

OPS243 Short Range Radar Sensor

Feature Set

- 1-100m (3-80') detection range
- Speed reporting up to 222 kph (138mph)
- Speed accurate to within $\pm 0.5\%$
- Direction reporting (Inbound/Outbound)
- Narrow 23° beam width (-3 dB)
- USB, UART, I²C, SPI, and Interrupt interface
- Simple API control
- FCC modular approval (pending)
- Wide operating input voltage, 5-12V
- 1.5W Active power, 0.6W Idle power
- Wide temperature operating range, -40°C to +85°C
- Small form factor 75 x 90 x 12 mm, 15g

The OPS243 is a small form factor, short range radar (SRR) module capable of detecting objects up to 100m away. The module can be used in a number of applications including security, traffic monitoring, drone collision avoidance, robotics, and as an IoT sensor. All radar signal processing is embedded in the module and a simple API is provided to ease system integration. Detected object information is communicated over a USB, UART, or simple interrupt interface and the API provides control over the output format of the data (units, digits, etc.). Data reported over the USB and UART interface includes motion detection, speed, and direction (inbound/outbound). Speed data is accurate to within $\pm 0.5\%$ which meets standards for police radar guns. Objects traveling up to 1,118 kph (695 mph) can be detected.

The detection range of the OPS243 covers a narrow 23° (-3dB point) in both the azimuth and altitude. Target detection range is 25 m (82 ft) for a person and 100 m (328 ft) for large metal objects such as a car. The API provides control over the transmit power which enables custom control over the detection range. Control over the transmit duty cycle is also provided enabling lower power operation. At full continuous power the module consumes 1.5W (target) and idle power (RF disabled) is 0.6W. Duty cycling can enable active modes with power consumption in between these values.

Connecting an OPS243 to a PC (Windows or Mac), Android phone/tablet, or Raspberry Pi is easily managed. By default, speed data is sent as a number in ASCII characters. All other messages are provided in JSON format for easy parsing and manipulation (speed can also be sent by JSON). The JSON output is compatible with emerging IoT standards and technologies such as NodeRed which is standard on Raspberry Pi distributions. This makes the module ready to plug into hybrid

solutions that use multiple sensors and inter-operate with IoT cloud-based solutions. See the applicable application note for interfacing to these products.

The module comes in a very small form factor of 75 x 90 x 12 mm. Utilizing the 24GHz millimeter spectrum, the module can easily be placed behind plastic enclosures and still function correctly.

Advance Information - Subject to Change

Description

Operating Principle

The OPS243 is a simple, short range radar module which provides motion detection, speed, and direction information. All radar signal processing is handled by the on-board ARM processor. The basic principle of the module is to detect Doppler frequency of a moving object and report its speed and direction.

On power-up, the embedded firmware initializes the module for the radar signal processing. After initialization is completed, the green LED will start to blink on a 1 second duty cycle. The default operation is set for data streaming over the UART interface. If the module is connected to a USB interface, it will complete the enumeration triggered by the host and data on the UART will be turned off. The red LED will be lit until the enumeration is complete. If the USB enumeration has not been successful, the red LED will stay lit. Alternatively, the simple interrupt can be used to monitor motion detection. The API provides for a means of filtering detected speed and signal magnitude for triggering the interrupt or which data is reported over the USB and UART interfaces.

When initialization is complete, the firmware will enable the LDO (low dropout) regulator providing power to the 24GHz RF device. With the RF powered up, the internal VCO (voltage controlled oscillator) will start generating the 24.125GHz signal. The initial frequency may not be 24.125GHz and an internal algorithm in the ARM processor is used to sense the VCO frequency and make adjustments to the VCO Control signal.

After a set time period, the ARM processor will enable the RF device to start transmitting a constant wave signal through the on-board transmit patch antennas. If a moving object is detected in the field of view, the transmitted signal will bounce back and be detected by the on-board receive patch antennas. The received signal is mixed with the transmitted signal to down convert to an IF signal which represents the Doppler frequency of the moving object. This signal is filtered and provided to the internal A/D converter of the ARM processor. The radar signal processing converts this signal into speed and direction information which is then output on the USB interface and the LEDs. If the object is moving towards the module, the red LED will light and if away, the blue LED. If direction has been turned off via the API, the green LED will light whenever motion is detected.

A watchdog timer is implemented starting with v1.3.1 firmware. The timer is serviced every 1 second. Upon 2 missed services, the third miss will trigger a board reset. The sensor can be queried for the reason for the reset.

A simple API allows control of the module and information that it provides. See Application Note [AN-010 API Interface Specification](#) for full details on using the API. The default settings of the OPS243 provide speed/direction readings at approximately 5-6 per second. Faster reporting can be achieved by increasing the sample frequency or reducing the buffer size used.

Note the speed reported by the OPS243 is not compensated for the cosine error. See [AN-011 Cosine Error Adjustment](#) to understand how to correct the speed for the angle to the detected object.

Block Diagram

The block diagram of the OPS243 is shown in Figure 1. The key components shown are the RF, IF filtering, ARM processor, and LDO for the RF.

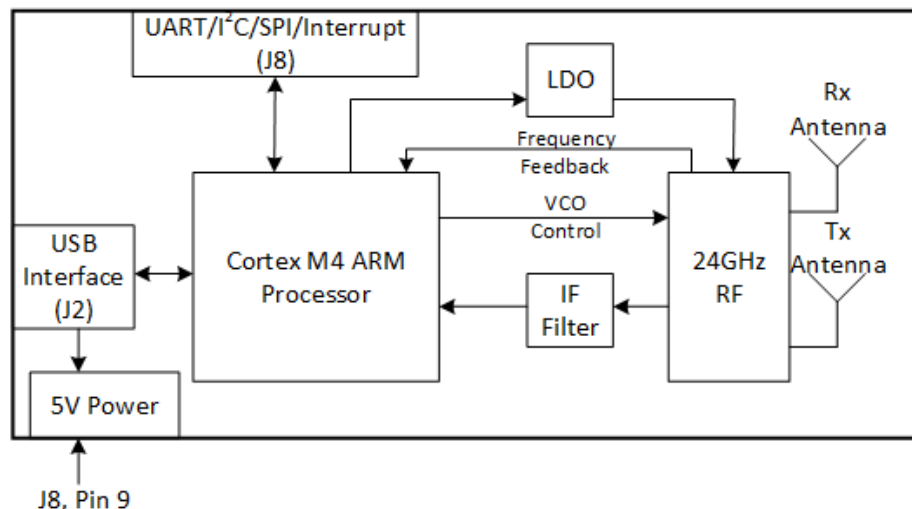


Figure 1. OPS243 Block Diagram

Interface

The OPS243 module provides four interfaces: USB, UART, simple interrupt, and LEDs. USB and UART provide detailed information and control of the module via the API while the simple interrupt and LEDs provide a quick check as to how the module is functioning or presence of an object detected.

USB

The module has a USB 2.0 interface for providing the processed radar information and control over the module via the API. A standard micro USB connector is used. The USB interface is also used to power the module. An alternate means of providing 5V power to the module is through header J3.

UART

The module provides a 3.3V UART interface over the J3 header. Table 1 lists the pin assignment for the Tx/D and Rx/D. The detected speed values stream out over the UART pins upon power-on and can be configured using the same API that is utilized for USB. The default baud rate is 57,600 with options for 9,600 through 115,200. The default configuration is 8-bit, no parity, one stop bit.

Table 1. J3 Header Pins (all signals 3.3V except Power and Ground)

Pin	Direction	Pin Name	Pin Description
1	Input/Output	GPIO	General purpose I/O
2	Input/Output	GPIO	General purpose I/O
3	Output	Host Interrupt	Interrupt from OPS243 to system
4	Input	/Reset	System reset of OPS243 (active low)
5	Input	SPI SEL	SPI device select
6	Input	SPI MOSI/RxD	SPI data input/UART receive
7	Output	SPI MISO/SDA/TxD	SPI data output/I ² C data/UART transmit
8	Input	SCL/SCK	SPI/I ² C clock
9	-	5V	Power
10	-	Ground	Ground

I²C/SPI

The OPS243 provides connections for I²C and SPI interfaces on J3. As of firmware version 1.3.3 these I/O are not supported. The pins are available for future support.

Simple Motion Interrupt

A simple interrupt is provided for motion detection. The signal comes out to pin 3 (Host Interrupt) on the J3 header and is 3.3V tolerant. It is enabled by the API command "IG". The signal is high when no object is detected and low when an object is detected. See [AN-16 Simple Motion Detection Interrupt](#) for further explanation of the usage of this signal and how to filter speed and magnitude.

Reset

A Reset pin is provided on the J3 header to reset the OPS243 radar sensor. The pin is active low with a required low time of 200ns to be active. After releasing the pin, the processor will start up within 2μs. The code will start to execute and in default mode initial data will be available to start streaming after 300ms.

GPIO

Two general purpose I/O pins are provided on the OPS243. These are reserved for future use.

Host Interrupt

A Host Interrupt pin is provided for the OPS243 to signal the host system there is data to pull from the sensor. Firmware to support this pins usage is not currently supported as of v1.3.3.

LED

LEDs are provided to give a quick understanding of the module operation. There are four LEDs on the module, red, green, orange, and an RGB LED. The LEDs functions are listed in

Table 2. Some variations on the LED operation may be made based on the version of code used. Check the API application note AN-10 for the latest descriptions.

Table 2. LED Functions

LED	Function	Reference	Notes
Red	USB enumeration	D3	Turns off when USB enumeration completed
Green	Heartbeat timer	D4	1 second duty cycle
Orange	Not used	D5	
RGB	Red – Inbound direction Blue – Outbound direction Green – Motion detection	D7	Green only used if direction detection turned off via API

Antenna Pattern

The OPS243 provides a narrow coverage with its patch antennas. The target beamwidth in the azimuth and altitude is 23° (-3 dB point). Minimal signal is transmitted behind the module due to its construction which helps eliminate false detections. The narrow antenna pattern coverage is shown in Figure 2.

(pattern to be provided)

Figure 2. Antenna Pattern

Detection Range

The detection range of the OPS243 is dependent on the object to be detected or its RCS (radar cross section). Generally, the OPS243 will detect human movement up to 25 m out and a large object (higher RCS value) such as a car at 100 m. As the object moves more to the right or left of the module center, the detection range will decrease.

Electrical Specifications

Target Absolute Maximum Ratings

$T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ with all voltages with respect to ground.

Parameter	Symbol	Min	Typ	Max	Units	Notes
Supply Voltage	V_{dd}	4.75		5.25	V	USB interface, per USB specification
Supply Voltage	V_{dd}	4.75		12.0	V	Pin 9 on header J3
Power Dissipation	P_{max}			1.6	W	
Operating Temperature	T_a	-40		85	$^{\circ}\text{C}$	
Storage Temperature	T_{stg}	-40		105	$^{\circ}\text{C}$	

Target Operating

$T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ with all voltages with respect to ground.

Parameter	Symbol	Min	Typ	Max	Units	Notes
Transmit Frequency	F_{tx}	24	24.125	24.25	GHz	
Transmit Power	P_{tx}	6	11	15	dBm	$24\text{GHz} \leq F_{tx} \leq 24.25\text{GHz}$
Transmit Power Adjustment	P_{txadj}	3	9		dB	Adjustable via API
Idle Transmit Power	P_{txadj}			-30	dBm	Not transmitting
Antenna Gain	G_{ant}		15		dBi	
Receive Antenna Azimuth	RA_{azi}		23 ¹		$^{\circ}$	-3 dB beamwidth
Receive Antenna Altitude	RA_{alt}		23 ¹		$^{\circ}$	-3 dB beamwidth
Active Current Consumption	I_{cc}		TBD	TBD	mA	Actively transmitting
Idle Current Consumption	I_{idl}		TBD	TBD	mA	Not transmitting
Reset Time	T_{RST}	200			ns	

Startup Time	T_{SRT}			2	μs	Processor startup time after release of T_{RST}
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¹ Without any EM lensing.

/RESET Pin

$T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ with all voltages with respect to ground.

Parameter	Symbol	Min	Typ	Max	Units	Conditions
HIGH Level Input Voltage	V_{IH}	2.475			V	
LOW Level Input Voltage	V_{IL}			0.99	V	
Input Leakage Current	I_{IN}			34	μA	
Input Capacitance	C_{IN}		5		pF	

Input SPI SEL, SPI MOSI/RxD, SCL/SCK Pins

$T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ with all voltages with respect to ground.

Parameter	Symbol	Min	Typ	Max	Units	Conditions
HIGH Level Input Voltage	V_{IH}	2.0		3.6	V	
LOW Level Input Voltage	V_{IL}	-0.3		1.18	V	
Input Leakage Current	I_{IN}	-1		1	μA	
Input Capacitance	C_{IN}		10		pF	

Output HOST INT, SPI MISO/SDA/TxD Pins

$T_A = -40\text{ }^{\circ}\text{C}$ to $85\text{ }^{\circ}\text{C}$ with all voltages with respect to ground.

Parameter	Symbol	Min	Typ	Max	Units	Conditions
HIGH Level Output Voltage	V_{OH}	2.9			V	$I_{OH} \geq -1.4\text{mA}$
		2.4			V	$I_{OH} \geq -2\text{mA}$
Low Level Output Voltage	V_{OL}			0.4	V	$I_{OL} \leq 2\text{mA}$
Motion Detect Time ¹	T_{MOL}	$2 \times T_{PROC}$			ms	

1. T_{PROC} is the time one report takes to process which is dependent on the sample rate and the buffer size setting. The default setting, 10ksps and 1024 buffer size, has a T_{PROC} of approximately 156ms and T_{MOL} minimum time is 312ms.

Advance Information - Subject to Change

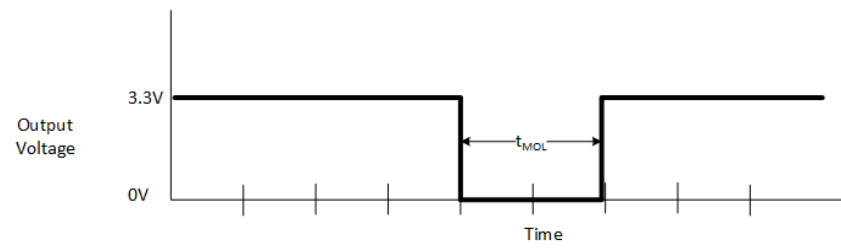


Figure 3. Host Interrupt Minimum Low Time

Advance Information - Subject to Change

Mechanical Specifications

The mechanical outline drawing for the OPS243 is shown in Figure 4. All units are in mm [mils].

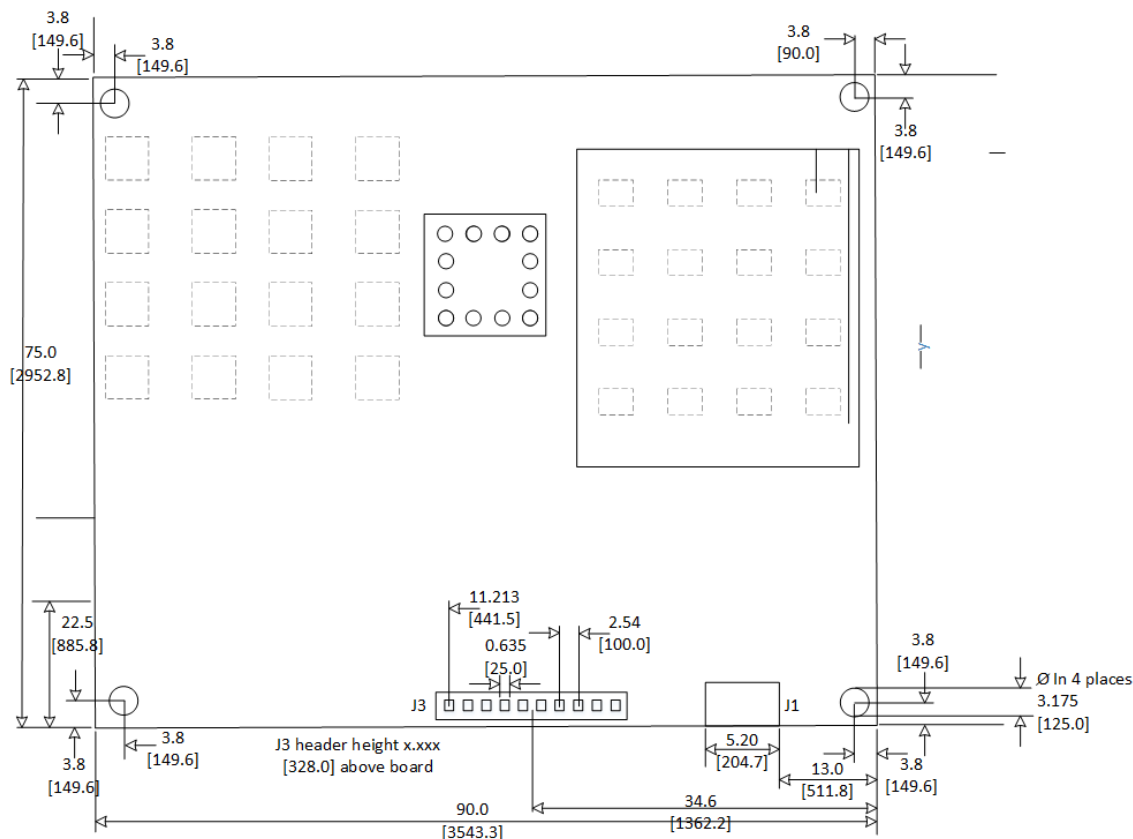


Figure 4. Mechanical Specifications

Ordering Information

The full part number for the OPS243 module is the OPS243-A-CW-RP. Please use this part number when submitting orders.

FCC Notice and Liability Disclaimer

(statement pending)

Advance Information - Subject to Change

Revision History

Version	Date	Notes
0.1	March 28, 2019	Advance information release.

Advance Information - Subject to Change