



Turntable Accessory Advanced Control Module

933-2321



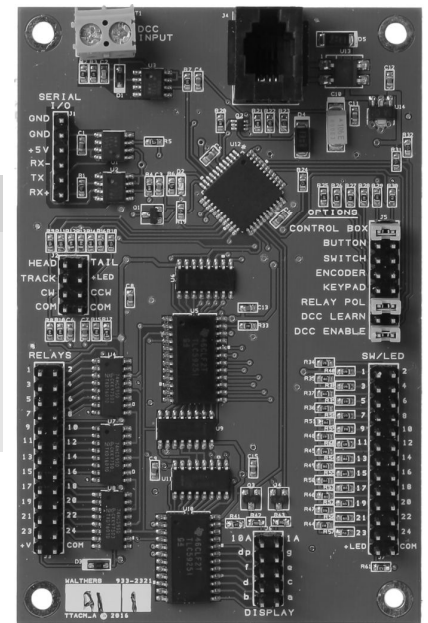
The Cornerstone® Turntable Advanced Control Module (ACM) can be added to new turntables using the new 'two digit' control boxes. Compatible turntables are shown in the table. The ACM is not compatible with any prior turntables using the older control systems.

The ACM circuit card is intended to be installed under the benchwork or inside a custom control panel and connects to the turntable control circuit at an existing control box, or may be directly connected to the turntable pit in place of the standard control box.

A custom control panel using the ACM may be used in addition to or as a replacement for the standard control box depending on the functions implemented.

The ACM provides the following functions. Each function is independent of the others and any or all may be used as required. Refer the relevant sections of the instruction sheet for details on making connections to the ACM connector headers. All wiring connections use industry standard .1 inch spaced pin headers with the exception of the DCC track signal which connects to a terminal block.

| Compatible Turntables | |
|-----------------------|-------------------|
| 933-2618 | N Scale 130 Foot |
| 933-2860 | HO Scale 90 Foot |
| 933-2851 | HO Scale 110 Foot |
| 933-2859 | HO Scale 130 Foot |



DCC Control

When enabled and connected to the DCC track power, the ACM can function as a stationary decoder, and translate accessory on/off (ie turnout thrown or closed) commands into turntable track selections. A simple to use 'learn' mode is used to enter decoder addresses and no DCC programming or CV settings are required. There are no restrictions on addresses and any decoder address (1-2044) can be used for any track. After setup, the turntable bridge head or tail can be sent to a track by setting the associated decoder address thrown or closed. An accessory address can also be used to initiate a turn (ie reversal) of the bridge from any location.

Serial I/O

An optically isolated logic level serial port can be connected to a remote device such as an Arduino, Raspberry Pi, or similar microcontroller, or to a PC or laptop with a suitable adapter. Simple human readable ASCII commands can be used to control any turntable function, including programming.

Switch Input

Several options are available to allow turntable control from pushbuttons, rotary selector switches, rotary encoder or numeric keypads. By using these functions, custom control panels can be used in place of or in addition to the standard control box. It is also possible to convert an existing turntable control panel used with older control systems for use with a new Walthers turntable.

Track LED Indicators

Indicator LEDs can also be connected to the switch contact inputs to provide visual indication of the bridge alignment in lieu of the track number display. The LEDs can be used with all control modes except Keypad, and are also active if none of the switch contact control modes are used.

Track Number Display

A two digit, seven segment digital display can be connected to display the selected track number, The display will mimic the display on the standard control box as well as indicate selections being made in any of the ACM control panel modes.

Track Power Relay Control

Logic level outputs are available to drive relays for track power control. Standard relay module cards may be used directly, or any standard control relay can be used with a suitable driver.

CONNECTING TO THE TURNTABLE

Check the package for the components shown. The ACM may be mounted either under your benchwork near the turntable pit, inside a custom control panel, or any other convenient location. If you are using one of the control panel modes, locating close to the input switches and LEDs is preferable.

The three jumpers connect to the Option Select header block as shown below. One is used to select the control input mode, one for setting the polarity for the relay logic outputs, and the third for the DCC mode. Attach them temporarily now so they are not misplaced. Connect the ACM to the turntable con-

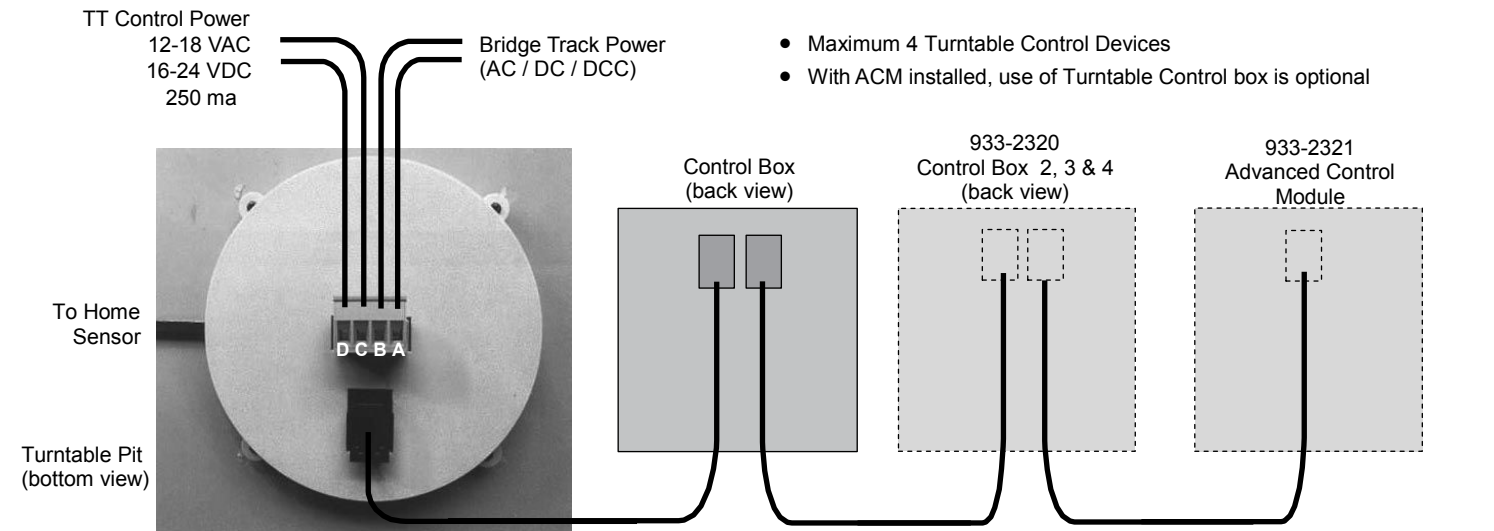
ACM Package Contents

- Mounting spacers and screws (4)
- Turntable control cable
- Option jumpers (3)
- Instruction sheet
- ACM pcb assembly

trol circuit as shown using the supplied cable. You may connect a maximum of four devices to the turntable pit and have up to three standard control boxes in addition to the ACM. The ACM is powered from the turntable pit, and no other power supply is required. You will need a separate power supply compatible with the relays you use for

track power switching if you use that feature. Do not make any connections to the other ACM terminals except as required by the functions you are using and as detailed in the following sections. Any terminals not used should be left open.

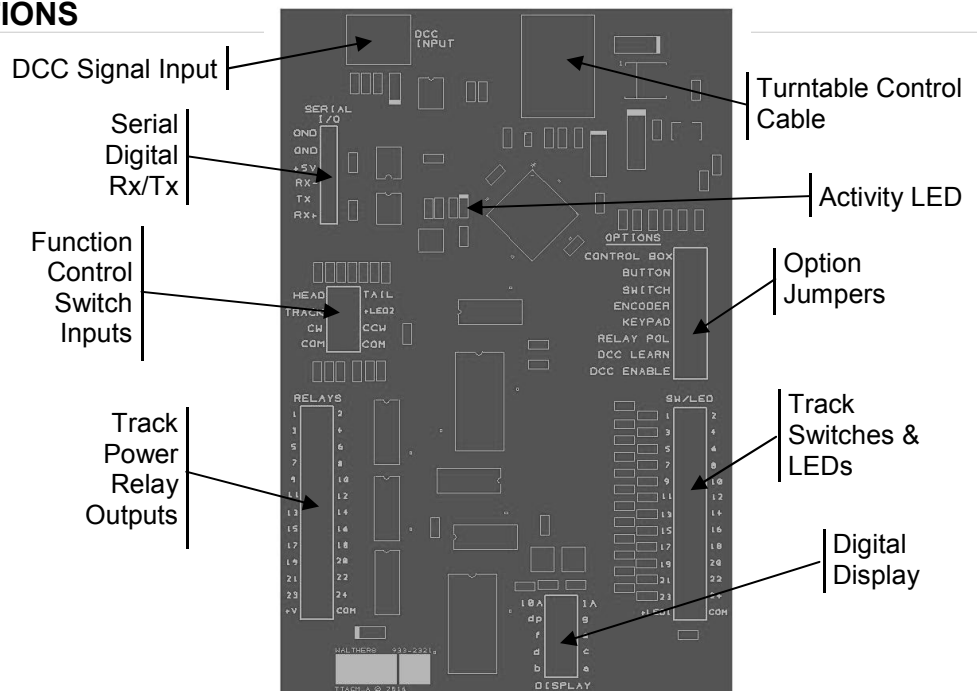
All control panel wiring to the ACM connectors use standard pin and socket headers. You may wish to use flat ribbon cable connectors for the relay, display, switch and relay headers. Individual wires with preinstalled socket connectors compatible with the ACM headers are readily available from many electronic hobby dealers as well as numerous on-line sources.



MAKING ELECTRICAL CONNECTIONS

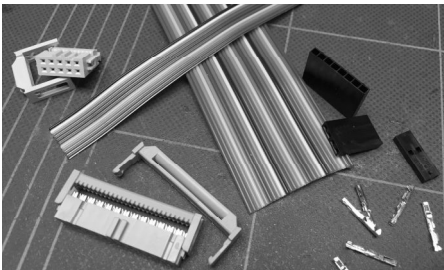
When connected to the turntable control circuit, the ACM DCC and Serial Rx/Tx inputs and Track Power Relay and Digital Display outputs are functional regardless of the control mode in use. The Option Jumpers determine how the Function Control and Track Switch inputs as well as the corresponding LED outputs are interpreted and displayed. Refer to the sections below for specifics on making connections to each of these headers.

The ACM uses standard .1 x .1 inch pin headers for connections to external switches and LEDs. While it is possible to solder wires directly to these pins, you will find it more practical to use matching socket headers designed for this purpose. Molex, Amp, FCI and a host of other vendors offer compatible products which are readily available from distributors such as Digi-Key, Mouser, and Jameco. Online sources such as Amazon also have many suppliers of these products. Use of multi-

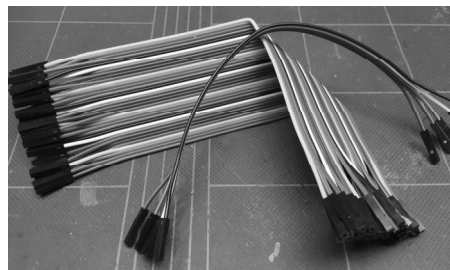


color flat ribbon cable will make keeping track of the many wires much easier as the switch and relay header pin-

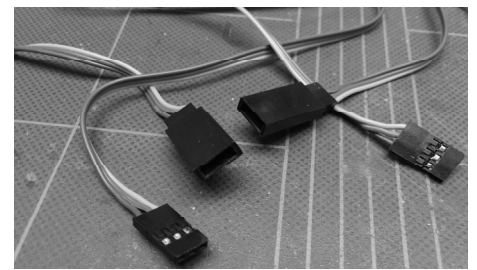
outs result in the connections running in number sequence across the width of the cable.



Multi-conductor cable and connectors



Breadboard Jumpers



Servo Extension Cables

A handy source of premade connector wires are jumpers with socket plugs intended for bread-boarding electrical circuits. These can be obtained in various lengths and connector configurations. The female to female type will facilitate making connections from the relay output connector to standard multi-channel relay cards allowing unused channels to be readily skipped. Female to male jumpers can be used to connect to your switches and LEDs by soldering the male pin to the panel device (or just removing it to attach the

wire) then plugging the other end into the ACM header. These jumpers are available from your local electronic hobby dealer and many on-line sources.

Another source for wiring are RC servo extension cables. These can be found in your local hobby shop's RC department. Extension cables are available in various lengths up to 1 meter. These cables are three wire only and feature a three pin socket on one end which will mate with the ACM pin headers. The

receptacle on the other end can be removed when connecting to your panel components or you can plug them end to end if you need extra long connections to your panel. Breadboard jumpers will also fit these connectors.

The multi-conductor cables can be readily separated into individual wires when needed, and the unwanted connectors on the ends of premade cables can be removed and the wires connected directly to the panel LEDs and switches.

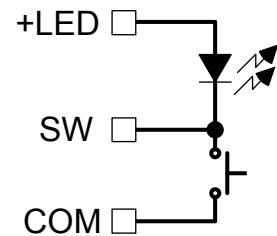
CONNECTING SWITCHES AND LEDS

Connect the switches and LEDs to the track and function switch inputs as shown in the diagram. Refer the sections for each switch input option for details on which switch terminals are active for each option. Unused inputs should be left open, and in most cases are inactivated by the ACM unless used for the option selected.

Connect the input switch terminals between the COM terminal on the connector header and the input pin. Con-

nect the track LED anode to the +LED1 terminal and the cathode to the switch input. Note that resistors are not required for the LEDs, as the ACM uses a constant current driver to regulate the LED current. If necessary, refer to the LED adjust section to set the LEDs either brighter or dimmer than the default setting.

You may use switches only, LEDs only, or both as the need requires.



The Head and Tail LEDs use +LED2.

Note that the Track, CW, and CCW function inputs do not support LEDs.

TRACK INPUT AND RELAY NUMBERING

The terminals on the track switch inputs and relay outputs are numbered 1-24. Since the turntable controller supports up to 99 service tracks which can be assigned any number from 1-99 and the ACM has just 24 input and output terminals, the following rules determine how the turntable track numbers are assigned the ACM terminal numbers. As a result, the terminals may or may not correspond the turntable service track numbers depending on both the number of tracks and the numbers assigned to them.

At power up, the ACM obtains a list of the current tracks from the turntable controller and assigns each to a switch input and relay output as follows:

1) If there are 24 or less tracks defined AND no track has a number greater than 24, the tracks are assigned to ter-

minals as numbered 1 to 1, 2 to 2, etc. Unused numbers are inactive.

2) If there are more than 24 tracks OR any track has a number greater than 24, the first 24 tracks, in numerical order, are assigned to terminals 1-24.

The track number to terminal mapping is refreshed on each power up cycle, so if you make any additions, deletions, or changes to the turntable service track numbers, you will need to power cycle the ACM to update the input and output terminal assignments.

As an example of how the mapping works, assume the turntable is set up with 4 tracks numbered 1, 2, 5 and 24. This configuration satisfies rule 1, and terminal 1 is track 1, terminal 2 is track 2, terminal 5 is track 5 and terminal 24 is track 24. Terminals 3 and 4 and terminals 6-23 are inactivated.

If the 4 turntable tracks are numbered 1, 2, 5, and 25, rule 2 is satisfied, and the assignments are terminal 1 is track 1, terminal 2 is track 2, terminal 3 is track 5, and terminal 4 is track 25. Terminals 5-24 are inactive.

If the turntable has more than 24 tracks defined, only the first 24 are accessible via the pushbutton, switch and encoder input modes. The control box and keypad modes can access all turntable tracks regardless of number or numbering. The track power relay outputs are assigned to the first 24 tracks only.

The serial input/output port always has access to all turntable tracks and can be used to add input and output functions required for turntable configurations of more than 24 tracks.

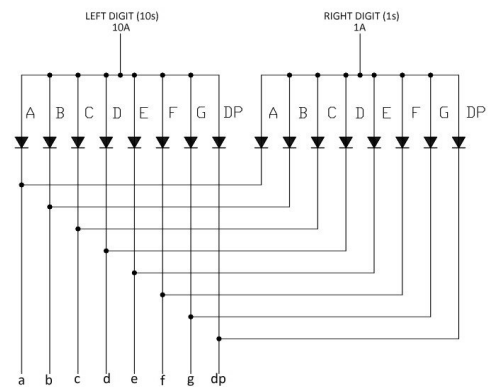
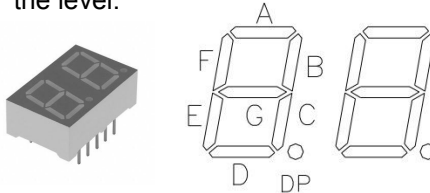
DIGITAL DISPLAY

A common anode two digit display may be connected to the ACM and will display the current or selected track in the same manner as the standard control box. The display will react to selections made on any control box in the turntable control circuit and is active in all modes.

Connect the left-hand digit anode connection to terminal 10A and the right-hand digit to 1A. The individual display segments connect to terminals a-g and the decimal point to dp. Separate LEDs can be connected to the dp pins

if you do not wish to use the display decimal points for the Head and Tail indicators. The Head and Tail function switch terminals also provide an LED output which duplicates the digit decimal points.

Display brightness is adjustable. See Appendix A for details on how to set the level.



DCC OPERATION

When connected to the DCC track circuit, the ACM will detect accessory decoder packets in the DCC signal, and if the decoder address matches an address saved, send a command to the turntable to rotate the bridge to the selected track. The ACM uses the accessory thrown or closed (on/off, diverging/straight, etc) command to specify head or tail alignment at the specified location. An address can also be stored for the turntable turn function which will cause the bridge to reverse the alignment at the current location.

Note that the ACM itself is not a DCC decoder, does not have a DCC address, and does not have any CV registers to program.

When placed in the 'Learn' mode, the ACM will store any accessory address received and associate it with the current track location. Any valid decoder address from 1 to 2044 can be stored for any track location or the turn function. Note that all decoder addresses may not be available due to limits of various DCC systems.

Manufacturers of DCC systems are not consistent with the way they refer to accessory decoder addresses or the on/off states of the decoder outputs. For the purpose of these instructions, we will refer to the accessory address by number, and the two decoder states as 'Thrown' and 'Closed' which is commonly used for decoders which are presumed to be controlling turnouts. Your system may use diverging/straight, on/off, or other terms to refer to the two decoder states.

As shipped, the ACM has as defaults decoder address 1 assigned to track 1,

DCC Quick Check

- Connect DCC track power to the DCC Input terminal block
- Place DCC option jumper on Enable
- Send a command to accessory decoder address 3
- The bridge will reverse ends at the current location

address 2 to track 2, and address 3 to the turn function.

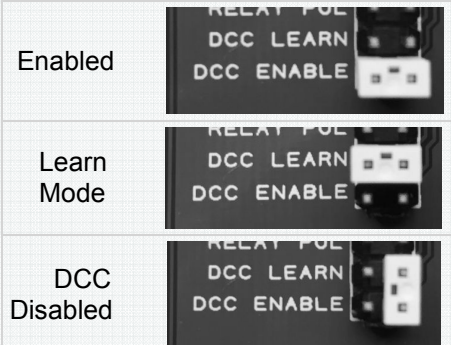
To familiarize yourself with how your DCC system interacts with the turntable, try the Quick Check first. Next, send commands to address 1, and note which command causes the head end of the bridge to move to track 1. This command corresponds to 'thrown' and will be used to save a decoder address for a track. The command which sends the tail to track 1 corresponds to 'closed' and is used to delete the decoder address for the current track.

If you are having trouble with sending commands to the default addresses, try the experiment shown below to determine how your system works. Make certain you know how to send accessory decoder commands before you try the experiment.

Once you are familiar with commanding the turntable with the default addresses, proceed to the DCC Setup to complete the learning process for the service tracks you wish to access via your DCC system.

The ACM stores the DCC addresses separately from the turntable controller. If you add or delete track numbers with the turntable controller, you will need to make matching changes to the DCC addresses on the ACM.

DCC Jumper Settings



DCC Experiment

- Connect DCC track power and place the jumper on 'LEARN'
- Move the bridge to a programmed track
- Send a thrown/diverging/on/etc command to an accessory decoder address
- Move the bridge to another track
- Send the opposite command (closed/straight/off/etc) to a different address
- Move the jumper to 'ENABLE'
- Send an accessory decoder command to each of the addresses. The turntable will respond to only one of the addresses used
- The command used for the addressable track is the command to save in Learn Mode, and move the bridge head to the track in Enabled mode
- The command used at the other track is used to delete addresses in Learn Mode, and move the bridge tail to the track in Enabled Mode

DCC Setup

- 1) If you have not already done so, connect the DCC track signal to the DCC Input terminals
- 2) Place the DCC Option jumper in the 'LEARN' position
- 3) Move the turntable bridge to the track you wish to program
- 4) Wait for the bridge to stop at the targeted track
- 5) Issue an accessory decoder 'Thrown' command to the address you wish to use for the current track
- 6) The bridge will execute an alignment jog acknowledging the stored address
- 7) Repeat steps 3 through 6 for each track you wish to store
- 8) To program the Turn function, use the manual rotation controls to move the bridge to any unprogrammed location
- 9) With the bridge stopped and the numeric display showing "--", issue a 'Thrown' command to the address you wish to use to reverse the bridge
- 10) When done, return the option jumper to "ENABLE"

DCC Notes

- In Learn mode, a 'Thrown' command stores the address, a 'Closed' command deletes it
- In Learn mode, accessory decoder commands are associated with the Turn function if the current location is not a programmed track
- To delete a stored address, move to the track, change to Learn mode, and issue a 'Closed' command to any address
- Adding or deleting DCC addresses can be done at any time and has no effect on the turntable track numbering or location
- A new address overwrites any existing address for the current track so it is not necessary to first delete an old address
- It is not necessary for accessory decoder addresses used for track access to be sequential or grouped
- Any accessory address (1-2044) can be used for any track or the turn function
- DCC accessory addresses reference the turntable tracks by number, not location

DCC Notes

- When using the Turn function DCC address, either "Thrown" or "Closed" will initiate the turn
- Moving the DCC Option jumper to the 'DISABLED' position will stop the ACM from generating turntable commands for stored addresses
- Sending an accessory command to the turntable while it is in motion will cancel the current move and stop the turntable bridge
- Any turntable motion started with a DCC command may be cancelled by pushing any button on any control box
- In Learn Mode, any accessory command received while the bridge is in motion is ignored.
- In Learn Mode, the ACM will acknowledge receipt of an accessory command by jogging the turntable bridge
- DCC accessory addresses may be added, deleted, or modified with serial I/O commands

TRACK POWER RELAYS

The ACM Track Power Relay outputs are logic level signals intended to control a relay in the service track power circuits. The ACM will energize one relay at a time corresponding to the current track. The digital output can be configured as active hi (+5V) or active low (0V), and the relay will activate when the turntable bridge starts a move to a new service track, allowing any engine decoders at the new track to fully initialize prior to the arrival of the bridge. If the bridge is stopped between programmed locations, all track power outputs are off.

Review the *Track Input and Relay Numbering* section and be certain you understand how the track relay output numbers correspond to service track numbers. The assignments will not reflect any additions, deletions or changes made by the turntable controller or serial input until the next power cycle occurs or a reset command is received by the serial port.

You will need an external power supply matching the relays used for power control. Only one relay is active at any time, so power requirement is low. A spare cell phone charger or USB wall-wart makes a handy supply when using 5V relays.

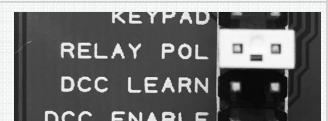
The ACM logic outputs cannot supply sufficient current to power a relay coil directly and a driver transistor, optocoupler or IC is required to provide the current necessary for a relay coil as well as accommodate commonly available control relays with 5V, 12V or 24V ratings.

See the diagrams below for examples using discrete transistors or optocouplers for driving relays. The readily available ULN2003 relay driver is specifically intended for this application and requires no additional resistors or diodes and can be used for relays up to 24V.

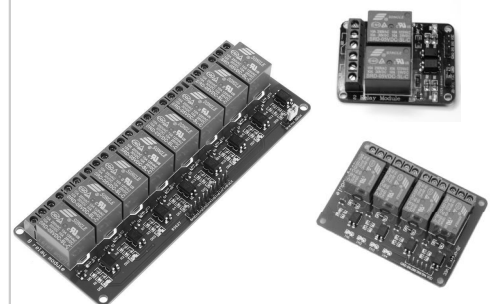
You may wish to use multi-channel relay modules intended for use with

Relay Polarity Setting

Install for
Active Low
Remove for
Active Hi

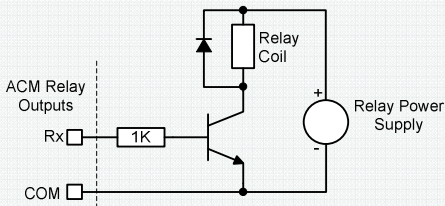


Arduino, Raspberry Pi and similar microcontrollers. These cards are available in 1, 2, 4, 8 and 16 channels with 5V or 12V relays and are directly compatible with the ACM outputs. Modules are available with either active high or active low logic inputs and if you use multiple modules, all must be the same type.



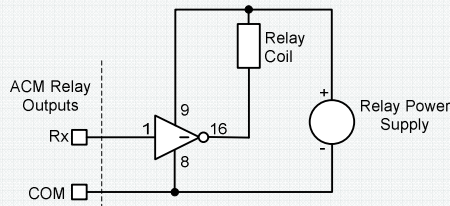
Using Transistor Relay Drivers

- NPN switching transistors such as 2N2222, 2N3904, 2N4401, BC548, or BC338 work well for small control relays.
- Use Active High setting (jumper off)
- Flyback diode on relay coil required, use 1N914 or 1N4148 for small relays, 1N4001 type for larger relays

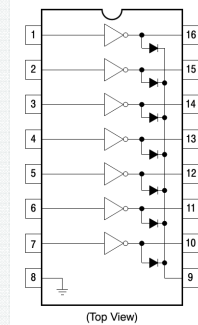
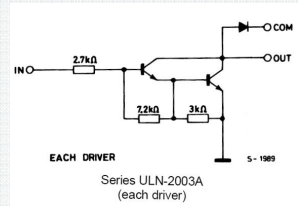


Using IC Drivers

- ULN2003 provides 7 driver channels in each 16 pin package
- Internal resistors and diodes mean no extra components required
- Use Active High setting (jumper off)



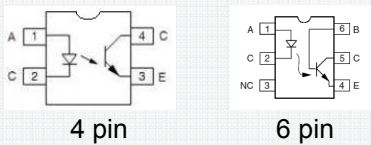
ULN2003 Info



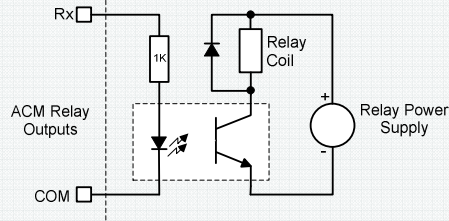
Using Opto-Couplers

- 4N33, H11 or PC817 types work well for small control relays
- Flyback diode on relay coil required, use 1N914 or 1N4148 for small relays, 1N4001 type for larger relays
- Can totally isolate turntable from relay power circuits
- Can be wired for either active lo or active high configurations

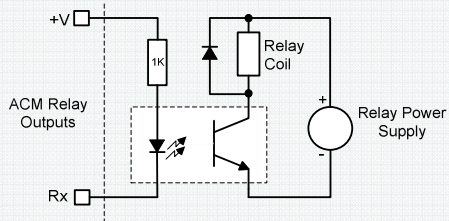
Opto-coupler Connections



Active High Connection



Active Low Connection



Using Relay Modules

- Commonly available modules use 4-pin opto-couplers for relay drivers
- Use active high or active low configuration which matches the module
- Remove any module jumpers connecting relay power to logic circuits
- Module input common connects to ACM COM for active high, and to ACM +V for active low
- Relay power - connection to ACM COM is permissible
- Never connect relay power + to any ACM pin
- Double check before applying power!

SERIAL PORT OPERATION

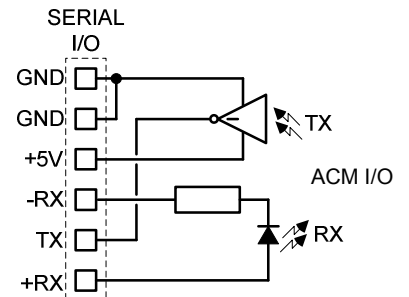
The ACM Serial Port is fully optically isolated digital logic level serial I/O port and compatible with both 3.3V and 5V devices. The ACM signals can be connected directly to the serial RX/TX pins on Arduino, Raspberry Pi and similar microcontrollers, and with appropriate adapters to standard serial or USB ports on PC, laptop, or tablet type computers.

Communication uses plain, human readable ASCII text messages allowing easy programming and debugging of your control program. All turntable control functions are available including programming as well as the ability to directly control the bridge by index position in addition to the normal track numbers. Thus all turntable programming and control functions can be off-loaded to your remote device to any extent you require.

Communication with the ACM is at 9600 baud, 8 bit, no parity, and 1 stop bit. Both RX and TX use normal logic polarity, ie idle state is high. Software or hardware handshake is not supported. The serial I/O is always enabled, and there are no jumpers or configuration needed.

Connect the GND and +5V to the external device's ground and +5V pins. Note the serial i/o power always connects to +5V regardless of the logic levels in use. The ACM TX output connects to the external device RX input and requires a pull-up to the receiver +Vdd logic power. Microcontrollers usually have an internal pull-up which can be used for this, but if not a resistor of 2-10K may be used.

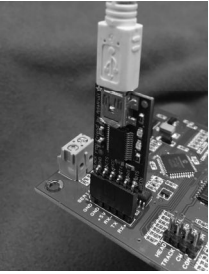
The external TX output connects to the ACM -RX pin. Connect the +RX pin to the transmitter's +Vdd (3.3V or 5V). It



is permissible to ground the -RX pin and drive the +RX pin with inverted data if required.

The 6-pin ACM Serial I/O connector is also pin compatible with the popular FTDI based serial adapters such as the Adafruit FTDI Friend pictured. When using an FTDI based device, pin 6 must be configured to be held at +5V to provide the current source for the RX opto-coupler LED. Most FTDI based devices have option jumpers for

this pin, and can be setup to connect it to pin 3 (+5V). If configured as the RTS output and you have access to the FTDI configuration, RTS can be held false, which is high (+5). However, the standard device drivers used by PCs and Linux computers do not have the ability to set RTS false and operate normally so jumpering pin 6 to +5V is a quick and easy solution and allows the standard drivers to communicate with the ACM.



Once connected, first send a character string to the ACM. The ACM serial port will echo all characters by default, so receiving the same characters as sent indicates your transmit and receive functions are working normally.

The ACM communicates using alphanumeric characters in formatted strings as shown in the command list table listed in Appendix C. A command string begins with an exclamation mark (!, dec 33) followed by an alpha command and one or more optional alphanumeric parameters, each delineated by one or more spaces, and terminated by a carriage return (dec 13).

The ACM will ignore all characters received before the "!" and after the carriage return, however all characters are echoed when enabled.

The ACM response to a command string will be preceded with a # (dec 35) and terminated with a carriage return. The ACM will respond to all command strings with either the expected response or an error message if the command cannot be parsed or a parameter is missing or invalid.

If a timeout error is returned to a Run, Stop, or Home command, check the turntable status before resending as the error may be related to the command response from the turntable and not the execution of the command itself.

In normal operation, wait for a response from the ACM before sending the next command. Attempting to overlap transmissions may prevent the prior command from completing normally.

Appendix D contains additional information regarding programming tracks for those who wish to provide a complete control solution or replace the standard control boxes completely with a serial i/o port connection.

Appendix E lists error messages which may also appear on the ACM digital display when a serial port error occurs.

CUSTOM CONTROL PANELS

The ACM supports five different operating modes for up to 24 switch or button track inputs. Each input also supports connection of an LED which can be used to indicate the current or selected track in lieu of or in addition to the digital track display.

The input mode is selected by inserting the option jumper at the desired position on the option header block. If switch inputs are not used, the jumper should be placed in the disabled position. The track indicator LEDs will function in all modes except Keypad and while disabled.

Consult the pertinent section below for details on how to make connections for the mode you wish to use. All switches and LEDs connect to the SW/LED and Function Control headers as shown in the *Connecting Switches and LEDs* section.

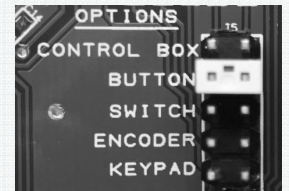
Review the *Track Input and Relay Numbering* section and be certain you understand how the switch contact numbers correspond to service track numbers. The assignments will not reflect any additions, deletions or changes made by the turntable controller or serial input until the next power cycle occurs or a reset command is received by the serial port.

Some custom panel examples are shown on page 12. Many other configurations are possible and limited only by your imagination. If you are replacing an existing turntable using an older control system, the switch or pushbutton modes can allow you to use the existing control panel switches and indicators with your new Cornerstone® Turntable.

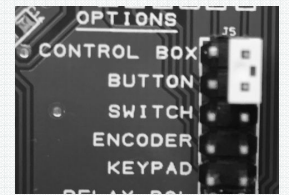
You should keep a standard control box connected, or readily available as the programming and home reset func-

Control Panel Options

Pushbutton (example)



Disabled



tions are not available in all modes. Control Box mode emulates the standard control box and all functions are available. Keypad mode will accept track 0 as an entry and perform the home reset. The other options do not have access to the programming and reset functions.

OPTION - CONTROL BOX

Connect five pushbutton switches to the CW, CCW, Head, Tail and Track terminals on the Function Switch header to use the ACM as a standard control box. In this mode, all turntable control functions are available as listed in the turntable instructions, including programming and home reset. You may use either the digital display readout or individual track indicator LEDs for position feedback. Note that the

track selection is not limited to the 24 count limit, although the track indicator LEDs will be.

Control Box mode allows the standard control functionality to be built into a control panel in any configuration desired, especially where you may not have room for the standard control box.

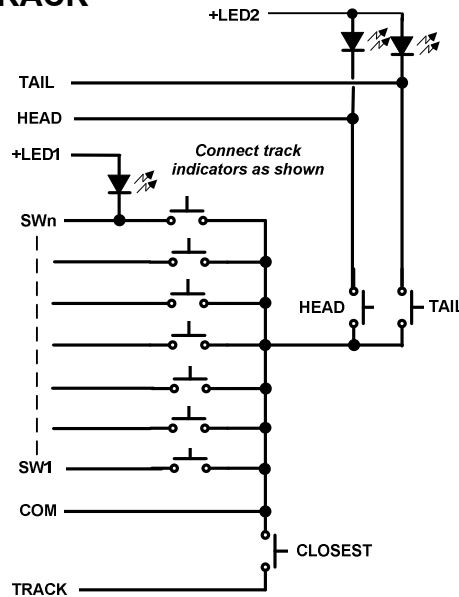
Control Box Operation

- Push Track button
- Push CW & CCW to select track
- Push Track for closest move, or Head or Tail to specify end to align
- For Turn function, push Head or Tail to reverse bridge at current location
- See turntable instructions for a complete list of commands

OPTION - PUSHBUTTON PER TRACK

Pushbutton mode uses a momentary pushbutton for selecting tracks and specifying the head, tail and closest end to begin rotation.

This option works well with the switches arranged on a graphic image of the service track layout or in a linear list such as those shown in the *Custom Control Panel Examples* section. Connect track indicator LEDs as shown for each track selection. The LEDs will flash to indicate a new selection is being made, as well as when the turntable bridge is in motion. Note that the LEDs will also react to commands which are entered via any standard control boxes which may also be present in the turntable control circuit.



Pushbutton Operation

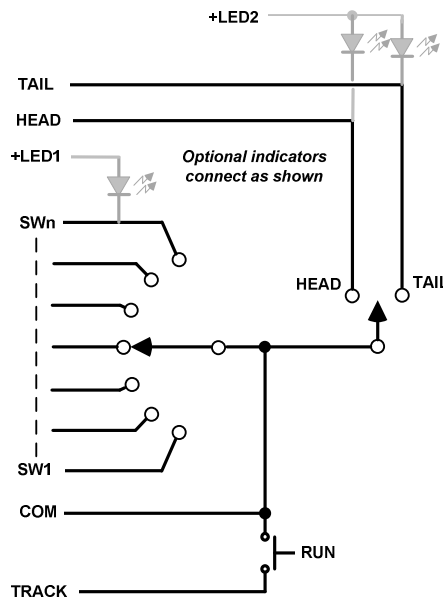
- Push button for desired track
- Push Head, Tail, or Closest button to initiate rotation
- For Turn, push Head or Tail button

Be certain to read the *Track Input and Relay Numbering* section for information on how track input terminals correspond to service track numbers. Note that any changes made to service track numbers may cause the switch assignments to change on the next power cycle.

OPTION - SWITCH INPUT

Switch Input mode uses a maintained contact such as a rotary selector switch or set of radio type latching pushbuttons to select the desired track. A SPDT toggle is used to specify the bridge end to align, and movement is initiated with a 'Run' pushbutton connected to the track terminal. Older turntable control systems typically used this type of switch input for track selection, and this option allows an existing turntable control panel to be used. Up to 24 contacts are supported.

Optional LEDs may be used to indicate track selection as shown in the diagram. Note that if the current bridge position does not match the switch positions, the LEDs will not illuminate. This may occur if the bridge is moved



Switch Operation

- Use switch to select desired track
- Select Head or Tail, or center off for closest move
- Push 'Run' button to initiate rotation
- For Turn, select opposite end with Head/Tail switch and push 'Run'

with another control box, or a new track or end is selected but the move not completed.

Use of a center-off type toggle will allow the closest move option to be used.

OPTION - ENCODER INPUT

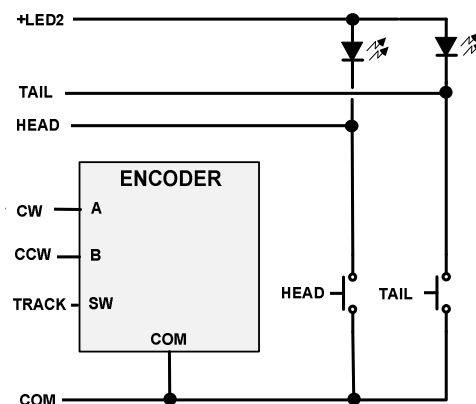
A digital rotary encoder such as those shown here allows a track to be quickly selected by rotating the knob and pushing a button. These devices offer continuous rotation and typically have 16 to 20 detents per rotation to allow precise selection. Many encoders have an integral switch which is

handy for the Track connection. If your encoder does not have an imbedded switch, you will need to add a third pushbutton if you wish to use the closest move option.

The encoder A & B outputs are sequenced in a manner that allows the

ACM to determine the direction of rotation and increment or decrement the selection accordingly.

Connect the encoder outputs as shown with the CW input leading CCW for



Encoder Operation

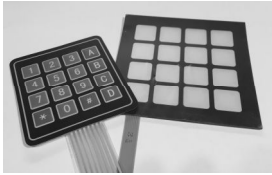
- Rotate Encoder to desired track
- Push Encoder switch for closest move, or Head or Tail to specify end to align
- For Turn function, push Head or Tail to reverse bridge at current location

clockwise rotation. If the track selections move in the wrong direction, reverse the A & B connections to CW & CCW.

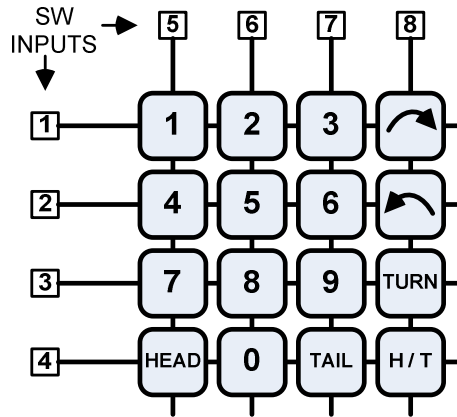
You may use either the numeric display or track LEDs for selection indication.

OPTION - KEYPAD INPUT

A standard 3x4 or 4x4 matrix keypad may be used to allow direct input of track numbers to



control turntable operation. You may wish to use a commonly available unit such as those shown, or you can construct your own from individual pushbuttons connecting a row and column as shown in the diagram. The matrix rows are connected to SW inputs 1-4 and the columns to inputs 5-8 as shown. The Keypad can access any defined service track and is not subject to the 24 count limit, and thus may be preferred for those installations

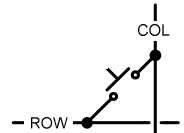


having a very large number of service tracks as the desired track number can be directly entered rather than picked from a list or diagram.

Keypad Operation

- Enter 1 or 2 digit track number
- Push Head or Tail to initiate rotation
- H/T makes closest move to track
- Turn may use dedicated button or use Head or Tail without entering a track number
- CW & CCW button may be used to manually move bridge to next track after release, same as standard control box

Momentary pushbuttons connect a row to a column



Appendix A — Display Brightness Setting

The ACM digital display and track indicator LED intensity is adjustable via an internal Brightness setting in a manner similar to the turntable standard control box. The range is 1 (dimpest) to 9 (brightest), and has a default level of 5. Note the ACM uses constant current drivers for the LEDs and series resistors cannot be used to set the display level.

If you have the serial port connected, the level can be adjusted directly at any time with the 'Bright' command.

If you are using the 'Control Box' switch option, the brightness adjust procedure for the standard control box can be used to set the level. See the turntable instruction sheet for details.

For the other input options you will need to use the switches connected to the CW, CCW, Head/Tail, and Track terminals on the Function Switch header to adjust the setting. If these switches are not included on your custom panel, such as Keypad, connect a temporary set of switches to the terminals to make the setting, which can be removed when completed.

When using the Encoder option, set the option jumper to Control Box to make the adjustment, then return to Encoder when done. You may need to disconnect the encoder outputs from the CW and CCW terminals as well, depending on the encoder in use.

Follow the steps listed to set the bright-

Setting Brightness Level

- Push and hold CW or CWW and apply power
- Continue to hold button until bx display appears
- Use CW and CCW to increment or decrement display to new setting
- Push Track button to save the new setting
- Push Head or Tail to cancel and revert to old setting

ness level. Once set, the level is stored internally and restored on power-up. An ACM Reset sent to the serial port will not change the brightness value.

Appendix B — Display Error Codes

| | | | |
|----|-----------------------|-----------------------------|--|
| E0 | Position Reference | <i>Pit Controller error</i> | <i>Home reference location could not be restored, reset required</i> |
| E1 | Home Sensor Not Found | <i>Pit Controller error</i> | <i>Home sensor may be blocked, bad pit LED, bad bridge sensor</i> |
| E2 | Communication Error | <i>Pit Controller error</i> | <i>Bridge wiper intermittent, bad control cable</i> |
| E3 | Bridge Not Responding | <i>Pit Controller error</i> | <i>Bridge is not installed, bad bridge wipers</i> |
| E4 | Configuration Error | <i>Pit Controller error</i> | <i>Internal configuration info bad, factory reset may clear</i> |
| E5 | Configuration Error | <i>ACM error</i> | <i>More than 4 control devices connected, remove one</i> |
| E6 | Pit Not Responding | <i>ACM error</i> | <i>Pit controller not running, bad control cable</i> |
| E7 | Internal Memory Error | <i>Pit Controller error</i> | <i>Internal ROM memory failure, fatal error</i> |
| E8 | Low Supply Voltage | <i>Pit Controller error</i> | <i>12-18 VAC / 16-24 VDC required for turntable operation</i> |
| E9 | Invalid Track Number | <i>ACM error</i> | <i>Track number is not defined</i> |

E0 Position Error can be cleared by pushing any key. Service track locations will not be correct until a reset of the home position is done. Other errors will clear automatically when the cause is corrected.

Appendix C— Serial Port Commands

Serial I/O Commands

- 9600 baud, 8 bit, no parity, 1 stop bit, handshake not supported
- Syntax, delimited with one or more spaces: **!cmd parm1 parm2 <CR>**
- Alpha numeric characters only: a-z, A-Z, 0-9
- Alpha commands and parameters may be abbreviated as shown in bold
- Use of leading zeros in numeric parameters is permitted
- Optional parameters denoted with ()
- General acknowledgement is "#OK: " followed by parsed command string if no error
- All characters before the ! and after <CR> are ignored but echoed (if enabled)

| Command | Parm1 | Parm2 | |
|-----------------|-----------------|----------------------|--|
| RUN | CW / CCW | | Rotates bridge in specified direction |
| | xxxxx | | Rotates bridge head to index position xxxxx using shortest direction |
| | HOME | | Rotates bridge CW to the home position |
| STOP | | | Immediately stops bridge rotation |
| | NEXT | | Stops bridge at next track in direction of rotation |
| | xxxxx | | Stops bridge at index location xxxxx |
| HOME | | | Rotates bridge CW to the home position (same as RUN HOME) |
| ECHO | ON / OFF | | Turns character echo on or off |
| BRIGHT | (n) | | Sets / Returns the display brightness level 1-9, default is 5 |
| INFO | | | Returns status string: #INFO: n dir position track end n - bridge speed 0-3, 0 is stopped dir - current or last bridge direction CW or CC position - current bridge head location track - current or target track, "- " if none end - current or target end |
| AUTO | | | Returns current Auto setting #AUTO: n |
| | nnn | | Starts automatic info transmit at nnn/10 per second, nnn = 0-250 |
| | ON / OFF | | On sets to 1/sec (AUTO 10), Off stops info transmits (AUTO 0) |
| RESET | ACM | | Restarts ACM (same as a power up) |
| TURN | | | Reverses bridge at current location |
| TRACK | | | Returns current or target track number, "- " if none |
| | nn | (HEAD / TAIL) | Rotates to specified track, uses closest move if parm2 is null |
| LOCATION | | | Returns current bridge location #LOCATION: xxxxx |
| | MAX | | Returns maximum value for position index #MAX: xxxxx |
| | nn | | Returns position index for track nn #LOCATION nn xxxxx |
| | NEXT | (nn) | Returns position index of next track larger than nn If nn = 0, returns index for lowest numbered track If nn is null, returns index for next track after previous nn Returns 0 if no track larger than nn is programmed |
| | TARGET | | Returns target position index #TARGET: xxxxx |
| DCC | nn | (dddd) | Sets / Returns decoder address dddd for track nn #DCC: nn dddd |
| | TURN | (dddd) | Sets / Returns decoder address dddd for turn function |
| PROGRAM | nn | (xxxxx) | Sets position index for track nn to xxxxx or current index if null |
| DELETE | nn | | Deletes position index definition for track nn |

Appendix D — Serial Port Track Programming

If you wish to program turntable service tracks via the serial port, follow the procedure below to retain the turntable controller's ability to accurately position the bridge at the desired track location.

The turntable controller relates the bridge head position to the home sensor location by keeping track of an index count as the bridge rotates. The absolute number of counts is related to the bridge motor gearing as well as the size of the turntable and differs for each of the turntable models. The *Location Max* command returns the value in use. The total number of counts allows rotational resolution to better than .01 degree anywhere on the pit circumference.

The controller is capable of stopping the bridge within a very small count window at any arbitrary location. As the bridge rotates, the count increments for clockwise rotation and decrements for counter-clockwise, rolling over at the home sensor which is located at the max count position. Thus the first count clockwise from the home position is 1, the first counter-clockwise is max-1.

When aligning the bridge to a service

track, it is also necessary to account for gear backlash in the bridge motor drivetrain and approach the stop position from the same direction as used when setting the track location. The controller uses the parity of the count assigned to a track number to indicate the required alignment direction. When the location is an odd number, the final alignment is clockwise, and when even counter-clockwise.

When a *Run xxxxx* command is sent, the controller calculates the direction of rotation required for the shortest move and automatically includes an overrun and reverse move when necessary to perform the final alignment in the proper direction based on the commanded target position.

As an example executing a *Run 10000* command from location 1000 will cause the bridge to rotate clockwise and perform a reverse alignment before stopping as the target count is an even number. Using *Run 10001* or *Run 9999* will result in the same move without the reverse alignment as the bridge is already moving in the correct direction.

The *Program nn xxxxx* command associates count position xxxxx with track nn. The stored count value is the head location and should be incremented or decremented to correct the parity to match the direction of last movement before saving. The *Info* command returns the direction of last movement when the bridge is stopped, which can relieve your external program from keeping track of it.

The index count always defines the location of the bridge head end, and the location of the tail is calculated by adding or subtracting max / 2 from the current location and correcting the result if necessary to maintain the parity.

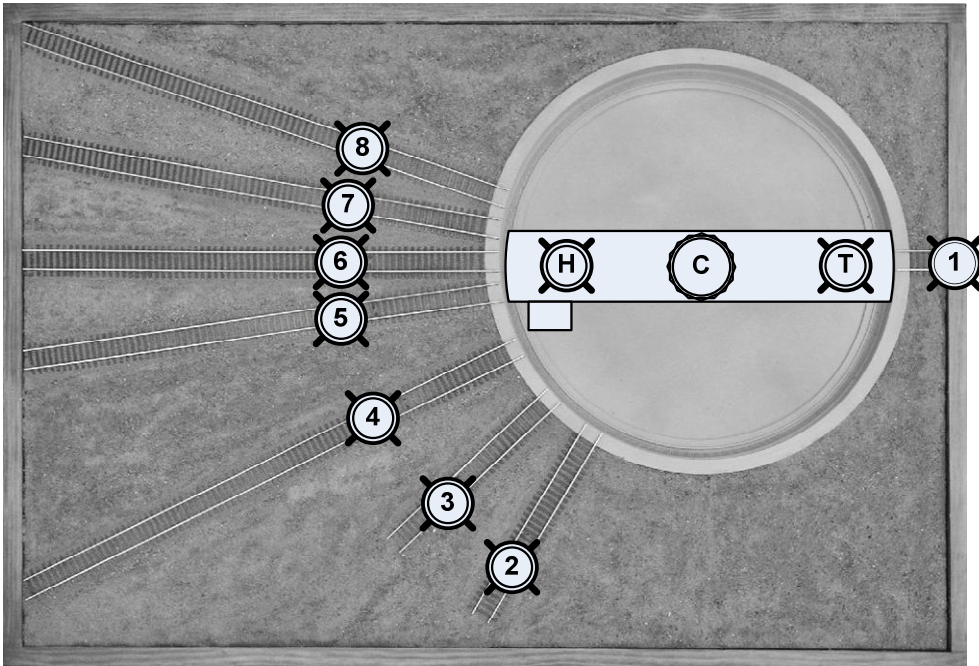
Track definition changes made via the serial port are effective immediately however it is necessary to execute a *Reset ACM* command or a power-up cycle to reinitialize the ACM relay drivers and switch inputs to include the updates. Note that terminal number to track number relationships on the ACM connector headers may change depending on the new active track numbers.

Appendix E — Serial Port Error Codes

| | | |
|-------|------------------------|--|
| Err 1 | Parameter Out of Range | <i>Numerical parameter is not valid</i> |
| Err 2 | Command Format Error | <i>Command string cannot be parsed or bad syntax</i> |
| Err 3 | ACM Busy | <i>Command cannot be executed, retry</i> |
| Err 4 | Buffer Overflow | <i>Command buffer length exceeded</i> |
| Err 5 | Command Timeout | <i>Pit controller response timeout - Check status before resending</i> |
| Err 6 | Turntable Busy | <i>Pit controller busy, command ignored</i> |
| Err 7 | Invalid Track Number | <i>Track number is not defined</i> |
| Err 8 | Invalid Command | <i>Command is not defined</i> |
| Err 9 | Command Ignored | <i>Command not executed, may be redundant</i> |
| Err A | Invalid Parameter | <i>Parameter is not defined or may be bad syntax</i> |

Error responses are followed by the parsed command string. ACM will respond to any character string sent between the ! and <CR> with the defined command response or an error message defined above.

CUSTOM CONTROL PANEL EXAMPLES

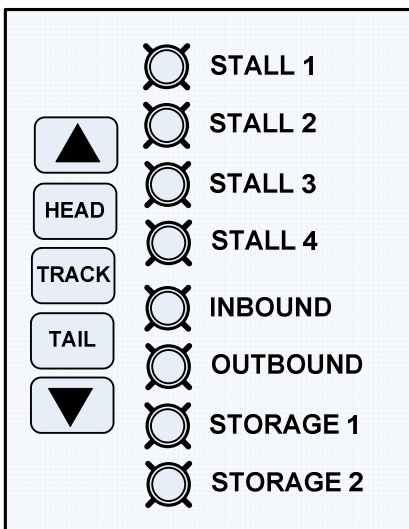


An easy to use control panel can be setup using a graphic image of the turntable service tracks. Here an LED illuminated pushbutton is used for each of the service tracks and the Head and Tail inputs. A non-illuminated button on the Track input is located at the center of the bridge to select the closest move option.

The graphic image also works well using a rotary encoder at the center position for track selection. LEDs are used to indicate the selected track, and the encoder push switch connects to the Track terminal for the closest move input.

In both cases the Turn function is accessed by using the unlit end button to swap the bridge ends at the current location.

Use of numbered indicators is optional as the graphic image conveys the position information.



Railroads frequently refer to tracks by name or function, rather than by number. A control panel can be set up using a list of track names with indicators to show the current or selected location as shown here. The head and Tail buttons are also illuminated to show the bridge orientation.

The Control Box mode Up/Down, Head/Tail and Track input buttons can be used to scroll the selection up or down the list and motion initiated with the Head, Tail, or Track buttons.

The control functions in Control Box Mode are the same as the standard control box, and the list will scroll thru a 'none' selection (meaning track 0) for

access to the turntable home reset function.

The Turn Function is available by selecting Head or Tail button first to swap ends of the bridge at the current track location.

The Control Box mode has the same functionality as the standard control box, so using a custom version retains the home reset function as well as the ability to control the bridge manually using the Up/Down (CW/CCW) buttons.

Encoder input mode also works well with a list of service track names as shown here. The encoder is used to scroll up and down to the desired track, and the Head or Tail button used to initiate the motion.

Encoders with an integrated push switch can be used, connecting the encoder button to the Track input terminal. In encoder mode the Track input functions as a 'closest move' command, which causes the bridge head or tail to align to the selected track, whichever is closest.

With the bridge empty, a service track can be selected simply by rotating the encoder to select the desired track,

then pushing the encoder knob to initiate the movement. With an engine on the bridge, the Head or Tail buttons would normally be used to specify the bridge end to align to the selected track.

Any other variation of the panels shown here can be used, and features can be mixed and matched as your particular needs require. The numeric digital display can be used with any of these examples if desired in addition to the track indicator LEDs.

Custom panels based on the ACM may be used simultaneously with one or more standard control boxes if multi-point control is a requirement.

