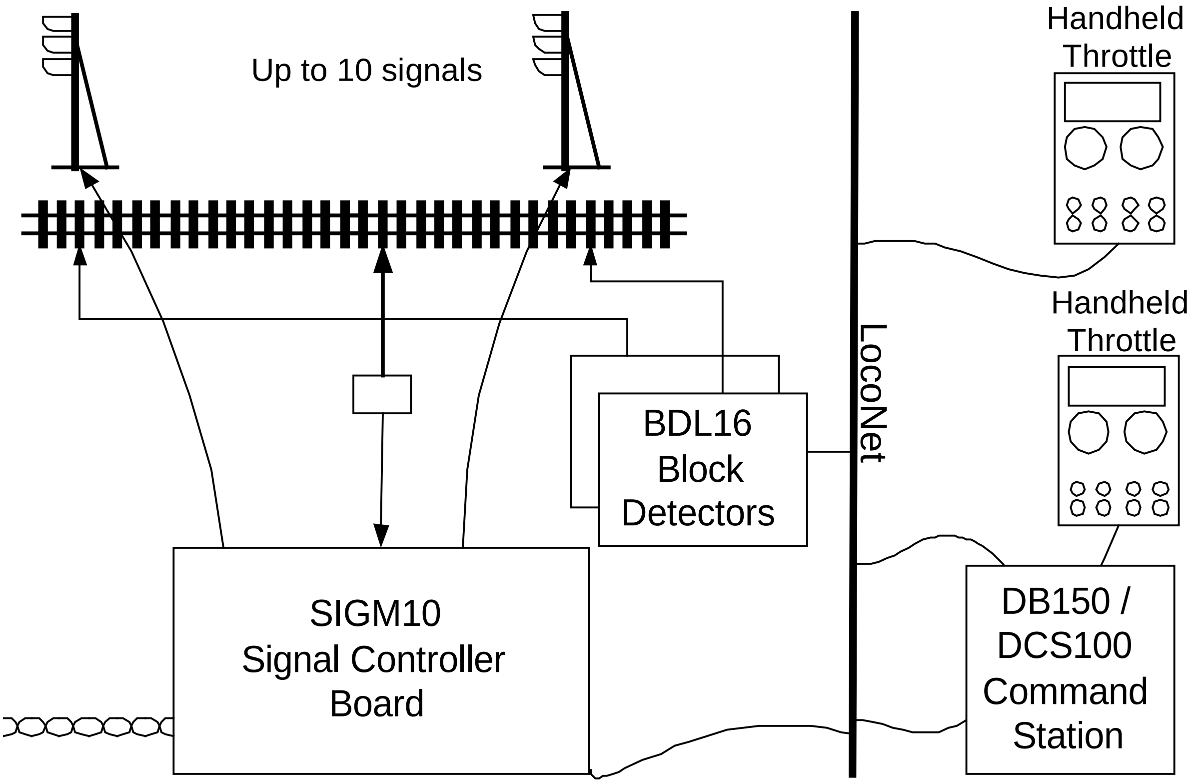
1 Introduction

The SIGM20 is a controller for up to 10 colour light signals. The signals are controlled automatically in response to the settings of the track and the passage of trains. This allows complex, realistic operation of a signalling system in response to all of the normal events that happen on a railway:

- Block operation as trains pass block sensors;
- Signals being held at red automatically if the track ahead isn't set correctly;
- Automatic or manual control of "running direction" for single tracks;
- Power isolation to halt a train at a red signal;
- Correct operation at junctions.

LocoNet makes all of this is possible. LocoNet connects together all of the control and sensor functions within the model railway and allows everything to have access to the information it needs. For example:

- BDL16 and other sensors can send messages reporting whether each track section is occupied;
- Handheld throttles can send commands to change points (switches);
- DTM16 Tower Master board controlling CTC and similar panels can send commands to change points (switches) and can display the block sensor states;
- The signal controller can listen to all of the messages about point state and sensor occupancy and determine the correct settings for the signals;
- Signal state can be reported by signal control messages.



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2 Configuring the SIGM20

In common with many DCC devices, the function performed by the SIGM20 is fully defined by the settings of a number of System Variables (SVs). The functions can also be defined in the "normal" manner using a CV programmer. These parameters may be user programmed as described in this section. The settings define the following behaviour of the board.

In most cases users will not need to program these settings directly. A PC program is available that allows the user to define the settings required and download them automatically into the board.

This manual has been provided for those that do wish to program the SVs manually, or who wish to understand more about the programming required.

2.1 SV Programming

2.1.1 PC Configuration

A PC based configuration program is provided to determine the SV settings, and to download them into the board through LocoNet. This can be accomplished on a "live" operating layout. This is the recommended method of programming and requires the smallest degree of user effort.

2.1.2 Manual Programming

Manual programming of the System Variables can be accomplished using the programming facilities offered by all DCC command stations. Each system is different: the specific use of any one command station is not covered by this manual.

The SIGM20 supports **Direct Mode Programming in Service Mode** only. This means that:

- For programming, it will need to be connected to the programming track output of the command station;
- SVs cannot be updated during normal operation of the layout.
  - "Paged mode" will program all but two SVs; unfortunately the command stations will not program two specific addresses.

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1. Disconnect power from the board’s power connector, SK1;
2. Remove any LocoNet connection;
3. Disconnect all signals from the board (SK5, SK6);
4. Disconnect any sensor or other inputs from SK7;
5. Disconnect any add-on boards from SK4;
6. Insert jumpers JP1;
7. Connect SK1 to the programming track;
8. Select the command station to generate Direct Mode programming commands.

In this manual all register addresses and SV contents are listed in decimal format. If your command station requires hexadecimal notation to describe the values to be programmed into each register, it will be necessary to convert the values to hex format. A decimal to hexadecimal conversion chart is provided in Appendix D.

The following sections define the values which may be programmed into each register to control the functions of the unit.

2.2 Board Base Address

The board has two different kinds of base address:

- The DCC accessory address at which the signals and reverse running zones can be controlled;
- The sensor addresses used for the sensor inputs.

The board base address for the signal & reverse running zone control is defined by the setting of SV5, SV6. The board occupies 16 locations starting at this address. The first address responded to (which controls signal 1) is given by:

Signal 1 Address = (SV6 Value * 256) + SV5 value

The sensor board number is defined by SV26. This should be set to a board number not used elsewhere within your layout. Specifically it must not conflict with a BDL16x board number, a SIGM10 number or another SIGM20 number.

Additionally, the board has a serial number in SV3, SV4. These are used to identify the board for in-situ SV programming through LocoNet. These SVs are factory programmed and normally can be left unchanged. If changes are needed, they are normally re-assigned by the PC based configurator software. Each software configurable board (currently SIGM10, SIGM20 & DTM20, but other vendors may provide such products) on a layout needs to have a different number from each other; the number is not used for any other purpose.

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2.3 Signal Type SVs

These SVs individually select the type of signal logic to be followed by each signal. This is dependent on the track formation ahead of the signal. There are only two settings:

Variable	Effect	Variable	Effect
SV30	Signal 1 Logic Type	SV35	Signal 6 Logic Type
SV31	Signal 2 Logic Type	SV36	Signal 7 Logic Type
SV32	Signal 3 Logic Type	SV37	Signal 8 Logic Type
SV33	Signal 4 Logic Type	SV38	Signal 9 Logic Type
SV34	Signal 5 Logic Type	SV39	Signal 10 Logic Type

Value	Programmed Behaviour
0	Signal controls a diverging junction
1	Signal is for a block section or non diverging junction

2.4 Signal Head Type SVs

These SVs determine the type of model signal used at each signalled location. Each is separately programmable. See section 4.4.2 of the SIGM20 manual for details.

Variable	Effect	Variable	Effect
SV10	Signal 1 Head type	SV15	Signal 6 Head type
SV11	Signal 2 Head type	SV16	Signal 7 Head type
SV12	Signal 3 Head type	SV17	Signal 8 Head type
SV13	Signal 4 Head type	SV18	Signal 9 Head type
SV14	Signal 5 Head type	SV19	Signal 10 Head type

Value	Programmed Behaviour
0	Signal head is 4 aspect, common cathode
1	Signal head is 4 aspect, common anode
2	Signal head is 3 aspect+aux, common cathode
3	Signal head is 3 aspect+aux, common anode
4	Signal head is 2 wire searchlight, aux anode is driven
5	Signal head is 3 wire searchlight, aux anode is driven
6	Signal head is European type distant signal, common cathode
7	Signal head is European type distant signal, common anode
8	Signal head is US style 3 aspect signal, common cathode
9	Signal head is US style 3 aspect signal, common cathode
10	Signal head is 2 aspect, common cathode
11	Signal head is 2 aspect, common anode

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2.5 Board Input Configuration SVs

These SVs define the behaviour of the board's 8 input signals, and any inputs attached as add-on boards via SK4. These are controllable to perform different functions according to the settings of SV20,21.

Variable	Effect
SV20	On-board inputs (SK7) type
SV21	External add-on board (connected via SK4) type

Value	Programmed Behaviour
0	These inputs are not used.
1	These inputs operate as general sensors and generate LocoNet INRP messages with sensor numbers 1-8
2	These inputs operate as general sensors and generate LocoNet INRP messages with sensor numbers 9-16
3	These inputs when driven to +12v force the corresponding signal to go red.

2.6 Optional Auxiliary Output Board

This SV controls the effect of an optional board added on to SK4.

Variable	Effect
SV22	Auxiliary Output Board type

Value	Programmed Behaviour
0	The auxiliary output board drives power isolating relays for signals 1-8
1	The auxiliary output board drives LEDs for signals 9,10

2.7 Signal LED Bank Settings

These SVs define the behaviour of the board's 24 signal LED outputs. These are controlled in two banks of 12 LED outputs.

Variable	Effect
SV24	Bank A (signals 1-4) output selection
SV25	Bank B (signals 5-8) output selection

Value	Programmed Behaviour
0	The signals in this bank have 3 LEDs; 4 separate signals are driven.
1	The signals in this bank have 4 LEDs; 3 separate signals are driven. The last signal in the group doesn't control any LEDs and can be used as a virtual signal.

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2.8 External Address Tables

In most cases, the logic to program signal states does not specify a full address for a point, sensor or signal. This is to save space in the SIGM20's internal memory and to allow extra logic to be fitted into the space. Instead, the SIGM20 keeps the full DCC addresses of all of the points, sensors & signals in a table (the "external device table) and the logic then refers to each entry or pigeonhole in that table. This section describes what the external device table needs to be programmed with.

(Note that the settings for this table are calculated automatically by the PC configuration software)

2.8.1 Point / Sensor Addresses

The SIGM20 can store the addresses of up to 48 points or sensors that the signals are dependent upon. This list needs to store:

- All of the point numbers that a diverging signal controls;
- All of the block sensor addresses used to determine whether the signal's block is occupied;
- All of the point addresses used in logic to make the signal red according to track state.

SV address	**External device table entry**	**SV address**	**External device table entry**
SV40, 41	Ext point/sensor 1	SV88, 89	Ext point/sensor 25
SV42, 43	Ext point/sensor 2	SV90, 91	Ext point/sensor 26
SV44, 45	Ext point/sensor 3	SV92, 93	Ext point/sensor 27
SV46, 47	Ext point/sensor 4	SV94, 95	Ext point/sensor 28
SV48, 49	Ext point/sensor 5	SV96, 97	Ext point/sensor 29
SV50, 51	Ext point/sensor 6	SV98, 99	Ext point/sensor 30
SV52, 53	Ext point/sensor 7	SV100, 101	Ext point/sensor 31
SV54, 55	Ext point/sensor 8	SV102, 103	Ext point/sensor 32
SV56, 57	Ext point/sensor 9	SV104, 105	Ext point/sensor 33
SV58, 59	Ext point/sensor 10	SV106, 107	Ext point/sensor 34
SV60, 61	Ext point/sensor 11	SV108, 109	Ext point/sensor 35
SV62, 63	Ext point/sensor 12	SV110, 111	Ext point/sensor 36
SV64, 65	Ext point/sensor 13	SV112, 113	Ext point/sensor 37
SV66, 67	Ext point/sensor 14	SV114, 115	Ext point/sensor 38
SV68, 69	Ext point/sensor 15	SV116, 117	Ext point/sensor 39
SV70, 71	Ext point/sensor 16	SV118, 119	Ext point/sensor 40
SV72, 73	Ext point/sensor 17	SV120, 121	Ext point/sensor 41
SV74, 75	Ext point/sensor 18	SV122, 123	Ext point/sensor 42

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SV76, 77	Ext point/sensor 19	SV124, 125	Ext point/sensor 43
SV78, 79	Ext point/sensor 20	SV126, 127	Ext point/sensor 44
SV80, 81	Ext point/sensor 21	SV128, 129	Ext point/sensor 45
SV82, 83	Ext point/sensor 22	SV130, 131	Ext point/sensor 46
SV84, 85	Ext point/sensor 23	SV132, 133	Ext point/sensor 47
SV86, 87	Ext point/sensor 24	SV134, 135	Ext point/sensor 48

Table 2-1: External Point & Sensor Address Table

The values to be used for point addresses in this table are described in Appendix B.
The values to be used for sensor addresses in this table are described in Appendix C.

The SIGM20 determine the state of the points using either DCC accessory messages or LocoNet turnout feedback messages. If the unit detects Turnout Feedback messages, it knows that feedback reporting has been enabled and it ignores any further DCC messages for that point.

2.8.2 Signal Addresses

The SIGM20 can store the addresses of up to 12 external signals that this board's signals are dependent upon. This list needs to store:

- All of the "next signal" numbers that are not on this board (those that refer to signals within a board do not need entries in the table, to keep numbers down);
- All of the signals that are referred to in signal condition groups.

SV address	External device table entry	SV address	External device table entry
SV136, 137	Ext signal 1	SV148, 149	Ext signal 7
SV138, 139	Ext signal 2	SV150, 151	Ext signal 8
SV140, 141	Ext signal 3	SV152, 153	Ext signal 9
SV142, 143	Ext signal 4	SV154, 155	Ext signal 10
SV144, 145	Ext signal 5	SV156, 157	Ext signal 11
SV146, 147	Ext signal 6	SV158, 159	Ext signal 12

Table 2-2: External Signal Address Table

The values to be used for this table are described in Appendix B.

2.9 Signal Definition SVs

The settings for each signal are defined in a table of 25 individual SVs. The start addresses for each signal can be found in a list below:

Signal	SV range	Signal	SV Range
1	SV 513-537	6	SV 638-662

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2	SV 538-562	7	SV 663-687
3	SV 563-587	8	SV 688-712
4	SV 588-612	9	SV 713-737
5	SV 613-637	10	SV 738-762

Each signal is controlled by a block of 25 consecutive SVs starting at the address shown above. The meanings of these SVs are dependent on the signal type which is included within the list. In the tables in the sections below, the start address for the signal's SVs is indicated as "**X**". The offset address needs to be added to the base address in each case.

2.9.1 Diverging Junction Signal SVs

SV Addr	**SV Meaning**	**Value**
X	Reverse running zone	If assigned identifies the reverse running zone to which the signal is assigned. Value 1,2,3: signal belongs to zone A-C running West to East Value 11,12,13: signal belongs to zone A-C running East to West
X+1	Junction point number	Specifies the external address table location for the address of the point controlling this junction.
X+2	Next signal if point closed	The external address table location of the next signal down the line if the point is CLOSED
X+3	Next signal if point thrown	The external address table location of the next signal down the line if the point is THROWN
X+4… X+6	Block occupancy if point closed	These define a number of logical conditions which are followed if the point is CLOSED. If any of these conditions are true the signal's block is declared to be occupied & the signal goes red.
X+7… X+11	"Red" conditions if point closed	These define a number of logical conditions which are followed if the point is CLOSED. If any of these conditions are true the signal goes red.
X+12 … X+14	Block occupancy if point thrown	These define a number of logical conditions which are followed if the point is THROWN. If any of these conditions are true the signal's block is declared to be occupied & the signal goes red.
X+15 … X+19	"Red" conditions if point thrown	These define a number of logical conditions which are followed if the point is THROWN. If any of these conditions are true the signal goes red.
X+20... X+22	Isolation zone conditions	These define logical conditions which if met override the isolation zone relay control.
X+23... X+24	Aux LED conditions	These conditions define if the AUX LED is lit. Lit if conditions true. (Note aux 1 and aux 2 have dedicated DCC addresses)

Table 2-3: Diverging Signal Definition SVs

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2.9.2 Block Signal Definition SVs

A block signal or a signal controlling a converging route has only one exit route. So only one set of conditions is needed to make it go red or to control its block occupancy.

SV Addr	SV Meaning	Value
X	Reverse running zone	If assigned identifies the reverse running zone to which the signal is assigned. Value 1,2,3: signal belongs to zone A-C running West to East Value 11,12,13: signal belongs to zone A-C running East to West
X+1	Point number	The number of the point associated with this signal (not currently used)
X+2	Next signal number	The signal table number of the next signal down the line.
X+3… X+5	Block Occupancy	These define a number of logical conditions which are followed. If any of these conditions are true the signal's block is declared to be occupied & the signal goes red.
X+6… X+19	"Red" Conditions	These define a number of logical conditions which are followed. If any of these conditions are true the signal goes red.
X+20... X+22	Isolation zone conditions	These define logical conditions which if met override the isolation zone relay control.
X+23... X+24	Aux LED conditions	These conditions define if the AUX LED is lit. Lit if conditions true.

Table 2-4: Block(Non Diverging) Signal Definition SVs

2.9.3 Signal Definition SV Meanings

Reverse running Zone

This identifies the reverse running zone and its running direction within which the signal is located.
The following values may be assigned:

- 0: the signal is not in a reverse running zone
- 1,2 or 3: the signal is located within zone A-C, running West to East;
- 11,12 or 13: the signal is located within zone A-C, running East to West.

Junction point number

Identifies an entry in the external point & sensor device table. This should refer to a point and is used to determine whether the point is closed or thrown. This is needed for diverging junctions to identify which exit route will be taken.

Legal values:

- 0=no point assigned;
- 1-48: specifies location 1-48 in the external device table

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Next signal number	Specifies the number of the next signal down the line from this one. Used to implement basic block control. Legal values: • 0: There is no “next signal” (i.e. cannot go to an “amber” state) • 1-10: the next signal is signal 1-10 on this board, and it behaves as a normal block signal; • 11-22: the next signal is signal 1-12 in the external signal device table, and it behaves as a normal block signal; • 101-110: the next signal is signal 1-10 on this board, and it behaves as a virtual signal. This signal will display the same aspect as the virtual one, unless it is driven to a more “red” state; • 111-122: the next signal is signal 1-12 in the external signal device table, and it behaves as a virtual signal. This signal will display the same aspect as the virtual one, unless it is driven to “red” by its own block occupancy or “red” conditions. • 255: The next signal does not exist, but is assumed to be red (used for the last signal approaching a terminus). (for diverging junctions there are two “next signal” numbers programmed that correspond to the point being closed or thrown).
Block Occupancy Conditions	These conditions define whether the block ahead of the signal is occupied, and consequently should force the signal red. This is needed for block control. Typically this will be a list of the sensors detecting train location in the block to the next signal.
“Red” conditions	These are additional conditions that force the signal to red. This is the mechanism by which the signal state is set according to the state of the trackwork.. Typically these conditions will be a list of the points, in the state (closed or thrown) requiring the signal to be showing “red”. Complex sequences e.g. at track junctions can be programmed. It is also possible to make this dependent on the state of other signals – e.g. to hold one signal at red until another signal is red to prevent train collision at crossings.

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Isolation Zone Conditions	These conditions define whether the power isolating relay should be overridden to leave power applied. If one or more of these conditions are true, the power isolating relay is left in the "powered" state when the signal first becomes red. This is used to detect that a train is passing the signal, and therefore the power should be maintained until it has gone (A condition dependent on a sensor located by the signal mast would be typical). Note that these conditions will make the signal go red.
Aux LED Conditions	These conditions determine whether the auxiliary LED for the signal (if it is present, e.g. for 3 aspect signals) should be lit. These conditions can be used for any purpose, e.g.: • Light the LED if the signal is green and the point is set to closed (for a junction's route indicator); • Light the LED if a specific DCC address has been set to thrown (for a user controlled "start" signal).

2.9.4 Condition Groups

A condition group is simply a list of numbers. The size of the list depends on the signal type and what the condition set is for and can be determined from Table 2-3 & Table 2-4.

The numbers in most cases refer to entries in the external device table, from which the states of the relevant points, sensors and signals can be found. The conditions need to do 2 things:

- Identify the point, sensor or signal concerned;
- Identify the state of that point, sensor or signal
    - i.e. point is closed or thrown; sensor is occupied or not occupied, signal is red or not red.

The conditions that can be defined, the consequenct SV values to be programmed, are as follows:

Required Event	**SV value**
A value of 0 should be programmed into the last condition in the list. It has no effect; any remaining entries in the list are ignored. • Commonly, the number of conditions available for a signal will be more than are actually used. Assign zeros for all unused entries.	0

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To make a condition true if a point is THROWN: • Find the position X in the external point & sensor device table for the point. • Program this value X into the SV	1-48
To make a condition true if a sensor is OCCUPIED: • Find the position X in the external point & sensor device table for the sensor. • Program this value X into the SV	1-48
To make a condition true if a signal is red: • Find the position X in the external signal device table for the sensor. • Program the value (X + 48) into the SV	49-60
To make a condition true if a point is CLOSED: • Find the position X in the external point & sensor device table for the point. • Program the value (X+60) into the SV	61-108
To make a condition true if a sensor is NOT OCCUPIED: • Find the position X in the external point & sensor device table for the sensor. • Program the value (X+60) into the SV	61-108
To make a condition true if a signal is NOT red: • Find the position X in the external signal device table for the sensor. • Program the value (X + 108) into the SV	109-120
To make a condition true if reverse running zone A is running West-to-East:	121
To make a condition true if reverse running zone A is running East-to-West;	122
To make a condition true if reverse running zone B is running West-to-East;	123
To make a condition true if reverse running zone B is running East-to-West;	124
To make a condition true if reverse running zone C is running West-to-East;	125
To make a condition true if reverse running zone C is running East-to-West;	126

2.9.4.1 Assigning “AND” Conditions

It is also possible to make more complex logic conditions. Suppose for a condition to be true, two events have to happen at once: e.g. “point 48 is thrown AND sensor 45,3 is occupied at the same time”

This can be done by adding a value of 128 to the first condition. When this is done, the result will only be true when both the first and the second condition is true.

2.10 Reverse Running Zone Condition SVs

Conditions are also assigned to determine the direction through which reverse running zones are set to operate. One group of conditions, if met, force the zone to run in the

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West-to-East direction. The other set of conditions, if met, force the zone to run in the East-to-West direction.

The settings for each zone are defined in a table of 25 individual SVs. The addresses for each zone can be found in a list below:

Zone	SV range	West-to-East conditions	East-to-West conditions	Exclusion conditions	Shunting Conditions
A	SV 180-204	SV 180-187	SV 188-195	SV 196-201	SV 202-204
B	SV 205-229	SV 205-212	SV 213-220	SV 221-226	SV 227-229
C	SV 230-254	SV 230-237	SV 238-245	SV 246-251	SV 252-254

[Note that the directions West-to-East and vice versa are entirely arbitrary and only have meaning when signals are assigned by the user. The user needs to be consistent.]

SV Address	SV Meaning	Value
X … X+7	West-to-East conditions	Conditions to make the zone set to the West-to-East direction. Note that the direction is changed only if no corresponding conditions in the East-to-West group are set.
X+8 … X+15	East-to-West conditions	Conditions to make the zone set to the East-to-West direction. Note that the direction is changed only if no corresponding conditions in the West-to-East group are set.
X+16 … X+21	Exclusion conditions	Conditions which if one or more is true cause the reverse running state not to change by passage of trains. (Typically used to "hold" the setting if a train is in the reverse running section).
X+22 … X+24	SHUNTING conditions	Conditions to make the zone enter SHUNTING state.

Note that the direction of the zone will only be changed if the decision is unambiguous. If both the West-To-East and the East-To-West conditions are true, the zone state will not change. This is to avoid the direction randomly changing as conditions become true and not true on each end of the argument.

2.11 Other SVs

2.11.1 Signal Passed at Danger SV

SV9 selects whether the board should take any action of it detects a signal being passed while red (i.e. in a danger condition). This is detected by the isolation zone override conditions becoming true while the signal is at red: this would occur if a sensor by the signal mast were suddenly occupied i.e. a train passes the signal mast.

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This function is enabled by setting SV9 to 1. When enabled, the SIGM20 issues 3 beeps when the train passes the signal mast. If SV9 is set to 0, this function is disabled.

2.11.2 Isolation Delay Time SV

SV764 sets the delay period that is used to “hold off” track power isolation when a train enters a protected block. This effect is used to allow time for a slow train to trip sensors to identify its presence before isolating power.

- When SV764=0: no delay is used and track power is isolated immediately the conditions allow. This will happen when the block occupancy conditions are true and the override conditions are not true.
- When SV764 is set to any different value, that value specifies the time in ¼ second (nominal) increments that the power is still applied for. This allows time for sensors (e.g. optical sensors) to trigger & identify train presence. For example a value if 27 will specify a nominal delay of 6.75 seconds.
- A default value of 8 (2 seconds delay) is programmed initially.

2.11.3 Interrogate Override

When SV763 is 0, it responds to the LocoNet interrogation process in the normal way. It should be set to this for use on Digitrax controlled layouts.

When SV763 is set to 1, the board will respond as normal. Additionally it will report its settings – whether interrogated for them or not – after a delay of approximately 10 seconds after power is applied.

2.11.4 Brightness Simulation

When SV765=0, LEDs change from on to off and vice versa instantly.

When SV765=1, the LEDs change slowly (over approximately half a second) to simulate the thermal inertia of real signal lamps.

2.11.5 Transponding Zone SVs

SV160-179 are provided to store the transponding zone associated with each signal. These are provided for future expansion only and are not currently used.

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Appendix A. Full List of SVs

SV1	EEPROM size	Readonly; =1
SV2	Software Version number	Readonly; value dependent on product version =0: beta release =1+: production release
SV3, SV4	Serial Number	2 SVs hold the board serial number, used for in-situ programming. Holds the value N for board N (i.e. board 17: SV3=17, SV4=0)
SV5, 6	Signal Base address	DCC address of signal 1. Binary, low byte =SV5, high byte = SV6
SV7	Device Id	Readonly; = 5 (identifies SIGM20)
SV8	Manufacturer id	Readonly; = 1 (identified CML Electronics Limited)
SV9	Signal Passed at Danger	=0: take no action; =1: report by 3 long beeps
 SV10 SV11 SV12 SV13 SV14 SV15 SV16 SV17 SV18 SV19	Signal Head Type SVs Defines signal head 1 Defines signal head 2 Defines signal head 3 Defines signal head 4 Defines signal head 5 Defines signal head 6 Defines signal head 7 Defines signal head 8 Defines signal head 9 Defines signal head 10	=0: signal head is 4aspect, common cathode =1: signal head is 4aspect, common anode =2: signal head is 3aspect+aux, common cathode =3: signal head is 3aspect+aux, common anode =4: signal head is 2 wire searchlight, aux anode is driven =5: signal head is 3 wire searchlight, aux anode is driven
 SV20, SV21	Sensor type SVs: defines serial sensor inputs SV20: sensors attached to board SV21: externally connected sensors	Program sensor behaviour SV=0: Inputs not used. SV=1: these inputs act as general sensors 1-8 SV=2: these inputs act as general sensors 9-16 SV=3: these inputs act as “force to red” inputs.
SV22	Defines aux output usage	SV=0: aux output drive isolating relays for signals 1-8 SV=1: aux output drive LEDs for signals 9,10
SV23	Not used	
 SV24 SV25	Signal Group LED Count Defines signals 1-4 Defines signals 5-8	Programs the behaviour of the signal heads, in two groups SV=0: the signals in the group have 3 LED outputs SV=1: signals in the group have 4 LED outputs; signal 4 or 8 behaves as a “virtual” signal
SV26	Sensor board number	Board number for sensor inputs. (The “X” of the X,Y format)
SV27, 28	unused	
SV29	Decoder Config	Readonly; =0x80 (accessory device)
 SV30 SV31 SV32 SV33 SV34 SV35 SV36 SV37 SV38 SV39	Signal Type SVs Defines signal 1 Defines signal 2 Defines signal 3 Defines signal 4 Defines signal 5 Defines signal 6 Defines signal 7 Defines signal 8 Defines (virtual) signal 9 Defines (virtual) signal 10	=0: signal controls a diverging junction =1: signal is for a block section or non diverging junction

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SV40-135	External point & sensor addresses (48)	48 pairs of SVs: even value (X) and odd value (Y) if Y<100: X,Y is a binary value defining a point address in the range 1-2048 (Y is high byte) if Y>100: X,Y defines a sensor address X,Y. X is the sensor board number; Y is the sensor number on the board + 100 (ie 113 implies sensor 13)
SV136-159	External signal addresses (12)	12 pairs of SVs: even value (X) and odd value (Y) X,Y is a binary value defining a signal address in the range 1-2048
SV160-175 (176-179 unused)	Signals 1-8 transponding zones	Future expansion. Binary, low byte 1st
SV180-204	Reverse running Zone A logic	These SVs define the direction of each “reverse running” zone.
SV205-229	Reverse running Zone B logic	
SV230-254	Reverse running Zone C logic	
SV513-537	Signal 1 logic	These blocks of SVs define the logic for each signal and are separately defined.
SV538-562	Signal 2 logic	
SV563-587	Signal 3 logic	
SV588-612	Signal 4 logic	
SV613-637	Signal 5 logic	
SV638-662	Signal 6 logic	
SV663-687	Signal 7 logic	
SV688-712	Signal 8 logic	
SV713-737	(Virtual) signal 9 logic	
SV738-762	(Virtual) signal 10 logic	
SV763	Interrogate override	SV=0: Normal interrogate behaviour SV=1: always respond 10s after power up
SV764	Isolation delay time	Time delay before activation of track power isolation =0: no delay =1-100: specifies delay in units of 1/4s (nominal) e.g. a value of 10 specifies approximately 2.5 seconds delay
SV765	Simulate Brightening / Dimming	=0: no effect =1: simulate slowly changing brightness of signal heads

Appendix B. External Point Address Chart

This appendix describes how to program the external device table to specify point addresses. Point addresses are those used on a handheld throttle to select each point. The user therefore "knows" what these values are. The point numbers need to be looked up in the following table to select a point address setting.

This table lists the sensor addresses corresponding to settings of the two SVs **A** & **B** for each assigned point. The **A** value is programmed into the first (even numbered) SV; the **B** value goes into the second (odd numbered) SV.

Increments of 10 for the **A** ("even") SV are shown to keep the table size sensible. The exact value required is likely to be an intermediate value in between two table cells. To get intermediate point addresses, add the difference to the **A** value found from the table.

Example: to program external address table entry 17 to specify point 279:

1. From Table 2-1, External address table entry 17 uses SV72, 73
2. From the table overleaf, **A** & **B** values of 20 & 1 respectively give a cell address of 276;
3. Therefore to get address 279, add 3 to the **A** value i.e A=23;
4. Program SV72 with 23 and SV73 with 1.

<u>External Signal Addresses</u>

The same table is used in the same way to program the addresses used by the external signal address table.

<u>Board Base Address, high Current Base Address</u>

This same table is used to assign the base addresses.
Board base address = DCC address that signal 1 responds to;

- Determine the A and B values as above for the desired address;
- Program the "A" value into SV5;
- Program the "B" value into SV6.

High Current Base Address = DCC address that high current o/p 1 responds to

- Determine the A and B values as above for the desired address;
- Program the "A" value into SV27;
- Program the "B" value into SV28.

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"even" SV (A)	"odd" SV (B)							
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**
0	0	256	512	768	1024	1280	1536	1792
10	10	266	522	778	1034	1290	1546	1802
20	20	**276**	532	788	1044	1300	1556	1812
30	30	286	542	798	1054	1310	1566	1822
40	40	296	552	808	1064	1320	1576	1832
50	50	306	562	818	1074	1330	1586	1842
60	60	316	572	828	1084	1340	1596	1852
70	70	326	582	838	1094	1350	1606	1862
80	80	336	592	848	1104	1360	1616	1872
90	90	346	602	858	1114	1370	1626	1882
100	100	356	612	868	1124	1380	1636	1892
110	110	366	622	878	1134	1390	1646	1902
120	120	376	632	888	1144	1400	1656	1912
130	130	386	642	898	1154	1410	1666	1922
140	140	396	652	908	1164	1420	1676	1932
150	150	406	662	918	1174	1430	1686	1942
160	160	416	672	928	1184	1440	1696	1952
170	170	426	682	938	1194	1450	1706	1962
180	180	436	692	948	1204	1460	1716	1972
190	190	446	702	958	1214	1470	1726	1982
200	200	456	712	968	1224	1480	1736	1992
210	210	466	722	978	1234	1490	1746	2002
220	220	476	732	988	1244	1500	1756	2012
230	230	486	742	998	1254	1510	1766	2022
240	240	496	752	1008	1264	1520	1776	2032
250	250	506	762	1018	1274	1530	1786	2042

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Appendix C. Sensor Address Selection

Sensor addresses have no natural “user” meaning. A convention has become established where sensor addresses are stored in an “X,Y” format. X is defined from the base address of the board and Y is determined from the sensor address within the board. X values range from 0 to 255; Y values range from 1 to 16.

Programming the External Point & Sensor Address Table

X and Y values are programmed into the external point & sensor address table as follows:

1. Determine the X, Y address of the sensor required.
2. Add 100 to the Y value.
3. Program the X value into the 1st (even) SV for the table entry;
4. Program the Y value into the 2ns (odd) SV.

Example: to program external address table entry 19 to specify sensor 66, 12
1. From Table 2-1, External address table entry 17 uses SV76, 77
2. Adding 100 to the Y value gives (100+12) = 112
3. Program SV76 with 66 and SV77 with 112.

If you are unsure of the X and Y values to use, see the notes below.

X, Y Values for BDL16

Users of some boards e.g. BDL16 will have programmed a board number “X” value directly into the board and no further information is needed. The Y value is determined directly by the channel number of the board. A value of 1 corresponds to the first channel; a value of 16 corresponds to the last channel.

X, Y Values for DS54

The board number “X” value will need to be determined from the board base address to which it was programmed. This appendix provides tables to allow the sensor address to be determined given knowledge of the board base address and the sensor connection to those boards.

The charts on the next two pages allow selection of the “X” value given the base address of the accessory decoder board. DS54 boards have only 8 sensors per board. Consequently two consecutive DS54 boards have the same X value: one occupies Y values 1-8 and the next occupies Y values 9-16. The “star” indicated in the table is used to decide which case is relevant.

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DS54 input	Wire colour	Y value (no star after X value)	Y value (star after X value)
Aux Input 1	Orange	1	9
Main input 1	Blue	2	10
Aux Input 2	Black	3	11
Main input 2	Violet	4	12
Aux Input 3	Yellow	5	13
Main input 3	Grey	6	14
Aux Input 4	Green	7	15
Main input 4	Red	8	16

Example (cells highlighted in table overleaf): A DS54 has a programmed base address of 45. Its corresponding X value is therefore 6. The "Y" value will need to be selected from the column with a "star" in the table above.

<u>X, Y Values for DAC10</u>

X values for DAC10 boards are assigned in exactly the same way as for DS54 boards. Note that a DAC10 can be programmed to base addresses which "straddle" two X values. This happens where a "star" follows the X value and the Y value needs to be determined from the right hand column of the table below.

DAC10 input	**Pin Numbers**	**Y value (no star after X value)**	**Y value (star after X value)**
Main input 1	1, 2	2	10
Main input 2	3, 4	4	12
Main input 3	5, 6	6	14
Main input 4	7, 8	8	16
Main input 5	9, 10	10	2, add 1 to X
Main input 6	11, 12	12	4, add 1 to X
Main input 7	13, 14	14	6, add 1 to X
Main input 8	15, 16	16	8, add 1 to X
Aux input 1	17, 18	1	9
Aux input 2	19, 20	3	11

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Base Addr	X	Base Addr	X	Base Addr	X	Base Addr	X	Base Addr	X	Base Addr	X
1	1	177	23	353	45	529	67	705	89	881	111
5	1*	181	23*	357	45*	533	67*	709	89*	885	111*
9	2	185	24	361	46	537	68	713	90	889	112
13	2*	189	24*	365	46*	541	68*	717	90*	893	112*
17	3	193	25	369	47	545	69	721	91	897	113
21	3*	197	25*	373	47*	549	69*	725	91*	901	113*
25	4	201	26	377	48	553	70	729	92	905	114
29	4*	205	26*	381	48*	557	70*	733	92*	909	114*
33	5	209	27	385	49	561	71	737	93	913	115
37	5*	213	27*	389	49*	565	71*	741	93*	917	115*
41	6	217	28	393	50	569	72	745	94	921	116
45	**6***	221	28*	397	50*	573	72*	749	94*	925	116*
49	7	225	29	401	51	577	73	753	95	929	117
53	7*	229	29*	405	51*	581	73*	757	95*	933	117*
57	8	233	30	409	52	585	74	761	96	937	118
61	8*	237	30*	413	52*	589	74*	765	96*	941	118*
65	9	241	31	417	53	593	75	769	97	945	119
69	9*	245	31*	421	53*	597	75*	773	97*	949	119*
73	10	249	32	425	54	601	76	777	98	953	120
77	10*	253	32*	429	54*	605	76*	781	98*	957	120*
81	11	257	33	433	55	609	77	785	99	961	121
85	11*	261	33*	437	55*	613	77*	789	99*	965	121*
89	12	265	34	441	56	617	78	793	100	969	122
93	12*	269	34*	445	56*	621	78*	797	100*	973	122*
97	13	273	35	449	57	625	79	801	101	977	123
101	13*	277	35*	453	57*	629	79*	805	101*	981	123*
105	14	281	36	457	58	633	80	809	102	985	124
109	14*	285	36*	461	58*	637	80*	813	102*	989	124*
113	15	289	37	465	59	641	81	817	103	993	125
117	15*	293	37*	469	59*	645	81*	821	103*	997	125*
121	16	297	38	473	60	649	82	825	104	1001	126
125	16*	301	38*	477	60*	653	82*	829	104*	1005	126*
129	17	305	39	481	61	657	83	833	105	1009	127
133	17*	309	39*	485	61*	661	83*	837	105*	1013	127*
137	18	313	40	489	62	665	84	841	106	1017	128
141	18*	317	40*	493	62*	669	84*	845	106*	1021	128*
145	19	321	41	497	63	673	85	849	107	1025	129
149	19*	325	41*	501	63*	677	85*	853	107*	1029	129*
153	20	329	42	505	64	681	86	857	108	1033	130
157	20*	333	42*	509	64*	685	86*	861	108*	1037	130*
161	21	337	43	513	65	689	87	865	109	1041	131
165	21*	341	43*	517	65*	693	87*	869	109*	1045	131*
169	22	345	44	521	66	697	88	873	110	1049	132
173	22*	349	44*	525	66*	701	88*	877	110*	1053	132*

Table 2-5: Sensor Base Addresses 1-1053

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Base Addr	X	Base Addr	X	Base Addr	X	Base Addr	X	Base Addr	X	Base Addr	X
1057	133	1233	155	1409	177	1585	199	1761	221	1937	243
1061	133*	1237	155*	1413	177*	1589	199*	1765	221*	1941	243*
1065	134	1241	156	1417	178	1593	200	1769	222	1945	244
1069	134*	1245	156*	1421	178*	1597	200*	1773	222*	1949	244*
1073	135	1249	157	1425	179	1601	201	1777	223	1953	245
1077	135*	1253	157*	1429	179*	1605	201*	1781	223*	1957	245*
1081	136	1257	158	1433	180	1609	202	1785	224	1961	246
1085	136*	1261	158*	1437	180*	1613	202*	1789	224*	1965	246*
1089	137	1265	159	1441	181	1617	203	1793	225	1969	247
1093	137*	1269	159*	1445	181*	1621	203*	1797	225*	1973	247*
1097	138	1273	160	1449	182	1625	204	1801	226	1977	248
1101	138*	1277	160*	1453	182*	1629	204*	1805	226*	1981	248*
1105	139	1281	161	1457	183	1633	205	1809	227	1985	249
1109	139*	1285	161*	1461	183*	1637	205*	1813	227*	1989	249*
1113	140	1289	162	1465	184	1641	206	1817	228	1993	250
1117	140*	1293	162*	1469	184*	1645	206*	1821	228*	1997	250*
1121	141	1297	163	1473	185	1649	207	1825	229	2001	251
1125	141*	1301	163*	1477	185*	1653	207*	1829	229*	2005	251*
1129	142	1305	164	1481	186	1657	208	1833	230	2009	252
1133	142*	1309	164*	1485	186*	1661	208*	1837	230*	2013	252*
1137	143	1313	165	1489	187	1665	209	1841	231	2017	253
1141	143*	1317	165*	1493	187*	1669	209*	1845	231*	2021	253*
1145	144	1321	166	1497	188	1673	210	1849	232	2025	254
1149	144*	1325	166*	1501	188*	1677	210*	1853	232*	2029	254*
1153	145	1329	167	1505	189	1681	211	1857	233	2033	255
1157	145*	1333	167*	1509	189*	1685	211*	1861	233*	2037	255*
1161	146	1337	168	1513	190	1689	212	1865	234	2041	0
1165	146*	1341	168*	1517	190*	1693	212*	1869	234*	2045	0*
1169	147	1345	169	1521	191	1697	213	1873	235		
1173	147*	1349	169*	1525	191*	1701	213*	1877	235*		
1177	148	1353	170	1529	192	1705	214	1881	236		
1181	148*	1357	170*	1533	192*	1709	214*	1885	236*		
1185	149	1361	171	1537	193	1713	215	1889	237		
1189	149*	1365	171*	1541	193*	1717	215*	1893	237*		
1193	150	1369	172	1545	194	1721	216	1897	238		
1197	150*	1373	172*	1549	194*	1725	216*	1901	238*		
1201	151	1377	173	1553	195	1729	217	1905	239		
1205	151*	1381	173*	1557	195*	1733	217*	1909	239*		
1209	152	1385	174	1561	196	1737	218	1913	240		
1213	152*	1389	174*	1565	196*	1741	218*	1917	240*		
1217	153	1393	175	1569	197	1745	219	1921	241		
1221	153*	1397	175*	1573	197*	1749	219*	1925	241*		
1225	154	1401	176	1577	198	1753	220	1929	242		
1229	154*	1405	176*	1581	198*	1757	220*	1933	242*		

Table 2-6: Sensor Base Addresses 1057-2045

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Appendix D. Hexadecimal Conversion Chart

All CV values in this manual are listed as decimal values. If your programming system requires hexadecimal values – for example Digitrax DT100 handheld throttles – use the following chart to convert.

dec	hex	dec	hex	dec	hex	dec	hex	dec	hex	dec	hex
0	00	44	2C	88	58	132	84	176	B0	220	DC
1	01	45	2D	89	59	133	85	177	B1	221	DD
2	02	46	2E	90	5A	134	86	178	B2	222	DE
3	03	47	2F	91	5B	135	87	179	B3	223	DF
4	04	48	30	92	5C	136	88	180	B4	224	E0
5	05	49	31	93	5D	137	89	181	B5	225	E1
6	06	50	32	94	5E	138	8A	182	B6	226	E2
7	07	51	33	95	5F	139	8B	183	B7	227	E3
8	08	52	34	96	60	140	8C	184	B8	228	E4
9	09	53	35	97	61	141	8D	185	B9	229	E5
10	0A	54	36	98	62	142	8E	186	BA	230	E6
11	0B	55	37	99	63	143	8F	187	BB	231	E7
12	0C	56	38	100	64	144	90	188	BC	232	E8
13	0D	57	39	101	65	145	91	189	BD	233	E9
14	0E	58	3A	102	66	146	92	190	BE	234	EA
15	0F	59	3B	103	67	147	93	191	BF	235	EB
16	10	60	3C	104	68	148	94	192	C0	236	EC
17	11	61	3D	105	69	149	95	193	C1	237	ED
18	12	62	3E	106	6A	150	96	194	C2	238	EE
19	13	63	3F	107	6B	151	97	195	C3	239	EF
20	14	64	40	108	6C	152	98	196	C4	240	F0
21	15	65	41	109	6D	153	99	197	C5	241	F1
22	16	66	42	110	6E	154	9A	198	C6	242	F2
23	17	67	43	111	6F	155	9B	199	C7	243	F3
24	18	68	44	112	70	156	9C	200	C8	244	F4
25	19	69	45	113	71	157	9D	201	C9	245	F5
26	1A	70	46	114	72	158	9E	202	CA	246	F6
27	1B	71	47	115	73	159	9F	203	CB	247	F7
28	1C	72	48	116	74	160	A0	204	CC	248	F8
29	1D	73	49	117	75	161	A1	205	CD	249	F9
30	1E	74	4A	118	76	162	A2	206	CE	250	FA
31	1F	75	4B	119	77	163	A3	207	CF	251	FB
32	20	76	4C	120	78	164	A4	208	D0	252	FC
33	21	77	4D	121	79	165	A5	209	D1	253	FD
34	22	78	4E	122	7A	166	A6	210	D2	254	FE
35	23	79	4F	123	7B	167	A7	211	D3	255	FF
36	24	80	50	124	7C	168	A8	212	D4		
37	25	81	51	125	7D	169	A9	213	D5		
38	26	82	52	126	7E	170	AA	214	D6		
39	27	83	53	127	7F	171	AB	215	D7		
40	28	84	54	128	80	172	AC	216	D8		
41	29	85	55	129	81	173	AD	217	D9		
42	2A	86	56	130	82	174	AE	218	DA		
43	2B	87	57	131	83	175	AF	219	DB		

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