Signal Animator
FEATURES

The function of the Signal Animator (SGA) is to take Danger/Clear/Approach (**DCA**) information and combine it with speed restrictions to drive LED signal indicators. The *Animator* part of its name comes from its ability to change indications with effects that mimic what happens with prototype wayside signals.

Operation Modes

The SGA has two modes of operation, differing in how it interprets DCA information:

CTC mode: DCA information must come from a signalling system that performs the logic necessary to generate it from occupancy, switch position, and dispatcher input. Such a system is necessary to provide a Centralized Traffic Control operator's interface in addition to operating wayside signals.

ABS mode: DCA information comes directly from occupancy detectors, sometimes via switch contacts. The SGA performs the signalling logic from this. This mode is useful for a basic Automatic Block Signalling system.

Selection of operation mode is done using a jumper.

Speed Restriction Indications

The SGA implements speed restriction indications locally, meaning that turnout position contacts directly feed inputs that are logically combined with the DCA information to provide the appropriate indications. For users of CTC mode, this means the signalling system only needs to generate DCA information using either two or three outputs. If a signalling system were to drive signals directly, some signals require up to nine outputs (three heads with three colours each) and would have to do more processing to generate the correct speed indication. The system would also have to manage flashing aspects.

Searchlight or Three Colour Lights?

Do you model signals searchlight signals (sometimes called "type SA"), with red, yellow, and green appearing from one lamp, or do you model signals with separate lamps for each colour (sometimes called "type D")? Searchlight signals may be modelled with tri-colour LEDs with four terminals, that place all three LEDs in one device and are wired exactly the same way that three separate LEDs are wired. Alternately, bi-colour LEDs with three terminals may be used. These LEDs contain only a red and green LED in one device, but by operating both at the same time, they appear yellow. The SGA can drive either type, using either three separate outputs, or with two outputs. This output mode is soft configured that is changeable using as simple process.

Common Anode or Cathode?

This is an important question with most circuits that drive LEDs, especially when using bi- or tri-colour LEDs with a common terminal. The SGA has been designed to work with either type. Selection is made by placing a jumper on one of two locations.

OPERATIONS

How one installs the SGA is very dependant on one's layout design. An overall signalling system can be very involved, and is best approached in small steps, one block at a time. For this reason, these instructions will present connection diagrams as small parts, showing the connections for a single signal installation, or perhaps one or two blocks.

Planning and wiring an entire signalling system for a layout, regardless of size, can be pretty overwhelming. The best approach is to do it one step at a time.

Outputs

The SGA has 9 outputs with current limiting resistors designed to directly drive three signal heads that use LEDs. Using incandescent lamps requires the use of a transistor, described in the section *Using Incandescent Lamps*.

The current limiting resistors on the SGA result in a current that is typically in the range of 10 to 15 mA. In most cases, no additional resistance is necessary. If the LEDs you use result in a current draw over 15 mA, it is recommended that additional resistance be added to your signals to bring the current draw down to 15 mA. If you find your LEDs draw less than 15 mA but glow brighter than you want, you may add resistance to reduce the brightness.

The three heads are identified as high, medium, and low. Each governs movement at its speed: high is the line's maximum speed, medium is usually 30 mph (50 km/h) and low is usually 15 mph (25 km/h). High-mounted signals protecting entry to an interlocking will have all three or the top two. Dwarf signals at an interlocking will have either just the low head, the low and medium head, or perhaps all three. The indications needed dictate what arrangement is installed, including whether a particular head needs to display all three colours or only a subset.

Automatic block signals between interlockings often have just the high head, but can have the high and medium head. The last automatic signal before an interlocking, often called an approach or distant signal, will usually have a high and a medium head, but occasionally may only have a high head. Like interlocking signals, the indications needed dictate what arrangement is installed.

The SGA is capable of three output modes:

Type D mode: Designed for use with three-colour signals This mode is used when signal heads have physically separate indicators. Three outputs are used per signal head to drive three separate LEDs (red, yellow, and green). Aspect changes have a brief dark moment.

Type SA, 2 output: Only the red and green outputs for each signal head are used to drive three-terminal bi-colour LEDs. Yellow aspects are displayed by activating the red and green outputs at the same time. The shade of yellow may be adjusted by adding resistance to either the green or the red LED. Aspect changes between yellow and green have a brief red flicker to simulate the prototype mechanism that has the red lens between yellow and green.

Type SA, 3 output: Three outputs are used per signal head to drive four-terminal tri-colour LEDs. Aspect changes between yellow and green have a brief red flicker to simulate the prototype mechanism that has the red lens between yellow and green.

The names "D" and "SA" come from GRS (General Railway Signal company) model designations. Type D may be referred to as "colour light" and Type SA may be referred to as "searchlight" signals. The SGA is initially configured for Type SA 2-output mode. See the section *Configuring Output Mode* for the procedure to change between output modes.

The SGA is designed to work with LEDs wired with either a common anode (+) or common cathode (-). Jumper JP1 is used to select the polarity used, see Figure 1. Place the jumper at the end of JP1 labelled CA for common anode, or place the jumper at the end of JP1 labelled $\overline{CC}$ for common cathode.
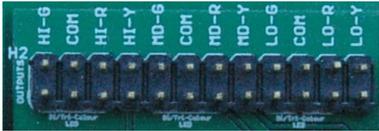
Connection to the outputs are through one row of a 2x12 header, see H2 in Figure 2. All pins of the other row (the row closest to the edge of the board) of the header are the common connection, either V+ or V- depending on jumper JP1. On the other row, four pins are for each signal head. Each four pins correspond to the Green, Common, Red, and Yellow connections for each head. This arrangement provides several connection options:

- 1x4 or 2x4 header sockets for each signal head
- 1x12 or 2x12 header sockets for the entire signal
- 1x2 header sockets for each individual LED/lamp
- 1x3 or 2x3 header sockets for each bi-colour LED
- Version of SGA with 12-terminal screw terminal block (special order)
- Version of SGA with bi-colour LEDs installed on board, for use with fiber optics (special order)

Inputs

The SGA has 14 active-low inputs. An active-low input normally has a +5 volt level and is activated by bringing it low, 0.8 volts or less. This can be done with contacts that grounds the input, or it may be driven by a circuit with an open-collector output, as shown in Figure 3. It may also be directly driven by a digital circuit or computer output that uses "TTL" levels (0-5 volts).
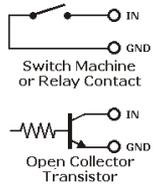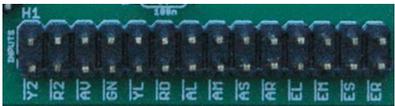
Six of the inputs are for DCA information and the other eight are used for speed restriction. Connection to these inputs are through one row of a 2x14 header, see H1 in Figure 4. All pins of the other row (the row closest to the edge of the board) of the header are ground (V-). As inputs are active low, for situations where an input must be always low, a jumper can be installed on the header to connect an input to its ground.

DCA information requires three inputs, but an additional R and Y input are available for use with ABS mode. The sixth input is used for an advance indications (advance approach), warning of a more restrictive signal two blocks down the line. Its function is the same for CTC and ABS modes, and is described the section Advance Inputs on page 6. The use of the other five inputs differs between CTC mode and ABS mode and will be described below.

DCA Inputs in ABS Mode

In ABS mode, the inputs labelled **RD**, **R2**, **YL**, **Y2**, and **GN** are used. Each of these inputs typically receive the output of a block occupancy detector. **RD** and **R2** are logically ORed together. This means that they are both logically do the same. They are provided for situations where two information sources must be logically combined, which can occur around a turnout. This prevents the need to electrically combine the source of the inputs. The same is true for the **YL** and **Y2** inputs.

Figure 5 shows an SGA that drives a signal for traffic from the left to the right at the boundary between the first and second blocks. The exit of the first block is where the signal is located, and this block is labelled *CURRENT BLOCK*. A train approaching this signal uses its indication to determine if it may enter the second block, labelled *ENTRY BLOCK*. When the train passes the signal and is in *ENTRY BLOCK*, it will be approaching the third block, labelled *APPROACH BLOCK*.
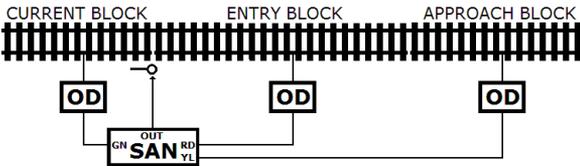
Figure 5

When *ENTRY BLOCK* is occupied, the signal must indicate stop, usually a red aspect. To make this easy to remember, the occupancy detector for *ENTRY BLOCK* must feed into the **RD** (or **R2**) input of this SGA.

When *ENTRY BLOCK* is vacant, the occupancy of *APPROACH BLOCK* will result in the signal displaying yellow. Therefore, its occupancy detector must feed into the **YL** (or **Y2**) input of the SGA.

The **GN** input is used for approach lighting, a feature that turns signals dark until a train is approaching, either in the *CURRENT BLOCK* or the *ENTRY BLOCK*. The **RD** or **R2** inputs tell the SGA when a train is in *ENTRY BLOCK*, and the occupancy detector for *CURRENT BLOCK* must feed into the **GN** input to tell the SGA when a train is there. If either *CURRENT BLOCK* or *ENTRY BLOCK* are occupied, the signal will be lit.

If approach lighting is not used (signal is always lit), place a jumper to connect **GN** to ground instead of feeding in an occupancy detector.

DCA Inputs in CTC Mode

In CTC mode, only the inputs labelled **RD**, **YL**, and **GN** are used. The system providing the DCA information may do so with either two, or all three inputs. When using three, only one may be active at a time.

When using only two, the **RD** and **GN** inputs that are used. When both are active, the SGA understands that as the same as the **YL** input.

When all three inputs are inactive, the signal will be dark. This allows the signalling system to implement approach lighting by making the signal dark with all outputs inactive. Since the **YL** input is never used in combination with either **GN** or **RD**, if **YL** is active with either or both of the other two, the signal will also be dark. Table 1 summarizes this as a truth table.

RD	YL	GN	SGA Interpretation
inactive	inactive	inactive	dark
inactive	inactive	active	clear
inactive	active	inactive	approach
inactive	active	active	invalid (dark)
active	inactive	inactive	danger
active	inactive	active	approach
active	active	inactive	invalid (dark)
active	active	active	invalid (dark)

Table 1

Speed Restriction Inputs

Speed restriction inputs are divided into two groups:

Entry: For the block immediately past the signal (*ENTRY BLOCK* in Figure 5)

**Approach:**   For the block past the next signal (*APPROACH BLOCK* in Figure 5)

For each group, there are four speed restrictions: **Limited**, **Medium**, **Slow**, and **Restricting**.

If any one of these inputs is active (low or ground), it will impose its speed restriction and control what the most permissive signal indication will be. For instance, if the Entry-Limited (**EL**) input were low while the DCA inputs indicate clear, then the output will be a "Limited to Clear" indication. If the DCA inputs indicate Approach, the output will be a "Limited to Stop" indication would be displayed, and if the DCA inputs indicate Danger, a the "Stop" indication would result. If more than one Entry input of a group is low, the indication will reflect the most restrictive active speed restriction input.

A truth table is available as a separate document on our website that shows all the possibilities. There is a separate table for CTC and ABS modes. Go to our website, http://circuits4tracks.daxack.ca and click on "Product Docs", then go down and click on the Signal Animator.

Figure 6 shows an example where two turnouts at an interlocking have contacts used to feed the speed restriction inputs of the SGA for the home signal at the points end (left side in the diagram) as well as the distant/approach signal on that side. The Entry Inputs are used for the home signal, and the Approach Inputs are used for the distant signal.

In the diagram, the turnout on the left has a medium speed limit for its diverging route, and the turnout on the right has a slow speed limit for its diverging route.
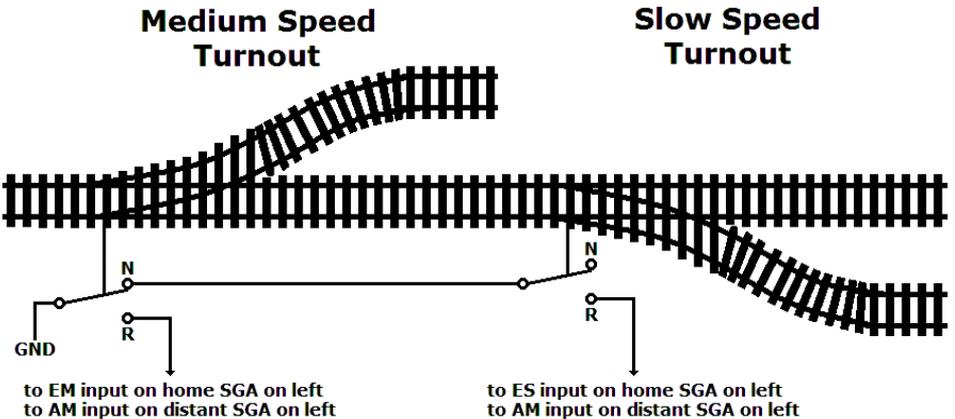
Figure 6

When a train approaches, the speed limit is unrestricted when both turnouts are in the normal position. If the left turnout is in the reverse position, then a medium speed restriction applies. If the left turnout is normal and the right is reverse, then a slow speed limit applies. Note that the common connection of the right turnout is only connected to ground when the left turnout is in the normal position. This ensures that a slow speed restriction only applies when a train is routed to the slow speed turnout.

Using Incandescent Lamps

The outputs of the SGA are rated to sink or source up to 25 mA, but current-limiting resistors keep the current to below 15 mA when used with most LEDs. Incandescent lamps cannot be used by directly connecting them the same way that LEDs are connected as they usually draw current in the 50 to 150 mA range, and can require a voltage greater than five volts.

To drive incandescent lamps, it is necessary to use a transistor such as the 2N3904 with a 1k resistor, as shown in Figure 7. The incandescent bulbs must be wired with a positive common, but the SGA must have JP1 installed in the common cathode (-) position.
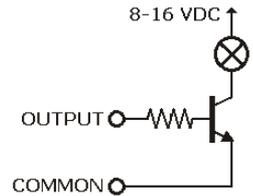
Figure 7

Configuring Output Mode

As described above, the SGA has three output operational modes: Type D mode uses three mutually exclusive outputs per signal head to display green, yellow, or red, and has a brief dark moment during signal changes; Type SA modes change between green and yellow aspects with a flicker of red, and there is the two-output version that uses the green and red outputs alone to display those colours, and uses them together to display yellow, and a three-output verison that uses the three separate outputs for each colour.
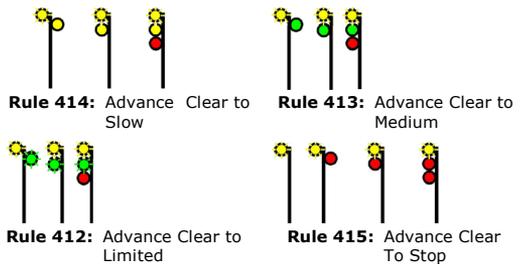
The SGA is initially configured for Type SA, 2-output mode. The following procedure changes the output mode:

1. Shut off or disconnect power to the SGA.
2. Remove the jumper from JP1, noting which end it was installed and place it on JP2.
3. Remove all inputs from the SGA, but place jumpers to short the following inputs as needed:

For Type_SA 2-input:	no jumpers
For Type SA_3-input:	jumper on ES
For Type_D:	jumper on ER

4. Power up or reconnect power to the SGA.
5. With the power on, remove the jumper from JP2.
6. You may now return the jumper on JP2 to its previous location on JP1, remove any jumper on ES or ER and reconnect the inputs, and the SGA will operate in the mode chosen. It will continue to operate in this mode each time it is powered up.

Advance Input (AV)

The input is labelled **AV** is used for "Advanced Clear to" indications. These are used where an additional indication for an upcoming less restrictive signal is displayed. There are four indications that exist, shown to the right with their CROR rule number and indication name.

Rule 414: Advance Clear to Slow

Rule 413: Advance Clear to Medium

Rule 412: Advance Clear to Limited

Rule 415: Advance Clear To Stop

Each indication is displayed when the SGA's inputs have the **AV** input active along with the necessary DCA and speed restriction inputs corresponding to the non-Advance version of the indication. See the indication Truth Table for the mode you are using (CTC or ABS), available on our website under Product Documentation.

To display these indications, the **AV** input must be active, along with the necessary DCA inputs (depending on mode) to generate a clear indication.

In all four cases, all four Entry speed inputs must be inactive while the required Advance speed input is active: **AS** for Advance Clear to Slow, **AM** for Advance Clear to Medium, **AL** for Advance Clear to Limited, and no Advance speed inputs active for Advance Clear to Stop.

Detailed Electrical Connections Between SGA and QOD

Other connection information focuses on detector output to SGA inputs. In ths section, full connection details with ground and power supply are included. In all cases, this is necessary, but other connection information does not repeat what is always the same in order to focus on situation-specific connections. Here, the details needed when using our Quad Occupancy Detector are provided. If using another occupancy detector, comparable connections will need to be used.
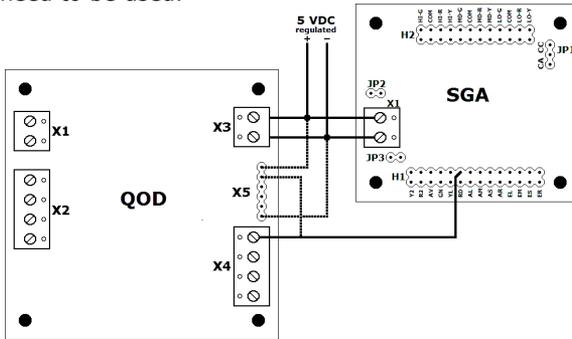

Figure 12

The most important connection that must always be made is the V- or ground connection. If both the QOD and the SGA use the same power supply, as shown in Figure 13, the negative of the power supply must be connected to the **V-** terminal of X3 on the QOD and the **-** terminal of X1 on the SGA. Note that if using the X5 header on the QOD, the **V-** is the pin closest to X4.

The next connection that must always be made is the positive connection of the power supply. The **V+** connection on the QOD is only needed for the on-board indicator LEDs. The detector will function properly if nothing is connected to the **V+**, but the LEDs will not light. If the 5 VDC version of the SGA is being used, the same 5 volt supply would be used for the **V+** on the QOD, either on X3 or X5 as shown in Figure 13.

If the 8-16 VDC version of the SGA is being used, there are a few choices for how to power the QOD. If the LED indicators don't need to be used, then nothing may be connected to **V+**. The second choice is to power the QOD with its own 5 VDC supply. If that is done, it is important for the negative output of that supply to be connected to the negative output of the power supply used for the SGA.
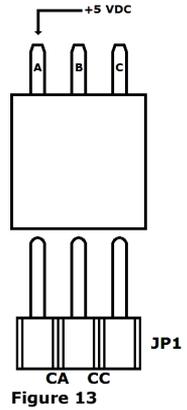
The third option is to power the QOD from the same 8-16 VDC supply that is used for the SGA. The issue with doing this is that the LEDs of the QOD will never be off. They will glow somewhat bright with the track is vacant, and will glow brighter when the track is occupied.

The final option is to power the QOD from the regulated 5 VDC that the SGA creates from the 8-16 VDC power supply. This is available on the "common anode" end of JP1

on the SGA.

If this is done, it is important to maintain the correct jumper setting for either common anode or common cathode. This would have to be done with a 3-position header socket as shown in Figure 14. For common anode, pins A and B must be connected together. For common cathode, pins B and C must be connected together. The regulated 5 volts DC is available on pin A.

Since a common ground has been established with the wiring described above, the connections to the inputs only need to involve a single connection. Be aware that the inputs are on the row of pins of H1 furthest from the edge of the circuit board. The diagram in Figure 13 shows the output of the first detector of the QOD being connected to the **RD** input on the SGA

Figure 13

Electrical Specifications

Power input requirements	8 - 16 volts DC, or 5 volts DC 12 mA minimum (dark indication) 75 mA maximum (typical worst case: 3-heads in Type SA/2-output mode displaying 2 yellows)
Output modes Soft configurable	Type SA: two outputs per head Type D: three outputs per head
Output common: Jumper configurable	Common Anode (+), or Common Cathode (-)
Operation modes: Jumper configurable	CTC mode: signalling logic provided externally ABS mode: signalling logic by SGA

Inputs:	Active low, with pull-up
	4 speed restrictions for entry block
	4 speed restrictions for following block
	1 input for "advance" indications
	CTC mode:
	     2 or 3 for danger/clear/approach
	ABS mode:
	     2 occupancy inputs for entry block
	     2 occupancy inputs for following block
	     1 occupancy input for rear block

Warranty

A factory-assembled SGA is tested and warranted against manufacturing defects for a period of 1 year from date of purchase. As the circumstances under which the SGA is installed cannot be controlled, failure of the SGA due to installation problems cannot be warranted. This includes misuse, miswiring, operation under loads beyond its specifications, or short circuits. The warranty is voided if the SGA is connected to a power supply the model's rated voltage, or if it is connected to an AC power supply of any voltage.

If the SGA fails for non-warranted reasons, it can be replaced with no questions asked for the cost of $25 plus shipping (this fee subject to change).

Send an email to **circuits@daxack.ca** for information on warranty or non-warranty replacement.

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