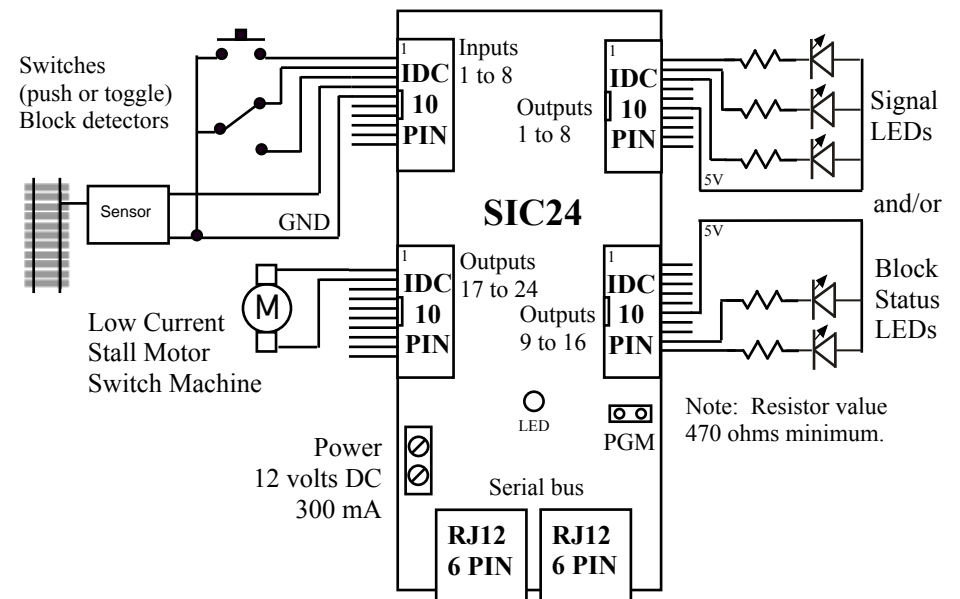# SIC24
Signal & Indicator Controller

> Control signals on your layout
> Control indicators on your layout or CTC panel
> Eight inputs for sensors
> 24 outputs to drive LEDs
> "Smart" Programming with self programming
> Simple inter-board wiring

Switches
(push or toggle)
Block detectors

Inputs
1 to 8

IDC 10 PIN

Outputs
1 to 8

IDC 10 PIN

Signal
LEDs

5V

Sensor

GND

SIC24

and/or

5V

Block
Status
LEDs

Outputs
17 to 24

IDC 10 PIN

IDC 10 PIN

Outputs
9 to 16

Low Current
Stall Motor
Switch Machine

Note: Resistor value
470 ohms minimum.

LED

PGM

Power
12 volts DC
300 mA

Serial bus

RJ12 6 PIN

RJ12 6 PIN

04.12.05

LocoNet is a trademark of Digitrax Inc.
Tortoise is a trademark of Circuitron.

1 Introduction

The SIC24 (Signal and Indicator Controller) is uniquely suited to control various types of signals and indicators on a layout or a CTC panel. It can be used as a signal controller, to indicate block occupancy and turnout position, and as a grade crossing gate controller with flashing signals. Combinations of some of these features are also possible. The SIC24 is compatible with most DCC systems.

Control signals on your layout
• Built-in logic for automatically controlling signals using block detection
• Configurable to model many signaling systems
• Control SE8C signals
• Computer not required

Control indicators on your layout or CTC panel
• Block detection
• Turnout status
• Crossing gate and flashers

Provides 24 outputs
• Drives up to eight 3 LED signal heads with common anode or common cathode
• Drives Bi-color LED searchlights with 2 or 3 leads.
• Drives Tortoise^{TM} switch machines for turnout control
• Drives Tortoise^{TM} switch machines for semaphore signal control including the middle yellow aspect.

Provides 8 inputs
• For local turnout control.
• For occupancy sensors
• For turnout feedback sensors

Simple inter-board wiring
• Serial bus reduces system wiring
• Digitrax LocoNet® compatible

Simple basic setup
• Built-in setup configuration options
• "Smart Programming" in conjunction with self programming

The SIC24 sends and receives switch command, switch position feedback and sensor/block detection messages. It uses these same type messages to communicate between multiple SIC24s and to determine signal states. Since all communication is done over a serial bus, the number of wires to implement a signal system is greatly reduced. The serial bus is based on Digitrax's LocoNet® and some features are unique to a Digitrax system. However, a Digitrax DCC system is not required for operation or programming. The SIC24 is compatible with LocoNet® block detectors such as the Digitrax BDL16 or detectors connected to its inputs such as the Team Digital DBD2 and the RR-CirKits BOD.

The block diagram on the front page shows the general features with examples of various input and output devices.

2 Getting Started

You can start using the SIC24 without doing any programming. The SIC24 comes from the factory programmed to implement up to a four block Automatic Block Signaling (ABS) system. If you want to use the SIC24 for some other signal or indicator arrangement, go to section 3 "Smart Programming" to see if there is a setup that meets your requirements. If there is not a setup that does exactly what you want, go on to section 4 Operation and section 5 Configuration Variables to learn how the SIC24 works and program your custom implementation.

To start using the SIC24 for an ABS system, you will need to connect block sensors to the inputs and LEDs to the outputs. Connect up to four block sensors to the first four inputs. Connect as many LEDs for the number of blocks you will be using starting with output number 1. Each LED requires a resistor as shown in the diagram on the front page. The relationship between the signal LED and the SIC24 output number is shown in figure 2. The color LED location used in the signals in figure 2 is shown in figure 1. See section 6 Connections for hooking up power and the relationship between input and output number and the SIC24 pin number.

In this application the output of the block detector connected to the SIC24 must go low indicating the block is occupied. If you are using Team Digital's DBD2 for block detectors, see its manual for connecting to the SIC24.

3 "Smart" Programming

"Smart" Programming is a term used to describe a method to program Configuration Variables (CVs) using switch addresses instead of requiring a calculation to determine the CV value. Consequently, the programming task become much easier. In "Smart" Programming you use the throttle just like you normally would to select and send switch commands. There is no need to go into the Page Service Mode to program each CV. Choose a setup based on your track plan and proceed through the steps. When you send a switch command with the throttle, the SIC24 records the step and gives an acknowledgment with a LED flash. You can watch the progress of the steps during the setup process. LEDs with appropriate resistors need to be connected to the first six outputs of the SIC24. As each step is completed that LED will be lit. At the end of the sixth step, enter the number of the setup you want the SIC24 to implement. After the two flash acknowledgment there is a pause as the logic is calculated and the CVs programmed. After successful completion, the LED flashes one time. If you decide to start over, just select 'c' option on the last step. The LED will flash five times and you are ready to try again.

There are some limitations. "Smart" Programming with the setup steps can not be used to program every possible track configuration. If a certain setup does not exactly match your track plan, you can always use the setup and then modify or change any of the CVs.

The outputs of the SIC24 are numbered 1 to 24. See section 6 Connections for the relationship between the connector, the connector pin number, and the output number. The base address is the address assigned to output 1. The rest of the addresses sequentially follow the output numbers. See the diagram on the front page for connector location.

Before using "Smart" Programming" determine which setup you want to use. This requires determining the base address, various other addresses, number of blocks and use of inputs.

To use "Smart" Programming:
1. With power off, connect the programming terminal (PGM) pins together.

2. Apply power. If you are programming via DCC, connect to the track, otherwise connect the DC power supply. Note: The SIC24 responds to switch commands from any source. Be sure the throttle you are using is the only one sending these commands.

3. Use the throttle to select the switch number which is the base address. Depending on the setup you have selected, send the switch command by selecting either the 't' (throw) or 'c' (close) option. If there are LEDs connected, the first LED will light.

4. Continue to select the switch number that is appropriate for the step you are on and execute the step with either the 't' or 'c' option until you have completed all the steps. **If the step is not used or you need to skip the step, select 'c' to execute the step. The switch number does not matter in this case.**

5. After the final LED flash, remove power and disconnect the programming terminal (PGM) pins. You are now ready to apply power and start operation.

Figure 1 shows the color location of each LED as used in setups with vertical signals. The 3 color signal is used to show block occupancy status and the dual aspect signal to show siding switch position. All setups program the SIC24 for use with common anode LEDs except setup 5.
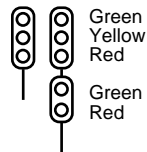
Green
Yellow
Red

Green
Red

Figure 1

Note: If common cathode LEDs are connected to the outputs, then these LEDs will initially be on and turn off as you progress through the steps. For convenience in programming set option 4 in CV2 when using common cathode LEDs. See section 5.2

NCE ProCab users: This document uses 'c' (close) and 't' (throw) which is equivalent to 'N' (nornal) and 'R' (reverse) respectively.

3.1 Setup 1 - Block Signal
This setup implements up to four blocks of 3 vertical aspect signals using ABS logic. The SIC24 comes pre-programmed with setup 1 implemented with a base address of 101 and four blocks numbered 1 to 4. Figure 2 shows the block arrangement and how the signal LEDs are assigned to and wired to each output. Figure 3 shows the assigned address of each output. SIC24s are designed to work together by knowing information about each other. This is done with the output address. If you are going to use more than four blocks the address of the red LEDs for both the west and east block signals are required. These addresses are the output addresses of the other SIC24s used for those blocks.
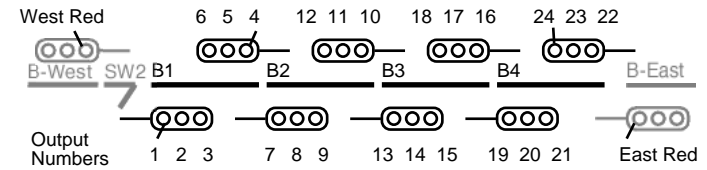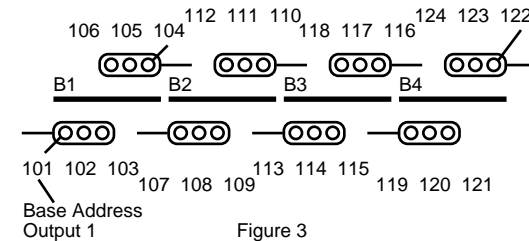
West Red   6 5 4   12 11 10   18 17 16   24 23 22

B-West SW2 B1   B2   B3   B4   B-East

Output
Numbers   1 2 3   7 8 9   13 14 15   19 20 21   East Red

Figure 2

106 105 104 112 111 110 124 123 122
             118 117 116

B1   B2   B3   B4

101 102 103 113 114 115 119 120 121
       107 108 109

Base Address
Output 1   Figure 3

Block Signal Setup			
Step	Description	t option	c option
1	Base address of outputs Enable output messages is required	enable output messages	disable output messages
2	Address of first block Enable inputs if they are connected to block sensors Input 1 is assigned to the first block	enable inputs	disable inputs
3	Number of blocks Maximum of 4	accept	accept
4	Address of west red signal ahead of first block	accept	don't use
5	Address of east red signal following last block	accept	don't use
6	Address of switch 2 of siding (see setup 2)	accept	don't use
7	Setup number = 1	accept	start over

As an example of how SIC24s are connected together using output addresses, lets look at setting up signals for seven blocks. This requires two SIC24s. Figure 4 shows how they could be assigned and the table shows how each could be programmed. Notice that SIC24 - 1 is given information about SIC24 - 2 in step 5 and SIC24 - 2 is given information about SIC24 - 1 in step 4. In this example the SIC24 inputs are enabled for block sensors.

\	Example of 7 block "Smart" programming	
Step	SIC24 - 1	SIC24 - 2
1	101 t	125 t
2	1 t	5 t
3	4 t	3 t
4	1 c - don't use	122 t
5	125 t	1 c - don't use
6	1 c - don't use	1 c - don't use
7	1 t	1 t

Figure 4

If you are going to use this setup 1 with the siding setup 2, the switch number for switch 2 is required in step 6. The position of switch 2 determines the signals for blocks 1 and 2 as a function of the mainline or the siding. See setup 2 for more information. If an address is entered for switch 2 in step 6 then when switch 2 is thrown, block 1 east signal will be red.

3.2 Setup 2 - Block Signal With Siding

This setup implements a two block mainline with a single block siding of 3 vertical aspect signals.   Figure 5 shows the block arrangement and how the signal LEDs are assigned to and wired to each output. If you are going to use more mainline blocks the address of the red LEDs for both the west and east block signals are needed. These addresses are the output addresses of the other SIC24s used for those blocks. See setup 1 to add more blocks. Switch 1 and 2 are required to have sequential numbers. When you enter the address for switch 1, say 50, then switch 2 is assigned 51. The switch position determines how the signals respond. In general if the switches are closed then block 3 occupancy determines their color. It they are thrown, then block 2 occupancy determines their color.

In Digitrax systems when a switch is thrown from the throttle, a switch type message appears on the serial bus and the SIC24 reponds accordingly. However, if you want to know switch position at power on, if moved manually or in non-Digitrax systems, you will need a micro switch attached to the switch mechanism or switch machine contacts connected to a SIC24 input. See the example a the end of this section for programming CVs.

The SIC24 with setup 2 does not control the two LEDs in the lower head. They need to be controlled from the switch machine moving the switch, a micro switch connected to the switch mechanism (could be the same mentioned above) or another SIC24.

| Block Signal with Siding Setup			
Step	Description	t option	c option
1	Base address of outputs Enable output messages is required	enable output messages	disable output messages
2	Address of first block Enable inputs if they are connected to block sensors Input 1 is assigned to the first block	enable inputs	disable inputs
3	Number of blocks Maximum of 3	accept	accept
4	Address of west red signal ahead of first block	accept	don't use
5	Address of east red signal following last block	accept	don't use
6	Address of switch 1 of siding	accept	accept
7	Setup number = 2	accept	start over
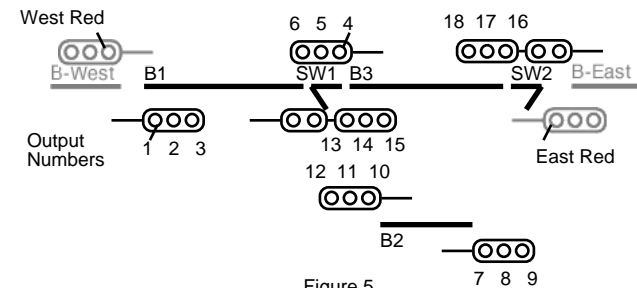
Figure 5

By using two SIC24s, you can have signals for up to six main line blocks and one siding. Implement setup #2 in one SIC24 and setup #1 in the other. Figure 6 shows how they work together and the table shows an example of how they could be programmed. It is important to note that a SIC24 always uses an address space of 24 regardless if all outputs are used or not.

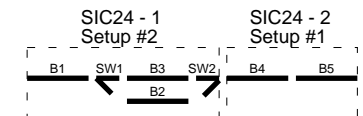| \	Example of siding "Smart" programming	
Step	SIC24 - 1	SIC24 - 2
1	101 t	125 t
2	1 t	4 t
3	3 t	2 t
4	1 c - don't use	116 t
5	125 t	1 c - don't use
6	50 t	51 t
7	2 t	1 t

Figure 6

Example of CV values if using a micro switch or switch machine contacts connected to SIC24 inputs. Use inputs 5 and 6 for switches #50 and #51 respectively. Program the CVs as follows. See section 5.4 for input control CV specifics.

For input 5   For input 6   Note: input goes hi, switch close message sent
CV 30 = 50   CV 35 = 51   input goes low, switch thrown message sent
CV 31 = 0   CV 36 = 0
CV 32 = 3   CV 37 = 3

3.3 Setup 3 - Block Occupancy Indication

This setup implements up to 24 blocks of occupancy indication with one LED indicator per block. An output is on if the block is occupied. Output 1 is assigned the first block address and the rest of the outputs are sequential block addresses up to the number of blocks. If the inputs are connected to block sensors, input 1 is assigned the first block address. Up to eight input can be used. Since there is no logic needed to indicate block occupancy, logic-cell status output messages are not needed and can be disabled in step 1. In this case the base address can be any number.

You can also choose to have two indicator LEDs per block. Perhaps red to show occupied and green to show unoccupied. The maximum number of blocks is now 12. Odd numbered outputs will be on when the respective block is occupied otherwise even numbered outputs will be on. In this setup, outputs are set to drive common anode type LEDs, see figure 11. If you want to use common cathode LEDs see section 5.6 to find out have to set the outputs for common cathode.

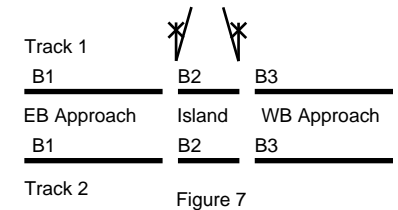|	Block Occupancy Indication Setup		
Step	Description	t option	c option
1	Base address of outputs Disable output messages is recommended	enable output messages	disable output messages
2	Address of first block Enable inputs if they are connected to block sensors Input 1 is assigned to the first block	enable inputs	disable inputs
3	Number of blocks Maximum of 12 or 24 based on step 4 8 inputs available	accept	accept
4	Number of indicator LEDs per block (1 or 2)	accept	N/A
5	Not used	skip	skip
6	Not used	skip	skip
7	Setup number = 3	accept	start over

3.4 Setup 4 - Grade Crossing

This setup implements a three block grade crossing with one or two tracks. The signal, bell and delayed gate lowering are initiated upon entering an approach. When the island is cleared the signal and bell stop and the gate is raised. The capability to activate two bell sounds is provided. Bell 1 is activated when the approach block is occupied and bell 2 takes over when the island block is occupied. See figure 7 for the approach and island arrangement.

For proper operation the approach block must be occupied as long as the train is in it or the signal flashing will not work correctly. This can be achieved if each train is not longer than the approach block or the train has enough resistive wheels sets. Also, the approach block must be occupied when the island block becomes occupied. Bell 2 operation for the island block will not work correctly if a train enters the island block and then backs up leaving the island block. Bell 2 also requires the inputs to be used for block sensors because secondary messages are utilized. See section 5.4 to learn about input control and secondary messages.

All logic cells are used to implement the grade crossing logic. However, most of the logic cell outputs are unused except for those controlling the flashing LEDs, crossing gate motor, and bells. There are also two outputs connected to inputs as part of the logic. These inputs are in addition to the inputs used as block sensors. To change the gate lowing delay, change the value in CV 196. See section 5.6 on what values to use.

Output connections: (see section 5.6 Output Control to learn how to flash LEDs)
outputs 17 & 18 normal flash LEDs, outputs 19 &20 reciprocal flash LEDs
outputs 21 & 22, crossing gate motor - 22 is opposite polarity for motor
output 23, bell
output 24, bell 2 - island activated
output 8 to input 7, for track 1 operation of bell 2
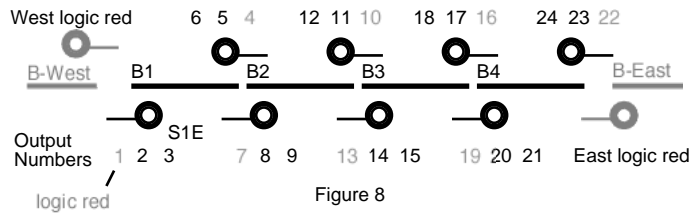output 16 to input 8, for track 2 operation of bell 2

Track 1
B1   B2   B3
EB Approach   Island   WB Approach
B1   B2   B3

Input connections:
inputs 1 thru 3, track 1 B1 thru B3 block sensors
inputs 4 thru 6, track 2 B1 thru B3 block sensors

Track 2   Figure 7

	Grade Crossing Setup		
Step	Description	t option	c option
1	Base address of outputs Enable output messages is required	enable output messages	disable output messages
2	Address of first block - Track 1 Inputs must be enabled and connected to block sensors for bell 2 operation Input 1 is assigned to the first block	enable inputs	disable inputs
3	Number of blocks Enter 3	accept	accept
4	Address of first block - Track 2 Input 4 is assigned to the first block	accept	don't use
5	Number of bells sounds (1 or 2)	accept	N/A
6	Not used	skip	skip
7	Setup number = 4	accept	start over

3.5 Setup 5 - Block Signal, Searchlight

This setup implements up to four blocks of searchlight signals using ABS logic. Figure 8 shows the block arrangement and how the signal LEDs are assigned to each output. This setup assumes common cathode LEDs. Only two outputs are connected to LEDs since bi-color LEDs are used. The lower numbered output of the two is connected to the red section of the LED and the other connected to the green section. So for signal S1E, output 2 is connected to red and output 3 connected to green. However, as in setup 1, **each signal is associated with three outputs.** Even though output 1 is not connected to S1E, it is still used internally as part of the logic. This output is the 'logic red' and its address is used in connecting SIC24s together as explained in section 3.1. Each signal has a 'logic red' output which is the dimmed number shown in figure 8. To implement searchlight signals for more than four blocks see the example in section 3.1.

Figure 8

Block Signal (Searchlight) Setup			
Step	Description	t option	c option
1	Base address of outputs Enable output messages is required	enable output messages	disable output messages
2	Address of first block Enable inputs if they are connected to block sensors Input 1 is assigned to the first block	enable inputs	disable inputs
3	Number of blocks Maximum of 4	accept	accept
4	Address of west 'logic red' signal ahead of first block	accept	don't use
5	Address of east 'logic red' signal following last block	accept	don't use
6	Not used	skip	skip
7	Setup number = 5	accept	start over

4 Operation

The SIC24 has 24 outputs. Each output can drive an LED and can be assigned a specific function. For signal control, a three color aspect signal will require three outputs if each aspect is to be individually controlled. Typical signal control is based on some set of rules or logic to turn each LED on. Consequently, some logic is required to turn on and off each output. In order to accomplish this, the SIC24 has a logic cell that controls each output. The logic cell determines if it's output will be on or off. When the logic cell is true the output is on. When it is false the output is off. The logic cell contains three logic elements, A, B and C. When all the logic elements are true, the logic cell is true and the output is on. Otherwise, the logic cell is false and the output is off. Each logic element can be assigned to be a block state, a switch state or a signal state. The concept of the logic cell allows the SIC24 to drive a variety of signal types. See figure 9 for a diagram of a basic logic cell.
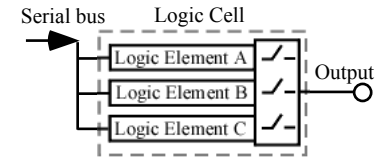

Figure 9

An illustration of Automatic Block Signaling (ABS) using a three color aspect signal can show how the logic cell works. For any given direction, when a block is occupied its signal is red and the following block signal is yellow if the following block is not occupied. If neither of the blocks is occupied, then the signal is green.

Here is a simple example of ABS block signal logic using B and S to represent block and signal respectively. B2 is the block after B1. That is, the train is traveling from B1 to B2.

S1 is red when B1 is occupied.
S1 is yellow when S2 is red and S1 is not red.
S1 is green when S1 is not yellow and not red.
S2 is red when B2 is occupied.

Six outputs of the SIC24 are assigned for the two signals. Three outputs for each signal. Each output driving an LED.
Output 1 – S1R – signal one red
Output 2 – S1Y – signal one yellow
Output 3 - S1G – signal one green
Output 4 – S2R – signal two red
Output 5 – S2Y – signal two yellow
Output 6 – S2G – signal two green

A logic cell controls each output. So each logic cell is configured to cause the output to respond to the conditions as defined above. When all logic elements that have been defined are true, the logic cell is true and the output is turned on lighting the LED. The following shows how each logic element is defined.

Logic Cell 1 (output 1, S1R)
  Logic element A – B1 occupied
  Logic element B – NU
  Logic element C – NU
Logic Cell 2 (output 2, S1Y)
  Logic element A – output 1, S1R not on
  Logic element B – output 4, S2R on
  Logic element C - NU
Logic Cell 3 (output 3, S1G)
  Logic element A – output 1, S1R not on
  Logic element B – output 2, S1Y not on
  Logic element C - NU

Logic Cell 4 (output 4, S2R)
  Logic element A – B2 occupied
  Logic element B – NU
  Logic element C - NU
Logic Cell 5 (output 5, S2Y) **
  Logic element A – NU
  Logic element B – NU
  Logic element C - NU
Logic Cell 6 (output 6, S2G)
  Logic element A – output 1, S2R not on
  Logic element B – output 2, S2Y not on
  Logic element C - NU

** this output is not used in this example

Each of the SIC24 outputs is assigned an address, so whenever an output changes state a sensor type serial bus message is sent with the address and state. So a logic cell can use the logic state of an output as part of its logic.

Some of the logic cells in the above example required more than one logic element to achieve the desired response. Both the conditions for element A AND element B had to be met before the output was on. As in the case of Logic Cell 2 (output 2, S1Y) in order for it to be true (on), output 1 had to be false (NOT on) and output 4 had to be true (on). These two elements are combined by AND logic. All three logic elements can be combined with one of four different logic schemes. The four combination are A OR B OR C, (A OR B) AND C, (A AND B) OR C and A AND B AND C.

An additional feature provides for control of the output. The output can be controlled so that when the logic cell is true the output is on, has a delayed turn on, is inverted or flashes. See figure 10 for a diagram of the complete logic cell with output control. It is important to note that when the logic cell tells the output to be on, that simply enables the output control to define what the output actual does. For example, it the output control is set to flash, the output will flash when the logic cell is true. The logic cell does not cycle from true to false each time the output flashes. The same holds true for a delay. The logic cell output is not delayed, only the output itself.
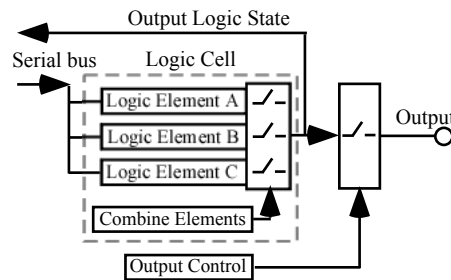

Figure 10

In some cases three logic elements in each logic cell may not be enough to implement the required logic. In these cases the logic cell of one or more unused outputs can be utilized for addition logic capability.

The SIC24 has eight inputs. Each input can be configured to send a switch command, switch position feedback or sensor/block detection serial bus message. The inputs are compatible with many stand-alone block detectors with noise filtering. Each input can be configured to send a message on a rising, a falling or a change of state signal.

Unique signal schemes can be implemented using the SIC24 by connecting outputs to inputs, particularly if an input is configured to send a message on a rising or falling state.

Digitrax's SE8C has a unique address to each of it's signals. One of the SIC24 configuration options enables one of these unique addresses to be sent whenever a logic cell goes true. Thus, using it's built in logic the SIC24 can turn on and off SE8C signals in much the same way as it controls it's own outputs.

The SIC24 does have limitations. It can not handle every possible signal scheme as a PC computer can. However, it does provide for signal and indication versatility with its logic capability.

5 Configuration Variables (CVs)

The SIC24 may be programmed via DCC by connected it to the programming track or via the serial bus (LocoNet) using a Digitrax system or the LN Programming Tool available for down load at Team Digital's web site. For normal operation a DC power supply is used. See section 6.

The SIC24 supports **Paged Mode in Service Mode Programming** and **Operations Mode Programming** (not available when connected to the track). To program in Paged mode, first connect the programming terminal (PGM) pins together (the supplied shorting bar can be used) with power off. Then connect power, either from the programming track or from the DC power supply when using LocoNet®. Each time a CV is programmed successfully, the LED will flash . Also, if any LEDs are connected to outputs 1 to 8 will flash. To enter normal operation, remove power and then the connection between the programming (PGM) pins and connect to the DC power supply.

When using LocoNet® in Paged Service Mode the programming track is not used. This means there won't be an actual decoder on the programing track and some systems may give a "nothing on track" error. That is OK. The SIC24 intercepts the throttle's LocoNet® messages to the command station to execute the programming commands. To program in Ops mode, the ops address must be set (non zero) and Configuration Option 1 must be enabled. Ops mode programming allows you to program logic cells without using the programming terminal pins and turning power off and on.

Programming CV3 with 170 will "reset" all CVs from 9 and above to a value of zero. Programming CV3 with 160 will "reset" all CVs to the factory value which implements a four block ABS signal system as show in figure 3. Some CVs require a calculation to determine their value because they contain information relating to several other CVs. To avoid these calculations use "Smart" programming section 3 or use the LN Programming Tool.

5.1 SIC24 Address
These CVs determine the base address. Each of the 24 logic cells are assigned a sequential address starting with the base address. If the base address is 101, than the address of logic cell one is 101 and the address of logic cell 24 is 124. See figures 2 and 3 to see the relationship between the output number and address. Whenever a logic cell changes state, a sensor type message is sent with it's address. The SIC24 is pre-programmed with CV1 set to 101 and CV 9 to zero.

CV1 - Base address, value 1 to 255   CV9 - Address adder, value 0 to 9
Address = value of CV1 + address adder

Note: A SIC24 always uses an address space of 24 regardless if all outputs are used or not.

If an address greater than 255 is needed then use the address adder. The following table shows the CV value to use for the adder.
Example: Address of 101, set CV1 = 101 & CV9 = 0
Address of 901, set CV1 = 133 & CV9 = 3

Address Adder										
CV value	0	1	2	3	4	5	6	7	8	9
Add	0	256	512	768	1024	1280	1536	1792	2048	2304

5.2 Configuration
This CV determines the configuration which consists of several options.
CV2 - Configuration, value 0 to 10

Option 1 - Ops Mode Programming. Allows Operations mode programming to be performed.
Option 2 - Output message control. Disable the sending of logic cell output state messages. In some cases like block occupancy indication these messages are not needed.
Option 3 - SE8C signal message control. Enable the sending a switch type message when ever a logic cell goes true. This allows the SIC24 to control a SE8C.
Note: Option 2 and 3 are mutually exclusive. Option 2 inhibits option 3.
Option 4 - Common cathode LEDs. Allows the four second lamp check at power on and "Smart Programming" LED step indication to work correctly when common cathode LEDs are used. This is for convenience only and does not effect the output control of the logic cells.

Configuration CV	Value	Select
All options cleared	0	
Option 1 - enable ops mode programming	1	
Option 2 - disable sending logic cell state messages	2	
Option 3 - enable sending SE8C signal addresses when a logic cell goes true	4	
Option 4 - common cathode LEDs	8	
CV value		

To combine any of the options, add their values together. Options 2 and 3 can not be set at the same time. Also there is no need for option 4 if option 3 is used.
Example: Set options 1 and 3
To calculate the value of CV2, add up the values. CV2 = 1 + 4 = 5

5.3 Operations Mode Address
These CVs determine the ops mode address.
CV5 - Address, value 1 to 255   CV6 - Address adder, value 0 to 9
Address = value of CV1 + address adder
If an address greater than 255 is desired then use the address adder. See the table in section 5.1 for the CV value to use for the adder.
Example: Address of 100, set CV97 = 100 & CV98 = 0
Address of 900, set CV97 = 132 & CV98 = 3

5.4 Input Control
These CVs determine how each of the inputs respond when activated. There are five CVs for each input. See section 7 for CV numbers.

The following table shows how each CV is defined and the value of each selection. Add the value of the selections together to determine the value to program the CV. In some cases only one of several selections are possible and are shown by a box as "Select one".

Input Control		
Primary Address CV	Value	Select
Address	0 - 255	
CV value		
Primary Type CV	Value	Select
Invert the normal state	128	Select
Normal state	0	one
Message type, sensor	32	Select
Message type, feedback type (actual switch position)	16	
Message type, switch(commanded switch position)	0	one
Address adder (see the address adder table for amount to add)	0 - 9	
CV value		
Transition CV	Value	Select
Send primary message on both edges	3	Select
Send primary message on falling edge	2	
Send primary message on rising edge	1	one
Disable primary message	0	
Send secondary message on both edges	12	Select
Send secondary message on falling edge	8	
Send secondary message on rising edge	4	one
Disable secondary message	0	
CV value		
Secondary Address CV	Value	Select
Address	0 - 255	
CV value		
Secondary Type CV	Value	Select
Invert the normal state	128	Select
Normal state	0	one
Message type, sensor	32	Select
Message type, feedback type (actual switch position)	16	
Message type, switch(commanded switch position)	0	one
Address adder (see the address adder table for amount to add)	0 - 9	
CV value		

When an input transition occurs one or two messages can be sent. There is a primary and secondary message for each input. Two CVs for each message determine the message address and the type of message. The transition CV determines if a message will be sent and what transition will initiate the message.

When a block detector is connected to an input, a sensor type message is normally sent on both a rising and falling edge. Most block detectors compatible with the SIC24 go low when the block is occupied. The input control must be programmed to send a hi (true) sensor type message when the input is low. This means the input control must be inverted from the normal state. As an example lets determine the value of the input control CVs for block 1 using the table.

*Primary Address CV = 1
*Primary Type CV = 160 (Invert normal state = 128, sensor message = 32, 128 + 32 = 160)
*Transition CV = 3   (Send primary message on both edges = 3)
*Secondary Address CV = 0
*Secondary Type CV = 0

As another example lets say you want to close switch (turnout) number 60 when block 1 becomes occupied, but do nothing with the switch when the block becomes unoccupied. The secondary address can be used for this. The switch address is 60, the transition is set to falling edge (block becomes occupied) with state inverted (send a true when input is lo) and switch type message. The input control CV values are now the following.
*Primary Address CV = 1
*Primary Type CV = 160
*Transition CV = 11   (Send primary message on both edges = 3, Send secondary message on falling edge = 8, 3 + 8 = 11)
*Secondary Address CV = 60
*Secondary Type CV = 0

The largest number you can have for the address is 255. In some cases the address of a switch or logic cell may be greater than 255. In these cases the address adder has to be used to go beyond the 255 limit. The value of the Address adder CV can be any number from 0 to 9. Select the value based on the amount you want to add to the address from the table in section 5.1.

Tip: To send a message with a true (close or hi) state when the input goes false (low), use the invert normal state selection. See above example.

Note: An input transition is when the voltage on a input goes from high to low (falling edge) or from low to high (rising edge). Example - If a push button is connected to an input and ground when it is pressed the input is grounded. This causes a high to low transition. When the button is released this causes a low to high transition.

5.5 Logic Cell

These CVs determine how each of the logic cells are defined. There are six CVs for each cell. See section 7 for CV numbers. Two CVs for each logic element. See figure 10 for a diagram of the logic cell. Each logic element has an address CV and a type CV which determine the address, type and state of the message that will cause the element to be true. When the SIC24 receives a message that matches the element definition, the element is true. The element will stay true until a message matches the element definition with the opposite state. The element will then be false. All three elements do not have to be used. An element is not defined and thus not used when it's address is zero. If only element A is used, the logic cell will be true and it's output on when element A is true.

Logic Combination	B Logic	C Logic
A OR B OR C	OR	OR
(A OR B) AND C	OR	AND
(A AND B) OR C	AND	OR
A AND B AND C	AND	AND

Logic elements B and C can be combined with logic element A in AND and OR logic combinations by using the logic selection in elements B and C. When the logic combination is satisfied, the logic cell is true.

The following tables show how each of the logic elements are defined and the value of each selection. Add the value of the selections together to determine the value to program the CV. In some cases only one of several selections are possible and are shown by a box as "Select one".

Logic Element A		
Element Address CV	Value	Select
Address	0 - 255	
CV value		

Element Type CV	Value	Select	
State, true (close or hi)	64		Select
State, false(NOT true) (throw or low)	0		one
Message type, sensor	32		Select
Message type, feedback type (actual switch position)	16		
Message type, switch(commanded switch position)	0		one
Address adder (see the address adder table for amount to add)	0 - 9		
CV value			

Logic Element B		
Element Address CV	Value	Select
Address	0 - 255	
CV value		
Element Type CV	Value	Select
Logic, AND	128	Select
Logic, OR	0	one
State, true (close or hi)	64	Select
State, false(NOT true) (throw or low)	0	one
Message type, sensor	32	Select
Message type, feedback type (actual switch position)	16	
Message type, switch(commanded switch position)	0	one
Address adder (see the address adder table for amount to add)	0 - 9	
CV value		

Logic Element C		
Element Address CV	Value	Select
Address	0 - 255	
CV value		
Element Type CV	Value	Select
Logic, AND	128	Select
Logic, OR	0	one
State, true (close or hi)	64	Select
State, false(NOT true) (throw or low)	0	one
Message type, sensor	32	Select
Message type, feedback type (actual switch position)	16	
Message type, switch(commanded switch position)	0	one
Address adder (see the address adder table for amount to add)	0 - 9	
CV value		

Lets look at some examples to see how to use the logic cells. We want output 1 to turn on a LED when block 1 becomes occupied. When block 1 become occupied a hi (true) type sensor message is sent. When this condition happens logic cell 1 must be true in order to make output 1 turn on. So we will set logic element A to respond to this condition. From the table the CV values are as follows.
Logic element A
*Element Address CV = 1
*Element Type CV = 96 (true state = 64, sensor message = 32, 64 + 32 = 96)

Going on, lets say we also want output 1 to turn on the LED when switch (turnout) number 61 is thrown. When switch 61 is thrown a throw (false) type switch message is sent. When this condition happens logic cell 1 must be true in order to make output 1 turn on. So we will set logic element B to respond to this condition. From the table the CV values are as follows.
Logic element B
*Element Address CV = 61
*Element Type CV = 0 (OR logic = 0, false state = 0, switch message = 0, 0 + 0 + 0 = 0)
In summary, when block 1 is occupied OR switch 61 is thrown, turn on output 1.

Note: Switch commands from the throttle only appear on the serial bus in a Digitrax system.

Now lets control logic cell 2 as a result of logic cell 1 and block 2. From section 5.1 we saw that the base address of the SIC24 sets the address of the logic cells. In this example the address of logic cell 1 has been set to 101. We want logic cell 2 to be true when logic cell 1 is false AND block 2 is occupied. Logic element A will be used to respond to the state of logic cell 1 and logic element B will be used to respond to the state of block 2. From the table the CV values are as follows.
Logic element A
*Element Address CV = 101
*Element Type CV = 32 (false state = 0, sensor message = 32, 0 + 32 = 32)

Logic element B
*Element Address CV = 2
*Element Type CV = 224 (AND logic = 128, true state = 64, sensor message = 32, 128 + 64 + 32 = 224)
In summary, when output 1 is off AND block 2 is occupied, turn on output 2.

Warning: When defining logic cells, be very careful not to create infinite loops (recursive). Otherwise various unexplained problems will occur. For example, if one of the elements is assigned the same address as it's output.

Now lets see how to control a low current stall type switch machine. We will give it an address of 60. Each machine requires two output logic cells with each motor terminal connected to an output. To implement a motor drive, program one of the logic cells with a address so it is true (close). Program the other logic cell with the same address so it is false (throw). Now the motor moves one way or the other depending on the state of the received message. From the table the CV values are as follows:
Logic cell 10 - Logic element A (the logic cell numbers are arbitrary)
*Element Address CV = 60
*Element Type CV = 96 (true state = 64, sensor message = 32, 64 + 32 = 96)

Logic cell 11 - Logic element A
*Element Address CV = 60
*Element Type CV = 32 (false state = 0, sensor message = 32, 0 + 32 = 32)

5.6 Output Control
This CV determines how the output will respond when the logic cell is true. There is an output control CV for each logic cell. See section 7 for CV numbers.

The following table shows how each output control is defined and the value of each selection. Add the value of the selections together to determine the value to program the CV. In some cases only one of several selections are possible and are shown by a box as "Select one".

Output Control			
Output Control CV	Value	Select	
Invert the normal state, for common cathode	128		Select
Normal State	0		one
Bi-color, phase 2	96		Select
Bi-color, phase 1	32		
Bi-color not used	0		one
Effect, dynamic flash	24		Select
Effect, flash	16		
Effect, delay	8		one
No effect	0		
Reciprocal or alternate (use with flash effect only)	4		
duration of time, use with effect (see the duration table)	0 - 3		
CV value			

The normal state for the outputs is to drive common anode LEDs. If you want to use common cathode type signals select the invert normal state. Do not use the invert normal state with two lead bi-color LEDs.

Bi-color LEDs with two leads require two outputs as shown in figure 11. Set one of the output control CVs to phase 1 and the other to phase 2. This gives the SIC24 the ability to display three colors.
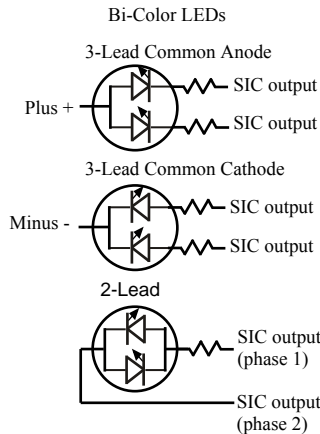
There are two types of flash effects. Flash causes the output to flash whenever the logic cell is true. Dynamic flash works only with logic element C. If the logic cell is true due to either logic element A or B the output will be on. If logic element C becomes true then the output will flash. This can be used to implement a flashing yellow aspect signal.

The delay effect causes the output to delay turn on once the logic cell is true. This can be used to delay the grade crossing gate lowering from the time the flashers start.

Reciprocal is used only with the flash effect to cause two outputs to flash alternately. Both outputs have to be selected to flash with the same duration. One of the outputs is selected for reciprocal. This can be used for grade crossing flashers.

Bi-Color LEDs

3-Lead Common Anode — SIC output / SIC output (Plus +)

3-Lead Common Cathode — SIC output / SIC output (Minus -)

2-Lead — SIC output (phase 1) / SIC output (phase 2)

Figure 11

The duration of time works only when one of the effects is selected. It determines the flash rate and delay time. See the table to get the value for selection based on the time.

Duration of Time		
Value	Flash	Delay
0	.5 sec	5 sec
1	1 sec	10 sec
2	2 sec	20 sec
3	4 sec	40 sec

5.7 Logic Cell Factor for SE8C Address
This CV determines the SE8C address assigned to the first logic cell.
CV7 - Factor, value 0 to 23
The value of this CV is multiplied by 12 to give a block of 12 SE8C addresses. The SE8C uses sequential pairs of switch addresses to control it's outputs. The switch state, throw or close, is used to differentiate between two of its outputs with the same address. When a logic cell becomes true a SE8C switch message is sent. Each logic cell is assigned to one of the SE8Cs outputs. So a SIC24 can control up to 24 sequential SE8C outputs. If the value of this CV = 0, than logic cell 1 is assigned the first SE8C address which is 257. Configuration Option 3 must be set to enable this feature.
Note: A SE8C output is used here to indicate one LED.

6 Connections

6.1 Power
The power connector is non polarized. Either terminal can be connected to plus or minus. The power supply should provide 12 volts DC with at least 300ma of current. When using the programming track, track power provides the power.

6.2 Input Interface
The normal or default state of each input is at 5 volts when no device is connect. This is a hi or true state. When the input is connected to ground by a push button switch or block sensor the state is low or false. A voltage higher than 5 volts must not be applied to an input.

6.3 Output Drive
The output supplies about 5 volts to drive LEDs and other low current devices such as low current stall type switch machines. The SIC24 has been tested with a Tortoise™ switch machine which can be used for a switch machine or a semaphore drive.

6.4 10 PIN Input and Output
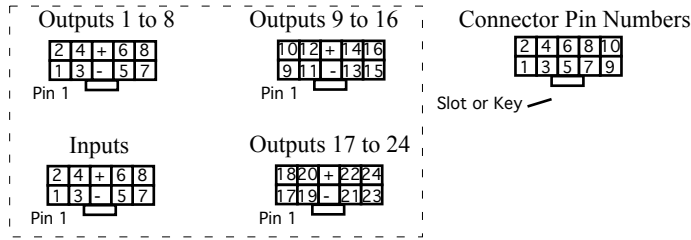Input and output connectors are flat ribbon cable Insulation Displacement (IDC) type. They have the same pin definitions. Jameco #32491 will work as the mating connector. See the diagram on the front page for connector location.
Warning: Do not connect the power supply ground (minus) to the ground (minus) pin of the 10 pin IDC connector. Do not connect any outputs together or to other SIC24 outputs.

Conn --------- Outputs 1 to 8 ------------ --------- Outputs 9 to 16 -----------
Pin # 1 2 3 4 5 6 7 8 9 10   1 2 3 4 5 6 7 8 9 10
Output# 1 2 3 4 - + 5 6 7 8   9 10 11 12 - + 13 14 15 16

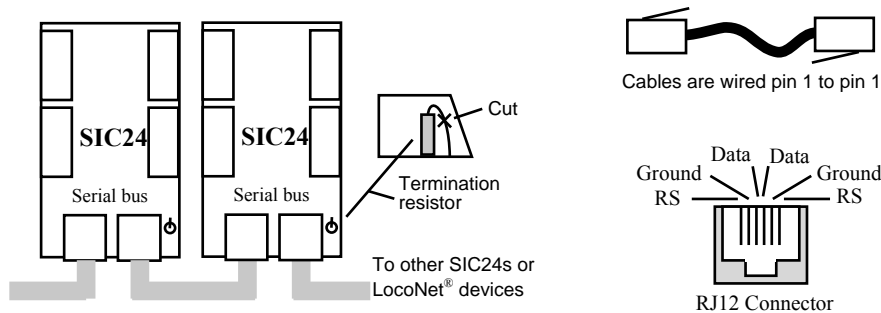Conn -------------- Inputs --------------- --------- Outputs 17 to 24 ----------
Pin # 1 2 3 4 5 6 7 8 9 10   1 2 3 4 5 6 7 8 9 10
Input# 1 2 3 4 - + 5 6 7 8   Output# 17 18 19 20 - + 21 22 23 24

Top view of connectors

Outputs 1 to 8   Outputs 9 to 16   Connector Pin Numbers
2 4 + 6 8   10 12 + 14 16   2 4 6 8 10
1 3 - 5 7   9 11 - 13 15   1 3 5 7 9
Pin 1   Pin 1   Slot or Key

Inputs   Outputs 17 to 24
2 4 + 6 8   18 20 + 22 24
1 3 - 5 7   17 19 - 21 23
Pin 1   Pin 1

6.5 Serial Bus

The SIC24 has two RJ12 connectors for ease in making connections as shown below. In a Digitrax system the data pins are LocoNet® and the RS pins are Rail Sync. RS is not used by the SIC24. In non-Digitrax systems when more than 10 SIC24s are used the bus terminating resistor should be cut on any additional SIC24s. In Digitrax systems the resistor is not required and may be cut.

SIC24   SIC24   Cut
                                      Termination resistor
Serial bus   Serial bus
                        To other SIC24s or
                        LocoNet® devices

Cables are wired pin 1 to pin 1

Data   Data
Ground   Ground
RS   RS

RJ12 Connector

7 Summary of Configuration Variables

CV#	Function	CV#	Function
1	Base Address	52	Logic Cell 1 - Logic Element B Address
2	Configuration	53	Logic Cell 1 - Element B Type
3	Manufacturer Version No.	54	Logic Cell 1 - Logic Element C Address
4	Manufacturer ID	55	Logic Cell 1 - Element C Type
5	Ops mode address	56	Logic Cell 1 - Output Control
6	Ops mode address adder	57	Logic Cell 2 - Logic Element A Address
7	Logic Cell factor for SE8C address	58	Logic Cell 2 - Element A Type
8	Reserved	59	Logic Cell 2 - Logic Element B Address
9	Address Adder	60	Logic Cell 2 - Element B Type
10	Input 1 Control - Primary Address	61	Logic Cell 2 - Logic Element C Address
11	Input 1 Primary Type	62	Logic Cell 2 - Element C Type
12	Input 1 Transition	63	Logic Cell 2 - Output Control
13	Input 1 Secondary Address	64	Logic Cell 3 - Logic Element A Address
14	Input 1 Secondary Type	65	Logic Cell 3 - Element A Type
15	Input 2 Control - Primary Address	66	Logic Cell 3 - Logic Element B Address
16	Input 2 Primary Type	67	Logic Cell 3 - Element B Type
17	Input 2 Transition	68	Logic Cell 3 - Logic Element C Address
18	Input 2 Secondary Address	69	Logic Cell 3 - Element C Type
19	Input 2 Secondary Type	70	Logic Cell 3 - Output Control
20	Input 3 Control - Primary Address	71	Logic Cell 4 - Logic Element A Address
21	Input 3 Primary Type	72	Logic Cell 4 - Element A Type
22	Input 3 Transition	73	Logic Cell 4 - Logic Element B Address
23	Input 3 Secondary Address	74	Logic Cell 4 - Element B Type
24	Input 3 Secondary Type	75	Logic Cell 4 - Logic Element C Address
25	Input 4 Control - Primary Address	76	Logic Cell 4 - Element C Type
26	Input 4 Primary Type	77	Logic Cell 4 - Output Control
27	Input 4 Transition	78	Logic Cell 5 - Logic Element A Address
28	Input 4 Secondary Address	79	Logic Cell 5 - Element A Type
29	Input 4 Secondary Type	80	Logic Cell 5 - Logic Element B Address
30	Input 5 Control - Primary Address	81	Logic Cell 5 - Element B Type
31	Input 5 Primary Type	82	Logic Cell 5 - Logic Element C Address
32	Input 5 Transition	83	Logic Cell 5 - Element C Type
33	Input 5 Secondary Address	84	Logic Cell 5 - Output Control
34	Input 5 Secondary Type	85	Logic Cell 6 - Logic Element A Address
35	Input 6 Control - Primary Address	86	Logic Cell 6 - Element A Type
36	Input 6 Primary Type	87	Logic Cell 6 - Logic Element B Address
37	Input 6 Transition	88	Logic Cell 6 - Element B Type
38	Input 6 Secondary Address	89	Logic Cell 6 - Logic Element C Address
39	Input 6 Secondary Type	90	Logic Cell 6 - Element C Type
40	Input 7 Control - Primary Address	91	Logic Cell 6 - Output Control
41	Input 7 Primary Type	92	Logic Cell 7 - Logic Element A Address
42	Input 7 Transition	93	Logic Cell 7 - Element A Type
43	Input 7 Secondary Address	94	Logic Cell 7 - Logic Element B Address
44	Input 7 Secondary Type	95	Logic Cell 7 - Element B Type
45	Input 8 Control - Primary Address	96	Logic Cell 7 - Logic Element C Address
46	Input 8 Primary Type	97	Logic Cell 7 - Element C Type
47	Input 8 Transition	98	Logic Cell 7 - Output Control
48	Input 8 Secondary Address	99	Logic Cell 8 - Logic Element A Address
49	Input 8 Secondary Type	100	Logic Cell 8 - Element A Type
50	Logic Cell 1 - Logic Element A Address	101	Logic Cell 8 - Logic Element B Address
51	Logic Cell 1 - Element A Type	102	Logic Cell 8 - Element B Type

CV#	Function	CV#	Function
103	Logic Cell 8 - Logic Element C Address	160	Logic Cell 16 - Element C Type
104	Logic Cell 8 - Element C Type	161	Logic Cell 16 - Output Control
105	Logic Cell 8 - Output Control	162	Logic Cell 17 - Logic Element A Address
106	Logic Cell 9 - Logic Element A Address	163	Logic Cell 17 - Element A Type
107	Logic Cell 9 - Element A Type	164	Logic Cell 17 - Logic Element B Address
108	Logic Cell 9 - Logic Element B Address	165	Logic Cell 17 - Element B Type
109	Logic Cell 9 - Element B Type	166	Logic Cell 17 - Logic Element C Address
110	Logic Cell 9 - Logic Element C Address	167	Logic Cell 17 - Element C Type
111	Logic Cell 9 - Element C Type	168	Logic Cell 17 - Output Control
112	Logic Cell 9 - Output Control	169	Logic Cell 18 - Logic Element A Address
113	Logic Cell 10 - Logic Element A Address	170	Logic Cell 18 - Element A Type
114	Logic Cell 10 - Element A Type	171	Logic Cell 18 - Logic Element B Address
115	Logic Cell 10 - Logic Element B Address	172	Logic Cell 18 - Element B Type
116	Logic Cell 10 - Element B Type	173	Logic Cell 18 - Logic Element C Address
117	Logic Cell 10 - Logic Element C Address	174	Logic Cell 18 - Element C Type
118	Logic Cell 10 - Element C Type	175	Logic Cell 18 - Output Control
119	Logic Cell 10 - Output Control	176	Logic Cell 19 - Logic Element A Address
120	Logic Cell 11 - Logic Element A Address	177	Logic Cell 19 - Element A Type
121	Logic Cell 11 - Element A Type	178	Logic Cell 19 - Logic Element B Address
122	Logic Cell 11 - Logic Element B Address	179	Logic Cell 19 - Element B Type
123	Logic Cell 11 - Element B Type	180	Logic Cell 19 - Logic Element C Address
124	Logic Cell 11 - Logic Element C Address	181	Logic Cell 19 - Element C Type
125	Logic Cell 11 - Element C Type	182	Logic Cell 19 - Output Control
126	Logic Cell 11 - Output Control	183	Logic Cell 20 - Logic Element A Address
127	Logic Cell 12 - Logic Element A Address	184	Logic Cell 20 - Element A Type
128	Logic Cell 12 - Element A Type	185	Logic Cell 20 - Logic Element B Address
129	Logic Cell 12 - Logic Element B Address	186	Logic Cell 20 - Element B Type
130	Logic Cell 12 - Element B Type	187	Logic Cell 20 - Logic Element C Address
131	Logic Cell 12 - Logic Element C Address	188	Logic Cell 20 - Element C Type
132	Logic Cell 12 - Element C Type	189	Logic Cell 20 - Output Control
133	Logic Cell 12 - Output Control	190	Logic Cell 21 - Logic Element A Address
134	Logic Cell 13 - Logic Element A Address	191	Logic Cell 21 - Element A Type
135	Logic Cell 13 - Element A Type	192	Logic Cell 21 - Logic Element B Address
136	Logic Cell 13 - Logic Element B Address	193	Logic Cell 21 - Element B Type
137	Logic Cell 13 - Element B Type	194	Logic Cell 21 - Logic Element C Address
138	Logic Cell 13 - Logic Element C Address	195	Logic Cell 21 - Element C Type
139	Logic Cell 13 - Element C Type	196	Logic Cell 21 - Output Control
140	Logic Cell 13 - Output Control	197	Logic Cell 22 - Logic Element A Address
141	Logic Cell 14 - Logic Element A Address	198	Logic Cell 22 - Element A Type
142	Logic Cell 14 - Element A Type	199	Logic Cell 22 - Logic Element B Address
143	Logic Cell 14 - Logic Element B Address	200	Logic Cell 22 - Element B Type
144	Logic Cell 14 - Element B Type	201	Logic Cell 22 - Logic Element C Address
145	Logic Cell 14 - Logic Element C Address	202	Logic Cell 22 - Element C Type
146	Logic Cell 14 - Element C Type	203	Logic Cell 22 - Output Control
147	Logic Cell 14 - Output Control	204	Logic Cell 23 - Logic Element A Address
148	Logic Cell 15 - Logic Element A Address	205	Logic Cell 23 - Element A Type
149	Logic Cell 15 - Element A Type	206	Logic Cell 23 - Logic Element B Address
150	Logic Cell 15 - Logic Element B Address	207	Logic Cell 23 - Element B Type
151	Logic Cell 15 - Element B Type	208	Logic Cell 23 - Logic Element C Address
152	Logic Cell 15 - Logic Element C Address	209	Logic Cell 23 - Element C Type
153	Logic Cell 15 - Element C Type	210	Logic Cell 23 - Output Control
154	Logic Cell 15 - Output Control	211	Logic Cell 24 - Logic Element A Address
155	Logic Cell 16 - Logic Element A Address	212	Logic Cell 24 - Element A Type
156	Logic Cell 16 - Element A Type	213	Logic Cell 24 - Logic Element B Address
157	Logic Cell 16 - Logic Element B Address	214	Logic Cell 24 - Element B Type
158	Logic Cell 16 - Element B Type	215	Logic Cell 24 - Logic Element C Address
159	Logic Cell 16 - Logic Element C Address	216	Logic Cell 24 - Element C Type
		217	Logic Cell 24 - Output Control