

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.

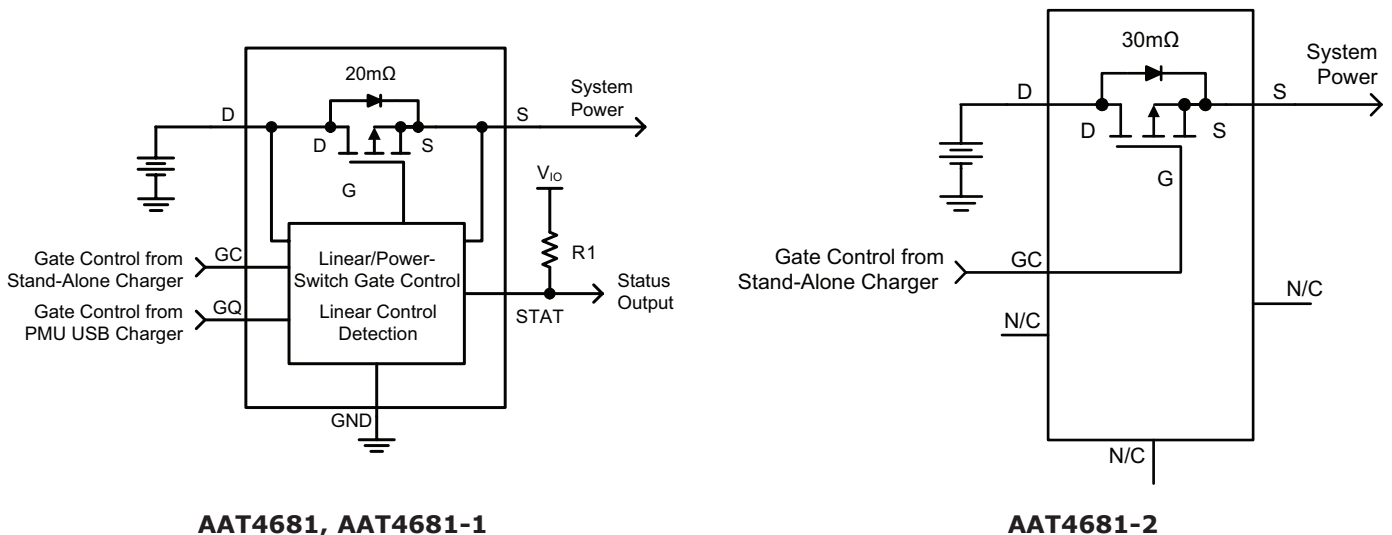
Features

- 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

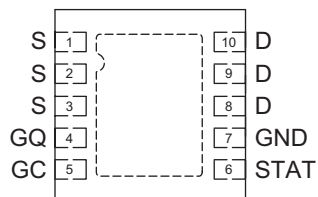
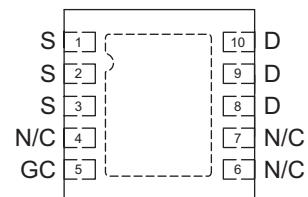
- Smart Phones
- Sub Notebooks
 - Smartbooks
 - Netbooks
- Ultra-Mobile PCs
- Wireless Media Devices

Typical Application



AAT4681**20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications****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**

20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications**Absolute Maximum Ratings¹**

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 @ $T_A = 85^\circ\text{C}$	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	$T_A = 25^\circ\text{C}$	± 4.0	A
		$T_A = 70^\circ\text{C}$	± 3.2	A
I_{DM}	Pulsed Drain Current	± 24	A	
I_S	Continuous Source Current (Source-Drain Diode)	-1.5	A	

Thermal Characteristics³

Symbol	Description	Value	Units
T_J	Operating Junction Temperature Range	-40 to +125	$^\circ\text{C}$
T_{LEAD}	Maximum Soldering Temperature (at leads, 10 sec.)	300	$^\circ\text{C}$
TDFN33-10L Thermal Impedance			
θ_{JA}	Maximum Junction-to-Ambient Thermal Resistance	50	$^\circ\text{C}/\text{W}$
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 $< 300\mu\text{s}$, duty cycle $< 1\%$.

3. T_J is calculated from the ambient temperature T_A and power dissipation P_D according to the following formula: $T_J = T_A + P_D \cdot \theta_{JA}$.

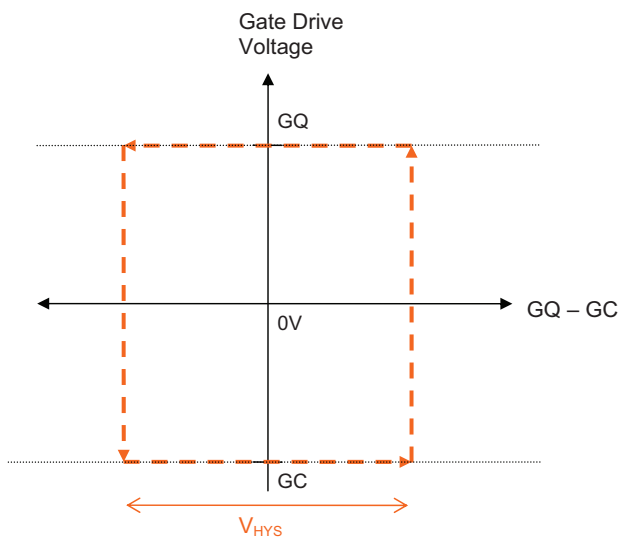
4. Thermal Resistance is specified with approximately 1 square inch of 1 oz. copper.

20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications

Electrical Characteristics

$T_A = -40^{\circ}\text{C}$ to $+85^{\circ}\text{C}$, unless otherwise noted. Typical values are at $T_A = +25^{\circ}\text{C}$.

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	$V_D = 4.2\text{V}$, $T_J = 55^{\circ}\text{C}$		3.6	15	μA
I_{DSS}	Drain-Source Leakage Current	$V_{GS} = 0\text{V}$, $V_{DS} = -5.5\text{V}$, $T_J = 55^{\circ}\text{C}$			-5	μA
$R_{DS(on)}$	P-Channel On Resistance ²	$V_D = V_{GC} = 4.2\text{V}$, $V_{GQ} = \text{GND}$, $I_D = 5\text{A}$, $T_A = 25^{\circ}\text{C}$		18	25	mΩ
				AAT4681	23	
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	$I_{STAT(SINK)} = 1\text{mA}$		0.025	0.4	V
$I_{STAT(SINK)}$	STAT Logic High Leakage Current	$V_{STAT} = 5.5\text{V}$, $V_{GC} = 5.5\text{V}$, $V_{GQ} = \text{GND}$		0.005	1	μA
AAT4681-2						
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{V}$, $I_D = -250\mu\text{A}$	-20			V
$R_{DS(ON)}$	Drain-Source On-Resistance ²	$V_{GS} = -4.5\text{V}$, $I_D = -4.0\text{A}$		27	40	mΩ
$I_{D(ON)}$	On-State Drain Current	$V_{GS} = -4.5\text{V}$, $V_{DS} = -5\text{V}$ (pulse) ²	-24			A
$V_{GS(th)}$	Gate Threshold Voltage	$V_{GS} = V_{DS}$, $I_D = -250\mu\text{A}$		-0.8		V

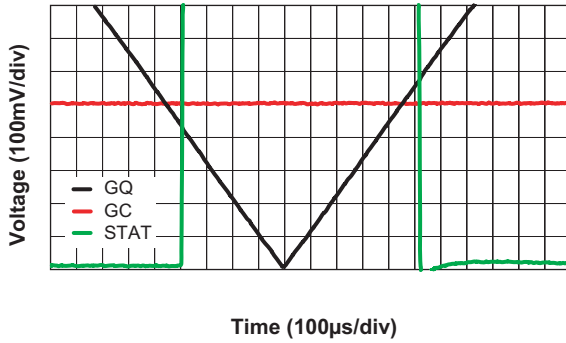


- Where V_{SYS} is the greater of V_D or V_S .
- Pulse width $< 300\mu\text{s}$, duty cycle $< 1\%$.

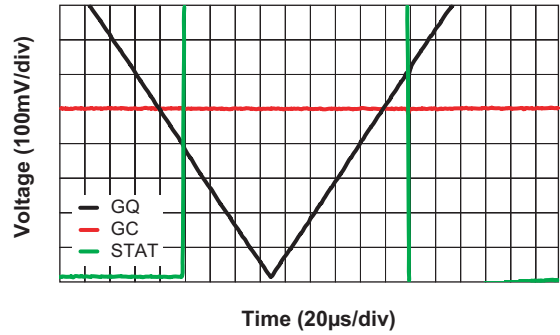
20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications

AAT4681/-1 Typical Electrical Characteristics

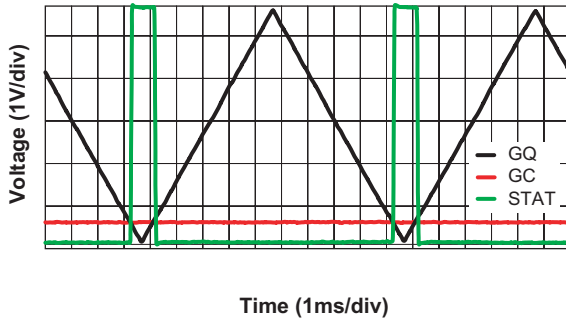
Hysteresis, GQ Ramp Time = 2.5ms
(S = 5.5V; GC = 0.5V; R_{STAT} = 5K; V_{IO} = 5.5V)



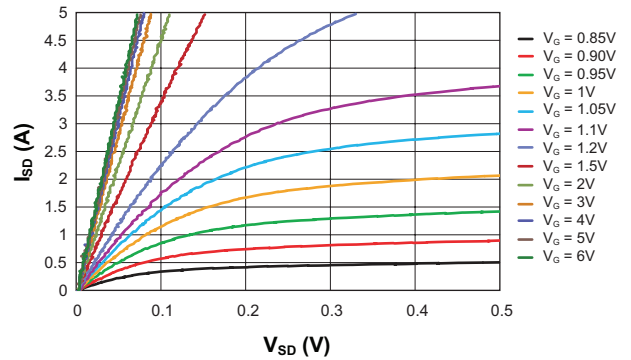
Hysteresis, GQ Ramp Time = 500µs
(S = 5.5V; GC = 0.5V; R_{STAT} = 5K; V_{IO} = 5.5V)



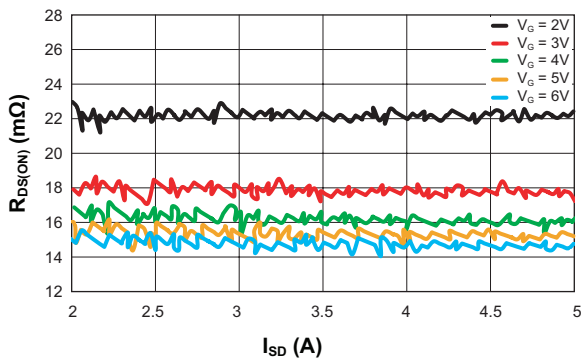
Timing
(S = 5.5V; GC = 0.5V; GQ ramp time = 2.5ms;
R_{STAT} = 5K; V_{IO} = 5.5V)



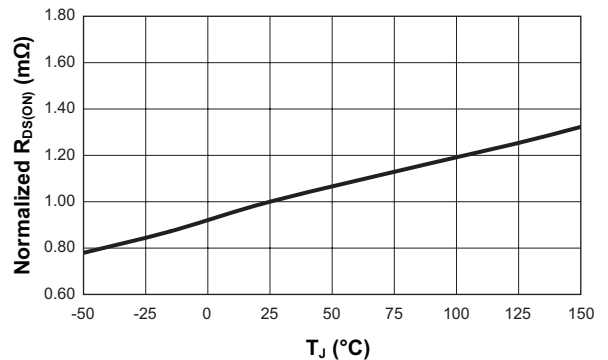
Shutdown Current vs. Shutdown Voltage



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



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

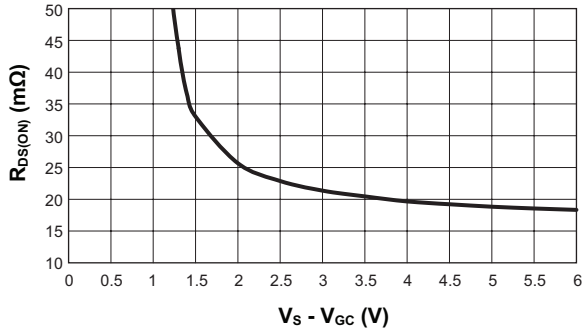


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AAT4681/-1 Typical Electrical Characteristics

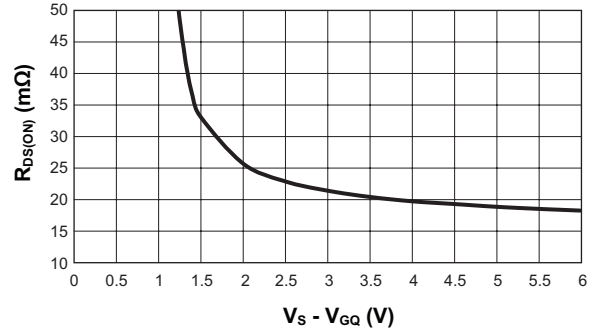
On-Resistance vs. Gate Voltage G_C

$(V_S = 6V; V_{GQ} = 0V, I_{DS} = 5A;$
Pulse Width < 300μs, Duty Cycle < 1%)



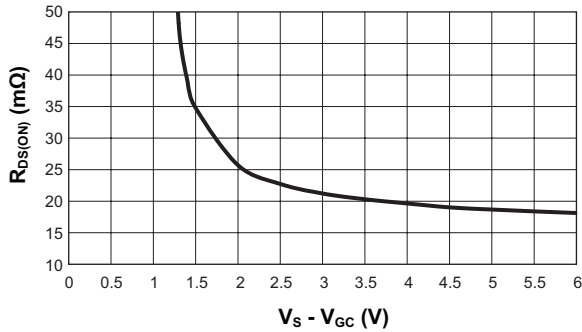
On-Resistance vs. Gate Voltage G_C

$V_S = 6V, V_{Gc} = 0V, I_{DS} = 5A;$
Pulse Width < 300μs, Duty Cycle < 1%)



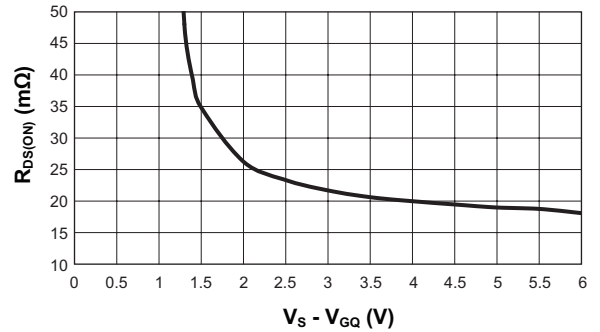
On-Resistance vs. Gate Voltage G_C

$V_S = 6V, V_{GQ} = 0V, I_{DS} = 7A;$
Pulse Width < 300μs, Duty Cycle < 1%)



On-Resistance vs. Gate Voltage G_Q

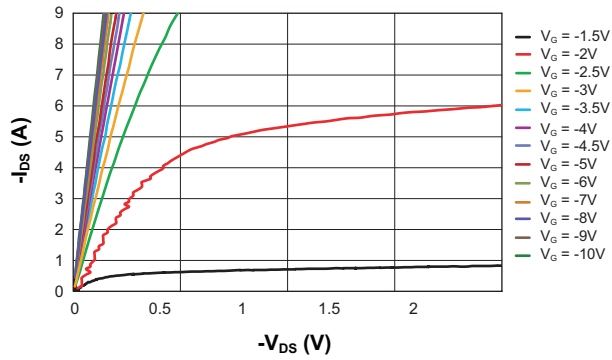
$V_S = 6V, V_{GQ} = 0V, I_{DS} = 7A;$
Pulse Width < 300μs, Duty Cycle < 1%)



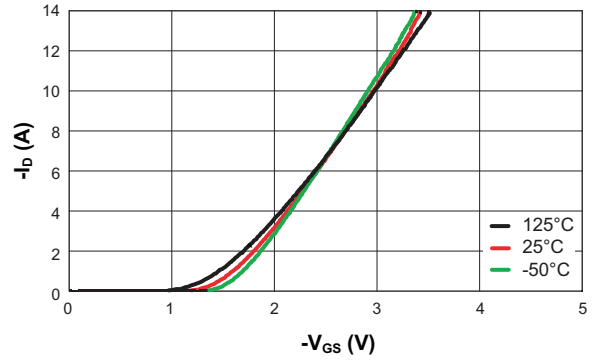
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AAT4681-2 Typical Electrical Characteristics

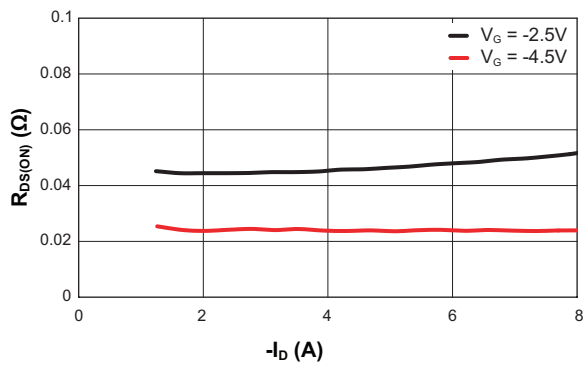
Output Characteristics



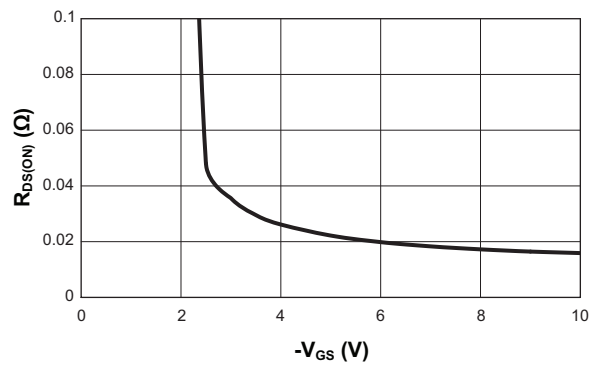
Transfer Characteristics



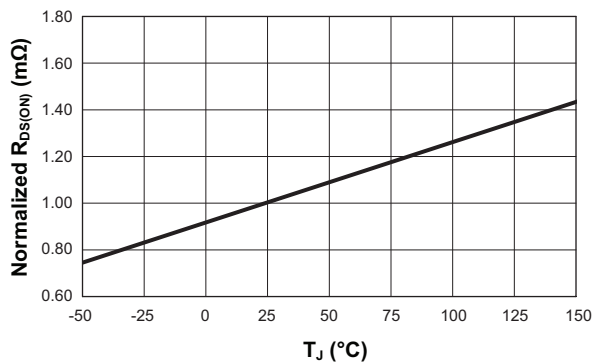
On-Resistance vs. Drain Current



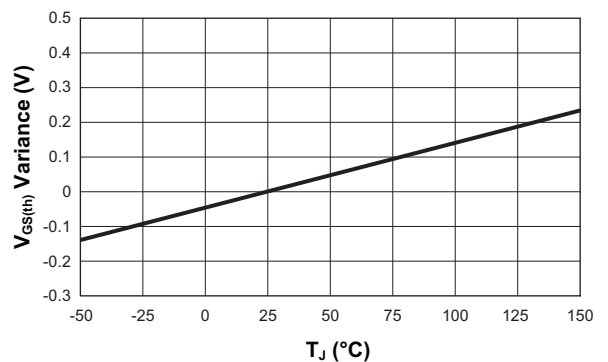
On-Resistance vs. Gate-Source Voltage



On-Resistance vs. Junction Temperature
(V_GS = -4.5V; I_D = -5.9A)



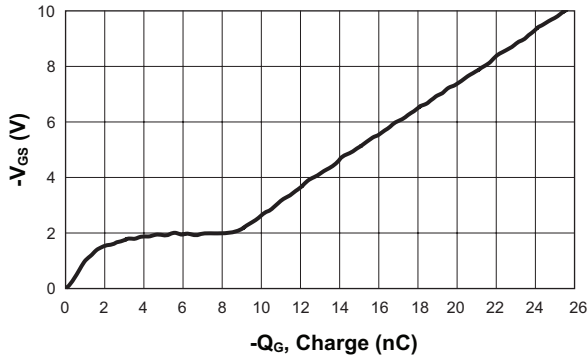
Threshold Voltage vs. Junction Temperature



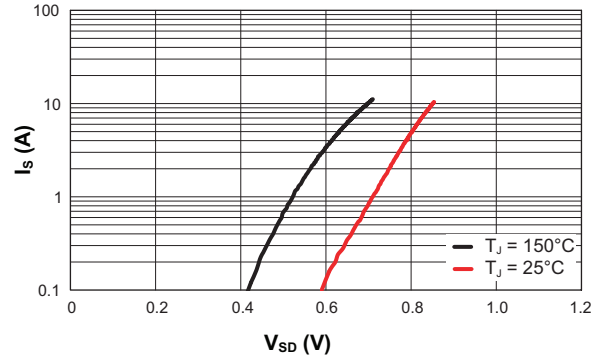
20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications

AAT4681-2 Typical Electrical Characteristics

Gate Charge

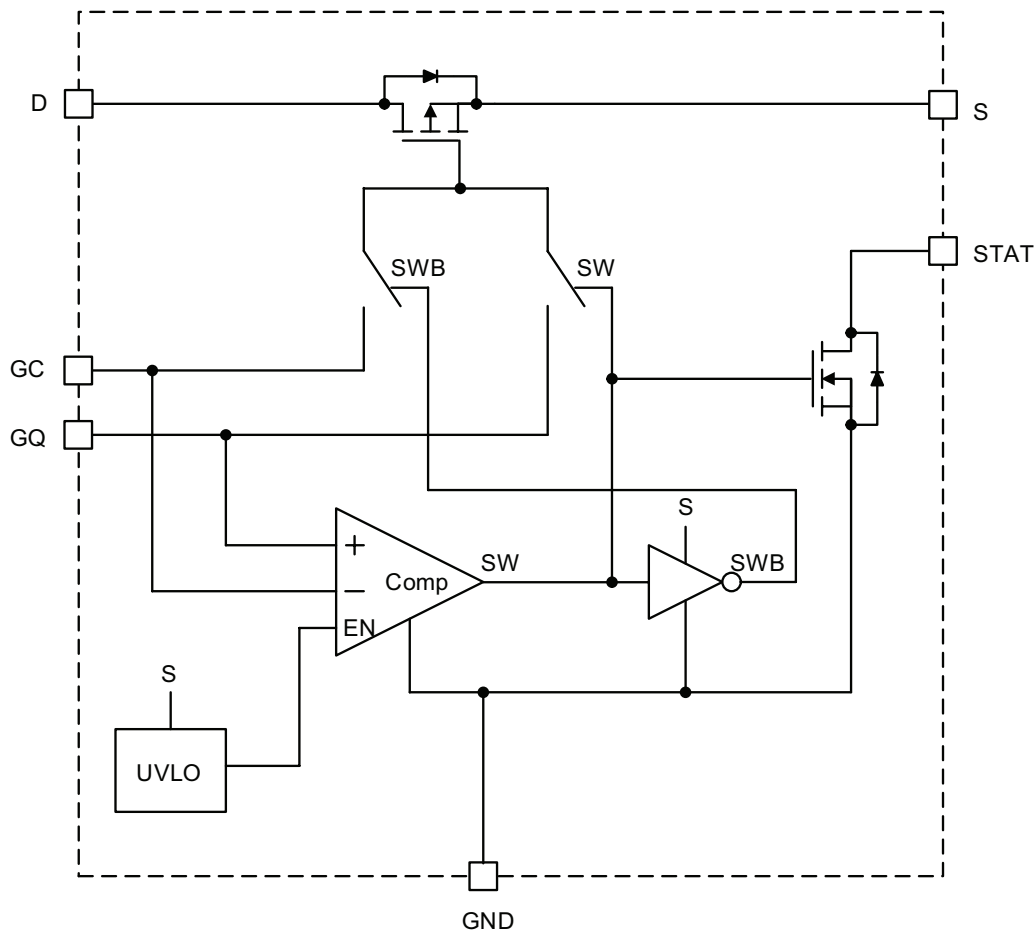


Source-Drain Diode Forward Voltage



20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications

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.

AAT4681

20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications

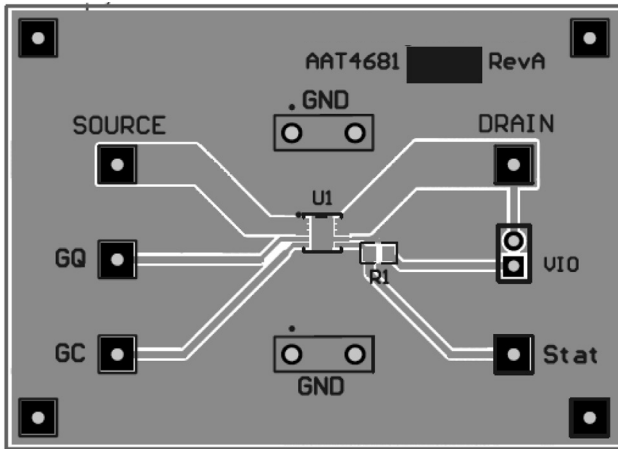


Figure 1: AAT4681IDE Evaluation Board Top Side Layout.

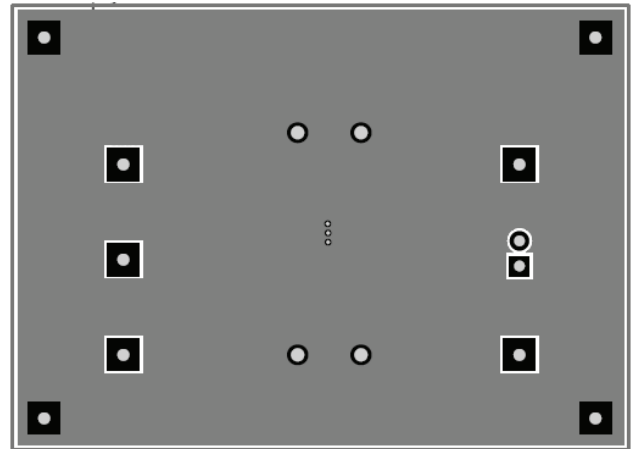


Figure 2: AAT4681IDE Evaluation Board Bottom Side Layout

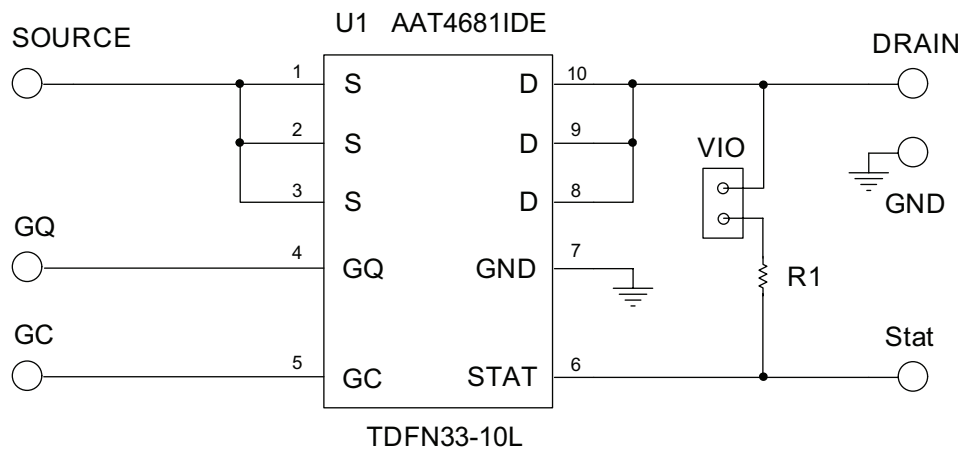


Figure 3: AAT4681IDE Evaluation Board Schematic.

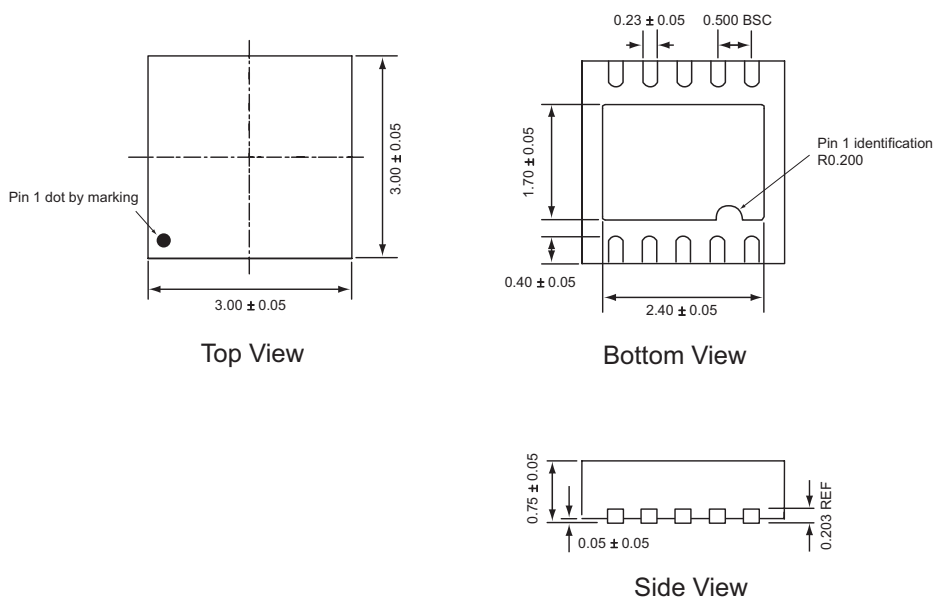
20mΩ P-Channel SmartSwitch for UMPC Battery Charging Applications**Ordering Information**

Package	Marking ¹	Continuous Drain Current (A)	Part Number (Tape and Reel) ²
TDFN33-10L	J8XYY	$\pm 7.0^3$	AAT4681IDE-T1
TDFN33-10L	F5XYY	$\pm 5.0^3$	AAT4681IDE-1-T1
TDFN33-10L	Y4XYY	$\pm 3.2^4$	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**TDFN33-10L⁵**

All dimensions in millimeters.

1. XYY = assembly and date code.
2. Sample stock is generally held on part numbers listed in **BOLD**.
3. $T_A = 85^\circ\text{C}$.
4. $T_A = 70^\circ\text{C}$.
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.

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