Advanced Monolithic Systems

AMS2027

SINGLE POWER DISTRIBUTION SWITCH

RoHS compliant
PRELIMINARY INFORMATION

FEATURES

- **110mΩ Typical (5V Input) High Side MOSFET Switch**
- **Short Circuit Protection**
- **Logic Overcurrent Output Error Flag**
- **Logic Undervoltage Output Error Flag**
- **Logic Overheat Output Error Flag**
- **Enable Input Compatible With 3V and 5V Logic**
- **Controlled Rise and Fall Times Limit Current Surges and Minimize EMI**
- **Undervoltage Lock-Out Guarantees the Switch is Off At Start-up**

- **100µA Maximum On-State Supply Current**
- **Available Active-High or Active-Low Enable**
- **Available in Space Saving 8 lead SOIC and 8 Lead PDIP**

APPLICATIONS

- **USB Power Management**
- **Hot Plug-In Power Supplies**
- **Battery-Charger Circuits**

PRODUCT DESCRIPTION

The AMS2027 is a power distribution switch intended for application where heavy capacitive loads and short-circuits are likely to be encountered. The high-side switch is a 110mΩ N-channel MOSFET. The switch is controlled by a logic enable input compatible with 3V and 5V logic and is available in active-high or active-low enable. The internal charge pump, designed to control the power switch rise and fall time to minimize current surges during switching, also provides the gate drive. Requiring no external components the charge pump allows operation from supplies as low as 3.3V. When an overload or a short circuit is encountered the AMS2027 limits the output current to a safe level by switching into a constant-current mode and the overcurrent logic output error flag is set to a low. The power dissipation in the switch will be increased by continuous heavy overloads and short circuits; this will cause the junction temperature to rise. The thermal protection circuit shuts the power switch off to prevent damage. Once the device has cooled sufficiently, it will turn on automatic. An under voltage lock-out is provided to insure that the power switch is in the Off state at start-up.
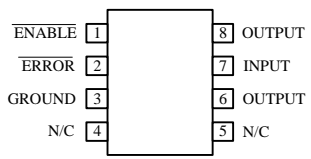
The AMS2027 is offered in the 8 lead SOIC package and the 8 lead PDIP package and is rated operational over a -40°C to 85°C temperature range.

ORDERING INFORMATION

PACKAGE TYPE		OPER. TEMP RANGE
8 LEAD SOIC	8 LEAD PDIP	
AMS2027S	AMS2027P	-40°C to 85°C

PIN CONNECTIONS

8 LEAD SOIC/ 8LEAD PDIP

$\overline{\text{ENABLE}}$	1	8	OUTPUT
$\overline{\text{ERROR}}$	2	7	INPUT
GROUND	3	6	OUTPUT
N/C	4	5	N/C

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ABSOLUTE MAXIMUM RATINGS (Note 1)

Input Voltage Range, V_I	-0.3V to 7V
Output Voltage Range, V_O	-0.3V to $V_{I(IN)}$ +0.3V
Input Voltage Range, V_I at /EN	-0.3V to 7V
Continuos Output Current, I_O	

Internal Power Dissipation (Note 3)	Internally Limited
Maximum Junction Temperature	+125°C
Storage Temperature	-65°C to +150°C
Lead Temperature (Soldering 25 sec)	265°C

ELECTRICAL CHARACTERISTICS

Electrical Characteristics at T_J=25°C, $V_{I(IN)}$ = 5.5V, I_O =rated current, /EN = 0V unless otherwise specified.

PARAMETER	CONDITIONS (Note 2)	AMS2027 Min.	AMS2027 Typ.	AMS2027 Max.	Units
Switch On-State Resistance	$V_{I(IN)}$ = 5.5V		75	95	mΩ
	$V_{I(IN)}$ = 5.0V		80	95	mΩ
	$V_{I(IN)}$ = 4.5V		90	110	mΩ
	$V_{I(IN)}$ = 4.0V		96	110	mΩ
Switch Output Leakage Current	/EN = V_I		0.01	5	μA
	/EN = V_I , -40°C ≤ T_J ≤ 85°C			10	μA
Switch Output Rise Time	$V_{I(IN)}$ = 5.5V, C_L = 1μF		4.0		ms
	$V_{I(IN)}$ = 2.7V, C_L = 1μF		3.8		ms
Switch Output Fall Time	$V_{I(IN)}$ = 5.5V, C_L = 1μF		3.9		ms
	$V_{I(IN)}$ = 2.7V, C_L = 1μF		3.5		ms
Enable High-Level Input Voltage	4.0V ≤ V_I ≤ 5.5V	2.4			V
Enable Low-Level Input Voltage	4.0V ≤ V_I ≤ 5.5V			.06	V
Enable Input Current	/EN = 0V or /EN = V_I	-1.0		1.0	μA
Enable Delay Time, Low-to-High Output	C_L = 1μF			20	ms
	C_L = 1μF			40	ms
Short Circuit Current	$V_{I(IN)}$ = 5.5V, T_J=25°C OUT Connected to GND, device enable into short circuit	0.66	1.2	1.8	A
Supply Current, Low-Level Output	/EN = V_I , T_J=25°C		0.015	10	μA
	/EN = V_I , -40°C ≤ T_J ≤ 85°C			10	μA
Supply Current, High-Level Output	/EN = 0V, T_J=25°C		73	100	μA
	/EN = 0V, -40°C ≤ T_J ≤ 85°C			100	μA
Undervoltage lock-out Low-Level Input Voltage		2.0	3.0	3.2	V

Note 1: Absolute Maximum Ratings are limits beyond which damage to the device may occur. For guaranteed performance limits and associated test conditions, see the Electrical Characteristics tables.

Note 2: To ensure constant junction temperature, low duty cycle pulse testing is used; thermal effects must be taken in consideration separately.

Note 3: The Power Dissipation for the SO-8 package is 725mW at T_A = 25 °C. Above T_A = 25 °C the Power Dissipation must be derated at 5.8mW/ °C (for T_A = 70 °C P_D = 464mW ; for T_A = 125 °C P_D = 145mW)

RECOMENDED OPERATING CONDITIONS:

	Min	Max
Input Voltage, V_I	4.0V	5.5V
Input Voltage, V_I at /EN	0V	5.5V
Continuous Output Current, I_O	0A	0.6A
Operating Junction Temp. Range	-40°C	+125°C

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PIN FUNCTIONS

Pin Name		Pin No.	I / O	Description
Enable	/EN	1	I	Enable Input, Logic turns power switch on.
Ground	GND	3	I	Ground.
Input	IN	7	I	Power switch input, also supplies IC's internal circuitry.
Error Flag	ERROR	2	O	Overcurrent, Over temperature, Logic output.
Output	OUT	6,8	O	Power switch output.

BLOCK DIAGRAM
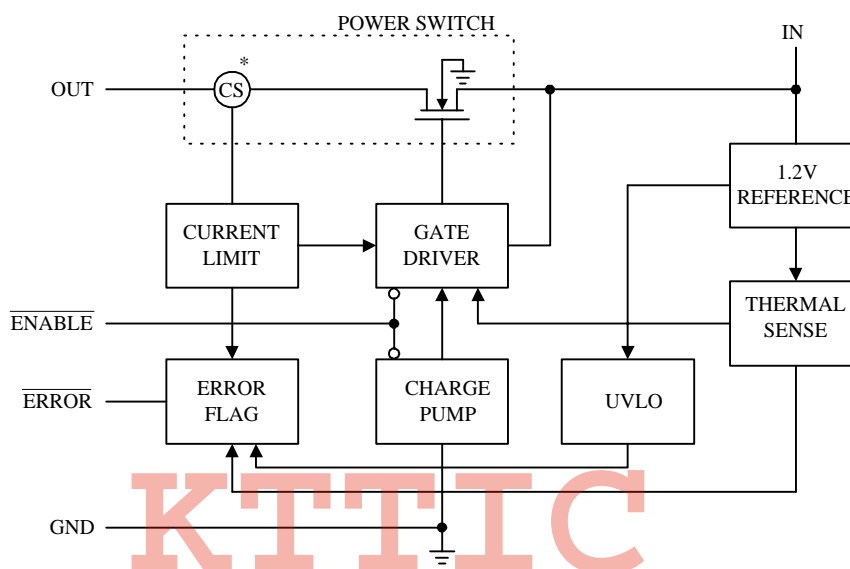
*Current Sense

FUNCTIONAL DESCRIPTION

Power Switch

The power switch is an N-channel MOSFET with a maximum on-state resistance of 140mΩ ($V_{I(IN)}$) = 5.0V, configured as a high-side switch.

Charge Pump

An internal 100kHz charge pump supplies the power to the driver circuit and provides the required voltage to pull the gate of the MOSFET above the source. The charge pump requires very little supply current and operates from input voltages as low as 3.3V.

Gate Driver

The driver controls the gate voltage of the power switch. The driver incorporates circuitry that controls the rise and fall times of the output voltage, as a result it limits large current surges and reduces the associated electromagnetic interference (EMI) produced. The rise and fall times of the output voltage are typically in the 2ms to 4ms range instead of the microsecond or nanosecond range for a standard FET.

Enable

A logic high on the /EN input turns off the power switch and the bias for the charge pump, driver, and other circuitry to reduce the supply current to less than 10µA. A logic zero input restore bias to the drive and control circuits and turns the power on. The enable input is compatible with both TTL and CMOS logic levels.

Error Flag

The error flag output, is an open drain logic output that is active low when output current exceeds current limit. Until the fault condition is removed the output will remain active low.

Current Limit

A sense FET monitors the current supplied to the load. In case of an overload or short circuit, the current limit circuitry sends a signal to the driver. The driver will then reduce the gate voltage and drive the power FET into its linear region, which switches the output into a constant current mode and holds the current constant while varying the voltage on the load.

Thermal Shutdown

The internal thermal shutdown circuit will shut the power switch off when the junction temperature rises to approx. 180°C. Hysterisis is build into the thermal sense circuitry, and after the junction temperature has dropped about 20°C, the switch turns back on. Until the fault is removed the switch will continue to cycle off and on.

Undervoltage Lock-out

An internal voltage sense monitors the input voltage. When the input voltage is below 3.2V nominal, the switch is turned off by a control signal. The typical fall time range due to the sense of a low voltage is 250µs to 750µs.

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APPLICATION HINTS

Power Supply Considerations

A 0.047µF ceramic bypass capacitor close to the device, between input and ground is recommended. When the output load is heavy or has large paralleled capacitors, a high value electrolytic capacitor should be used. To improve the immunity of the device to ESD, use a 0.1µF ceramic capacitor to bypass the output.

Current Limit

A sense FET monitors overcurrent conditions. When an overcurrent condition is detected the device maintains a constant output current and decreases the voltage accordingly. If the condition is present long enough to activate the thermal limiting the result is the shutdown of the device.

There are three situation in which overload can occur. In the first case, the output has been shorted before the device is enabled or before V_I has been applied. The device senses the short and switches into a constant-current output.

In the second case, the short occurs while the device is enabled. When this happens, very high currents flow for a short time before the current-limit circuit can react. After the current-limit circuit has tripped, the device limits normally.

In the third case, the load has been gradually increased beyond the recommended operating current. The current will rise until the current-limit threshold is reached. The AMS2027 is able to deliver current up to the current-limit threshold without damage. When the threshold has been reached the device switches into the constant current mode. When over current condition is detected the error flag logic output remains low until the condition is removed.

Power Dissipation and Junction Temperature

The thermal resistance of the surface-mount packages such as SOIC is high compared to that of power packages. The use of the N-cannel MOSFET which has low on-resistance, makes it possible for small surface-mount packages to pass large currents. To determine the power dissipation and junction temperature the first step is to find r_{ON} at the input voltage and operating temperature.

As an initial estimate use the highest operating ambient temperature of interest and read r_{ON} from Figure1. Power dissipation is equal to:

$$P_D = r_{ON} \times I^2$$

Calculate the junction temperature:

$$T_J = P_D \times R_{\theta JA} + T_A$$

Where $R_{\theta JA}$ is the thermal resistance and is 172°C/W for the SOIC package. Compare the calculated junction temperature with the initial estimate and if they don't mach within a few degrees, repeat the calculations using the calculated value as the new estimate. A few repetitions will be sufficient to give a reasonable answer.

Thermal Protection

Thermal protection prevents damage to the device when over load or short circuits conditions are present for extended periods of time. These conditions force the AMS2027 into the constant current mode. As a result the voltage across the high-side switch will increase. Under short-circuit conditions the voltage across the switch is equal to the input voltage. Continuous heavy over loads and short circuits increase the power dissipation in the switch and causes the junction temperature to rise to dangerously high levels. The protection circuit shuts off the switch when it senses the high junction temperature. The switch remains off until the device has cooled about 20°C. The switch continues to cycle off and on until the fault is removed.

Undervoltage Lock-out

An undervoltage lock-out is provided to insure that the switch is in the off state at start-up. When the input voltage falls below 3.2V the switch will be turned off immediately. This will make it easy for designers of hot plug-in systems that may not be able to turn the switch off before removing the input power. In such cases when the device is reinserted, the turn on will have a controlled rise time to reduce EMI and voltage overshoots.
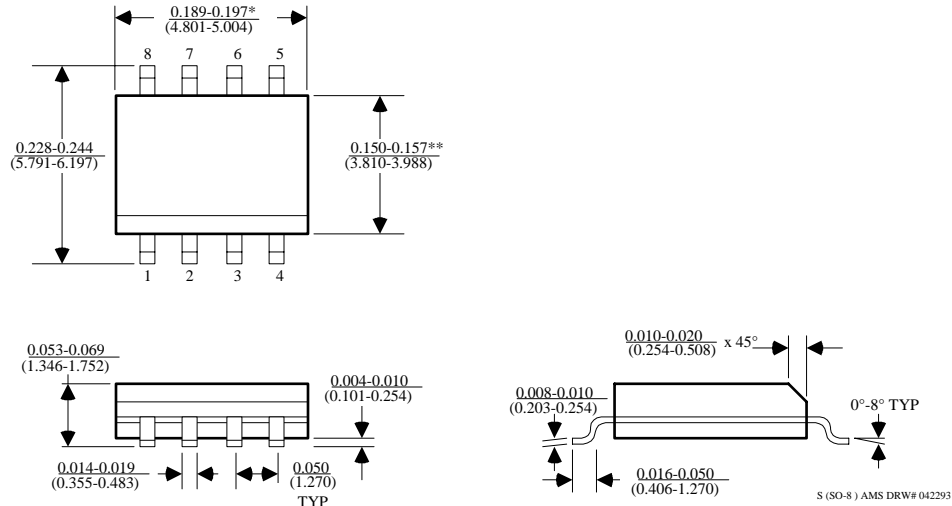
TYPICAL APPLICATIONS

Figure 1
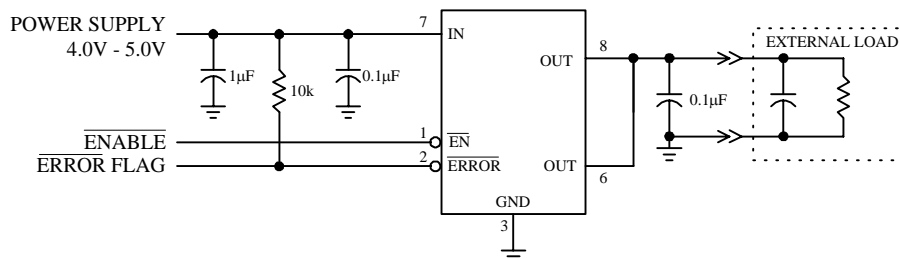
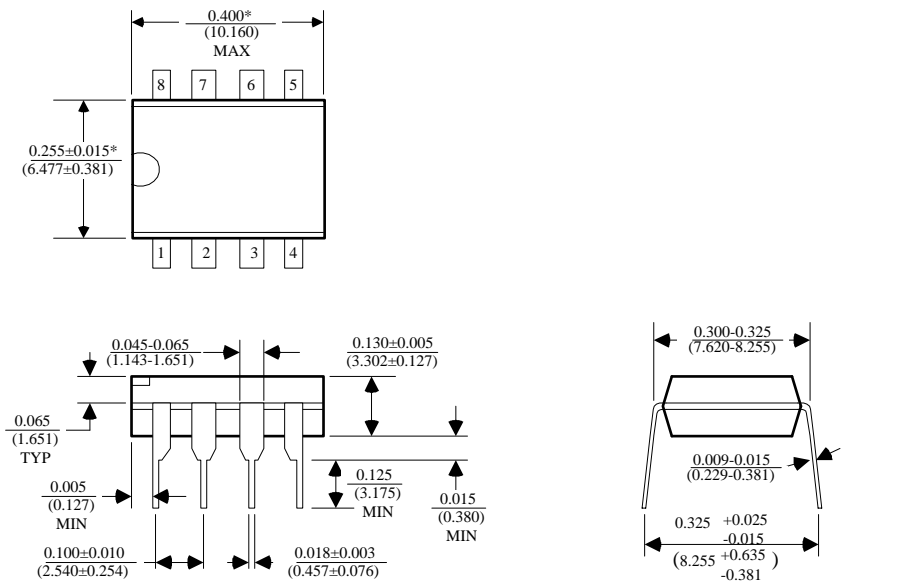**PACKAGE DIMENSIONS** inches (millimeters) unless otherwise noted.

8 LEAD SOIC PLASTIC PACKAGE (S)

0.189-0.197*
(4.801-5.004)

8 7 6 5

0.228-0.244
(5.791-6.197)

0.150-0.157**
(3.810-3.988)

1 2 3 4

0.053-0.069
(1.346-1.752)

0.004-0.010
(0.101-0.254)

0.014-0.019
(0.355-0.483)

0.050
(1.270)
TYP

0.010-0.020
(0.254-0.508) x 45°

0.008-0.010
(0.203-0.254)

0°-8° TYP

0.016-0.050
(0.406-1.270)

S (SO-8) AMS DRW# 042293

*DIMENSION DOES NOT INCLUDE MOLD FLASH. MOLD FLASH
SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

**DIMENSION DOES NOT INCLUDE INTERLEAD FLASH. INTERLEAD
FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

8 LEAD PLASTIC DIP PACKAGE (P)

0.400*
(10.160)
MAX

8 7 6 5

0.255±0.015*
(6.477±0.381)

1 2 3 4

0.045-0.065
(1.143-1.651)

0.130±0.005
(3.302±0.127)

0.065
(1.651)
TYP

0.005
(0.127)
MIN

0.125
(3.175)
MIN

0.015
(0.380)
MIN

0.100±0.010
(2.540±0.254)

0.018±0.003
(0.457±0.076)

0.300-0.325
(7.620-8.255)

0.009-0.015
(0.229-0.381)

0.325 +0.025
-0.015
(8.255 +0.635
-0.381)

P (8L PDIP) AMS DRW# 042294

*DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTUSIONS.
MOLD FLASH OR PROTUSIONS SHALL NOT EXCEED 0.010" (0.254mm)

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