SOLID-STATE POWER CONTROLLERS (SSPCs)

SERIES 90000 – 28 & 270-VDC, @10 & 20 AMPS

GENERAL DESCRIPTION

Series 90000 Solid-State Power Controllers are TTL-controlled power switches with programmable trip characteristics designed for use as solid-state replacements for 3- to 20-ampere circuit breakers.

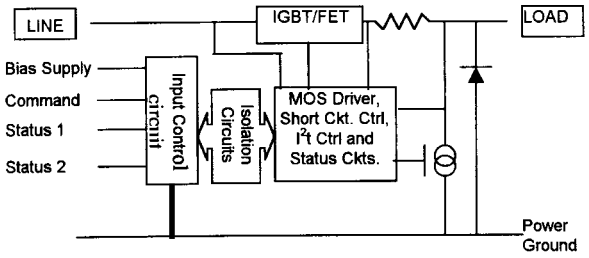
- **Four DC versions—**28 and 270 VDC, 10 and 20 Amperes.
- **Externally programmable** for I^2T and instant current trip points.
- **Status reporting** permits remote sensing of trip, over-temperature, line voltage, and SSPC failures.
- **Thick-film hybrid technology** delivers high reliability in small size.
- **Low junction-to-case thermal resistance—**achieved through metallurgical bonding of power devices directly on mounting tabs.

APPLICATIONS

Designed for use in land, air, sea and space deployed systems that require low cost and high reliability power control.

FEATURES

- **INSTANT TRIP PROTECTION—Pin-programmable to 1,200% of rating**
- **INTERNAL THERMAL OVERLOAD PROTECTION**
- **OPTICALLY ISOLATED CONTROL STATUS CIRCUITRY**
- **I^2T PROTECTION—Pin-programmable to 30% of rating**
- **MIL-STD-704 COMPLIANT**
- **LOW 'ON' RESISTANCE**
- **LOW POWER DISSIPATION**
- **HERMETICALLY SEALED**
- **LOW COST**
- **HIGH RELIABILITY**



Block Diagram

	MAXIMUM RATINGS/BREAKDOWN VOLTAGE		RECOMMENDED OPERATING CONDITIONS	
SSPC Model	**90028-XX**	**90270-XX**	**90028-XX**	**90270-XX**
Line/Load Terminal-to-Signal Ground	**100 VDC**	**600 VDC**	**5 to 50 VDC**	**5 to 300 VDC**
Bias Supply Voltage	**-0.5 to 7.0 VDC**		**4.5 to 5.5 VDC**	
Control Input-to-Signal Ground	**±30 VDC**		**0 to 6.0 VDC**	

STORAGE TEMPERATURE -65°C to +150°C. OPERATING TEMPERATURE -55°C to 125°C

Table 1—Maximum Ratings and Recommended Operating Conditions

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UNDERSTANDING SOLID-STATE POWER CONTROLLERS

As computer-controlled system technology advances, more system functions, including power control, fall under its command. Since mechanical circuit breakers do not lend themselves to this type of control, a solid state solution was developed. Solid State Power Controllers (SSPCs) were the result.

To understand SSPC specifications, it is necessary to understand the mechanical circuit breaker. These devices protect wire harnesses from overheating, which may result from abnormally high current drains due to a malfunctioning system component.

In addition, circuit breakers must be able to turn reactive loads on and off. Turning on into a capacitive load results in high inrush currents that may be more than 10 times their rated currents. Conversely, turning off highly inductive loads results in a large voltage or inductive kick, which can exceed their voltage rating. Contact erosion caused by arcing in these load types severely limits circuit breaker life and produces severe EMI problems.

Circuit breakers work by passing current through a bimetallic strip. When this strip heats, due to I^2R power dissipation, the resultant deflection serves as a trip mechanism. The deflection is directly proportional to the temperature, and the temperature is proportional to the length of time it has dissipated its I^2R power. Thus the I^2T curve seen so often in SSPC data sheets.

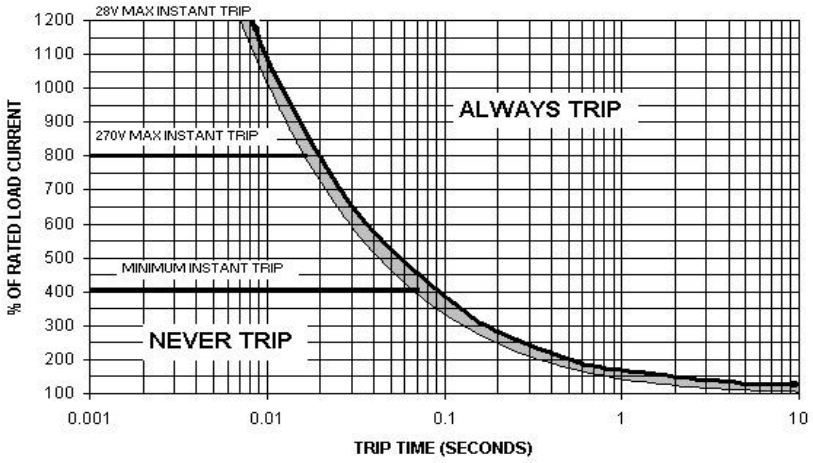
One of the significant advantages of SSPCs is the elimination of contact closure. The soft turn-on feature of SSPCs reduces the peak inrush current into capacitive loads, reducing EMI emissions greatly. In addition, during turn-off of inductive loads, stored energy can be dissipated in the pass element, as well as, a shunt diode.

A multiplier and comparator duplicate the I^2T trip characteristics. In addition to I^2T circuitry, an instant trip circuit shuts off the SSPC when the inrush current exceeds the preset level. This forms the upper limit of the I^2T curve.

Referring to Figure 1, the heavy line shows the instant trip set to 400% of rated load. With decreasing current, the trip time increases. For light overloads, the unit will trip in 10 seconds. As a convenience to our customers, NHI has designed its SSPC to allow external programming of both the I^2T trip point and the instant trip time.

The Series 90000 package provides superior electrical performance and lowest possible thermal resistance. Being a matched TCE system, the package will withstand stringent environmental conditions. The flexibility of the unique construction of the Series 90000 packages allows for quick and affordable configurations.

Figure 1 - Typical I^2T curves



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- **INSTANT TRIP PROTECTION—Pin-programmable to 1,200% of rating.**
  Series 90000 SSPCs incorporate a programmable instant trip feature. If the load current exceeds the programmed level, the unit will trip in less than 25µ seconds.*

- **INTERNAL THERMAL OVERLOAD PROTECTION**
  Series 90000 SSPCs contain built-in thermal overload protection. The temperature of the switching elements is constantly monitored. If their temperature exceeds a safe limit, the unit will turn off and report an "over temperature" fault on its status outputs. Restart is automatic when the unit cools down approximately 15°C. For certain applications involving "battle override" requirements, the unit can be supplied such that an over-temperature condition is reported on the status output, without protecting itself by turning off.

- **OPTICALLY ISOLATED CONTROL/STATUS CIRCUITRY**
  Series 90000 SSPCs utilize optical couplers for the control and status reporting functions, ensuring complete isolation of these "TTL"-compatible functions from the power line. The control input is a diode-protected schmitt trigger gate for maximum noise immunity. The status outputs are "HC" CMOS compatible and can sink or source a minimum of 4 mA.

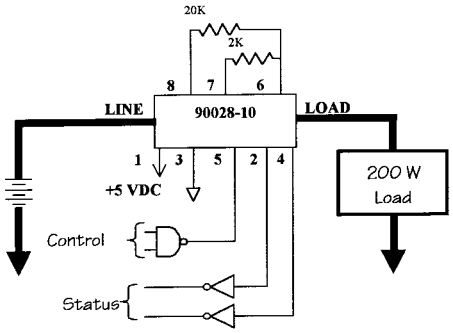
  * Programmable to 800% for 270V, 1200% for 28V, by the addition of an external resistor.

- **I^2T PROTECTION—Pin-programmable to 30% of rating.**
  Series 90000 SSPCs feature programmable, I^2T trip characteristics. This provides a relatively long (many seconds) trip time for modest overloads, while severe overloads will trip in milliseconds. By the addition of an external resistor, the actual trip point can be lowered to as low as 30% of its nominal rating. This allows a single type to be utilized in multiple applications, reducing inventory and costs.

- **MIL-STD-704 COMPLIANT**
  NHi's SSPCs are compliant to the surge and transient requirements of MIL-STD-704. The off-state voltage blocking rating between the power and control/status pins is 100 VDC, with 500V minimum isolation for the 28V models. The 270V models exhibit 600VDC voltage blocking with a minimum of 1000V isolation.

- **LOW LOSS**—Forward voltage drop as low as 0.1 V on 28 VDC devices. Power MOSFETs provide low ON resistance. The 270 VDC units use low Vsat IGBTs (<1.2 Volts max.) as the pass elements. The unique construction of Series 90000 SSPCs utilizes the high-current input/output tabs as the mounting mechanism, and the heat sink for the high-power switching elements. The direct metallurgical bond between the switching elements and these tabs ensures extremely low electrical ON resistance and a minimum Øjc for the switching elements.

TYPICAL APPLICATIONS



Set to trip at 8 Amps and Instant trip at 80 Amps.
This is a reasonable selection for operating a 200W lamp load.

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OPERATING CONSIDERATIONS

- **Voltage Transients**
  In any circuit configuration, it is necessary to guard against voltage transients during Off switching of SSPCs. NHI SSPCs are equipped with an internal shunt diode for negative transients on the load side. On the Line side, the user is required to place a transient voltage suppressor. The transients at this terminal are positive and add to the line voltage. To prevent voltage breakdown of the switch elements, a Transorb of proper voltage and energy rating is utilized. Voltages on 28 VDC units should never exceed 100 VDC, and 600 VDC on 270 VDC units. Transorb should be installed as close as possible to the SSPC. Any inductance between the two compromises Transorb effectiveness.

- **Current Transients**
  During 'turn on', capacitive loads cause high surge currents limited only by wire impedances. If the capacitance value is too great, the instant trip circuit might trip the SSPC. Soft turn-on of the MOSFET or IGBT reduces the effect of this condition. However, the design engineer should carefully examine his system to ensure that high capacitive loads are minimized and that there is a reasonable resistance in the wiring to limit high surge currents.

SYMBOL	PARAMETER	MIN	TYPICAL	MAX	UNITS
V_{ih}	Control Input High	3.15			Volts
V_{iL}	Control Input Low			0.9	Volts
V_{OH}	Output High	4.0			Volts
V_{OL}	Output Low			0.4	Volts
I_{dd}	Supply Current		25	35	mA

Table 2 — I/O Specifications

	COMMAND	CONTROL INPUT	STATUS S1	STATUS S2	OUTPUT	SSPC STATUS
1	OFF	0	0	0	OFF	Normal Off
2	OFF	0	0	1	OFF	Over Temp
3	OFF	0	1	0	OFF	SSPC Fail
4	OFF	0	1	1	OFF	No Line Voltage
5	ON	1	0	0	ON	Normal On
6	ON	1	0	1	OFF	Over Temp
7	ON	1	1	0	OFF	Tripped
8	ON	1	1	1	OFF	SSPC Failure

Table 3 — Truth Table
TTL/CMOS - compatible status lines report SSPC operating conditions to the system. Eight different states are possible, as described above.

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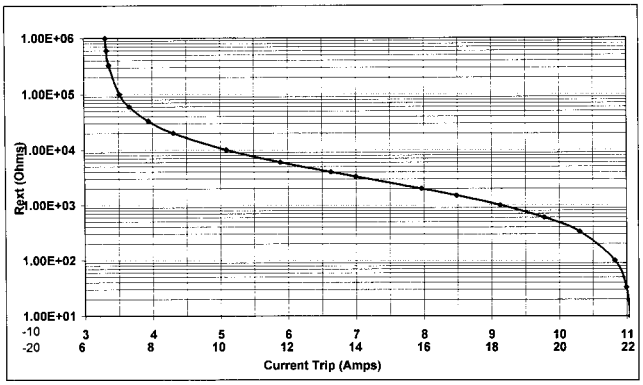

Figure 2 : Current Trip Selection
A resistor between pins 6 and 7 allows the user to set the trip point to any value between 3 and 10 Amps. The chart shows the relationship between the resistor value (R_{ext}) and the trip current.

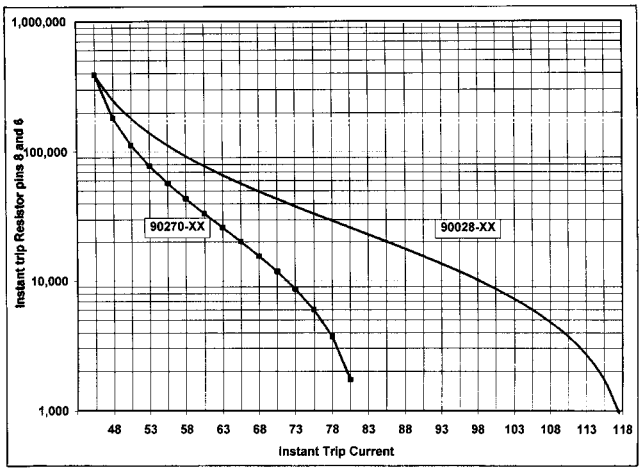

Figure 3: Instant Trip Selection
Leaving Pin 8 open sets trip to 40 Amps. Connecting it to Pin 6 sets it to 120 Amps. (80 Amps for 270-Volt units.) Placing a resistor between pins 6 and 8 allows the user to set the INSTANT trip point to any value between 40 and 120 Amps (40 and 80 Amps for 270-Volt Units). The chart shows the relationship between the resistor value and the INSTANT trip current.

SYMBOL	PARAMETER	MIN	TYPICAL	MAX	UNITS
I_L	Instantaneous Trip Current	40		120	Amps
	(90270-XX)	40		80	Amps
R_{ON}	On Resistance 90028-10		.025	.03	Ohms
	90028-20		.015	.02	
Fwd Drop	Forward Drop 90270-XX		1.2	1.5	Volts
I_{Leak}	Leakage Current		200		uAmps
$V_{O\ off}$	V out when off (No Load)			1	Volts
C_{IO}	Line to Load Capacitance			1000	pFarads
t_{on}	Delay to t_{on}			1	mSecs
t_{OFF}	Delay to t_{OFF}			1	mSecs
θjc	Thermal Resistance			0.25	°C/Watt
t_r	Rise Time		0.6	1	mSecs
t_f	Fall Time		0.1		mSecs
	Trip Time @ 200% of rated load		.35		Secs
	Trip Time @ 300% of rated load		.15		Secs

Table 4 - Power Characteristics

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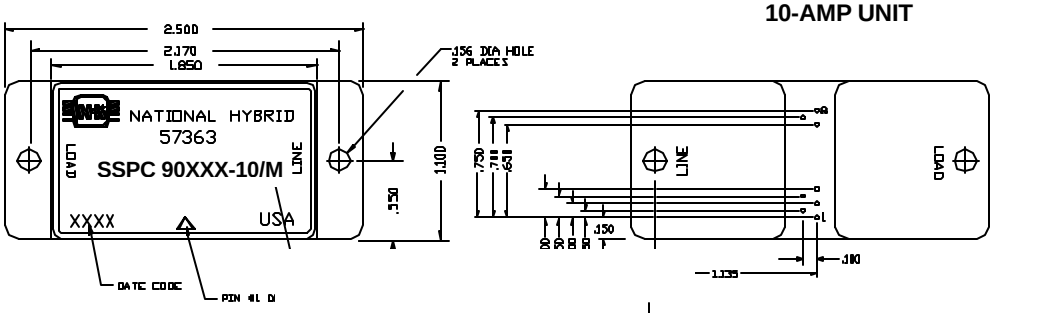
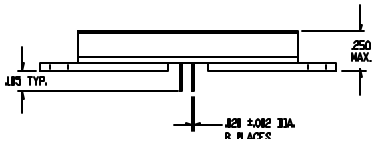
OUTLINE DRAWINGS 28 & 270V

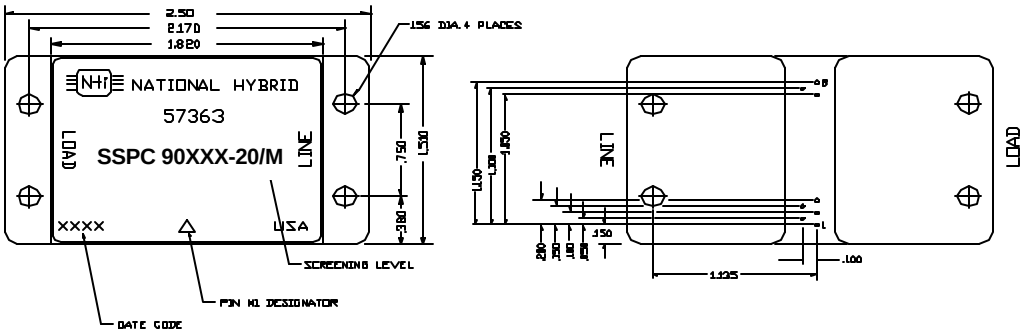
10-AMP UNIT





SIDE VIEW (10 & 20 Amp Units)

20-AMP UNIT



TOP VIEW **BOTTOM VIEW**

PIN ASSIGNMENTS (10 & 20 A)

1. **+5 volt Bias**
2. **S1 Status**
3. **+5 Volt Return**
4. **S2 Status**
5. **Control In**
6. **Load**
7. **I Current Trip Adj.**
8. **I Instant Trip Adj.**

Weight

10 amp version - 1.11 oz (31 gms)

20 amp version - 1.45 oz (41 gms)

ORDERING INFORMATION

SSPC 90028 – 10 / M

028 = 28V
270 = 270V

10 = 10 Amp
20 = 20 Amp

M = Military Screening to MIL-STD-883, -55°C to +125°C
T = Industrial, -55°C to +125°C
(Blank) = Industrial, -40°C to +85°C

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