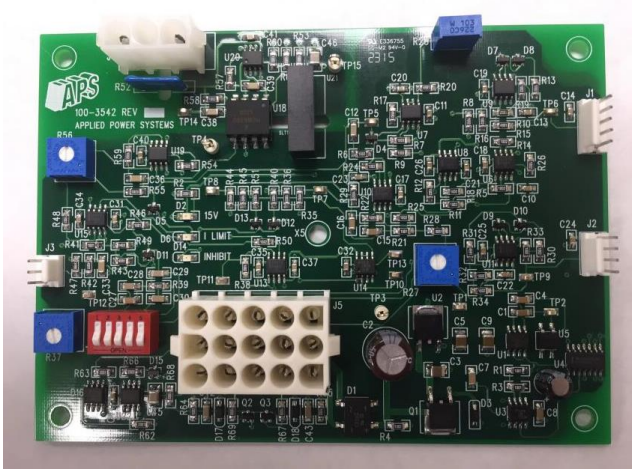
APPLIED POWER SYSTEMS, INC.

BAP 3542 General Purpose Closed Loop SCR Controller



Features:

- Interfaces with APS Standard SCR Controllers (BAP1950A & BAP3012)
- Enable/Inhibit Dual Channel Interlock
- On-Board Diagnostic LED Indicators
- Feedback for Solid State Over Temperature Sensing of SCR Heatsink
- On-Board Multi-Parameter Feedback Control -eliminates the need for external controllers
- Optional On-Board Optically Isolated Voltage Feedback
- Galvanically Isolated Current Feedback Inputs via Industry Standard LEM Hall Effect Sensors
- Industry Standard Size, Form Factor & Connector Interface
- Current Limit in Open Loop Mode
- On-Board pot for Phase Angle Control in Open Loop Mode

Functional Description

Options for Powering the Board

Designed with ease of integration as a paramount priority, the BAP3452 has two options for powering the board. Power can be supplied by either a 24VAC source or 24VDC source via connections on J5. These supplies may be provided by the user from a standalone source or via the on board outputs of the BAP1950A or BAP3012; both of which offer user available power sources.

Enable/Inhibit Lockout

The BAP3452 features a dual channel Inhibit/Enable scheme. In order for the BAP3542 to be enabled, J5-5 and J5-10 must be tied to the Inhibit Annunciate pin of its respective SCR controller. In order to provide a controlled and orderly start up sequence, the delay angle commanded by the user is not instantly applied to the SCR controllers at turn-on.

At start up, the delay angle is forced to the maximum value. Once the individual controllers' integrated fault detection circuit phase locks to the mains power and senses that no faults are present it will allow this signal to go low enabling that channel. If both channels' SCR controllers do not communicate this low going signal the Inhibit interlock will not allow any output from the Delay Angle outputs; J5-4 and J5-9.

Once both of these Inhibit signals have gone low the RED INHIBIT LED indicator will extinguish and the Delay Angle Output will begin to ramp to its Voltage Program value set via J5-4 and J5-9. (Factory default ramp time is 1 second to mitigate any contention with ramp times of the individual controllers. Consult factory for custom ramp times)

Fault Detection and Shut Down Sequence

As mentioned previously; if the BAP3452 does not receive two low Inhibit signals the user will be locked out of enabling the system and the RED INHIBIT LED will remain illuminated. Regardless of the state of the voltage program input or current limit input, the Inhibit signal dominates all.

If during operation, one of the boards being driven by the BAP3452 senses a fault of any kind it will communicate a high back to the controller and the controller will immediately lock the user out. The controller will re-enable itself and go through a soft start ramp once all faults are cleared and a low is communicated back from BOTH SCR controllers.

Delay Angle Control/ Voltage Program

The Voltage Program input can be factory configured to suit any application. The magnitude of the delay angle determines the point on the input waveform an SCR will be switched on. This controls the output voltage of a Converter (AC in, DC out) or an AC Controller (AC in, phase-controlled AC out).

The BAP3452 will accept a voltage or a current that will allow the user to control the delay angle. Standard options for the Delay Angle Control input include: 0-3.3VDC, 0-5VDC, 0-10VDC and 4-20mA.

To customize this input see options for Vprog on page 8

Where:
0V or 0mA corresponds to maximum delay angle (minimum conduction angle) or zero output

And:
3.3VDC, 5VDC, 10VDC, or 20mA corresponds to minimum delay angle (maximum conduction angle) or maximum output.

With the BAP3452 in open loop mode, the delay angle is controlled directly by the delay angle control signal supplied by the user at J3-2.In closed loop mode, the delay angle is controlled by the output of the voltage and current loops

Current Limit

A potentiometer (R23) allows the user to vary a current limit threshold that when reached will prevent any additional current from being sourced by the SCR bridges.

The pot may be installed on board or remotely mounted depending on customer preference.

Paralleled bridges require a current sensor, either Hall Effect or shunt, in both bridges that is fed back to the current feedback points J1(X-Bridge) or J2(Y-Bridge).

The BA3542 allows the user to incorporate this feature in open loop or closed loop modes.

Current feedback provided at J1 and J2 by an open loop Hall Effect sensor or shunt and a current limit controlling pot installed locally or remotely in the R23 footprint is all that is required.

A 10k Ω pot should be used in this application.

Open Loop Mode

In Open Loop mode, the delay angle controlling when the SCRs are fired is directly controlled by either a voltage or current input to J3-2 or by a pot mounted in the J3 location.

When the signal applied to J3-2 is 5V, 10V or 20mA (or when the pot in J10 is rotated fully CW), the delay angle is a minimum producing maximum output voltage.

When the voltage or current applied to J3-2 is 0 (also when the pot in J10 is rotated fully CCW), the delay angle is maximum, producing a minimum output voltage.

In a converter topology that produces only positive DC output voltage and current, the SCRs will not begin to conduct until the voltage is ≥1.75 volts at J3-2 (there will be a deadband in the pot as it is turned CW from fully CCW). In an AC controller topology, the SCRs will begin to conduct when the voltage applied to J3-2 is just above 0 (or when the pot is initially rotated CW form fully CCW).

Current Balancing Scheme

The BAP3542 controller uses active circuitry to force the currents out of two paralleled N pulse bridges to be matched to within 1%. Current feedback from either Hall Effect sensors or shunts monitoring the current out of each bridge is used to independently adjust the delay angle control voltage for each bridge to match the currents.

The reason for the diverging currents is often due to the input transformer. System designers are at the mercy of transformer manufacturers that attempt to match the turns ratios of both delta and wye secondary's.

The deviation in primary to delta and primary to wye ratios often results in two paralleled secondary bridges with slightly different output voltages, which may result in significantly different bridge currents.

The BAP3542 will constantly read the current out of each bridge and actively correct any imbalances.
Note:

1) The BAP3542 interfaces directly with the HAS, HAC, or HAX series Hall Effect sensors from LEM or equivalent. If a shunt is to be used consult the factory for additional equipment necessary (external isolation boards). The current magnitude out of each bridge will determine the current rating of the transducer.

Connectors

Connectors J1, J2 and J3 R23 (optional)

Standard MTA-100 IDC connectors are used for current feedback and voltage program connectors. The mates for these connectors are supplied with the board.

Part Numbers:

J1:3-640440-5, Dust Cover: 640550-5
J2: 3-640440-4, Dust Cover:640550-4
J3, R23: 3-640440-3, Dust Cover: 640550-3

Connectors J4 and J5

Two Mate-N-Lok™ type connectors allow for a convenient interface with the SCR gates. The mates for these connectors are supplied with the board.

Part Numbers:
J5:350736-1, J4:1-480700-0
Pins: 350550-1

J1 – Current Feedback X-Bridge

Pin	Signal Name	Description
1	+15VDC	+15VDC
2	-15VDC	-15VDC
3	Current Feedback X-Bridge	Voltage proportional to the current sensed out of Bridge X
4	GND	GND
5	N/C	No Connection; used for keying of Current Feedbacks

J2 – Current Feedback Y-Bridge

Pin	Signal Name	Description
1	+15VDC	+15VDC
2	-15VDC	-15VDC
3	Current Feedback Y Bridge	Voltage proportional to the current sensed out of the Y Bridge
4	GND	GND

J3 – Delay Angle Control/Voltage Prog.

Pin	Signal Name	Description
1	5V Reference	Precision 5V reference created on board used to control output voltage; limited to 10 mA. Connected to the high side of the pot.
2	Pot Wiper	**Standard:** Connected to the wiper of an external pot. **Option:** This pin can also be driven by a remote voltage source referenced to pin 3, where 0V is 0V on the output and 5V is the full-scale output.
3	GND	GND; Connected to the low side of the pot

J4 – High Voltage Feedback

Pin	Signal Name	Description
1	Output Voltage	DC output voltage up to 1000V; tied to the cathodes of upper SCRs, or after filter in a converter topology
2	Blank	
3	Output Reference	DC output reference; tied to the anodes of the lower SCRs in a converter topology

J5 – Control Interface

Pin	Signal Name	Description
1	24VAC INPUT	20mA for customer use, Board may also be powered via a 24VAC aux source.
2	24VAC INPUT	20mA for customer use, Board may also be powered via a 24VAC aux source.
3	24VDC INPUT	50mA available for customer use.
4	INHIBIT contact closure to 5/15VDC enables board	Shorting this to pin 6 or 7 enables the board. Letting it float will disable gating signals within 1mS
5	N/C	
6	15VDC	25mA available for customer use.
7	5VDC	25mA available for customer use.
8	GND	Reference for BAP3542control circuitry including delay angle control, therefore it must be tied to reference for delay angle control if external source is used.
9	INHIBIT ANNUN.	Normally low through a 100Ω resistor. Transitions high in a Fast turn off (J5-4 goes high), in an out of phase lock condition, phase loss condition or over temperature condition
10	PHASE ANGLE CONTROL	0 to 5 V analog input to control delay angle. 0V → Max Delay Angle; 5V®Min Delay Angle3
11	GND	Reference for BAP3542 control circuitry including delay angle control, therefore it must be tied to reference for delay angle control if external source is used.
12	SOFT STOP	When transitioned from a contact closure to pin 11 to an open circuit the delay angle ramps down from maximum to programmed value. If the board is running, when it transitions from an open circuit to a contact closure to pin 11, the delay angle ramps up from the programmed value to the max value.
13	Voltage Feedback	Optically Isolated representation of system output voltage. Factory default scaling is 0-10V Full Scale. Consult factory for custom scaling.
14	GND	Reference for BAP3542 control circuitry including delay angle control, therefore it must be tied to reference for delay angle control if external source is used.
15	Output Current Sum.	Isolated summation of system output current. . Factory default scaling is 0-10V Full Scale. Consult factory for custom scaling.

Adjustable Closed Loop Compensation

The BAP3542 comes equipped with dual parameter adjustable closed loop compensation via DIP Switch U12 and Potentiometer R37.

Rotating R37 fully clockwise increases damping to a maximum value of 21kΩ while rotating R37 fully counter clockwise will decrease the damping to a minimum value of 1kΩ.

Refer to the chart below for switch positions 1-4 which provide 4 discrete values of compensation to tailor the closed loop response of the BAP3542 to the dynamic characteristics of the load.

U12 Switch

SW1	1µF
SW2	.47µF
SW3	.22µF
SW4	.1µF
SW5	49.9K (Unity Gain)

For ease of system testing, SW5 may be closed leaving all other switch positions open thus putting the controller in a unity gain operating mode.

If Open Loop operation is desired the user can simply put the controller in Unity Gain Operation Mode by closing SW5 and removing the Voltage Feedback from the J4 Connector.

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The BAP3542 controller uses active circuitry to force the current sharing of paralleled bridges to be matched to within 1%.

Current feedback from Hall Effect sensors monitoring the current out of each bridge is used to independently adjust the delay angle control voltage for each bridge to match the currents.

System designers are at the mercy of transformer manufacturers that attempt to match the turns ratios of both delta and wye secondaries.

The deviation in primary to delta and primary to wye ratios often results in two paralleled secondary bridges with slightly different output voltages, which may result in significantly different bridge currents.

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APPLICATIONS

The BAP3542 controls multiple SCR firing boards in several common applications, **12 pulse regulated DC converter, 18 pulse regulated DC converter and 24 pulse regulated DC converter and AC Controller**. These are the most common circuit topologies found in industry. Please contact the factory for further details and schematics.

Ordering Information:

BAP3542-X-XXX-XXX-X

V_{prog}
- **1 -** 0 - 10V
- **4** – 4 – 20 mA
- **5** – 0 - 5V
- **P –** Onboard Potentiometer
- **H** – 3 pin header (for remote pot.)

Full Scale DC Voltage

Full Scale DC Current

Voltage Controlled by SCRs

- **1** – 10 – 100VAC
- **2** – 100 -690VAC
- **3** – High Voltage (consult factory for options)