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D3 Engineering

RS-1843AOP
Radar
Sensor

D3 Engineering RS-1843AOP Radar Sensor User Guide

Contents

D3 Engineering

D3 Engineering RS-1843AOP Radar Sensor

RS-1843AOP RF Compliance Notices

The following RF emissions statements apply exclusively to the RS-1843AOP model radar sensor.

FCC and ISED Identification Label
The RS-1843AOP device has been certified to be in compliance with FCC Part 15 and ISED ICES-003. Due to its size the required FCC ID including the grantee code is included in this manual below.
FCC ID: 2ASVZ-01
Due to its size the required IC ID including the company code is included in this manual below.
IC: 30644-01

FCC Compliance Statement
This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

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.
   Please note that changes or modifications not expressly approved by the party responsible for compliance
   could void the user's authority to operate the equipment. Changes or modifications not expressly approved by
   the party responsible for compliance could void the user's authority to operate the equipment.

FCC RF Exposure Statement
This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter. In order to

avoid the possibility of exceeding the FCC radio frequency exposure limits, this equipment should be installed and operated with minimum distance 20 cm (7.9 in) between the antenna and your body during normal operation. Users must follow the specific operating instructions for satisfying RF exposure compliance.

ISED Non-Interference Disclaimer
This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. This device may not cause interference.
2. This device must accept any interference, including interference that may cause undesired operation of the device. This device complies with the Canadian ICES-003 Class A specifications. CAN ICES-003(A) / NMB-003 (A).

ISED RF Exposure Statement
This equipment complies with ISED RSS-102 radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm (7.9 inches) between the radiator and any part of your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

FCC and ISED Modular Approval Notice
This module was approved under a Limited Modular Approval, and because the module has no shielding, each other host which is not identical in construction/material/configuration would have to be added through a Class II Permissive Change with appropriate assessment following C2PC procedures. This section provides module integration instructions as per KDB 996369 D03.

List of Applicable Rules See section 1.2.

Summary of the Specific Operational Use Conditions
This Modular Transmitter is approved for use only with specific antenna, cable and output power configurations that have been tested and approved by the manufacturer (D3). Modifications to the radio, the antenna system, or power output, that have not been explicitly specified by the manufacturer are not permitted and may render the radio non-compliant with applicable regulatory authorities.

Limited Module Procedures
See the remainder of this integration guide and section 1.7.

Trace Antenna Designs
There are no provisions for external trace antennas.

RF Exposure Conditions
See section 1.3.

Antennas
This device employs an integrated antenna which is the only configuration approved for use. Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Label and Compliance Information
The end product must carry a physical label or shall use e-labeling following KDB 784748 D01 and KDB 784748 stating: "Contains Transmitter Module FCC ID: 2ASVZ-01, IC: 30644-01" or "Contains FCC ID: 2ASVZ-01, IC: 30644-01".

Information on Test Modes and Additional Testing Requirements
See section 1.7.

Additional Testing, Part 15 Subpart B Disclaimer
This modular transmitter is only FCC authorized for the specific rule parts listed on the grant, and the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

EMI Considerations
While this module was found to pass EMI emissions alone, care should be taken when used with additional RF sources to prevent mixing products. Best design practices should be used with regard to electrical and mechanical design to avoid creating mixing products and to contain/shield any additional EMI emissions. A host manufacturer is recommended to use D04 Module Integration Guide recommending as "best practice" RF design engineering testing and evaluation in case non-linear interactions generate additional non-compliant limits due to module placement to host components or properties.

Integration Instructions

Class 2 Permissive Change Test Plan

When this module is to be used in an end device with a different host, the end device must be tested to ensure compliance has been maintained, and the results must be submitted as a Class 2 Permissive Change. FCC Class II Permissive Change filing by the grantee (Define Design Deploy Corp, 150 Lucious Gordon Dr., West Henrietta NY 14586 USA) is required for each new host configuration. To perform the testing, the worst-case chirp profile should be hard-coded in the firmware or input into the command UART port to begin operation as listed in Figure 1 below.

```
sensorStop
flushCfg
dfeDataOutputMode 1
channelCfg 15 7 0
adcCfg 2 1
adcbufCfg -1 0 1 1 1
profileCfg 0 77 4 6 200 0 0 20 1 64 2500 0 0 30
chirpCfg 0 0 0 0 0 0 0 1
chirpCfg 1 1 0 0 0 0 0 2
chirpCfg 2 2 0 0 0 0 0 4
frameCfg 0 2 16 0 30 1 0
lowPower 0 0
guiMonitor -1 1 1 0 0 0 1
cfarCfg -1 0 2 8 4 3 0 15 1
cfarCfg -1 1 0 4 2 3 1 15 1
multiObjBeamForming -1 1 0.5
clutterRemoval -1 0
calibDcRangeSig -1 1 -5 8 128
extendedMaxVelocity -1 0
lvdsStreamCfg -1 0 0 0
compRangeBiasAndRxChanPhase 0.0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0 1 0
measureRangeBiasAndRxChanPhase 0 1.5 0.2
CQRxSatMonitor 0 3 19 125 0
CQSigImgMonitor 0 125 16
analogMonitor 0 0
aoaFovCfg -1 -90 90 -90 90
cfarFovCfg -1 0 0 31.50
cfarFovCfg -1 1 -.32 .32
calibData 0 0 0
enableSpreadSpec 1
sensorStart
```

Figure 1. Worst-Case Chirp Config

After this configuration is activated, proceed to test compliance to the applicable agency specifications as described below.

Test Objective: Verify the electromagnetic emissions of the Product.

Specifications:

- Transmit output power according to FCC Part 95.3367, with limits of 55 dBm/MHz Peak and 50 dBm/MHz RMS.
- Spurious unwanted emissions according to FCC Part 95.3379, with limits below 40 GHz according to FCC 15.209 within bands listed in FCC 15.205, and limit of -30 dBm/MHz above 40 GHz

Setup:

- Place the Product on the turn platform within the anechoic chamber.
- Position the measurement antenna on the antenna mast at a distance of 3 meters from the Product.
- For fundamental power set transmitter to operate in continuous mode on the highest aggregate power, and highest power spectral density to confirm continued compliance.
- For band edge compliance, set the transmitter to operate in continuous mode on the widest and the narrowest bandwidths per modulation type.
- For radiated spurious emissions up to 10th harmonic the following three parameters should be tested:
  - widest bandwidth,

- highest aggregate power, and
- highest power spectral density.
- If according to the radio module's initial test report these conditions do not all combine in the same mode, then multiple modes should be tested: set transmitter to operate in continuous mode at low, mid and top channels with all the supported modulations, data rates and channel bandwidths until the modes with these three parameters have been tested and confirmed.

Rotation and Elevation:

- Rotate the turn platform 360 degrees.
- Gradually raise the antenna from 1 to 4 meters.
- **Purpose**: Maximize emissions and verify compliance with Quasi-peak limits below 1 GHz and Peak/Average limits above 1 GHz; and compare with the appropriate limits.

Frequency Scans:

- Initial scan: Cover frequency ranges from 30 MHz to 1 GHz.
- Subsequent scan: Change measurement setup for above 1 GHz measurements.

Verification:

- Verify fundamental emission levels, according to FCC Part 95.3367 within passband 76–81 GHz.
- Check harmonics according to FCC Part 95.3379.

Extended Scans:

- Continue scanning for frequency ranges:
    - 1–18 GHz
    - 18–200 GHz (10th harmonic of fundamental)

Spurious Emissions:

- Verify against quasi-peak, peak and average limits.

INTRODUCTION

This document describes how to use the D3 Engineering DesignCore® RS-1843AOP, RS-6843AOP, and RS-6843AOPA single-board mmWave sensor modules.
The sensors covered in this integration guide have an identical form factor and interfaces. Here is a summary of the different models. More information can be found in the data sheet for the given device.

Table 1. RS-x843AOP Models

Model	Device	Frequency Band	Antenna Pattern	Qualification (RFIC)
RS-1843AOP	AWR1843AOP	77 GHz	Azimuth Favored	AECQ-100
RS-6843AOP	IWR6843AOP	60 GHz	Balanced Az/El	N/A
RS-6843AOPA	AWR6843AOP	60 GHz	Balanced Az/El	AECQ-100

MECHANICAL INTEGRATION

Thermal and Electrical Considerations

The sensor board has to evacuate up to 5 Watts to avoid overheating. The design includes two surfaces that should be thermally coupled to some form of heatsink that is designed to perform this transfer. These are at the side edges of the board where the screw holes are. A polished metal surface should contact the bottom of the board from the edge approximately 0.125" inward. The surface can be relieved to avoid shorting three via areas on the bottom. There is solder mask over the vias that provides insulation, however in an environment with vibration it is safest to create a void above them. Figure 2 shows the locations of the via areas.
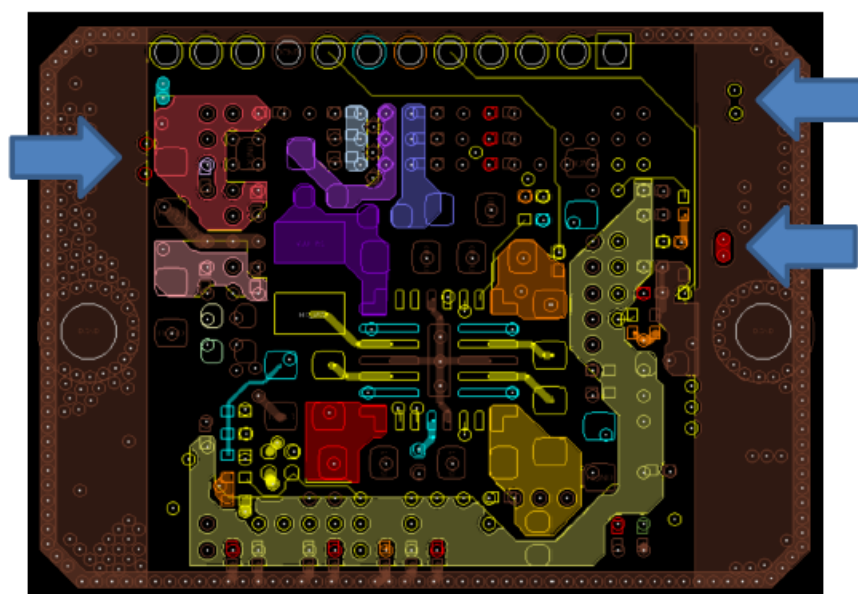

Figure 2. View through circuit board top-down

Antenna Orientation

It should be noted that the application firmware can operate with any orientation of the sensor, but some prebuilt applications may assume a given orientation. Please verify that the orientation configured in the software matches the actual placement of the sensor.

Enclosure and Radome Considerations

It is possible to create a cover over the sensor, but the cover must appear invisible to the radar by making it a multiple of a half wavelength in the material. More on this can be found in section 5 of TI's application note found here: **https://www.ti.com/lit/an/spracg5/spracg5.pdf**. D3 Engineering offers consulting services on Radome design.

INTERFACES

There is just one interface for the RS-x843AOP module, a 12-pin header. The header is Samtec P/N SLM-112-01-G-S. There are several mating options. Please consult Samtec for different solutions.
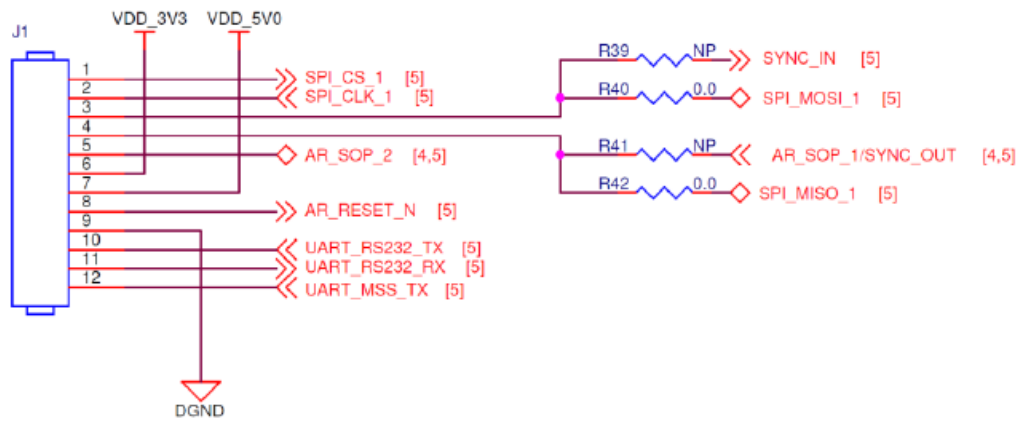
Figure 3. 12-Pin Header

Please reference the table below for more details on the header pinout. Please note that most I/Os can be used as general purpose I/Os as well, depending on the software loaded. These are denoted with an asterisk.

Table 2. 12-Pin Header Pin List

Pin Number	Device Ball Number	Direction WRT Sensor	Signal Name	*Function* / Device Pin Functions	Voltage Range
1*	C2	Input	SPI_CS_1	SPI Chip Select GPIO_30 SPIA_CS_N CAN_FD_TX	0 to 3.3 V
2*	D2	Input	SPI_CLK_1	SPI Clock GPIO_3 SPIA_CLK CAN_FD_RX DSS_UART_TX	0 to 3.3 V

3*	U12/F2	Input	SYNC_IN SPI_MOSI_1	Synchronization Input SPI Main Out Secondary In GPIO_28, SYNC_IN, MSS_UARTB_RX, DMM_MUX_IN, SYNC_OUT GPIO_19, SPIA_MOSI, CAN_FD_RX, DSS_UART_TX	0 to 3.3 V
4*	M3/D1	Input or Output	AR_SOP_1 SYNC_OUT SPI_MISO_1	Boot option input Synchronization Output SPI Main In Secondary Out SOP[1], GPIO_29, SYNC_OUT, DMM_MUX_IN, SPIB_CS_N_1, SPIB_CS_N_2 GPIO_20, SPIA_MISO, CAN_FD_TX	0 to 3.3 V

5*	V10	Input	AR_SOP_2	Boot option input, high to program, low to run SOP[2], GPIO_27, PMIC_CLKOUT, CHIRP_START, CHIRP_END, FRAME_START, EPWM1B, EPWM2A	0 to 3.3 V
6	N/A	Output	VDD_3V3	3.3 Volt output	3.3 V
7	N/A	Input	VDD_5V0	5.0 Volt input	5.0 V
8	U11	Input and Output	AR_RESET_N	Resets RFIC NRESET	0 to 3.3 V
9	N/A	Ground	DGND	Voltage Return	0 V
10	U16	Output	UART_RS232_TX	Console UART TX (note: not RS-232 levels) GPIO_14, RS232_TX, MSS_UARTA_TX, MSS_UARTB_TX, BSS_UART_TX, CAN_FD_TX, I2C_SDA, EPWM1A, EPWM1B, NDMM_EN, EPWM2A	0 to 3.3 V
11	V16	Input	UART_RS232_RX	Console UART RX (note: not RS-232 levels) GPIO_15, RS232_RX, MSS_UARTA_RX, BSS_UART_TX, MSS_UARTB_RX, CAN_FD_RX, I2C_SCL, EPWM2A, EPWM2B, EPWM3A	0 to 3.3 V
12	E2	Output	UART_MSS_TX	Data UART TX (note: not RS-232 levels) GPIO_5, SPIB_CLK, MSS_UARTA_RX, MSS_UARTB_TX, BSS_UART_TX, CAN_FD_RX	0 to 3.3 V

SETUP

The RS-x843AOP Sensor is programmed, configured, and started via the Console UART.

Requirements

- TI mmWave SDK: https://www.ti.com/tool/MMWAVE-SDK
- TI Uniflash Utility: https://www.ti.com/tool/UNIFLASH
- TI mmWave Visualizer: https://dev.ti.com/gallery/view/mmwave/mmWave_Demo_Visualizer/ver/3.5.0/
- RS-232 to TTL adapter (with Ribbon cable to mate with the header) or D3 AOP USB Personality board

- 5 Volt supply, rated for at least 1.5 A

Programming

To program, the board must be reset or powered up with the AR_SOP_2 signal (pin 5) held high for the rising edge of reset. Following this, use a PC serial port with an RS-232 to TTL adapter or a PC USB port with the AOP USB personality board to communicate with the sensor over pins 10 and 11. Ensure there is a ground connection to the board from the adapter as well. Use TI's Uniflash utility to program the Flash connected to the RFIC. The demo application is found within the mmWave SDK. For example: "C:\ti\mmwave_sdk_03_05_00_04\packages\ti\demo\xwr64xx\mmw\xwr64xxAOP_mmw_demo.bin". D3 Engineering offers many other customized applications as well.

Running the Application

To run, the board must be reset or powered up with the AR_SOP_2 signal (pin 5) open or held low for the rising edge of reset. Following this, a host can communicate with the command line of the sensor. If you are using a host with RS-232 levels, an RS-232 to TTL adapter must be used. The command line depends on the application software running, but if using the mmWave SDK demo application, you can find the command line documentation within your install of the SDK. You may also use the TI mmWave Visualizer to configure, run, and monitor the sensor. This can be run as a web application or downloaded for local use. With the standard demo application, data output from the sensor is available on pin 12 (UART_MSS_TX). The data format is described within the documentation for the mmWave SDK. Other software may be written that performs other functions and uses the peripherals differently.

Table 3. Revision History

Revision	Date	Description
0.1	2021-02-19	Initial Issue
0.2	2021-02-19	Added Other Pin Functions and Radome and Antenna Information
0.3	2022-09-27	Clarifications
0.4	2023-05-01	Addition of FCC Statements for RS-1843AOP
0.5	2024-01-20	Correction to FCC and ISED statements for RS-1843AOP
0.6	2024-06-07	Further corrections to FCC and ISED statements for RS-1843AOP
0.7	2024-06-25	Addition of Modular Approval Class 2 Permissive Change Test Plan
0.8	2024-07-18	Refinement of Limited Modular Approval information

Documents / Resources

D3 Engineering RS-1843AOP Radar Sensor [pdf] User Guide
AWR1843, 2ASVZ-01, 2ASVZ01, RS-1843AOP Radar Sensor, RS-1843AOP, Radar Sensor, Sensor

References

- 🔵 **mmWave Demo Visualizer**
- 🔴 **UNIFLASH Software programming tool | TI.com**

- **User Manual**