 axis MEMS gyroscope and accelerometer, internal voltage regulator, signal processing circuitry and a RISC microprocessor running our patented error correcting algorithm. The R6093U uses an adaptive reduced order Kalman filter to reduce the errors that affect this type of sensors (i.e. bias drift, scale factor, asymmetry), as the result it produces very accurate stabilized angular rates and heading angle. The start-up time is less than 1 second, which is used to compute bias parameters; it does not require further calibration thereafter. The R6093U is the best 6 axis measuring solution for navigation applications.

1.2. Block diagram

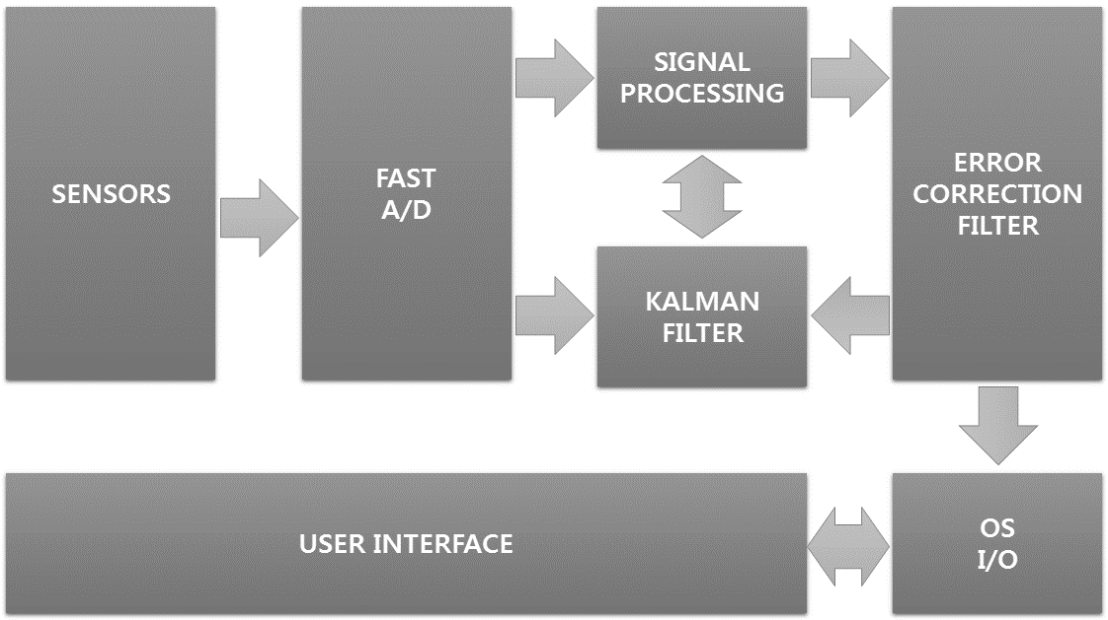
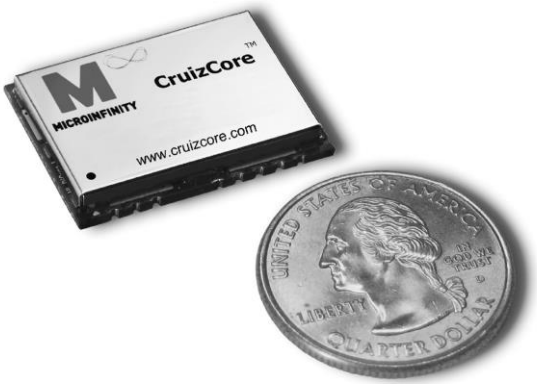


Figure 1: Functional diagram.

1.3. Features

- I2C, UART output (selectable)
- Low power consumption
- Compact package
- Fast startup
- Fully self-contained
- 3 axis rate output
- 3 axis angle output
- 3 axis acceleration output



1.4. System start-up

The CruizCore R6093U startup time is less than one second. It internally compensates for errors due to changes in temperature. However, sudden temperature changes shortly after powering-on the unit can cause static rate errors. If such temperature changes are expected, we recommend leaving the gyro stationary for 5 seconds after startup. During startup time, it is required that the CruizCore R6093U is stationary on a level surface to obtain the best performance.

1.5. Installation

Mounting Information(Coordinate System)

To mount the CruizCore R6093U on your system, please refer to Figure 2, coordinate system. The R6093U must be mounted parallel to the ground, and the coordinates systems are different by mounting surface.
To obtains accurate attitude, please recall that mounting is very important and mounting error can cause attitude errors. If you want to use another coordinate system, please contact us.

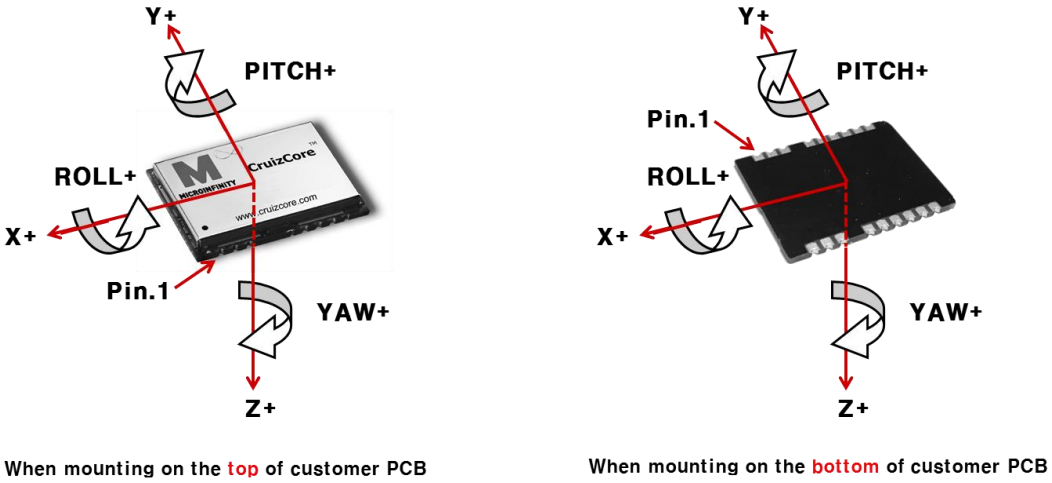
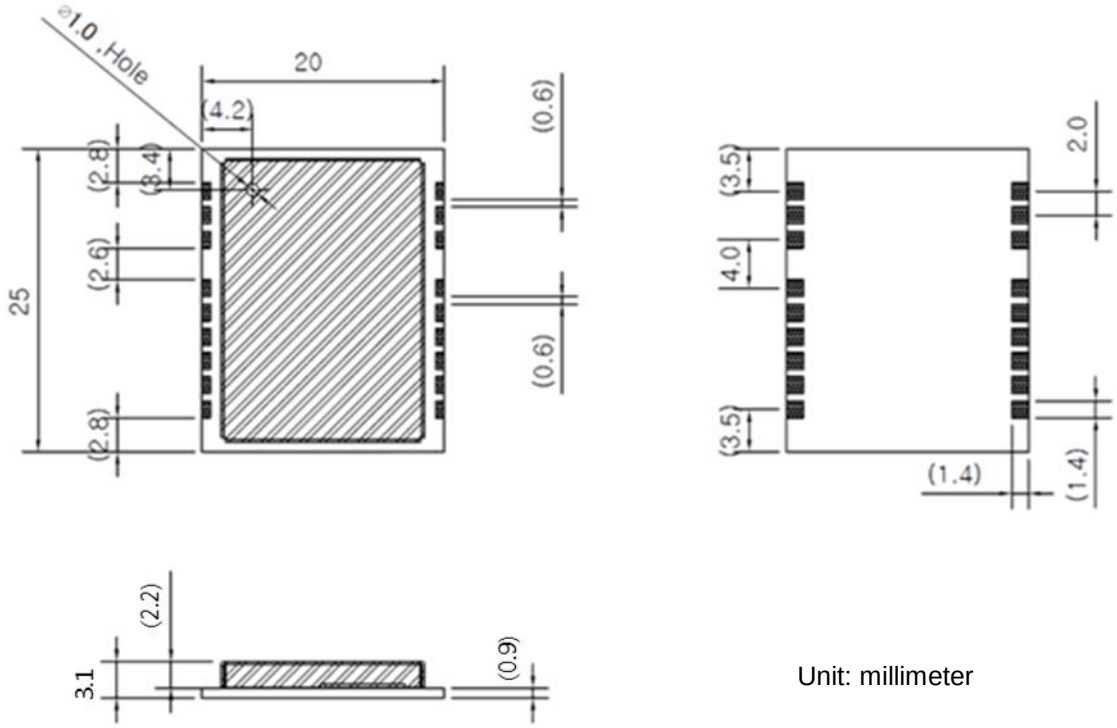


Figure 2: The CruizCore R6093U coordinate system

2. Mechanical Specification

2.1. Dimensions



Unit: millimeter

Figure 3: Dimensions

2.2. Specification

Table 1: Mechanical specification

Parameter	Specification	Tolerance	Comment
Length	25.0	±0.2	Unit: millimeter.
Width	20.0	±0.2	
Height	3.1	±0.3	
Weight	3.0	-1.5	Unit: gram

3. Interface Specification

3.1. Pin Configuration

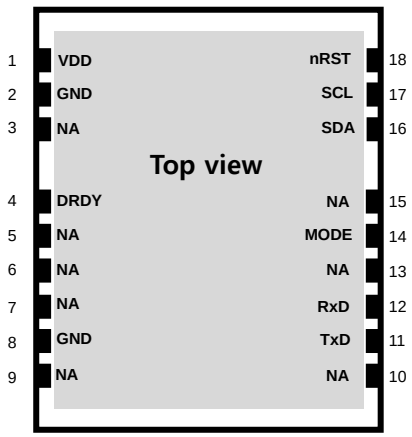


Figure 4: Pin configuration of connectors

3.2. Pin Definition

Table 2: Pin definition

Pin No.	Pin name	I/O	Description
1	VDD	-	Main power (2.9V ~ 5.5VDC)
2	GND	-	Power ground
4	DRDY	O	In I2C mode, active-low data ready signal output.
8	GND	-	Power ground
11	TxD	O	UART transmit data
12	RxD	I	UART receive data
14	MODE	I	I2C / UART mode selection. For UART mode connect to GND or leave open. Tied to VDD for I2C mode.
16	SDA	I/O	I2C serial bus data.
17	SCL	I	I2C serial bus clock input.
18	nRST	I	System reset input. Must be driven by and open drain or equivalent output.
-	NA	-	Not available (leave open)

4. Electrical Specification

Table 3: Absolute maximum ratings

Parameter	Symbol	Value	Unit	Note
Power supply voltage	V_{DD}	-0.3 ~ 6.0	V	GND=0V
nRST Input voltage	V_{nRST}	-0.3 ~ 4.0	V	GND=0V
Port Input voltage	V_{IO}	-0.3 ~ 4.0	V	GND=0V
Operating temperature	T_{OPR}	-20 ~ +80	℃	
Storage temperature	T_{STG}	-40 ~ +85	℃	

Table 4: The CruizCore R6093U electrical characteristics

Parameter			Value			Unit
			Min.	Typ.	Max.	
Supply power	Input voltage	Operating	2.9		5.5	V
		Recommended		3.0		V
	Current	@ 3.0 V		13		mA
	Power consumption	@ 3.0 V		39		mW
I/O voltage	Pins for communication	Input “L”			1.2	V
		Input “H”	1.6			V
		Output “L”			0.4	V
		Output “H”	2.4			V
	nRST[1]	Input “L”			0.6	V
		Input “H”	2.4			V

* Data voltage levels can vary slightly due to internal load changes.
1. Use open collector logic when using the nRST function.

5. Performance Specification

Table 5: The CruizCore R6093U performance characteristics

Parameter		Value			Unit
		Min.	Typ.	Max.	
Start-up time[1]	Fast warm-up		0.5		sec
	Full alignment			5	min
Measurement range[2]	Angular rate			±250	deg/sec
	Acceleration			±2	g
Bandwidth[3]	Angular rate		12		Hz
	Acceleration		62.5		Hz
Yaw axis angular rate[4]	Scale factor error		0.3		%
	Bias drift		10		deg/hr
Yaw axis relative angle[4]	Proportional error		0.3		%
	Drift error		10		deg/hr
Roll, pitch accuracy[4]	Static error		0.3		deg
	Dynamic error		0.7		deg
Resolution[5]	Angular rate		0.01		deg/sec
	Angle		0.01		deg
	Acceleration		1		mg
Data rate[5]	Adjustable		100		Hz

* The system must be installed in the correct position.

** @T_{OPR}=+25℃, V_{DD}=3.0V.

1. Full alignment: Total time that takes for full bias error calibration and temperature compensation. It is the worst case on condition that the temperature goes up suddenly without temperature compensation.
2. Other measurement range is available by customizing option(angular rate range is available up to 2000 deg/sec, acceleration range is available up to 16g). Please contact us
3. Other bandwidth is available by customizing option. Angular rate and acceleration each bandwidth are available up to 523Hz and 1kHz.
4. Guaranteed only under conditions: full alignment, steady-state room temperature, start-up on a level surface, under moderate dynamics (250 deg/sec angular rate).
5. Other data rate and resolution are available by customizing option.

6. UART Protocol

The CruizCore® R6093U provides UART rate, angle and acceleration outputs. The output format is shown in Figure 5 and is described in Table 7. The output consists on a 2 byte header, a 1byte index, a 4byte reserved, a 22 byte data section and 1 byte checksum. The checksum is the sum of all bytes in the data packet, excluding the header and checksum field. The output voltage level of the serial port is 2.8V. If you want another data format, please contact us.

Table 6. Serial setting

Baudrate	Data bits	Parity bit	Stop bits
38400	8	None	1

6.1. System information

When the CruizCore R6093U is powered up, it transmits the system information. For example:

%R6093U
%VX. XX-XX

The system information output can be changed without notice.

6.2. Output format

Following the system information the CruizCore R6093U starts transmitting the sensor data packages. The angular rate and angle provides measurements with 0.01 degree resolution, i.e. a 0.1 degree angle will be displayed as 10 (or 0x0A HEX).

HEADER		INDEX	DATA																CHECK SUM
			ROLL		PITCH		YAW		ROLL RATE (P)		PITCH RATE (Q)		YAW RATE (R)		X-AXIS ACCELERATION		Y-AXIS ACCELERATION		Z-AXIS ACCELERATION		RESERVED 1		RESERVED 2		
0xA6	0xA6																								
2byte		1byte	2byte		2byte		2byte		2byte		2byte		2byte		2byte		2byte		2byte		2byte		2byte		1byte

Figure 5: The CruizCore R6093U data packet format

Table 7: The CruizCore R6093U data fields description.

Output data	Byte	Comments
HEADER	1-2	Hex value is: 0xA6A6
INDEX	3	0x00 ~ 0xFF
ANGLE[1] (ROLL, PITCH, YAW)	4-9	Provided in 0.01 resolved deg.
RATE[1] (ROLL, PITCH, YAW)	10-15	Provided in 0.01 resolved deg/sec.
ACCELERATION[1] (X, Y, Z)	16-21	Provided in 1mg resolution.
RESERVED	22-25	
CHECKSUM[2]	26	Sum of all bytes excluding the header.

1. First byte is the least significant.
2. CHECKSUM is 1 byte and the overflowed more than 1 byte is ignored.

6.3. Software reset

The CruizCore R6093U can accept reset input command.

Table 8: Software reset command.

Function	Command
Software reset	$MIB,RESET*87

This command '$MIB,RESET*87' resets the device. Refer to 1.4. for other details about sensor initialization.

7. I2C Interface

The CruizCore® R6093U operates as a slave that sends and receives data through and I2C 2-wire interface. The interface uses a Serial Data Line (SDA) and a Serial Clock Line (SCL) to achieve bi-directional communication between master(s) and slave(s). A master (typically a microcontroller) initiates all data transfers and generates the SCL clock that synchronizes the data transfer. The SDA line operates as both an input and an open-drain output. A pull-up resistor, typically 4.7 kΩ, is required on SDA. The SCL line operates only as an input. A pull-up resistor, typically 4.7 kΩ, is required on SCL. For simplifying data synchronization, the R6093U features a 100Hz data-ready signal(DRDY) which indicates when a new set of measured data is available.

7.1. DRDY(Data ready)

DRDY indicates when a new data is ready for retrieval. When DRDY transitions from high to low, new data are ready.

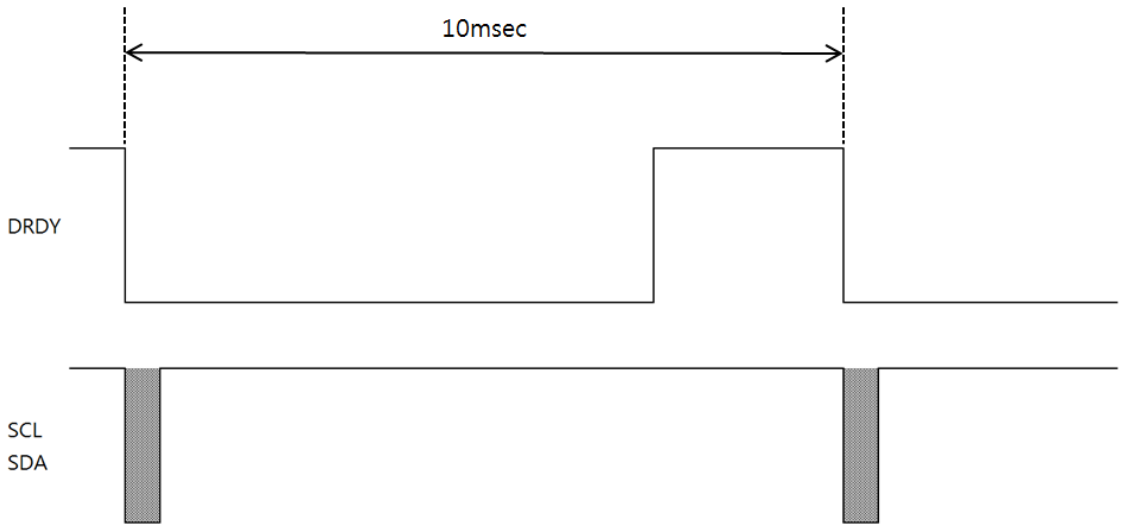


Figure 6. DRDY signal example

7.2. I2C protocol

The R6093U has a 7-bit slave address. The bit following the 7-bit slave address(bit eight) is the R/W bit, which is low for a write command and high for a data read command. The R6093U has a factory set I2C slave address which is normally 0110101(0x36, 7bit). Contact us to request a different I2C salve address.

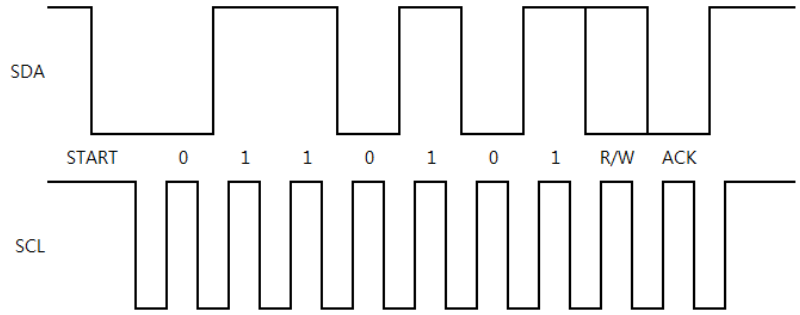


Figure 7. I2C slave address

The I2C data consists on an address byte, 18 byte data section, 1 byte index section and 1 byte checksum. Figure 8. Illustrates an example of how to read data from the R6093U and I2C master may also write data to register 0x00 or 0xAA for reset. The checksum is the sum of all bytes in the slave output data packet, excluding checksum field.

Read rate, angle and acceleration

Master	START	Salve address + R (0x6B)														
Slave			ACK	ROLL lower byte	ACK	ROLL higher byte	ACK	PITCH lower byte	ACK	PITCH higher byte	ACK	YAW lower byte	ACK	YAW higher byte	ACK	
				ROLL RATE lower byte	ACK	ROLL RATE higher byte	ACK	PITCH RATE lower byte	ACK	ROLL RATE higher byte	ACK	YAW RATE lower byte	ACK	YAW RATE higher byte	ACK	
				X-AXIS ACCELERATION lower byte	ACK	X-AXIS ACCELERATION higher byte	ACK	Y-AXIS ACCELERATION lower byte	ACK	Y-AXIS ACCELERATION higher byte	ACK	Z-AXIS ACCELERATION lower byte	ACK	Z-AXIS ACCELERATION higher byte	ACK	
							NACK	STOP								
				Index	ACK	Checksum										

Angle data are set to 0

Master	START	Salve address + W (0x6A)		Register address (0x00)		Data (0x00)		Data (0x00)		STOP
Slave			ACK		ACK		ACK		ACK	

Software reset

Master	START	Salve address + W (0x6A)		Register address (0x00)		Data (0xAA)		Data (0xAA)		STOP
Slave			ACK		ACK		ACK		ACK	

Figure 8. I2C data format

8. Environmental Specification

Table 9: Environment and mechanical test.

No.	Items	Test condition
1	High temperature storage	85℃ x 120h
2	Low temperature Storage	-40℃ x 72h
3	Temperature and Humidity cycling	25℃, 60%RH(4h) / 55℃, 95%RH(10h) / -30℃(2h) / 75℃(2h), 10cycles
4	Thermal shock	-40 ℃ ↔ 85 ℃ 1hour at each temperature, 10cycles
5	Drop	Free drop from 750mm height on a wooden board for 3 times
6	Vibration	10Hz to 55Hz amplitude 0.75mm, 55Hz to 500Hz acceleration 98m/s^2, 10Hz→500Hz→10Hz 15min/cycle, 6h(2h x 3directions)
7	ESD	R(330Ω) C(150pF), Contact discharge, 5times, 2kV

* After each test, there should be no visible damage and corresponds to criteria of the MIBX-R001-1701RC-A244(R6 Series Reliability Test Procedures).

9. Reflow Temperature Guideline

Recommended temperature conditions at reflow is shown on the following Figure 6.

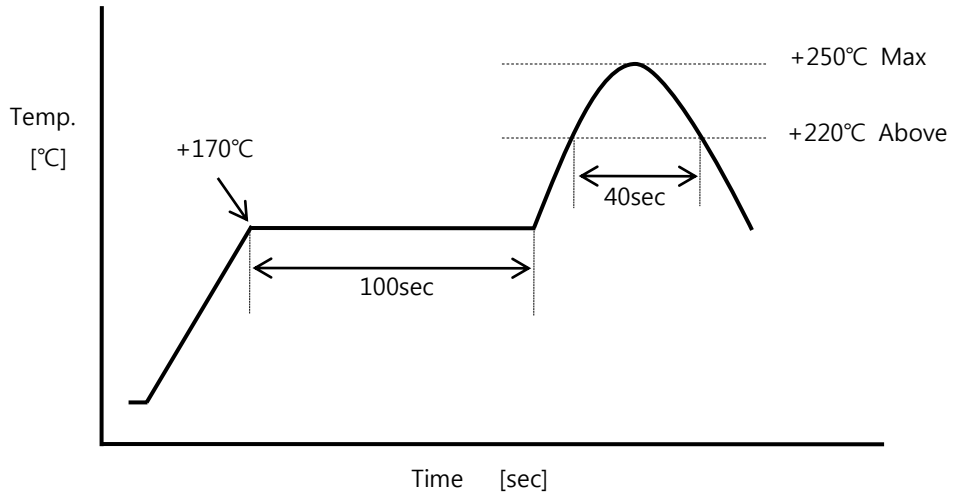


Figure 9: Temperature conditions at reflow

Pre-heating temperature: +170℃ Pre-heating time: 100sec

Heating temperature: +220℃ Heating time: 40sec

Peak temperature ≤ +250℃

10. Packing Specification

10.1. Tray dimensions

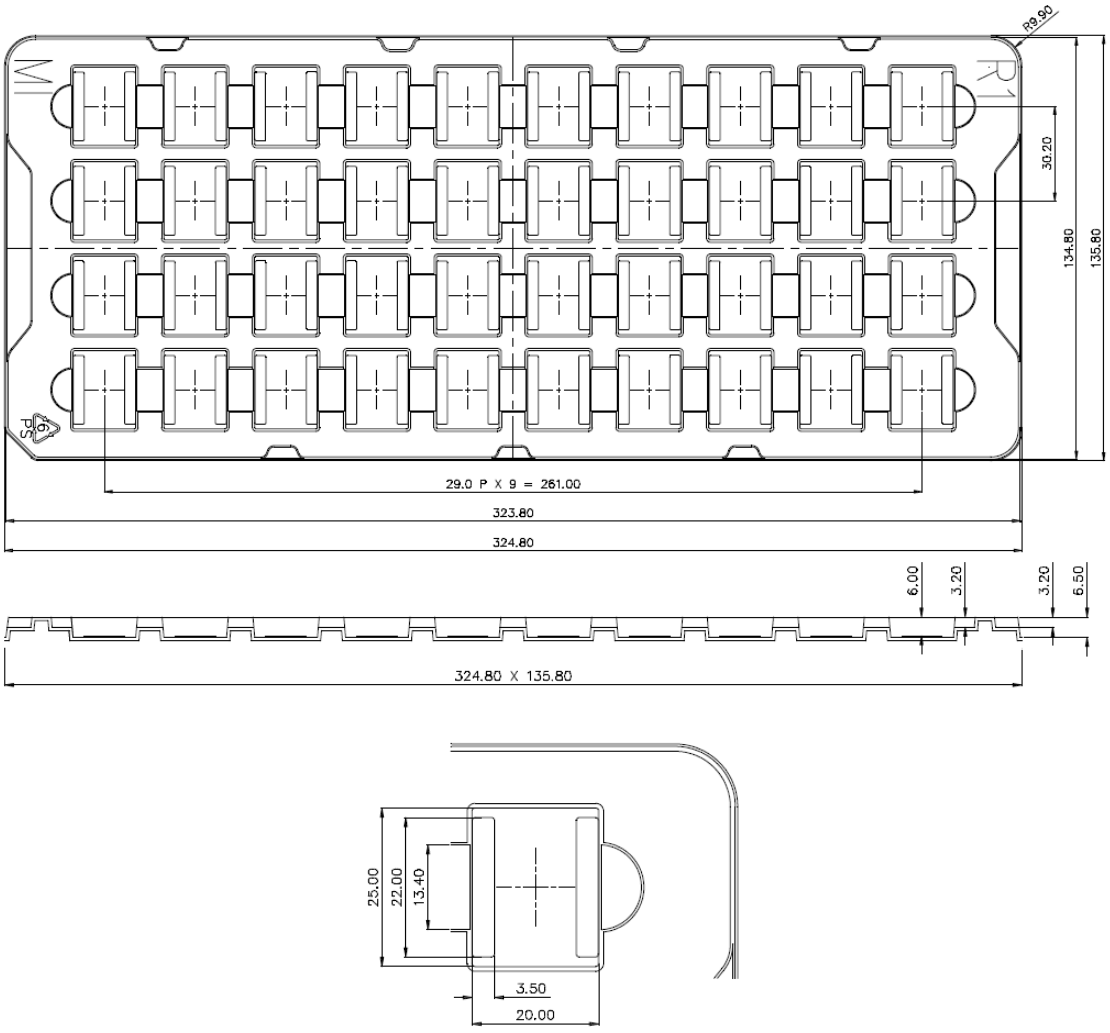
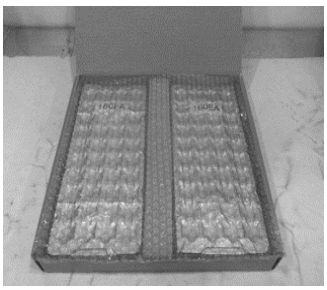


Figure 10 : Packing tray

10.2. Box Packing

R6093U

- 40pcs/Tray (4x10)
- Stack 5 tray (including one empty tray)
- Totally 160pcs (40x4)



- Vacuum sealing
- Cushion bar and bubble sheet
- Totally 320pcs (160x2)

320pcs/Inner box

- 1,280pcs/Carton (320x4)
- Stack 4 inner box

11. RoHS Compliance

The CruizCore® R6093U module and its homogeneous materials comply with European Union's restriction on use of hazardous substances("RoHS") Directive, 2002/95/EC.

12. Handling Precaution

This product includes MEMS sensor. Please handle carefully paying attention to the next points. We recommend to avoid mechanical shocks during handling and transport. The excessive shock may make the characteristic of product change or deteriorate. So please set up your site so that the shock becomes as small as possible. Please be sure to check the characteristics in case that the product is dropped from the desktop and too much shock is applied to the products. This product has built-in protections against high electrostatic discharges or electric fields. However, when the excessive static electricity is charged, product may break. So please use conductive ones for packing and carrying containers.

Contact Information

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