2.4 GHz DSSS low power radio transceiver

STD-503

Operation Guide

Version 2.2 (Jan. 2022)

- This product requires electrical and radio knowledge for setup and operation.
- To ensure proper and safe operation, please read this operation guide thoroughly prior to use.
- Please keep this operation guide for future reference.

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Contents

1. Outline

The STD-503 operates in the 2.4 GHz band available worldwide. Designed to be embedded in equipment, this small 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.
The communication setting of the STD-503 can be configured via serial communication (UART).

2. Features and applications

Features

- Direct-sequence spread spectrum (DSSS)
- Transparent input/output interface (Clock synchronization)
- True diversity reception
- Small and thin 40 x 29 x 5.5 mm
- Communication range 300 m (LOS)
- Low power operation 3.3 V, TX 48 mA (Typ.), RX 55 mA (Typ.)
- Channel stepping option controlled via CHC pin
- Data rate 19.2 kbps
- Built-in data frame detection function
- Operating temperature range -20 to +65°C
- Compliant with EN300 440, FCC Part 15.247, IC RSS-210 and ARIB STD-T66 regulations

Applications

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

3. Specifications

General specifications

All values were measured with the antenna ports terminated into 50 ohm and at 25 degree C +/- 5 degree C unless otherwise noted.

Item	Specification
Applicable standard	EN300 440, FCC part 15.247, ARIB STD-T66, IC RSS-210
Communication method	Simplex
Transmission method	Direct sequence spread spectrum
Modulation method	FSK
Operation frequency range	2.4 GHz band (2402.5 – 2478.5 MHz), 1-MHz step, 77 channels
Number of channels	77ch (Ch 0 to Ch 76)
Antenna connector *1	MHF connector
Dimensions	40 × 29 × 5.5 (W x D x H) mm
Weight	10 g
Soldering conditions	Hand soldering Soldering iron temp.: 350°C within 3 seconds

*1 Mating cycles: 30 cycles when tested using a dedicated tool.
Depending on the way of antenna placement and/or the condition of use, RF connector may be easily disconnected. Please take measures such as fixing the connector accordingly.

Interface specifications

Item	Specification			Unit	Remarks
Interface for command setting	Bit rate: 19.2 kbps (typ.), No parity Data length: 8 bits, Stop bit : 2 bits				Bit rate 19.2 / 38.4 / 57.6 kbps
	Output	TXD	L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	UART
	Input	RXD	L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	UART
RX data output	DO		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	RX data out using transparent format
CLK for data input/output	CLK		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	
TX data input	DI		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	TX data in using transparent format
Diversity receiving antenna	DIV		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	Shows on which antenna the data is received.
TX/RX switching terminal	TXRXSEL		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	H:RX / L:TX
RF standby terminal	STBY		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	H:RF operation / L:Standby
Reset terminal	RST		L = 0 to 0.25 H = Vref - 0.4 to Vref	V	Reset with L for more than 100 us
Interface reference terminal	VREF		3.1 - Vcc	V	Vref (a terminal for applying a reference voltage to fix the external interface level)
Channel change terminal	CHC		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	Switches between the pre-set channels.
Channel change enable terminal	LE		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	Enables the channel change terminal.
Channel reset terminal	CLR		L = 0 to 0.25 H = Vref - 0.4 to Vref *2	V	Resets the channel.

*2 " H" level depends on the voltage level applied to the interface level reference terminal (VREF).
* The input terminals should be driven with an open-drain or a CMOS output. .

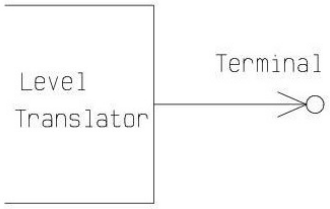
Electrical specification

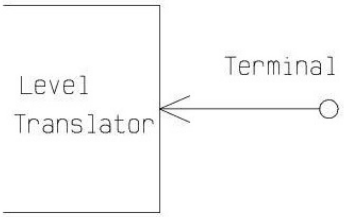
Item	Conditions	MIN	TYP	MAX	Unit	Remarks
Operating voltage		3.3		5.0	V	Absolute max. voltage 5.5V
TX current	Vcc = 3.3 V		48	59	mA	
Output power	-20 °C to +65 °C /all channels	2	5	6.1	mW /MHz	Conducted 50 ohm
RX current	Vcc = 3.3 V		55	65	mA	
Receiver sensitivity	-20 to + 65°C /all channels		-93		dBm	Bit error rate = < 0.1 %
Maximum input level				-13	dBm	
Operating temperature range		-20		65	°C	No dew condensation
Storage temperature range		-30		80	°C	No dew condensation
Frequency drift		-1		1	ppm / year	TX / RX Lo frequency
Initial frequency tolerance		-10		10	ppm	Transmission frequency
Oscillation type	Fractional-N PLL controlled VCO					
Frequency stability	-20 to +65°C	-10		10	ppm	
Channel spacing	1 MHz		1		MHz	
Data bit rate			19.2		kbps	
Chip rate			288		kcps	
PLL reference frequency			26		MHz	TCXO

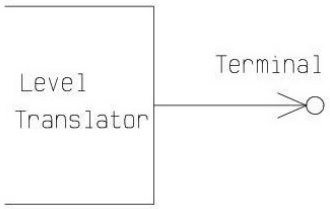
Actuation time

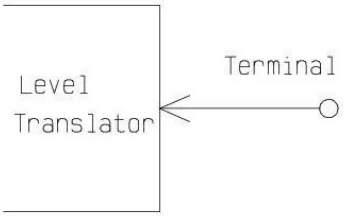
Item		MIN	TYP	MAX	Unit
TX mode	Power on -> Transmission			50	ms
	Frequency change command reception -> RF output			2.5	ms
	Frequency change command reception -> Completion of command response			5	ms
	Switching from RX mode to TX mode (until stable RF output)			1	ms
	Recovery from standby			1.7	ms
	Frequency change via CHC terminal (until stable RF output)			1.7	ms
RX mode	Power on -> Reception			50	ms
	Frequency change command reception -> Data output			2.5	ms
	Frequency change command reception -> Completion of command response			5.5	ms
	Switching time from TX mode to RX mode (until stable data output)			0.7	ms
	Recovery from standby			1.7	ms
	Frequency change via CHC terminal (until stable data output)			1.7	ms

4. Terminal specifications

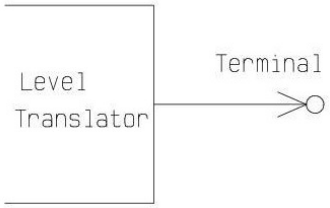
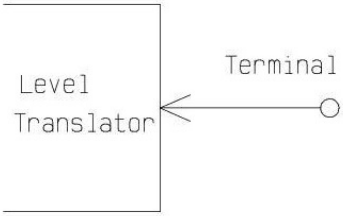
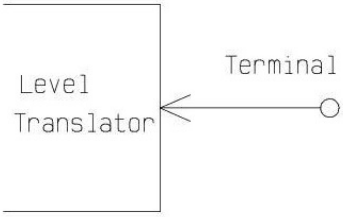
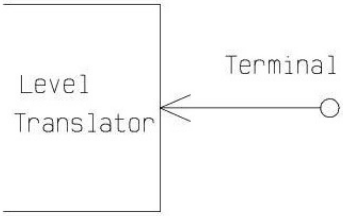
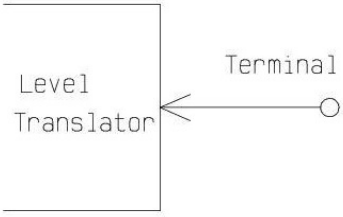
<table>
<tr><th rowspan="2">Terminal No.</th><th rowspan="2">Terminal name</th><th rowspan="2">Input/ Output</th><th colspan="2">Input/Output level (V)</th><th rowspan="2">Internal equivalent circuit</th></tr>
<tr><th>Low</th><th>Hi</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">CLK</td><td>Output</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">When in TX mode: Synchronous CLK for TX data input

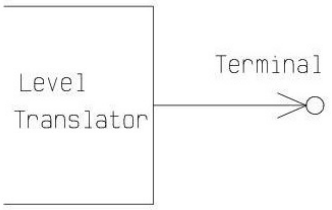
When in RX mode: Synchronous CLK for RX data output</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">RST</td><td>Input</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">The initialization terminal for the frame detection function*.
The internal circuit is initialized with ‘L’ level for more than 100 µs.
Normally set this terminal to ‘H’ or open.

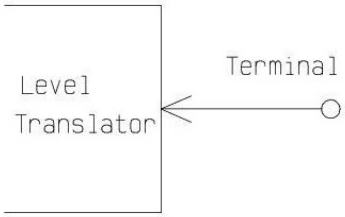
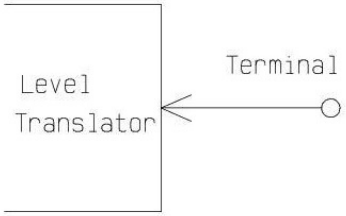
* For details of the frame detection function, refer to 13. Frame detection function.</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">TXD</td><td>Output</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">The output terminal for serial communication.

<table><tr><th colspan="2">Settings for serial communication</th></tr><tr><td>Bit rate</td><td>19.2 kbps *</td></tr><tr><td>Data length</td><td>8 bits</td></tr><tr><td>Parity</td><td>none</td></tr><tr><td>Stop bits</td><td>2 bits</td></tr></table>
* Can be changed with the command (See 9.9 "@U" UART communication speed setting).</td></tr>
<tr><td rowspan="2">4</td><td rowspan="2">RXD</td><td>Input</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">The input terminal for serial communication.

<table><tr><th colspan="2">Settings for serial communication</th></tr><tr><td>Bit rate</td><td>19.2 kbps *</td></tr><tr><td>Data length</td><td>8 bits</td></tr><tr><td>Parity</td><td>none</td></tr><tr><td>Stop bits</td><td>2 bits</td></tr></table>
* Can be changed with the command (See 9.9 "@U" UART communication speed setting).</td></tr>
</table>

Terminal No.	Terminal name	Input/ Output	Input/Output level (V)		Internal equivalent circuit
			Low	Hi	
5	DO	Output	0 to 0.25	Vref -0.4 to Vref	
		The RX data output terminal. Outputs RX data in synchronization with the clock signal from the CLK terminal. The DO data should be read at the rising edge of the CLK signal.			
6	DI	Input	0 to 0.25	Vref -0.4 to Vref	
		The TX data input terminal. Inputs TX data in synchronization with the clock signal from the CLK terminal. Data should be set to the DI at the falling edge of the CLK signal.			
7	CHC	Input	0 to 0.25	Vref -0.4 to Vref	
		Switches the channel in the order previously set by users. Channel change is done at the falling edge of the CHC terminal. This terminal is enabled when the LE terminal is set to “L”. (See *14 Channel stepping option controlled via CHC pin)*			
8	LE	Input	0 to 0.25	Vref -0.4 to Vref	
		Setting this terminal to “L” enables the CHC terminal. Set to “H” or open when the CHC terminal is not used. (See *14 Channel stepping option controlled via CHC pin)*			
9	CLR	Input	0 to 0.25	Vref -0.4 to Vref	
		Resets the channel to the first channel of the channel plan. Then channel reset is done with “L”. Normally set this terminal to “H”.			

<table>
<tr><th rowspan="2">Terminal No.</th><th rowspan="2">Terminal name</th><th rowspan="2">Input/ Output</th><th colspan="2">Input/Output level (V)</th><th rowspan="2">Internal equivalent circuit</th></tr>
<tr><th>Low</th><th>Hi</th></tr>
<tr><td rowspan="2">10</td><td rowspan="2">GND</td><td>GND</td><td>-</td><td>-</td><td rowspan="2"></td></tr>
<tr><td colspan="3">The GND terminal.</td></tr>
<tr><td rowspan="2">11</td><td rowspan="2">GND</td><td>GND</td><td>-</td><td>-</td><td rowspan="2"></td></tr>
<tr><td colspan="3">The GND terminal.</td></tr>
<tr><td>12</td><td>NC</td><td colspan="3"></td><td></td></tr>
<tr><td rowspan="2">13</td><td rowspan="2">GND</td><td>GND</td><td>-</td><td>-</td><td rowspan="2"></td></tr>
<tr><td colspan="3">The GND terminal.</td></tr>
<tr><td rowspan="2">14</td><td rowspan="2">VREF</td><td>Input</td><td>3.1</td><td>Vcc</td><td></td></tr>
<tr><td colspan="3">The input terminal for interface reference voltage.
Communication is performed using the voltage level applied to this terminal.
The reference voltage is applied to the following terminals:
CLK / TXD / RXD / DO / DI / CHC / LE
CLR / DIV / STBY / TXRXSEL</td><td></td></tr>
<tr><td rowspan="2">15</td><td rowspan="2">DIV</td><td>Output</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">This terminal shows which of the two RF input terminals received the signal actually used for data output. .
<table><tr><th>DIV</th><th>RF input terminal</th></tr><tr><td>L</td><td>RFi</td></tr><tr><td>H</td><td>RFio</td></tr></table></td></tr>
</table>

<table>
<tr><th rowspan="2">Terminal No.</th><th rowspan="2">Terminal name</th><th rowspan="2">Input/ Output</th><th colspan="2">Input/Output level (V)</th><th rowspan="2">Internal equivalent circuit</th></tr>
<tr><th>Low</th><th>Hi</th></tr>
<tr><td rowspan="2">16</td><td rowspan="2">STBY</td><td>Input</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">Sets the STD-503 into RF-standby state. Setting this terminal to H enables TX/RX operation and setting to L enables RF-standby. RF-standby can be used to reduce the current consumption.</td></tr>
<tr><td rowspan="2">17</td><td rowspan="2">TXRX SEL</td><td>Input</td><td>0 to 0.25</td><td>Vref -0.4 to Vref</td><td rowspan="2"> 
</td></tr>
<tr><td colspan="3">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.
When the terminal is high impedance, the TX mode is enabled.</td></tr>
<tr><td rowspan="2">18</td><td rowspan="2">VCC</td><td>VCC</td><td>3.3</td><td>5.0</td><td rowspan="2"></td></tr>
<tr><td colspan="3">The power supply terminal.
Do not apply voltage exceeding the operating voltage range.

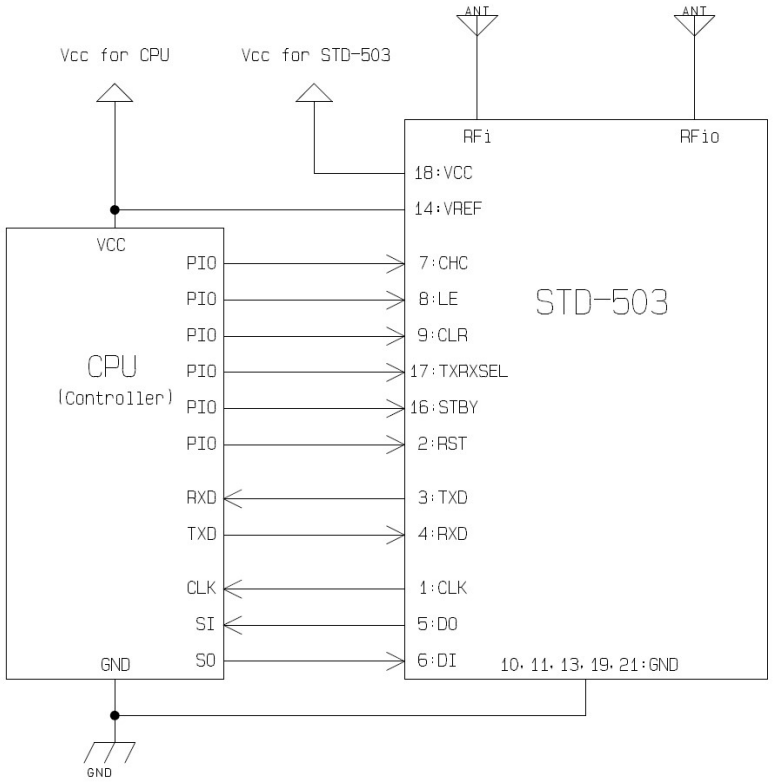
*Exercise care to avoid reverse connection of the power supply. Reverse connection may damage the module.</td></tr>
<tr><td rowspan="2">19</td><td rowspan="2">GND</td><td>GND</td><td>-</td><td>-</td><td rowspan="2"></td></tr>
<tr><td colspan="3">The GND terminal.</td></tr>
<tr><td>20</td><td>NC</td><td colspan="3"></td><td></td></tr>
<tr><td rowspan="2">21</td><td rowspan="2">GND</td><td>GND</td><td>-</td><td>-</td><td rowspan="2"></td></tr>
<tr><td colspan="3">The GND terminal.</td></tr>
</table>

5. Frequency channel table

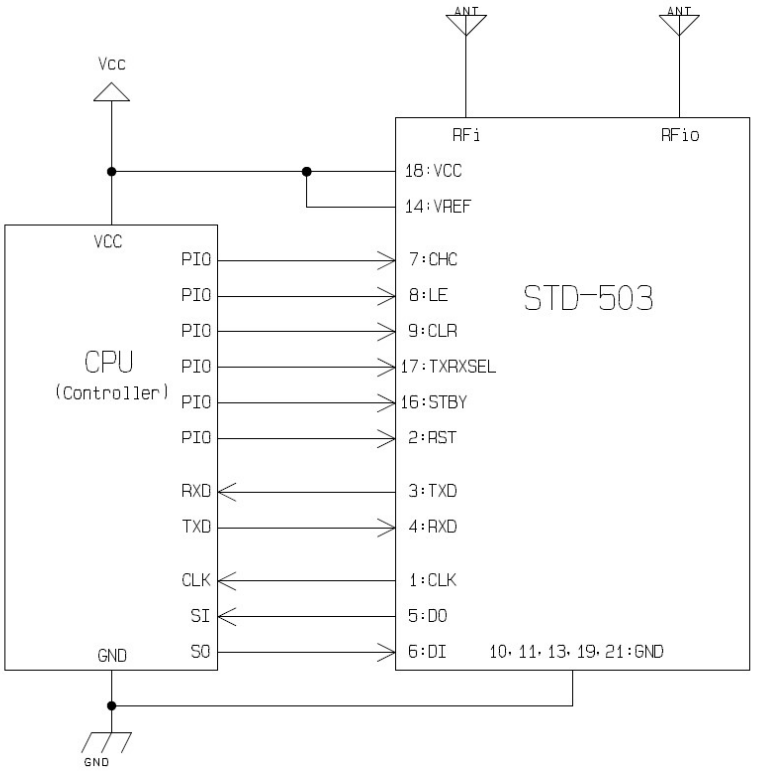
CH No.		Frequency [MHz]	CH No.		Frequency [MHz]
Dec	Hex		Dec	Hex	
0	00	2402.5	39	27	2441.5
1	01	2403.5	40	28	2442.5
2	02	2404.5	41	29	2443.5
3	03	2405.5	42	2A	2444.5
4	04	2406.5	43	2B	2445.5
5	05	2407.5	44	2C	2446.5
6	06	2408.5	45	2D	2447.5
7	07	2409.5	46	2E	2448.5
8	08	2410.5	47	2F	2449.5
9	09	2411.5	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. Connection diagram

* The length of connection wire between the STD-503 and the CPU should be within 20 cm.



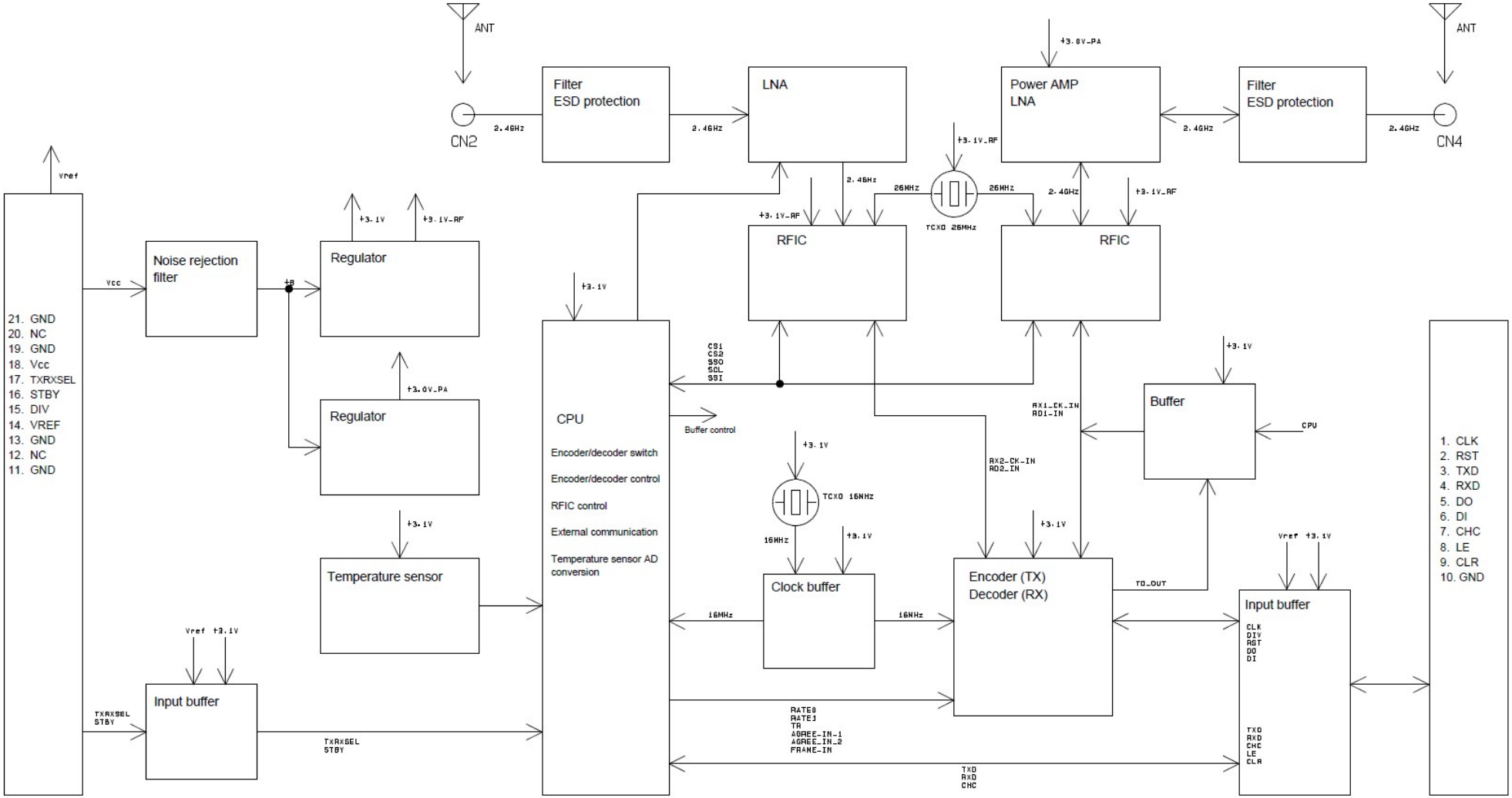
Using a different VCC voltage for the CPU and the STD-503



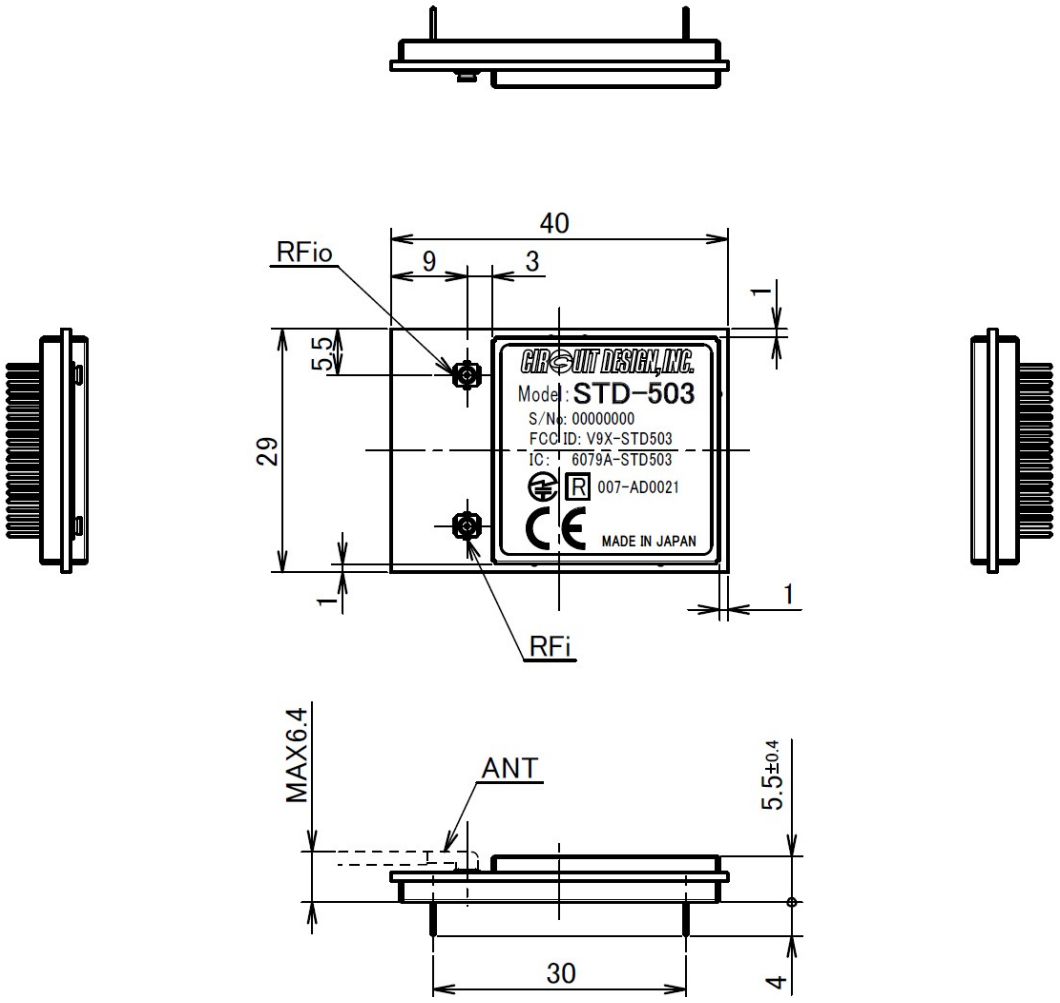
Using a common VCC voltage for the CPU and the STD-503

Connection example using the SIO of a CPU

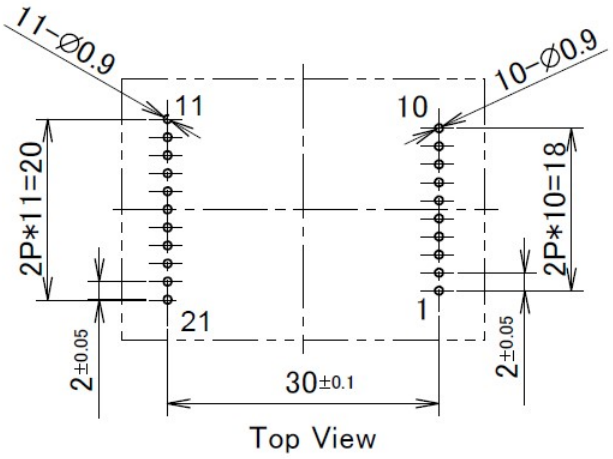
7. Block diagram



8. External dimensions



Reference hole position for PCB mounting



11 GND	10 GND
12 NC	9 CLR
13 GND	8 LE
14 VREF	7 CHC
15 DIV	6 DI
16 STBY	5 DO
17 TXRXSEL	4 RXD
18 Vcc	3 TXD
19 GND	2 RST
20 NC	1 CLK
21 GND	

Caution: No trace allowed underneath the module

9. Commands and responses

9.1 Control commands & responses

Control command basic format

Prefix ('@') + command name + value + [CR]

Prefix: **'@' = 40h**, a code that indicates the start of the command string.
Command name: An ASCII code of one or two characters.
Value: An ASCII code of two or four characters corresponding to each command.

Control response basic format

Prefix ('*') + command name + value + [CR]

Prefix: **'*'=2Ah**, a code that indicates the start of the response string.
Command name: An ASCII code of one or two characters corresponding to the received command.
Value: An ASCII code of two or four characters corresponding to each command.

9.2 "@C" Frequency channel setting

Sets the channel to be used.
Specify the channel following **'@C'** with an ASCII code of two characters.

Value: '0"0' - '4"C' (ASCII codes indicating the channel numbers of 0 to 76)

Example: Change the channel to **0Fh.**

Control command: @C0F
Control response: *C0F

9.3 "@R" RSSI level readout command

The command for reading out RSSI levels.
Following **'@R'**, specify one of the following two ASCII codes.

Value: '0"1' : Reads out the RSSI level of the receiver circuit for RFIN/RFOUT.
'0"2' :Reads out the RSSI level of the receiver circuit for RFIN.

Example: Reads out the RSSI level of the receiver circuit for RFIN/RFOUT.

Control command: @R01
Control response: *R5D

The absolute value of the RSSI level is returned in hexadecimal.
The RSSI level can be obtained by decimalizing the value part of the control response and adding "- (minus)" . *R5D is -93 dBm.

9.4 "@D" Default frequency channel setting

Sets the default frequency channel to be stored in the internal memory.
Specify the channel following **'@D'** with the ASCII code of two characters.
The setting is enabled when the power is turned on again.

Value: '0''0' - '4''C' (ASCII codes indicating the channel numbers of 0 to 76)

Example: Change the channel to **4Ch.**

Control command: @D4C
Control response: *D4C

* The default setting is '0''0'.
* The number of setting times for frequency channel is up to 2000.

9.5 "@F" Frame detection function setting

Sets the frame detection function.
Specify one of the following two ASCII codes following **'@F'** .
The setting is no longer retained when the power is turned off.

Value: '0''0' : enables the frame detection function.
'0''1' : disables the frame detection function.

Example: Enable the frame detection function.

Control command: @F00
Control response: *F00

* The default setting is '0''1' (frame detection function disabled).
* For details of the frame detection function, refer to *13. Frame detection function*.

9.6 "@A" Allowable error bit setting for frame detection

Sets the allowable error bit number for the frame detection function.
Specify one of the following ASCII codes following **'@A'** .
The setting is no longer retained when the power is turned off.

Value: '0''0' : 0 error bit allowed (all 31 bits should be matched)
'0''1' : 4 error bits allowed (27 bits should be matched)
'1''0' : 6 error bits allowed (25 bits should be matched) '1''1' : 8 error bits allowed (23 bits should be matched)

Example: Set the allowable error bit number to 4.

Control command: @A01
Control response: *A01

* The default setting is '0''0'.
* For details of the frame detection function, refer to *13. Frame detection function*.

9.7 "@U" UART communication speed setting

Sets the UART communication speed.
Specify one of the following ASCII codes following **'@U'** .

The UART communication speed is set to 19.2 kbps whenever the module is turned on.

Value: '1''9' : 19.2 kbps
'3''8' : 38.4 kbps
'5''7' : 57.6 kbps

Example: Set the UART communication speed to 57.6 kbps.

Control command: @U57
Control response: *U57 (the response is returned at the previous speed)

9.8 "@NV" Setting the number of stepping channels

Sets the number of the stepping channels when the channel stepping option via CHC pin is used.
Specify the number of the channels following **'@NV'** with the ASCII code of two characters.

Value: '0''1' - '1''4' (ASCII codes indicating 1 to 20)

Example: Set the number of stepping channels to **3**

Control command: @NV03
Control response: *NV03

* If a number out of setting range is set, the error response of "*E02 is returned.
* For details of the channel stepping option via CHC pin, refer to *14. Channel stepping option controlled via CHC pin*

9.9 "@N" Setting each stepping channel with the channel value

Sets each stepping channels with the channel value when the channel stepping option via CHC pin is used.
Specify the position in the channel plan and the channel value following **'@N'** with the ASCII code of two characters.
The setting is enabled when the power is turned on again.

Value1: '0''1' - '1''4' (ASCII codes indicating 1 to 20)
Value 2: '0''0' - '4''C' (ASCII codes indicating 00 to 76)

Example: Set the channel value 03h as the second channel and 20h as the third channel in the channel plan.

Control command: @N0203
Control response: *N0203
Control command: @N0320
Control response: *N0320

* If a number out of setting range is set, the error response of "*E02 is returned.
* For details of the channel stepping option via CHC pin, refer to *14. Channel stepping option controlled via CHC pin*

9.10 Error responses

If there is an error in the format of the command issued, an error code of the type shown below is sent in response.

・Format

Prefix ('*') + response name ('E') + value + [CR]

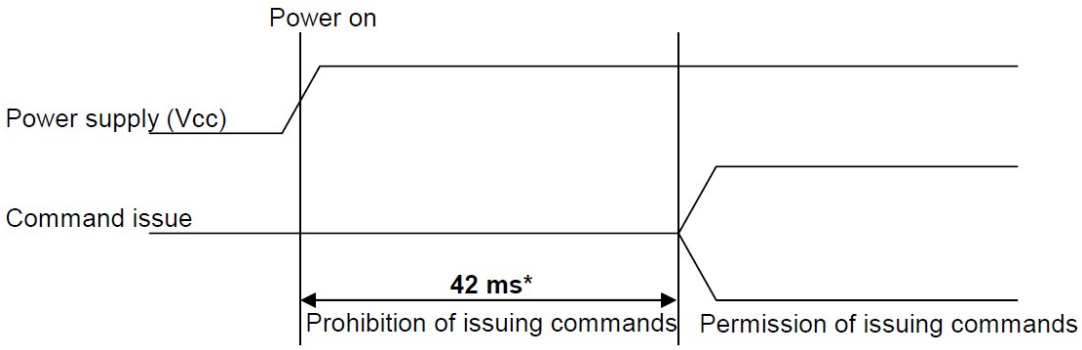
Prefix: **'*'=2Ah**, a code that indicates the start of the response string.
Response name: A single ASCII character 'E'.
Value: an ASCII code of two characters shown in the error code list.

・Error code list

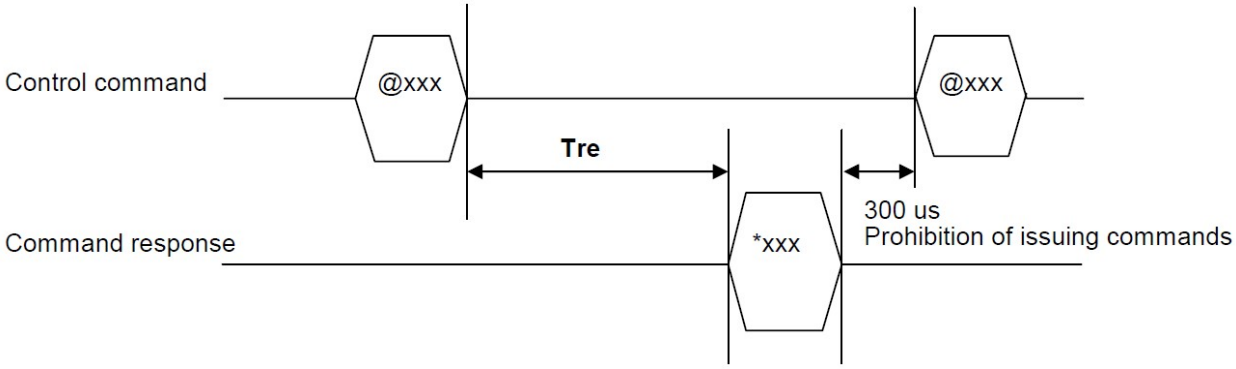
Code	Description
‘0’’1’	The issued command does not exist.
‘0’’2’	The specified channel is outside the setting range.
‘0’’3’	Initialization failed. Turn the power on again.
‘0’’4’	Command setting failed. Perform setting again.
‘0’’5’	Memory error. Turn the power off and then on again.

10. Command timing

Period when issuing commands is prohibited when turning on power



Control command and response timing

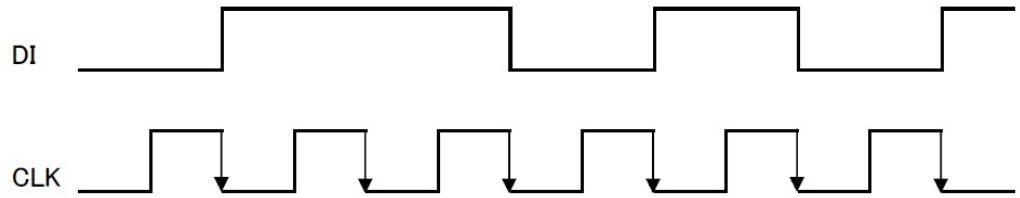


Command	Tre (Response time)	Unit
@Cxx	2.1	ms
@R0x	500	us
@Dxx	290	ms
@F0x	500	us
@Axx	500	us
@Uxx	500	us
@NV	500	us
@N	500	us

11. Timing between TX/RX data and clock

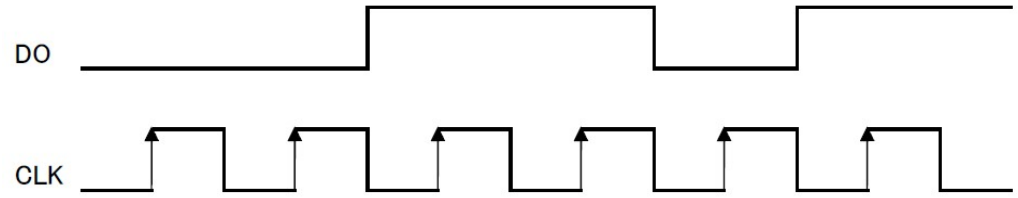
Timing between TX data and clock

Set the TX data (DI) in synchronization with the falling edge of the clock signal (CLK).



Timing between RX data and clock

Read the RX data (DO) in synchronization with the rising edge of the clock signal (CLK).



*There is a known problem with the clock signal while the STD-503 is receiving. Please make sure to check the errata sheet (Errata_STD503-01e) attached at the end of this document.

12. How to detect user data

To detect user data from the received data, place a 2- or 3-byte preamble and a unique 16- or 32-bit frame code prior to the user data.

However, if any code in the user data should match with the frame code, the user data cannot be properly detected. To prevent the false detection, an error detection/correction code needs to be added to the user data.

For detecting user data, the frame detection function of the STD-503 can be also used. (See *13. Frame detection function*)

13. Frame detection function

By using the frame detection function of the STD-503, user data can be detected from the received data.
To enable the frame detection function, issue the command of "@F00" to the RXD after turning on the power of the STD-503.
The following procedure shows how to use the frame detection function using the SIO interface of the user CPU.

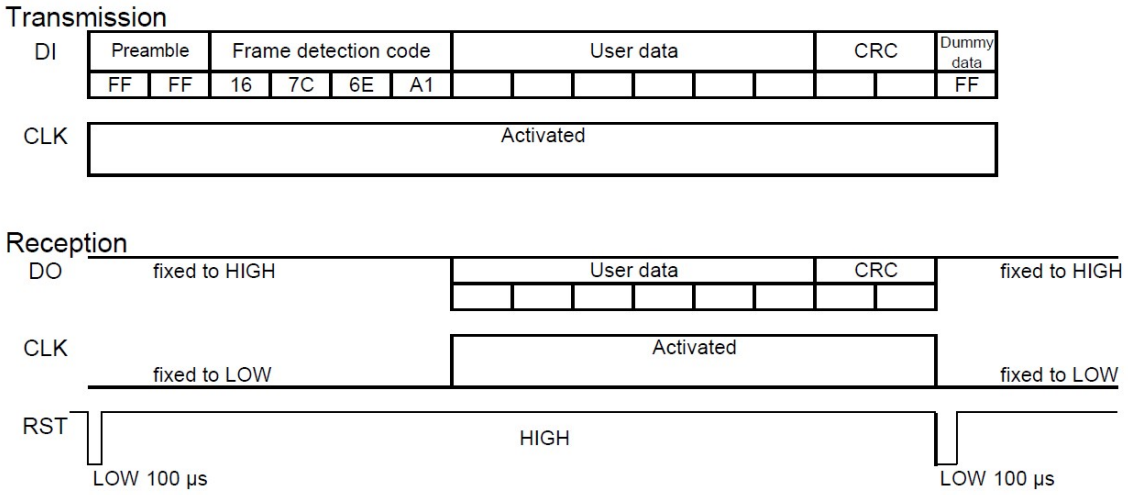
Transmission:

1. Set the SO of the user CPU so that data is set at the falling edge of the CLK.
2. Input a 2-byte preamble (e.g. FF, FF) by 8 bits in hexadecimal.
3. Input a 32-bit frame detection code by 8 bits (hex) in the order of 16, 7C, 6E, A1.
4. Input user data by 8 bits from first (ID code etc.) to last (CRC etc.) .
5. Finally input a byte of dummy data (e.g. FF) to prevent the last bit of the user data from dropping out.
6. Repeat the above steps 1 to 5 to send the next data.

Reception:

1. Set the RST terminal to 'L' for more than 100 µs to initialize the detection circuit and set it back to 'H'. At this point, the DO is fixed to 'H' and the CLK is fixed to 'L'.
2. Set the SI of the user CPU so that the data is taken in at the rising edge of the CLK, and then enable the SIO reception interrupt.
3. When a frame detection code is received, a SIO reception interrupt occurs at every byte. Process the SIO reception interrupts over the user data from the first byte (ID code etc.) to the last (CRC etc.).
4. Once the last data is processed, repeat the above steps of 1 and 2 to be ready for the next data.

Data frame



Setting of allowable error bit number

By default, all 31 bits of the frame detection code should be completely coincident. Use the @A command to set the number of allowable error bits.

@A00 No error bit allowed (31-bit matching)
@A01 4-error bits allowed (27-bit matching)
@A10 6-error bits allowed (25-bit matching)
@A11 8-error bits allowed (23-bit matching)

14. Channel stepping option controlled via CHC pin

With the STD-503, in addition to the channel change by issuing the command via UART, you can also change channels with a pulse input to the CHC pin. This option supports developing a communication system where the communication channel moves during communication according to the pre-set channel plan. The channel plan needs to be previously configured via UART. The maximum number of stepping channels used in a channel plan is 20.

How to use this option

To enable this option, initially configure a channel plan by setting the number of channels and the channels used.

The setting commands are as follows:

Command to set the number of stepping channels ”@NVxx”

”xx”:‘0’’1’-‘1’’4’ (ASCII codes indicating 1 to 20)

Command to set the stepping channel and order ”@Nxxyy”

“xx” :‘0’’1’-‘1’’4’ (ASCII codes indicating the orders from 1 to 20)

“yy” : ‘0’’0’-‘4’’C’ (ASCII codes indicating the channel values from 00 to 76)

After the initial setting, apply signals according to the timing chart show below:

Operation timing chart

Related terminals:

LE: CHC enable terminal

CHC: Channel change terminal (Processed at the falling edge)

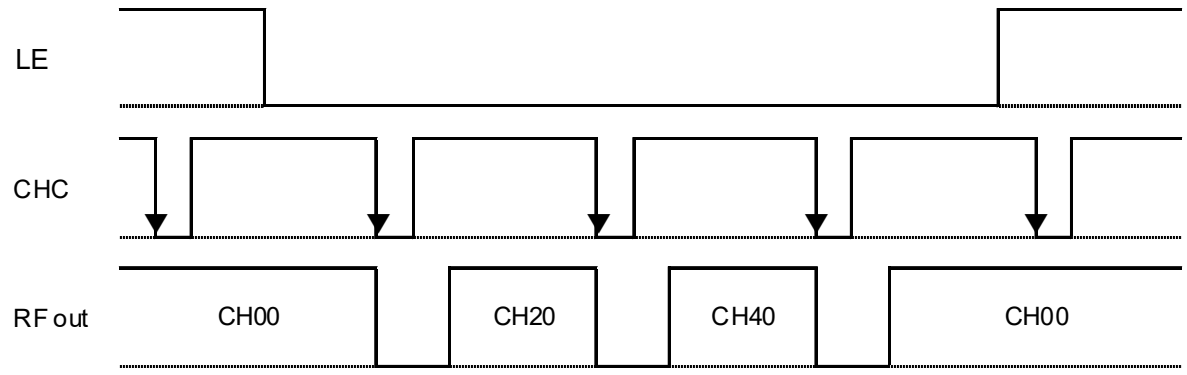
CLR: Channel plan initialization terminal (Set back to the first channel of the plan)

Example channel plan

The number of channels is set to 3: ”@NV03”

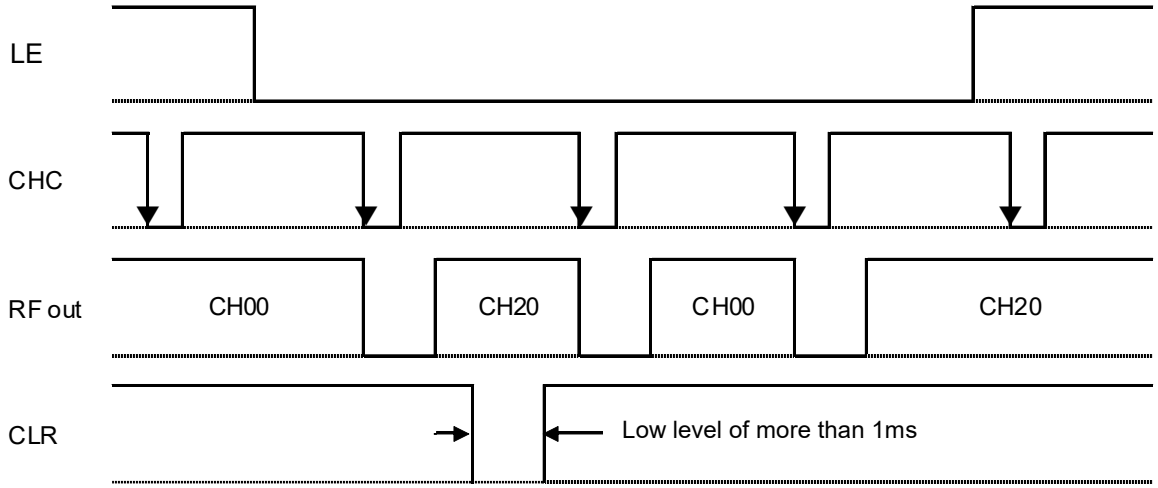
The stepping channels and the orders are set to as follows:

The first channel=CH00h ” @N0100”
The second channel=CH20h ”@N0220”
The third channel=CH40h ”@N0340”



Channel reset by CLR terminal

The channel is reset to the first channel at the falling edge of the CHC terminal after the CLR terminal is set to Low for more than 1ms and back to High.



15. Caution for use in continuous transmission

- when using the STD-503 in continuous transmission of more than 30 seconds

The STD-503 automatically corrects the RF output power according to the module temperature in order to stabilize the RF output power.

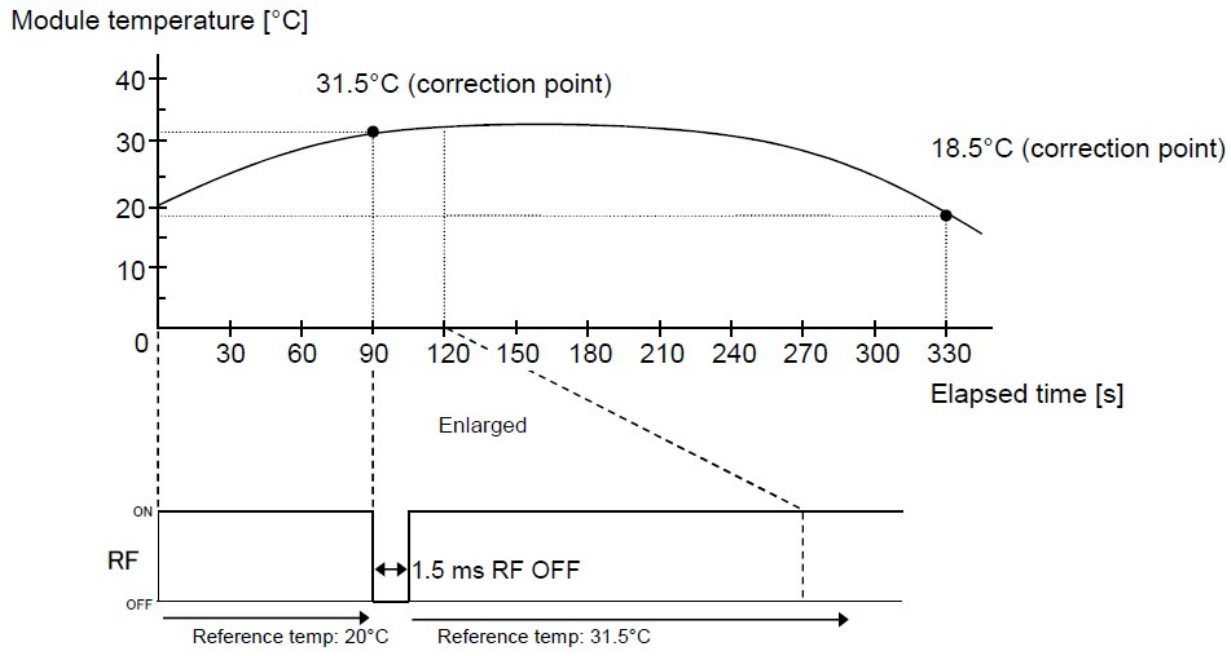
The automatic temperature correction is performed at the following timings:

1. Switching from reception to transmission.
2. Switching from stand-by mode to transmission.
3. Changing the channel during transmission (change by command or CHC pin).
4. In case the module temperature changes by more than 10°C while transmission is continued for more than 30 seconds.

If the STD-503 is used in continuous transmission of more than 30 seconds, please pay careful attention to the operation of #4 above mentioned. During the automatic temperature correction, the RF output is transiently stopped (the operation details are explained below).

The details on the operation of automatic output power correction during continuous transmission

The STD-503 stores the module temperature at the time it is turned on as a reference temperature. During transmission, it monitors the module temperature every 30 seconds and corrects the output power if the module temperature changes by more than 10°C from the reference temperature. While the correction is performed, the RF output power is transiently turned off. The duration of RF-power off is approx.1.5 ms. Once the correction finishes, the RF output is automatically turned on again. The module temperature at the time the correction is performed becomes the new reference temperature.



Example of RF power correction during continuous transmission

16. Channel plan for using multiple STD-503 in the same area

Avoiding the interference caused by spurious emission

The STD-503 emits spurious emissions at 13 MHz intervals from the carrier frequency due to the characteristics of the RFIC used in the STD-503. The spurious level is well within the regulation limit of each country where the STD-503 is approved for use.

However, when multiple STD-503 modules are operated at the same time within a range of 30 m, if there is an STD-503 whose receiver channel matches up with one of the spurious frequencies of other modules, cross-talk may be caused between the modules.
To avoid this problem, the followings are recommended:

1. **Use a channel plan to avoid interference**
   First, create a basic channel plan to avoid third-order intermodulation interference*.
   Then eliminate the 13 MHz-spaced spurious frequencies from the plan you made.
   Use the resultant channels for multiple-channel operation in a small area.

   * Circuit Design provides a calculation tool to create a channel plan to avoid third-order intermodulation interference on its website: https://www.cdt21.com/technical_tools/channel-planning/

2. **Include channel setting information in transmission data**
   By including channel setting information in the transmission data, the receiver only processes the data if the channel setting information matches channel setting of receiver.

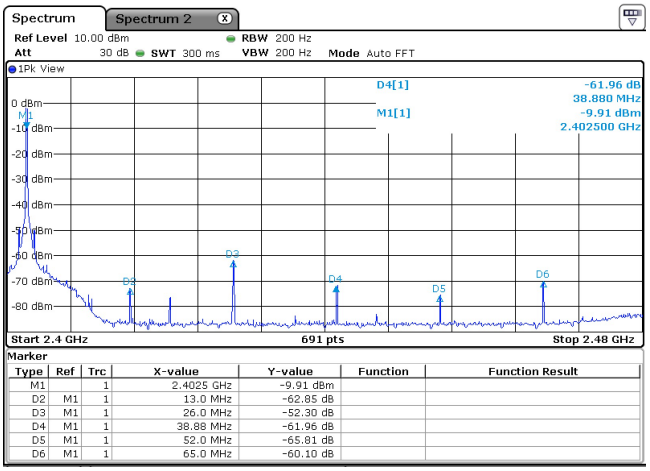


Fig.1
13MHz-spaced spurious when the channel is set to CH00

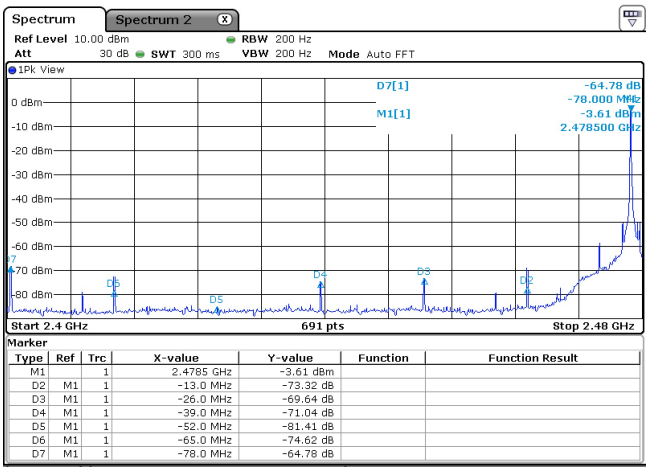


Fig. 2
13MHz-spaced spurious when the channel is set to CH4C

Regulatory compliance information

Regulatory Statement for FCC

The STD-503 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.

This module should be installed in the host device according to the interface specification.
The following statements must be described on the user manual of the host device of this module;

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-STD503
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-STD503 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 module and all persons. This module 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 module.

The antennas used with this module are as follows;
Antenna Type & Antenna Gain;
Sleeve Antenna 2 dBi
Loop PCB Antenna 1.89 dBi
Sleeve antenna with MHF 1.5 dBi

Instructions to the final system 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.

Regulatory Statement for IC

This device complies with Industry Canada license-exempt RSS standard(s). 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.

Cet appareil est conforme avec Industrie Canada exempts de licence standard RSS (s). L'utilisation de ce dispositif est autorisee seulement aux conditions suivantes : (1) il ne doit pas produire de brouillage et (2) l' utilisateur du dispositif doit etre pret a accepter tout brouillage radioelectrique recu, meme si ce brouillage est susceptible de compromettre le fonctionnement du dispositif.

This module should be installed in the host device according to the interface specification.
The following statements must be described on the user manual of the host device of this module;

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.

Labeling:

IC Number: 6079A-STD503

The proposed IC Number label format is to be placed on the module. If IC Number is not visible when the module is installed into the system, "Contains IC: 6079A-STD503" shall be placed on the outside of final host system.

Antenna

This radio transmitter IC Number 6079A-STD503 has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

The antenna used this module is as follows;
Antenna Type & Antenna Gain;
Sleeve Antenna 2 dBi
Loop PCB Antenna 1.89 dBi
Sleeve antenna with MHF 1.5 dBi

Caution: Exposure to Radio Frequency Radiation

To comply with IC 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.

Pour se conformer aux exigences en matiere d'exposition RF IC, une distance de separation d'au moins 20 cm doit etre maintenue entre l'antenne de cet appareil et toutes les personnes. Cet appareil ne doit pas etre co-localisees ou operant en conjonction avec une autre antenne ou un autre emetteur.

DoC and restrictions for CE

Declaration of Conformity

Hereby, Circuit Design, Inc. declares that the STD-503 is in compliance with RE Directive (2014/53/EU). The full text of the EU Declaration of Conformity is available at www.circuitdesign.jp.

Hiermit erklärt Circuit Design, Inc,, dass der Funkanlagentyp STD-503 der Richtlinie 2014/53/EU entspricht. Der vollständige Text der EU-Konformitätserklärung ist unter der folgenden Internetadresse verfügbar: www.circuitdesign.jp

Le soussigné, Circuit Design, Inc, déclare que l'équipement radioélectrique du type STD-503 est conforme à la directive 2014/53/UE. Le texte complet de la déclaration UE de conformité est disponible à l'adresse internet suivante: www.circuitdesign.jp

Il fabbricante, Circuit Design, Inc., dichiara che il tipo di apparecchiatura radio STD-503 è conforme alla direttiva 2014/53/UE. Il testo completo della dichiarazione di conformità UE è disponibile al seguente indirizzo Internet: www.circuitdesign.jp

Por la presente, Circuit Design, Inc. declara que el tipo de equipo radioeléctrico STD-503 es conforme con la Directiva 2014/53/UE. El texto completo de la declaración UE de conformidad está disponible en la dirección Internet siguiente: www.circuitdesign.jp

Remark:

This module is for a portable application. The final system integrator will need to conduct full EMC testing in accordance with EN301 489-3 in the final use configuration.
Also the final system needs to fulfill the safety requirements in the final product configuration.

Cautions:

Antenna
The conformity assessment of the STD-503 was performed using the following antennas:
Antenna Type & Antenna Gain;
Sleeve Antenna 2 dBi
Only those antennas with same type and lesser gain can be used with this module. If you use an antenna other than the recommended antennas, further radio conformity assessment may be required.

Enclosure
To fulfill the requirements of EMC and safety requirements, the STD-503 should be mounted on the circuit boards of the final products and must be enclosed in the cases of the final products. No surface of the STD-503 should be exposed.

Exposure to radio frequency radiation
This module must not be co-located or operating in conjunction with any other antenna or transmitter.

Conformity assessment of the final product
The manufacturer of the final product is responsible for ascertaining the conformity of the final product to the requirements of the RE Directive.

Cautions and guidance for use in Japan

The STD-503 has obtained a Technical Regulations Conformity Certification as a second generation low power radio communication system (STD-T66) based on the Radio Law in Japan.
Certification Number : 007-AD0021

Warnings

- Do not take apart or modify the module. If do so, you may be punished by the Radio law.
- Do not remove the product label on which the technical conformity mark and certification number are printed. It can be an infringement of the Radio law if you use radio equipment which has no Technical conformity mark.
- Do not show the certification number on the final product.
- The conformity assessment of the STD-503 was performed using the following antennas:

  Sleeve Antenna 2 dBi
  Loop PCB Antenna 1.89 dBi
  Sleeve antenna with MHF 1.5 dBi

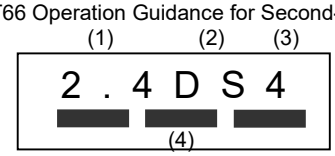
  If you use an antenna other than the above antennas, further conformity assessment will be required. For details, please ask Circuit Design, Inc.

This product shares a frequency band with a wide range of equipment: e.g. industrial, scientific, and medical equipment such as microwave ovens, premises radio stations (radio stations requiring licenses) and specified low-power radio stations (radio stations not requiring licenses) for RFID used for factory production lines as well as amateur radio stations (radio stations requiring licenses).

1. Before use, confirm that no premises radio stations and specified low-power radio stations for RFID or amateur radio stations operate in your vicinity.
2. In the event that this product causes harmful interference to any premises radio station for RFID, immediately change frequencies or halt radio wave emission and contact us at the information indicated below for consultation on interference avoidance measures (e.g., partition installation).
3. Contact us at the information indicated below if this product causes harmful interference to any specified low-power radio stations for RFID or amateur radio stations or if other problems arise.

When operating the radio system embedding the STD-503, we recommend that you follow the instructions in the “ARIB STD-T66 Operation Guidance for Second-generation Low-power Data Communication Systems Radio Stations”.

Indication of symbols on equipment (defined in “ARIB STD-T66 Operation Guidance for Second-generation Low-power Data Communication Systems Radio Stations”)



(1) Frequency band: 2.4 GHz
(2) Modulation system: DS
(3) Estimated interference-causing radius: Within 40 m
(4) Frequency-changing capability: The system uses the entire band and is capable of avoiding the band used by RFID systems.

Indication of information on fixed, outdoor-installed equipment
When operating the radio system embedding the STD-503 as a fixed outdoor radio station, indicate the following information at a prominent location on the on the main unit, antenna or casing of the system.

(Example from “ARIB STD-T66 Operation Guidance for Second-generation Low-power Data Communication Systems Radio Stations”)

(1) Indication of radio station : The equipment shall be clearly labeled as “2.4 GHz band low-power data communications system radio station.”
(2) Name of owner or operator : The name of the individual shall be indicated if the radio station is owned or operated by that individual. The names of the relevant entity and section or person in charge shall be indicated if the radio station is owned or operated by that entity.
(3) Contact information : Telephone number, e-mail address, or URL shall be indicated.
(4) Others : Useful information on interference avoidance may be indicated, as necessary.

For more details, please contact Circuit Design, Inc.

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.

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.

Revision History

Version	Date	Description	Remark
0.9	Dec. 2014	Preliminary	
0.91	Dec. 2014	Preliminary	
1.0	Mar. 2015		
1.1	Mar. 2015	Correction of erroneous descriptions, Section 15 added	
1.2	Apr. 2015	Correction of erroneous descriptions	
1.3	Apr. 2016	Correction of erroneous descriptions in the reference hole position diagram	
2.0	May 2020	Update according to RED requirements	
2.1	Nov. 2020	Comments added on errata sheet (Section 11)	
2.2	Jan. 2022	Link address to the calculation tool for channel plan updated (Section 16)	

November 10, 2020

Errata sheet

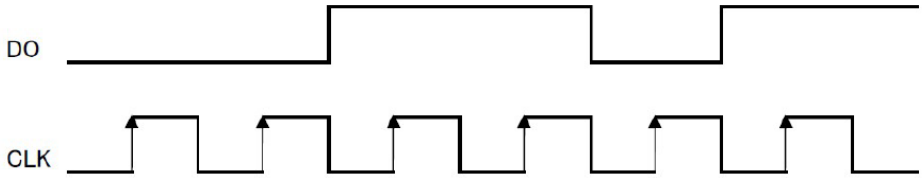
Model name: STD-503

This errata sheet describes the known problem with the clock signal while the STD-503 is receiving.

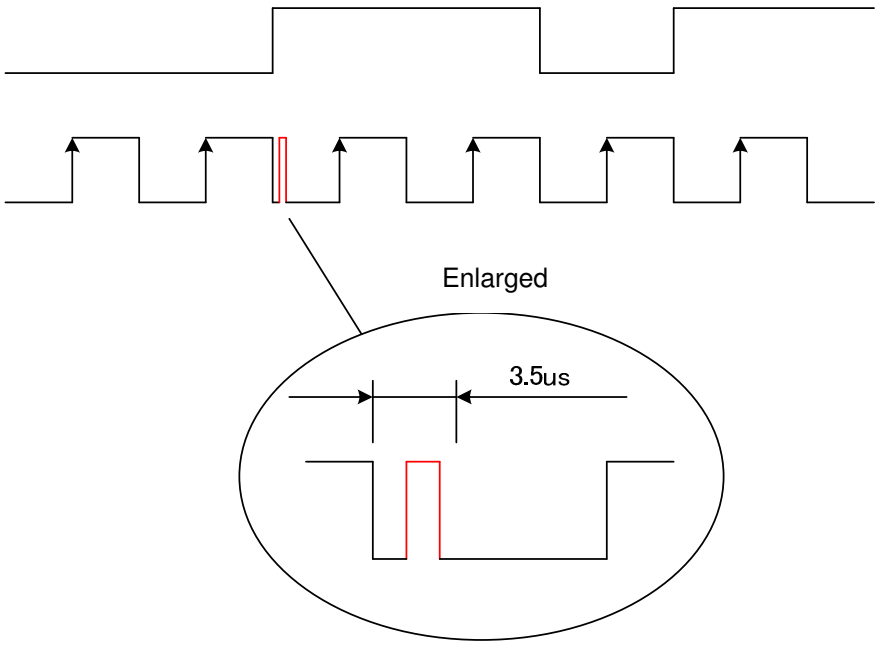
As to the timing between RX data and clock with the STD-503, Section 11 of the operation guide instructs, as shown below, that the RX data (DO) needs to be read in synchronization with the rising edge of the clock signal (CLK).

Timing between RX data and clock

Read the RX data (DO) in synchronization with the rising edge of the clock signal (CLK).



In the clock signal, it has been confirmed that a short pulse may occur within 3.5 us after the falling edge of the CLK as shown below, depending on reception conditions.



Reading the RX data at the rising edge of this short pulse will cause a problem where wrong data is read.
We request that you incorporate processing in your system to avoid false-positives due to this short pulse.
This short pulse does not occur when transmission data is set.

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Revision history

Date	Description
Nov. 10, 2020	First issue