NT Series Transceiver Command Data Interface

Reference Guide RG-00101



Introduction

The NT Series transceiver has a serial Command Data Interface (CDI) that offers the option to configure and control the transceiver through software instead of through hardware. This interface consists of a standard Universal Asynchronous Receiver Transmitter (UART) with a serial command set. This allows the module to be configured dynamically instead of hardwired, which enables applications such as frequency hopping or listen before talk.

Connecting the Command Data Interface

The CDI uses five lines on the module (Figure 1). These are described in Figure 2.

The CDI is activated by pulling the CMD_DATA_TYPE line low. It uses Command Data In (CMD_DATA_IN) and Command Data Out (CMD_DATA_OUT) as a serial port. The data format follows standard UART conventions of 8 data bits, 1 start bit, 1 stop bit and no parity. The UART voltage levels are mark (1) = $\rm V_{\rm CC}$ and space (0) = GND. The Command Data Baud (CMD_DATA_BAUD) line sets the baud rate of the serial interface to either 9,600bps (low) or 57,600bps (high).

The serial interface is available for use when the transceiver is not in Power Down or Standby mode. The Ready output ($\overline{\text{READY}}$) can be used for simple hardware flow control similar to Clear To Send (CTS). This output is logic low when the transceiver is able to receive command data. If $\overline{\text{READY}}$ is logic high, the transceiver cannot receive commands.

| 1 | ☐GND | GND | 3 | 44 |
|----|----------|---------------|---|----|
| 2 | ∑ис | ANTENNA | ζ | 43 |
| 3 | ☐GND | GND | ₹ | 42 |
| 4 | ∑NC | NC | ζ | 41 |
| 5 | ∑NC | NC | ζ | 40 |
| 6 | ☐GND | GND | ζ | 39 |
| 7 | ∑NC | DATA_IN | ζ | 38 |
| 8 | ∑NC | DATA_OUT | ζ | 37 |
| 9 | TRPT/PKT | NC | ζ | 36 |
| 10 | CHN_SEL0 | NC | ζ | 35 |
| 11 | ☐GND | GND | ζ | 34 |
| 12 | CHN_SEL1 | NC | ζ | 33 |
| 13 | CHN_SEL2 | NC | ζ | 32 |
| 14 | ∑LVL_ADJ | CMD_DATA_BAUD | ζ | 31 |
| 15 | READY | CMD_DATA_TYPE | ζ | 30 |
| 16 | ∑NC | CMD_DATA_OUT | ζ | 29 |
| 17 | GND | GND | ζ | 28 |
| 18 | T/R_SEL | CMD_DATA_IN | ζ | 27 |
| 19 | BAUD0 | STANDBY | ζ | 26 |
| 20 | ∑BAUD1 | VCC | 3 | 25 |
| 21 | ∏RSSI | POWER_DOWN | ζ | 24 |
| 22 | GND | GND | 3 | 23 |

Figure 1: NT Series Transceiver Pinout (Top View)

| NT Se | NT Series Transceiver Pin Descriptions | | | | | | | |
|-------|--|--|--|--|--|--|--|--|
| Pin # | Name | Description | | | | | | |
| 15 | READY | Ready. This line is low when the transceiver is ready to communicate and high when its busy. This line can be used for hardware handshaking on the command port. | | | | | | |
| 27 | CMD_DATA_IN | Command Data In. This line is the input for command data to set up the module or packet data to be transmitted over the air. | | | | | | |
| 29 | CMD_DATA_OUT | Command Data Out. This line outputs the command data responses when setting up the module or packet data that has been received. | | | | | | |
| 30 | CMD_DATA_TYPE | Command Data Type. This line sets the serial data as either command data or packet data. Pull low for command data; pull high for packet data. | | | | | | |
| 31 | CMD_DATA_BAUD | Command Data Baud. This line sets the baud rate of the command and packet data. Pull low for 9,600bps; pull high for 57,600bps. This line is checked once on power-up. | | | | | | |

Figure 2: NT Series Transceiver Pin Descriptions

The Command Data Interface Command Set

The serial message consists of four bytes: Command (read/write/program), Parameter, Value, and Terminator.

Input message:

Command + Parameter + Value + Terminator (0xFF)

A response is returned after a command is received. If the command is correct, the response message is an ACKnowledgement (Command = 0x06) with the Parameter that was received and either the Value that was received for a write Command or the Value that was queried for a read Command. If the Command is incorrect, the response message is a Negative ACKnowledgement (Command = 0x15) with the Parameter that was received and an error code in the Value byte. Every message must have a Terminator byte (0xFF) that identifies the end of the message.

Reply Message:

ACK: Command (0x06) + Parameter Received + Value Received + Terminator (0xFF) NACK: Command (0x15) + Parameter Received + Error Code + Terminator (0xFF)

The Command byte distinguishes between three different actions.

Read – 0x01: When Command is 0x01, the module reads the current parameter settings. This is useful to poll the module for its current operating status. The Value byte is not used on a read input message, so is set to 0x00. This byte will contain the appropriate value on the output message.

Write – 0x02: When Command is 0x02, the module writes the parameter into temporary memory. Once power is removed from the module, these settings are lost and the default settings are restored on power up. This allows the module to be controlled through software while allowing a return to the factory default state on a power cycle. This is also useful in frequency hopping algorithms where the channel can be changed quickly without having to wait the required time for writing to non-volatile memory.

Program – 0x03: When Command is 0x03, the module programs the parameter into non-volatile memory. These settings are used after the module has been turned off instead of the factory default settings. They can be used as a one-time setup through software or as custom default settings when power is cycled to the module.

The command set uses binary data and not ASCII data.

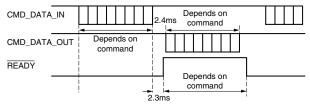


Figure 3: NT Series Transceiver Command Data Interface Timing

The Command Data Interface Commands

The commands available through the serial interface are equivalent to the hardware interface pins. This provides the option of using software and two lines to configure the module instead of hardware and up to seven lines. Figure 4 shows the commands for the Command Data Interface. See Appendix B for more details of the command set.

| Command Data Structu | re | | | | | | |
|------------------------|-----------------|---|----------------------|--|--|--|--|
| Input Message | Command + Para | Command + Parameter + Value + Terminator (0xFF) | | | | | |
| ACK Reply Message | Cmd (0x06) + Rc | vd Parameter + Value | + Terminator (0xFF) | | | | |
| NoACK Reply Message | Cmd (0x15) + Rc | vd Parameter + Error (| Code + Terminator (0 | xFF) | | | |
| Function | Cmd | Cmd Parameter Value Description | | Description | | | |
| Read / Write / Program | | | | | | | |
| Channel | 01 – 03h | 10h | 00 – 64h | Channel (0 - 100) | | | |
| Baud Band | 01 – 03h | 11h | 01 – 04h | Baud Band (1 – 4) | | | |
| TX/RX Mode | 01 – 03h | 12h | 00 – 01h | Transmit/Receive (0 - 1) | | | |
| Level Adjust Value | 01 – 03h | 13h | 00 – 39h | TX output power (0 – 57) | | | |
| Pin Override Mask | 01 – 03h | 14h | 00 - 0Fh | Software override of hardware settings | | | |
| Read Only | | | | | | | |
| Device Name | 01h | 01h | 00h | Returns the 2 character name (NT) | | | |
| Firmware Version | 01h | 02h | 00h | Returns the 2 byte firmware version | | | |
| Serial Number | 01h | 03h | 00h | Returns the 4 byte serial number | | | |
| Get RSSI Value | 01h | 1Fh | 00h | Returns the RSSI value | | | |
| Write Only | | | | | | | |
| Return to Default | 03h | 80h | 00h | Return to factory default | | | |
| Error Codes | | | | | | | |
| ERR_CMD | 15h | | F1h | Invalid Command | | | |
| ERR_CHAN | 15h | | F2h | Channel value is out of range | | | |
| ERR_BAUD | 15h | | F3h | Baud band value is out of range | | | |
| ERR_RXTX | 15h | | F4h | RX/TX value is out of range | | | |
| ERR_LVL_ADJ | 15h | | F5h | Level Adjust value is out of range | | | |
| ERR MASK | 15h | | F6h | Command is not enabled by the mask | | | |

Figure 4: NT Series Transceiver Command Data Interface Command Set

The pin override mask on the following page (Figure 5) enables or disables software control of the configuration settings. It uses the four LSB bits of the Value byte to control the four settings: Channel Selection (bit 0), Baud Band (bit 1), TX/RX Mode (bit 2), and Level Adjust (bit 3). A 0 activates hardware control through the pins; a 1 activates software control. If software control is activated then the states of the hardware lines are ignored. Likewise, software control of a feature is disabled when hardware control is active.

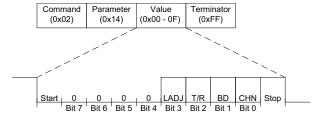


Figure 5: NT Series Transceiver Command Data Interface Timing

The RF channel is set by entering the number of the desired channel. The range of this value depends on the frequency version. The valid range for the 900MHz version is 0 to 100 as shown in Figure 6. The valid range for the 868MHz version is 0 to 67, as shown in Figure 9. This command is the equivalent of the CHN_SEL0, CHN_SEL1 and CHN_SEL2 lines but offers many more channels.

| NT Series Tra | NT Series Transceiver 900MHz Serial Channels | | | | | | |
|---------------|--|---------|-----------|-----------------|-------------------|---------|-----------|
| Channel | Frequecy | Channel | Frequency | Channel | Frequency | Channel | Frequency |
| 0 | 902.62 | 26 | 909.12 | 51 | 915.37 | 76 | 921.62 |
| 1 | 902.87 | 27 | 909.37 | 52 | 915.62 | 77 | 921.87 |
| 2 | 903.12 | 28 | 909.62 | 53 | 915.87 | 78 | 922.12 |
| 3 | 903.37 | 29 | 909.87 | 54 | 916.12 | 79 | 922.37 |
| 4 | 903.62 | 30 | 910.12 | 55 | 916.37 | 80 | 922.62 |
| 5 | 903.87 | 31 | 910.37 | 56 | 916.62 | 81 | 922.87 |
| 6 | 904.12 | 32 | 910.62 | 57 | 916.87 | 82 | 923.12 |
| 7 | 904.37 | 33 | 910.87 | 58 | 917.12 | 83 | 923.37 |
| 8 | 904.62 | 34 | 911.12 | 59 | 917.37 | 84 | 923.62 |
| 9 | 904.87 | 35 | 911.37 | 60 | 917.62 | 85 | 923.87 |
| 10 | 905.12 | 36 | 911.62 | 61 | 917.87 | 86 | 924.12 |
| 11 | 905.37 | 37 | 911.87 | 62 | 918.12 | 87 | 924.37 |
| 12 | 905.62 | 38 | 912.12 | 63 | 918.37 | 88 | 924.62 |
| 13 | 905.87 | 39 | 912.37 | 64 | 918.62 | 89 | 924.87 |
| 14 | 906.12 | 40 | 912.62 | 65 | 918.87 | 90 | 925.12 |
| 15 | 906.37 | 41 | 912.87 | 66 | 919.12 | 91 | 925.37 |
| 16 | 906.62 | 42 | 913.12 | 67 | 919.37 | 92 | 925.62 |
| 17 | 906.87 | 43 | 913.37 | 68 | 919.62 | 93 | 925.87 |
| 18 | 907.12 | 44 | 913.62 | 69 | 919.87 | 94 | 926.12 |
| 19 | 907.37 | 45 | 913.87 | 70 | 920.12 | 95 | 926.37 |
| 20 | 907.62 | 46 | 914.12 | 71 | 920.37 | 96 | 926.62 |
| 21 | 907.87 | 47 | 914.37 | 72 | 920.62 | 97 | 926.87 |
| 22 | 908.12 | 48 | 914.62 | 73 | 920.87 | 98 | 927.12 |
| 23 | 908.37 | 49 | 914.87 | 74 | 921.12 | 99 | 927.37 |
| 24 | 908.62 | 50 | 915.12 | 75 | 921.37 | 100 | 927.62 |
| 25 | 908.87 | | Dark (| Gray = Hardware | e Selectable Char | nnels | |

Figure 6: NT Series Transceiver 900MHz Serial Channels

The European regulations are quite different from the North American regulations. The 900MHz rules in North America only specify output power and harmonic levels. The 868MHz rules in Europe subdivide the 863MHz to 870MHz band into sub-bands that are intended for specific applications. The output power varies by sub-band and there is a requirement to either listen before transmitting or comply with a duty cycle limit.

Listen Before Talk (LBT) is simply checking the RSSI level of the channel before transmitting. If the RSSI level is high, the channel is occupied and the system waits until it is clear. The system may also use Adaptive Frequency Agility (AFA) which has the system change channels to avoid ones that are occupied. These features can be implemented in a microcroller outside the module.

If LBT is not implemented, then the system must comply with duty cycle limits. This refers to the amount of time the transmitter is on per hour. This requires that the transmit time and the total time be tracked. The limits vary with the sub-band.

Figure 9 shows the max output power and duty cycle limits by channel. Figure 7 shows the 868MHz channels that are available through the hardware pin selection and Figure 8 shows the 900MHz channels.

| Series Transceiver 868MHz Parallel Channels | | | | | | |
|---|-----|-----|--------|-----------|--|--|
| CS2 | CS1 | CS0 | CHANEL | FREQUENCY | | |
| 0 | 0 | 0 | 0 | 863.15 | | |
| 0 | 0 | 1 | 10 | 864.15 | | |
| 0 | 1 | 0 | 20 | 865.15 | | |
| 0 | 1 | 1 | 30 | 866.15 | | |
| 1 | 0 | 0 | 52 | 868.35 | | |
| 1 | 0 | 1 | 58 | 868.95 | | |
| 1 | 1 | 0 | 64 | 869.55 | | |
| 1 | 1 | 1 | 67 | 869.85 | | |

Figure 7: NT Series Transceiver 868MHz Parallel Channels

| NT Series Transceiver | IT Series Transceiver 900MHz Parallel Channels | | | | | | |
|-----------------------|--|-----|--------|-----------|--|--|--|
| CS2 | CS1 | CS0 | CHANEL | FREQUENCY | | | |
| 0 | 0 | 0 | 3 | 903.37 | | | |
| 0 | 0 | 1 | 15 | 906.37 | | | |
| 0 | 1 | 0 | 21 | 907.87 | | | |
| 0 | 1 | 1 | 27 | 909.37 | | | |
| 1 | 0 | 0 | 39 | 912.37 | | | |
| 1 | 0 | 1 | 51 | 915.37 | | | |
| 1 | 1 | 0 | 69 | 919.87 | | | |
| 1 | 1 | 1 | 75 | 921.37 | | | |

Figure 8: NT Series Transceiver 900MHz Parallel Channels

| Channel | Frequency | D.C. | Max Power | Channel | Frequency | D.C. | Max Power |
|---------|-----------|-------|-----------|---------|-----------|-----------|------------|
| 0 | 863.15 | 0.10% | 25mW | 34 | 866.55 | 0.10% | 25mW |
| 1 | 863.25 | 0.10% | 25mW | 35 | 866.65 | 0.10% | 25mW |
| 2 | 863.35 | 0.10% | 25mW | 36 | 866.75 | 0.10% | 25mW |
| 3 | 863.45 | 0.10% | 25mW | 37 | 866.85 | 0.10% | 25mW |
| 4 | 863.55 | 0.10% | 25mW | 38 | 866.95 | 0.10% | 25mW |
| 5 | 863.65 | 0.10% | 25mW | 39 | 867.05 | 0.10% | 25mW |
| 6 | 863.75 | 0.10% | 25mW | 40 | 867.15 | 0.10% | 25mW |
| 7 | 863.85 | 0.10% | 25mW | 41 | 867.25 | 0.10% | 25mW |
| 8 | 863.95 | 0.10% | 25mW | 42 | 867.35 | 0.10% | 25mW |
| 9 | 864.05 | 0.10% | 25mW | 43 | 867.45 | 0.10% | 25mW |
| 10 | 864.15 | 0.10% | 25mW | 44 | 867.55 | 0.10% | 25mW |
| 11 | 864.25 | 0.10% | 25mW | 45 | 867.65 | 0.10% | 25mW |
| 12 | 864.35 | 0.10% | 25mW | 46 | 867.75 | 0.10% | 25mW |
| 13 | 864.45 | 0.10% | 25mW | 47 | 867.85 | 0.10% | 25mW |
| 14 | 864.55 | 0.10% | 25mW | 48 | 867.95 | 0.10% | 25mW |
| 15 | 864.65 | 0.10% | 25mW | 49 | 868.05 | 1% | 25mW |
| 16 | 864.75 | 0.10% | 25mW | 50 | 868.15 | 1% | 25mW |
| 17 | 864.85 | 0.10% | 25mW | 51 | 868.25 | 1% | 25mW |
| 18 | 864.95 | 0.10% | 25mW | 52 | 868.35 | 1% | 25mW |
| 19 | 865.05 | 0.10% | 25mW | 53 | 868.45 | 1% | 25mW |
| 20 | 865.15 | 0.10% | 25mW | 54 | 868.55 | 1% | 25mW |
| 21 | 865.25 | 0.10% | 25mW | 55 | 868.65 | 0.10% | 25mW |
| 22 | 865.35 | 0.10% | 25mW | 56 | 868.75 | 0.10% | 25mW |
| 23 | 865.45 | 0.10% | 25mW | 57 | 868.85 | 0.10% | 25mW |
| 24 | 865.55 | 0.10% | 25mW | 58 | 868.95 | 0.10% | 25mW |
| 25 | 865.65 | 0.10% | 25mW | 59 | 869.05 | 0.10% | 25mW |
| 26 | 865.75 | 0.10% | 25mW | 60 | 869.15 | 0.10% | 25mW |
| 27 | 865.85 | 0.10% | 25mW | 61 | 869.25 | 0.10% | 25mW |
| 28 | 865.95 | 0.10% | 25mW | 62 | 869.35 | 0.10% | 25mW |
| 29 | 866.05 | 0.10% | 25mW | 63 | 869.45 | 10% | 500mW |
| 30 | 866.15 | 0.10% | 25mW | 64 | 869.55 | 10% | 500mW |
| 31 | 866.25 | 0.10% | 25mW | 65 | 869.75 | None / 1% | 5mW / 25m\ |
| 32 | 866.35 | 0.10% | 25mW | 66 | 869.85 | None / 1% | 5mW / 25m\ |
| 33 | 866.45 | 0.10% | 25mW | 67 | 869.95 | None / 1% | 5mW / 25m\ |

Figure 9: NT Series Transceiver 868MHz Serial Channels

The Baud Band command sets the Baud Band for the over-the-air data. The range of this value is 1 to 4 as shown in Figure 10. This command is the equivalent of the BAUD0 and BAUD1 lines.

| NT Series Tra | NT Series Transceiver Baud Selection | | | | | | |
|---------------|--------------------------------------|-------|---------------------|-----------------------|---------------------------------------|--|--|
| Baud Band | BAUD1 | BAUD0 | Baud rate (kbps) | IF Bandwidth (kHz) | Typical Receiver Sensitivity (dBm) | | |
| 0 | 0 | 0 | 1 to 19.2 | 100 | -113 | | |
| 1 | 0 | 1 | 19.2 to 80 | 150 | -110 | | |
| 2 | 1 | 0 | 80 to 160 | 200 | -106 | | |
| 3 | 1 | 1 | 160 to 300 | 300 | -102 | | |

Figure 10: NT Series Transceiver Baud Selection

The transceiver has an optional internal packet generator that can be used instead of a custom protocol. Please see the Packet Generator Reference Guide for more information on Packet Mode. In Packet Mode, this value sets the over-the-air baud rate as shown in Figure 11. This does not affect the baud rate of the Command Data Interface. Using a lower baud rate results in better range.

| NT Series Transceiver Packet Mode Baud Selection | | | | | | |
|--|-------|-------|---------------------|--|--|--|
| Baud Band | BAUD1 | BAUD0 | Baud rate (kbps) | | | |
| 0 | 0 | 0 | 19.2 | | | |
| 1 | 0 | 1 | 57.6 | | | |
| 2 | 1 | 0 | 153.6 | | | |
| 3 | 1 | 1 | 300 | | | |

Figure 11: NT Series Transceiver Packet Mode Baud Selection

The TX/RX Mode command puts the transceiver into Receive Mode or Transmit Mode. This value is 0 for receive or 1 for transmit. This command is the equivalent of the T/R_SEL line. Note that this command is ignored when the transceiver is in Packet Mode.

The Level Adjust value sets the transmitter output power. The range of this value is 0 for the lowest power to 57 for maximum power. This command is the equivalent of the LVL_ADJ line. Figure 12 shows the typical output power for each level.

| NT Series Tran | NT Series Transceiver Level Adjust Value vs. Typical Output Power | | | | | | |
|----------------|---|-------------|----------|-------------|----------------------|-------------|----------------------|
| Power Level | P ₀ (dBm) | Power Level | P₀ (dBm) | Power Level | P ₀ (dBm) | Power Level | P ₀ (dBm) |
| 57 | 12.22 | 42 | 5.38 | 27 | -1.46 | 12 | -8.36 |
| 56 | 12.12 | 41 | 4.83 | 26 | -1.84 | 11 | -8.83 |
| 55 | 12.14 | 40 | 4.33 | 25 | -2.39 | 10 | -9.39 |
| 54 | 11.86 | 39 | 4.05 | 24 | -2.83 | 9 | -9.13 |
| 53 | 11.85 | 38 | 3.49 | 23 | -3.27 | 8 | -9.68 |
| 52 | 9.58 | 37 | 3.11 | 22 | -3.79 | 7 | -10.23 |
| 51 | 9.78 | 36 | 2.77 | 21 | -4.30 | 6 | -10.86 |
| 50 | 8.94 | 35 | 2.12 | 20 | -4.85 | 5 | -11.50 |
| 49 | 8.33 | 34 | 1.65 | 19 | -5.47 | 4 | -12.23 |
| 48 | 8.02 | 33 | 1.16 | 18 | -5.78 | 3 | -13.04 |
| 47 | 7.42 | 32 | 0.81 | 17 | -6.12 | 2 | -13.98 |
| 46 | 6.99 | 31 | 0.38 | 16 | -6.72 | 1 | -14.59 |
| 45 | 6.72 | 30 | -0.18 | 15 | -7.09 | 0 | -15.78 |
| 44 | 6.33 | 29 | -0.66 | 14 | -7.52 | | |
| 43 | 5.80 | 28 | -0.93 | 13 | -7.91 | | |

Figure 12: NT Series Transceiver Level Adjust Value vs. Typical Output Power

The Get RSSI command returns a value that is proportional to the received signal strength. This command is the equivalent of the RSSI line, but offers slightly more resolution. This value is a signed byte that can be converted into a power level with the following formula:

Signal Strength (dBm) = $-1 * [(RSSI \ Value / 2) -1]$

The Return to Default command returns the module to the factory settings. Figure 13 shows some examples of the Command Data Interface.

| NT Series Transceiver Command Data Interface Examples | | | | | |
|---|----------------------------------|-------------------------------|--|--|--|
| Example Messages Input to the Module | | | | | |
| Read Baud Band | 0x01 + 0x11 + 0x00 + 0xFF | Returns the current baud band | | | |
| Write Baud Band | 0x02 + 0x11 + 0x02 + 0xFF | Temporary (RAM) Baud = Baud1 | | | |
| Program Baud Band | 0x03 + 0x11 + 0x04 + 0xFF | New (EEPROM) Baud = Baud3 | | | |
| Example Messages Output from the Me | odule | | | | |
| ACKnowledge Baud Band | 0x06 + 0x11 + 0x04 + 0xFF | ACKnowledge Baud = Baud3 | | | |
| No-ACKnowledge Baud Band | 0x15 + 0x11 + 0xF3 + 0xFF | Value is out of range | | | |

Figure 13: NT Series Transceiver Command Data Interface Examples

Typical Applications

Figure 14 and Figure 15 show two circuits using the CDI.

Figure 14 shows the transceiver set up for transparent data operation. The TRPT/PKT line is pulled high, placing the module into Transparent Mode. The microcontroller monitors the READY line for flow control and to monitor the status of the module. It controls POWER_DOWN and STANDBY for power conservation, though these could be hardwired if power conservation is not necessary for the application. CMD_DATA_IN and CMD_DATA_OUT are connected to the TX and RX lines of the UART in the microcontroller. CMD DATA TYPE is hardwired low for command data. CMD_DATA_BAUD is hardwired to the low data rate (9,600bps). DATA IN and DATA OUT are connected to GPIOs on a microcontroller that generates and decodes the over-the-air data.

The channel, power level, transmit/receive state and baud band are controlled by the microcontroller through the CDI rather than by the hardware lines. The microcontroller also reads the RSSI level through the CDI.

Figure 15 shows the transceiver set up for packet operation. The TRPT/PKT line is pulled low, placing the module into Packet Mode. CMD_DATA_IN and CMD DATA OUT are connected to the TX and RX lines of the UART in the microcontroller. The microcontroller controls the CMD_DATA_TYPE line to toggle between Command Data for changing the module's settings and Packet Data for transmission or reception. It also controls POWER DOWN and STANDBY for power conservation. The microcontroller monitors the READY line for flow control and to monitor the status of the module. CMD_DATA_BAUD is hardwired to the high data rate (57,600bps).

The channel, power level and baud band are controlled by the microcontroller through the CDI rather than by the hardware lines. The microcontroller also reads the RSSI level through the CDI.

Please see the Packet Generator Reference Guide for more information on Packet Mode.

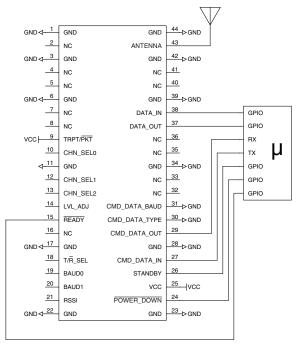


Figure 14: NT Series Transceiver Typical Application Circuits

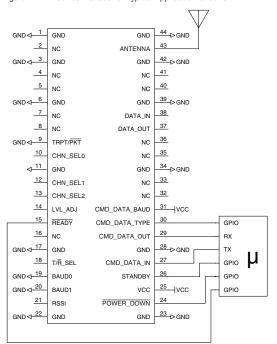


Figure 15: NT Series Transceiver Typical Application Circuits (2)

Appendix A - Sample Firmware

The following sample firmware allows an application to use a frequency agility algorithm to have the receiver listen on an optimal frequency. In this sample, there are three channels used: channel 27 (909.37MHZ), channel 51 (915.36MHz) and channel 75 (921.37MHz).

The application periodically polls the receiver's RSSI on each channel, selecting the one with the lowest RSSI. This becomes the receiver's base listening channel. When the application needs to transmit data, it sends the same data message on each of the three channels. When done transmitting, the application puts the module back into receive mode on its base channel.

```
//***************************
  Overview: This function reads RSSI from the NT module on each of three
              channels. The channel with the lowest value for RSSI
              is selected as the active listening channel.
              The order for serial communication is as follows:
              1. Set the NT to software control for channel and RX/TX select.
              2. Set the NT to receive mode.
              3. Set the NT to each channel frequency while reading RSSI.
              4. Set the NT to the 1st channel frequency.
              5. Read RSSI from the NT module.
              6. If RSSI is lower than the previous RSSI, use this channel.
              7. Set the NT to the 2nd channel frequency.
              8. Read RSSI from the NT module.
              9. If RSSI is lower than the previous RSSI, use this channel.
              10. Set the NT to the 3rd channel frequency.
              11. Read RSSI from the NT module.
              12. If RSSI is lower than the previous RSSI, use this channel.
              13. Set the NT channel to the quietest frequency selected.
  Input:
              none
  Output:
              none
//***************************
void Select RX Channel(void)
  static unsigned int8 i, rx ch, temp;
  static unsigned int8 nt rply[4] = \{0,0,0,0,0\};
  static unsigned int8 channel[3] = {27,51,75};
  static signed int8 prev rssi;
  static signed int8 rssi val;
  // Initialize the previous RSSI value to OdBm
  prev rssi = 0;
  // Initialize the RX channel to the 1st channel in the sequence
  rx ch = channel[0];
  // Set the NT module for software control of Channel and RX/TX Select.
  printf("%c%c%c%c", 0x02, 0x14, 0x05, 0xFF);
  // Flush the NT ACK response by waiting for the terminating character
  while (getc() != 0xFF);
  // Set the NT module to receive mode
  printf("%c%c%c%c", 0x02, 0x12, 0x00, 0xFF);
   // Flush the NT ACK response by waiting for the terminating character
```

```
while (getc() != 0xFF);
  // Get RSSI for each channel & assign the receiver to the quietest frequency
  for (i=0; i<3; i++)
       \ensuremath{//} Set the NT module to the next channel in sequence
     printf("%c%c%c%c", 0x02, 0x10, channel[i], 0xFF);
     // Flush the NT ACK response by waiting for the terminating character
     while (getc() != 0xFF);
       // Read RSSI from the NT module
     printf("%c%c%c%c", 0x01, 0x1F, 0x00, 0xFF);
      // Get the RSSI value from the NT
     nt rply[0] = getc();
     nt rply[1] = getc();
     rssi val = getc();
     nt rply[3] = getc();
       // Use the channel with the lowest RSSI value for receive mode
     if (rssi_val < prev rssi)</pre>
        // Assign the quieter channel frequency
        rx ch = channel[i];
        // Update the previous RSSI value
        prev rssi = rssi val;
  }
  // Set the NT module to the selected channel frequency
  printf("%c%c%c%c", 0x02, 0x10, rx ch, 0xFF);
  ^- // Flush the NT ACK response by waiting for the terminating character
  while (getc() != 0xFF);
             //**************************
  Overview: This function allows over-the-air (OTA) application data from pin
             DATA IN to be transmitted on each of three channels.
             The receiver listens on one of these three channels.
             The idea is to send the same message on each channel so the
             receiver has the opportunity to listen on the quietest channel.
             The order for serial communication is as follows:
              1. Set the NT to software control for channel and RX/TX select.
             2. Set the NT to transmit mode.
             3. Set the NT to the 1st channel frequency
             4. Send the OTA data packet into DATA IN pin of the NT module.
              5. Set the NT to the 2nd channel frequency
              6. Send the OTA data packet into DATA_IN pin of the NT module.
             7. Set the NT to the 3rd channel frequency
             8. Send the OTA data packet into DATA IN pin of the NT module.
             NOTE:
  Input:
             none
            ******************
void Transmit Data(void)
```

```
static unsigned int8 i;
static unsigned int8 channel[3] = {27,51,75};
// Set the NT module for software control of Channel and RX/TX Select.
printf("%c%c%c%c", 0x02, 0x14, 0x05, 0xFF);
// Flush the NT ACK response by waiting for the terminating character
while (getc() != 0xFF);
// Set the NT module to transmit mode
printf("%c%c%c%c", 0x02, 0x12, 0x01, 0xFF);
// Flush the NT ACK response by waiting for the terminating character
while (getc() != 0xFF);
\ensuremath{//} Transmit a data packet on each of the 3 channel frequencies
for (i=0; i<3; i++)
   // Set the NT module to each channel frequency used in the sequence
   printf("%c%c%c%c", 0x02, 0x10, channel[i], 0xFF);
   // Flush the NT ACK response by waiting for the terminating character
   while (getc() != 0xFF);
   // *** Application sends data packet to NT's DATA IN pin here ***
}
```

Appendix B - Example CDI Value Bytes

Values to set the channel frequency range from 0 to 100 (0 to 64 hexadecimal) as shown in Figure 16.

| NT Series Transceiver Comm | Series Transceiver Command Data Interface Channel Value Examples | | | | | |
|----------------------------|--|--|--|--|--|--|
| Channel Number | Value | Description | | | | |
| 0 | 00h | Center frequency is 902.62MHz | | | | |
| 3 | 03h | Center frequency is 903.37MHz (parallel channel 0) | | | | |
| 15 | 0Fh | Center frequency is 906.37MHz (parallel channel 1) | | | | |
| 21 | 15h | Center frequency is 907.87MHz (parallel channel 2) | | | | |
| 27 | 1Bh | Center frequency is 909.37MHz (parallel channel 3) | | | | |
| 39 | 27h | Center frequency is 912.37MHz (parallel channel 4) | | | | |
| 51 | 33h | Center frequency is 915.37MHz (parallel channel 5) | | | | |
| 69 | 45h | Center frequency is 919.87MHz (parallel channel 6) | | | | |
| 75 | 4Bh | Center frequency is 921.37MHz (parallel channel 7) | | | | |
| 100 | 64h | Center frequency is 927.62MHz | | | | |

Figure 16: NT Series Transceiver Command Data Interface Channel Value Examples

Values to set the Baud Band range from 0 to 3 as shown in Figure 17.

| T Series Transceiver Command Data Interface Baud Band Value Examples | | | | |
|--|-------|-------------------------|-------------|--|
| Baud Band Number | Value | Over-the-Air Baud Rates | | |
| Daud Balld Nullibel | | Transparent Mode | Packet Mode | |
| 0 | 01h | 1kbps to 19.2kbps | 19.2kbps | |
| 1 | 02h | 19.2kbps to 80kbps | 57.6kbps | |
| 2 | 03h | 80kbps to 160kbps | 153.6kbps | |
| 3 | 04h | 160kbps to 300kbps | 300kbps | |

Figure 17: NT Series Transceiver Command Data Interface Baud Band Value Examples

| NT Series Transceiver Command Data Interface Transmit / Receive Value Examples | | | | |
|--|-------|--------------------------|--|--|
| Operation | Value | Description | | |
| Receive Mode | 00h | Turns on the receiver | | |
| Transmit Mode | 01h | Turns on the transmitter | | |

Figure 18: NT Series Transceiver Command Data Interface Transmit / Receive Value Examples

| T Series Transceiver Command Data Interface Level Adjust Value Examples | | | | |
|---|-------|--|--|--|
| Operation | Value | Description | | |
| Min. TX output power | 00h | Typical output power should be -15.78dBm | | |
| Transmit Mode | 01h | Turns on the transmitter | | |

Figure 19: NT Series Transceiver Command Data Interface Level Adjust Value Examples

The pin override mask tells the module to use either the hardware pins or the CDI commands to configure the channel, baud band, TX/RX mode and output power level. The values range from 0 to 15 (0 to F hexadecimal) and depend on which items are to be controlled with the CDI and which are to be controlled with the hardware pins. Figure 20 shows example values.

| NT Series Transceive | Γ Series Transceiver Command Data Interface Pin Override Mask Value Examples | | | | |
|----------------------|--|---|--|--|--|
| Operation | Value | Description | | | |
| No bits set | 00h | All settings are controlled with the hardware pins | | | |
| Bit 0 set | 01h | Channel is controlled with the CDI and the hardware pin is ignored | | | |
| Bit 1 set | 02h | Baud rate is controlled with the CDI and the hardware pin is ignored | | | |
| Bit 2 set | 04h | TX/RX mode is controlled with the CDI and the hardware pin is ignored | | | |
| Bit 3 set | 08h | Level Adjust is controlled with the CDI and the hardware pin is ignored | | | |
| Bits 0 and 2 set | 05h | Channel and TX/RX mode are controlled with the CDI, others with the hardware pins | | | |
| All bits set | 0Fh | All settings are controlled with the CDI | | | |

Figure 20: NT Series Transceiver Command Data Interface Pin Override Mask Value Examples



Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов:
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001:
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.



Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)

Факс: 8 (812) 320-02-42

Электронная почта: org@eplast1.ru

Адрес: 198099, г. Санкт-Петербург, ул. Калинина,

дом 2, корпус 4, литера А.