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AV01-RF Manual
Deadman Technologies, LLC Transceiver Module
AV01-RF, version 0.1

AV01-RF is a wireless transceiver data module with reasonably small form factor, low power consumption, good stability and reliability. It has wide application uses in remote control, industry automation, wireless telemetry and remote consumer applications. This module has an embedded micro-controller and is highly versatile with several General Purpose Input and Output (GPIO) options for equipment and other devices' connectivity.

AV01-RF is designed with Texas Instruments CC2510F32 transceiver chip with embedded MCU. The module comes preprogrammed from the factory employing spread spectrum diversity and compliant to FCC 15.241

Changes or modifications not expressly approved by Deadman Technologies, LLC could void the user's authority to operate the equipment.

FCC

The following statement must be placed in the finish product users manual:

Changes or modifications not expressly approved by Deadman Technologies, LLC could void the user's authority to operate the equipment.

Or equivalently:

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

The following statement must be placed in the finish product users manual[1]:

"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."

The following statement is required to be placed on the product. If the product is too small, (defined by <4 x 4 inches) or if approved by the FCC, this statement may be placed in the manual.

"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."

The finished product label must state the following:
Contains FCC ID: 244KR-AV01RF
Contains IC: 11230A-AV01RF
The FCC ID and/or IC certification numbers must be placed on a non-removable portion of the exterior of the finished product. Contact Deadman Technologies, LLC for questions regarding placement of certification numbers.

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[1] For class B devices (intended for residential use), contact Deadman Technologies for changes to required statements.

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Industry Canada

The following statements (both English and French versions of the text) must be placed in the finish product users manual:

English	French
This device complies with Industry Canada licence-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.

For laboratory use wherein FCC and IC approvals are not required:

The Texas Instruments CC2510 data sheet is appended in this users manual for detailed instructions on programming, register settings and all other performance specifications related to the GPIO, MCU programming and device performance. The IAR workbench is required to adjust and reprogram the product. *Any adjustment or reprogramming voids the users authority to use the product outside the laboratory.*

The device comes with one IO assigned from the factory. If additional IO assignments are required, contact Deadman Technologies, LLC for firmware development of up to 21 GPIO with custom defined interrupt routines.

The electrical specifications in the CC2510 data sheet are fully applicable to this module and must be adhered to (see the CC2510 data sheet). Summary technical specifications are:

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1. Summary Technical Specifications

PERFORMANCE

Power Output:	Programmable up to 0dBm
RF Line-of-sight Range:	300m
RF Effective Rate:	Programmable up to 500kBaud
Receiver Sensitivity:	-103dBm@2.4kBaud

NETWORKING

Networking Topology:	Point-to-point, point-to-multipoint

POWER

Supply Voltage:	3.3 VDC external
Transmit Current:	26mA typical
Receive Current:	19.7mA typical
Sleep current:	0.220 mA typical

GENERAL

Communication Mode:	Half-duplex
Frequency Band:	2400Mhz – 2483.5Mhz; The module is programmed at the factory and certified with two hopping frequencies of 2405MHz and 2425MHz **Any changes to the hopping frequencies voids the FCC certification unless recertified by the user or by Deadman Technologies, LLC.**
Channel:	2 – default; multiple programmable BW/spacing dependent
Interface:	I^2S, UART, USB

PHYSICAL PROPERTIES

Size:	30mm×36mm×7mm
Weight:	20g
Antenna Base:	50Ω, chip antenna with balun
Operating Temperature:	Industrial:-40℃~+85℃
Frequency Stability:	±40ppm total tolerance including a) initial tolerance, b) crystal loading, c) aging, and d) temperature dependence.

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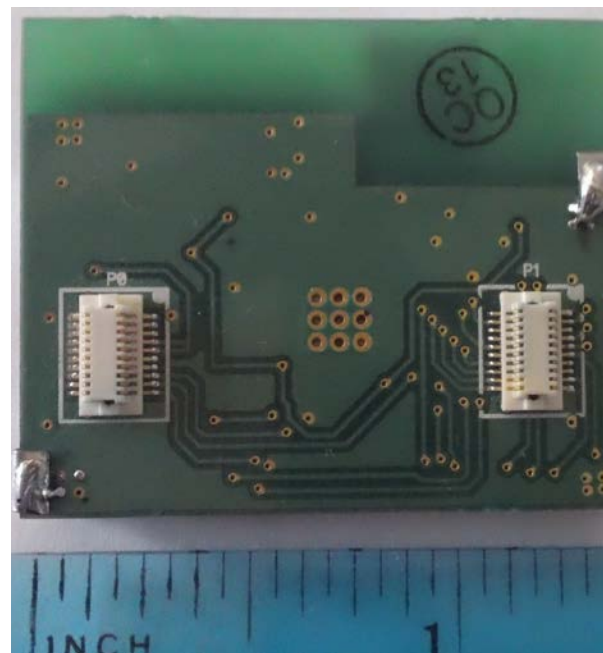
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2. AV01-RF Module Application Field

* AMR (Automatic Meter Reading)
* Wireless alarm and security systems
* Building automation, wireless monitoring, Access Control System;
* Wireless data transmission, automatic data collection system;
* Wireless remote control,
* Wireless LED display,
* Industry automation, wireless telemetry, SCADA
* Other ISM wireless data communication needs

3. How To Use The AV01-RF

TOP   BOTTOM

1. Requires regulated 3.3VDC power supply

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AV01-RF Module Pin Out			
AV01-RF Pin	CC2510F32 Pin	CC2510F32F Function	AV01-RF Function
Connector P0			
1	nc	nc	nc
2	nc	nc	nc
3	nc	nc	nc
4	2,10,19,22,25,26,28,29	regulated DVDD, AVDD and Guard	3.3VDC power input
5			3.3VDC power input
6	nc	nc	nc
7	nc	nc	nc
8	36	Reset	Transceiver Reset
9	1	P1_2	GPIO
10	14	P2_0	GPIO (transmitter trigger input, receiver trigger output)
11	nc	nc	nc
12	11	P0_5	GPIO
13	gnd	ground	ground
14	gnd	ground	ground
15	gnd	ground	ground
16	gnd	ground	ground
17	gnd	ground	ground
18	gnd	ground	ground
19	gnd	ground	ground
20	gnd	ground	ground
Connector P1			
1	gnd	ground	ground
2	9	P0_4	GPIO
3	6	P0_1	GPIO
4	7	P0_2	GPIO
5	8	P0_3	GPIO
6	5	P0_0	GPIO
7	3	P1_1	GPIO
8	12	P0_6	GPIO (Output for AV01-RF)
9	13	P0_7	GPIO (Output for AV01-RF)
10	gnd	ground	ground
11	32	P1_7	GPIO
12	33	P1_6	GPIO
13	34	P1_5	GPIO
14	35	P1_4	GPIO
15	16	P2_2	GPIO
16	15	P2_1	GPIO
17	nc	nc	nc
18	4	P1_0	GPIO
19	36	P1_3	GPIO
20	nc	nc	nc

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Step 1:

    a. Design in the Hirose mating connector to plug the AV01-RF module into the application product. Hirose mating connector DF12D(3.5)-20DP-0.5V(81) can be purchased from Digikey or other distribution channels.

       Use 25mm center to center in the connector layout as shown below:

25mm center on center of the connectors
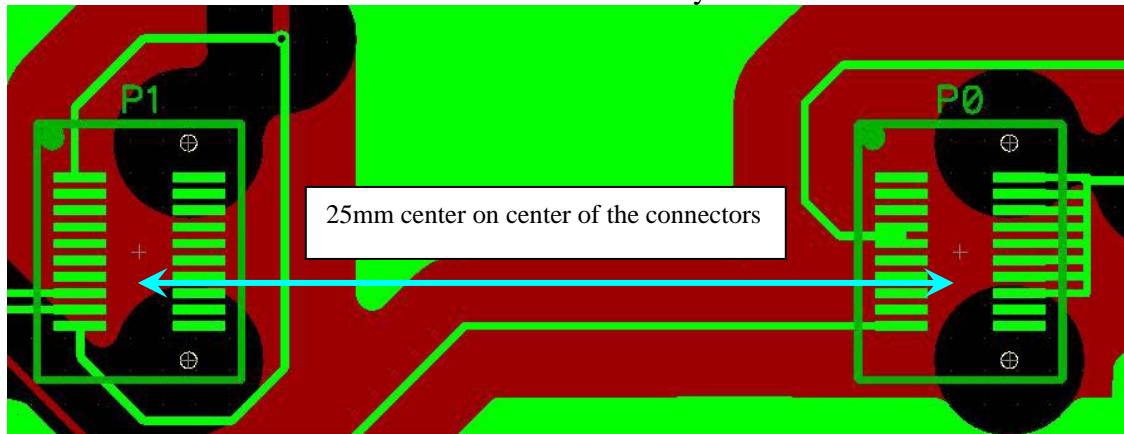
Step 2:

Connector P0 pin 10 is transmitter trigger input and receiver trigger output per the connector list above and shown in the layout picture above. Outputs from AV01-RF are on Connector P1 pins 8, 9 (see the connector list and layout picture above). IOs are described in more detail below.

    a. See CC2510 data sheet for electrical specifications on GPIO pins.

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4. Operational Description

4.0 <u>Overview</u>

This module may operate as a transceiver for relay control, remote controller or other point to point data link solutions. The module is a transceiver operating/hopping at 2.405GHz and 2.425GHZ and is capable of operating/hopping the full range of 2400MHZ – 2483.5MHZ, however **any changes to the hopping frequencies voids the FCC certification unless recertified by the user or by Deadman Technologies, LLC.**

The equipment module is comprised of a transceiver, antenna, balun, crystal oscillator, biasing resistors and filtering capacitors. The equipment module can be installed in a variety of systems for wireless data transmission in the 2400MHZ – 24835MHZ range.

Modules can be purchased as Transmitter or Receiver modules or as custom transceiver solutions for simplex data communications for point to point transmissions. If point to multipoint or multipoint to multipoint topology is required, please contact Deadman Technologies, LLC for custom application support.

Modules have two active high outputs (Connector P1, pins 8, 9) for LED indication or other use. Transmitter only has these two outputs and one trigger input. Receiver has these two outputs and one additional output for trigger synchronization with the transmitter. Contact Deadman Technologies, LLC custom application support for use of additional IO needs.

The transmission link between two modules is secure by means of Deadman Technologies, LLC proprietary firmware code. It is not possible to add another transmitter or receiver to the link except through custom application support for point to multipoint or multipoint to multipoint applications. Moreover, for an established link there is no cross talk between nearby adjacent links of other compatible modules. All links are secure and completely independent of adjacent links.

There is no learning or other effort required between modules. An AV01-RF receiver is only compatible with an AV01-RF transmitter. Any receiver can link with any transmitter. Once a link is established, the link is locked and no other devices can connect. The link is secure and data will only pass between the linked transmitter and receiver.

4.1 <u>Operational Information</u>

The equipment module is a wireless frequency hopping system. The COTS products are preprogrammed as Transmitter or Receiver modules for point to point simplex data communications. Although the modules are ordered as "Transmitter" and "Receiver" they both transmit and receive via continuous handshaking and are indeed transceivers. Custom transceiver code that retains FCC certification compliance can be installed through Deadman Technologies, LLC. For custom application support, please contact Deadman Technologies, LLC.

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4.1.1. Transmit Mode (order the dash 'T' option as part number AV01-RF-T)

The module comes preprogrammed for transmit mode such that RF transmission requires a trigger input on Connector P0, pin 10, active high. The module transmits only when a trigger is present and will cease transmission within 1 second (typical 0.1 second) of trigger termination.

The module is in sleep mode until a trigger is present. Sleep mode current is less than 1uA. Wake up time is typically 0.1ms (100us). The module will return to sleep mode within 30 seconds after trigger is removed and remain in sleep mode until a trigger is applied. 30 seconds sleep delay can be changed by Deadman Technologies, LLC custom application support team.

In sleep mode the two outputs are turned off to conserve power.

4.1.2. Receive Mode (order the dash 'R' option as part number AV01-RF-R)

The Module comes preprogrammed for receive mode such that the module is in receive mode until it receives connectivity request from a compatible transmit module. When connectivity is established and the transmitter has a trigger, the receiver will output an active high on Connector P0, pin 10.

The receive module never enters sleep mode. If sleep mode is required for the receive module, contact Deadman Technologies, LLC for custom application support.

When the receive module receives a connectivity request from a compatible transmit module, it will acknowledge the transmission and two systems will establish a link.

The receiver will remain linked to the transmitter continuously providing the transmitter has a trigger. If the trigger is removed from the transmitter for about 30 seconds, continuously, then the two modules will release the link and the receiver will revert back to constant receive mode, listening for a compatible Transmitter.

The trigger may be removed and reapplied to the transmitter within 30 seconds to retain the link. Link disintegration will only occur if the trigger is removed for a duration of about 30 seconds.

4.2 Theory of Operation

The Receiver is constantly listening for a compatible Transmitter. When a compatible transmission is detected from a compatible Transmitter, the receiver will acknowledge the transmitter and the two units will establish a secure link.

Handshaking occurs continuously during the link. Handshaking communications dictate hopping periods which are proprietary to Deadman Technologies, LLC and are compliant to FCC requirements. **Any changes to the code voids the FCC certification and requires recertification by the user or by Deadman Technologies, LLC.**

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Modules have two active high outputs (Connector P1, pins 8, 9) for LED indication or other use. The following table shows the conditions and logic levels of the two output pins.

Condition	PIN 8	PIN 9
sleep	off	off
no link	low	high
link, with trigger	high	low
link, no trigger	toggles at ~300ms intervals	low

Alternative IO configurations for FCC compliant custom applications can be achieved through Deadman Technologies, LLC or by the user recertifying the module.

4.3 Regulation reference
    FCC 15.249

4.4 Nominal transmit frequency
    2.405 and 2.425 GHz

> **Any changes to the hopping frequencies voids the FCC certification and requires recertification by the user or by Deadman Technologies, LLC.**

Transmit frequency is controlled by a 26.00 MHz crystal oscillator
The maximum tolerance is +/− 50ppm.

4.5 Modulation scheme
    Minimum-Shift Keying (MSK), no Manchester coding
    Phase shifts are performed with a constant transition time
    Data rate is set at 250kBaud with typical selectivity shown in Fig.2
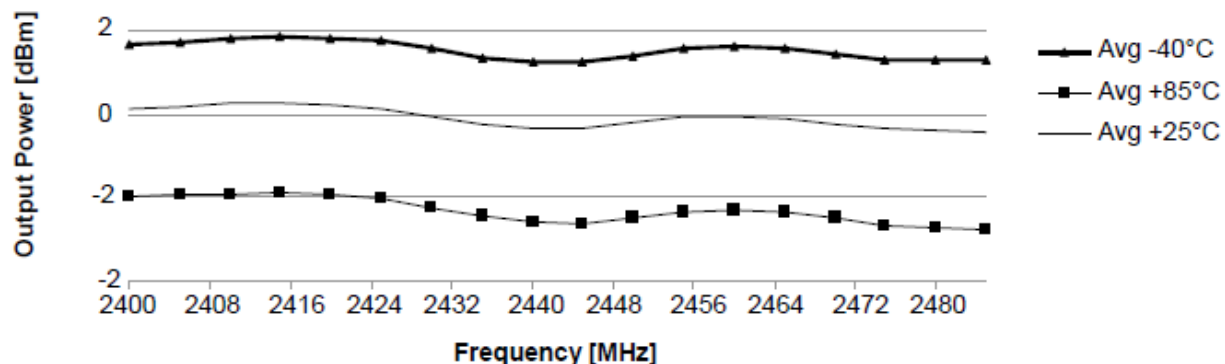
Figure 1: Transmit data

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$T_A = 25°C$, VDD = 3.0 V

Parameter	Min	Typ	Max	Unit	Condition/Note
Differential load impedance		80 + j74		Ω	Differential impedance as seen from the RF-port (RF_P and RF_N) towards the antenna.
Output power, highest setting		1		dBm	Output power is programmable and is available across the entire frequency band. See Figure 3 typical variation over operating conditions (output power is 0 dBm) Delivered to a 50 Ω single-ended load
Output power, lowest setting		−30		dBm	Output power is programmable and is available across the entire frequency band Delivered to a 50 Ω single-ended load
Occupied bandwidth (99%)		−28		dBc	2.4 kBaud, 38.2 kHz deviation, 2-FSK, 250 kHz channel spacing
		−27		dBc	10 kBaud, 38.2 kHz deviation, 2-FSK, 250 kHz channel spacing
		−22		dBc	250 kBaud, MSK, 750 kHz channel spacing
		−21		dBc	500 kBaud, MSK, 1 MHz channel spacing
Spurious emissions					0 dBm output power.
25 MHz - 1 GHz			−36	dBm	
47 - 74, 87.5 - 118, 174 - 230, and 470 - 862 MHz			−54	dBm	
1800 - 1900 MHz			−47	dBm	Restricted band in Europe
At 2·RF and 3·RF			−41	dBm	Restricted bands in USA
Otherwise above 1 GHz			−30	dBm	

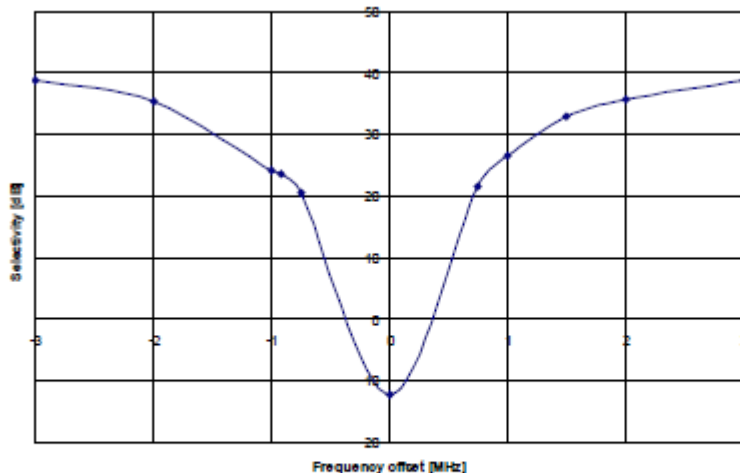**RF Transmit Section**

Typical Variation in Output Power (0 dBm) over Frequency and Temperature

Figure 2: Typical Selectivity

Typical Selectivity at 250 kBaud. IF Frequency is 457 kHz.
MDMCFG2.DEM_DCFILT_OFF=1

5. Custom Design Needs

For all deviations from this design to meet custom design criteria, please contact:

Deadman Technologies, LLC
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Tel: 1-800-436-4435

Appendix A

Link to CC2510F32 data sheet:
http://www.ti.com/product/cc2510f32

To view the full data sheet, click on the page shown below.

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CC2511F8 - Not Recommended for New Designs

CC2510Fx / CC2511Fx

Low-Power SoC (System-on-Chip) with MCU, Memory, 2.4 GHz RF Transceiver, and USB Controller

Applications

- *2400 - 2483.5 MHz ISM/SRD band systems*
- *Consumer electronics*
- *Wireless keyboard and mouse*
- *Wireless voice-quality audio*
- *RF enabled remote controls*
- *Wireless sports and leisure equipment*
- *Low power telemetry*
- *CC2511Fx: USB dongles*

Product Description

The *CC2510Fx/CC2511Fx* is a true low-cost 2.4 GHz system-on-chip (SoC) designed for low-power wireless applications. The *CC2510Fx/CC2511Fx* combines the excellent performance of the state-of-the-art RF transceiver *CC2500* with an industry-standard enhanced 8051 MCU, up to 32 kB of in-system programmable flash memory and 4 kB of RAM, and many other powerful features. The small 6x6 mm package makes it very suited for applications with size limitations.

The *CC2510Fx/CC2511Fx* is highly suited for systems where very low power consumption is required. This is ensured by several advanced low-power operating modes. The *CC2511Fx* adds a full-speed USB controller to the feature set of the *CC2510Fx*. Interfacing to a PC using the USB interface is quick and easy, and the high data rate (12 Mbps) of the USB interface avoids the bottlenecks of RS-232 or low-speed USB interfaces.
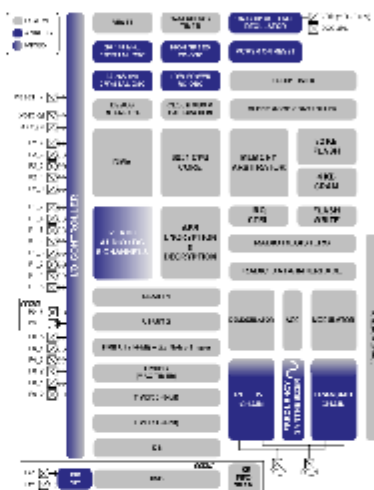
Key Features

- **Radio**
    - High-performance RF transceiver based on the market-leading CC2500
    - Excellent receiver selectivity and blocking performance
    - High sensitivity (−103 dBm at 2.4 kBaud)
    - Programmable data rate up to 500 kBaud
    - Programmable output power up to 1 dBm for all supported frequencies
    - Frequency range: 2400 - 2483.5 MHz
    - Digital RSSI / LQI support

- **Current Consumption**
    - Low current consumption (RX: 17.1 mA @ 2.4 kBaud, TX: 16 mA @ −6 dBm output power)
    - 0.3 µA in PM3 (the operating mode with the lowest power consumption)

- **MCU, Memory, and Peripherals**
    - High performance and low power 8051 microcontroller core.
    - 8/16/32 kB in-system programmable flash, and 1/2/4 kB RAM
    - Full-Speed USB Controller with 1 kB USB FIFO (*CC2511Fx*)
    - I^2S interface
    - 7 - 12 bit ADC with up to eight inputs
    - 128-bit AES security coprocessor
    - Powerful DMA functionality
    - Two USARTs
    - 16-bit timer with DSM mode
    - Three 8-bit timers
    - Hardware debug support
    - 21 (*CC2510Fx*) or 19 (*CC2511Fx*) GPIO pins

- **General**
    - Wide supply voltage range (2.0V - 3.6V)
    - Green package: RoHS compliant and no antimony or bromine, 6x6mm QFN 36