Overview

Today's high cost of energy mandates proportional control, you only use the exact amount of energy necessary to get the job done. Modern actuator technology makes proportional control easy for water valves and air dampers, but proportional control for electric heat, fans and refrigeration systems may be complex and cost prohibitive.

The BAPI BA/SQ4R sequences multiple on-off devices based on a single analog output from any controller. Now items such as cooling towers with multiple two-speed fans, staged electric heat and multi-compressor chillers can be cost effectively controlled to provide the utmost efficiency and consistency for the load at hand. Each BA/SQ4R provides four NO/NC outputs that open and close at fixed voltages across the control voltage range. Two BA/SQ4R devices may be cascaded to provide eight output stages. Each output on the BA/SQ4R can be set for normal or inverted polarity and provides 24VDC at 80mA.

The BA/SQ4R is capable of rotating its output sequences. Rotating output sequences can save wear and tear on equipment as well as save energy. Simply setting the controllers voltage to the device to less than 0.5 VDC changes the sequence.

All outputs open when power is removed from the device.

Mounting

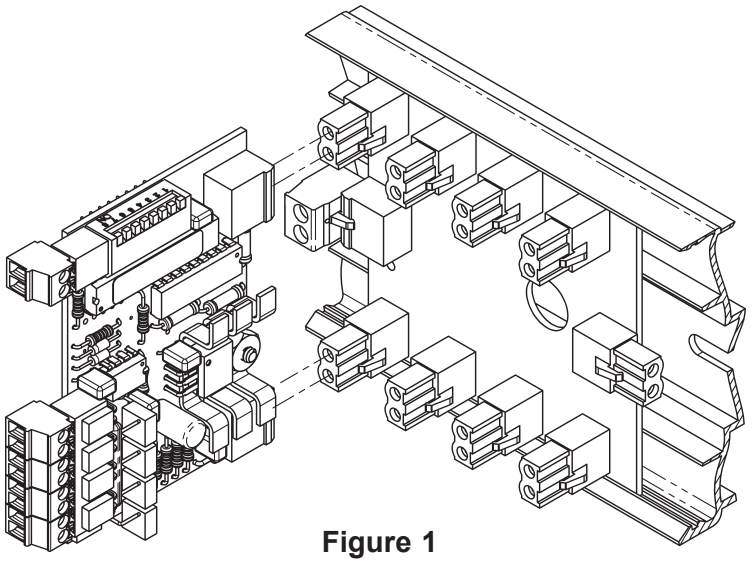

Figure 1
BA/SQ4R plugging into a BA/BP4

Termination

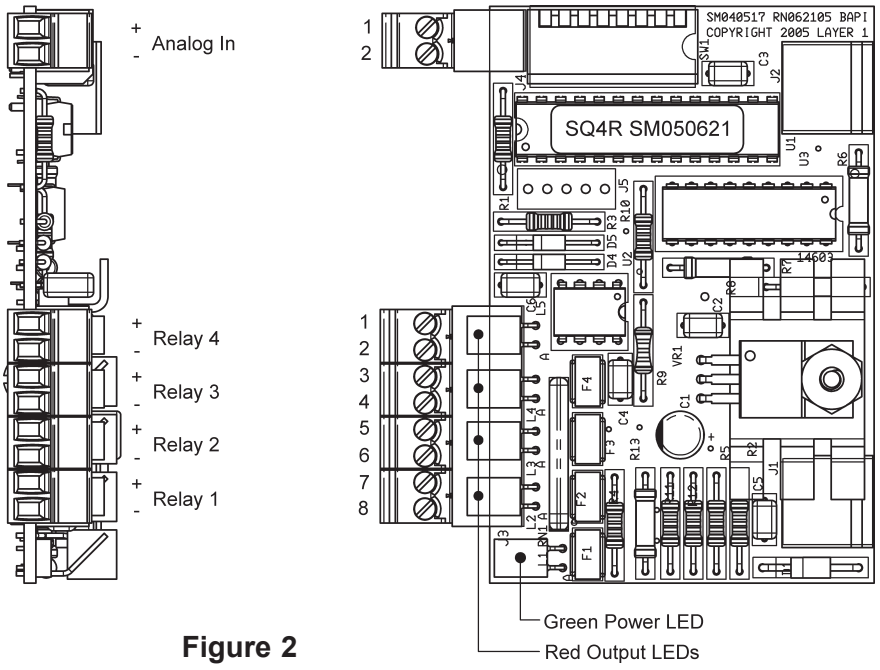

Figure 2
BA/SQ4R Component Identifier

Table 1: BA/SQ4R Connection List	
J4	
Pin 1	Analog voltage from Controller +
Pin 2	Analog voltage from Controller -
J3	
Pin 1	Relay 4 +, 24VDC @ 80mA
Pin 2	Relay 4 -
Pin 3	Relay 3 +, 24VDC @ 80mA
Pin 4	Relay 3 -
Pin 5	Relay 2 +, 24VDC @ 80mA
Pin 6	Relay 2 -
Pin 7	Relay 1 +, 24VDC @ 80mA
Pin 8	Relay 1 -

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Operation

The switch settings that govern how the BSQ4 operate are listed in table 2. (The switch is OFF when the toggle is up and ON when the toggle is down.)

Setting switches 5, 6 and 7 of the BA/SQ4R selects how many outputs you want to sequence. Up to eight outputs may be sequenced by using two BA/SQ4R's in tandem. Table 3 at right shows how to set the switches for the desired number of outputs:

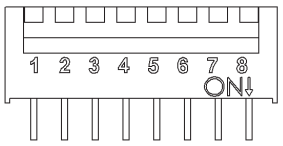

Figure 3 Dip Switch showing switch numbers

Table 2: BA/SQ4R Switch Settings

Switch	OFF Function (Default)[Switch Toggle Up]	ON function [Switch Toggle Down]
1	Output 1 Polarity normal	Output 1 Polarity inverted
2	Output 2 Polarity normal	Output 2 Polarity inverted
3	Output 3 Polarity normal	Output 3 Polarity inverted
4	Output 4 Polarity normal	Output 4 Polarity inverted
5	Selection Bit 0	Selection Bit 0
6	Selection Bit 1	Selection Bit 1
7	Selection Bit 2	Selection Bit 2
8	Analog voltage from controller = 0 to 10 VDC	Analog voltage from controller = 0 to 5 VDC

Table 3: BA/SQ4R Output Switch Settings

# Of Outputs to Sequence	Switch 5	Switch 6	Switch 7
1	Off	Off	Off
2	On	Off	Off
3	Off	On	Off
4	On	On	Off
5	Off	Off	On
6	On	Off	On
7	Off	On	On
8	On	On	On

Note: If sequencing less than the total number of outputs, the switching voltage remains the same as shown in the figures below.

FOUR OUTPUTS

If you plan to sequence 4 or less outputs, set switches 5 through 7 to the number you need as shown in Table 3. You have the option of using a 0-5 or a 0-10 volt controller voltage to sequence the outputs. Switch 8 sets the voltage.

The BA/SQ4R takes an analog input voltage and turns on the desired relay driver outputs. The BA/SQ4R allows the user to rotate the sequence of the outputs by setting the controllers voltage below 0.5 VDC When the BSQ4 encounters 0.5 VDC or less from the controller, it will rotate the sequence automatically.

For example, with increasing controller voltage to the BA/SQ4R, the BA/SQ4R will initially drive output 1, then output 2, then output 3, then output 4. When the controller's voltage drops under 0.5 VDC, The BA/SQ4R drives it's outputs beginning with output 2, then output 3, then output 4, then output 1. The next time the controller's voltage drops under 0.5 VDC, the BA/SQ4R will drive output 3, output 4, output 1, then output 2. The sequencing advances as follows:

Initial sequence: 1,2,3,4 • 1st 0 VDC Occurrence: 2,3,4,1 • 2nd 0 VDC Occurrence: 3,4,1,2
3rd 0 VDC Occurrence: 4,1,2,3 • 4th 0 VDC Occurrence: 1,2,3,4 • 5th 0 VDC Occurrence: 2,3,4,1

Every time the controller's voltage drops to 0VDC, the output sequence will change. See Figure 4 below. (Switch 8 ON)

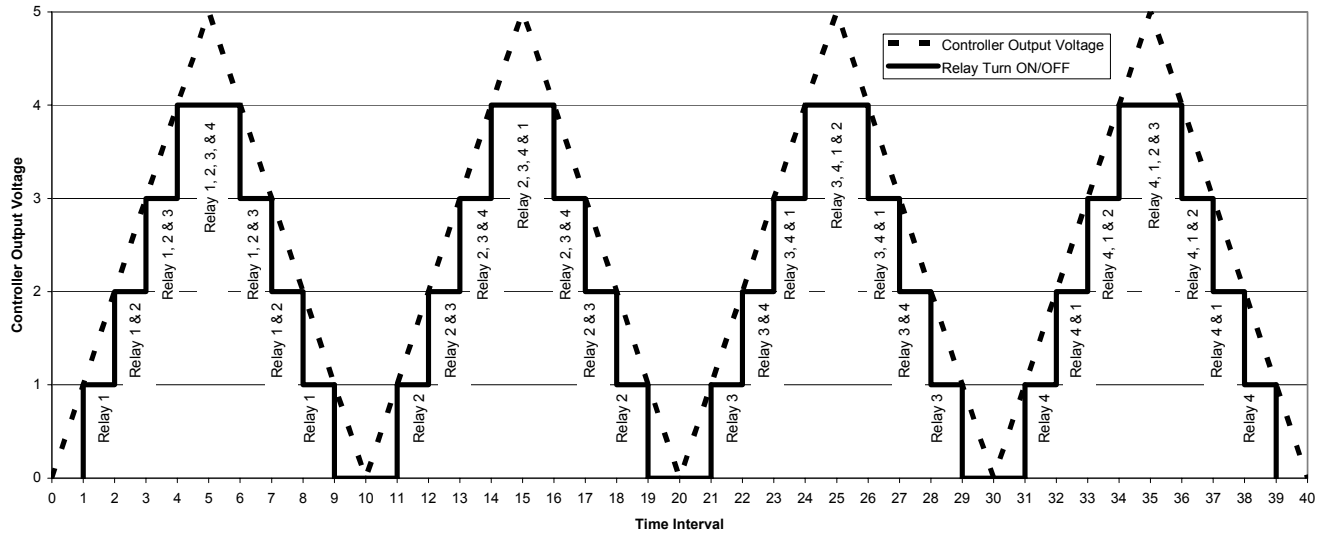

Figure 4: Rotational Sequence Four Outputs

The sequence will not change if the controller's voltage drops low enough that all relays turn off but does not drop below 0.5 VDC. See Figure 5 below. (Switch 8 OFF)

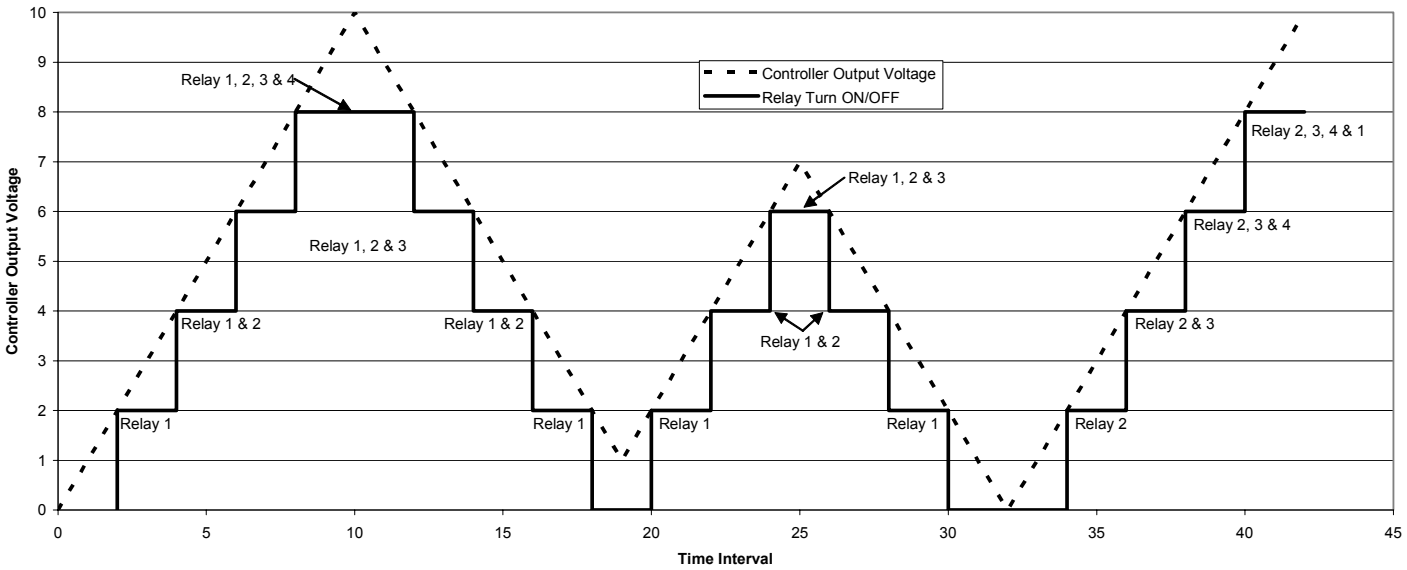

Fig. 5: Output sequence showing that the sequence does not rotate until controller voltage drops below 0.5VDC

Note: All step voltages have about 0.200 Volts of hysteresis. This means that once the outputs turn on, they'll have to drop by 0.200 volts before the outputs turn off. For example, if a given output turns on at 2.0 volts, it will turn off at 1.80 Volts. All voltages are +/- 5%.

EIGHT OUTPUTS (Two SQ4R Cards Connected Together)

BAPI realizes the need for flexibility and accuracy. Two BA/SQ4R sequencer cards can be connected together to sequence up to 8 outputs. Connect the same controller voltage to the Analog In on both cards. Set switches 5, 6 and 7 ON, on both cards. (Sequencing 8 outputs) Designate one card as Board_1 and the second as Board_2. Set Board_1 switch 8 OFF, the output sequence is illustrated in Figure 6:

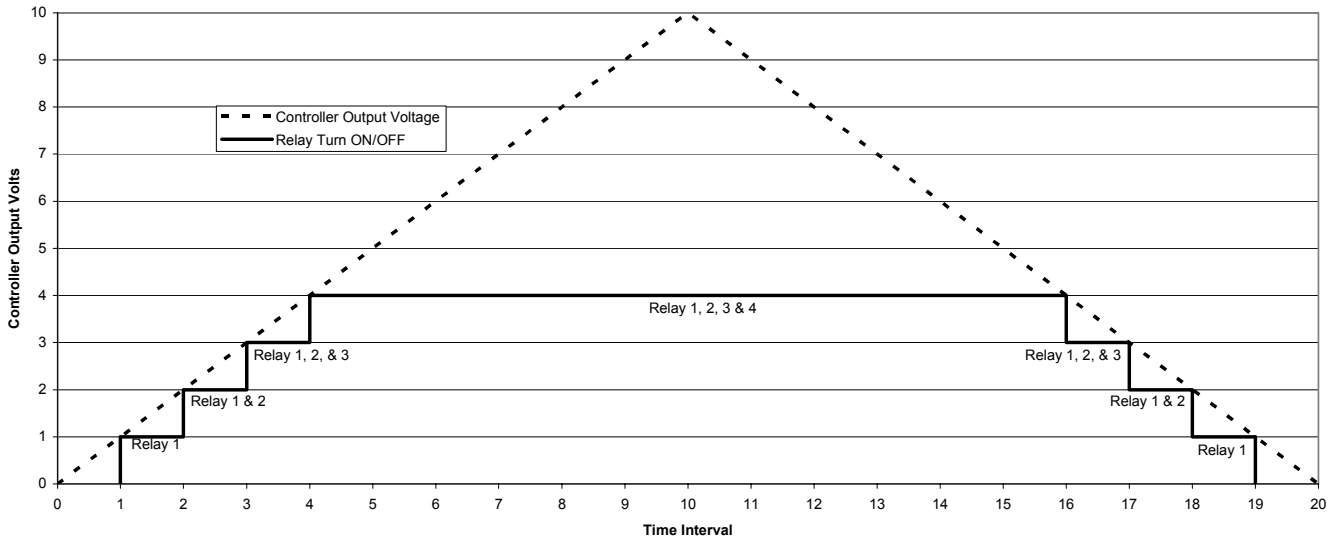

Fig. 6: Board_1 output sequence

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EIGHT OUTPUTS (Two SQ4R Cards Connected Together) continued....

Set Board_2 switch 8 ON, the output sequence is illustrated in Figure 7:

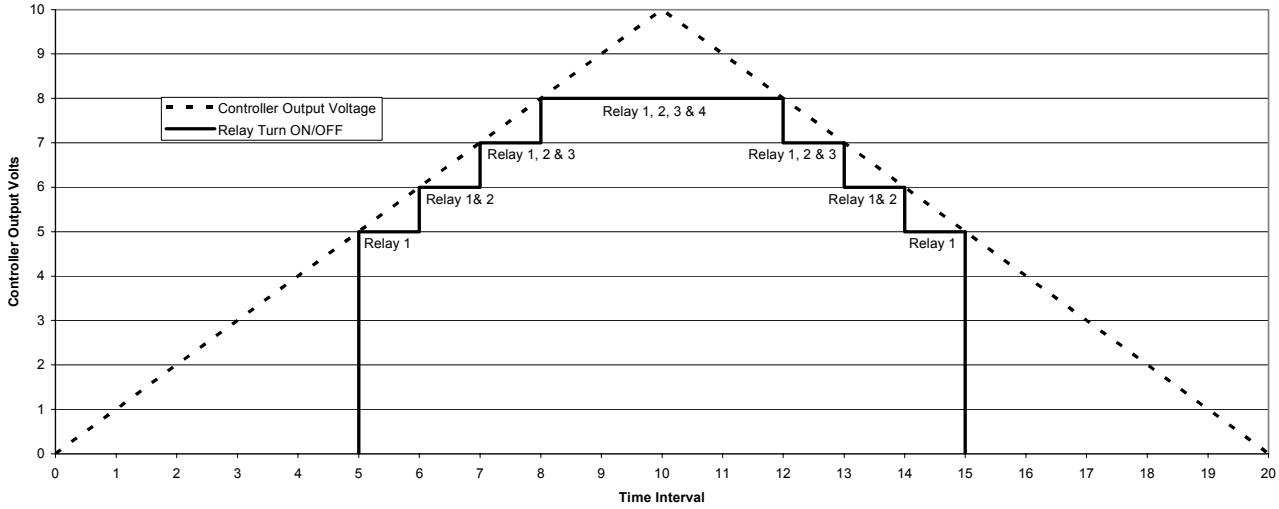

Fig. 7: Board_2 output sequence

Figures 6 and 7 show the base sequence of two boards set up for 8 outputs, in conjunction with one another they provide eight discrete outputs over a 0-10 VDC control range. All eight outputs rotate their output sequence as shown in the following example, and is graphically shown in figure 8.

Initial sequence: 1,2,3,4,5,6,7,8 • 1st 0 V Input Occurrence: 2,3,4,5,6,7,8,1
2nd 0V Input Occurrence: 3,4,5,6,7,8,1,2 • 3rd 0 V Input Occurrence: 4,5,6,7,8,1,2,3
4th 0 V Input Occurrence: 5,6,7,8,1,2,3,4 • 5th 0 V Input Occurrence: 6,7,8,1,2,3,4,5
6th 0 V Input Occurrence: 7,8,1,2,3,4,5,6 • 7th 0V Input Occurrence: 8,1,2,3,4,5,6,7
8th 0 V Input Occurrence: 1,2,3,4,5,6,7,8 • 9th 0 V Input Occurrence: 2,3,4,5,6,7,8,1

NOTE: Output 1,2,3,4 resides on Board_1. Outputs 5,6,7,8 reside on Board_2

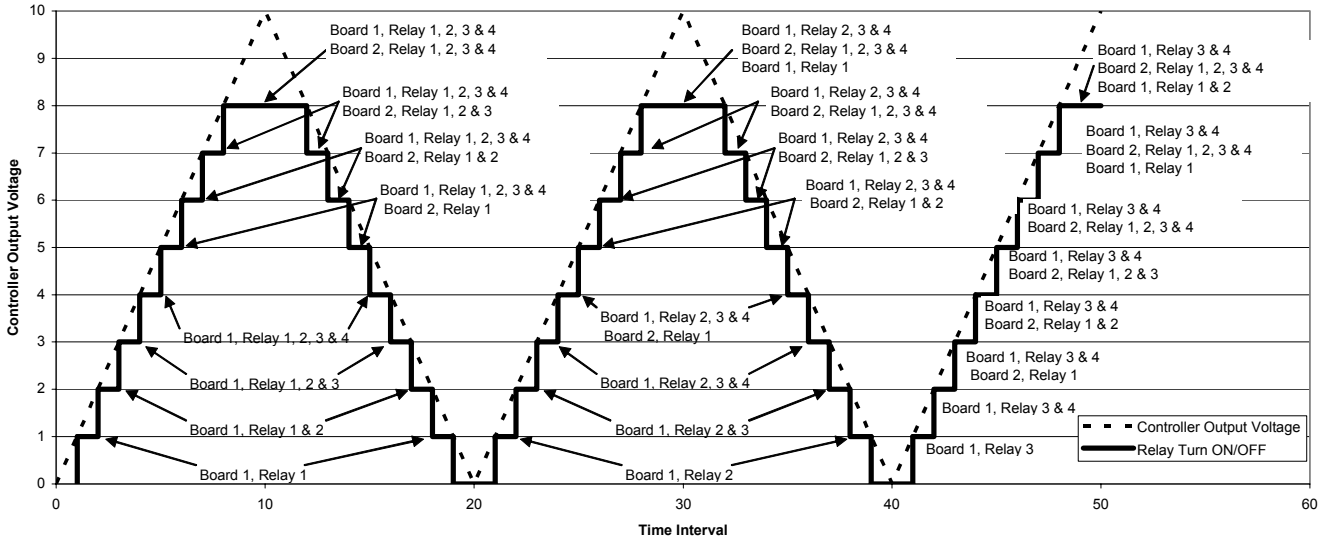

Fig. 8: First three sequences in an eight-output configuration

Specifications

Outputs: 24Vdc Nominal @ 0.80 Amps Max • Analog In (Control voltage): 0-10 VDC • Input Impedance: 132k Ohms +/- 1%

Specifications subject to change without notice.