Linx TECHNOLOGIES

MT Series Transcoder Module Data Guide

Wireless made simple®

Warning: Some customers may want Linx radio frequency ("RF") products to control machinery or devices remotely, including machinery or devices that can cause death, bodily injuries, and/or property damage if improperly or inadvertently triggered, particularly in industrial settings or other applications implicating life-safety concerns ("Life and Property Safety Situations").

NO OEM LINX REMOTE CONTROL OR FUNCTION MODULE SHOULD EVER BE USED IN LIFE AND PROPERTY SAFETY SITUATIONS. No OEM Linx Remote Control or Function Module should be modified for Life and Property Safety Situations. Such modification cannot provide sufficient safety and will void the product's regulatory certification and warranty.

Customers may use our (non-Function) Modules, Antenna and Connectors as part of other systems in Life Safety Situations, but only with necessary and industry appropriate redundancies and in compliance with applicable safety standards, including without limitation, ANSI and NFPA standards. It is solely the responsibility of any Linx customer who uses one or more of these products to incorporate appropriate redundancies and safety standards for the Life and Property Safety Situation application.

Do not use this or any Linx product to trigger an action directly from the data line or RSSI lines without a protocol or encoder/decoder to validate the data. Without validation, any signal from another unrelated transmitter in the environment received by the module could inadvertently trigger the action.

All RF products are susceptible to RF interference that can prevent communication. RF products without frequency agility or hopping implemented are more subject to interference. This module does not have a frequency hopping protocol built in.

Do not use any Linx product over the limits in this data guide. Excessive voltage or extended operation at the maximum voltage could cause product failure. Exceeding the reflow temperature profile could cause product failure which is not immediately evident.

Do not make any physical or electrical modifications to any Linx product. This will void the warranty and regulatory and UL certifications and may cause product failure which is not immediately evident.

Ordering Information

Ordering Information	
Part Number	**Description**
LICAL-TRC-MT	MT Transcoder
MDEV-LICAL-MT	MT Master Development System

MT transcoders are shipped in reels of 1,600

Figure 2: Ordering Information

Absolute Maximum Ratings

Absolute Maximum Ratings				
Supply Voltage V_{CC}	–0.3	to	+6.5	VDC
Any Input or Output Pin	–0.3	to	V_{CC} + 0.3	VDC
Max. Current Sourced by Output Pins		25		mA
Max. Current Sunk by Input Pins		25		mA
Max. Current Into V_{CC}		250		mA
Max. Current Out Of GND		300		mA
Operating Temperature	–40	to	+85	ºC
Storage Temperature	–65	to	+150	ºC

Exceeding any of the limits of this section may lead to permanent damage to the device. Furthermore, extended operation at these maximum ratings may reduce the life of this device.

Figure 3: Absolute Maximum Ratings

Warning: This product incorporates numerous static-sensitive components. Always wear an ESD wrist strap and observe proper ESD handling procedures when working with this device. Failure to observe this precaution may result in module damage or failure.

Pin Assignments

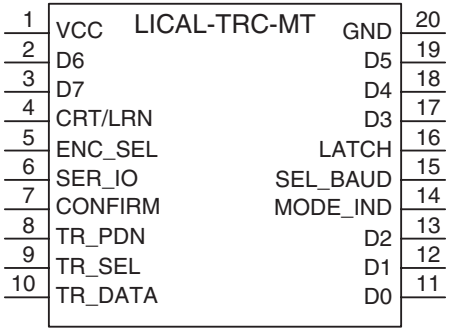

Figure 5: MT Series Transcoder Pin Assignments (Top View)

Pin Descriptions

Pin Descriptions

Pin Number	Name	I/O	Description
1	V_{CC}		Supply Voltage
2, 3, 11–13, 17–19	D0–D7	I/O	Status Lines. Each line can be configured as either an input to register button or contact closures or as an output to control application circuitry.
4	CRT/LRN	I	Create / Learn Mode Activation Line. When this line goes high, the transcoder enters Learn Mode. If it is held high for ten seconds, the transcoder clears its memory. If it goes high while the ENC_SEL line is high, the transcoder enters Create Mode. If it goes high while the SER_IO line is high, the transcoder enters Serial Mode.
5	ECN_SEL	I	Encoder Only Select Line. If this line is tied high, the MT operates as an encoder only. If it is tied low, the MT defaults to a decoder until it is set as a transcoder in Create Mode.
6	SER_IO	I/O	Serial Interface Line. This line is used for the Serial Interface Engine, which allows the transcoder to be programmed by an external device. The transcoder also uses this line to output the ID of the originating transcoder, status line states, and custom data.
7	CONFIRM	O	Transmission Confirmation Line. This line goes high when the transcoder receives a confirmation that its transmission was received correctly.

Overview

Many products and applications call for the transfer of button presses or switch closures across a wireless link. Traditionally, a remote control link has operated in only one direction, from a transmitter to a receiver. The cost associated with transceivers has been too high to practically implement in low-cost products. With the increasing availability of low-cost transceiver solutions, bidirectional links are now practical and open a new world of opportunity.

In a wireless environment, maintaining the reliability and uniqueness of a transmitted signal is generally of great importance. In a unidirectional system, IC devices called encoders and decoders are often utilized to simplify this process. The encoder side turns the status of a number of input lines into an encoded serial bit-stream output intended for transmission via an RF or infrared link. Once received, the decoder decodes, error checks and analyzes the transmission. If the transmission is authenticated, the decoder's output lines are set to replicate the states of the encoder's input lines.

To accommodate bidirectional links, a new type of device has been developed. Called a transcoder, this device combines a remote control encoder and decoder into a single device, and is capable of sending commands as well as receiving them. It is also able to receive an automatic confirmation from the remote side indicating that its command was received.

The Linx MT Series is a revolutionary transcoder product designed for wireless remote control applications. The same device can be used as an encoder, decoder, or transcoder and is ideal for both uni and bidirectional applications and even mixtures of the two. The MT Series is easily implemented, making it ideal for even the most basic applications, but its rich feature set also allows it to meet the needs of far more complex applications. These features include the ability to identify the originating transmitter, establish user permissions, select output latch modes on a "per pin" basis, and a powerful serial interface that allows control and information exchange with external microcontrollers or a PC.

Consider a brief example of how just one of the MT's innovative features could be used to transform a relatively simple application, the common garage door opener. In competitive devices, encoded transmissions are generally either recognized or denied based on the address. If the

Transcoder Operation

When the transcoder powers on for the first time, it looks at the state of the ENC_SEL line. If the line is high, then the transcoder enters Encoder Mode and acts like an encoder only. It pulls the TR_SEL line high to set the transceiver into transmit mode and makes all of its status lines inputs. The transcoder does not have an address, so one must be created before normal operation can start.

If the ENC_SEL line is low, then the transcoder enters Decoder Mode and acts like a decoder only. It pulls the TR_SEL line low to set the transceiver into receive mode and makes all of its status lines outputs. The transcoder has not learned any addresses, so it will not respond to any transmissions. Once a user is learned, the transcoder requires that the transmission have a valid, learned address before it responds.

The process of creating an address also defines which status lines are inputs and which are outputs. Once this is completed, if the ENC_SEL line is high, then the MT Series acts as an encoder only using just the defined inputs and the address that was created.

If the ENC_SEL line is low, the MT Series enters Transcoder Mode and uses both the inputs and outputs as well as the address that was created. In this mode, it can send commands as well as receive commands. It must go through Learn Mode to learn another device's address before it responds to transmissions.

Create Mode

Create Mode allows the generation of a unique address to ensure the uniqueness of a transmission and prevent unintentional operation of devices. The MT Series transcoder allows for the creation of 16,777,216 (2^{24}) possible addresses. The assignment of the status lines as inputs or outputs also occurs in this mode.

Create Mode is entered by holding the ENC_SEL line high and pulling the CRT/LRN line high. The address is randomized for as long as the CRT/LRN line is high (the ENC_SEL line is not checked again once the process is begun). Once the line is pulled low, the resulting address is saved in memory and the transcoder is ready to accept the status line assignments. Each line that is to be an input should be pulled high. Any lines not taken high are set as outputs. There is no requirement for the order in which the lines are activated or the time between activations as long as all of the desired lines are activated within the time out period. The transcoder saves the assignments and goes to sleep when the CRT/LRN line is taken high again or when it times out after 15 seconds.

Learn Mode

In order for the MT to accept transmissions from a specific transcoder, it must first learn that transcoder's address. This is done by taking the CRT/LRN line high then low to place the transcoder into Learn Mode. Once in Learn Mode, the MODE_IND line starts switching, allowing for connection of an LED to provide visual indication that the transcoder is ready to accept a new address. This continues until the CRT/LRN line goes high again or until a time-out after 15 seconds.

The transcoder looks for a valid transmission from another transcoder and records the received address. It also records the status line that was activated in the Control Permissions. Each status line on the transmitting side that is authorized to control the receiving transcoder needs to be activated. The receiving transcoder updates the Control Permissions with each valid packet that contains a new active status line. It is not necessary to hold all of the desired status lines on the transmitting side high at the same time, simply press each one that is to be authorized within the time out period. When the CRT/LRN line is taken high again or the transcoder times-out after 15 seconds, the recorded address and Control Permissions are saved in memory and the transcoder returns to sleep.

Receive Mode

When a rising edge is seen on the TR_DATA line, the transcoder enters Receive Mode. It then looks for a valid packet, meaning that there are no errors and that the received address matches one that is saved in memory. In addition, if Targeted Device Addressing is enabled, then the received targeted address must match the transcoder's local address. If no valid data is received within 16 or 32ms (dependent on the selected baud rate) then Receive Mode is exited. If there is a match, then the transcoder pulls the MODE_IND line high as an indication that a valid signal has been received. It compares the received commands to the Control Permissions associated with the transcoder that sent the signal, and reproduces the states of the authorized status lines on the originating transcoder on its own status line outputs.

If Confirmation is enabled, the transcoder pulls the TR_SEL line high to place the transceiver into transmit mode and sends a confirmation to the originating transcoder. It also outputs the ID of the originating transcoder, a Command Byte that represents the states of the status lines, and a custom data byte programmed by the user. It then looks for the next valid data packet. If, at any time, an error or an unknown address is detected, then the transcoder ignores the packet and looks for the next one. If the 131ms timer runs out before any valid packets are received, then the transcoder goes back to sleep.

TX ID

The transcoder outputs an eight-bit binary number on the SER_IO line to identify which learned transcoder sent the transmission. The number normally corresponds to the order in which the transcoder was learned, so the first transcoder learned gets number '1', the second gets number '2', and so on. An exception arises when the memory is full, in which case the first numbers are overwritten as described in the Learn Mode section. An exception also arises if the serial interface is used to write an address to a specific location in memory. The TX ID is output with the Status and Custom Data bytes after every valid packet that is received, as described in the Serial Output section.

Custom Data Transmission

The MT Series offers the option of sending one byte of custom data with the command packet. The custom byte is entered into the transcoder through the SIE using the Read and Write Custom Data Value commands. This option is enabled or disabled using the Enable and Disable Custom Data commands. The custom data byte is output on the receiving end with the TX ID and Status bytes. Custom Data Transmission only needs to be enabled on the transmitting side. The receiving side identifies the packet as containing custom data and outputs the byte. This option is disabled by default and the receiving transcoder outputs a value of 0xFF for the custom byte.

This feature is useful for sending an 8-bit A/D value from a sensor, custom command codes, or an additional user-defined ID for additional proprietary system authentication. There are no restrictions on the 8-bit value, though 0xFF is not recommended for use since that is the default value with no data.

The Custom Data is output with the Status and TX ID bytes, as described in the Serial Output section.

Mode Entry Timings

The transcoder may enter the desired mode within minimum timings shown in the figure below. However, if the transcoder is in another mode at the time the CRT/LRN line goes high, then it could take longer for the transcoder to recognize the trigger. For example, Receive Mode at 9,600bps can take 32ms to exit. For this reason, it is recommended to increase the time to ensure that the transcoder enters the correct mode. Typical times are shown in Figure 8, Figure 9 and Figure 10, but may be adjusted according to the application.

Serial Output

Upon reception of every valid packet, the transcoder outputs a serial data stream containing information about the transmission. The information takes two forms depending on the User Access setting.

If the User Access is set to open, then the serial output consists of a start byte, the three byte address of the transmitting device, a status line byte, a custom data byte and a stop byte. The start byte is 0x00 and the stop byte is 0xFF.

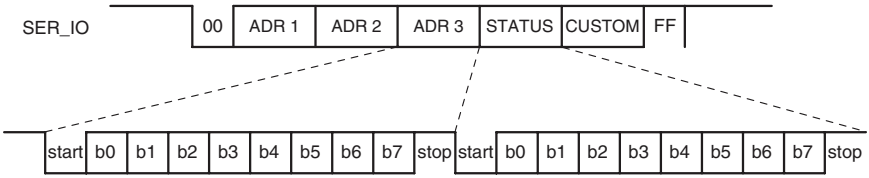

Figure 11: MT Series Transcoder Open Access Serial Output

If the User Access is set to locked, then the serial output consists of a start byte, TX ID byte, status line byte, custom data byte and a stop byte. The start byte is 0x00 and the stop byte is 0xFF.

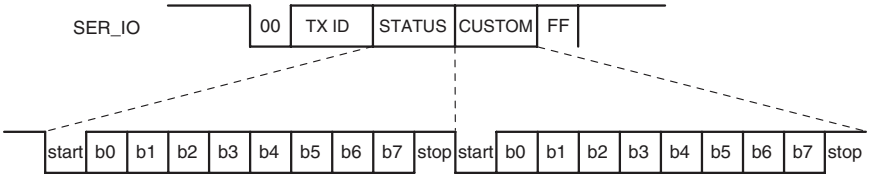

Figure 12: MT Series Transcoder Locked Access Serial Output

The status line byte reflects the states of the status lines, '1' for high and '0' for low. This represents the current logic states of the outputs, not the command that was received, so that the states of latched lines are correctly represented. Line D0 corresponds to bit b0 in the byte, D1 corresponds to b1, and so forth. This allows applications that use an embedded microcontroller to read the transmitted commands without having to monitor eight hardware lines.

The TXID and Custom Data bytes are described in their own sections.

The bytes are output asynchronously least significant bit first with one start bit, one stop bit, and no parity at the baud rate determined by the SEL_BAUD line. During normal operation, the SER_IO line is an input, becoming an output only when sending the data stream or responding to a serial command. These are described more in the Serial Interface section.

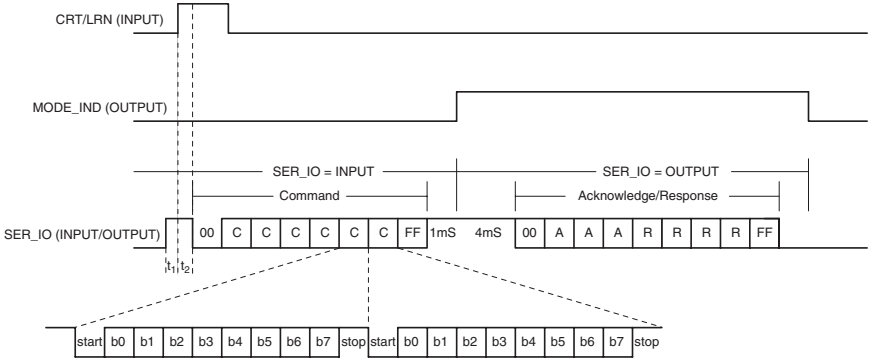

Figure 13: MT Series Transcoder Serial Programming

Time t1 in the figure above does not have to be any specific time, just so long as the SER_IO line goes high before the CRT/LRN line. Time t2 should be greater than 120µs (typical of 35ms, see the Mode Entry Timings section) to ensure that the transcoder goes into Serial Mode. There is not a maximum time specified. Once in Serial Mode, the transcoder waits for the start byte (0x00) of the serial command.

The timings associated with each command and the transcoder's response are listed in Figure 14 (9,600bps) and Figure 15 (28,800bps).

To send consecutive commands, keep the CRT/LRN line high and take the SER_IO line high within 50µs of the MODE_IND line going low.

It should be noted that all of the settings are written into non-volatile memory, so they are retained if power is removed from the chip. This includes all values, such as custom byte and target address, as well as the enabled / disabled states.

Figure 15: MT Series Transcoder Serial Interface Engine Timings (ms) at 28,800bps

MT Series Transcoder Serial Interface Engine Timings (ms) at 28,800bps

	SER_IO = Input		SR_IO = Output						
Definition	Min Ready	Max Ready	Receive Cmd	Process Cmd	Reply Wait	Transmit Reply	Finish Process	Min Total Time	Max Total Time
Read Local Settings	0.08	17.00	2.80	1.11	4.00	3.10	0.04	11.13	28.05
Write Local Settings	0.08	17.00	2.80	1.03	4.00	1.73	17.80	27.44	44.36
Read Next User ID	0.08	17.00	2.80	1.06	4.00	2.07	0.04	10.06	26.97
Write Next User ID	0.08	17.00	2.80	1.04	4.00	1.73	3.65	13.30	30.22
Read Specific User	0.08	17.00	2.80	1.11	4.00	3.11	0.04	11.14	28.06
Write Specific User	0.08	17.00	2.80	1.04	4.00	1.73	14.30	23.95	40.87
Read Target Address	0.08	17.00	2.80	1.10	4.00	2.77	0.04	10.79	27.71
Write Target Address	0.08	17.00	2.80	1.05	4.00	1.73	10.74	20.40	37.32
Read Custom Data Value	0.08	17.00	2.80	1.07	4.00	2.08	0.04	10.07	26.99
Write Custom Data Value	0.08	17.00	2.80	1.05	4.00	1.73	3.65	13.31	30.23
Read Latch Mask Value	0.08	17.00	2.80	1.07	4.00	2.08	0.04	10.07	26.99
Write Latch Mask Value	0.08	17.00	2.80	1.05	4.00	1.73	3.65	13.31	30.23
Read Status Outputs	0.08	17.00	2.80	1.05	4.00	2.08	0.04	10.05	26.97
Write Status Inputs	0.08	17.00	2.80	1.06	4.00	1.73	**	9.73	26.65
Read Confirmation EN	0.08	17.00	2.80	1.07	4.00	2.08	0.04	10.07	26.99
Write Confirmation EN	0.08	17.00	2.80	1.06	4.00	1.73	3.65	13.32	30.24
Read Device Targeting EN	0.08	17.00	2.80	1.08	4.00	2.08	0.04	10.08	27.00
Write Device Targeting EN	0.08	17.00	2.80	1.06	4.00	1.73	3.65	13.32	30.24
Read Custom Data EN	0.08	17.00	2.80	1.08	4.00	2.08	0.04	10.08	27.00
Write Custom data EN	0.08	17.00	2.80	1.07	4.00	1.73	3.65	13.33	30.25

MinRdy applies when MT is in Encoder Only mode.
MaxRdy applies when MT is in Transcoder mode and time may be longer due to possible receive timeout period.
Receive Command is calculated for 8 bytes at 28,800bps (34µs/bit).
Transmit Reply is measured on the SER_IO pin from the MT
** Finish Process time for the Write Status Inputs command = 0.06ms + (Packet Time * Number of Packets). See Figure 19 for Packet Time.

Serial Interface Connections

The serial interface on the MT Series can be connected to any device capable of serial communication, including microcontrollers, RS-232 drivers and computers. Figure 17 gives an example of connecting the MT to the Linx QS Series USB module for connection to a computer.

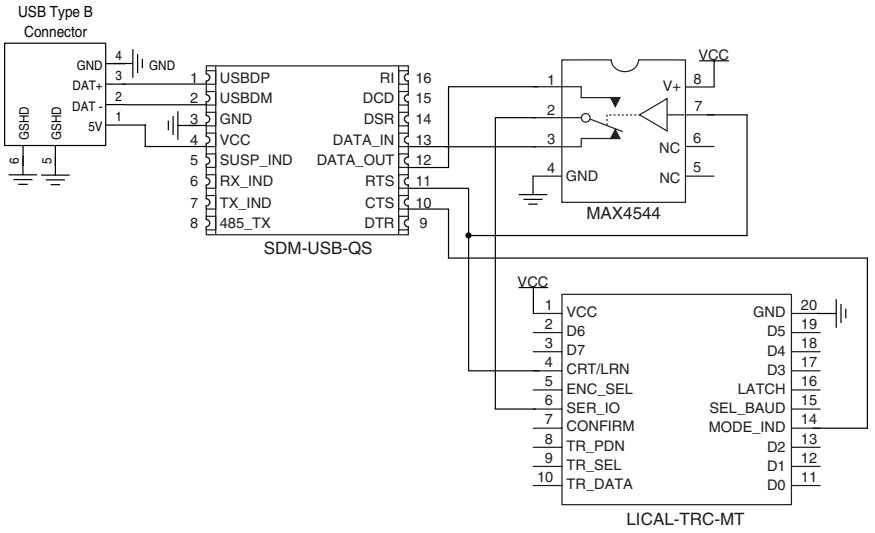

Figure 17: MT Series Transcoder Serial Interface to a PC

The USB module follows the RS-232 convention of using separate lines for data input and data output while the transcoder has a single line for all data. This requires a switch to alternatively connect the transcoder's SER_IO line to the DATA_IN and DATA_OUT lines on the module.

The RTS line is used to throw the switch as well as to activate the CRT/LRN line placing the transcoder into Serial Mode. This gives the PC the ability to control when communication is initiated.

The MODE_IND line goes high when the transcoder is prepared to send data, so the CTS line on the USB module is used to monitor the MODE_IND line. This allows the computer to know when to throw the switch and look for data from the transcoder.

One point of note is that voltage translation may be necessary if the 5V USB module is used to communicate with a transcoder operating at 3V. There are many components and methods for implementing level shifting, so it is up to the designer to determine the best solution for the product.

MT Series Transcoder Activation Times and Transmitted Packet Duty Cycle							
Confirmation	Custom Data Transmission	Targeted Device Addressing	Baud Rate (bps)	Packet Time (ms)	Min Activation Time (ms)	Max Activation Time (ms)	TX Data Duty Cycle (%)
Off	Off	Off	9,600	20.0	9.6	337.6	22.0
Off	Off	Off	28,800	11.3	5.0	170.0	18.6
On	Off	Off	9,600	23.0	9.6	337.6	19.1
On	Off	Off	28,800	11.0	5.0	170.0	19.1
Off	On	Off	9,600	21.3	11.0	339.0	23.2
Off	On	Off	28,800	11.9	5.7	170.7	19.3
On	On	Off	9,600	24.4	11.0	339.0	20.3
On	On	Off	28,800	11.6	5.7	170.7	19.8
Off	Off	On	9,600	23.8	13.8	341.8	25.6
Off	Off	On	28,800	12.9	7.0	172.0	20.9
On	Off	On	9,600	27.2	13.8	341.8	22.4
On	Off	On	28,800	12.9	7.0	172.0	20.9
Off	On	On	9,600	25	15.1	343.1	26.6
Off	On	On	28,800	13.4	7.6	172.6	21.6
On	On	On	9,600	28.6	15.1	343.1	23.3
On	On	On	28,800	13.6	7.6	172.6	21.3

Minimum Activation time without Transceiver Power Control
Maximum Activation time with Transceiver Power Control

Figure 19: MT Series Transcoder Activation Times and Transmitted Packet Duty Cycle

Transcoder MODE_IND Definitions

The MODE_IND line is the primary means of indicating the state of the transcoder to the user. The table below gives the definitions of the MODE_IND signals.

MT Series Transcoder MODE_IND Definitions

MODE_IND Signals	Description
Receive Mode	ON for as long as the transcoder is receiving data from a learned user. This only indicates authorized data reception, not status output activation.
Create Address Mode	ON during address generation while the CRT/LRN line is HIGH, then it flashes* when the CRT/LRN line is taken LOW. Once the 15-second timer expires or the CRT/LRN line is asserted again, the MODE_IND line turns OFF.
Learn Mode	ON while the CRT/LRN line is held HIGH until taken LOW to enter Learn Mode, then it flashes* for 15 seconds until the timer expires or the CRT/LRN line is asserted again. If the 60th user profile has been saved, it blinks* 5 times to indicate the next user profile will overwrite the first.
Erase Mode	ON while the CRT/LRN line is held HIGH for 10 seconds and Erase Mode is entered, then it turns OFF until the CRT/LRN line is released. It then turns back ON again for 2 seconds to indicate erase completion.
Serial Interface Mode	OFF while a command is being received (SER_IO = input) and ON while an ACK/reply is being sent (SER_IO = output).

*Blink = ON for 1sec and OFF 250ms
*Flash = ON for 65ms and OFF for 65ms

Figure 22: MT Series Transcoder MODE_IND Definitions

Typical Applications

The MT Series transcoder is ideal for replicating button presses for remote control applications. An example application circuit is shown in Figure 24.

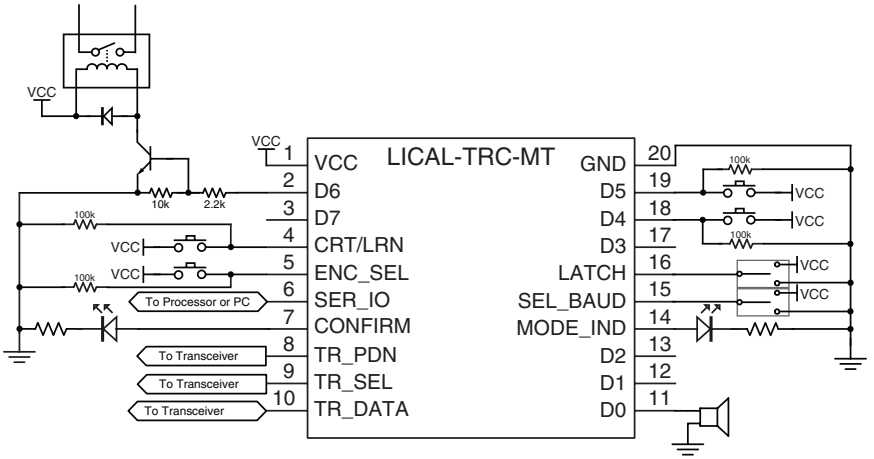

Figure 24: MT Series Transcoder Application Circuit

SPDT switches are used to select the baud rate and set the latch mode. These can be tied directly to supply or ground if they will not change.

The TR_PDN line can be connected to the PDN line of a transceiver or it can be left floating.

SER_IO can be connected to a microprocessor or a PC to program the transcoder through the serial command set or to record the transmitter identity. Application Note AN-00157 has sample code.

An LED indicator is attached to the MODE_IND line to provide visual feedback to the user that an operation is taking place. This line can source a maximum of 25mA, so the limiting resistor may not be needed, depending on the LED chosen and the brightness desired.

The CONFIRM line is connected to an LED to indicate that the remote device successfully received the command.

The CRT/LRN and ENC_SEL lines are connected to buttons that pull the lines high when pressed. 100kΩ resistors are used to pull the lines to ground when the buttons are released.

The TR_DATA line is connected directly to the data line of the transceiver.

Design Steps to Using the MT Series

Creation of an Address and assignment of status lines

1. Take the CRT/LRN line high while the ENC_SEL line is high to enter Create Mode.
2. The Address is randomized for as long as the CRT/LRN line is high (the ENC_SEL is not monitored once Create Mode has been entered). The MODE_IND line goes high to indicate that the Address is being randomized.
3. Release the CRT/LRN line and the MODE_IND line begins switching to indicate that the transcoder is ready to set status line assignments.
4. Take each line that is to be an input high within fifteen seconds.
5. Take the CRT/LRN line high again or let the transcoder time out after fifteen seconds to exit Create Mode.

Learn another transcoder's Address

1. Take the CRT/LRN line high then low to enter Learn Mode.
2. The MODE_IND line begins switching to indicate that the transcoder is ready to receive a transmission. On the transmitting side, activate each status line that is to be authorized. The transcoder records the Address and the activated status lines as the Control Permissions.
3. Take the CRT/LRN line high again or let the transcoder time out after fifteen seconds to exit Learn Mode.

Erase all Address in memory

1. Take the CRT/LRN line high and hold for ten seconds.
2. The MODE_IND line goes high when the CRT/LRN line is activated, then low after ten seconds to indicate that the memory has been erased.

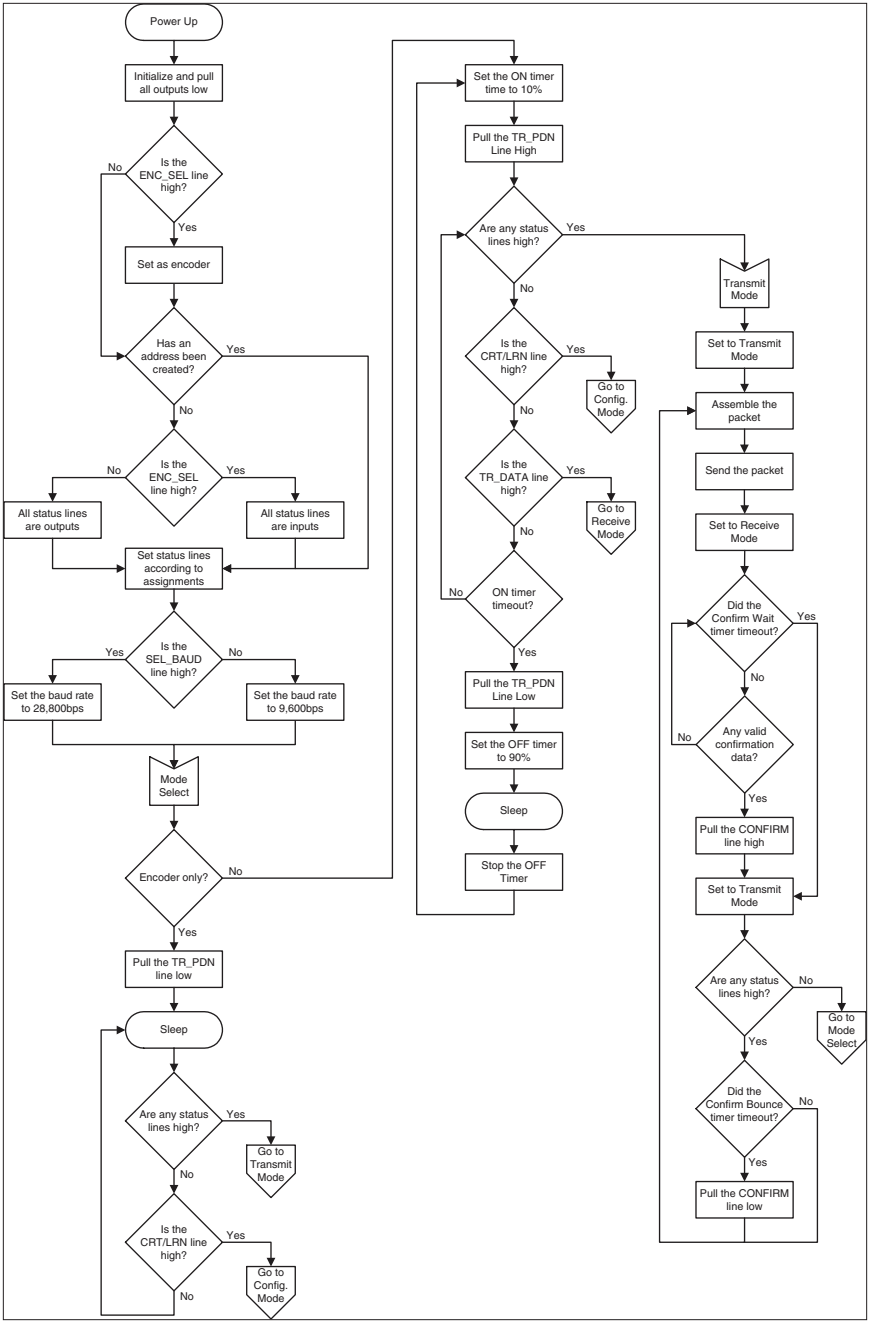

Figure 25: MT Series Transcoder Power-up Flowchart

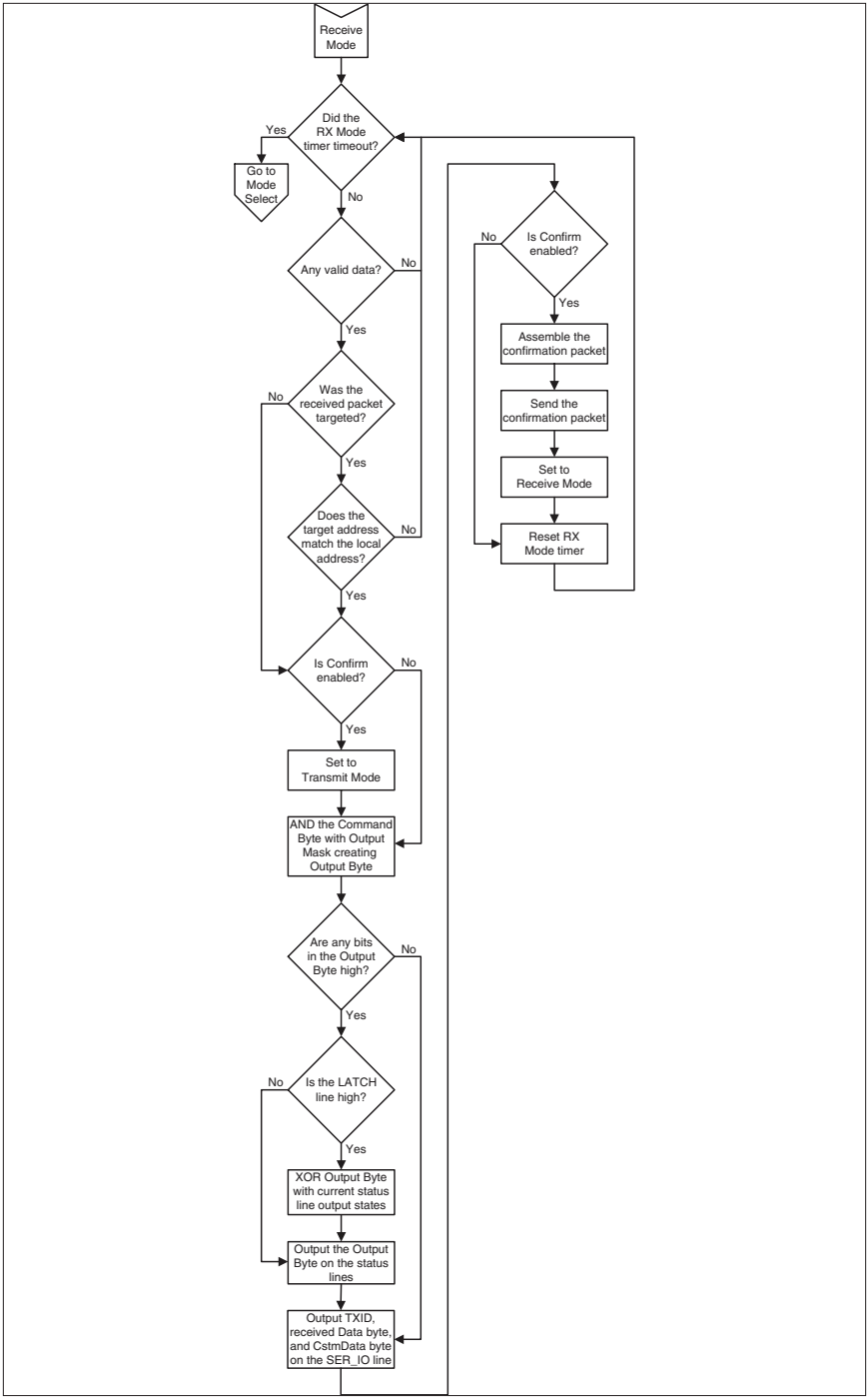

Figure 27: MT Series Transcoder Receive Flowchart

Linx Technologies
159 Ort Lane
Merlin, OR, US 97532

Phone: +1 541 471 6256
Fax: +1 541 471 6251

www.linxtechnologies.com

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