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 20 mA. In most cases, no additional resistance is necessary. If the LEDs you use result in a current draw over 20 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 in some cases 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 will have the high and medium head when the signal is a distant signal for an interlocking, of it needs to convey a possible upcoming speed restriction. As with interlocking signals, the indications needed dictate what arrangement is installed.

The SGA is capable of three output modes:

1) Type SA-2 mode: Only the red and green outputs for each signal head are used to drive three-terminal 2-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.

2) Type SA-3 mode: Three outputs are used per signal head to drive four-terminal 3-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.

3) 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 (30 ms) dark moment.

The names “SA” and “D” come from GRS (General Railway Signal company) model designations. Type SA are also referred to as “searchlight” signals and Type D are also referred to as “colour light”. The SGA may be configured for any mode, the software version number ends with the mode number of its default. 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.

Figure 1

Connection to the outputs use three 1x4 header, see H2H, H2M, and H2L in Figure 2. The pin labelled “COM” is either V+ or V-, depending on jumper JP1. The pin arrangements have the Green and Red outputs on each side of the common pin so that a 3-position plug may be used with SA-2 mode signals.

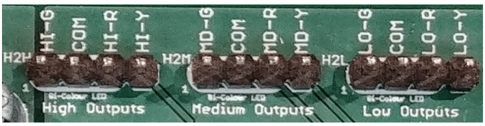


Figure 2

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 connect the input to V-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).

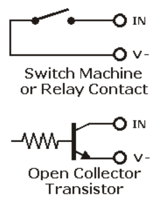


Figure 3

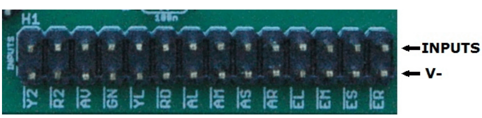


Figure 4

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 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 V-.

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 stop signal two blocks further down the line (the second signal “in rear” of this signal). Its function is the same for CTC and ABS modes, and is described the section Advance Inputs on page 7. The use of the other five inputs differs between CTC mode and ABS mode and will be described below.

Software Version

When the SGA is powered up, it will blink the Red outputs of the high and low signal heads to indicate the software version. At the time of this release, the version will be either 3.11, 3.12, or 3.13 depending on the default operating mode is (see page 2).

About one second after power up, each digit is blinked at a 200 ms rate to show the digit, with a 800 ms pause between digits. If a digit is zero, the a single 1200 ms blink will be used. A final 700 ms pause will occur before normal SGA operation begins.

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.

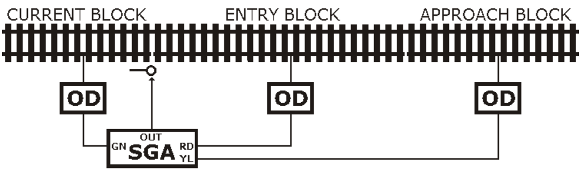


Figure 5

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*.

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 V- 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 are used. When both are active, the SGA understands that as the same as the **YL** input.

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

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 provides a truth table for the inputs **RD**, **YL**, and **GN**.

Speed Restriction Inputs

Speed restriction inputs are divided into two groups:

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

Approach: For the block past (in rear of) the next signal, labelled *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 (connected to V-), 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 active 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, regardless of any of the Entry inputs. If more than one Entry input of a group is low, the indication will reflect the most restrictive active 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.

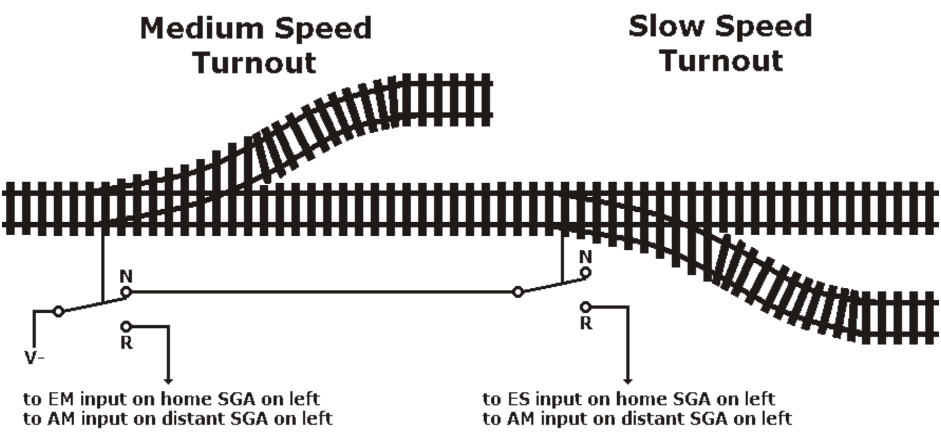


Figure 6

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 V- 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

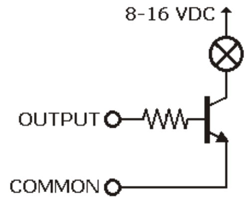


Figure 7

The outputs of the SGA are rated to sink or source up to 25 mA, but current-limiting resistors keep the current to below 20 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. The "COMMON" label in Figure 7 must be a common V- connection for both the SGA's power supply and the power supply for the incandescent lamp.

Configuring Output Mode

As described above, the SGA has three output operational modes: 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; 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.

The initial configured mode depends on the last digit of its software version, as the mode descriptions on page 2. The following procedure is used to change the output mode:

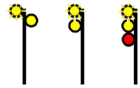
1. Shut off/disconnect power to the SGA.
2. Remove the jumper from JP1, noting which end it was installed and place it on JP2.
3. Remove all inputs and outputs from the SGA, but place jumpers to short the following inputs as needed:

For Type SA-2 mode:	no jumpers
For Type SA-3 mode:	jumper on ES
For Type D mode:	jumper on ER

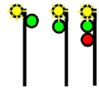
4. Power up/reconnect power to the SGA.
5. With the power on, remove the jumper from JP2.
6. Shut power off again and return the jumper on JP2 to its previous location on JP1, remove any jumper on ES or ER and reconnect the inputs and outputs. The SGA will operate in the mode chosen each time it is powered up.

Advance Input (AV)

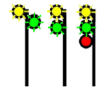
The input is labelled **AV** is used for "Advanced Clear to" indications. These are used where an additional indication for an upcoming less restrictive signal is displayed. There are four indications that exist, shown to the right with their CROR rule number and indication name.



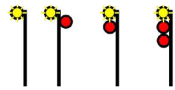
Rule 414: Advance Clear to Slow



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 V- and V+ 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.

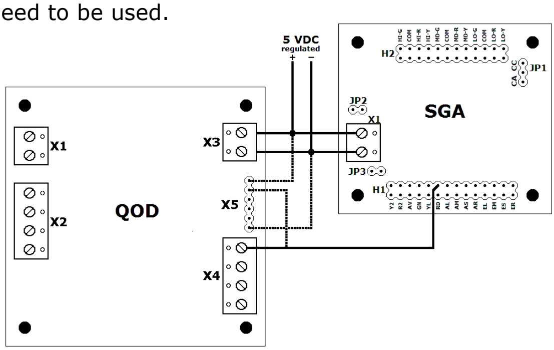


Figure 12

The most important connection that must always be made is the V-. If both the QOD and the SGA use the same power supply, as shown in Figure 12, 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 12.

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.

Electrical Specifications

Power input requirements	5 VDC, or 8 - 16 VDC 1-2 mA minimum (dark indication) Plus 10-20 mA per LED illuminated
Output modes Soft configurable	Type SA-2: two outputs per head Type SA-3: three 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
Input connector:	2x14 header, 0.1"/2.54 mm spacing
Output connectors:	1x4 header for each signal head, 0.1"/2.54 mm spacing

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 outside its 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 $22.50 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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