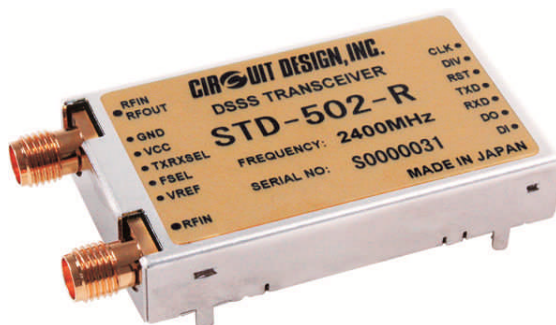2.4 GHz DSSS low power radio transceiver
STD-502-R

Operation Guide
Version 0.9 (Feb. 2013)

Preliminary

CIRCUIT DESIGN, INC.

7557-1 Hotaka, Azumino
Nagano 399-8303 JAPAN
Tel: 0263-82-1024
Fax: 0263-82-1016

e-mail: info@circuitdesign.jp
http://www.circuitdesign.jp

1. Outline

The STD-502-R operates in the 2.4 GHz band available worldwide. Designed to be embedded in equipment, this radio transceiver module was developed for industrial applications that require stable and reliable operation. With battery operation, it achieves line of sight radio communication beyond 300 m.

Besides using highly noise-resistant direct-sequence spread spectrum (DSSS) modulation, the module has a true diversity receiver function for preventing signal dropout due to multipath fading. This ensures highly stable and reliable radio communication in the congested 2.4. GHz ISM band.

The transceiver uses a transparent input/output interface, enabling users to use their own protocols. In addition, the transceiver can transmit data that includes long consecutive identical bits that cannot be transmitted with conventional radio modules.

2. Features and applications

Features

- Direct sequence spectrum (DSSS)
- True diversity receiving
- Communication range 300 m (LOS)
- Low power operation 10 mW, 3.3 V, 68 mA
- Data rate 19.2 kbps
- Built-in data frame coincidence detection function
- Operating temperature range -20 to +65°C
- Compliance with European EN300 440, American FCC Part 15.247, and Japan ARIBSTD-T-66 regulations

Applications

- Remote control of industrial equipment
- Industrial telemetry and monitoring systems

3. Specifications

General specifications

* All values are taken with the antenna ports terminated with 50 ohm and at 25 degree C +/- 5 degree C unless otherwise noted

Item	Specification	Unit	Remarks
Applicable standard	EN300 440-1, FCC part 15.247, ARIB STD-T66		
Communication method	Simplex		
Emission type	Direct sequence spread spectrum		
Modulation method	FSK		
Number of channels	77ch (Ch 0 to Ch 76)		
Antenna connection	RP-SMAJ		
Dimensions	50 × 30 × 9 (W x D x H)	mm	RP-SMAJ and power & signal connector pins excluded
Weight	24	g	

Interface specifications

Item	Specification			Unit	Remarks
Interface for module setting	Baud rate: 19.2 kbps (typ.), No parity Character: 8 bits, Stop bit : 2 bits				Baud rate 19.2 / 38.4 / 57.6 kbps
	Input	TXD	L = 0 to 0.25 H = Vref - 0.4 to Vref	V	UART [1]
	Output	RXD	L = 0 to 0.25 H = Vref - 0.4 to Vref	V	UART [1]
RX data output	DO		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	RX data out using a transparent method [1]
CLK for data input/output	CLK		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	[1]
TX data input	DI		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	TX data out using a transparent method [1]
Diversity receiving antenna	DIV		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	Shows on which antenna data is received. [1]
TX/RX switching terminal	TXRXSEL		L = 0 to 0.3 H = Vcc - 0.4 to Vcc	V	H: RX / L: TX
RF standby terminal	STBY		L = 0 to 0.3 H = Vcc - 0.4 to Vcc	V	H: Standby / L: RF operation
Reset terminal	RST		L = 0 to 0.25 H = Vcc - 0.4 to Vcc	V	Reset with L for more than 100 us
Communication level reference terminal	VREF		3.1 - 5.5	V	Vref (a terminal for applying a reference voltage consistent with the external communication level)

[1] " H" level depends on the voltage level applied to the communication level reference terminal.

Electrical specification (Common)

Item	Specification	MIN	TYP	MAX	Unit	Remarks
Operating voltage		3.3		5.5	V	
TX current	Vcc = 3.3 V		66		mA	at 10 mW
RX current	Vcc = 3.3 V		75		mA	
TX/RX frequency range	2.4 GHz band	2402.5		2478.5	MHz	Refer to the frequency table
Operating temperature range	-20°C to + 65°C	-20		65	°C	No dew condensation
Storage temperature range	-30°C to +90°C	-30		90	°C	No dew condensation
Aging rate	< +/- 1 ppm / year	-1		1	ppm	TX / RX Lo frequency
Initial frequency tolerance	+/- 10 ppm within one year from shipment	-10		10	ppm	Transmission frequency
Oscillation type	Fractional N PLL controlled VCO					
Frequency stability	+/- 10 ppm (-20 to +65°C)	-10		10	ppm	Reference temp. = 25 C
Channel spacing	1 MHz		1		MHz	
Data bit rate	19.2 kbps		19.2		kbps	can be changed with the command
Chip rate	288 kcps		288		kcps	can be changed with the command
Number of chips	M-sequence (111101010001100)		15		bit	
PLL reference frequency	26		26		MHz	TCXO : NT2520SA

Electrical specification (Transmitter)

Item	Specification	MIN	TYP	MAX	Unit	Remarks
Output power	-10 to +55°C /all channels		10		mW	
	-20 to +65°C /all channels	2		TBD		
Spurious emission	TBD				dBm	EN300 440-1 compliant
Adjacent channel power	TBD				dBc	EN300 440-1 compliant
Occupied frequency bandwidth	TBD				kHz	EN300 440-1 compliant
Actuation time	Power on -> command reception			42	ms	Power on in the TX mode
	Command reception -> TX			5	ms	Country code reception -> stable RF output
	Frequency change			3	ms	Command transmission -> Stable RF output
	RX to TX			2	ms	Terminal input -> Stable operation
	Recovery from standby			1.2	ms	Standby -> stable RF output

Electrical specification (Receiver)

Item		Specification	MIN	TYP	MAX	Unit	Remarks
Reception method		Low IF					
Maximum input level					-13	dBm	
Receiver sensitivity (BER, 9.6 kbps)		-20 to + 65°C /all channels		-93		dBm	error rate = < 1 %
Receiver sensitivity (BER, 19.2 kbps)		-20 to + 65°C /all channels		-93		dBm	error rate = < 1 %
Blocking		EN300 440-1 compliant	-45			dBm	2 signal test, 1% error
Spurious radiation (1st Lo)						dBm	
Actuation time	Power on -> County code reception				42	ms	Power on in the RX mode
	Command reception -> RX				5	ms	
	Frequency change				3	ms	Command reception -> RX start
	TX to RX				2	ms	Terminal input -> Stable operation
	Recovery from standby				1.2		Standby -> RX start

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4. Terminal specifications

Terminal No.	Terminal name	Input/ Output	Input/Output level (V)		Internal equivalent circuit
			Low	Hi	
1	CLK	Output	0 to 0.25	Vref -0.4 to Vref	
		TX: Synchronous CLK for TX data input RX: Synchronous CLK for RX data output			
2	DIV	Output	0 to 0.25	Vref -0.4 to Vref	
		This terminal shows which of the two receiving terminals received the signal actually used for data output. .			
3	RST	Input	0 - 0.25	Vcc -0.4 to Vcc	
		The initialization terminal for coincidence detection function*. The internal ASIC is reset with 'L' level for more than 100 µs. Normally set this terminal to 'H'. * For details of the frame coincidence detection function, refer to "Frame coincidence detection function" on page 16.			
4	TXD	Input	0 to 0.25	Vref -0.4 to Vref	
		The input terminal for serial communication.			

DIV table:

DIV	Data receiving terminal
L	RF in
H	RF in/out

Settings for serial communication:

Settings for serial communication	
Baud rate	19.2 kbps
Character bits	8 bits
Parity	none
Stop bits	2 bits

Terminal No.	Terminal name	Input/ Output	Input/Output level (V)		Internal equivalent circuit
			Low	**Hi**	
5	RXD	Output	0 to 0.25	Vref -0.4 to Vref	
		The output terminal for serial communication. **Settings for serial communication** Baud rate — 19.2 kbps Character bits — 8 bits Parity — none Stop bits — 2 bits			
6	DO	Output	0 to 0.25	Vref -0.4 to Vref	
		The RX data output terminal. Outputs RX data in synchronization with the clock from the RX-CLK. The DO data should be read at the rising clock edge of the RX-CLK			
7	DI	Input	0 to 0.25	Vref -0.4 to Vref	
		The TX data input terminal. Inputs TX data in synchronization with the clock from the TX-CLK. Data should be set to the DI at the falling clock edge of the TX-CLK.			
8	TXRX SEL	Input	0 - 0.3	Vcc -0.4 to Vcc	
		The terminal for switching the TX mode and RX mode. Setting this terminal to 'L' enables the TX mode and setting to 'H' enables the RX mode.			
9	NC	Input	0 - 0.3	Vcc -0.4 to Vcc	
		Sets the STD-502-R into RF-standby state. Setting this terminal to L enables normal operation and setting to H enables RF-standby. RF-standby can be used to reduce the current consumption.			
10	Vref	Input	3.1	5.5	
		The input terminal for interface reference voltage. Communication can be performed using the voltage level applied to this terminal.			

5. Frequency table

CH No.	Channel No. (Hex)	Frequency [MHz]	CH No.	Channel No. (Hex)	Frequency [MHz]
0	00	2402.5	39	27	2441.5
1	01	2403.5	40	28	2442.5
2	02	2404.5	41	29	2443.5
3	03	2405.5	42	2A	2444.5
4	04	2406.5	43	2B	2445.5
5	05	2407.5	44	2C	2446.5
6	06	2408.5	45	2D	2447.5
7	07	2409.5	46	2E	2448.5
8	08	2410.5	47	2F	2449.5
9	09	2411.5	48	30	2450.5
10	0A	2412.5	49	31	2451.5
11	0B	2413.5	50	32	2452.5
12	0C	2414.5	51	33	2453.5
13	0D	2415.5	52	34	2454.5
14	0E	2416.5	53	35	2455.5
15	0F	2417.5	54	36	2456.5
16	10	2418.5	55	37	2457.5
17	11	2419.5	56	38	2458.5
18	12	2420.5	57	39	2459.5
19	13	2421.5	58	3A	2460.5
20	14	2422.5	59	3B	2461.5
21	15	2423.5	60	3C	2462.5
22	16	2424.5	61	3D	2463.5
23	17	2425.5	62	3E	2464.5
24	18	2426.5	63	3F	2465.5
25	19	2427.5	64	40	2466.5
26	1A	2428.5	65	41	2467.5
27	1B	2429.5	66	42	2468.5
28	1C	2430.5	67	43	2469.5
29	1D	2431.5	68	44	2470.5
30	1E	2432.5	69	45	2471.5
31	1F	2433.5	70	46	2472.5
32	20	2434.5	71	47	2473.5
33	21	2435.5	72	48	2474.5
34	22	2436.5	73	49	2475.5
35	23	2437.5	74	4A	2476.5
36	24	2438.5	75	4B	2477.5
37	25	2439.5	76	4C	2478.5
38	26	2440.5			

6. External dimensions
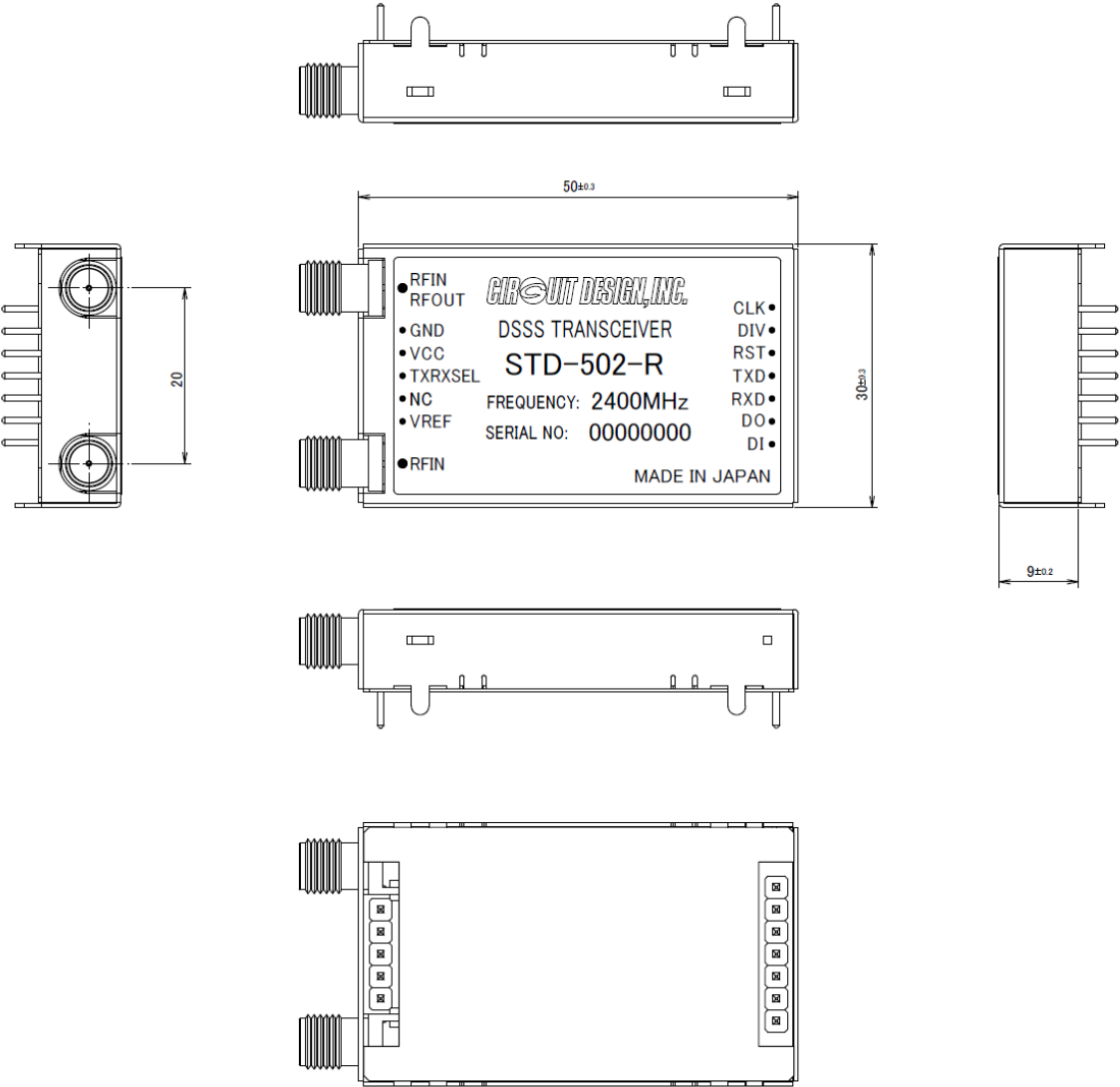
Regulatory compliance information

Regulatory Statement for FCC

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.

Caution: Any changes or modifications not expressly approved by the party responsible for product compliance could void the user's authority to operate the equipment.

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
—Reorient or relocate the receiving antenna.
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help.

Labeling:
FCC ID: V9X-STD502R
The proposed FCC ID label format is to be placed on the module. If FCC ID is not visible when the module is installed into the system, "Contains FCC ID: V9X-STD502R shall be placed on the outside of final host system.

Caution: Exposure to radio frequency radiation
To comply with FCC RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons. This device must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

Antenna
Only those antennas with same type and lesser gain filed under this FCC ID number can be used with this device.

The antenna used this module is as follows;
Antenna Type & Antenna Gain;
Sleeve Antenna, 2dBi
Loop PCB Antenna, 1.89dBi
Coaxial Antenna, 1.67dBi

Instructions to OEM Integrators
The final system integrator must ensure there is no instruction provided in the user manual or customer documentation indicating how to install or remove the transmitter module.

To comply with FCC RF exposure compliance requirements, a separation distance of at least 20 cm must be maintained between the antenna of this device and all persons. This device must not be co-located or operating in conjunction with any other antenna or transmitter, except in accordance with FCC multi-transmitter product procedures.

DoC and restrictions for CE

Hereby, Circuit Design, Inc., declares that this STD-502-R is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.
This equipment is marked with the $C\epsilon$ symbol and can be used throughout the European community.
This indicates compliance with the R&TTE Directive 1999/5/EC and meets the relevant parts of following technical specifications:

EN 300 440-2, Electromagnetic compatibility and Radio spectrum Matters (ERM);Short range devices; Radio equipment to be used in the 1 GHz to 40 GHz frequency range; Part 2: Harmonized EN covering the essential requirements of article 3.2 of the R&TTE Directive

EN 301 489-17, Electromagnetic Compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 17: Specific Conditions for Wideband Data and HYPERLAN Equipment.

EN 60950-1, Safety of Information Technology Equipment.

EN 62311, Assessment of electronic and electrical equipment related to human exposure restrictions for electromagnetic fields (0 Hz-300 GHz).

Remark:
This module is for a portable application. The OEM integrator will need to conduct full EMC testing in accordance with EN301 489-17 in the final use configuration.

Caution: Exposure to radio frequency radiation
This device must not be co-located or operating in conjuction with any other antenna or transmitter.

Important notice

- Customers are advised to consult with Circuit Design sales representatives before ordering. Circuit Design believes the provided information is accurate and reliable. However, Circuit Design reserves the right to make changes to this product without notice.
- Circuit Design products are neither designed nor intended for use in life support applications where malfunction can reasonably be expected to result in significant personal injury to the user. Any use of Circuit Design products in such safety-critical applications is understood to be fully at the risk of the customer and the customer must fully indemnify Circuit Design, Inc for any damages resulting from any improper use.
- As the radio module communicates using electronic radio waves, there are cases where transmission will be temporarily cut off due to the surrounding environment and method of usage. The manufacturer is exempt from all responsibility relating to resulting harm to personnel or equipment and other secondary damage.
- The manufacturer is exempt from all responsibility relating to secondary damage resulting from the operation, performance and reliability of equipment connected to the radio module.

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Cautions

- Do not use the equipment within the vicinity of devices that may malfunction as a result of electronic radio waves from the radio module.
- Communication performance will be affected by the surrounding environment, so communication tests should be carried out before actual use.
- Ensure that the power supply for the radio module is within the specified rating. Short circuits and reverse connections may result in overheating and damage and must be avoided at all costs.
- Ensure that the power supply has been switched off before attempting any wiring work.
- The case is connected to the GND terminal of the internal circuit, so do not make contact between the '+' side of the power supply terminal and the case.
- When batteries are used as the power source, avoid short circuits, recharging, dismantling, and pressure. Failure to observe this caution may result in the outbreak of fire, overheating and damage to the equipment. Remove the batteries when the equipment is not to be used for a long period of time. Failure to observe this caution may result in battery leaks and damage to the equipment.
- Do not use this equipment in vehicles with the windows closed, in locations where it is subject to direct sunlight, or in locations with extremely high humidity.
- The radio module is neither waterproof nor splash proof. Ensure that it is not splashed with soot or water. Do not use the equipment if water or other foreign matter has entered the case.
- Do not drop the radio module or otherwise subject it to strong shocks.
- Do not subject the equipment to condensation (including moving it from cold locations to locations with a significant increase in temperature.)
- Do not use the equipment in locations where it is likely to be affected by acid, alkalis, organic agents or corrosive gas.
- Do not bend or break the antenna. Metallic objects placed in the vicinity of the antenna will have a great effect on communication performance. As far as possible, ensure that the equipment is placed well away from metallic objects.
- The GND for the radio module will also affect communication performance. If possible, ensure that the case GND and the circuit GND are connected to a large GND pattern.

Warnings

- Do not take apart or modify the equipment.
- Do not remove the product label (the label attached to the upper surface of the module.) Using a module from which the label has been removed is prohibited.