



MS-RA11M Operational Description

1. Product Outline

MS-RA1xM radar modules are the motion sensors that detect motion and speed of objects. As Doppler radar sensor modules, they operate in the 24 GHz ISM band.

The RA1xM series can be categorized into three product groups—MS-RA11M, MS-RA12M, and MS-RA14M—in accordance with a number of their antennas. Table 1 introduces operating ranges of three product groups, which are based on an RCS1 [1m²] (targeting an adult).

Table 1. Operating Ranges of Three Product Groups

Product group	Operating ranges
MS-RA11M	5 to 8 m
MS-RA12M	7 to 10 m
MS-RA14M	9 to 12 m

The range introduced in the table 1 can be adjusted by the operating environment and the gain of the digital amplifier embedded in the module.

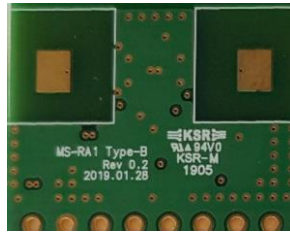
Since the MS-RA1xM module includes an exclusive transceiver for one-chip radars and an MCU for 32-bit signal processing, it has outstanding performance and provides various functions through digital signal processing.

As a one-chip device, the radar IC has almost no margin of error even at a high frequency of 24 GHz and adjusts the temperature to match the external environment with a temperature compensation circuit embedded in the IC.

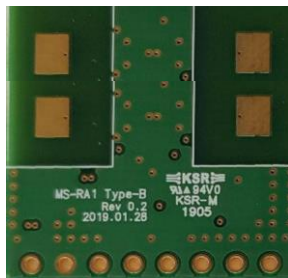
Features such as the digital amplifier, FFT signal processor, and signal comparator can be implemented by using the embedded 32-bit Cortex M0+ MCU, and the functions including fine tuning of detection range (50 stages), configuration of object speed (km/h), configuration of range of 2-stage proximity detection, and prevention of error caused by vibration are supported. These features and functions are configured and adjusted in real time via the serial communication port.

Radar modules comprised of current individual components detect motion using an analog comparator, which is not suitable for more complex situations. The MS-RA1xM module uses digital signal processing to achieve outstanding signal characteristics, and provides features that are completely differentiated from that of other radar modules.

A GUI software application for PC is available to conduct performance tests when developing applications using the MS-RA1xM module, enabling users to easily assess performance and achieve target goals. With the PC software, users can develop their desired products more easily and rapidly by conducting sufficient tests in the stages prior to product development.



MS-RA11M



MS-RA12M



MS-RA14M



Figure 1. Real Chip Size Comparison

2. Features

- A radar module operating in K-Band of 24.05GHz–24.25GHz
- Motion and speed detection available both for indoor and outdoor use
- Product groups with various detection ranges between 5 m and 15 m (detection range is based on human motion, and the maximum range may be adjusted using the embedded digital amplifier and gain controller)
- PCB patch antenna with various operating ranges
- Small (22 x 18 mm/22 x 22.5 mm/33 x 32 mm) and low-power module (60 mA)
- Embedded 32-bit digital signal processing function
 - 8-stage digital amplifier
 - 30-stage gain controller
 - Adjustment of detection range, and detection of micromotion (240-stage fine tuning achieved by a combination of 8-stage digital amplifier and 30-stage gain controller)
 - Detection of object speed (km/h) using 256 FFT
 - Min/max speed detection
 - 2-stage proximity detection
 - Vibration error detection
- Evaluation board and GUI software for simple evaluation of module operations and easy application development
- SDK for development of dedicated software (including signal processing library)
- Temperature compensation circuit maintaining operational features even with changes in environmental conditions
- Embedded protection filter (2.4 GHz Wi-Fi noise immunity) to prevent interference from surrounding noises, especially communication noises
- The most common single power source, 3.3 V power supply operates the device.
- Same interface pins used for all modules to ensure compatibility.

3. Pin Descriptions

Table 2. Pin Descriptions

Pin number	Pin name	Type	Description
1	VCC	POWER	3.3V (Typical) (Note1)
2	GND	POWER	
3	PWM	I/O	User definition I/O (Note2)
4	nRESET	INPUT	Module reset
5	Motion out	OUTPUT	Motion detection signal output
6	IO1	I/O	User definition I/O (Note3)
7	IO2	I/O	User definition I/O (Note3)
8	Velocity out	OUTPUT	Velocity detection signal output
9	RX	INPUT	Command control port
10	TX	OUTPUT	Command control port

NOTES:

1. The MS-RA11M module operates with a precision analog circuit, and offers expected features when connected to a noise-free power supply. The noise-free power can be supplied by filtering the system or power unit using an LC filter.
2. The PWM pin is a general-purpose I/O that is programmed as an input or an output according to the user's purpose. In addition, the PWM pin is connected to the hardware PWM block of the internal MCU, and can be used in lighting control.
3. The I/O pin is a general-purpose I/O that is programmed as an input or an output according to the user's purpose. In addition, the I/O pin is connected to the A/D converter block of the internal MCU, and can be used as an analog input.

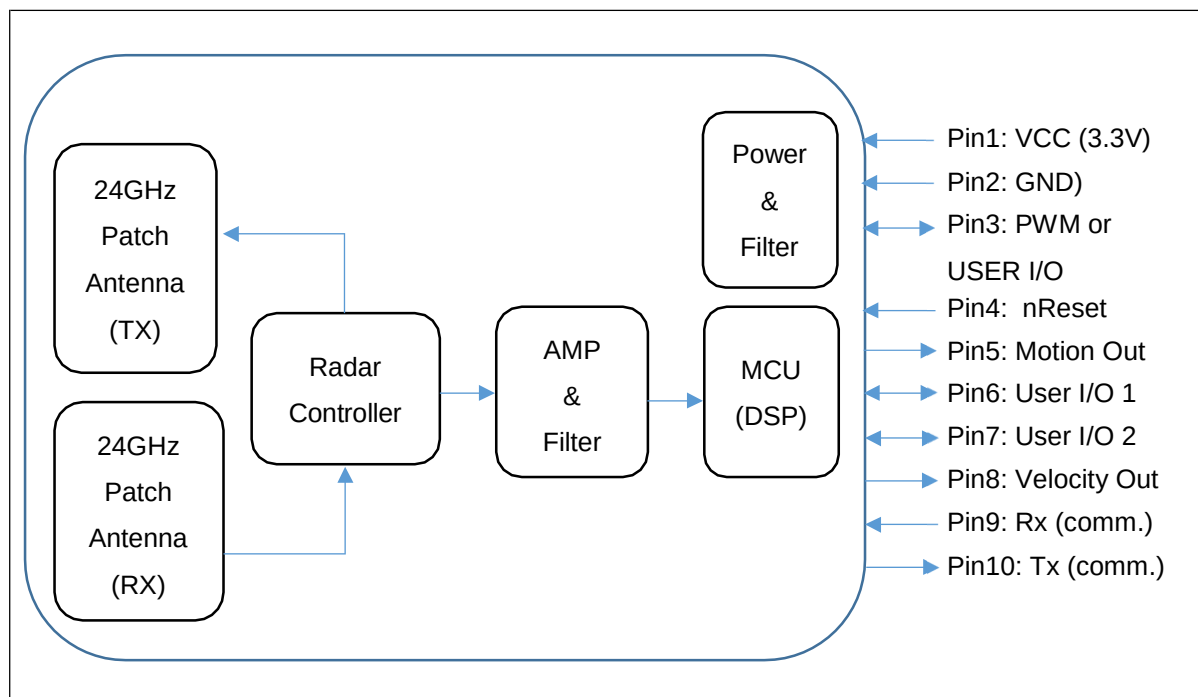


Figure 2. Blocks and Pin Descriptions

Pin 1: VCC

Power noise should be removed as much as possible to ensure normal analog operations of the radar on a 3.3 V operating voltage.

Pin 2: GND

Pin 3: PWM or User I/O

The PWM is connected to the dedicated PWM port of the embedded MCU, and thus can be used as a dimming control port for LED lighting. If the pin 3 is not used as a PWM port, it can be used as a general-purpose I/O.

Pin 4: nReset

Low active reset signal

Pin 5: Motion Out

Motion detection signal output detected by the radar. A motion output signal is produced when motion is detected within the motion detection range set by a user.



Pin 6 / Pin 7: I/O1 / I/O 2

Pin 6 and pin 7 are used for general-purpose user I/O interface signals. These pins are connected to the A/D converter, and thus can be used for analog input signal interface. For instance, pin 6 and pin 7 can be used for temperature measurement with a thermistor or other analog devices.

Pin 8: Velocity Out

A signal is produced if the speed of a detected object falls within the velocity range set by the user. The velocity range can be adjusted from the provided GUI interface. The default value ranges from 1 km/h to 6 km/h.

Pin 9/ Pin 10: Tx/ Rx for Command Control Interface

The MS-RA1xM module is capable of interfacing various information with external MCUs through serial communication. Pin 9 and pin 10 support this interaction. Information about the motion and speed of detected objects can be exchanged in real time with external MCUs, and the range of detection can also be configured in real time.