**SmartSwitch™**

General Description

The AAT4615 SmartSwitch™ is a member of AnalogicTech™'s Application Specific Power MOS-FET™ (ASPM™) product family. It is a Current Limited P-channel MOSFET power switch designed for high-side load-switching applications. This switch operates with inputs ranging from 2.7V to 5.5V, making it ideal for both 3V and 5V systems. An integrated current-limiting circuit protects the input supply against large currents which may cause the supply to fall out of regulation. The AAT4615 is also protected from thermal overload which limits power dissipation and junction temperatures. It can be used to control loads that require up to 2.25A. Current limit threshold is programmed with a resistor from a SET pin to ground. The AAT4615 has an active shutdown load discharge circuit to rapidly turn off a load circuit when the switch is disabled. The reverse blocking feature prevents current from flowing from OUT to IN when disabled.

This device has a programmable turn on delay time feature allowing turn-on time from 30µs to 5ms using one small external capacitor. The quiescent supply current is typically a low 12µA. In shutdown mode, the supply current decreases to less than 1µA.

The AAT4615 is available in a 12 pin TSOPJW package and is specified over a -40 to 85°C temperature range.
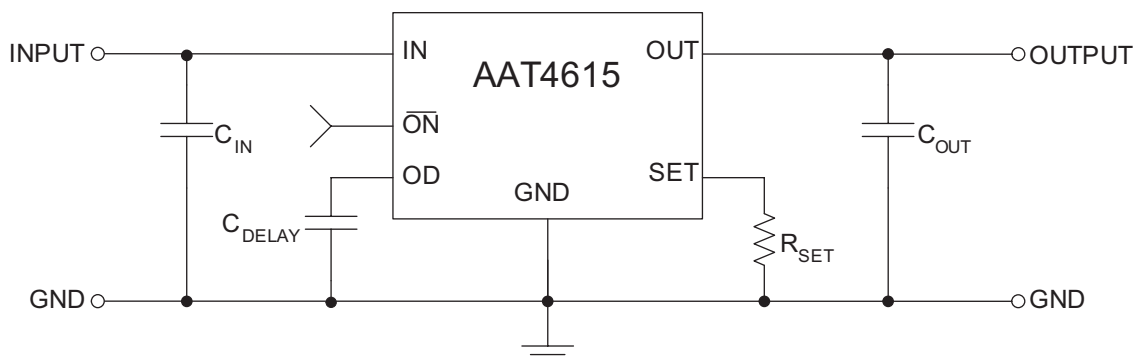
Features

- V_{IN} Range: 2.7 - 5.5 Volts
- Programmable current limit up to 2.25A
- Programmable turn-on time
  - 30µs to 5ms
- Reverse Current Blocking Protection
- Fast shutdown load discharge
- Fast transient response:
  - 2.5µs response to short circuit
- Low quiescent current
  - 12 µA typical
- 1.0 µA max with Switch off
- 72 mΩ typical $R_{DS(ON)}$ at 5V
- Only 1.5V needed for ON/OFF Control
- Undervoltage Lockout
- Thermal shutdown
- Temperature range -40 to 85°C
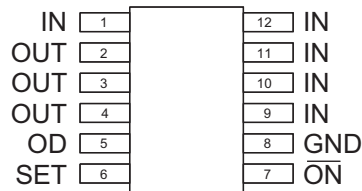- Available in 12-pin TSOPJW package

Applications

- CF card port power protection
- Personal Data Assistants (PDA)
- Notebook computers
- Personal communication devices
- Hot swap supplies

Typical Application

Pin Descriptions

Pin #	Symbol	Function
1,9,10,11,12	IN	Input pins to the P-channel MOSFET source. Connect 1µF capacitor from IN to GND.
2,3,4	OUT	P-channel MOSFET drain connection. Connect a 0.47µF capacitor from OUT to GND.
5	OD	On Delay. Turn on time delay control pin. A capacitor connected between this pin and ground will set the turn on delay time. Leave open circuit for the minimum turn on time.
6	SET	Current-Limit Set Input. A resistor from SET to ground sets the current limit for the switch.
7	$\overline{ON}$	Active low enable input. A logic low turns the switch on.
8	GND	Device ground connection.

Pin Configuration

TSOPJW-12
(Top View)

```
        IN  ┌1      12┐  IN
        OUT ┌2      11┐  IN
        OUT ┌3      10┐  IN
        OUT ┌4       9┐  IN
        OD  ┌5       8┐  GND
        SET ┌6       7┐  ON
```

Absolute Maximum Ratings [1]

Symbol	Description	Value	Units
V_{IN}	IN to GND	-0.3 to 6	V
V_{ON}	ON to GND	-0.3 to V_{IN}+0.3	V
V_{SET}, V_{OUT}	SET, OUT to GND	-0.3 to V_{IN}+0.3	V
I_{MAX}	Maximum Continuous Switch Current	1.5	A
T_J	Operating Junction Temperature Range	-40 to 150	°C

Note 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.

Thermal Characteristics

Symbol	Description	Value	Units
θ_{JA}	Maximum Thermal Resistance [2]	160	°C/W
P_D	Maximum Power Dissipation [2, 3] (T_A = 25°C)	625	mW

Note 2: Mounted on an FR4 board.
Note 3: Derate 6.25mW/°C above 25°C.

Electrical Characteristics [1]

V_{IN} = 5V, T_A = -40 to 85°C unless otherwise noted. Typical values are at T_A = 25°C

| Symbol	Description	Conditions	Min	Typ	Max	Units
V_{IN}	Operation Voltage		2.7		5.5	V
I_Q	Quiescent Current	V_{IN} = 5V, ON($\overline{ON}$) = active, I_{OUT} = 0		12	25	µA
$I_{Q(OFF)}$	Off Supply Current	ON($\overline{ON}$) = inactive, V_{IN} = 5.5V			1	µA
$I_{SD(OFF)}$	Off Switch Current	ON($\overline{ON}$) = inactive, V_{IN} = 5.5V, V_{OUT} = 0		0.01	1	µA
V_{UVLO}	Undervoltage Lockout	Rising edge, 1% hysteresis		1.8	2.4	V
$R_{DS(ON)}$	On-Resistance	V_{IN} =5.0V, T_A=25°C		72	90	mΩ
		V_{IN} =4.2V, T_A=25°C		78	110	
		V_{IN} =3.0V, T_A=25°C		92	120	
TC_{RDS}	On-Resistance Temp. Coefficient			2800		ppm/°C
I_{LIM}	Current Limit	R_{SET} = 6.8kΩ	0.75	1.0	1.25	A
$I_{LIM(MIN)}$	Minimum Current Limit			120	250	mA
$V_{ON(L)}$	$\overline{ON}$ Input Low Voltage	V_{IN} = 2.7 - 5.5V			0.4	V
$V_{ON(H)}$	$\overline{ON}$ Input High Voltage	V_{IN} = 2.7 - 5.5V	1.4			V
$I_{ON(SINK)}$	$\overline{ON}$ Input leakage	V_{ON} = 5.5V		0.01	1	µA
T_{RESP}	Current Limit Response Time	V_{IN} = 5V		2.5		µs
T_R	Turn-On Rise Time	R_O = 10Ω		14		µs
T_{DEL_OFF}	Turn-Off Delay Time	V_{IN} = 5V		5	15	µs
T_{DEL_ON}	Turn-On Delay Time	V_{IN} = 5.0V, OD = Open	10	28	60	µs
		V_{IN} = 5.0V, OD = 0.1µF	4000	5300	6500	
T_{SD}	Over Temp Shutdown Threshold			135		°C
T_{HYS}	Over Temp Shutdown Hysteresis			25		°C

Notes:
1. The AAT4615 is guaranteed to meet performance specification over the -40 to 85°C operating temperature range and are assured by design, characterization and correlation with statistical process controls.
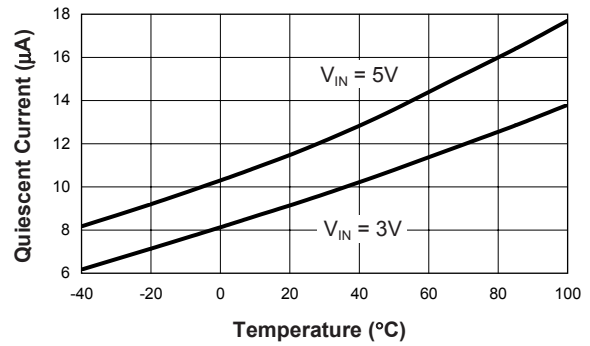
Typical Characteristics
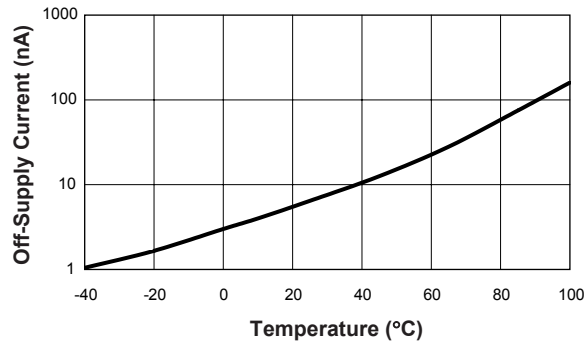
(Unless otherwise noted, V_{IN} = 5V, T_A = 25°C)
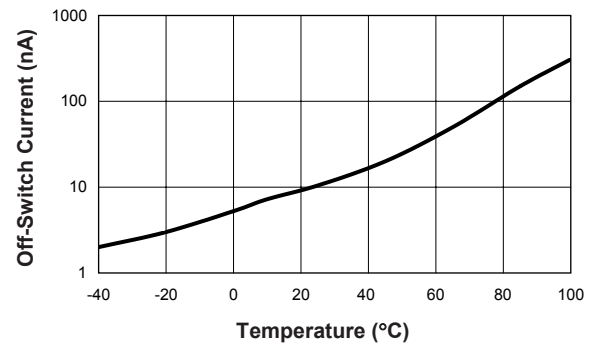
Quiescent Current vs. Input Voltage
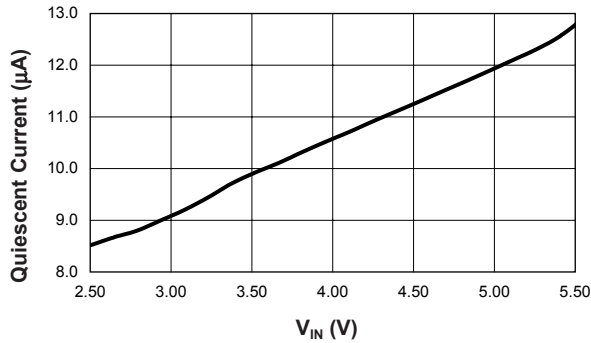
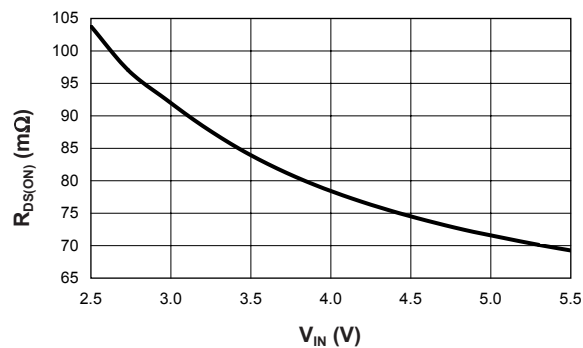### Quiescent Current vs. Temperature

Off-Supply Current vs. Temperature
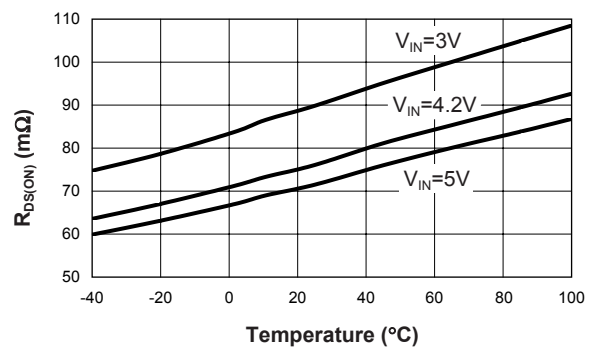

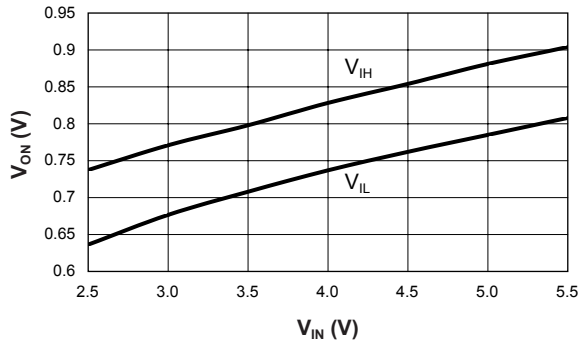### Off-Switch Current vs. Temperature

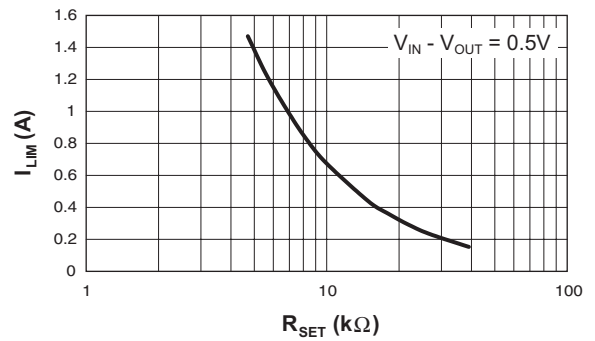### $R_{DS(ON)}$ vs. Input Voltage

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

Typical Characteristics
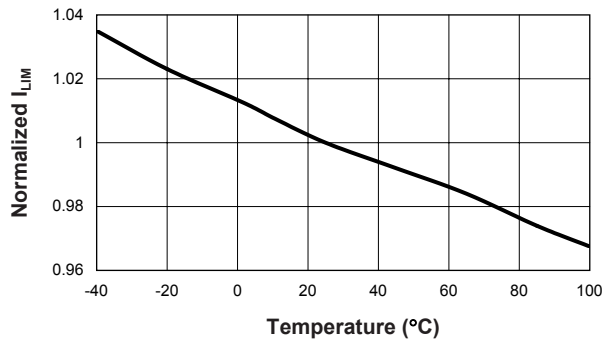
(Unless otherwise noted, V_{IN} = 5V, T_A = 25°C)
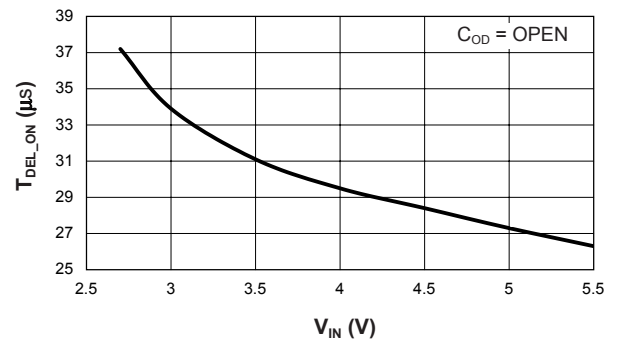
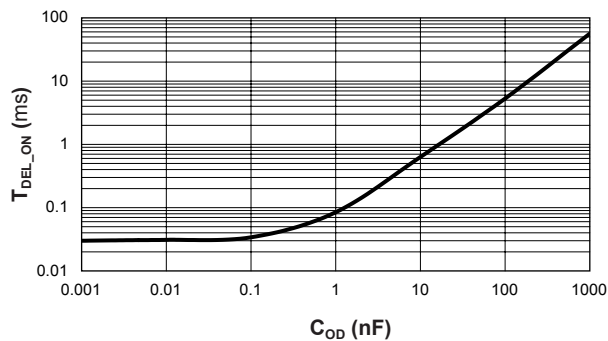**V_{IH} and V_{IL} vs. V_{IN}**

Current Limit I_{LIM} vs. R_{SET}

Normalized I_{LIM} vs. Temperature

Turn On Delay Time vs. V_{IN}

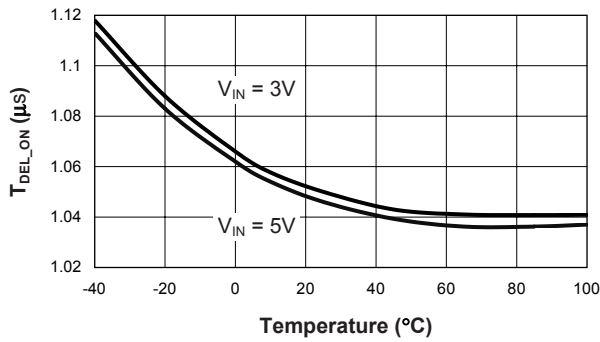**Turn On Delay Time vs. C_{OD}**

Turn On Delay Time vs. Temperature
R_O = 10Ω, C_O = 1µF, C_{OD} = OPEN
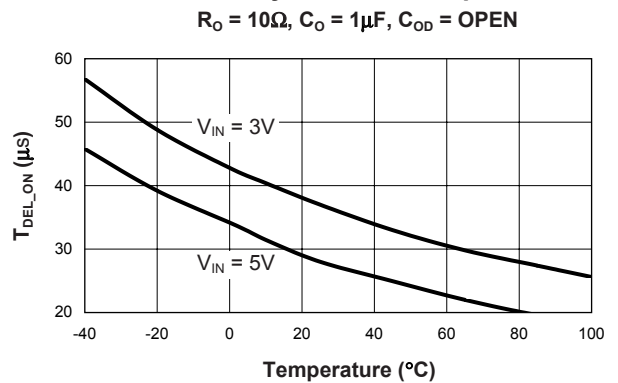
Typical Characteristics
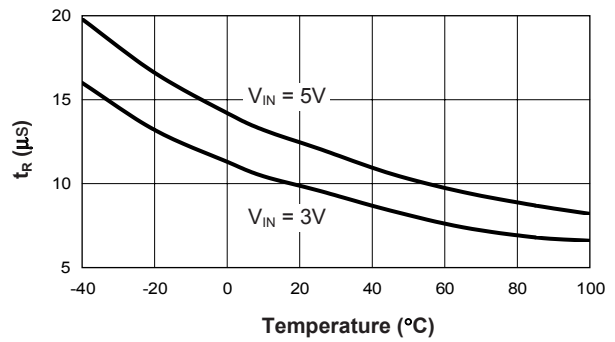
(Unless otherwise noted, V_{IN} = 5V, T_A = 25°C)

Turn On Delay Time vs. Temperature
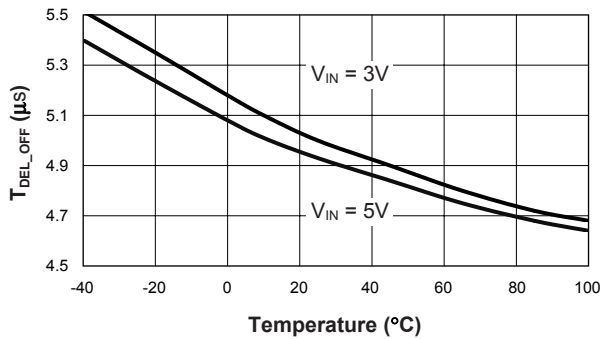R_O = 10Ω, C_O = 1μF, C_{OD} = 20nF

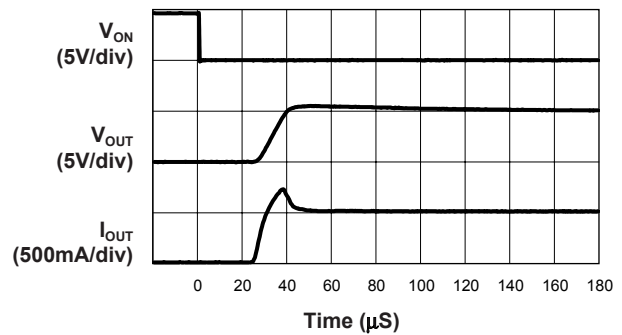**Turn On Rise Time vs. Temperature**
R_O = 10Ω, C_O = 1μF

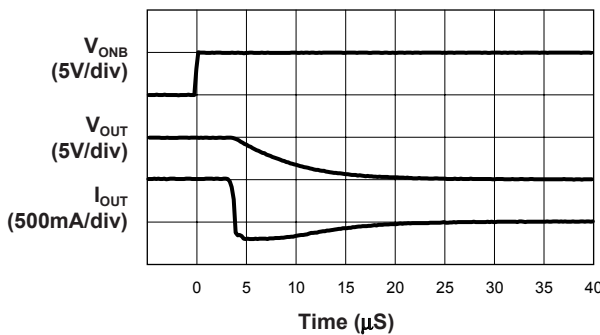**Turn Off Delay Time vs. Temperature**
R_O = 10Ω, C_O = 1μF

Turn-On Response
R_O = 10Ω, C_O = 1μF, C_{OD} = open, R_{SET} = 6.8kΩ

Turn-Off Response
R_O = 10Ω, C_O = 1μF, R_{SET} = 6.8kΩ

Turn-On Response
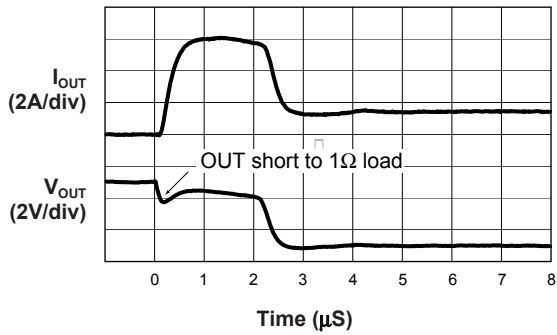R_O = 10Ω, C_O = 220μF, C_{OD} = open, R_{SET} = 6.8kΩ
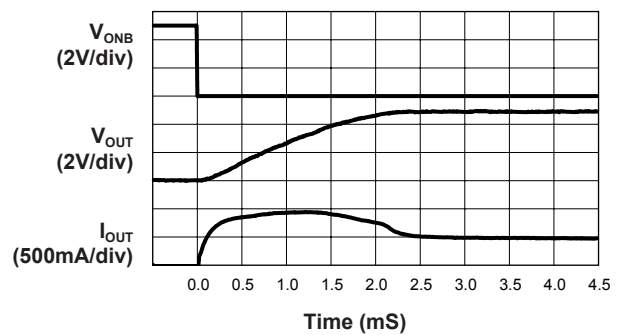
Typical Characteristics

(Unless otherwise noted, V_{IN} = 5V, T_A = 25°C)

Current Limit Transient Response

I_{OUT}
(2A/div)

V_{OUT}
(2V/div)

OUT short to 1Ω load

Time (μS)

Thermal Response
R_{SET} = 6.8kΩ

V_{OUT}
(1V/div)

Thermal Cycling
OUT short to 1Ω load

I_{OUT}
(0.5A/div)

Short removed

Time (mS)
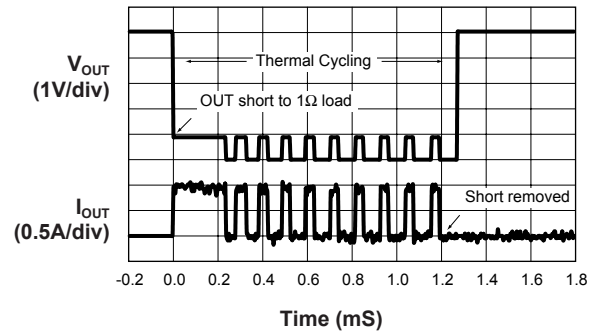
Output Current vs. Output Voltage

Output Current (mA)

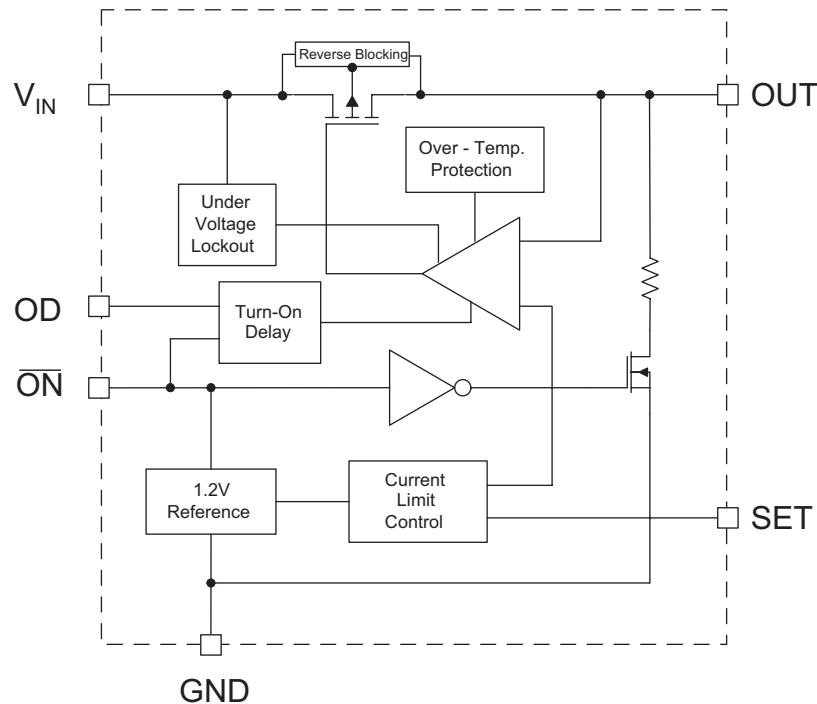R_{SET} = 6.8kΩ

Output Voltage (V)
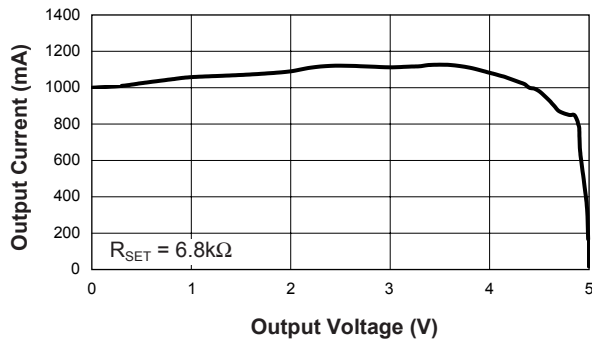
Functional Block Diagram

Functional Description

The AAT4615 is an integrated P-Channel MOSFET load switch with an adjustable current limit, programmable turn on time, over temperature protection, level shifted input with turn on timing control and a shutdown output discharge circuit. The current limit control is combined with an over temperature thermal limit circuit to provide a comprehensive system to protect the load switch under short circuit or other adverse operating conditions. The AAT4615 is ideally suited for control and protection of peripheral ports for CF cards and other low power external connections in compact portable products.

The current limit and over temperature circuits will act independently. The device current limit is activated when the output load current exceeds an internal threshold level. The internal current limit threshold is determined by an external resistor connected between the SET pin and ground. The minimum current limit threshold is specified by

$I_{LIM(MIN)}$. If the load switch ambient temperature becomes excessive or if a short circuit condition persists, the die temperature will rise causing the over temperature protection circuit to activate.

If a current limit level less than $I_{LIM(MIN)}$ is required, the AAT4615 can be used to operate in fold back current limit mode. To achieve this, an R_{SET} value can be chosen to program a current limit lower than $I_{LIM(MIN)}$; in this case, when the load current reaches $I_{LIM(MIN)}$, the current will immediately drop, limiting at the programmed value.

The AAT4615 has a turn on delay feature to suit different power up sequencing requirements. Start up times can be set by attaching a small ceramic capacitor between the on delay (OD) pin and ground. The AAT4615 will typically turn on in 30µs with no capacitor connected. The turn on time can be slowed to 5ms with a 0.1µF or more with a greater capacitor value. The load switch is turned off by applying a logic high level to the $\overline{ON}$ pin. When the device is in the shutdown mode, the output pin is connected to ground through a switch.

The output discharge switch impedance to ground is less than 25Ω. The $\overline{ON}$ function has logic level thresholds that allow the AAT4615 to be TTL compatible and may also be controlled by 2.5V to 5.0V CMOS circuits. The voltage level applied to the $\overline{ON}$ pin should not exceed the input supply level present on the IN pin.

The AAT4615 has an integrated reverse-current blocking feature to protect the system and prevent unwanted battery discharge. It stops current flowing from the OUT pin to the IN pin when the AAT4615 is in shutdown state.

The AAT4615 typically consumes 12μA when operating; when off, the device draws less than 1μA. In the off state, current is prevented from flowing between the input and output.

Current Limit R_{SET} Values

R_{SET} (Ω)	Current Limit typ (mA)	Device will not current limit below: (mA)	Device always current limits below: (mA)
40.2	200	150	250
30.9	250	188	313
24.9	300	225	375
22.1	350	263	438
19.6	400	300	500
17.8	450	338	563
16.2	500	375	625
14.7	550	413	688
13.0	600	450	750
10.5	700	525	875
8.87	800	600	1000
7.50	900	675	1125
6.80	1000	750	1250
6.04	1100	825	1375
5.49	1200	900	1500
5.10	1300	975	1625
4.64	1400	1050	1750
4.22	1600	1200	2000
3.74	1900	1425	2375
3.24	2200	1650	2750
2.80	2500	1875	3125
2.61	2700	2025	3375
2.49	2800	2100	3500
2.32	3000	2250	3750

Turn On Delay C_{OD} Values

C_{OD} (nF)	Turn On Delay (μs)
0.1	34
0.22	40
0.47	55
1	85
2.2	150
4.7	300
10	633
22	1300
47	2600
100	5300
220	12000
470	26000
1000	56400

Ordering Information

Package	Marking[1]	ON/OFF Enable	Part Number (Tape and Reel)
TSOPJW-12	LNXYY	Active Low	AAT4615ITP-T1

Note 1: XYY = assembly and date code.

Package Information

TSOPJW-12

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