

### General Description

The AAT4682 dual electronic resettable fuse is a member of AnalogicTech's Application Specific Power MOSFET™ (ASPM™) product family. It has two 1A current limited P-channel MOSFET power devices that remain fully enhanced as long as the input power supply is above an under-voltage lock-out threshold and the load is below the current limit setting. If the load increases above the current limit setting, as is the case during a short circuit, the MOSFET effectively becomes a constant current source equal to the current limit. If the current limit condition persists long enough to heat the MOSFET to an extreme temperature, both devices will thermal cycle off and on until the current limit condition is removed. Independent open drain  $\overline{\text{FAULT}}$  flags signal an over-current or over-temperature condition. Quiescent current typically is a low 10 $\mu\text{A}$ .

The AAT4682 is available in a Pb-free, 6-pin SOT23 package and is specified over the -40°C to +85°C temperature range.

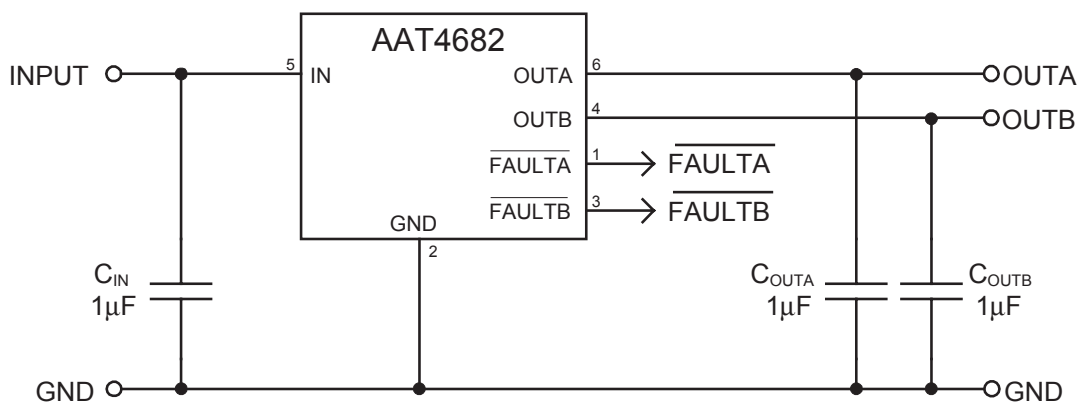
### Features

- Dual P-Channel MOSFETs
- 500mA Steady State Load Current
- 600mA Minimum Current Limit Trip Point
- Low Quiescent Current, Typically 10 $\mu\text{A}$
- Over-Temperature Protection
- Fast Transient Response:
  - <1 $\mu\text{s}$  Response to Short Circuit
- 400m $\Omega$  Typical  $R_{\text{DS(ON)}}$
- Under-Voltage Lockout
- Temperature Range: -40°C to +85°C
- $\overline{\text{FAULT}}$  Flag with 2ms Blanking
- 6-Pin SOT23 Package

### Applications

- Cell Phone Ports
- Desktop PCs
- Peripheral Ports
- USB Ports

### Typical Application

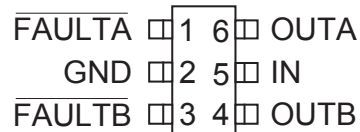


## Pin Descriptions

Pin #	Symbol	Function
1	$\overline{\text{FAULTA}}$	Channel A open drain output; signals over-current and over-temperature condition.
2	GND	Ground connection.
3	$\overline{\text{FAULTB}}$	Channel B open drain output; signals over-current and over-temperature condition.
4	OUTB	Channel B P-channel MOSFET drain.
5	IN	Channel A and Channel B P-channel MOSFET sources.
6	OUTA	Channel A P-channel MOSFET drain.

## Pin Configuration

### SOT23-6



### Absolute Maximum Ratings<sup>1</sup>

$T_A = 25^\circ\text{C}$ , unless otherwise noted.

Symbol	Description	Value	Units
$V_{IN}$	IN to GND	-0.3 to 6	V
$V_{OUT}$	OUTA or OUTB to GND	-0.3 to 6	V
$V_{FLG}$	$\overline{\text{FAULTA}}$ or $\overline{\text{FAULTB}}$ to GND	-0.3 to 6	V
$I_{OUT}$	Output Current	Internally Limited	A
$T_J$	Operating Junction Temperature Range	-40 to 150	$^\circ\text{C}$
$V_{ESD}$	ESD Rating <sup>2</sup> - HBM	5000	V
$T_{LEAD}$	Maximum Soldering Temperature (at Leads)	300	$^\circ\text{C}$

### Thermal Characteristics<sup>3</sup>

Symbol	Description	Value	Units
$\Theta_{JA}$	Maximum Thermal Resistance	150	$^\circ\text{C}/\text{W}$
$P_D$	Maximum Power Dissipation	667	mW

1. Stresses above those listed in Absolute Maximum Ratings may cause permanent damage to the device. Functional operation at conditions other than the operating conditions specified is not implied. Only one Absolute Maximum Rating should be applied at any one time.
2. Human body model is a 100pF capacitor discharged through a 1.5k $\Omega$  resistor into each pin.
3. Mounted on a demo board.

### Electrical Characteristics

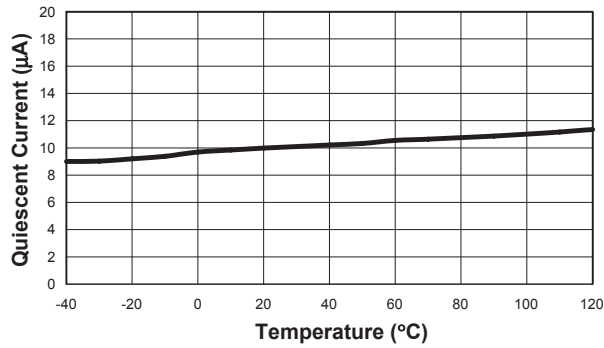
$V_{IN} = 5V$ ,  $T_A = -40^{\circ}C$  to  $+85^{\circ}C$ , unless otherwise noted. Typical values are at  $T_A = 25^{\circ}C$ ; **bold** values designate full temperature range.

Symbol	Description	Conditions	Min	Typ	Max	Units
$V_{IN}$	Operation Voltage		<b>1.8</b>		<b>5.5</b>	V
$I_Q$	Quiescent Current	$V_{IN} = 5V$ , $I_{OUT} = 0$		10	<b>20</b>	$\mu A$
$V_{UVLO}$	Under-Voltage Lockout	$V_{IN}$ Falling		1.5		V
$V_{UVLO(HYS)}$	Under-Voltage Lockout Hysteresis			0.3		V
$R_{DS(ON)}$	On Resistance	$V_{IN} = 5.0V$ , $T_A = 25^{\circ}C$		400	500	m $\Omega$
		$V_{IN} = 3.V$ , $T_A = 25^{\circ}C$		525	650	
$I_{LIM}$	Current Limit	OUT < IN to 0.5V	0.6	0.875	1.25	A
$t_{RESP}$	Current Loop Response	$V_{IN} = 5V$		500		ns
$V_{FAULTLOW}$	$\overline{FAULT}$ Logic Output Low	$I_{SINK} = 1mA$			<b>0.4</b>	V
$I_{SINK}$	$\overline{FAULT}$ Logic Output High Leakage Current	$V_{\overline{FAULT}} = 5.5V$		0.5	<b>1</b>	$\mu A$
$T_{blank}$	$\overline{FAULT}$ Blanking Time			2		ms
$T_{SD}$	Over-Temperature Threshold			125		$^{\circ}C$

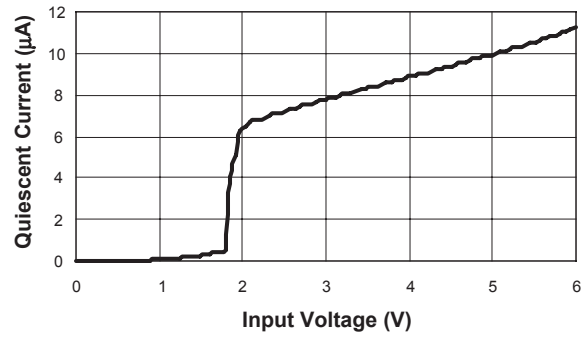
### Typical Characteristics

Unless otherwise noted,  $V_{IN} = 5V$ ,  $T_A = 25^\circ C$ .

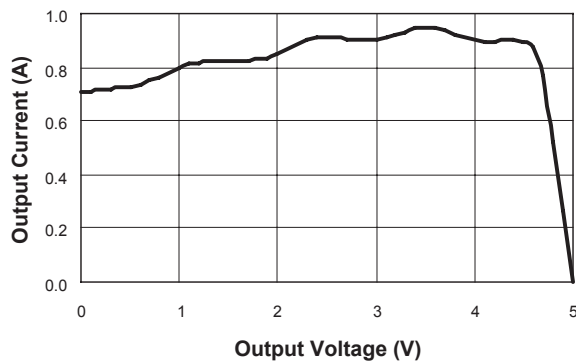
Quiescent Current vs. Temperature



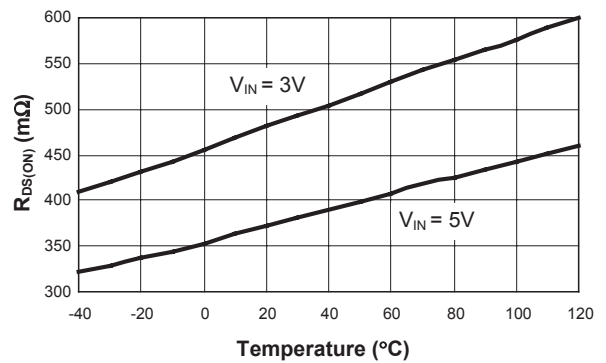
Quiescent Current vs. Input Voltage



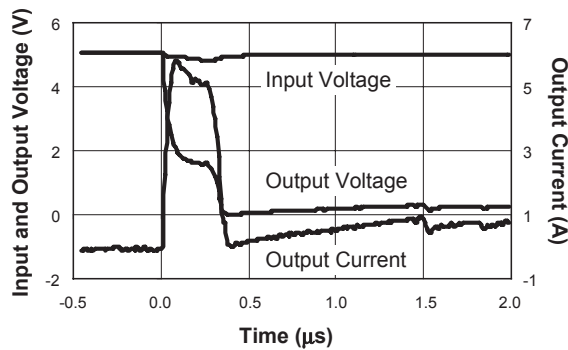
Current Limit vs. Output Voltage



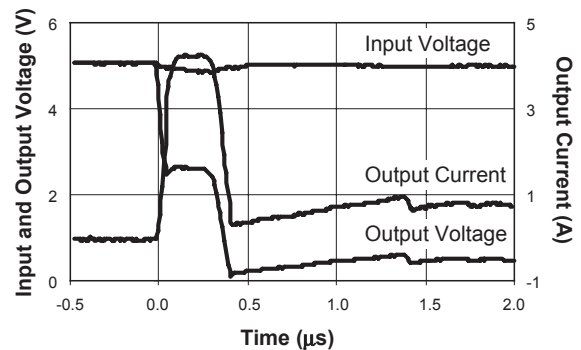
$R_{DS(ON)}$  vs. Temperature



Short Circuit Through 0.3Ω



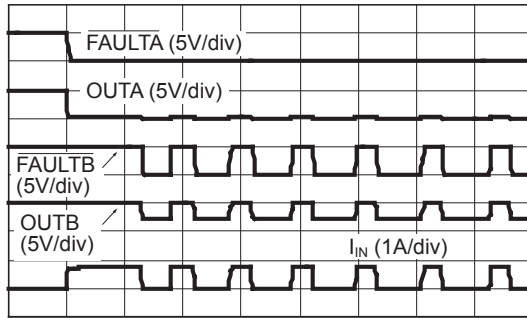
Short Circuit Through 0.6Ω



### Typical Characteristics

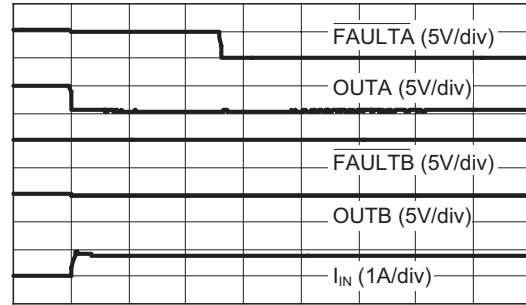
Unless otherwise noted,  $V_{IN} = 5V$ ,  $T_A = 25^\circ C$ .

**Thermal Shutdown Response**



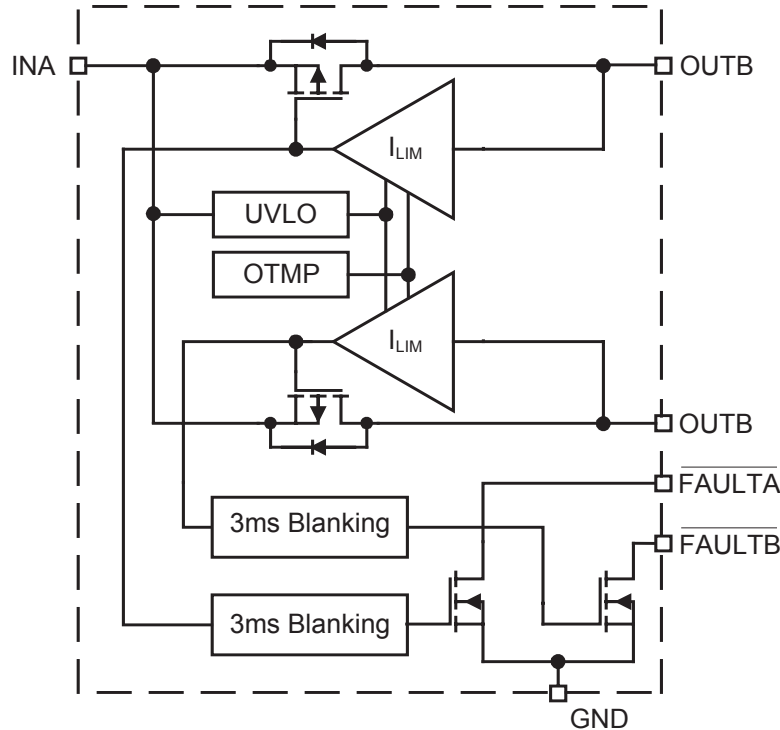
Time (50ms/div)

**Fault Delay**



Time (500µs/div)

### Functional Block Diagram



### Functional Description

The AAT4682 is a dual channel electronic resettable fuse that protects against short-circuit conditions by current limiting to a preset level. A patented fast acting current limit loop limits load current in a fraction of a microsecond and instantly resets back to a low impedance state once the short-circuit condition is removed. A current limit condition is reported by the open drain  $\overline{\text{FAULT}}$  output after a two millisecond blanking interval. The blanking prevents false reporting during the charging of a capacitive load, which typically occurs when a load is connected. The AAT4682 is internally protected from thermal damage by an over-temperature detection circuit. If the die temperature reaches the internal thermal limit, both power devices are switched off until the die temperature cools to a level below the thermal limit threshold. The device

will thermal cycle indefinitely until the over-current condition is removed. Due to the high thermal conductivity of silicon and the size of the die, the temperature across the die is relatively uniform at high temperatures; therefore, as a precaution, both power devices are switched off when the thermal threshold is reached. The AAT4682 operates with input voltages ranging from 1.8V to 5.5V which, along with its extremely low operating current, makes it ideal for battery-powered applications. In cases where the input voltage drops below 1.8V, the AAT4682 internal MOSFETs are protected from entering the saturated region of operation by being automatically shut down by an under-voltage lock-out circuit.

The AAT4682 is ideally suited for protection of peripheral ports such as USB, RS232, and parallel ports.

### Applications Information

#### Input Capacitor

The input capacitor protects the power supply from current transients generated by the loads attached to the AAT4682. If a short circuit is suddenly applied to a AAT4682 output, there is a 500 nanosecond long period during which a large current can flow before current limit circuitry activates. (See characteristic curve "Short Circuit Through 0.3Ω.") In this event, a properly sized input capacitor can dramatically reduce the voltage transient seen by the power supply and other circuitry upstream from the AAT4682.

$C_{IN}$  should be located as close to the device VIN pin as practically possible. Ceramic, tantalum, or aluminum electrolytic capacitors may be selected for  $C_{IN}$ . There is no specific capacitor equivalent series resistance (ESR) requirement for  $C_{IN}$ . However, for higher current operation, ceramic capacitors are recommended for  $C_{IN}$  due to their inherent capability over tantalum capacitors to withstand input current surges from low impedance sources such as batteries in portable devices.

#### Output Capacitors

In order to insure stability while current limit is active, a small output capacitance of approximately 1μF is required at each output. No matter how big the output capacitor, output current is limited to the value set by the AAT4682 current limiting circuitry, allowing very large output capacitors to be used.

For example, USB ports are specified to have at least 120μF of capacitance downstream from their controlling power switch. The current limiting circuit will allow an output capacitance of 1000μF or more without disturbing the upstream power supply.

#### Attaching Loads

Capacitive loads attached to the AAT4682 will charge at a rate no greater than the current limit setting.

#### FAULT Outputs

FAULT flags are provided to alert a system if a AAT4682 load is not receiving sufficient voltage to operate properly. If current limit or over-temperature circuits in any combination are active for more than approximately two milliseconds, the corresponding  $\overline{\text{FAULT}}$  output is pulled to ground through approximately 100Ω. Removal of voltage or current transients of less than two milliseconds prevents capacitive loads connected to the AAT4682 output from activating the  $\overline{\text{FAULT}}$  flag when they are initially attached. Pull-up resistances of 10kΩ to 100kΩ are recommended. Since the  $\overline{\text{FAULT}}$  outputs are open drain terminals, they may be pulled up to any voltage rail less than the maximum operating voltage of 5.5V, allowing for level shifting between circuits.

#### Thermal Considerations

Since the AAT4682 has internal current limit and over-temperature protection, junction temperature is rarely a concern. However, if the application requires large currents in a hot environment, it is possible that temperature, rather than current limit, will be the dominant regulating condition. In these applications, the maximum combined current available without risk of an over-temperature condition can be calculated. The maximum internal temperature while current limit is not active can be calculated using Equation 1.

$$\text{Eq. 1: } T_{J(\text{MAX})} = I_{\text{MAX}}^2 \cdot R_{\text{DS(ON)(MAX)}} \cdot R_{\theta\text{JA}} + T_{\text{A(MAX)}}$$

In Equation 1,  $I_{\text{MAX}}$  is the maximum current required by the load.  $R_{\text{DS(ON)(MAX)}}$  is the maximum rated  $R_{\text{DS(ON)}}$  of the AAT4682 at high temperature.  $R_{\theta\text{JA}}$  is the thermal resistance between the AAT4682 die and the board onto which it is mounted.  $T_{\text{A(MAX)}}$  is the maximum temperature that the PCB under the AAT4682 would be if the AAT4682 were not dissipating power. Equation 1 can be rearranged to solve for  $I_{\text{MAX}}$ ; Equation 2.

$$\text{Eq. 2: } I_{\text{MAX}} = \sqrt{\frac{T_{\text{SD(MIN)}} - T_{\text{A(MAX)}}}{R_{\text{DS(ON)(MAX)}} \cdot R_{\theta\text{JA}}}}$$



$T_{SD(MIN)}$  is the minimum temperature required to activate the AAT4682 over-temperature protection. The typical over-temperature threshold specification is 125°C; therefore, 115°C is a safe minimum value to use.

For example, if an application is specified to operate in 50°C environments, the PCB operates at

temperatures as high as 85°C. The application is sealed and its PCB is small, causing  $R_{\theta JA}$  to be approximately 150°C/W. Using Equation 2:

$$\text{Eq. 3: } I_{MAX} = \sqrt{\frac{115 - 85}{600 \cdot 150}} = 575\text{mA}$$

To prevent thermal limiting, the combined operating load current of each output in the application must be less than 575mA.

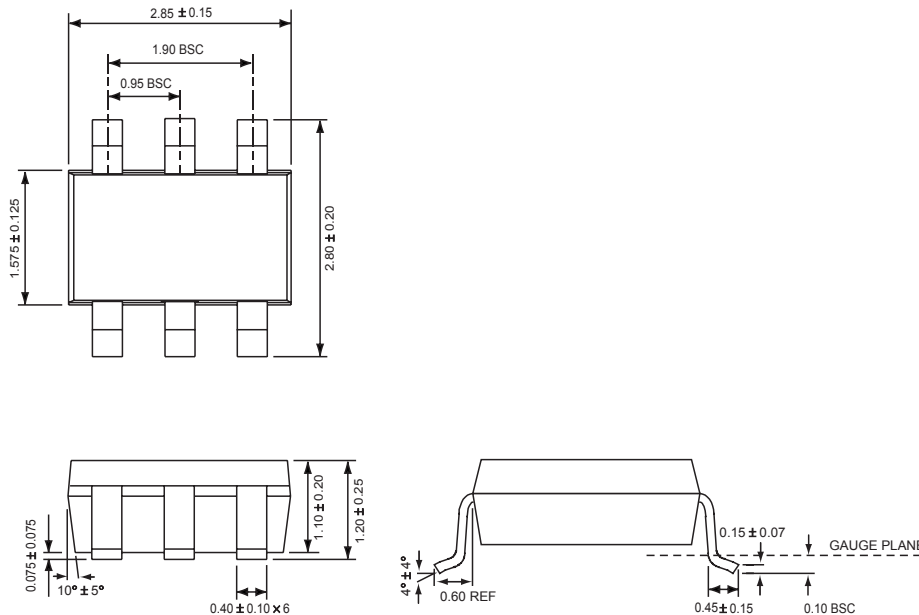
### Ordering Information

Package	Marking <sup>1</sup>	Part Number (Tape and Reel) <sup>2</sup>
SOT23-6	BXYY	AAT4682IGU-T1



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### Package Information



All dimensions in millimeters.

1. XYY = assembly and date code.
2. Sample stock is generally held on part numbers listed in **BOLD**.

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**Advanced Analogic Technologies, Inc.**  
 830 E. Arques Avenue, Sunnyvale, CA 94085  
 Phone (408) 737-4600  
 Fax (408) 737-4611