

RR-CirKits

Specializing in Affordable Electronics for Model Railroads

TC-64 Tower Controller

64 line I/O to LocoNet® Interface
Firmware Revision 5

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User's Guide



LocoNet Certification applied for.

LocoNet® is a trademark of Digitrax Inc. (<http://www.digitrax.com/>)

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Table of Contents

Contact Information.	
Overview	1
1.0 Features	1
2.0 Quick Start	1
3.0 Connections and Indicators	2
3.1 LocoNet® Connector	2
3.2 Power Connector	2
3.3 Status Indicators.	2
4.0 Boot Loader	3
5.0 Input/Output Connections	4
5.1 Port Connections	4
5.1.1 Port Electrical	4
5.1.2 Connector Pin Identification	5
5.1.3 Port Configuration	5
5.2 Control Bit Definition CV17-22	6
5.3 Control Bit Definition CV1-16 CV23-278	7
5.4 Per Line Bit Definition (byte one)	8
5.5 Per Line Bit Definition (byte two)	9
5.6 Per Line Bit Definition (byte three - four)	10
6.0 Input/Output Boards	11
7.0 Trouble Shooting	14
7.1 Sanity Test	14
7.2 Loop Back Test	14
7.3 Factory Reset	15
8.0 Local Power	15
9.0 Optical Isolation	16
10.0 Warranty Information	16
11.0 FCC Information	16

Contact Information

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WARNING: This product contains a chemical known to the state of California to cause cancer, birth defects or other reproductive harm.

9.0 Optical Isolation

The Tower Controller provides complete electrical isolation between the layout and the LocoNet®. This prevents possible ground loop problems between the LocoNet® and your layout power supplies. For example, many systems are installed without properly grounding the booster to power ground, but use grounded power supplies for accessories.

Some devices connect the LocoNet® ground directly to the interface boards. This provides a ground path from the local power supplies to the LocoNet® and then to the booster. At best this indirect grounding causes electrical noise. At worst it could create a fault path via the small gage LocoNet® wiring to ground.

Properly ground your boosters, your power supplies, and your desktop computer through a 3 wire cable, and isolate them from each other via isolated equipment.

10.0 Warranty Information

We offer a one year warranty on the TC-64. This device contains no user serviceable parts. If a defect occurs, please contact RR-CirKits at: service@rr-cirkits.com for a replacement.

11.0 FCC Information

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. this device must accept any interference received, including interference that may cause undesired operation.

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.

Any modifications to this device voids the user's authority to operate under and be in compliance with these regulations. The actual measured radiation from the Tower Controller is much lower than the maximum that is permitted by the FCC Rules, so it is unlikely that this device will cause any RFI problems.

Overview

The TC-64 Tower Controller 64 line LocoNet® interface provides a simple and easy way to connect between the Digitrax LocoNet® bus and the layout. It may be connected at any convenient point on the LocoNet®.



1.0 Features

- 64 lines of Input/Output arranged in 8 groups of 8 lines each.
- Each group may be configured as an input or output.
- LocoNet® certified (certification applied for)
- CV controlled programming via Software. (e.g. JMRI DecoderPro 2.0 or later.)
- Both read and write of CV values is supported in OPs mode.
- Each port can be individually addressed, or as part of a group.
- Full optical isolation between LocoNet® and TC-64.
- Automatically saves status during power down. (optionally)
- Boot Loader allows firmware upgrades over LocoNet® connection
- External power input accepts 9V-20V wide range without overheating. Internal switching regulator provides up to 1 amp at 5VDC total power to ports for I/O modules..



2.0 Quick Start

We suggest that you use a computer program such as the JMRI DecoderPro (2.0 or later) to setup the Tower Controller. The "point and click" interface will save you much time and frustration while setting the many possible options that you will need to configure.

- **OPS Mode Address:** Each Tower Controller has a single address that is used for OPS mode programming on the layout. Each individual Tower Controller on your layout must have its own address. Your Tower Controller comes pre-programmed with an address that is 10xxx where xxx are the last three numerical digits of the serial number. E.g. device serial number 015d would have a programming address of 10015.
- This address is only used to configure the Tower Controller. It has nothing to do with the addresses that each input/output line will use to communicate information with the LocoNet® system.
- This address must not conflict with that of any Locomotives in use on the layout, as no distinction is made between mobile and fixed decoders in OPS mode. This address must be in the range of 0-16383. We suggest

that you choose a 5 digit address to avoid potential conflicts.

- **Prior to connecting** your TC-64 you should make a DecoderPro roster entry for it. Open the '**Service Mode Programmer**' and select RR-CirKits TC-64 as the decoder type. Click 'Open Programmer', then go to the 'Basic' tab, check '4 digit addressing' and enter your unit's **5 digit** address in the 'Long Address' box. Go to the 'Roster Entry' tab, enter an ID (e.g. TC 10030) and then click on the 'Save' button.
- All configuration must be done with the '**Operations Mode Programmer**'.
- The lower green status indicator should illuminate as soon as your TC-64 is powered up.
- Connect the unit's LocoNet® jack to any point on your system's LocoNet®. The upper green status indicator should illuminate, and the red status indicator should indicate all LocoNet® activity. The yellow command indicator will light each time the TC-64 initiates or responds to a LocoNet® command.
- You should now be able to interface to your Railroad from your software.

3.0 Connections and Indicators

The TC-64 Tower Controller has eleven connectors and four status indicators.

3.1 LocoNet® Connector

The LocoNet® connection is made to the TC-64 via the provided LocoNet® cable connected to either of the two RJ-12 (6 pin) modular jacks. LocoNet® cables are wired straight through, not reversed like phone cables.

Pin outs for the RJ-12 connector:

Pin	Description	Color
1	Rail_Sync-	white
2	Signal Ground	black
3	LocoNet-	red
4	LocoNet+	green
5	Signal Ground	yellow
6	Rail_Sync+	blue

LocoNet® pins 2 and 5, and pins 3 and 4 are connected together internally.

3.2 Power Connections

The TC-64 requires an external power source of between 9 and 25 volts AC/DC and should provide 8VA or more. Multiply the output voltage times the rated current to get VA. For example a 12V 800ma. supply would provide 9.6VA and be a good choice. A 9V 300ma, supply would only provide 2.7VA and severely limit the output drive capability of the TC-64.

The LocoNet® receiver and driver circuits receive their power from the Rail_Sync lines and draw only a few milliamperes. (see section 7.0 for local power options)

Steps:

1. Open the JMRI LocoNet® Monitor window.
1. Using a switch input on the TC-64, send a command.
2. The switch command should appear in the LocoNet® monitor window and both the TC-64 command (Y) and activity (R) LEDs should blink.
3. Using JMRI send commands (e.g. switch commands) to the TC-64.
4. The commands should appear in the LocoNet® monitor window and the TC-64 command and activity LEDs should blink.

If there is activity at the interface, but no activity light at the TC-64 when switch commands are sent, check the LocoNet® wiring. If the command is seen in the activity light, but not in the command light, be sure that the command you are sending is addressed to respond on this TC-64. If there is no activity shown in the LocoNet® monitor window, check that you have the correct interface selected in the JMRI preferences, and that you have the correct COM port selected.

7.3 Factory Reset

If the TC-64 settings get lost, the unit may be returned to its factory default settings by sending a value of 170 (hex AA) to CV21 using JMRI DecoderPro in 'Service Mode'. (Note: This is the only TC-64 use of Service Mode) The factory default Ops address is 10000 with all ports set as input contacts, with ports 1-8 base addresses set to; 0, 8, 16, 24, 32, 40, 48, and 56 respectively.

Steps:

1. Using a paper clip, press the "Program" switch located under the small hole labeled "Program" for 3 seconds. The yellow "Command" LED should begin to flash indicating that the TC-64 is in Service Mode.
2. Open DecoderPro (2.0 or later) and select 'Service Mode'. Be sure that there are no locomotives on your program track. Select RR-CirKits – TC-64 as the decoder. Click on 'Reset'. The flashing yellow light on the TC-64 should flicker as the 'reset' command is sent to the unit.
3. Set the proper address for this unit in the "Basic" tab, then switch to the "CVs" tab and write just CV17 and CV18. (red error is OK)
4. Press the "Program" switch again to return the TC-64 to its normal operating mode.

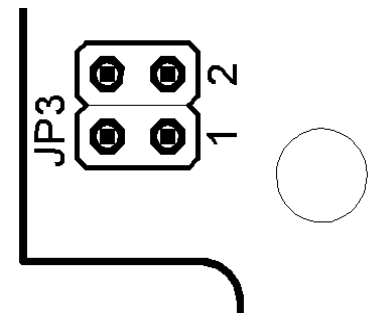
8.0 Local Power

This device includes jumper positions to provide local power to the internal LocoNet® circuits. This may be useful if the TC-64 is being used without a Digitrax command station.

The use of an external Rail Sync power supply such as provided by the various Digitrax UP panels is a better alternative.

Note: Use of these jumpers bypasses the built in optical isolation.

To enable the internal power, carefully open the case and install jumpers at both positions 1 and 2 of the option connector JP3.



Other Planned TC-64 Input/Output modules include:

- **IRD-8** (Infra-Red Detector Board) with 8 inputs. This board includes 8 infra-red detector inputs, sensitivity controls, and indicators. It may be configured to use 38KHz IR long range beam block detectors, or else simple retro reflective and emitter/detector beam break units. Each of the 8 channels are sequentially accessed to prevent interference between them. Narrow band pulsed beam technology greatly reduces sensitivity to ambient lighting conditions and backscatter from other IR sources such as hand held throttles or remote controls.
- **TSB-8** (Terminator Splitter Board) This board is a convenient way to convert from 10 pin ribbon cable to screw terminals. It may be used for inputs or outputs, and includes pads for mounting resistors such as required for connecting LEDs used for direct drive signals or panels.
- **RCSB-8** (RC Servo Driver Board) with 8 outputs. This board is designed to control 4 to 8 RC servos. Uses include semaphores, crossing gates, train order signals, wig-wags, operating building doors, etc.

7.0 Trouble shooting

7.1 Sanity Test

To perform a very basic TC-64 sanity test perform the following steps:

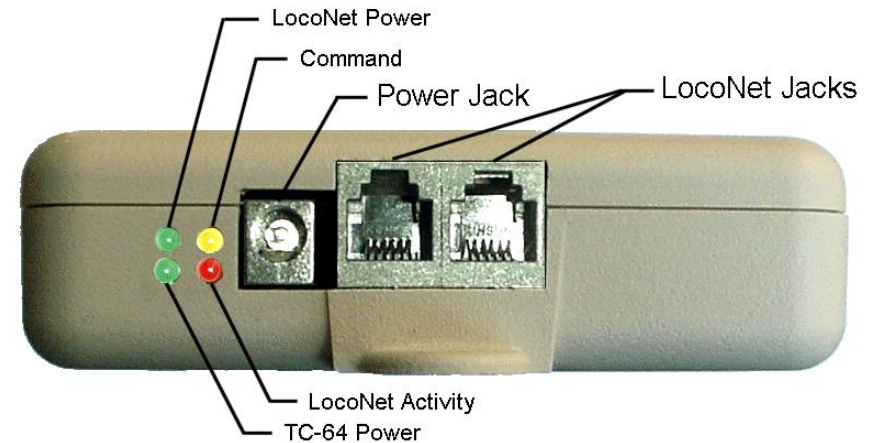
1. Power up the Tower Controller by plugging it into the computer.
2. The lower green power LED should come on.
3. Plug in the LocoNet® cable. The upper green power LED should light.
4. Unplug the LocoNet® cable. The red activity light should blink briefly as the cable is removed.
5. Using a paper clip, press the "Program" switch located under the small hole labeled "Program" for 3 seconds. The yellow "Command" LED should begin to flash indicating that the TC-64 has entered Service Mode and is waiting for an address change. Press the switch again briefly and the LED should extinguish.

If the lower green power LED does not light, be sure that the power supply is connected and provides at least 9V to the Tower Controller.

If the Rail Sync upper power LED does not light, or if the activity LED does not blink when you unplug the LocoNet® cable, be sure that your DCC command station is powered up, then check your LocoNet® wiring.

7.2 Loop Back Test

The Tower Controller's input circuit and code reads directly from the unit's LocoNet® jack, so if you send a character it should be seen on the input line. This test uses the free software available from the JMRI project to watch the test commands. (www.jmri.info)



3.3 Status Indicators

The TC-64 has four status indicators located next to the power connector. The two green status indicators show the power status. The upper green indicator shows the power status of the LocoNet® Rail-Sync power input. The lower green indicator shows the power status of the TC-64 itself. The red status indicator normally shows all LocoNet® activity, and activity/error status during a boot loader firmware upgrade. The yellow indicator shows LocoNet® activity

directed to, or coming from, this specific TC-64. It also indicates programming status. (see section 4.0) LocoNet® commands not acted upon by the TC-64 will blink the red Activity indicator but not the yellow Command indicator.

4.0 Boot Loader

When an update to your TC-64 firmware is needed, a program such as "Download Firmware" in JMRI version 2.3.4 or later is required. **Do Not** use JMRI version 2.2 – 2.3.2 as they contain a bug related to 'Download Firmware'.

To enter Boot loader mode, make a tool from a bent paper clip to depress the internal switch located under the small hole in the top of the TC-64 labelled "Program". Depress the switch for 10 seconds, until the Command light starts to blink, then lights steadily, and then release it. The yellow led will continue to light steadily indicating the boot loader is now ready to accept messages from the JMRI Down loader. Start JMRI and select "LocoNet" then "Download Firmware". Select the latest TC-64 upgrade and click "Read file" then "Download". The red activity led will blink each time it receives a data packet from the JMRI down loader. When programming is successful, the yellow led will extinguish automatically, and normal operation will resume automatically.

Error codes:

During boot loading, several possible error codes are shown by the red led:

- 1 blink: manufacturer code or product code mismatch;
- 2 blinks: hardware version mismatch;
- 3 blinks: hex file software version equal or lower;
- 4 blinks: unused (no LocoNet® data);
- 5 blinks: internal programming error detected.

Each of the above errors will halt the boot loader process. To recover from the first three error types, just cycle power to restart the device, correct the error, and then re-run the JMRI program. Nothing has been overwritten.

To recover from the last error type, it must be assumed that the firmware is in an undefined state, most probably damaged or incomplete. If the process is interrupted for any reason you will also end up with corrupted firmware.

To recover from a corrupted upgrade you must first unplug the power to the TC-64, then, while holding the program switch depressed, plug in the power again. This will place the unit directly into program mode and allow you to resend the upgrade. (the yellow command light will light steadily) The boot loader code itself is protected against being written over.

5.0 Input/Output Connections

The TC-64 Tower Controller Inputs and Outputs are connected via eight internal 10 pin polarized headers, Each header is know as a "Port" and they are numbered from 1 through 8. Each port is configured individually with its own CV values. Each port may be configured to be either an input or an output. Each port has its own individual starting address. The number of addresses used by each port will be either 4 or 8 depending on its configuration and use. Multiple ports may be assigned to the same or to different addresses. CV 1-16 are used to set the address and direction of each port. (see 5.3 for details)

We suggest that the user take advantage of JMRI DecoderPro or a similar program to set the values, rather than using a hand held controller due to the large number of items to set. Current versions of DP have the capability of setting groups of values with one selection.

5.1 Port connections

Each port connector contains 8 I/O data lines and two power connections, +5VDC and Ground. The +5VDC power available from any single port is limited to 200ma. (power connections plus lines)

5.1.1 Port Electrical

The maximum current draw by user devices such as LEDs should not exceed 15ma. at 5VDC per output line. The maximum current draw from any individual port, including data lines and the 5V supply line is 200ma. The total current per TC-64 is limited to 960ma. The TC-64 includes an internal 1A switching power supply and internal auto reset fuses to protect against long term overloads that exceed these values. If you need to drive more voltage and/or current, then you will need to use an external I/O module powered from its own source.



SMD-8 (Stall Motor Driver – 8 line) The SMD-8 board contains 8 individual, optically isolated, H-Bridge drivers. This allows the board to be powered from any supply between 9 Volts and 18 Volts. It is primarily designed to drive stall motor turnout machines such as those found in Tortoise® and

Switchcraft® machines . Do not exceed 15VAC or 24VDC at the power input.

The port cable connector wiring is as follows. This board includes an adjustable regulator to allow you to control the speed of your switch machine motors. This regulator will draw 100ma. plus your load current, and the board normally runs warm even with no load.



DCDB-8 (Direct Current Driver Board - 8 line)

The DCDB-8 driver board contains 8 individual, optically isolated, H-Bridge drivers. This allows the board outputs to be powered from any supply between 8 Volts and 28Volts. It is primarily designed to drive small DC motors. Do not exceed

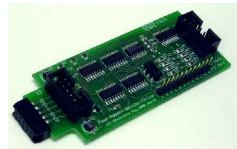
24VAC or 36VDC at the power input. This board includes an on-board 5V switching regulator to allow safe operation at high voltages. The regulator will draw 50-100ma. plus your load current, and normally runs warm even with no load.

The DCDB-8 drivers include clamp diodes and may be used to directly drive inductive loads such as relay or solenoid coils if desired. The outputs are wired in an "H" bridge configuration but may be used single ended. Both positive and negative common return points are provided for single ended operation.

The DCDB-8 outputs are rated at 600ma. per line, not to exceed 1.2A peak for 100µs non repetitive. The board includes an auto reset fuse that will prevent extended operation in excess of 1A total continuous output current per board, but it will NOT protect it from direct short circuit currents. Short circuits on any output line may destroy the board, so be careful of your wiring.

The DCDB-8 input lines are active low so the TC-64 should be configured as "Driver" for each port that is connected to a DCDB-8. This inverted input mode matches most types of driver outputs, and the drive polarity may be easily switched either in the TC-64 setup or by reversing the DCDB-8 output lines.

Revision 5 and later TC-64 firmware now directly supports dual coil solenoids. In 'Dual Coil' mode the output lines are paired such that the port requires just 4 addresses. It is no longer required to use secondary addressing for dual coil operation. Setting the Port 'Direction' to 'Output' and the Port 'Toggle' bit to 'Alt Action' places the port into paired mode. Each line of a pair normally responds to either 'Closed' or 'Thrown' with the output action selected for each line. This action will normally be a 0.1 second pulse when driving solenoids. Dual coil operation should not be attempted if the switch machine power supply is not of the capacitive discharge type that will limit the long term current to a low value. **Failure to observe this precaution may result in destruction of equipment and be a fire hazard!**



4ASD-4 (4 Aspect Signal Driver - 4 head) This output board drives up to 4 four aspect signal heads with 9VDC. The outputs are multiplexed to allow 4 heads on a single 10 wire flat ribbon cable. LED current dropping resistors are included on the board allowing the signals to be directly attached to the cables without purchasing any

extra hardware for each signal. To control the fourth aspect two CV's are required and "signal" mode must be enabled:

- 1st, 3rd, 5th and 7th lines: this output byte controls the timing of the flashing aspect;
- 2nd, 4th, 6th and 8th lines: this output byte selects the two alternating aspect colors.

Normally the 4th aspect will be set to 'dark' and the software will blink the signal if a flashing mode is required by sending alternate 'dark' and 'color' commands. Select 'SE8c 4 Aspect' as the JMRI signal type for this application. It is also possible to allow the TC-64 to directly flash the signals in the 4th aspect selection. The selection of 'LDT LS-DEC' for the signal type will make this easy to configure.



SDB-4 (4 Aspect Searchlight Signal Driver - 4 head) This output board drives up to 4 four aspect searchlight signal heads using either dual color 3 wire R/G LEDs or bipolar 2 wire R/G LEDs. The bipolar output of this board has color balance adjustments for each output. The outputs are wired to allow 4 heads on a single 10 wire flat ribbon cable. The LED current dropping resistors are included on

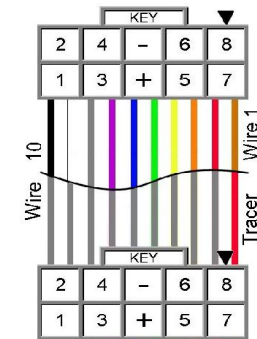
the board allowing the signals to be directly attached to the cables without purchasing any extra hardware for each signal. To control the fourth aspect two CV's are used and "signal" mode should be enabled:

- 1st, 3rd, 5th and 7th lines: this output byte controls the timing of the flashing 4th aspect;
- 2nd, 4th, 6th and 8th lines: this output byte selects the two alternating 4th aspect colors.

Normally the 4th aspect will be set to 'dark' and the JMRI software will blink the signal by sending alternate 'dark' and 'color' commands if a flashing mode is required. Select 'SE8c 4 Aspect' as the JMRI signal type for this application. It is also possible to allow the TC-64 to directly flash the signals in the 4th aspect selection. The selection of 'LDT LS-DEC' for the signal type will make this option easy to configure.

5.1.2 Connector Pin Identification

Wire/Pin number			I/O line number
Brown	1	Tracer	Line 8 (h)
Red	2	Gray	Line 7 (g)
Orange	3	Gray	Line 6 (f)
Yellow	4	Gray	Line 5 (e)
Green	5	Gray	Ground
Blue	6	Gray	+5VDC
Violet	7	Gray	Line 4 (d)
Gray	8	Gray	Line 3 (c)
White	9	Gray	Line 2 (b)
Black	10	Gray	Line 1 (a)



Note: I/O line 1 is wire 10, I/O line 8 is wire 1. 10 position IDC connector

5.1.3 Port Configuration

Input. To configure a port as inputs using DecoderPro, open the OPs mode programmer with the OPs mode address of the TC-64 you are configuring. Set the port as input and then select the type of input message that you want each line to generate and the desired signal polarity. Input lines can generate general sensor messages, turnout feedback messages, or switch request commands. To drive an input you can use either a contact, open collector transistor, or TTL logic level output. Tie one side of the contact or emitter of an open collector transistor to ground (port pin 5) and the other side to one of the input lines. (8 per port) The TC-64 includes internal 4.7K pull up resistors to make this simple.

When inputs are configured as General Sensor Messages then each port uses 4 addresses to create 8 inputs. To calculate the first reporting number of a port multiply the port base address times two and then add 1. For example a port with the base address of 8 will report as LS17-LS24.

When inputs are configured as Normal Switch Request, then the Address plus one is the first reporting address, but each port uses two input lines per address, one thrown, and the next closed, for a total of 4 addresses per port.

When inputs are configured as Alt Button, then the first reporting address is the port address plus one. (see example below) If the Alt Button is being used to control switch machines, then the ports should be addressed the same as the ports controlling the machines.

When inputs are configured as Switch Feedback, then the address plus one is the first reporting address. Switch feedback ports should be addresses the same as the driver ports they correspond with.

Output. Each port may also be configured as outputs. Each output line may be configured to respond to sensor messages or turnout commands.

When output ports are configured as drivers they respond to turnout Commands, (Switch Request) and the port base address plus one is the first responding line's address. For example a port with the base address of 8 will respond as LT9-LT16.

As way of explanation; normally outputs are configured to respond to turnout messages, and inputs are sensor messages. However, if your outputs were

driving panel indicators indicating block occupancy, then you could use the same port address as your occupancy sensors input port as an output port and set it to respond to sensor commands so it would respond directly to the sensors messages.

In like manner, if you wanted to add some buttons that send turnout commands, then you could change the input message type to be "turnout" commands rather than sensor messages.

For example to control track switches from local push buttons; set an input port (for the push buttons) to the same address as an output port (used for the switch machines). Set the output port to "Driver" and the input port to "Alt Button" using DecoderPro. This will allow these local push buttons to control the switch machines even if the computer is not running.

Note, the LocoNet® must be powered up for this example to work, as the commands are read directly from the LocoNet®.

Duplicate Input port and output port addresses may be located on different Tower Controllers, (e.g. Control buttons may be located at multiple panel locations as well as track side). Input and output addresses may also be duplicated on multiple ports of the same Tower Controller if desired for some reason.

The following Bit information is for reference only!

Always use JMRI DecoderPro to actually configure your Tower Controller.

5.2 Control Bit Definition CV 17-22

CV17-18 = Ops Mode Address
To program Ops address in service mode, press and hold program button until command light starts to blink, then set SV17-18 to desired address. Press command button again till command light goes out to exit service mode.

CV18 Ops Mode Address	CV17 Ops Mode Address
a a a a a a a a	1 1 h h h h h h h h
a = Low Address Bits	h = High address Bits

CV19 = Configuration Options
To program configuration options in service mode, press and hold program button until command light starts to blink, then set SV19 to desired value. Press command button again till command light goes out to exit service mode.

CV19 Configuration options	
m - - - s g o 1	x1 enable port state memory
m - - - s g 1 p	x2 enable ops mode program
m - - - s 1 o p	x4 enable gpon interrogate
m - - - 1 g o p	x8 enable special interrogate
1 - - - s g o p	8x enable master mode

CV20 = Reserved

CV21 = Software Version (read only)
(Send AA to restore Factory defaults)

CV 21	Read = Software Version Number Write = AA to Restore factory defaults
x x x x x x x x	

CV22 = Mfg. ID (87 read only = RR-CirKits)

CV 22 Manufacturer (87)
0 1 0 1 0 1 1 1

CV23-278 I/O line control words and Secondary message control words, configured in groups of 4 bytes per line. (see section 5.1 and 5.3)

6.0 Input/Output Cards

The RR-CirKits Tower Controller I/O cards are designed to either be plugged directly into the TC-64, or else be clipped into Tyco 3-1/4" Snap-Track® mounted to the bench work and connected with short ribbon cables. (Snap-Track® is a plastic channel designed to mount PC cards to a chassis, not something to run trains on.) Each I/O module card is equipped with two connectors to facilitate these connection options.



BOD-8 (DCC Block Occupancy Detector - 8 block) The BOD-8 does not expect you to re-wire your layout to bring track feeders to the detector cards. The small CT (Current Transformer) detection coils are placed directly on the track feeders where they belong. Simple lengths of Cat-5 cable are the usual way to run the signals back to the detector boards. Use of CT coils means that there are no track voltage losses associated with the detectors. Normal detection levels are 1ma. but may be adjusted to higher levels with on board pots.

During a DCC bus power failure the Power-Lok input on the BOD-8 instantly locks the current state of each block detector. I.e. the state of the layout does NOT change during a DCC power outage, neither to all occupied, nor to all vacant. It just suspends sending any occupancy changes until after power is restored and things have stabilized again. If you do not want the feature there is a jumper switch to disable it.

The BOD-8 outputs are low during detection so the TC-64 should be configured as "Detector" for each port that is connected to a BOD-8. This inverts the input lines to match most types of detector outputs.



OIB-8 (Opto Isolator Board - 8 input) This 8 input board is used when a non-isolated source of voltage needs to be monitored and input to the TC-64. One example would be to monitor the DCC voltage on a set of points to determine the position of a turnout without using auxiliary contacts.

This board may be configured to monitor the absence or presence of an AC or DC signal. It may also be configured to monitor the polarity of a DC signal. This board requires 10ma. for reliable operation and includes pads for customer supplied dropping resistors.



SCSD-8 (Single Coil Solenoid Driver) The SCSD-8 Output Module is designed to drive individual solenoid coils or other high voltage high power devices. Normally the input voltage should not exceed 35VDC. The SCSD-8 board is optically isolated from the driving circuitry to protect the TC-64 or other control device from the high power outputs.

By using the proper options on the Tower Controller the SCSD-8 may also be used to control dual coil momentary switch machines. See section 4.0 for upgrade information.

5.6 Per Line Bit Definition

Bytes Three and Four - SV25-26 etc. Secondary Message Control

Secondary Output Message uses two SVs for each line.

Byte Three - Secondary low address bits

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

Sec. Address

Byte Four - Secondary Control

1 bit controls polarity for response

2 bits control Secondary message type

4 Bits control Secondary high address bits

d	p	t	t	h	h	h	h
---	---	---	---	---	---	---	---

Sec. Control

Secondary Command direction

0	p	t	t	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 0x xx Send Secondary Message

1	p	t	t	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 8x xx Receive Secondary Message

Byte Four

Byte Three

Secondary Command polarity

d	0	t	t	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 0x XX ↑=close ↓=throw ↑=closed ↓=thrown ↑=hi ↓=low

d	1	t	t	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 4x XX ↑=throw ↓=close ↑=thrown ↓=closed ↑=low ↓=hi

Byte Four

Byte Three

Secondary message type Control

d	p	0	0	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 0x xx switch request (close - throw)

d	p	0	1	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 1x xx switch feedback message (closed - thrown)

d	p	1	0	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 2x xx general sensor message (high - low)

d	p	1	1	h	h	h	h
---	---	---	---	---	---	---	---

a	a	a	a	a	a	a	a
---	---	---	---	---	---	---	---

 3x xx Reserved

d = direction
p = polarity
t = type
h = High address Bits
a = Low Address Bits

Secondary messages are optionally sent on the detection of any change of input or output state (or on both changes).
Secondary messages may optionally be received at any address and will trigger the same action as the primary address.

Address Range = 0 – 2047 for turnouts; 0 – 4095 for sensors.

Any type of message may be sent to, or received at, any address (do not send to itself, or a tight loop may occur).

Byte one controls the I/O transition that triggers the message. Bytes three and four control the type of message, if the message is to be sent or received, and it's address.

The normal use of Secondary Output Messages is to create cascaded commands. One example would be to implement a yard ladder. Another would be to sequence a traffic signal. Yet another would be to control the lights in a town or a sound system. Optionally Secondary Receive Messages allow two different commands to trigger the same output. An example Secondary Receive Message would allow a simulated (or actual) lamp test by programming in a single Secondary Receive Message address for each panel lamp.

Secondary Messages are in addition to any messages that are normally sent or received, and may be sent to or respond to any address. They may be sent on the same or a different transition of the input line.

5.3 Control Bit Definition CV1-16, CV23-278

Range = 0 - 2047

First byte of each pair = low address 0 – 255

Second byte of each pair adds high address bits plus:

- port direction d: 1 = input 0 = output
- switch input t: 1 = toggle (alt action) 0 = normal
- input output t: 1 = precision 0 = normal
- output paired t: 1 = paired lines 0 = normal (Rev5+ only)
- enable signal s: 1 = signal port 0 = normal

CV1-CV16 = Port Starting Addresses and direction.
(sets the first of 8 line addresses for each port)

Factory default values:

CV 1 = 0 SV 2 = 128 (1- 8 input)
CV 3 = 8 SV 4 = 128 (17- 24 input)
CV 5 = 16 SV 6 = 128 (33- 40 input)
CV 7 = 24 SV 8 = 128 (49- 56 input)
CV 9 = 32 SV 10 = 128 (65- 72 input)
CV 11 = 40 SV 12 = 128 (81- 88 input)
CV 13 = 48 SV 14 = 128 (97-104 input)
CV 15 = 56 SV 16 = 128 (113-120 input)

CV23-278 I/O line control words and Secondary message control words, configured in groups of 4 bytes per line.

Port 1

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV23-24	CV25 - CV26						
line2=CV27-28	CV29 - CV30						
line3=CV31-32	CV33 - CV34						
line4=CV35-36	CV37 - CV38						
line5=CV39-40	CV41 - CV42						
line6=CV43-44	CV45 - CV46						
line7=CV47-48	CV49 - CV50						
line8=CV51-52	CV53 - CV54						

CV1
CV2 8x = in 0x = out

Port 2

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV55-56	CV57 - CV58						
line2=CV59-60	CV61 - CV62						
line3=CV63-64	CV65 - CV66						
line4=CV67-68	CV69 - CV70						
line5=CV71-72	CV73 - CV74						
line6=CV75-76	CV77 - CV78						
line7=CV79-80	CV81 - CV82						
line8=CV83-84	CV85 - CV86						

CV3
CV4 8x = in 0x = out

Port 3

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV87 - 88	CV89 - CV90						
line2=CV91 - 92	CV93 - CV94						
line3=CV95 - 96	CV97 - CV98						
line4=CV99 - 100	CV101 - CV102						
line5=CV103-104	CV105 - CV106						
line6=CV107-108	CV109 - CV110						
line7=CV111-112	CV113 - CV114						
line8=CV115-116	CV117 - CV118						

CV5
CV6 8x = in 0x = out

Port 4

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV119-120	CV121 - CV122						
line2=CV123-124	CV125 - CV126						
line3=CV127-128	CV129 - CV130						
line4=CV131-132	CV133 - CV134						
line5=CV135-136	CV137 - CV138						
line6=CV139-140	CV141 - CV142						
line7=CV143-144	CV145 - CV146						
line8=CV147-148	CV149 - CV150						

CV7
CV8 8x = in 0x = out

Port 5

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV151 - 152	CV153 - CV154						
line2=CV155 - 156	CV157 - CV158						
line3=CV159 - 160	CV161 - CV162						
line4=CV163 - 164	CV165 - CV166						
line5=CV167 - 168	CV169 - CV170						
line6=CV171 - 172	CV173 - CV174						
line7=CV175 - 176	CV177 - CV178						
line8=CV179 - 180	CV181 - CV182						

CV9
CV10 8x = in 0x = out

Port 6

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV183-184	CV185 - CV186						
line2=CV187-188	CV189 - CV190						
line3=CV191-192	CV193 - CV194						
line4=CV195-196	CV197 - CV198						
line5=CV199-200	CV201 - CV202						
line6=CV203-204	CV205 - CV206						
line7=CV207-208	CV209 - CV210						
line8=CV211-212	CV213 - CV214						

CV11
CV12 8x = in 0x = out

Port 7

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV215-216	CV217 - CV218						
line2=CV219-220	CV221 - CV222						
line3=CV223-224	CV225 - CV226						
line4=CV227-228	CV229 - CV230						
line5=CV231-232	CV233 - CV234						
line6=CV235-236	CV237 - CV238						
line7=CV239-240	CV241 - CV242						
line8=CV243-244	CV245 - CV246						

CV13
CV14 8x = in 0x = out

Port 8

a	a	a	a	a	a	a	a
d	t	s	-	-	h	h	h
Control-Operation				Secondary Message			
line1=CV247-248	CV249 - CV150						
line2=CV251-252	CV253 - CV254						
line3=CV255-256	CV257 - CV258						
line4=CV259-260	CV261 - CV262						
line5=CV263-264	CV265 - CV266						
line6=CV267-268	CV269 - CV270						
line7=CV271-272	CV273 - CV274						
line8=CV275-276	CV277 - CV278						

CV15
CV16 8x = in 0x = out

5.4 Per Line Bit Definition

Byte One - CV23 etc. Message Type & Input Transition Control
 5 Bits control Input/Output (yellow/blue)
 2 bits control Secondary message (orange/rust)

d	-	m	m	s	s	t	t
---	---	---	---	---	---	---	---

d = direction m = mode s = secondary (transition)
 t = transition (input)

Direction

Input & Secondary Mode only

0	-	m	m	s	s	t	t
1	-	m	m	s	s	t	t

Input & Secondary Command Direction

0x ↑=close ↓=throw ↑=closed ↓=thrown ↑=hi ↓=low
 8x ↑=throw ↓=close ↑=thrown ↓=closed ↑=low ↓=hi

Input Mode

d	-	0	0	s	s	t	t
d	-	0	1	s	s	t	t
d	-	1	0	s	s	t	t
d	-	1	1	s	s	t	t

Input Response Type

0x send switch request
 1x send switch feedback message
 2x send general sensor message
 4x Reserved

Output Mode

d	-	0	0	s	s	t	t
d	-	0	1	s	s	t	t
d	-	1	0	s	s	t	t
d	-	1	1	s	s	t	t

Output Responds To

0x switch request (B0)
 1x switch feedback (B1)
 2x general sensor (B2)
 4x Reserved

Secondary Transition Control

Input and Output Modes

d	-	m	m	0	0	t	t
d	-	m	m	0	1	t	t
d	-	m	m	1	0	t	t
d	-	m	m	1	1	t	t

x0 no secondary message sent or received
 x4 send/respond on low to high transition ↑
 x8 send/respond on high to low transition ↓
 xC send/respond on both transitions ⇕

Input Transition Control

Input Mode only

d	-	m	m	s	s	0	0
d	-	m	m	s	s	0	1
d	-	m	m	s	s	1	0
d	-	m	m	s	s	1	1

x0 no input message sent
 x1 send on low to high transition ↑
 x2 send on high to low transition ↓
 x3 send on both transitions ⇕

5.5 Per Line Bit Definition

Byte Two - CV24 etc. Input / Output Control

8 Bits control Input and Output Messages

i	t	t	t	T	T	T	T
---	---	---	---	---	---	---	---

i = invert t=type T=Timing

Output Invert

0	t	t	t	T	T	T	T
1	t	t	t	T	T	T	T

0x normal output
 8x invert output

Input / Output type

i	0	0	0	T	T	T	T
i	0	0	1	T	T	T	T
i	0	1	0	T	T	T	T
i	0	1	1	T	T	T	T
i	1	0	0	T	T	T	T
i	1	0	1	T	T	T	T
i	1	1	0	T	T	T	T
i	1	1	1	T	T	T	T

0x output: short pulse / input: debounce
 1x output: long pulse
 2x output: short blink / input: toggle 'on' time
 3x output: long blink
 4x reserved
 5x reserved
 6x reserved
 7x reserved

Input / Output Timing

i	t	t	t	0	0	0	0
i	t	t	t	0	0	0	1
i	t	t	t	0	0	1	0
i	t	t	t	0	0	1	1
i	t	t	t	0	1	0	0
i	t	t	t	0	1	0	1
i	t	t	t	0	1	1	0
i	t	t	t	0	1	1	1
i	t	t	t	1	0	0	0
i	t	t	t	1	0	0	1
i	t	t	t	1	0	1	0
i	t	t	t	1	0	1	1
i	t	t	t	1	1	0	0
i	t	t	t	1	1	0	1
i	t	t	t	1	1	1	0
i	t	t	t	1	1	1	1

	short	long	4 th aspect *
x0	. Steady **.	10 sec.	yy yellow
x1	. 0.1.sec. .	15 sec.	ry alt. red / yellow
x2	. 0.2.sec. .	20 sec.	gy alt. green / yellow
x3	. 0.35 sec. .	30 sec.	dy blinking yellow
x4	. 0.5.sec. .	40 sec.	yr alt. yellow / red
x5	. 0.65 sec. .	50 sec.	rr red
x6	. 0.8.sec. .	1 min.	gr alt. green / red
x7	. 1 sec. .	1.5 min.	dr blinking red
x8	. 1.25 sec. .	2 min.	yg alt. yellow / green
x9	. 1.5.sec. .	3 min.	rg alt. red / green
xA	. 2 sec. .	4 min.	gg green
xB	. 3 sec. .	5 min.	dg blinking green
xC	. 4 sec. .	6 min.	yd blinking yellow
xD	. 5 sec. .	7 min.	rd blinking red
xE	. 6 sec. .	8 min.	gd blinking green
xF	. 8 sec. .	10 min.	dd dark

When no light is connected to the 4th output aspect of a signal head (like in a three aspect signal), flashing aspects can be used on the respective signal head. To setup a flashing signal, two CV's are required:

1st, 3rd, 5th and 7th lines: this output byte controls the timing of the flashing aspect;
 2nd, 4th, 6th and 8th lines: this output byte selects the two alternating aspect colors (3rd column). Normally one of these will be "dark" but that is not required.

* The associated port control byte (CV3 <2x> etc.) needs to have "signal" enabled.

** Output: steady; Input: no debounce / 0.1 sec. toggle 'on' time.