

**Features Include:**

- Compact, rugged construction
- Applications include:
  - Windmill Converters
  - Motor Starters
  - Motor Drives
  - Phase Control AC
  - Regulated DC Power Supplies
- Variable Output Voltage
- Output Ratings:
  - AC to 500ARMS
  - DC to 600ADC
- 10 to 750VAC Input Voltage
- 40HZ to 80Hz Input Tracking with No Tuning
- Standard Options Include:
  - Filter Capacitor Bank
  - Input Fusing
  - Laminated Bus
  - Snubber Board
  - Current Sense
  - Forced Air Cooling

**Description:**

The APS SixPac™ Series of power controllers are built on a rugged, compact, all-inclusive, economical base. They have a great deal of flexibility to provide OEMs with a fully functional set of power stages. They have been designed for long life in heavy-duty industrial applications. The SixPac™ includes three dual isolated SCR modules that can be configured as either a three-phase AC Controller (AC in, phase-controlled AC out) or a regulated DC Converter (AC in, regulated DC out). This versatile power stage can be applied to virtually any power application that needs phase controlled AC or regulated DC and includes solid-state motor starters, soft-start/soft-stop, variable speed drives, windmill alternator converters and regulated power supplies to name a few.

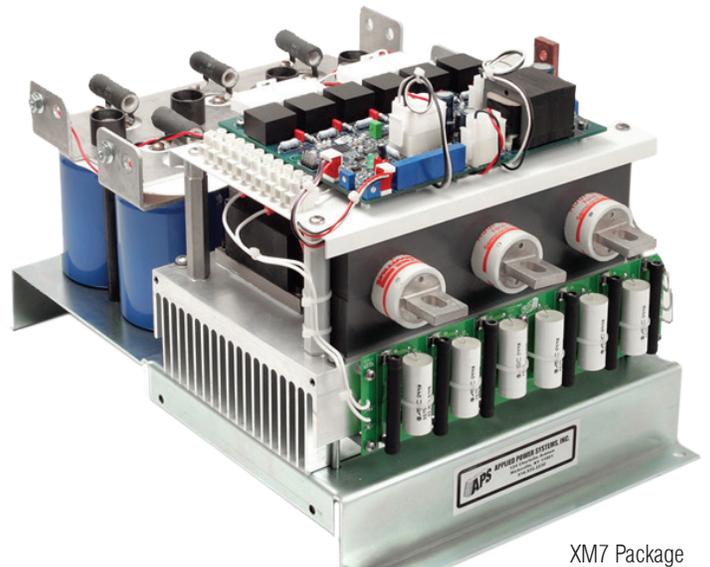
The isolated SCR modules are mounted on a high efficiency heatsink with input fusing, forced air cooling, and a capacitor filter bank (for regulated DC output). A snubber for the SCRs is available if dv/dt limiting is required. The compact design of our standard system measures approximately 18" wide by 10" long by 11" high, including the cooling fan, fuses, Hall effect transducer, output bus, snubber board, SCR gate drive board, capacitor bank, etc.

The SixPac™ is available with input from 10VAC to 700VAC, input frequencies from 40 Hz to 80Hz without tuning (this means that input from variable frequency alternators is acceptable as long as the frequency is within limits). AC Controller output currents range from 50ARMS to over 500ARMS. Regulated Converter outputs range from 100ADC to over 600ADC.

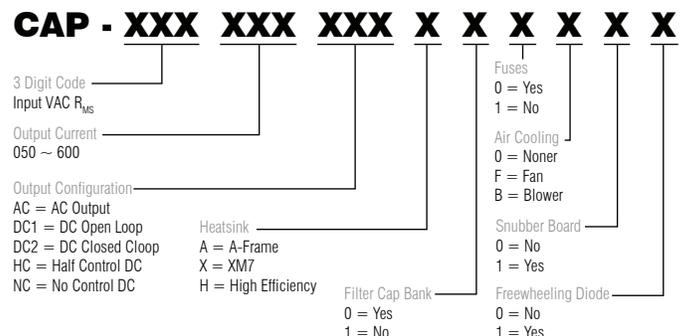
All units come with our industry proven BAP1950 SCR Gate Firing Board. The BAP1950 board is a flexible three-phase SCR controller suited for industrial/commercial power supplies of any power level. It utilizes advanced FPGA control logic to increase reliability, circuit flexibility and reduce circuit component count. The BAP1950 is designed to keep the programmed delay angle constant over a wide input frequency range (40Hz to 80Hz). This universal input feature does not require tuning in applications where the input mains frequency may vary, as in motor generator sets, windmill power generating equipment, and all field generating systems. The three-phase mains input is filtered by a unique signaling processing circuit that is not sensitive to harmonic distortion, input voltage amplitude fluctuations, frequency variations or phase sequence.



A-Frame Package with Fan  
Rated ### / ### / ### / ## VAC (3-Phase)  
Up to 900VDC at ### / ### / ### / ### Amps



XM7 Package  
Rated ### / ### / ### / ## VAC (3-Phase)  
Up to 1,000VDC at ### / ### / ### / ### Amps





PARAMETER	DESCRIPTION/CONDITIONS	CODE	MIN	NOM	MAX	UNITS
Input	3-Phase Delta Connection					
Input Current						
Input Surge						
Input Frequency		?	47		63	Hz
		?	400		480	
Hold Up	No Filter Capacitors	0				
	With Filter Capacitors	1				
Harmonics / Power Factor						
Optional Fuse	Each Phase					
Output Configuration		AC				
		DC1				
		DC2				
		HC				
		NC				
Output Current		050	-	-	050	Amps
		100			100	
		150			150	
		300			300	
		600			600	
		800			800	
		900			900	
		1000			1000	
Voltage Adjust Range						
Output Current Adjust Range						
Auxilliary Voltage		+5V	-		50	mA
Efficiency Range	at Nominal Input & 80% Load		-			
Regulation						
Ripple / Noise	20MHz					
Transient Response						
Turn On Delay						
Turn-On Rise Time						
Operating Temperature						
Strage Temperarure						
Temperature Coefficient						
Shock						
Vibration						



### **Phase Reference Sensing & Frequency Tracking**

An on board low pass filter is used to greatly reduce the harmonic content of the mains input used to generate the reference signals. The low pass filter attenuates the fifth harmonics above 60Hz, reducing delay angle errors from input line distortion. Additional circuitry actively forces the programmed delay angle to remain invariant over a mains input frequency from 40Hz to 80Hz. Therefore, operation of the SixPac™ in applications where frequency fluctuations occur regularly, i.e. when running from an alternator input powered by a diesel, gasoline or turbine engine; or when running from a system with an un-stabilized frequency is permissible. The programmed delay angle will remain constant over the frequency range from 40Hz to 80Hz with an accuracy of  $\pm 0.25^\circ$ .

### **Closed Loop Voltage Regulation**

The SixPac™, when supplied as a DC Converter, is equipped with circuitry to provide a regulated DC output, with adjustable voltage and current limits. The output is determined by a voltage reference that can be obtained from either an off board reference, the on board pot or an off board pot. The voltage reference is compared via an error amplifier to output voltage feedback that is processed through an isolation amplifier. Current feedback is brought back to the board via a connector (J11) that interfaces with an industry standard Hall Effect current transducer. An example of such an application is shown in Figure 1. Consult factory for output voltage scaling and error amplifier compensation networks to obtain the desired transient response and stability.

### **Soft-Start /Stop**

This circuit overrides the gate delay angle command. It is enabled by the power-on-reset feature or by contact closure inputs. SCR gating begins at the maximum delay angle limit and ramps down to the commanded delay angle at a rate determined by the soft-start time constant. The Soft-Stop feature, when activated by a contact closure, causes the SCR gate delay angle to ramp up from the command angle to the maximum delay angle limit before SCR gating is inhibited.

### **Fast Turn-off**

SCR gating is quickly enabled or inhibited ( $\sim 20\mu\text{Sec}$ ) on contact closure input.

### **Phase Loss Inhibit**

The phase loss circuit inhibits the SCR gate drive if a loss of phase voltage is detected. When voltage is restored, the soft-start circuit is engaged.

### **Overtemperature Inhibit**

SCR gating is instantaneously inhibited in an over temperature condition. Gate Delay Transfer Function The gate delay is determined by a phase locked loop consisting of a summing junction, low pass filter, voltage-controlled oscillator and an application specific integrated circuit. The voltage-controlled oscillator frequency is locked to the mains frequency. The DC control voltage is inserted into the summing junction to set the SCR delay angle.

The SCR gate delay angle is controlled by an input signal between 0 and +5 VDC. Gate delay angle is inversely proportional to this input signal. Minimum and maximum delay angles are determined for a given application and the proper offset resistor is selected from the provided resistor network.

### **DC Gate Drive**

The SixPac™ drives each SCR with direct current. The firing signal is an initial 2Amp pulse with a 500mA current for the duration of the conduction angle. The open circuit voltage is 24 Volts DC. This gate drive is suitable for driving large area SCRs in high di/dt applications.

### **Remote Voltage Control**

The output voltage of the power supply can be controlled remotely with an external pot (the minimum pot used in this application should be a 1K) or a 0 to 5V signal. This connector can be replaced with an on board 10K pot to control the power supply output voltage. The 5V reference at J10-1 has a limited source capability of 10 mA. Therefore, it should not be used for any circuitry other than the pot.

### **Current Limit Control**

The DC output of the power supply is brought back to the board via J6. An isolation amplifier attenuates the high voltage and isolates it from the output so that the feedback can be referenced to the signal ground.

**J10 CONNECTOR: Make & Model / Mates with**

PIN	PIN FUNCTION	DESCRIPTION
1	5VSB	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	Connected to the wiper of an external pot. 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

**J8 CONNECTOR: Make & Model / Mates with**

The DC output of the power supply is brought back to the board via J6. An isolation amplifier attenuates the high voltage and isolates it from the output so that the feedback can be referenced to the signal ground.

PIN	PIN FUNCTION	DESCRIPTION
1	High Side	To external high side of pot
2	Pot Wiper	To external pot wiper (10kΩ)
3	GND	To external pot low side

**TB1 Connector: Make & Model / Mates with**

Customer Interface for an AC to DC Converter AC to AC Controller Applications

PIN	PIN FUNCTION	DESCRIPTION
1	120 / 208 VAC	From J4 on BAP1950 board
2	120 / 2080 VAC	From J4 on BAP1950 board
3	N/C	Not Used
4	Fast-Turn-Off	Shorting this pin to pin 10 enables the power supply. Letting this pin float will disable the power supply within 20μSec.
5	Soft Start / Stop	When opened from GND (pin 6 or 9), the delay angle ramps down from maximum to the preprogrammed value. If supply is running when the pin is shorted (to pin 6 or 9), the delay angle ramps up from the programmed value to the maximum value.
6	GND	Reference for BAP1950 control circuitry including delay angle control, therefore it must be tied to reference for delay angle control
7	Inhibit Enunciate	Normally low through a 1k resistor. Transitions high in a Fast turn off or in an out of phase lock condition.
8	Delay Angle Control	0 to 5 V analog input to control delay angle, when operating in OPEN LOOP mode. 0V Max Delay Angle; 5V Min Delay Angle
9	GND	Reference for BAP1950 control circuitry including delay angle control, therefore it must be tied to reference for delay angle control
10	+5V Aux	Up to 50mA for customer use

**J8 CONNECTOR or Potentiometer: Make & Model / Mates with**

PIN	PIN FUNCTION	DESCRIPTION
1	High Side	To external high side of pot
2	Pot Wiper	To external pot wiper (10kΩ)
3	GND	To external pot low side

J11, J12, J3, J4, J6 LOOK USED BY FACTORY (DO NOT USE)



J?? CONNECTOR: Terminal Strips

PIN	PIN FUNCTION	DESCRIPTION
1		
2		
3		
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