
Integrated Turnout Controller

ITC

User Guide

Version 1.2 04/18/2017

Introduction

The Integrated Turnout Controller (ITC) is an updated design of the Remote Stall Motor Controller (RSMC) introduced in 2013 by Model Railroad Control Systems (MRCS). This document describes the functional blocks of the controller, how to use it, and DIY assembly instructions.

The ITC is designed to provide all control functions needed for remote, local, and locking of a turnout for various styles of turnout motors. The ITC may operate as a standalone turnout controller, with no computer needed. The ITC provides LED outputs with onboard current limiting resistors for route and switch lock status.

An Atmel AtTiny85 microprocessor executes the software logic for controlling turnout functions. Power to operate the logic is provided by an onboard 5 Vdc regulator derived from the 12 Vdc motor power. Fascia status LEDs (optional) can display the state of the Unlocked signal and selected turnout route. Frog power switching is supported through external switch contacts in the stall motor routed to an onboard screw terminal block.

Revision History

v1.2	04/18/2017	CC
v1.1	04/09/2017	CC
v1.0	04/04/2017	CC
v0.15	03/07/2017	CC
v0.14	02/28/2017	CC
v0.1	08/11/2016	CC
v1.1 RSMC	01/19/2014	CC Original art design

Model Railroad Control Systems
www.modelrailroadcontrolsystems.com

Chuck Catania, chuck@modelrailroadcontrolsystems.com
Seth Neumann, seth@modelrailroadcontrolsystems.com

Table of Contents

1. System Overview	3
2. ITC Block Diagram	4
3. Control Ports - Input And Output	5
4. Software Logic Flow	5
4.1. Remote Switch - Out of Correspondence	6
5. Turnout Connection Examples	6
6. Screw Terminal Blocks	8
7. Quick Connection Diagrams	9
8. Turnout Motor Connections	9
8.1. Circuitron Tortoise®/Switchmaster® Stall Motor	9
8.2. Tortoise Switch Motor Connector	10
8.3. MP1/MP5/Fulgurex Connection.....	10
9. Reversing Motor Connections	11
10. External Switch Contact Connection	11
11. Actual Turnout Position	11
12. ITC AtTiny85 Sketch Code.....	12
13. Turnout Motor Connector Options	13
14. Bill Of Materials.....	14
15. Assembly Instructions	14

Table of Figures

Figure 1 ITC Block Diagram.....	4
Figure 2 Simple Turnout Throw	6
Figure 3 Simple Computer Control	6
Figure 4 Full Turnout Control With Dispatcher Switch Locking	7
Figure 5 Computer Control With Crew Controlled Switch Lock	7
Figure 6 Local Control With Dispatcher Locking (CTC)	7
Figure 7 External Turnout Controller	8
Figure 8 ITC Screw Terminal Connection	8
Figure 9 Tortoise Pin Assignments	10
Figure 10 External Contacts Connection Option.....	11
Figure 11 External Contacts To Report Block Occupied For A Siding	11
Figure 12 Default Position Reporting Option.....	12
Figure 13 Actual Turnout Position Reporting Option	12

1. System Overview

The Integrated Turnout Controller (ITC) is designed to operate with stall motor style turnout motors (Tortoise, Switchmaster), reversing switch turnout motors (MP1/MP5, Fulgurex), or any turnout motor driver which can take a single input level and generate turnout throw bar movement (MRCS Servo Driver, MRCS Twin Coil Driver).

The ITC has the following features:

- Standalone or computer turnout motor control
- Local Throw input
- Remote Throw input
- Switch Lock input
- Turnout position feedback output
- Route LED ports, Normal/Reverse (Common Anode, Sinking)
- Open Source sketch software
- Motor power input, 9-12 Vdc
- Onboard 5v regulator for logic power
- Turnout motor driver (TC4428 MOSFET), up to 500 ma drive
- Frog power routing using external switch contacts (Tortoise, Switchmaster™, MP1/MP5)
- 8 position motor pads for a .156" Molex connector, .156" edge connector, or .100" (2.54mm)
- Separate motor pads for connection to additional crossover turnout motors

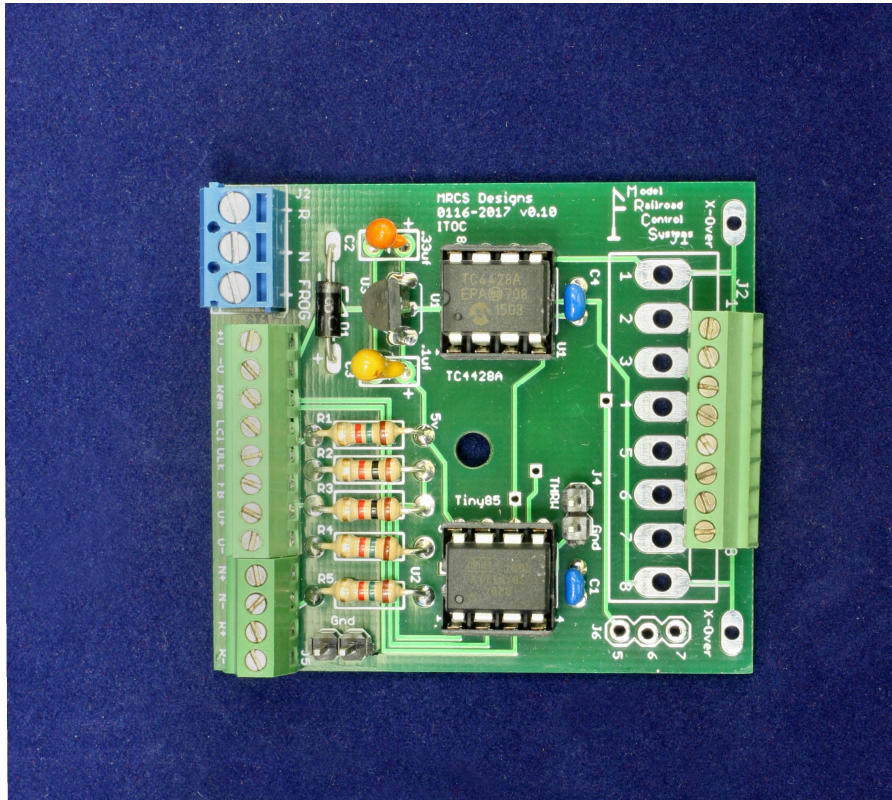
Pads for connection to a Tortoise stall motor are .156" for Molex™. The pad spacing also mates to a standard 8 position .156" edge connector. Right angle or straight header pins can be soldered directly to the Tortoise edge connector and mate to a Molex connector on the ITC.

Pads for connection to .100" (2.54mm) screw terminal blocks or other .100" spaced connectors are parallel connected to the .156" pads.

A direct throw output is provided for driving the MRCS Servo Controller, MRCS Twin Coil Driver. The TC4428 MOSFET driver chip (U2) may be removed using this configuration.

Solder pad options bring out external switch contacts (pins 5, 6, and 7) to .100" (2.54mm) pads. Header pins, screw terminal blocks may be inserted into these pads. One use for the external contacts would be for connecting a series resistor to an undetected track section for a bonded siding.

Logic ground is available at solder pads J6.



2. ITC Block Diagram

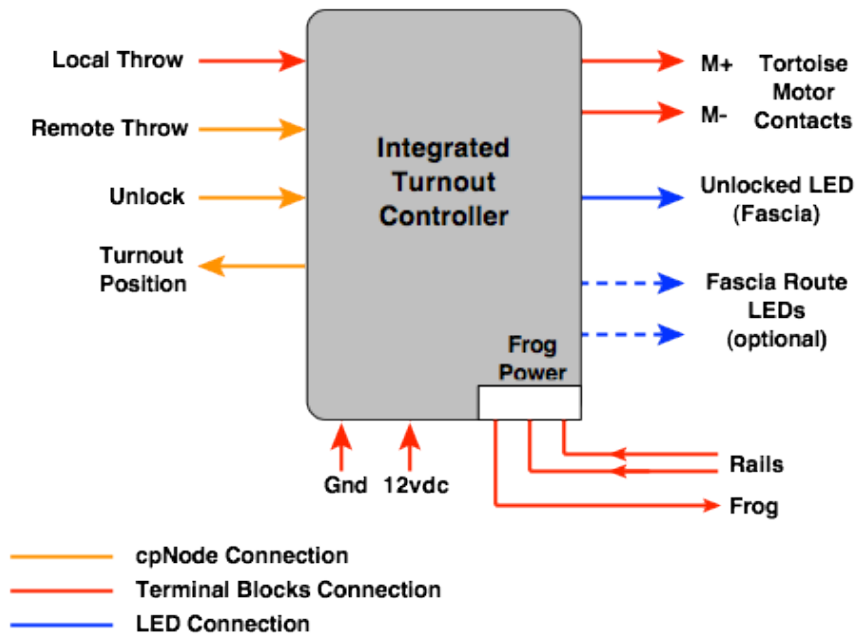


Figure 1 ITC Block Diagram

3. Control Ports - Input And Output

The ITC has three input ports and one output port used for controlling a turnout motor. Each input is intended to provide an equivalent control line, which may be found in prototype turnout control installations.

Remote Throw - (Input) This input controls the operation of the turnout from a remote source, such as a computer output or CTC switch lever. A Low input will throw the turnout to the opposite position.

Local Throw - (Input) This input controls the operation of the turnout from a local source like as fascia toggle switch. A Low input will throw the turnout to the opposite position.

Unlock - (Input) This input controls whether the Local Throw input can control the position of the turnout. This input is normally connected to a Switch Lock lever on a CTC machine or a key switch arrangement on a fascia panel. A High input will unlock the turnout. A Low input will lock the turnout. The Unlocked LED shows the state of the Unlock line.

The ITC only responds to one throw input at a time depending upon the state of the Unlock line. If the ITC is locked, the Remote Throw is active. If unlocked, the Local Throw input is active.

Turnout Position (Feedback) - (Output) This output reflects the last commanded position of the turnout. This output is normally connected to a computer input port for monitoring by control software. A High state indicates the Normal route is selected, a Low state, the Reverse route is selected. The position of a turnout within a signaled section is normally used to set the correct signal aspect in ABS/CTC environments.

Unlocked LED (Output) - This LED shows the state of the Unlocked line. The LED is ON the turnout is Unlocked and can be thrown by the Local fascia switch. An onboard limiting resistor is provided for the LED.

Route LEDs (Output) - The ITC provides direct drive for status LEDs. Normally, the LEDs are mounted on fascia panels. Two signals are provided which are intended to drive fascia mounted LEDs to indicate which route (Normal/Reverse) is active. Limiting resistors are provided onboard for the LEDs.

4. Software Logic Flow

At power on, the Local throw line state reflects the position of the fascia switch. The Remote throw will be at the state set by the remote port.

Unlock will be High if no computer output is present indicating the switch is unlocked and the Unlocked LED will be lit. The stall motor may move to the position of the local fascia switch. If the Unlock is connected to a computer port output, setting the port Low will lock the turnout, allowing only remote control of the turnout. The local throw input is ignored when Unlock is asserted.

Only one throw input is valid at a time. In Lock mode, the Remote Throw is active; when Unlocked, the Local Throw is active.

With the control software not running, the state the ITC is Unlocked. The turnouts can be thrown from the Local throw input.

With the control software running, the ITC is in Remote mode and Locked, ready to accept remote commands from the control software for the turnout.

4.1. Remote Switch - Out of Correspondence

When using the switch lock feature, if the crew has been granted local control and leaves the turnout in the "Reverse" position, when returning control to the Dispatcher, the Unlocked LED will blink indicating that the turnout is "out of correspondence" with the Dispatcher panel.

The Dispatcher must then unlock the turnout, and have the crew put the turnout back into Normal. When the crew confirms that the switch is in the Normal, the Dispatcher can then lock the turnout and take back control.

5. Turnout Connection Examples

The ITC can be configured to support various turnout control scenarios. The following diagrams show some of the possible connection.

Figure 2 is a simple turnout connection to throw a turnout motor. The fascia switch can be a SPST toggle connected to the power supply ground. The ITC provides connections to fascia mounted LEDs for the selected route.

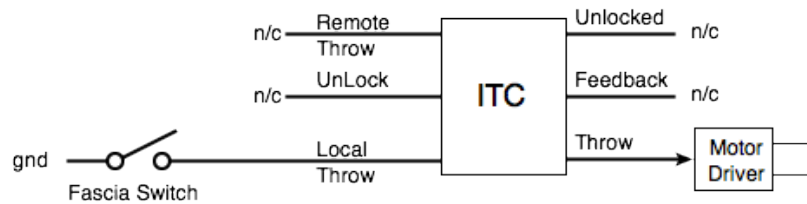


Figure 2 Simple Turnout Throw

Figure 3 is a simple computer connection where the control software manages the turnout and can read the state of the turnout points. Feedback is the status of the last throw command. See the Options section for further information on the Feedback line.

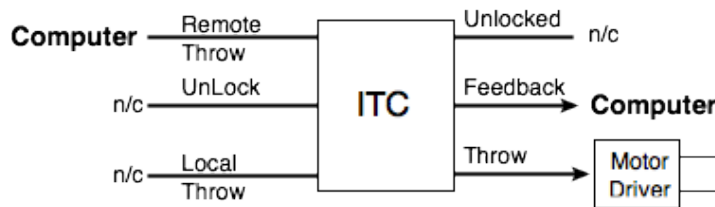


Figure 3 Simple Computer Control

Figure 4 shows a complete turnout control scheme where a remote operator (Dispatcher) has complete control over the turnout. This configuration provides 1) remote throwing of the turnout,

2) granting access to a road crew by unlocking the turnout, and 3) monitoring which route has been selected. This configuration can be used for implementing a CTC operating scheme with a Dispatcher.

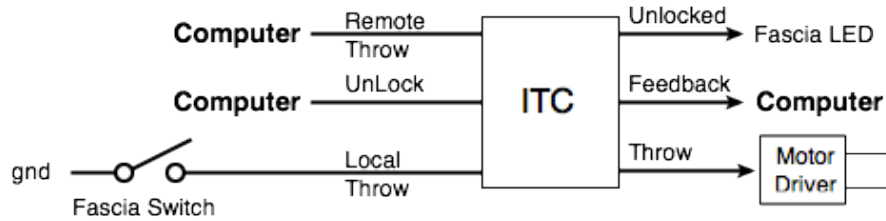


Figure 4 Full Turnout Control With Dispatcher Switch Locking

Figure 5 can be used to provide local crew control for locking/unlocking a turnout with authority issued by a Dispatcher. Operating procedures could include a key issued to the road crew, which is used to unlock the turnout at the fascia. There are excellent examples of switch locking and lock designs in Dr. Chubb's CMRI manuals.

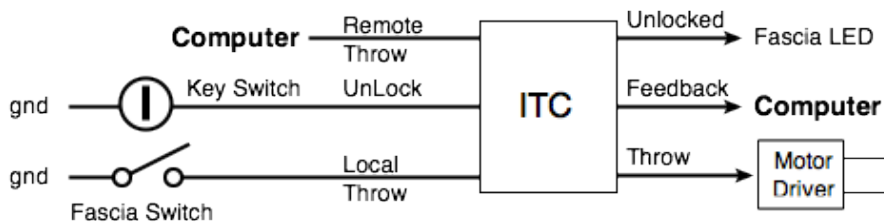


Figure 5 Computer Control With Crew Controlled Switch Lock

Figure 6 is the configuration for having the Dispatcher control the unlocking of a turnout after granting the local crew authority to use the switch.

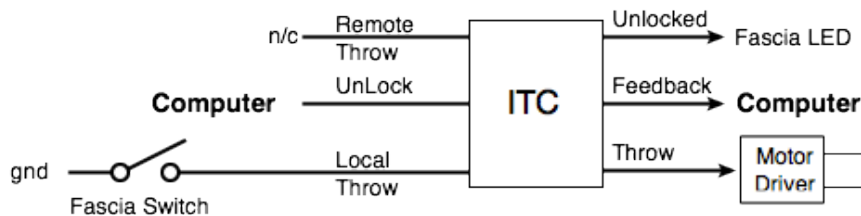


Figure 6 Local Control With Dispatcher Locking (CTC)

Figure 7 shows an external turnout controller connected to the throw output pin. Any controller which can take a single low (or ground) input can be connected to the throw pin. The MRCS

Servo Controller and Twin Coil Driver are examples. In this configuration, the onboard turnout motor driver (TC4428) is not installed.

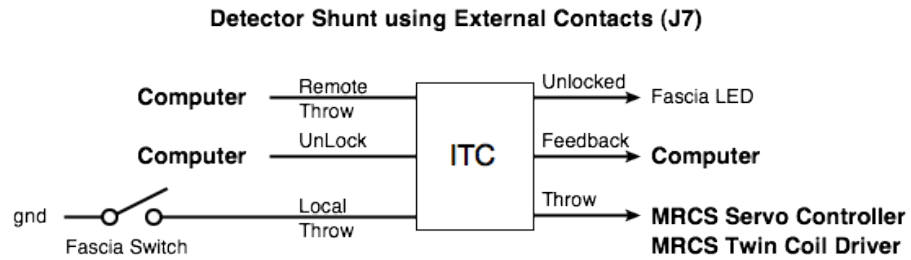


Figure 7 External Turnout Controller

6. Screw Terminal Blocks



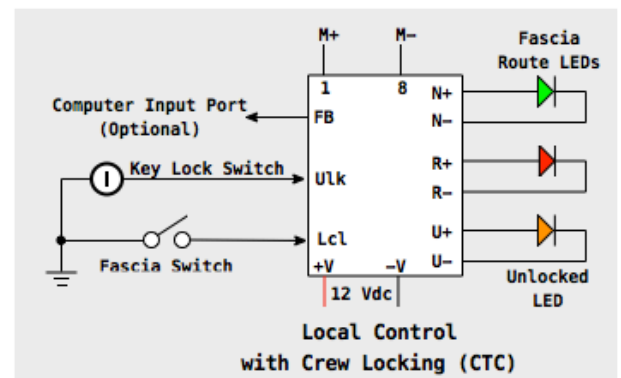
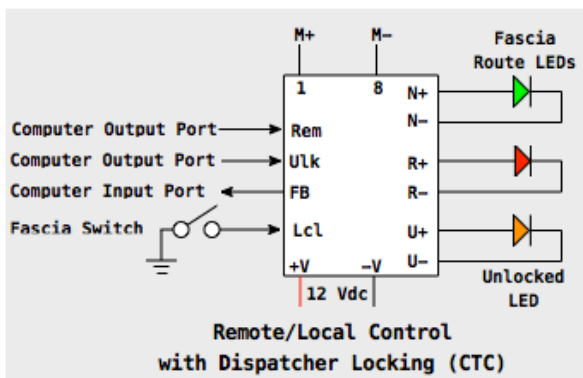
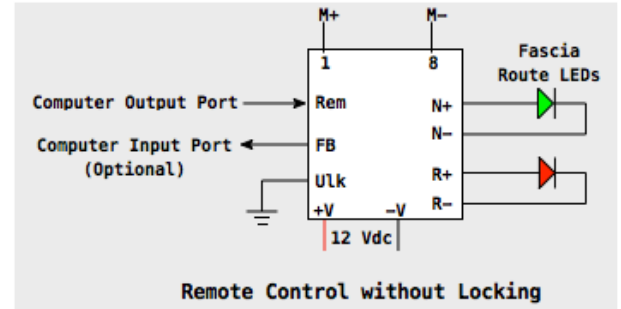
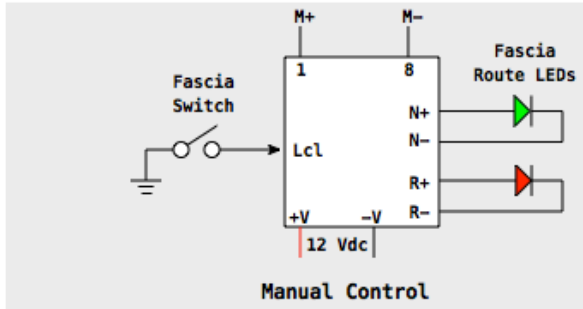
Pin	Label	Description
12	R-	Reverse LED -
11	R+	Reverse LED +
10	N-	Normal LED -
9	N+	Normal LED +
8	U-	Unlocked LED -
7	U+	Unlocked LED +
6	FB	(OUT) Turnout Position Feedback
5	ULk	(IN) Unlock
4	Lcl	(IN) Local Throw
3	Rem	(IN) Remote Throw
2	-V	Motor Voltage -
1	+V	Motor Voltage +

.100" (2.54mm) Screw Terminal Connector

Figure 8 ITC Screw Terminal Connection

7. Quick Connection Diagrams

Wiring diagrams for some typical turnout connections. Port names (e.g. Rem) are those on the silkscreen. LEDs are Common Anode (current sinking). The long lead is on the LED is +.

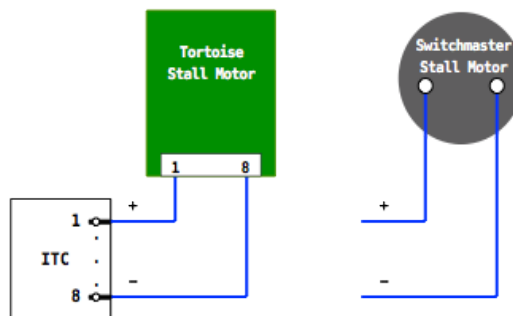


8. Turnout Motor Connections

Connection to a turnout motor is through the 8-position connector, J1/J2. Pin 1 and Pin 8 are the motor voltage outputs. The ITC reverses the polarity of the output pins based on the state of the onboard throw signal. Various types of turnout motors can be interfaced to the ITC.

8.1. Circuitron Tortoise®/Switchmaster® Stall Motor

Direct connection to stall motor style turnout motors. Changing the motor voltage polarity changes direction of throw bar.



8.2. Tortoise Switch Motor Connector

Direct connection to a Tortoise stall motor is done through the .156" pads. The pads can have a .156" female Molex connector or an 8-position card edge connector. A right angle Molex male connector can be easily soldered to the edge finger pads on the Tortoise stall motor.

If hardwired connections to a turnout motor is desired, a set of .100" (2.54 mm) spaced pads are provided for a screw terminal block, male header pins, or direct solder. These pads are connected to the .156" pads.

The Turnout Position Feedback signal can be routed through pins 5 and 6, in conjunction with the ACTPOS jumper to provide true turnout position. Cutting the trace between the ACTPOS pads will break the internal path for the feedback output and route it through the Tortoise (or other switch) contacts. See the Section 11 for information on Actual Turnout Position options.

Pins 2,3 and 4 are connected to the Frog power connector.

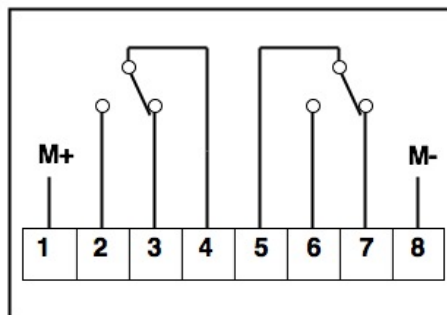
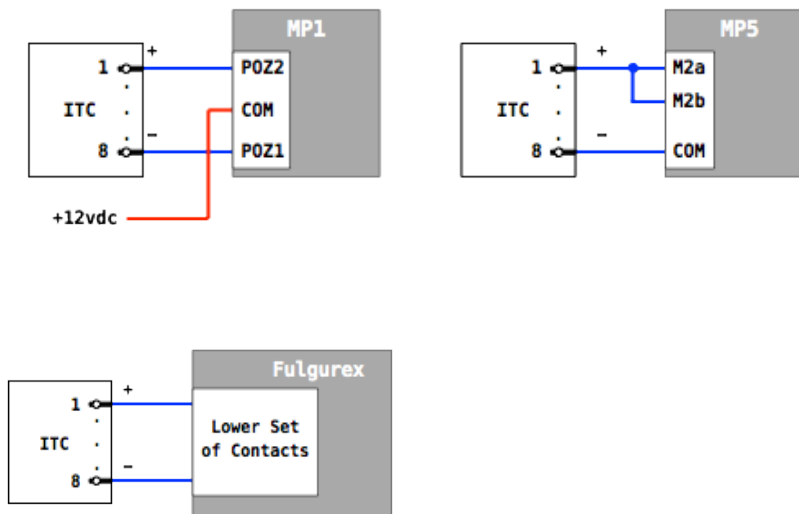


Figure 9 Tortoise Pin Assignments

8.3. MP1/MP5/Fulgurex Connection

The MP1, MP5, and Fulgurex are end stop style turnout motors.



9. Reversing Motor Connections

If the turnout motor, on power up, does not align to the desired default route, flip the ITC over when using the Molex connector, or rotate the ITC 180 degrees if using the card edge connector, or swap the motor wires (pin 1 and 8) on the .100" output screw terminal block.

10. External Switch Contact Connection

Internal or External switch contacts, which are connected to the turnout motor connector pads, can be accessed by cutting the traces between the T5 and T6 solder pads on the bottom of the circuit board. Doing this, isolates the switch contacts from the onboard circuitry. The switch contacts are available at the three pads below the output connector pads. The contact pads are marked J6 on the circuit board.

Note: Using this option, the ACTPOS jumper must be in place if turnout position needs to be sensed remotely.

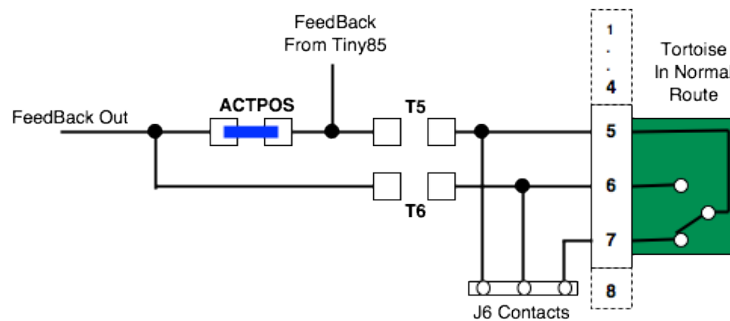


Figure 10 External Contacts Connection Option

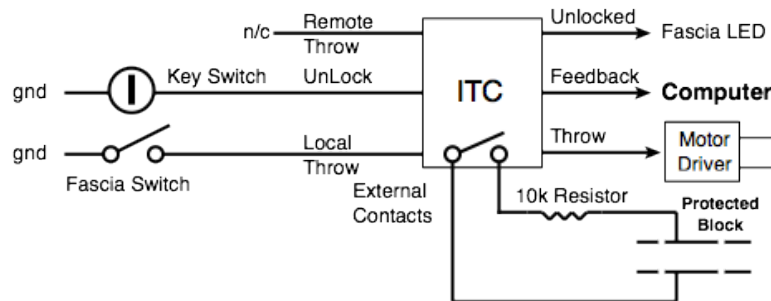


Figure 11 External Contacts to Report Block Occupied for a Siding

11. Actual Turnout Position

The default reporting state for the position of the turnout motor is that of the last throw command from either the Remote or Local throw switch. The status of the Feedback Out line is the signal level of pin 7 of the Tiny85. The onboard software sets this status. In this mode, it is assumed that the turnout motor has moved the points to the commanded position. This is a common assumption for model railroad operations.

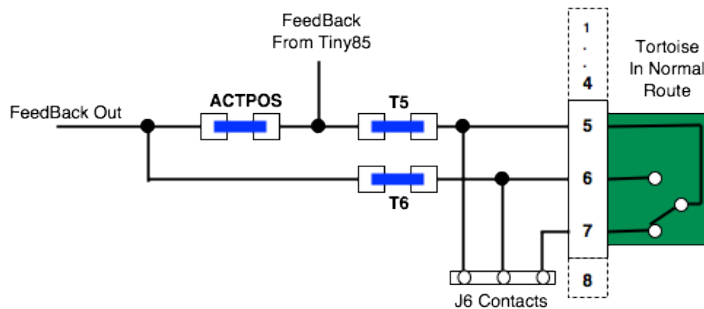


Figure 12 Default Position Reporting Option

If the actual position of the thrown points is desired, based upon the state of either internal switch contacts e.g. Tortoise, or external micro switches connected to the throw arm, the ACTPOS (actual position) can be used. The option pads are located on the bottom side of the circuit board and are marked ACTPOS, T5, and T6

The Feedback signal from the Tiny85 is routed directly to the Feedback output on the screw terminal block through the ACTPOS solder pad jumper. By cutting the trace between the solder pads, the Feedback Out signal is routed through pins 5 and 6 of the motor connector. If the turnout has been commanded to Reverse, when the turnout motor switch contact closes, the Feedback Out signal is routed to the screw terminal block.

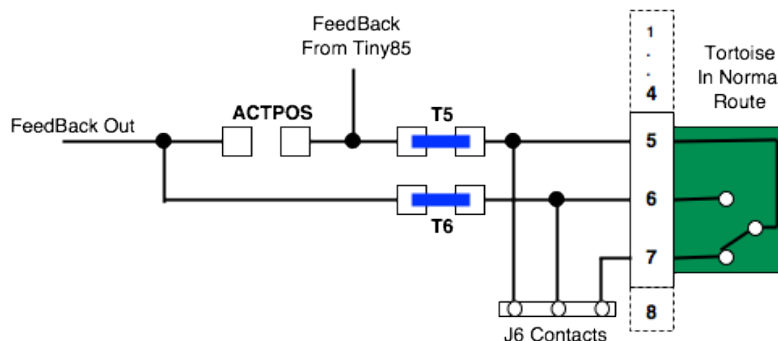


Figure 13 Actual Turnout Position Reporting Option

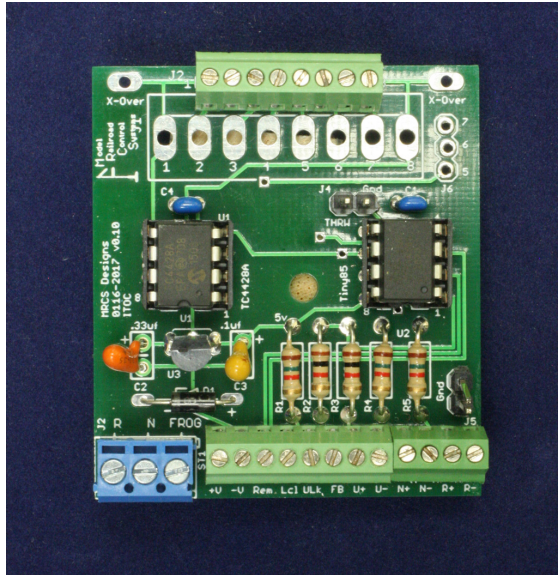
12. ITC AtTiny85 Sketch Code

The software(sketch), which runs in the ITC processor, is available for download from the MRCS web site www.modelrailroadcontrolsystems.com.

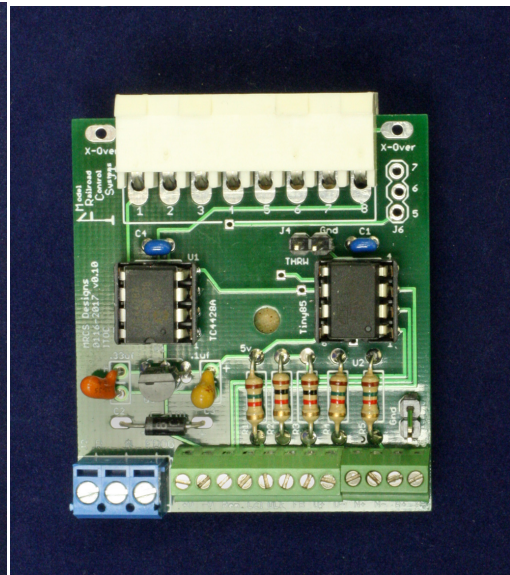
The sketch can be compiled using the Arduino IDE. The IDE must have the AtTiny85 libraries added to the IDE directory. See <http://highlowtech.org/?p=1695> for instructions on installing the AtTiny libraries.

The AtTiny family of processors requires programming hardware. Sparkfun has a programmer with a USB interface, which easily connects to the Arduino IDE. <https://www.sparkfun.com/products/11801>

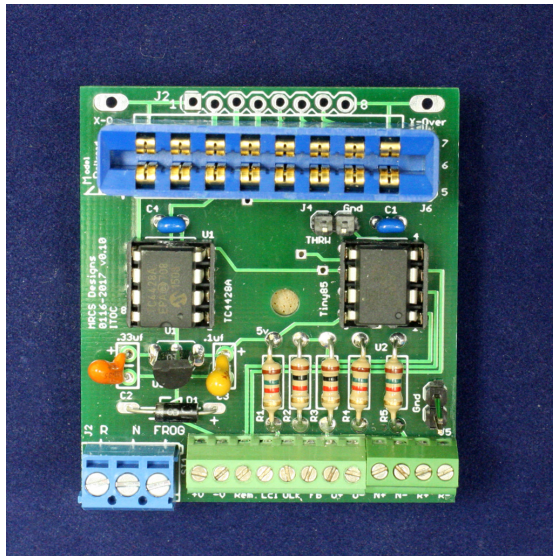
13. Turnout Motor Connector Options



Screw Terminal



Molex



Edge Connector

14. Bill Of Materials

Description	Ref	Qty	Supplier	Part No.
ITC PCB	PCB1	1	MRCS	ITC
AtTiny85	U1	1	eBay	
TC4428A MOSFET	U2	1	Digikey	TC4428AEPA-ND
78L05	U3	1	Jameco	51183
Capacitor .01uF	C1,C4	2	Jameco	25507
Capacitor .33uF 35v Tantalum	C2	1	Jameco	33523
Capacitor .1uF 35v Tantalum	C3	1	Jameco	33486
Resistor 1000 Ohm	R2,R3	2	Jameco	690865
Resistor 1500 Ohm	R1,R4,R5	3	Jameco	690902
Diode Schottky 1N5819	D1	1	Jameco	177965
DIP Socket 8 pin	Tiny85,TC4428	2	Jameco	112206
8 pos Screw Terminal .100"	S1a	1	Electronics Salon	GS019-2.54
4 pos Screw Terminal .100"	S1b	1	Electronics Salon	GS019-2.54
8 pos Screw Terminal .100"	J2 Pads	1	Electronics Salon	GS019-2.54
3 pos Screw Terminal 3.5mm	J3 FROG	1	Jameco	2094514
8 Pin .156" RA Female Header	J1 MOLEX	0	Digikey	WM13505-ND
8 Pos Card Edge Connector	J1 EdgeConn	0	Jim's Trains	JMT/TCONN
2 pos male pin .100"	J4 THRW	0	Electronics Salon	GS019-2.54
2 pos male pin .100"	J5 GND	0	Electronics Salon	GS019-2.54
3 pos male pin .100"	J6 Contacts	0	Electronics Salon	GS019-2.54

15. Assembly Instructions

[] All of the components are through-hole technology with wire leads. A useful tool is a lead bender for forming the leads at 90 degrees for easy insertion into the pad holes. Start with inserting the lower height components.

[] Install the IC socket for U1. Orient the socket with pin 1 shown on the silk screen.

[] Install the IC socket for U2. if the TC4428 is to be installed.

[] Install U3. Orient the regulator flat edge as shown on the silk screen.

[] Install the capacitors C2 (.1 uF) Observe polarity

[] Install the capacitors C3 (.33 uF) Observe polarity

[] Install the Schottky Diode D1 (1N5819)

[] Install the bypass capacitors C1,C4 (.01 uF)

[] Install resistors R2,R3 (1000 ohms)

[] Install resistor R1,R4,R5 (1500 ohms)

[] Install the 8 position, .100" screw terminal block, ST1a

[] Install the 4 position, .100" screw terminal block, ST1b

[] Install the 3 position, 3.5 mm screw terminal block, J3 (Frog Power)

Install the 8 position, .156" Molex connector or .156" Edge Connector, J1

OR

Install the 8 position, .100" screw terminal block, J2

----- Configuration Dependent -----

Install the 2 position, .100" male pin header THRW, J5

Install the 3 position, .100" male pin header, J6