GCC GRADE CROSSING CONTROLLER

By

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1. INTRODUCTION

Your GCC Grade Crossing Controller is the latest and most complete grade crossing scene controller available. It works with layouts using Command Control, DC or AC control systems for operating trains, and can be used in any scale. The GCC is the master unit, and only one GCC is needed for a grade crossing. As the master, the GCC provides train detection for the first of the tracks, and controls all of the scene operation.

You can add up to seven Grade Crossing Expanders to each GCC. This will allow you to have as many as eight tracks at each crossing. And, for a little extra interest, you can add one of our Train Speed Indicators (TSI) to each GCC. This will allow the GCC to display the speed of the most recent train, in scale miles per hour (0 to 99).

The following list of features is provided by your GCC. Later in this manual, we will explain how to use all of them.

- The GCC will provide train detection for the first track in your grade crossing scene and control all of the action within the scene.
- Train detection by current sensing - your GCC will see your train no matter how long or short or how twisted your track is in the blocks.
- Works with your layout control system - use DC Cab control or Digital Command Control, or even AC - your GCC will work with any of them.
- Provides an audio output with an accurately reproduced prototype bell for use with any 8-ohm loudspeaker.
- When merged with your train detection and signaling system, the GCC will combine its train detection with the overlapping signaling blocks and output both OCCUPIED and VACANT status for the merged blocks- you can operate two aspect signals with no additional hardware.
- Manual raise and lower controls to handle station stops.
- Significant output capacity – will operate a pair of crossbucks with four LED's each, and a low current stall motor to raise or lower the gates. The motor output could also activate a relay to control a higher current motor drive or other mechanisms.
- Power supply included - depending on the type and number of your output devices, you may not need any additional power supply.
- Output flexibility - you can operate LED's, incandescent bulbs or relays
- Modularity – an optional GCX Grade Crossing Expander is available. Add one for each additional track crossing the road, to a total of 8 tracks.
- Furnished assembled and tested - no need to understand electronics. Use the mounting hardware and card edge connector included with each unit, and follow the instructions, and you will have a state of the art train detection and grade crossing control system. Just add the gates, crossbucks and loudspeaker of your choice.
- Cost: THERE IS NO OTHER CROSSING CONTROLLER AVAILABLE WITH ALL OF THESE FEATURES – AT ANY PRICE!

If you have any suggestions or recommendations, please share them with us. We are happy to hear from you, and are committed to being **THE SUPPLIER** of the finest, most cost-effective model railroad signaling and control devices available to the serious hobbyist.

FOR A FAST START:

This manual is divided into a number of logical sections, each intended to answer specific questions or to provide help of a specific type. So, to help you to find the information you need, here are some suggestions.

a. To see a description of the features and functions of your GCC Grade Crossing Controller Board, read Section 2, GCC OPERATIONAL FEATURES.
b. Section 4, INSTALLING YOUR shows you exactly how to install your GCC with the minimum effort and risk. Only read this section if you want it to work right the first time you turn it on.
c. For test as you go instructions, or trouble-shooting help at any time, read Section 4.7, TESTING YOUR GCC
d. If all else fails, for emergency relief read Section 5, CUSTOMER SUPPORT.

2.   GCC OPERATIONAL FEATURES

The GCC Grade Crossing Controller is the latest state of the art device for sensing the presence of trains in sections of track, and providing control signals to activate crossing gates, flashing crossbucks, and generate an audio bell sound which you can use with the speaker of your choice. The GCC also has circuitry that will allow you to manually raise and lower your gates during station stops, and merge your grade crossing scene into your block detection and signaling system.

The next several paragraphs describe many of these features in detail.

2.1   CURRENT SENSING TRAIN DETECTION

The GCC monitors current in the track to detect trains – just as the prototype does. In doesn't matter how long, or short, or twisted your track may be. The GCC will detect an approaching train when it enters an approach block, and immediately start the operation of crossbucks and bell. Later, as soon as the rear of the train crosses the road, the GCC will raise the gates, stopping the flashing crossbucks and bell when the gates are up.

The GCC uses a pair of 3 amp diodes to generate a small voltage whenever current is flowing to something in a block: a motor, command control receiver, light bulb, detectable wheel set, or anything else that draws current. The diodes share a common ground return connection. Hence, a common rail power distribution must be used to power the blocks connected to any given GCC. Figure 4-14 Basic Wiring of the GCC shows how the GCC is connected in a typical layout control system

The diodes are connected in series with the track feed to a block, and will result in a voltage drop of approximately ± 0.7 volts. A current of less than .1 milliamp will be detected. To prevent burning out the diodes, your cabs should have some means for limiting their output current to 3 amps or less if a short circuit occurs. For brief time intervals, the GCC input circuitry can withstand overload currents up to 10 amps. In case of a derailment, you will have sufficient time to shut off train power before any damage is done if you react promptly.

All of the DCC boosters we are aware of have built-in overload protection that will prevent any problems due to such short circuits. And most DC throttles have some sort of protection built-in as well. Just check to make sure that you have some protection in place. Other than that, you probably won't have to do anything.

The detected current is processed to eliminate any detection chatter due to dirty track or wheels. Special processing is also required with DCC controlled layouts to compensate for the effects of the high speed switching of the voltage

applied to the track by boosters. All of this special processing is performed automatically by special circuitry included in the GCC.

Please understand that the GCC works by detecting your engines and cars, and then decides where your train is around the grade crossing. While having engine only, or engine and caboose, detection may be acceptable for block occupancy purposes, this will probably not give acceptable results with grade crossing operation.

Suppose, for example, that you operate trains longer than your approach blocks and that only your engine and caboose are detectable. The action begins when the engine first enters an approach block. As soon as the engine passes over the road, the GCC, since it can't detect the cars, will determine that the road is clear and raise the gates! Then, when the caboose enters the approach block, the same thing happens. There isn't a rivet counter around who could resist the urge to comment on this!

We strongly encourage you to make all of your rolling stock detectable. This can be accomplished easily by replacing at least one axle per car with a detectable wheel set. Some people prefer replacing the outer two axles on each car. This helps prevent loss of detection due to dirty wheels and rail, and makes sure that both ends of the car are detectable, in case the car spans a block boundary. Detectable wheel sets are available from us or from other sources. Or, if you prefer, you can make your own. It's not too difficult, but does take some time.

2.2   TYPES OF OUTPUTS

Your GCC has several different outputs: for crossbuck LED's or bulbs, for gate motor drive, the audio output to your speaker, and signal outputs for use with your signaling system. These are described below.

2.2.1   Crossbuck Outputs

There are two outputs provided to operate the crossbuck lights. They are called, naturally, "BLINKRIGHT" and "BLINKLEFT". Normally, these two outputs are open-circuits. When flashing is active, these two signals alternately close to board common, allowing current to flow from a positive supply to common through the light. Each crossbuck will have either 2 or 4 lights, depending on the style of the crossbuck

If you are using LED's, you can use the 5-volt supply included on the GCC board. Normally, you will operate your LED's with 10 to 20 milliamps of current.

All LED's require a resistor in series for current limiting, and the resistor is usually located outside the LED. Unless the instructions with your crossbucks specifically tell you that the resistor is included inside the LED itself, you will have to add these resistors externally. Later, in the installation portion of this manual, we will show you several ways to connect your LED's.

But, you may not have LED's in your crossbucks. That's ok, you can still use the GCC. For incandescent bulbs, there are, just as with LED's, certain precautions that must be taken to protect both the bulbs and the GCC outputs. We provide complete instructions on this in the installation section of the manual as well.

As you probably know, an incandescent bulb will normally draw a large current, very briefly, when it first turns on. Then, after the tungsten filament heats up, in a fraction of a second, its resistance increases and it begins drawing its "normal" current. The inrush current can be 10 times greater than the normal current. Thus, if your bulb is shown as a 15-milliamp bulb, you can expect it to draw perhaps 150 milliamps when it first turns on. With two, or maybe four of these per output, the GCC output transistors could be damaged.

For bulbs, even the low current bulbs, you will need to install a small resistance in series with the bulb and use a separate power supply for the bulbs. Once you discover the proper value for a particular type of bulb, use that same

value whenever you use those bulbs. We'll provide more information later on how to determine the value of the current limiting resistors.

2.2.2   Gate Drive Output

The GCC has two outputs for operating the crossing gates. One output is active to raise the gates; the other to lower them. Each output, when active, provides current flow to board common from a power supply, either the internal 5-volt supply, or an external supply of no more than 12 VDC. An active output can carry up to 200 milliamps without damage.

If you are using a 3-volt slow speed motor, such as the motors included with the TOMAR HO crossing gates, the 5-volt GCC power supply will be able to power the motor. A circuit to do this is shown later in the manual.

If you are using another type of low current slow speed motor, one that operates from 12-volts DC or less, the GCC will handle that as well. A circuit is provided for that, too.

If your gate operating mechanism is of some other type, requiring either higher currents or voltages or both, you can use the GCC output to activate a relay. The relay contacts can then operate your other mechanism. We provide a circuit for you to use for this case as well.

2.2.3   Audio Output

The GCC has a 1-watt 8-ohm audio output signal. You can simply connect this to any 8-ohm speaker using a pair of wires. This connects the same way as virtually any speaker.

The output power is sufficiently high to be bothersome in most layout rooms. So, we have provided a volume control on the board, allowing you to adjust the output to a comfortable level – loud enough to hear when you are near the crossing, but not loud enough to hear everywhere in the room.

2.2.4   Signaling Operation

If you have a train detection and signaling system installed on your layout, you will need to merge the three blocks needed by the GCC with your signaling blocks so that both systems can operate together.

The first possibility is that your GCC is located entirely within a signaling block. In this case, you will use external detection for the portions of the signaling block outside the crossing scene, and the GCC for the scene detection. Simply connect the proper external detector "occupied" outputs to the GCC external detector inputs. The GCC will provide an occupied and vacant output for the merged blocks.

We have designed the GCC so that you can have one signaling block boundary located anywhere in the grade crossing scene, and the GCC will handle the overlap itself. In the case, you will need up to three external detectors to monitor occupancy in the portions of the signaling blocks outside the crossing scene. Just connect them to the proper GCC inputs, described later in the manual. The GCC has two sets of signaling block outputs, with occupied and vacant for each, which will provide the merged block status.

These merged signaling outputs can be used directly for two color signaling, our connected to other circuitry if desired.

There are three contacts on the GCC connector that are used to identify the signaling block configuration. If you don't have a signaling system, ignore these contacts. If you do have a signaling system, check the diagrams later in this manual for the correct connections to make.

2.3   ASSEMBLED AND TESTED

We realize that most model railroaders have railroading as their hobby - not electronics. To give you access to the latest electronic technology, without getting you into the electronics field, your GCC comes to you completely assembled and tested. You don't have to have any knowledge of electronics to use all of the board's features. Simply follow the detailed instructions in this manual.

If you still have questions, we'll be happy to help. Ask your questions by phone, fax or email, and we'll work with you to get everything working perfectly.

3.   PLANNING YOUR GRADE CROSSING

Now is the time to plan your grade crossing. You probably have a general idea of what you would like to accomplish. But, to help you clarify any issues that may be undefined, we would like to present some ideas that may be helpful.

The information included in this manual is a typical approach to handling grade crossings. You may have a specific prototype railroad you are modeling, and they may do things differently. That's ok. Just follow their methods and the GCC will probably be able to handle the scene.

In a basic installation, you plan your crossing scene just as the prototype does. You will have an approach block on each side of the road, called the "east approach block" and "west approach block". There will be a short, 88-scale feet long block across the road. This length is required if you will be using our TSI Train Speed Indicator to show the speed of trains as they pass.
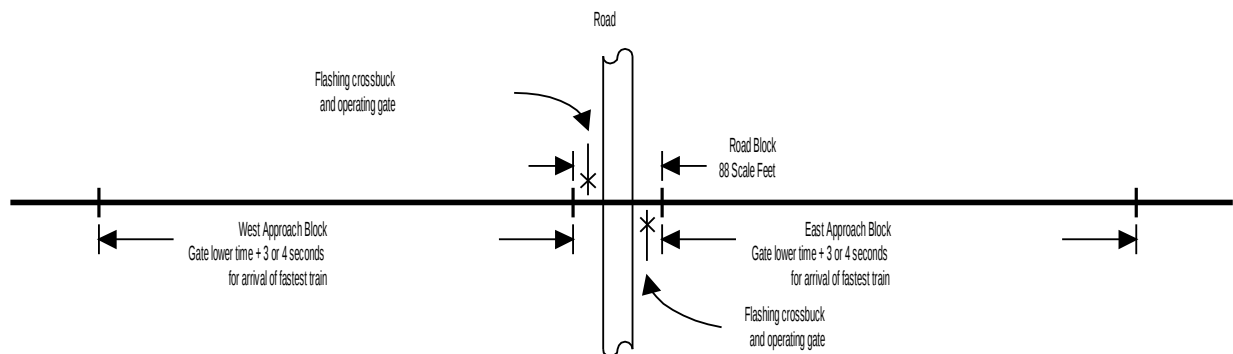
Figure 3-1 Basic Grade Crossing Scene

The prototype is required to have their gates down at least five seconds before the fastest train arrives. As soon as a train enters an approach block, the bell begins ringing and the crossbucks start flashing. They do this for about two seconds to warn motorists and pedestrians that the gates are about to lower. The GCC has this same delay when you select any of the actions that include gates.

Depending on the speed of your gate drive mechanism, it may take 4-10 seconds for your gates to drop. Measure the speed of your gates. The TOMAR HO gates we offer take about 8 seconds to lower. So, by combining the 2-second warning time with the gate descend time, you will need to allow about 10 seconds for the train to arrive.

Using a little selective compression, your fastest trains should take about 12 seconds to enter an approach block and reach the road. You can get the recommended length of your approach blocks, in scale feet, from Table 3-1. Just as with the prototype, if your trains run fast, your approach blocks may have to be very long!

Note that the prototype is subject to laws that restrict train speeds based on the type of protection available at grade crossings. That's one reason why many grade crossings are being eliminated all across the country. In order to keep train speeds at the maximum, they have to close crossings or replace them with over or under passes. How you "model" this on your layout is up to you. In any case, though, you want the gates down before the train reaches your road.

Table 3-1 Length of Approach Blocks with Gates

Speed	Gate Descend Time in Seconds						
SMPH	4	5	6	7	8	9	10
10	118	132	147	162	176	191	206
20	235	265	294	323	353	382	412
30	353	397	441	485	529	573	617
40	470	529	588	647	706	764	823
50	588	662	735	809	882	956	1029
60	706	794	882	970	1058	1147	1235
70	823	926	1029	1132	1235	1338	1441
80	941	1058	1176	1294	1411	1529	1646
90	1058	1191	1323	1455	1588	1720	1852
100	1176	1323	1470	1617	1764	1911	2058

If you are not using gates, your approach blocks can be much shorter and still provide warning time to motorists and pedestrians. Use Table 3-2 to determine the recommended length of approach blocks when you are not using gates. The warning times listed are the time that the bell and flashers are active before the train reaches the road.
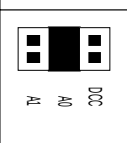
Table 3-2 Lengths of Approach Blocks without Gates

Speed	Desired Warning Time in Seconds						
SMPH	4	5	6	7	8	9	10
10	59	74	88	103	118	132	147
20	118	147	176	206	235	265	294
30	176	221	265	309	353	397	441
40	235	294	353	412	470	529	588
50	294	368	441	515	588	662	735
60	353	441	529	617	706	794	882
70	412	515	617	720	823	926	1029
80	470	588	706	823	941	1058	1176
90	529	662	794	926	1058	1191	1323
100	588	735	882	1029	1176	1323	1470

The GCC has three of its operations that you will need to select, and this is very simple. First, you will need to select way you want the crossing to operate when a train arrives. Then, you will need to tell the GCC if you are using DCC or some other type of train running power. Finally, you will need to tell the GCC what signaling block arrangement you have, if any.

First, consider the type of action you want. The GCC provides four actions to protect your crossings. Two push-on jumper plugs are provided to make the action selection. These are the A0 and A1 jumpers identified as item 4 in Figure 4-11 GCC Assembly and Parts. These actions and the jumper positions are shown in Figure 3-3 Crossing Action Selection.

A1 A0 DCC	No crossing gates. Bell ringing and crossbuck flashing begin when train enters approach. Ringing and flash end when train clears the road.
A1 A0 DCC	Bell ringing and crossbuck flashing begin when train enters approach. Bell rings only during gate descent. Crossbucks flash and gates are down until train crosses road. Gates rise as soon as train clears the road. Crossbucks flash until the gates finish rising.
A1 A0 DCC	Bell ringing and crossbuck flashing begin when train enters approach. Bell rings until train reaches road. Crossbucks flash and gates are down until train crosses road. Gates rise as soon as train clears the road. Crossbucks flash until the gates finish rising.
A1 A0 DCC	Bell ringing and crossbuck flashing begin when train enters approach. Bell rings and crossbucks flash until train clears the road. Gates rise as soon as train clears the road. Bell rings and crossbucks flash until the gates finish rising.

Figure 3-3 Crossing Action Selection

Install the programming jumpers as shown to select the action style you prefer. Naturally, you can easily change to a different action at any time. The jumpers are located on the board when you unwrap it. They simply pull off and push on. If your fingers are of prototype size, as are ours, you'll find that small tip needle nose pliers will help a lot. Be careful not to bend or break off the contact pins on the board.

Next, you will need to tell the GCC whether you are using DCC or some other form of train control. For various technical reasons, the GCC uses a special way of monitoring train current in a DCC system. One additional push on jumper is used to select the DCC train current option. This is shown in Figure 3-4 Train Control System Selection.
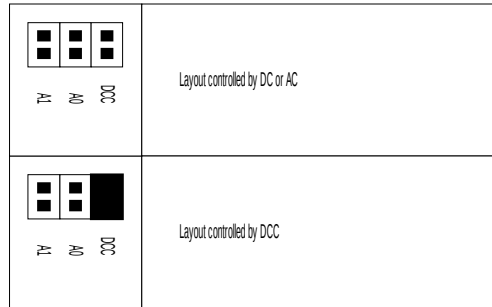
Figure 3-4 Train Control System Selection

Finally, you may need to consider the signaling system you have, if any. The three grade crossing blocks have to be detected separately by the GCC. Just as with the prototype railroads, these blocks may also be a part of your signaling system. There are six different signaling block arrangements that the GCC can directly support. Each form depends on the location of a single signaling block boundary within the grade crossing scene. To select from among these choices, simply connect jumper wires to the connector as shown below.

3.1   SCENE TRACK CONFIGURATIONS

There are six track configurations supported by the GCC. The figures in the next few paragraphs show you how to identify your specific track configuration and set up the GCC to handle it.

3.1.1   Basic Scene without Signaling

If you don't have a signaling system, you can use the GCC in its simplest form. In this case, just connect the GCC to the two approach and one road block for train detection. This scene is shown in Figure 3-5 GC Scene without Signaling. For this case, you need not install any track configuration connections on the GCC connector.

West Approach   Road   East Approach

Grade Crossing Scene

Figure 3-5 GC Scene without Signaling

3.1.2   Grade Crossing Scene with Signaling

The GCC always handles primary detection of trains within the grade crossing scene. However, when the GCC is used with a train detection and signaling system, external detectors are used to monitor signaling blocks that overlap the scene. The external detectors must be merged with the GCC detection to give proper operation of both the grade crossing and the signaling system. The prototype does this, and we have to also. Because of functions performed by the GCC, it's not as difficult as you might imagine.

The next five paragraphs illustrate the different track configurations supported by the GCC. You need only select which track arrangement best describes your situation, and then connect a few wires to the GCC to get the job done.

The GCC has four outputs: VAC1, OCC1, VAC2 and OCC2. These outputs are used to output block status when the crossing scene blocks are merged with other, overlapping signaling blocks. These are open collector closure to ground outputs capable of carrying 200 milliamps when on, and withstanding 16 volts DC when off.

Depending on the signaling block arrangement, you will connect certain pins on the GCC connector. Make these connections using a small gauge wire, something between 22 and 30 gauge.

3.1.2.1 Grade Crossing Scene within a Single Signaling Block

With the signaling block arranged as shown in Figure 3-6 GC Scene Totally within One Signaling Block, you will provide detection gaps to divide the signaling block as shown below. If the signaling block boundary is immediately at the left end of the west approach, or the right end of the east approach, the either the small block X1 or X2, or both, will not exist at all.

Connect the "occupied" output of the external detectors, if any, to the X1 and X2 inputs. If either or both external blocks do not exist, connect nothing to the X1 and X2 inputs. This would be the situation if the signaling block were the same as the three-combined grade crossing blocks. In any case, the GCC will provide outputs VAC1 and OCC1 to indicate that the signaling block is vacant or occupied, respectively.
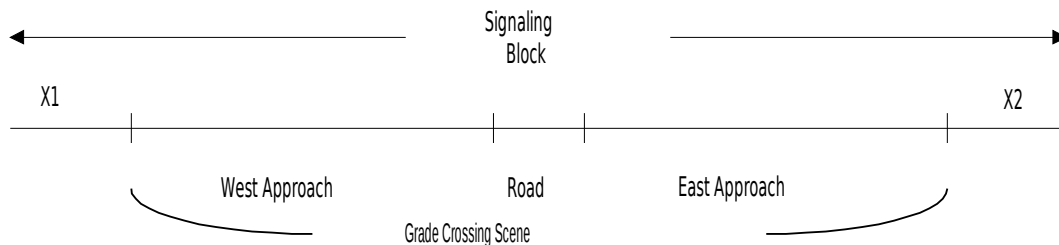
Figure 3-6 GC Scene Totally within One Signaling Block

To use this configuration, connect pins M and B on the connector.

3.1.2.2 Signaling Block Boundary in West Approach

This track configuration handles a signaling block boundary located within the west approach block for the grade crossing scene. In this case, there are three external detectors needed. Detectors X1 and X2 provide detection for the portions of signaling block 1 that appear outside and inside the west approach respectively. The GCC provides detection for the rest of the scene, all of which is contained in signaling block 2. External detector X3 provides detection for the portion of signaling block 2, if any, which exists outside the GC scene.
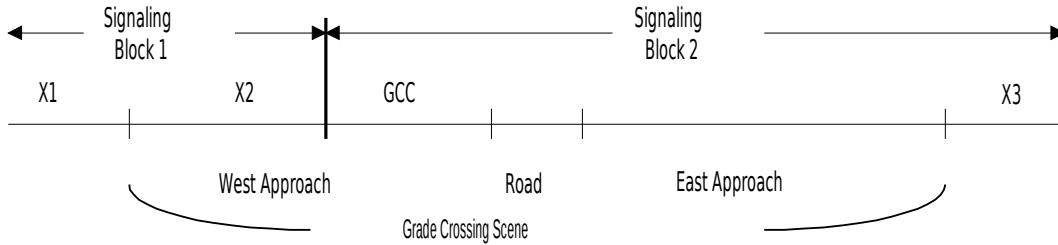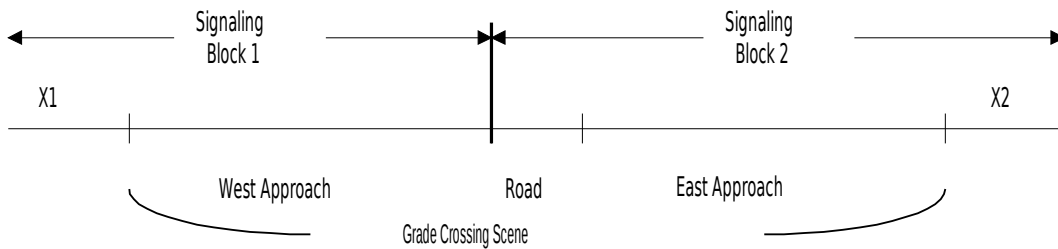
Figure 3-7 Signal Block Boundary in West Approach

To use this configuration, connect pins M and C on the connector.

The OCC1 and VAC1 outputs provide the occupied and vacant outputs for signaling block 1; OCC2 and VAC2 provide the occupied and vacant outputs for signaling block 2.

3.1.2.3 Signaling Block Boundary West of Road

This track configuration handles a signaling block boundary located at the West End of the road block in the GC scene. In this case, two external detectors are needed. Detector X1 detects the portion of signaling block 1 outside the west approach; detector X2 does the same for the portion of signaling block 2 which is outside the road and east approach blocks.

Figure 3-8 Signaling Block Boundary at West End of Road Block

To use this configuration, connect pins M, B and C on the connector.

The OCC1 and VAC1 outputs provide the occupied and vacant outputs for signaling block 1; OCC2 and VAC2 provide the occupied and vacant outputs for signaling block 2.

3.1.2.4 Signaling Block Boundary East of Road

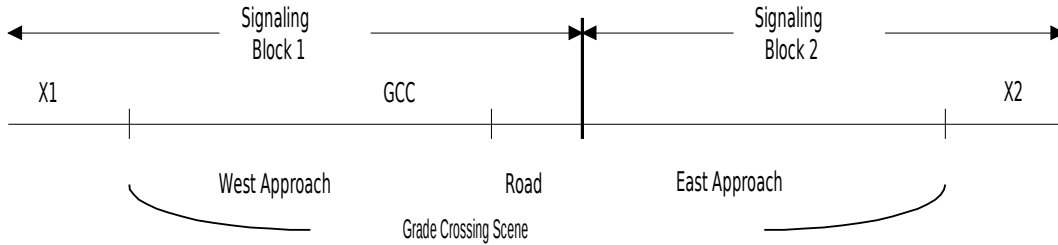This arrangement is very similar to the previous signaling track configuration. It works in the equivalent manner.
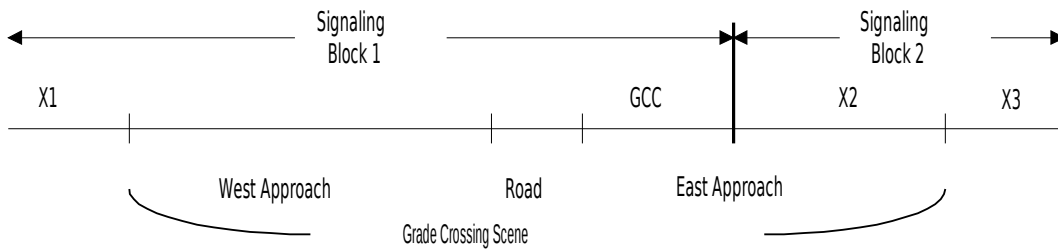
Figure 3-9 Signaling Block Boundary at East End of Road Block

To use this configuration, connect pins M and D on the connector.

The OCC1 and VAC1 outputs provide the occupied and vacant outputs for signaling block 1; OCC2 and VAC2 provide the occupied and vacant outputs for signaling block 2.

3.1.2.5 Signaling Block Boundary in East Approach

The final signaling block configuration has the signaling block boundary located in the east approach block. Again, three external detectors are required. X1 detects the portion of signaling block 1 that is outside the GC scene; X2 detects the portion of signaling block 2 that forms part of the east approach; X3 detects the portion of signaling block 2 that is outside the scene.

Figure 3-10 Signal Block Boundary in East Approach

To use this configuration, connect pins M, B and D on the connector.

The OCC1 and VAC1 outputs provide the occupied and vacant outputs for signaling block 1; OCC2 and VAC2 provide the occupied and vacant outputs for signaling block 2.

4.   INSTALLING YOUR GCC

Installation of your GCC is very simple. Very little wiring is required, and the instructions below should provide everything needed to get a normal system working perfectly.

There are a few electrical connections to make. Use a small soldering iron, no more than 40 watts. A 25-watt iron would be ideal. Remember that you only have to connect one end of one wire at a time. Do that enough times, and the installation is done! Even the pros that wire the space shuttle do it that way.

Figure 4-11 below shows how your GCC and related items will look when ready for installation. For your reference, the major items are identified individually. The action plug and its jumpers (item 4), the board activity indicators LED (item 2), and the bell volume control (item 3), are the only board mounted parts of interest to you.

Prior to installation, you will want to prepare the card edge connector (item 5) and the mounting hardware. We envision that you will mount the board to a flat surface, such as a piece of plywood or a 1x6, attached beneath your benchwork. You will find packed in a small bag the following hardware

- Pan-head #4-40 Stainless steel machine screws (2), item 9
- Stainless steel #4 flat washer (4), item 8
- Stainless steel #4 internal tooth lock washer (2), item 7
- Stainless steel #4 hex nut (2), item 6
- Angle brackets (2), item 11.
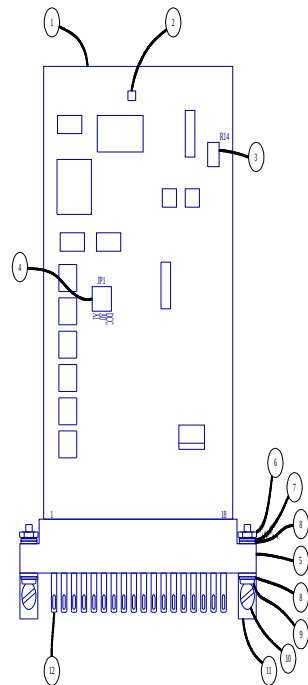
Figure 4-11 GCC Assembly and Parts

Also identified in this figure are some of the other items of interest:
- Action and Detection Header JP1 (item 4),
- Bell volume control R14 (item 3),
- Board activity indicator (item 2).

The action and detection header was illustrated in a prior figure. Add or remove the three jumpers provided to select the scene action and type of train control system.

The volume control is provided so you can adjust the level to any desired loudness. Use a small jeweler's screwdriver to change the setting. Turning clockwise increases the volume; turning counter-clockwise decreases the volume.

The board activity indicator is a LED which blinks about 2 times per second whenever power is applied to the GCC. If the LED is out completely, the power supply is either not connected, or the 5-volt supply on the board is shorted to ground by a connection to pin 16. If it is on, but not flashing, then the processor is not functioning. Turn off the power to the board by unplugging the AC adapter provided for about 10 seconds. Then plug it back in. If the LED still does not blink, the board may not be working. Please contact us to arrange for a repair.

4.1   Physical Installation of the GCC Board

Decide on a location to mount the GCC board. This will probably be near the grade crossing scene. We suggest that you mount the GCC on a flat surface, such as a 1x6 piece of pine about 8-12 inches long. Then, mount the pine to a bench leg or some other accessible location beneath your layout.

Figure 4-12 GCC Board Installation

Pin 9: Gate Motor Lower Output
Pin 8: Manual Gate Lower Input
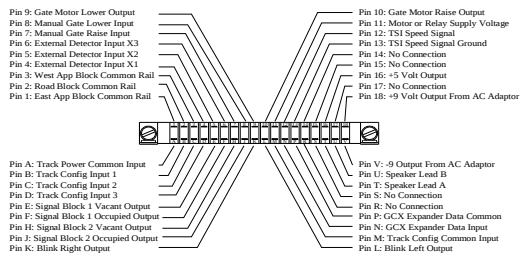Pin 7: Manual Gate Raise Input
Pin 6: External Detector Input X3
Pin 5: External Detector Input X2
Pin 4: External Detector Input X1
Pin 3: West App Block Common Rail
Pin 2: Road Block Common Rail
Pin 1: East App Block Common Rail

Pin 10: Gate Motor Raise Output
Pin 11: Motor or Relay Supply Voltage
Pin 12: TSI Speed Signal
Pin 13: TSI Speed Signal Ground
Pin 14: No Connection
Pin 15: No Connection
Pin 16: +5 Volt Output
Pin 17: No Connection
Pin 18: +9 Volt Output From AC Adaptor

Pin A: Track Power Common Input
Pin B: Track Config Input 1
Pin C: Track Config Input 2
Pin D: Track Config Input 3
Pin E: Signal Block 1 Vacant Output
Pin F: Signal Block 1 Occupied Output
Pin H: Signal Block 2 Vacant Output
Pin J: Signal Block 2 Occupied Output
Pin K: Blink Right Output

Pin V: -9 Output From AC Adaptor
Pin U: Speaker Lead B
Pin T: Speaker Lead A
Pin S: No Connection
Pin R: No Connection
Pin P: GCX Expander Data Common
Pin N: GCX Expander Data Input
Pin M: Track Config Common Input
Pin L: Blink Left Output

Figure 4-13 Card Edge Connector Pin Diagram

Make sure that you have adequate light and room to work. We all know it's often awkward and uncomfortable working under a layout. Try to make it as convenient as possible. Also, you will be making a number of connections to pins on the card edge connector. While each pin is labeled on the connector, they can be difficult to read in dim light, at a bad angle, with less than a fighter pilot's eyes.

To help with this, Figure 4-13 Card Edge Connector Pin Diagram is provided showing all of the pins, and identifying them for your convenience. Note that the top row of pins is numbered from 1 to 18. The bottom row are lettered as follows: A, B, C, D, E, F, H, J, K, L, M, N, P, R, S, T, U, and V.

Mounting hardware is provided with the GCC to give you all you need to install the board as described. Just mount the connector as shown in Figure 4-12 GCC Board Installation. When the wiring is done, plug in the GCC board with the components on the circuit board facing you, and you're done.

Figure 4-12 shows an optional barrier strip used to strain relief the four wires required to connect the GCC to the train running circuits. If the length of these wires is fairly short, less than about 5 or 6 feet, and your trains don't draw much current, less than an amp or so, you can probably wire the track circuits using 20 or 22 gauge wire. The connector pins can handle such wires. Make sure you install a strain relief of some kind near where the barrier strip is shown. This simple precaution will prevent damage to the connector if someone accidentally pulls on the wires. In fact, it is always good practice to provide a strain relief for wiring going to connectors. The strain reliefs are very cheap; connectors are very expensive and time-consuming to replace.

Most wiring to train tracks will be heavier and longer. Because the pins on the connector are limited to 20-gauge wire, you will need a convenient place to convert from the heavy track wires to short, small gauge wires that go to the connector. A barrier strip like this is a good, professional way to do it. A four-circuit barrier strip is available from many sources. One good example would be a product by Cinch-Jones called the model 4-140 Barrier Strip. It's available from Digikey (1-800-344-4539) for less than $2.00. You may not need this, or you may have other methods you prefer, but you are limited to 20-gauge wires to the connector.

4.2   Connecting the Detection Circuit to Your Layout

In most cases, connecting the GCC to your layout is very simple. The basic wiring diagram is shown in Figure 4-14 Basic Wiring of the GCC. As you can see, most of the wiring is connected to the crossbucks and gate motors.
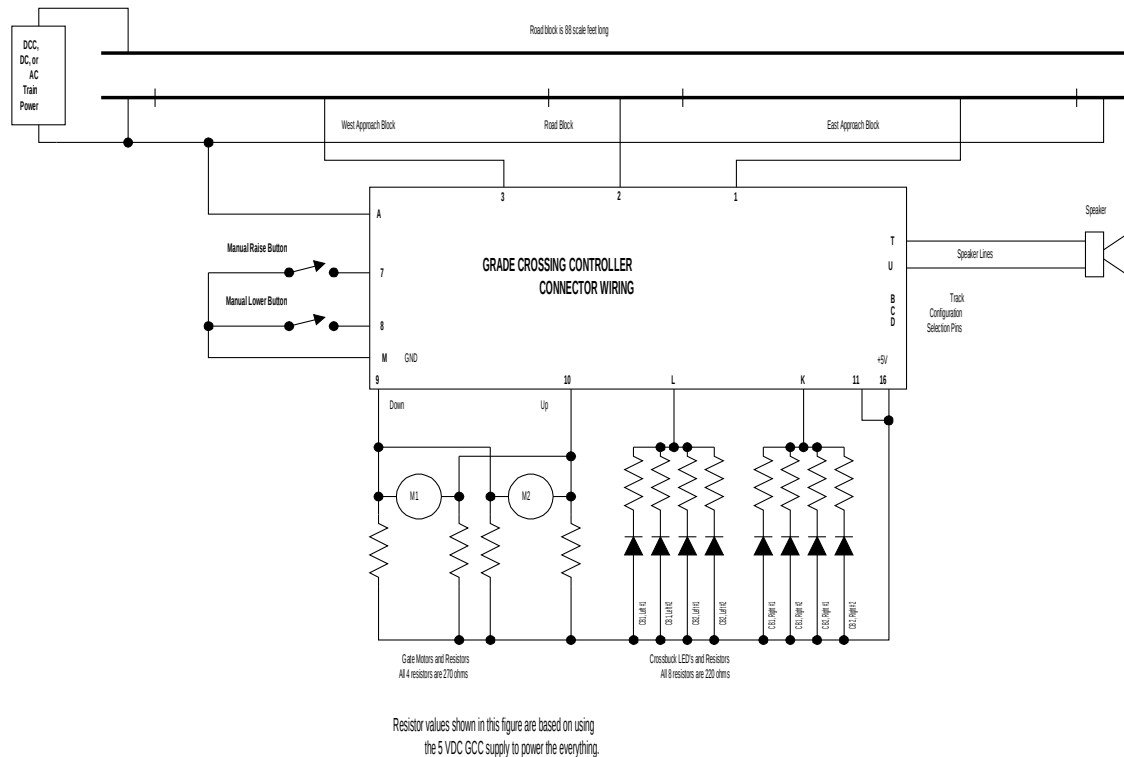
Figure 4-14 Basic Wiring of the GCC

Even if you are using some other brand of gates and crossbucks, your wiring will be very similar to this.

The first step is to wire the GCC detection circuits in to the track in your grade crossing scene. Based on the planning you did above, you will be electrically isolating one rail of the two approach blocks and the road block from the rest of the control wiring. Then, we will reconnect the three blocks, through the GCC detectors. We will do this one block at a time, and test as we go, to keep from creating any big problems.

Begin by isolating the three scene blocks. To do this, you will have to cut the four gaps in the common rail as shown above. Then disconnect the existing wires from these rails to isolate then from the rest of the layout. Incidentally, you may want to leave the feed wires connected to the rails, and just cut them off a few inches below the roadbed. Leave enough wire so you can use them to reconnect to the rail.

Test this step by trying to run a train through the scene. If it runs in any of the three scene blocks, then you have at least one feed wire still connected to the block. Keep looking for it until your train no longer runs in the three scene blocks, but <u>does</u> run everywhere else.

When the common rail has been isolated, connect all of the rail feeds for the east approach block together and then run a single wire to the GCC connector pin 1. Then test run a train through the scene. It should run only in the east approach block, and stop in the road block and west approach. You will need to plug the GCC board into the connector to run this test, but its power need not be turned on.

Repeat the process for the road block, connecting its common rail feed to pin 2. And finish by connecting the west approach common to pin 3. Test each of these blocks as you go. As each block is finished, your test train should run through the newly connected track.

4.3   Alternatives for Connecting to the Crossbucks

There are several different types of crossbucks available, and the GCC should be able to operate them all. Here are a number of alternative circuits for connecting to crossbucks if you can't use the method shown above.

4.3.1   Crossbucks with Bulbs

Some crossbucks are available with bulbs, both low voltage (1.5 volts) and "normal" voltage (12 volts). Incandescent bulbs can present a very high current surge when they first turn on. As the filament reaches operating temperature, the current drops to the value quoted in the spec sheet. These surges have to be controlled because they can damage the GCC output transistors. Or, if low voltage bulbs are powered from the 5-volt GCC supply, the turn-on surge can cause the power supply voltage to drop low enough that the circuitry resets and appears not to work.
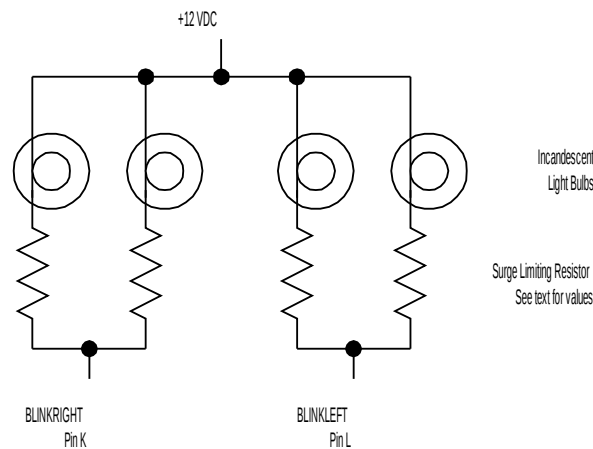

Figure 4-15 Crossbucks with Bulbs

In any case, be sure to use a surge-limiting resistor when using bulbs. This will protect the GCC outputs from damage, and will prolong the life of your bulbs. This is particularly important when using 12-volt bulbs with a 12-volt supply. For example, one typical grain of wheat bulb is rated 14-16 volts and will draw 30 milliamps. This means that, after the filament is hot, the bulb has an equivalent resistance of about 470 ohms. However, during the turn-on surge, the equivalent resistance may be as little as 50 ohms. This would give a turn-on surge of ¼ amp! Even one such bulb connected to a GCC output transistor without a surge-limiting resistor could cause damage. And the typical grade crossing would have at least two bulbs on at a time.

We recommend that you pick resistors values that will keep the total current per GCC output transistor to no more than 200 milliamps during the surge. Begin by determining the equivalent resistance of the bulb during normal operation. Simply divide the operating voltage by the operating current. If you can't find the operating current listed in the data sheet for the bulb, measure the current. Use a power supply of the correct voltage and an ammeter. Record the operating current, and calculate the equivalent resistance of the bulb.

Next, assume that the bulb turn-on resistance will be 1/10th of the normal resistance. For the example above, the turn-on resistance would be 1/10th of 470 ohms, or about 47 ohms. If you have only two bulbs on at a time, you will want to limit the current of each to 100 milliamps. To limit the current from a 12-volt supply to 100 milliamps, the circuit resistance should be 120 ohms (12 volts divided by 0.1 amps). The bulb will provide 47 of these ohms (in this example). Therefore, your surge limiting resistor should be 120 – 47 = 73 ohms. The nearest standard value would be either 68 or 75 ohms. We suggest that you pick the higher value.

This will not only limit the surge current at turn-on, but will increase the life of your bulbs significantly. The reduction in brightness will probably not be objectionable. Bulbs are normally too bright anyway!

Follow the above example for the bulbs you are using. Simply substitute the voltage and current rating for the bulb in the formulas and turn the crank to get the resistor values. Put one such resistor in series with each bulb, as shown in Figure 4-15.

4.4   Connecting to the Gate Drive

In addition to the 3-volt stall motor, provided with the TOMAR gates, there are other gate drive circuits that you can use to operate your gates. Our recommendations appear below.

4.4.1   Using the TOMAR Crossing Gates

Figure 4-14 specifically shows the wiring when used with the TOMAR model H-863 Crossing Gates (HO). Each gate has its own 3-volt stall motor. Each crossbuck has 4 LED's, two facing toward the track and two away. The box labeled "DCC, DC or AC Train Power" represents the system you use to operate your trains. Naturally, the figure does not show cab select switches or any of the other electrical hardware used in a DC or AC powered layout.


4.4.2   Using a 12 Volt Stall Motor

There are a number of 12-volt stall motors available that you could use to operate your gates. These motors are normally used to operate turnouts, and they will work well for many slow motion mechanisms.

In any case, the motor you use must operate with resistors as shown below. A slow speed motor that operates directly off a 12-volt supply without current limiting resistors cannot be used directly. Such a motor can be used, but you will need to operate it using a relay circuit shown in Figure 4-17 or Figure 4-18.

The stall motors we see in the hobby will typically use resistors of 1200 ohms resistance. They will work just fine in this circuit. IN NO CASE USE THIS CIRCUIT WITH RESISTOR VALUES LESS THAN 220 OHMS. For such cases, use the relay circuit to operate your motors.

You will have to determine the motor polarity that causes the gates to move up and down properly. Trial and error is good for this. And do the test with one motor at a time. Wire the circuit as shown, except for the connections to the GCC connector and between the motors. Turn on the 12-volt supply (not provided with the GCC), and use a test lead to connect the point labeled "GATES DOWN" to the negative output of the supply. If your gate moves down, connect that motor lead to GCC pin 9; if it moves up, connect it to GCC pin 10. Then, repeat these steps for the second motor.

+12 VDC

See text for
resistor values

Motor 1

Motor 2

MOTOR V
Pin 11

GATES DOWN
Pin 9

GATES UP
Pin 10
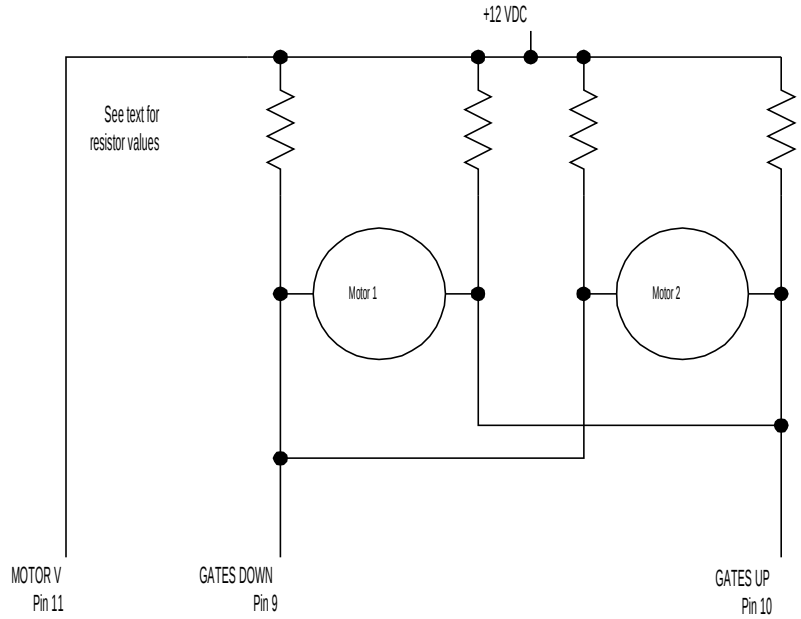
**Figure 4-16 High Voltage Stall Motor**

4.4.3   Relay Circuits for Operating Gate Mechanism

You may not want to use a low voltage/low current stall motor to operate your gates. Figure 4-17 shows a circuit that will work well in some other cases. The basic circuit uses a double-pole double-throw relay to operate the gate motors. The relay coil is connected to the GCC 'down' output, pin 9. When the gates are to be lowered, the GCC energizes the relay, and the relay contacts route the voltage to the motor with the proper polarity to lower the gates. When the GCC turns off the 'down' output, the relay releases, and the raise polarity is applied to the motor.

Without a stall motor, you will need switches to cut off the motor when the gates are either completely raised or lowered. You will need a separate switch for each end of the gate travel, since the contact must open only when the mechanism reaches the limit.

Figure 4-17 shows a single set of limit switches. We only recommend this approach if the same motor, through a mechanical linkage of some kind operates both gates. If this circuit with two motors, you have the risk that the slower motor will actuate the contacts, and the faster motor will travel too far before the contacts operate.

The most reliable solution, using two motors, would be to have separate limit switches on each gate mechanism. Each motor stops when its gate gets to the raised or lowered position, independent of the other gate.
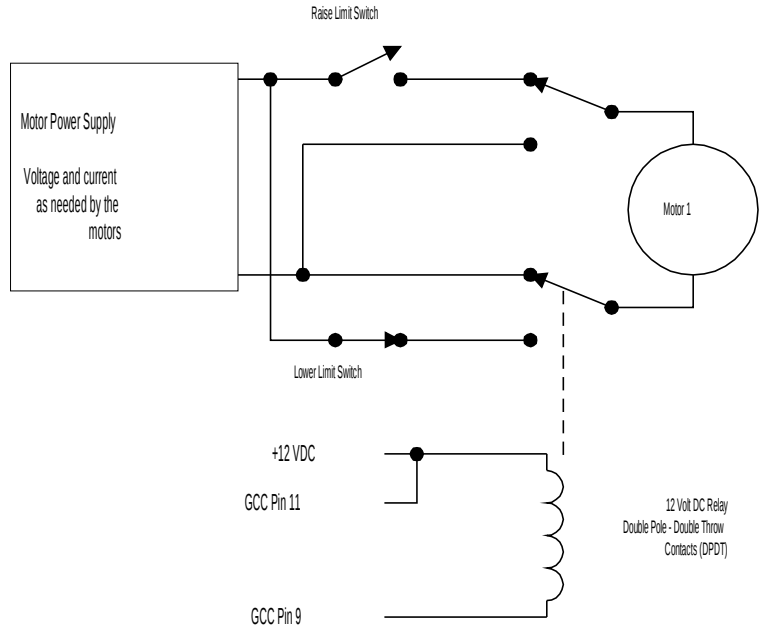
Figure 4-17 Relay Circuit for One Motor Drive

Shown below is the recommended circuit to be used with separate drive motors for each gate. It is superior to the preceding circuit because each mechanism automatically stops when its limits are reached. There is no chance of over-running the stops if switches connected to a slower motor are limiting a faster motor.
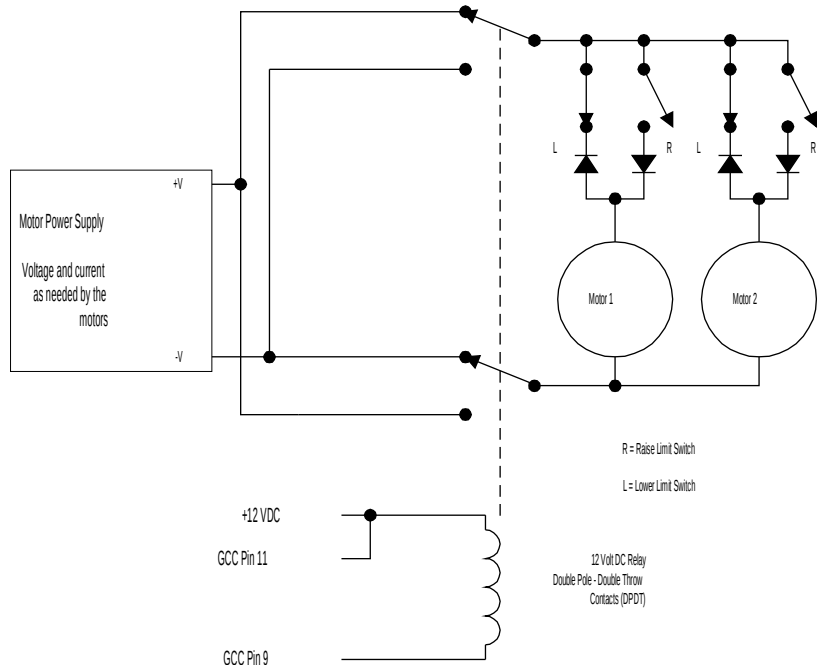
Figure 4-18 Relay Circuit with Independent Limit Switches

The circuit depicts the gate up position, and the two 'R' switches have just stopped the motors with the gates at the top. When the GCC energizes the relay to lower the gates, the polarity applied to the motors is reversed, and the

motor current passes through the 'L' switches and diodes until the gates reach the lowered position. Again, each gate stops when it is down, even if the other is still running.

4.5 Connecting to the Audio Speaker

Connecting your speaker is particularly simple. We recommend that you use a twisted pair cable of stranded wire, perhaps 18-22 gauge. There are no special limitations on the connection. Just hook it up as you would any stereo speaker.
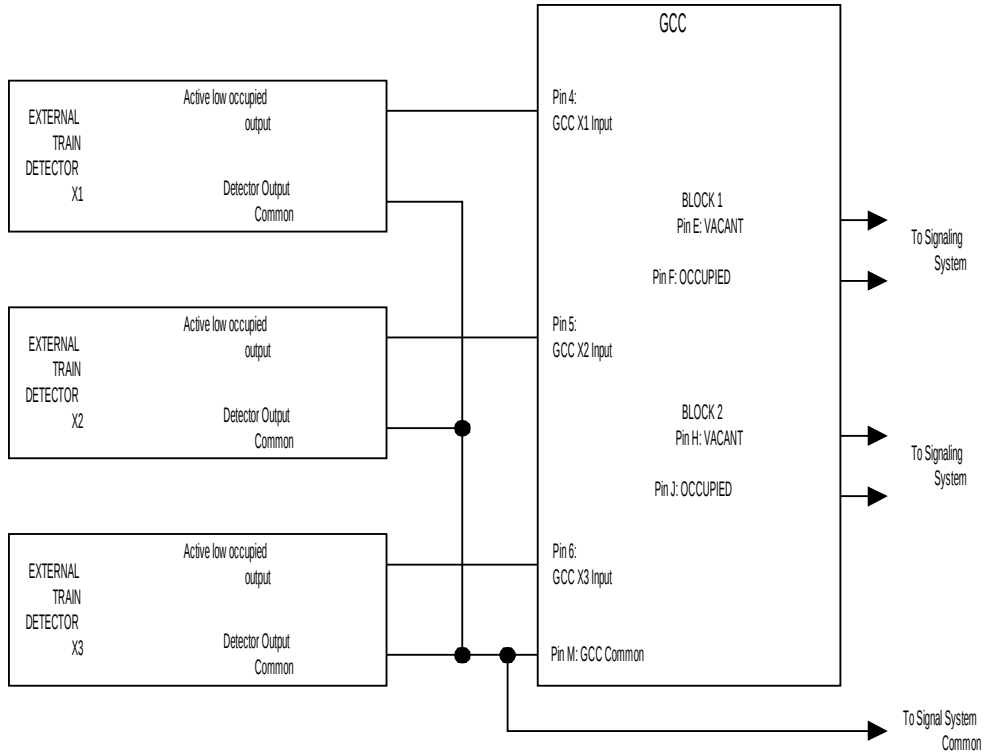
4.6 Connecting the Signaling System Outputs

Only a few additional wires are needed to connect the GCC to your signaling system. First, select the type of overlap you have between the grade crossing scene and your signaling blocks. Then, connect the proper jumpers as described in 3.1.2.

Next, connect the occupied outputs from the external detectors to the proper GCC inputs as shown below. Then, connect the GCC signaling outputs to the signaling system.

Simple, isn't it?

The external detectors need an output that is 0 volts when its block is occupied, and an open circuit or 5 volts when its block is vacant. Our line of Block Occupancy Detectors, the BD8 and BD16 handle 8 and 16 blocks each, respectively, will work perfectly; other block detectors may work as well. If you have something specific in mind that you would like to use, we'll be happy to look into it to see if it will work.

Figure 4-19 Connections to a Signaling System

4.7   TESTING YOUR GCC INSTALLATION

We thoroughly test each GCC before shipping it to you. If you have been connecting things, step by step, and described above, everything should be working.

Many of the tests will have been done as you work through the installation. For the final test, run a train. Start it outside the scene, and run it slowly through. The action should begin as soon as the engine enters the approach block. And the gates should begin to rise as soon as the train crosses the road. Watch closely to make sure that everything works properly. Take note of what doesn't and then go to the trouble-shooting section for additional help.

4.7.1   Trouble Shooting Suggestions

The step by step conversion and installation procedures described throughout this manual should help you avoid most problems, and quickly identify the rest as you go. The important thing is to make just one or two changes and see if everything is still working. If not, there is some problem with what you did since the last test. The more you do between tests, the harder it will be to locate the problem.

Another benefit of the do a little and test approach to this is that it helps you to build your confidence as you go. Success breeds success, and every time you see something that you did work right, no matter how simple or seemingly inconsequential, you will see that it's really not that difficult after all.

The next few paragraphs are a few additional suggestions for ways to prevent or at least identify problems.

4.7.1.1 The Train Doesn't Run Through Scene

Several simple things can cause this. First, have you turned on your train control system and is the GCC plugged in to its connector? These are obvious things to check.

If the train doesn't run in any of the GCC blocks, you may not have connected the train control common to pin A of the GCC. Or, you may not have connected the common rails from the 3 blocks to the pin 1, 2 and 3 inputs on the GCC.

Another possibility is that you still have one of your original common rail feed wires connected to the GCC detected blocks. In this case, the wire will cause the train running current to bypass the GCC.

If all else fails, go back to section 4.2 and follow the step-by-step procedure again.

4.7.1.2 The Crossbucks Don't Flash

If the gates and/or bell are working, then the crossbuck lights are probably not connected properly. If you are using LED's, check to see that they are connected with the right polarity. If you briefly connect a test lead from pin V to either pin K or L, you should see the LED's light properly.

If you are using the GCC 5-volt output (pin 16) to power your LED's, the GCC has to be turned on. Is the GCC activity LED, item 2 in Figure 4-11 GCC Assembly and Parts blinking? If not, then the GCC is not powered up, or there is a short to between pin 16 and one of the GCC common pins (13, A, M, P or V). Disconnect the power, unplug the GCC and test this with an ohmmeter.

Check to see that pin 16 is connected to the anodes of your LED's.

4.7.1.3 The Gates Don't Operate

If everything else is working (bell and crossbucks), but the gates don't operate, check the gate drive wiring you have used. There are several circuits provided above for this. The GCC lower output on pin 9 should be at 0 volts to cause the gates to descend. If necessary, temporarily connect a test lead between pin V and pin 9. If this doesn't get the gates to lower, check the wiring and power supply.

If the gates go down, but don't go up, then the raise output on pin 10 may not be connected. This is not a factor if you are using one of the relay circuits, because the gates should rise when the relay turns off. If the GCC turns off the relay properly, you probably have a wiring problem in the relay to motor wiring.

Perhaps the limit switches are open when they should be closed. Note that the switches should be open only when the motor reaches the desire up or down position. And only one switch should be open at that time.

4.7.1.4 The Gates Operate Backward

If the gates go up when they should go down, and vice versa, you may have connected pin 9 and pin 10 backward. Or, the motors may have been wired in the wrong polarity. Check the wiring and repeat the up-down test described in section 4.4.

4.7.1.5 Standing Trains are Not Detected

This may be a problem if you are using DC or AC to operate your trains. With these control systems, the track voltage is zero to stop the train. And current through the GCC detection circuits may not be taking place.

As long as your throttles do not short the rails together, you can use a low current AC source to cause a small voltage to be present even when the throttles are off. The circuit below will often solve the problem.

Typically, the resistors would be 5K to 10K ohms, ¼ watt. One such resistor should be connected to the power rain in every block with train detection.

This circuit is not needed when you are using DCC or other forms of command control. If you are, make sure that the command control power station or booster is on and putting out power to the track.
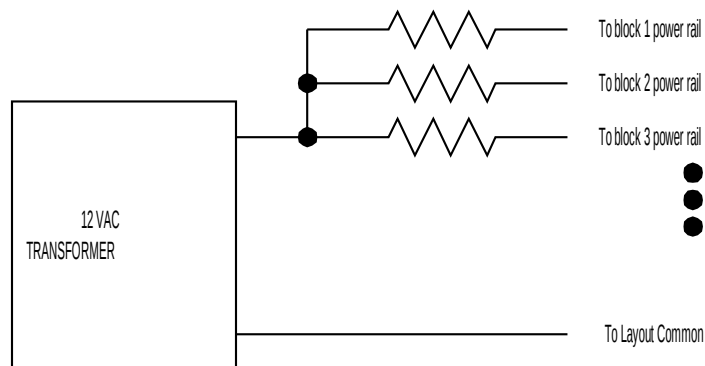

Figure 4-20 Standing Train Detection Circuit

4.7.1.6 Manual Raise and Lower Don't Work

The manual raise and lower circuit is simply two push-button switches, or the equivalent. Check the wiring shown in Figure 4-14.

Also, the raise and lower functions only work while a train is in an approach block. If no train is present, or if the train is in the road block, the manual controls won't function. This is designed in to the circuit. Pull a train into an approach block, and try the raise and lower buttons again. If they're wired correctly, they will be working.

4.7.1.7 Action Starts When Train Reaches Road

If the action only starts when the train reaches the road block, check the wiring of the approach block. Also, if you are using the GCC with a signaling system, check the track configuration wires to pins B, C and D. And, make sure that the external detectors are wired in correctly.

You may want to use a test lead and connect between pin V and the X1 (pin 4), X2 (pin 5) and X3 (pin 6) inputs as appropriate. When you do, you simulate an occupied signal from the external detector. If the action starts this way, then check the external detector wiring and the detector itself. Also, the detector output common, perhaps called a "ground" connection, must be wired to the GCC pin M. If this connection is missing, the external detector output will not be seen by the GCC.

4.7.1.8 External Signaling Operates Incorrectly

First, check to see that the external detectors are connected to the proper GCC inputs. Then, make sure that you are using the proper GCC outputs. Look at Figure 4-19 and make sure that you have wired things in this way.

4.7.1.9 When All Else Fails

When you have done everything you know how to do, and have followed the installation and test suggestions in this manual, and still things aren't working, please contact us. We will do all we can to help solve the problem.

We have always been able to help our customers get everything working properly. We'll help you, too.

5.   CUSTOMER SUPPORT

We understand that many model railroaders have limited experience or training in electronics, and may be somewhat apprehensive about installing train detection and signaling systems. Our goal is to make our expertise available to those in the hobby who could benefit. We are doing this by developing products, and associated manuals, which take care of as many of the details as possible, and explain clearly how you can finish your installation and enjoy the additional operational features that are now possible.

If you have questions, or recommendations, please write. We will do our best to help you get the most satisfaction available from your investment in your GCC.

5.1   TECHNICAL ASSISTANCE

We are available to provide reasonable assistance to help you get the greatest possible benefit from the GCC Grade Crossing Controller. Feel free to write to us with any questions or comments you may have. Please enclose a large SASE if you are expecting a reply. We will do our best to clear up any issues you may raise about the use of the GCC.

We welcome any suggestions you may have for improvements to the GCC, or for any related products you would like to see available. All such recommendations will be considered as we plan our future product offerings.

You can write to us at:

> The Signaling Solution, Inc.
> PO Box 37
> Shelburn, IN 47879
> VOICE: 812-533-1047 (9-4 edt)
> FAX: 708-570-6140

5.2   LIMITED WARRANTY

Your satisfaction with your new GCC is our primary concern. The GCC Grade Crossing Controller is warranted free of defects in materials and workmanship for a period of 90 days from date of purchase. This does not cover damage due to misuse-use, improper installation, or connection to excessive voltages or currents. We will, at our option, repair or replace any defective unit.

The GCC Grade Crossing Controller is further warranted for 30 days to perform in a satisfactory manner when connected as described in this manual. Should you feel that your GCC is not performing as you would expect, simply write to us, describing your difficulty. Tell us what you expect of the GCC, and how it appears to fall short. If we cannot clear up any problems you have, we will refund your full purchase price upon return of your GCC in good working order.

Naturally, we cannot be responsible for units that have been damaged by misuse-use, improper installation or connection.

OTHER SIGNALING
AND LAYOUT CONTROL
PRODUCTS WE SUPPLY

> BD16 Block Occupancy Detector for 16 blocks
> BD8 Block Occupancy Detector for 8 blocks
> MSC Master Signal Controller
> GCC Grade Crossing Controller
> GCX Grade Crossing Expander
> Detectable Wheel Sets
> Signal Mounting Adapters
> TOMAR Signals, switch stands, crossing gates and flashing cross bucks
> Sunrise signals for N-scale and HO-scale
> Oregon Rail Supply signals and signal kits

And our new CLICS™ System

COMPLETE LAYOUT INTEGRATED CONTROL SYSTEM