20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications

General Description

The AAT4681 SmartSwitch enables separate stand-alone AC adapter and PMU USB chargers to independently control a single low $R_{DS(ON)}$ power MOSFET between battery and system power output. A 20V version is available for multi-cell Li-ion applications and a 6V version is available for single-cell Li-ion applications.

The two P-channel power MOSFETs required in UMPC applications for controlling independent charger ICs can be consolidated to a single device, saving space and reducing cost. The single 20mΩ P-channel device in the AAT4681/-1 has four times lower $R_{DS(ON)}$ than the equivalent path resistance formed by two series devices.

Ordering options are available for multi-cell and single-cell Li-ion versions. For the single-cell application, a 6V device with dual independent gate control is available. For 2-cell and 3-cell applications a 20V ordinary P-channel device is available in the same package and pin configuration. Both devices are available in the TDFN-10L 3mm x 3mm package.

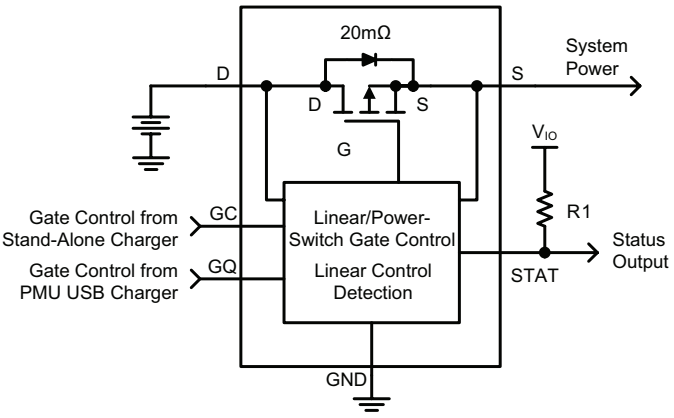
Features

- Multi-Cell 20V Device and Single-Cell 6V Device
- Dual Independent Gate Controls
  - Independent Linear Regulator and SMPS Power Switch States are Maintained
- 3mm x 3mm TDFN-10L package
- Temperature Range: -40°C to 85°C

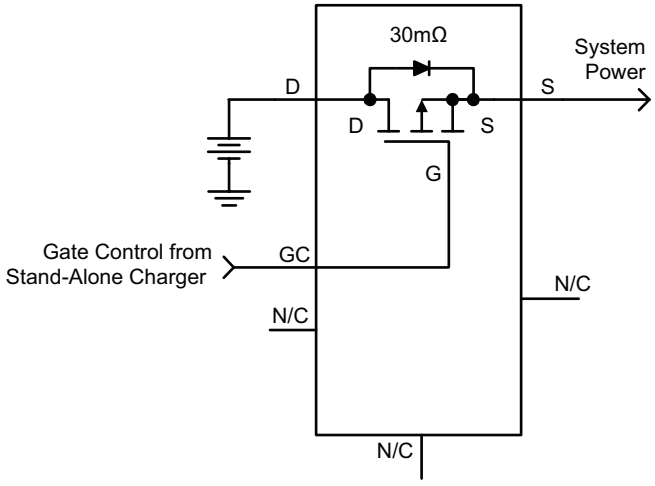
Applications

- Smart Phones
- Sub Notebooks
  - Smartbooks
  - Netbooks
- Ultra-Mobile PCs
- Wireless Media Devices

Typical Application



AAT4681, AAT4681-1



AAT4681-2

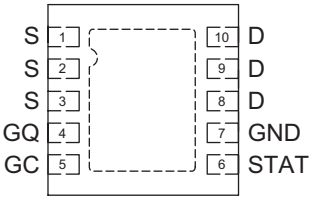
Pin Descriptions

Pin #	Pin Name		Function
	AAT4681/-1	AAT4681-2	
1, 2, 3	S	S	Source connection.
4	GQ	N/C	Gate control from PMU charger.
5	GC	GC	Gate control from stand-alone charger.
6	STAT	N/C	Open drain status output. "STAT" signal "high" means QC is "on" and "STAT" signal low means GQ is "on"
7	GND	N/C	Ground connection
8, 9, 10	D	D	Drain connection.

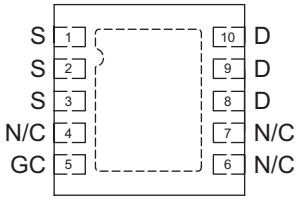
Pin Configuration

TDFN33-10L
(Top View)

AAT4681/-1



AAT4681-2



Absolute Maximum Ratings[1]

Symbol	Description		Value	Units
AAT4681, AAT4681-1				
V_D, V_S	Drain or Source Voltage to GND		6.0	V
V_{STAT}	STAT to GND		-0.3 to 6.0	V
I_{STAT}	STAT Current		10	mA
V_{GC}, V_{GQ}	Gate Voltage Levels to GND		-0.3 to 6.0	V
I_D	Continuous Drain Current @ T_A = 85°C	AAT4681	±7	A
		AAT4681-1	±5	
I_{DM}	Pulsed Drain Current[2]		±10	A
I_S	Continuous Source Current (Source-Drain Diode)		-1.5	A
AAT4681-2				
V_{DS}	Drain-Source Voltage		-20	V
V_{GS}	Gate-Source Voltage		±12	V
I_D	Continuous Drain Current	T_A = 25°C	±4.0	A
		T_A = 70°C	±3.2	A
I_{DM}	Pulsed Drain Current		±24	A
I_S	Continuous Source Current (Source-Drain Diode)		-1.5	A

Thermal Characteristics[3]

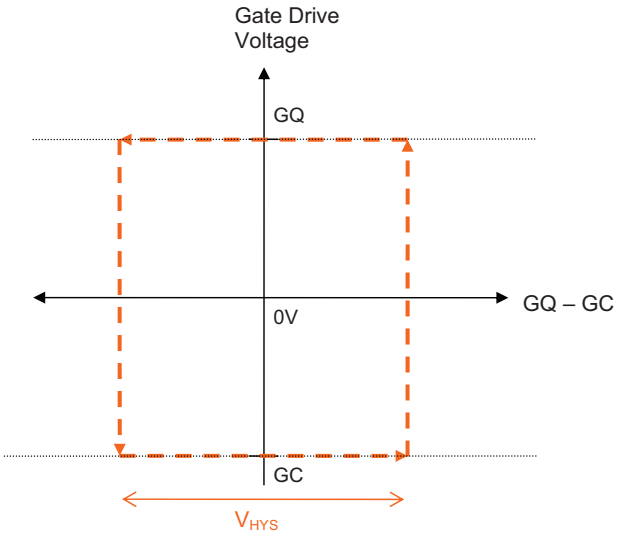
Symbol	Description	Value	Units
T_J	Operating Junction Temperature Range	-40 to +125	°C
T_{LEAD}	Maximum Soldering Temperature (at leads, 10 sec.)	300	°C
TDFN33-10L Thermal Impedance			
θ_{JA}	Maximum Junction-to-Ambient Thermal Resistance	50	°C/W
P_D	Maximum Power Dissipation[4]	2	W

1 Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.
2. Pulse width <300µs, duty cycle <1%.
3. T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \cdot \theta_{JA}$.
4. Thermal Resistance is specified with approximately 1 square inch of 1 oz. copper.

Electrical Characteristics

T_A = -40°C to +85°C, unless otherwise noted. Typical values are at T_A = +25°C.

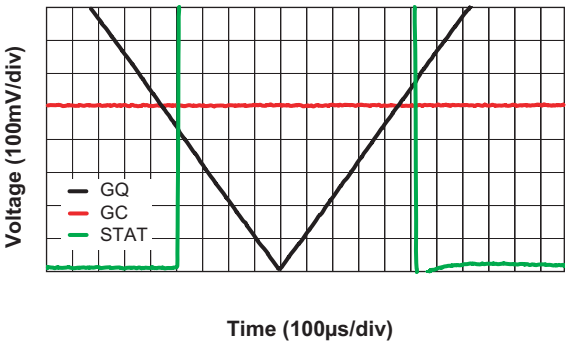
Symbol	Description	Conditions		Min	Typ	Max	Units
AAT4681/-1							
V_{SYS}	Input Voltage Range[1]			1.8		5.5	V
V_{UVLO}	Under-Voltage Lockout	For V_{SYS} < V_{UVLO}, GC active			1.4		V
I_Q	Quiescent Current	V_D = 4.2V, T_J = 55°C			3.6	15	µA
I_{DSS}	Drain-Source Leakage Current	V_{GS} = 0V, V_{DS} = –5.5V, T_J = 55°C				-5	µA
$R_{DS(on)}$	P-Channel On Resistance[2]	V_D = V_{GC} = 4.2V, V_{GQ} = GND, I_D = 5A, T_A = 25°C	AAT4681		18	25	mΩ
			AAT4681-1		23	28	
V_{HYS}	GQ-GC Transition Hysteresis					300	mV
t_{GSW}	GQ-GC Transition Delay	Slew rate of QG @ 1ms			10		µs
$V_{STATLOW}$	STAT Logic Output Low	$I_{STAT(SINK)}$ = 1mA			0.025	0.4	V
$I_{STAT(SINK)}$	STAT Logic High Leakage Current	V_{STAT} = 5.5V, V_{GC} = 5.5V, V_{GQ} = GND			0.005	1	µA
AAT4681-2							
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS} = 0V, I_D = -250µA		-20			V
$R_{DS(ON)}$	Drain-Source On-Resistance[2]	V_{GS} = -4.5V, I_D = -4.0A			27	40	mΩ
$I_{D(ON)}$	On-State Drain Current	V_{GS} = -4.5V, V_{DS} = -5V (pulse)[2]		-24			A
$V_{GS(th)}$	Gate Threshold Voltage	V_{GS} = V_{DS}, I_D = -250µA			-0.8		V



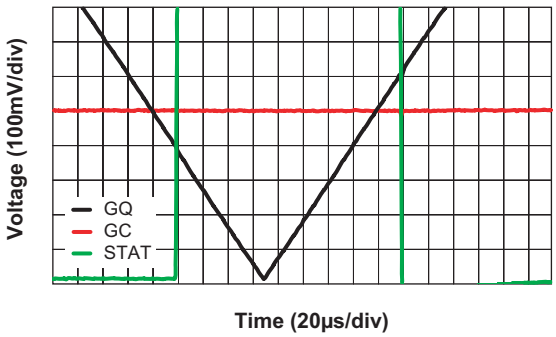
1. Where V_{SYS} is the greater of V_D or V_S.
2. Pulse width < 300µs, duty cycle < 1%.

AAT4681/-1 Typical Electrical Characteristics

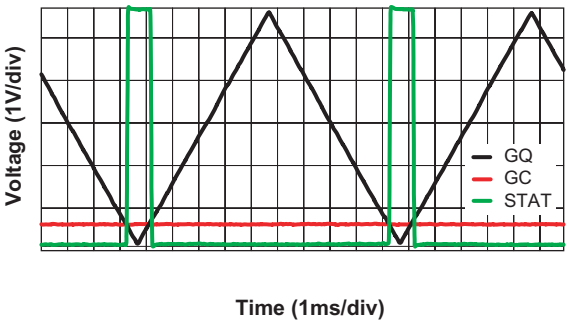
Hysteresis, GQ Ramp Time = 2.5ms
(S = 5.5V; GC = 0.5V; R_{STAT} = 5K; V_{IO} = 5.5V)



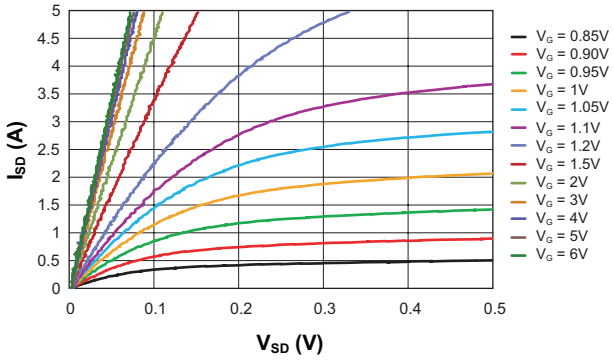
Hysteresis, GQ Ramp Time = 500µs
(S = 5.5V; GC = 0.5V; R_{STAT} = 5K; V_{IO} = 5.5V)



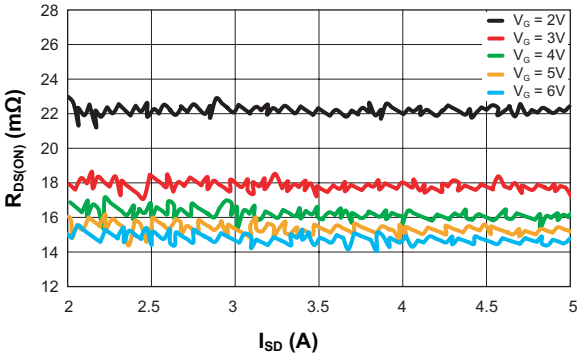
Timing
(S = 5.5V; GC = 0.5V; GQ ramp time = 2.5ms;
R_{STAT} = 5K; V_{IO} = 5.5V)



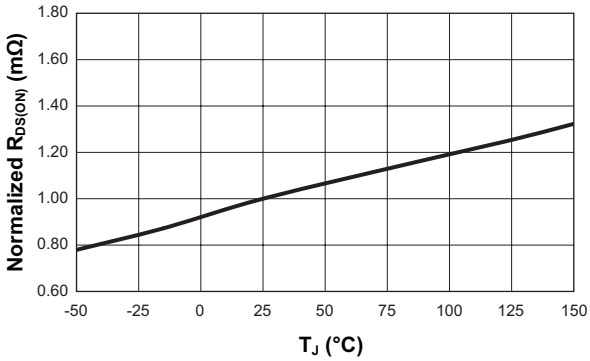
Shutdown Current vs. Shutdown Voltage



$R_{DS(ON)}$ vs. I_{SD}

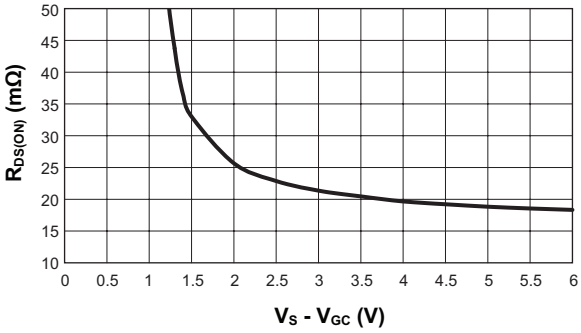


On-Resistance vs. Junction Temperature
(V_S = 6V; I_{DS} = 5A; Pulse width <300µs; Duty Cycle < 1%)

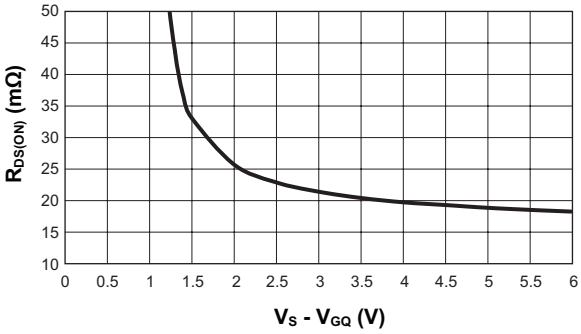


AAT4681/-1 Typical Electrical Characteristics

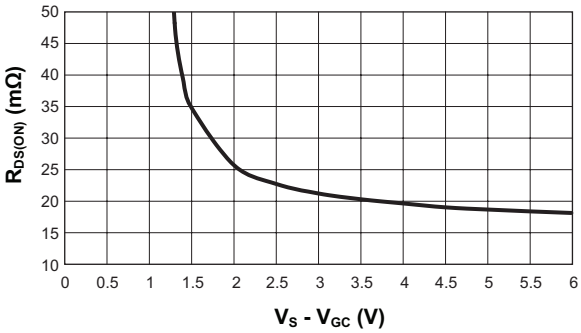
On-Resistance vs. Gate Voltage G_C
(V_S = 6V; V_{GQ} = 0V, I_{DS} = 5A;
Pulse Width < 300µs, Duty Cycle < 1%)



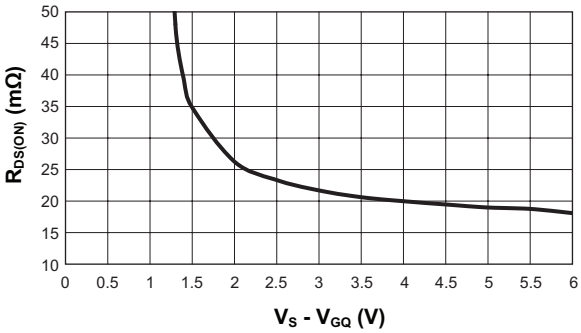
On-Resistance vs. Gate Voltage G_C
V_S = 6V, V_{GC} = 0V, I_{DS} = 5A;
Pulse Width < 300µs, Duty Cycle < 1%)



On-Resistance vs. Gate Voltage G_C
V_S = 6V, V_{GQ} = 0V, I_{DS} = 7A;
Pulse Width < 300µs, Duty Cycle < 1%)

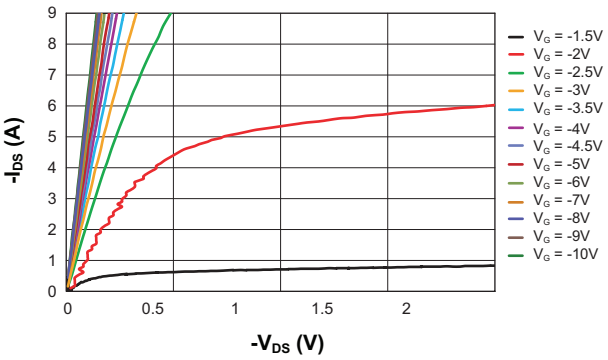


On-Resistance vs. Gate Voltage G_Q
V_S = 6V, V_{GQ} = 0V, I_{DS} = 7A;
Pulse Width < 300µs, Duty Cycle < 1%)

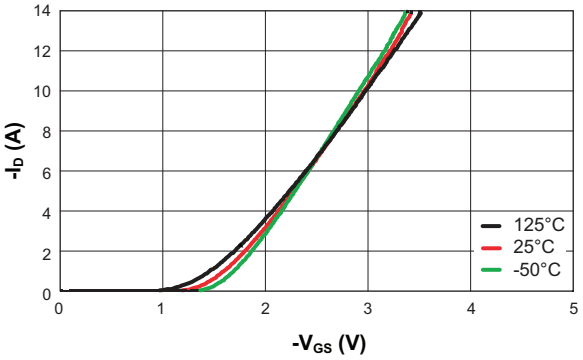


AAT4681-2 Typical Electrical Characteristics

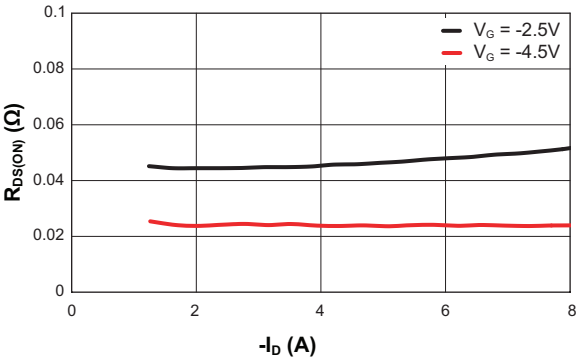
Output Characteristics



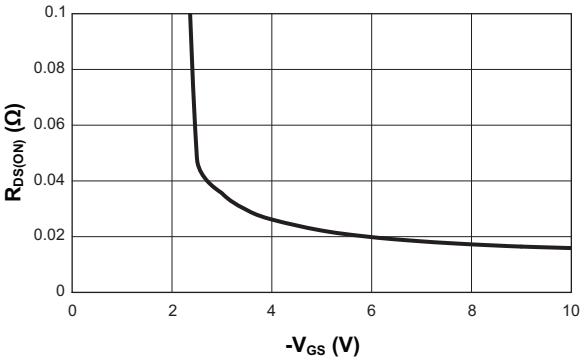
Transfer Characteristics



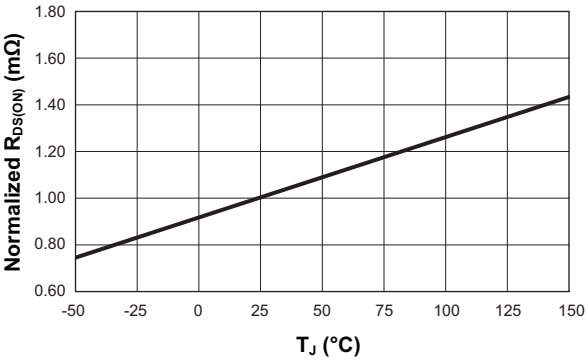
On-Resistance vs. Drain Current



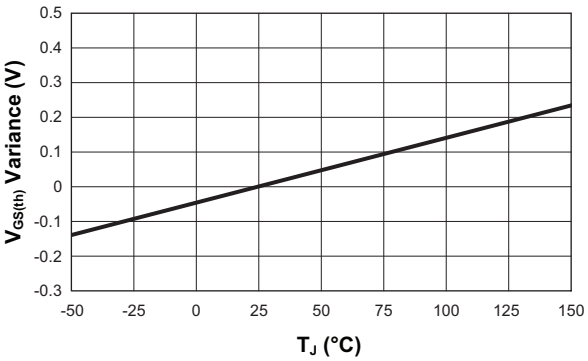
On-Resistance vs. Gate-Source Voltage



On-Resistance vs. Junction Temperature
(V_{GS} = -4.5V; I_D = -5.9A)

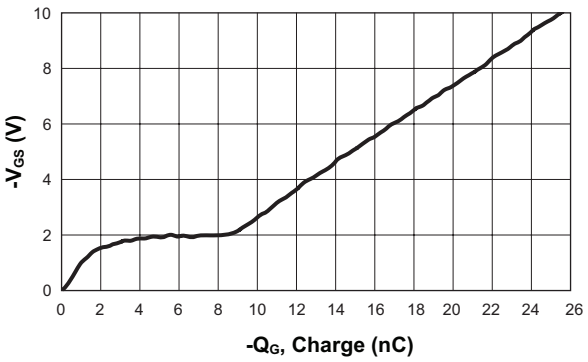


Threshold Voltage vs. Junction Temperature

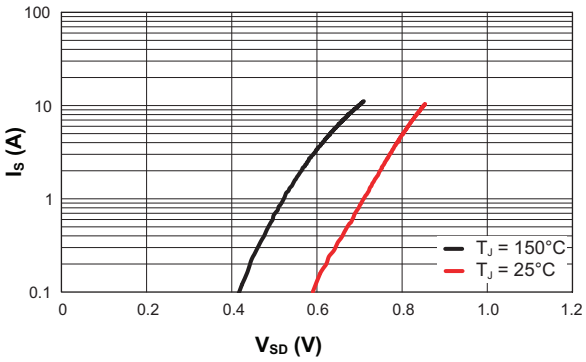


AAT4681-2 Typical Electrical Characteristics

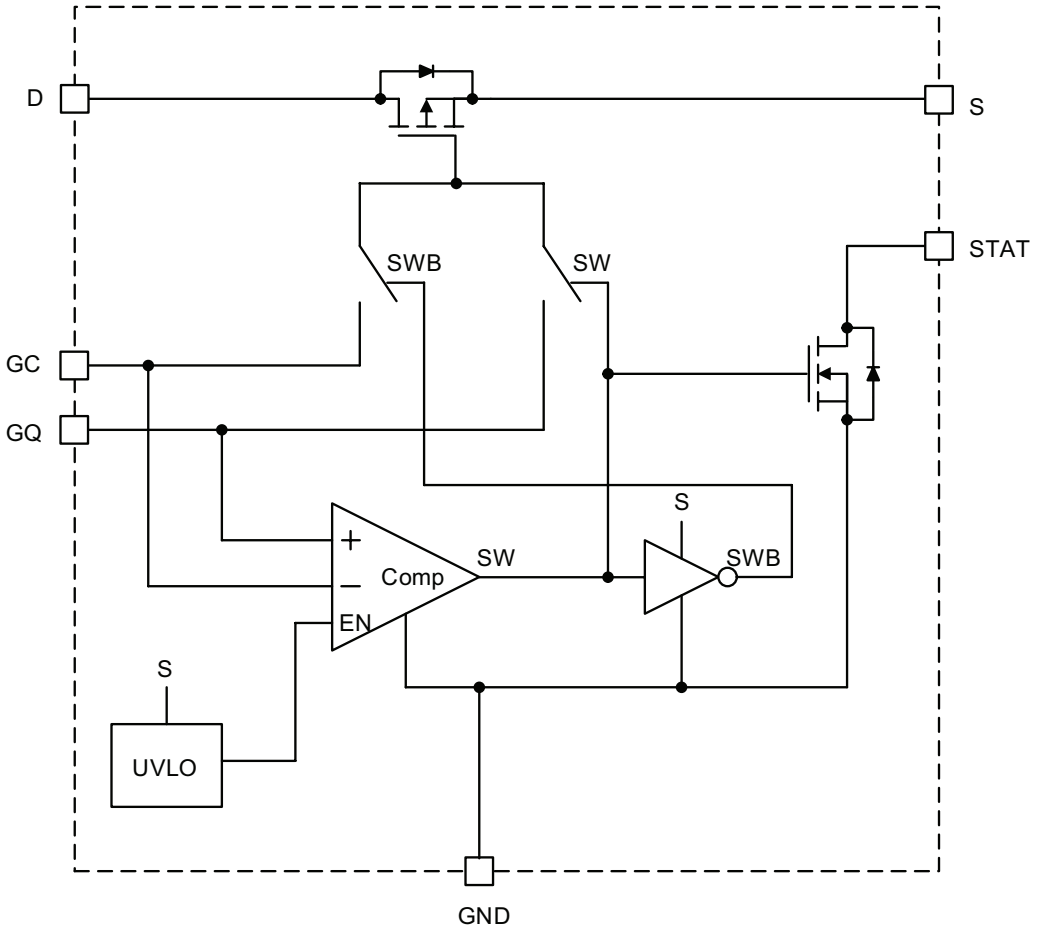
Gate Charge



Source-Drain Diode Forward Voltage



Functional Block Diagram



GC (Gate Control from Stand-Alone Charger)	GQ (Gate Control from PMU USB Charger)	P-Ch Gate Voltage Control Source
Vin	Vin	GC
Linear	0V	GC
0V*	Linear	GQ
0V	0V	GC
float	float	GC

*Switch to GQ when GQ > GC even if QC is not equal to zero.

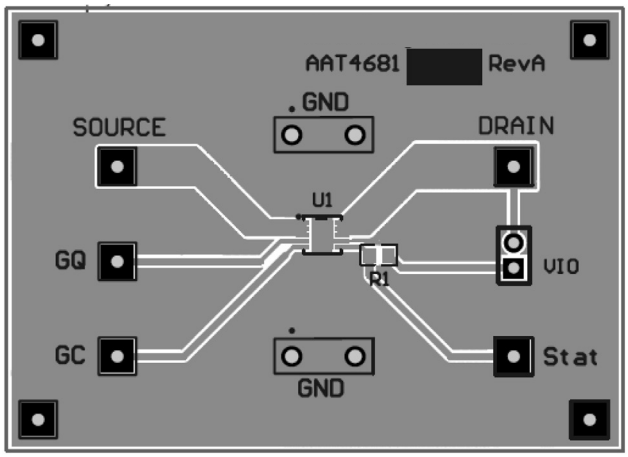


Figure 1: AAT4681IDE Evaluation Board Top Side Layout.

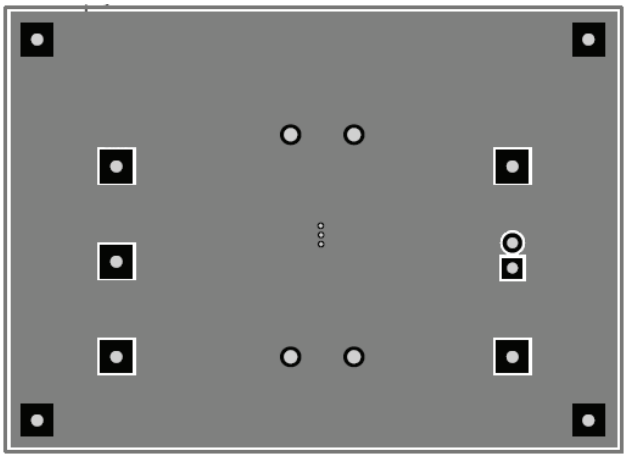


Figure 2: AAT4681IDE Evaluation Board Bottom Side Layout

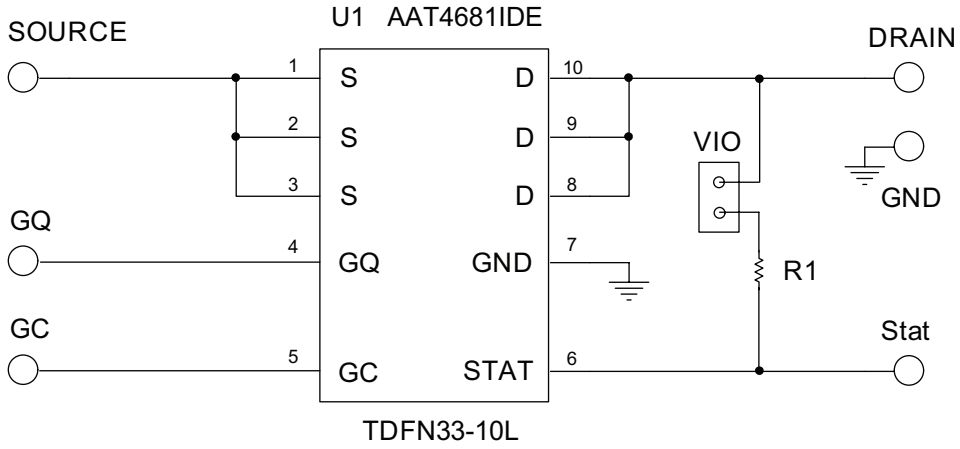


Figure 3: AAT4681IDE Evaluation Board Schematic.

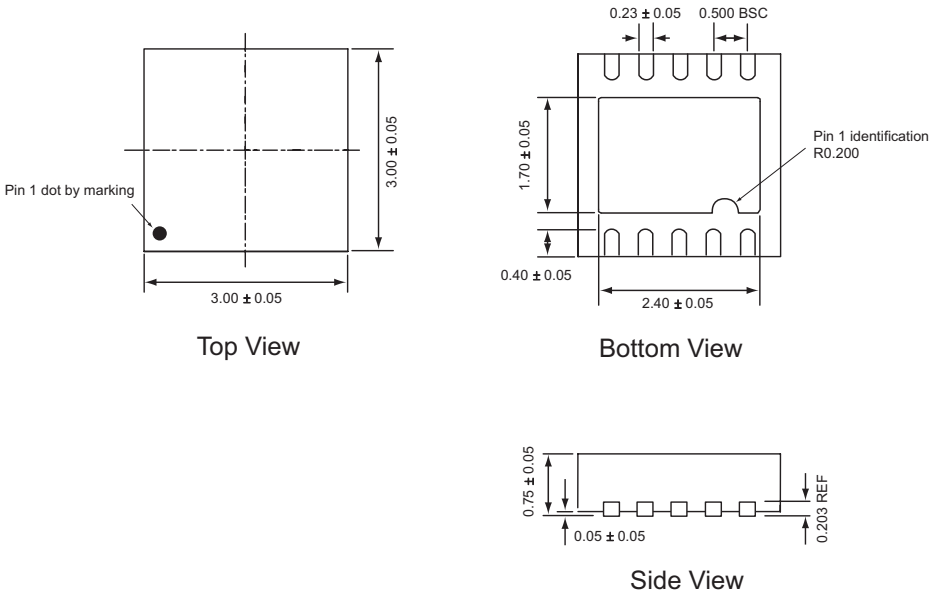
Ordering Information

Package	Marking[1]	Continuous Drain Current (A)	Part Number (Tape and Reel)[2]
TDFN33-10L	J8XYY	±7.0[3]	**AAT4681IDE-T1**
TDFN33-10L	F5XYY	±5.0[3]	**AAT4681IDE-1-T1**
TDFN33-10L	Y4XYY	±3.2[4]	**AAT4681IDE-2-T1**

Skyworks Green™ products are compliant with all applicable legislation and are halogen-free. For additional information, refer to *Skyworks Definition of Green™*, document number SQ04-0074.

Package Information

TDFN33-10L[5]



All dimensions in millimeters.

1. XYY = assembly and date code.
2. Sample stock is generally held on part numbers listed in **BOLD**.
3. T_A = 85°C.
4. T_A = 70°C.
5. The leadless package family, which includes QFN, TQFN, DFN, TDFN and STDFN, has exposed copper (unplated) at the end of the lead terminals due to the manufacturing process. A solder fillet at the exposed copper edge cannot be guaranteed and is not required to ensure a proper bottom solder connection.