

**Features:**

- Isolated Controls
- Isolated Status Outputs
- Fault Protection
  - Thermal Shutdown
  - Undervoltage & Overvoltage Shutdown
  - Current Limitation
  - Short Circuit Protection

**Applications:**

- Power Distribution In Land/Air/Launch Vehicles
- Motor Switch
- Displays/Lamps/Controls
- Industrial Automation
- Switching Heaters
- Test Equipment
- Machine Control Equipment
- Medical Lab Equipment

**DESCRIPTION**

The **53248** is a 28 VDC Solid State High Side Power Controller (SSPC) that is designed to replace electromagnetic circuit breakers rated at 10 amperes. It is a high side switch utilizing N-channel vertical power FET technology with integral charge pump. The SSPC provides a status output that signals a variety of conditions including over temperature shutdown, overvoltage or undervoltage, over-current or short circuit. It will trip off for any of the above conditions and automatically (based on an internal thermal time constant) cycle On/Off until the fault or the control signal is removed.

Using vertical MOSFET technology, the SSPC offers extremely low "ON" resistance. This results in very low power dissipation, which allows operation over the temperature range of  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  with minimal heat sinking.

**ABSOLUTE MAXIMUM RATINGS**

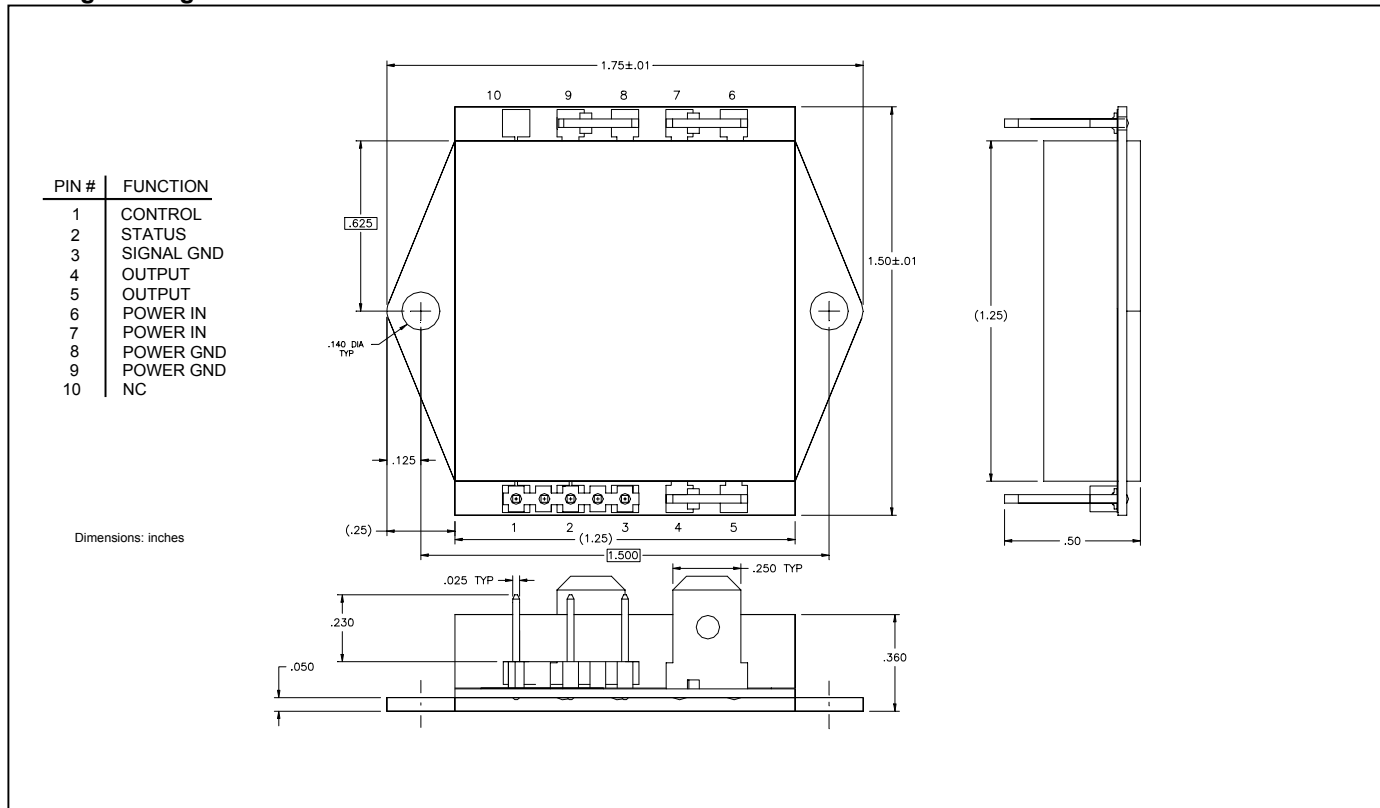
(@  $T_C = 25^{\circ}\text{C}$  unless otherwise specified)

Input Control Current.....	10 mA
Reverse Input Voltage (Control to Signal Ground).....	- 5 VDC
Pins to Case Isolation.....	1000 VDC
Input-Output Isolation.....	1000 VDC
Lead Temperature.....	+300°C
Junction Temperature.....	+150°C

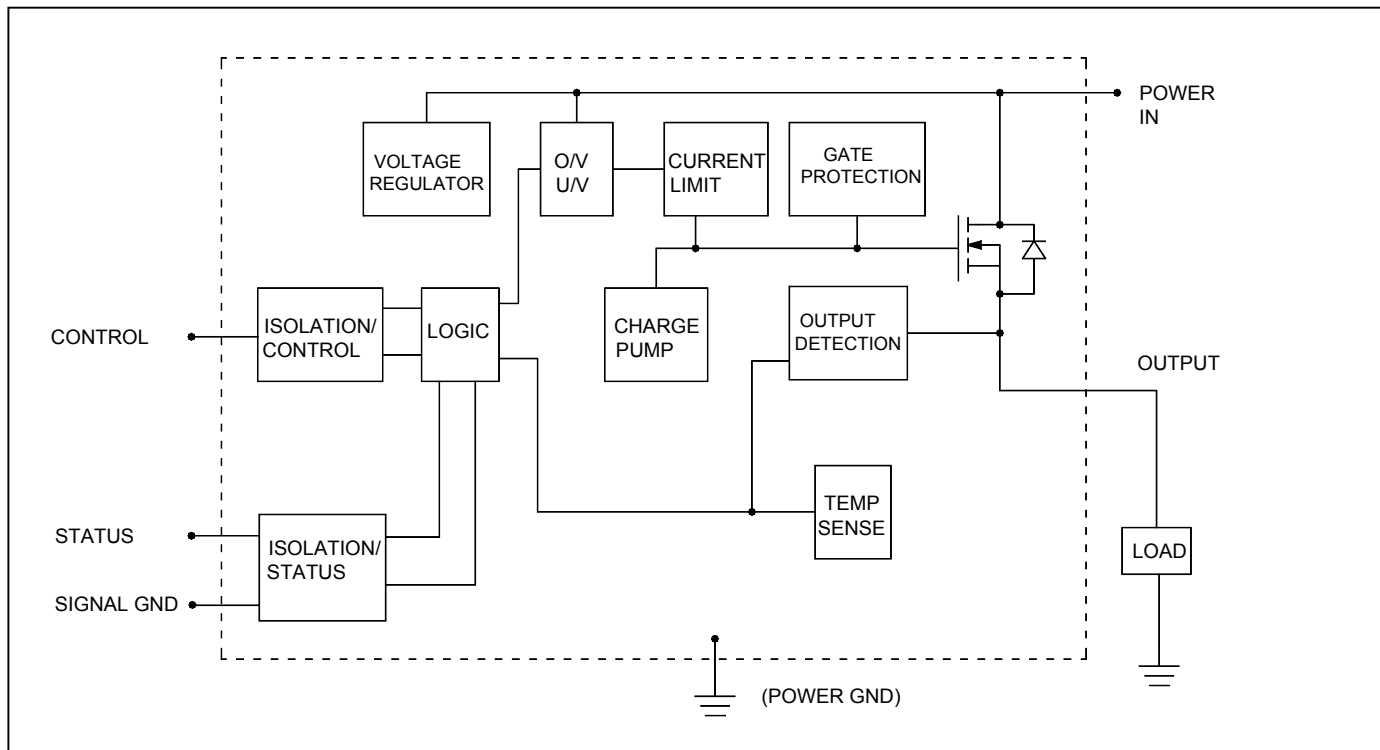
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28 VDC SOLID STATE HIGH SIDE SELF-PROTECTED POWER CONTROLLER

Package Configuration



Functional Block Diagram



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**28 VDC SOLID STATE HIGH SIDE SELF-PROTECTED POWER CONTROLLER****SPECIFICATIONS**(@  $T_C$  25°C unless otherwise specified)**Control Function**

Input Type ..... 1.5 k $\Omega$  resistor in series with 1.3 V drop LED  
 Turn-on Control Current ..... 2 mA (min)  
 Turn-off Control Current ..... 10  $\mu$ A (max)

**Status Function**

Open Collector transistor,  $V_{CC} = +40$  VDC (max)  
 Output High is  $V_{CC}$ , Output Low is +0.4 V (max) @  $I_{CC} = 10$  mA (max)  
 Status output transistor off (logic high) indicates unit is off.  
 Status output transistor on ( $V \leq 0.4$  VDC) indicates unit is on.

**Power Circuit**

Supply Voltage (for normal operation) ..... 5 VDC (min), 28 VDC(typ), 33 VDC (max)  
 Continuous Current ..... 10 A  
 On-state Resistance,  $T_j$  @ 25°C ( $I_L \geq 5$ A) ..... 35 m $\Omega$   
 On-state Resistance,  $T_j$  @ 150°C ( $I_L \geq 5$ A) ..... 70 m $\Omega$   
 Minimum Output Voltage Drop ( $I_L = 0.5$ A) ..... 50 mV  
 Power Dissipation at  $T_C = 25^\circ\text{C}$  and Full Load ..... 4 W  
 Power Output Leakage Through Load ..... 15  $\mu$ A  
 Trip Reset Time ..... Temperature Dependent  
 Body Diode Current Capacity ..... 10 A  
 Quiescent Current (@ No load) ..... 8 mA

**Temperature Range**

Operating (Case) ..... -40°C to +85°C  
 Storage ..... -55°C to +150°C

**Thermal Resistance**

Junction to Case ..... 2.5 °C/W  
 Case to Ambient ..... TBD °C/W

**Physical Characteristics**

See Package Configuration

**Timing at 28 VDC ( $I_L = 1$ A)**

Turn-on Time ..... 200  $\mu$ sec (max)  
 Status Turn-on Delay ..... 200  $\mu$ sec (max)  
 Turn-off Time ..... 250  $\mu$ sec (max)  
 Status Turn-off Delay ..... 300  $\mu$ sec (max)

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**28 VDC SOLID STATE HIGH SIDE SELF-PROTECTED POWER CONTROLLER**

**FUNCTIONAL DESCRIPTION**

The 53248 SSPC is a fully protected switch that offers a wide range of features. These include overvoltage and undervoltage shutdown with automatic reset, overcurrent and short circuit protection provided by temperature sensing with automatic reset when temperature drops to safe levels, built in transient protection and fully optically isolated control and status lines. The overcurrent and short circuit protection are achieved through the temperature-sensing feature of the controller. Overcurrent is sensed through the increasing  $R_{DS(ON)}$  causing increase power dissipation in the pass element, which additionally causes a further increase in  $R_{DS(ON)}$ . As junction temperature approaches +150°C, drive to the pass element is decreased, causing  $V_{DS}$  to increase. When the pass element temperature is between +150°C and +175°C, the drive to the pass element is removed and current flow ceases. When the temperature is reduced approximately 10°C the device will resume operations. This will continue until the overcurrent/short circuit is removed or the control is turned off. Status will indicate the overcurrent condition until the fault is removed.

**Peak Current Limits vs. Junction Temperature\***

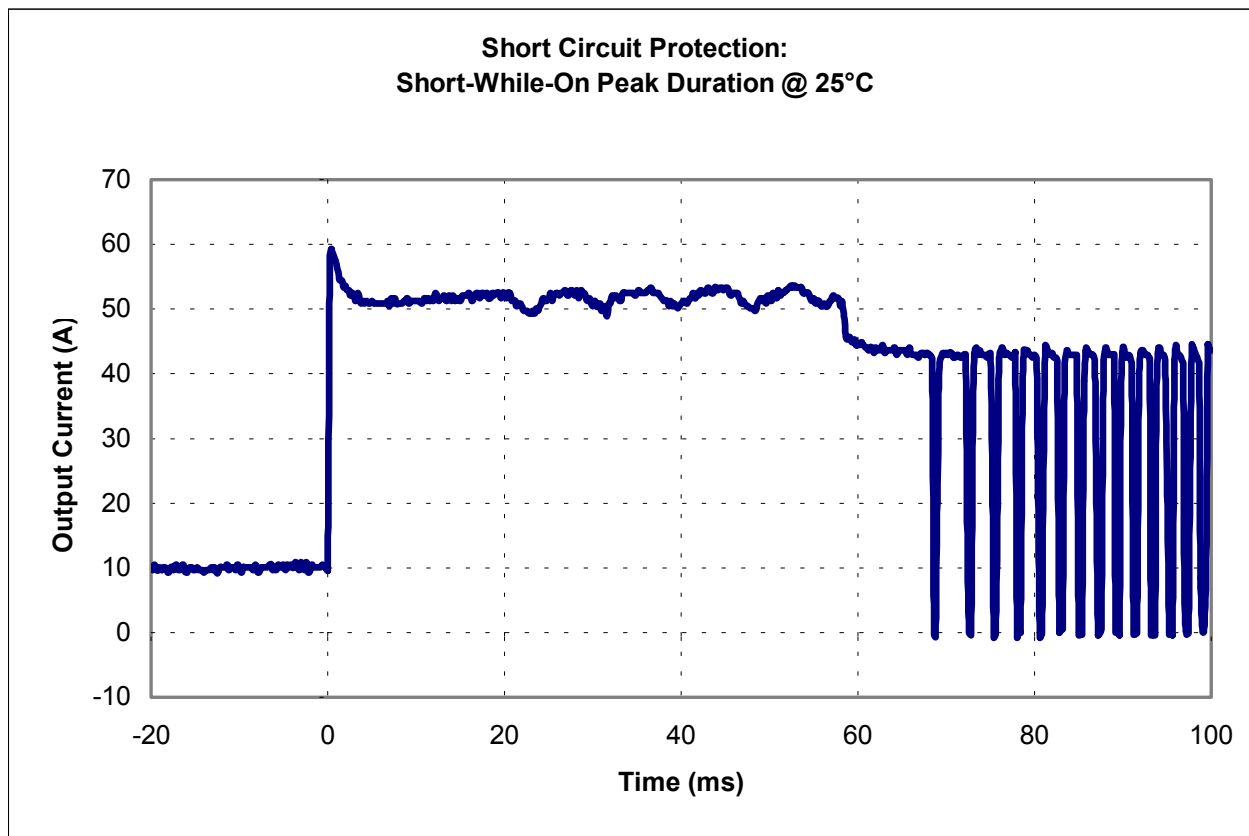
Junction Temperature	Min	Typ	Max	Unit
-40°C	48	56	65	A
+25°C	40	50	58	A
+150°C	31	37	45	A

**Overvoltage and Undervoltage Limits**

Overvoltage	+34 VDC to +43 VDC
Undervoltage	+3.4 VDC to +5.0 VDC
Overvoltage hysteresis	Typical +1.0 VDC
Undervoltage hysteresis	Typical +0.5 VDC

( $T_j = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ )

**\*Peak Duration - Typical Waveform**



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## 28 VDC SOLID STATE HIGH SIDE SELF-PROTECTED POWER CONTROLLER

### APPLICATION INFORMATION

The cable harness occupies an important position in the total network to be protected. The wide variety and in some cases considerable length and packing density used makes them particularly susceptible to persistent overloads and overheating. The maximum current carrying capacity of a cable depends on its resistance, type of insulation material and the ambient temperature. A cable, including insulation, generally consists of at least two materials with different thermal capacitance and thermal resistance. The maximum temperatures of most cables are at least +150°C (depending on the insulation properties) which is very close to the maximum junction temperature of the SSPC (Shutdown). Since under overcurrent or short circuit conditions, the unit resistance per unit length for the cable is much less than the  $R_{DS}$  of the SSPC, the unit heating will also be much less. Under these conditions, it is apparent that the SSPC can adequately protect properly selected cabling.

The following formulas provide methods for calculating the primary parameters.

#### Trip Current

$$I_{\text{trip}} = \{(T_{j \text{ max}} - T_a) / [R_{\theta ja}] [R_{ON}(T_{j \text{ max}})]\}^{1/2}$$

$T_{j \text{ max}}$  = Maximum Trip Temperature

$R_{\theta ja}$  = Thermal Resistance, Junction to Ambient

$T_a$  = Ambient Temperature

$R_{ON}(T_{j \text{ max}})$  = On-state resistance at Trip Temperature

#### On-state Resistance

$$R_{ON}(T) = \{(Y_2 - Y_1)T^2 + (300)(Y_2 - Y_1)T + (67500)Y_1 - (8125)Y_2\} / 59375$$

$Y_1$  =  $R_{ON}$  at +25°C

$Y_2$  =  $R_{ON}$  at +150°C

$T$  =  $T_j$  at temperature of interest in °C

With the above information, the temperature and current trip can be determined based upon the type of mounting chosen and the ambient temperatures of operation.

#### Precaution

When a short circuit causes turn-off of the SSPC, precautions must be taken to limit transient voltages generated by any inductance in the load. External protection is recommended, either across the switch or across the load, should the application result in energies beyond this level.

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**28 VDC SOLID STATE HIGH SIDE SELF-PROTECTED POWER CONTROLLER****Truth Table**

	<b>Control</b>	<b>Output</b>	<b>Status</b>
Normal Operation	L	L	H
	H	H	L
Current Limitation	L	L	H
	H	H	**
Short circuit to Power Ground	L	L	H
	H	L	**
Over-Temperature	L	L	H
	H	L	**
Short circuit to Power In	L	H	L
	H	H	L
Undervoltage	L	L	H
	H	L	H
Overvoltage	L	L	H
	H	L	H

Note: L = "Low" Level

H = "High" Level

\*\* Status output will cycle between H and L while SSPC is in auto-reset mode.

**Loads**

The 53248 SSPC is designed to handle low side loads from +5 VDC to +33 VDC. Any combination of inductive, resistive and capacitive may be used. This includes lamps and DC motors.

Inductive loads require protecting the SSPC from voltage transients as pointed out in the precaution section above. Charging Capacitive loads is generally not a problem due to the auto-reset feature of the current limit function. For capacitive loads, the user must assure that junction temperatures are not exceeded and at turn off if the  $V_{CC}$  drops below the voltage charge on the capacitor, any current will flow through the body diode of the FET switch. Since this is a normal PN junction, the power dissipated for a given current can be many times that of the forward current through the FET.

Incandescent lamps must be treated much like capacitive loads in that in-rush currents at turn-on can cause an overcurrent condition.

DC motors must be treated like capacitive loads because in-rush currents can be very high. Should a machine continue to rotate after power is removed, reverse currents due to back EMF need to be addressed.

**Heatsinking**

The SSPC is designed to take advantage of the relationship between junction temperatures and heat sink thermal impedance. As described in the section discussing current trip characteristics, the thermal impedance of the heat sink utilized can determine the magnitude of over current or short circuit current expected in a system.

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**28 VDC SOLID STATE HIGH SIDE SELF-PROTECTED POWER CONTROLLER**

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**Offset voltage**

The Power MOSFETs used in Micropac's SSPC have very low on resistance and therefore low power dissipation. Typical on-state resistance at 25°C is only 27 mΩ. Due to internal design the typical  $V_{DS}$  at 0.5 A is 50 mV. This stays relatively constant until the current reaches approximately 2 amperes when  $V_{DS}$  is 60 mV. For higher currents, the  $R_{DS}$  is constant at  $T_j$  of +25°C. Maximum  $R_{DS}$  at +150°C is 70 mΩ.

Since the design of SSPC current limit is temperature dependent, there is no need for a current sensing resistor and therefore no additional voltage drop which would add to the  $R_{DS}$ .

**Isolation of Control and Status**

The SSPC was designed to utilize optical isolation both on the input/control and the status feed back. The only input power required is that necessary to drive a control LED and provide pull up power for the open collector status transistor. The SSPC derives its energy for operation from the 28 VDC load supply. As a result, the power in and power out are completely isolated.

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