Surge Protected, Single Input, Dual Output Load Switch with OVP

Features

- Single Input, Dual Output Low On-Resistance Switch
  - VBUS to OUT: typ. 21mΩ
  - VBUS to BAT: typ. 12.5mΩ (Reverse Blocking)
- Wide Input Voltage Range: 2.7V – 13.5V
  - VBUS Abs Max: 28V
- Surge and ESD Protected Input
  - Surge Protection
    - IEC61000-4-5: > ±100V
  - ESD Protection
    - IEC61000-4-2 (Level 4) VBUS
      - Contact: ±8kV
      - Air Gap: ±15kV
    - HBM: 2kV All Pins
- Selectable Over-Voltage Protection (OVP)
  - KTS1679: VBUS to OUT: 13.9V ±400mV or 5.8V ±200mV
  - KTS1679-1: VBUS to OUT: 10.4V ±300mV or 5.8V ±200mV
  - VBUS to BAT: 5.8V ±200mV
- Maximum Continuous Current
  - VBUS to OUT: 3.5A
  - VBUS to BAT: 6A
- Dual Enable Control
  - Active LOW VBUS to OUT
  - Active HIGH VBUS to BAT
- Battery OVP Sense Pin
- VBUS to BAT FLAG
- Over Temperature Protection
- Pb-free 28-Bump, WLCSP 2.96mm x 1.67mm
- -40°C to 85°C Operating Temperature Range

Brief Description

The KTS1679 features two low resistance power switches configured as single input, dual output, change-over switch. The input to both switches is protected against VBUS surge voltages of up to ±100V, and is also protected against over-voltage, with preset trip points on both the VBUS to OUT and VBUS to BAT paths, providing protection to downstream components from abnormal input conditions.

The main switch (VBUS to OUT) features a unidirectional active –low enabled 3.5A rated MOSFET, with a selectable OVP trip point of 13.9V ±400mV or 5.8V ±200mV or 10.4V ±300mV or 5.8V ±200mV for KTS1679-1. The secondary switch (VBUS to BAT) is an active-HIGH enabled, reverse-blocking 6.0A rated MOSFET, with an OVP trip point of 5.8V ±200mV. The input to both switches is rated up to a maximum of 28V. A CMOS FLAG pin signals when VBUS to OUT switch is enabled.

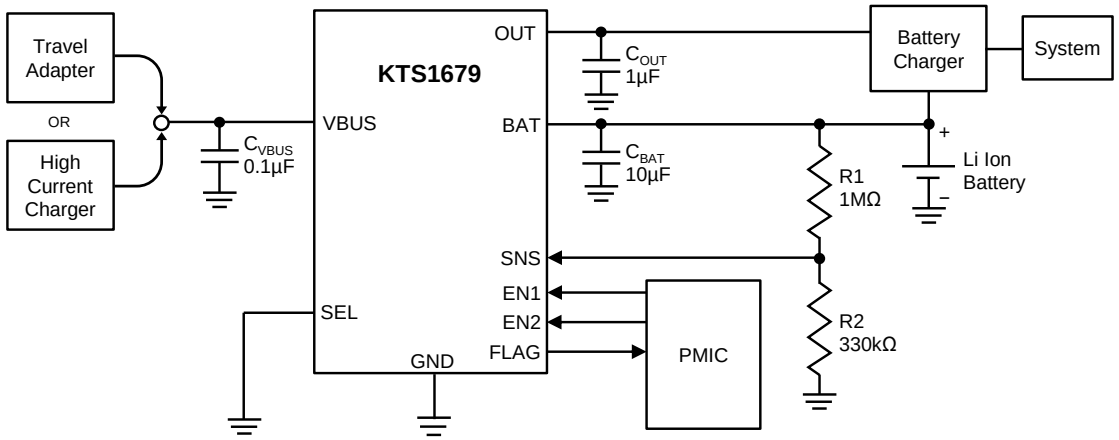
The KTS1679 also features an OVP battery sense pin to prevent damage to the battery during charge, and also integrates over-temperature thermal shutdown protection. The over-voltage status will be latched and FLAG will be pulled LOW to indicate the fault. To reset this channel, EN2 is required to toggle from LOW to HIGH.

The KTS1679 is packaged in advanced, fully “green” compliant, 2.96mm x 1.67mm, Wafer-Level Chip-Scale Package (WLCSP).

Applications

- Smartphones and Tablets
- Mobile Internet Devices
- Wearables, Portable Devices

Typical Application

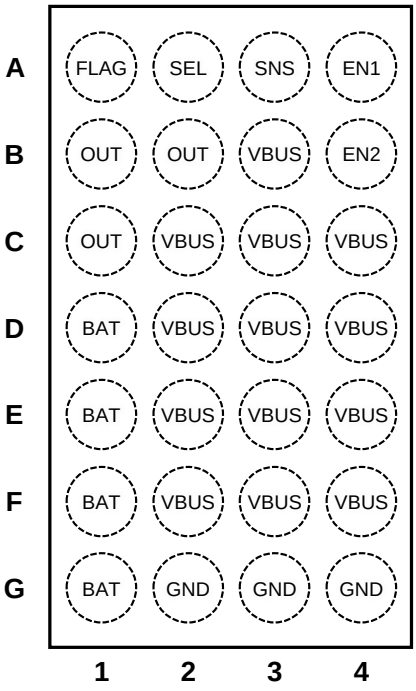


Pin Descriptions

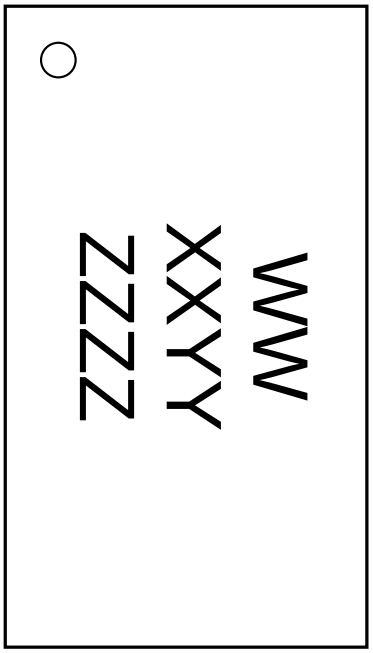
Pin #	Name	Function
A1	FLAG	Active HIGH CMOS Power good for VBUS to BAT path.
A2	SEL	VBUS to OUT, OVP trip point selector pin. Connect to ground or leave floating (see Table 1 for details)
A3	SNS	Battery overvoltage monitor pin.
A4	EN1	Active LOW enable with internal 1MΩ pull-down resistor, for VBUS to OUT path only
B1, B2, C1	OUT	Power switch output to load
B3, C2, C3, C4, D2, D3, D4, E2, E3, E4, F2, F3, F4	VBUS	Input to the power switches and device supply
B4	EN2	Active HIGH enable with internal 1MΩ pull-down resistor, for VBUS to BAT path only
D1, E1, F1, G1	BAT	Power switch output to battery
G2, G3, G4	GND	Ground

WLCSP-28

TOP VIEW



TOP VIEW



28-Bump 2.96mm x 1.67mm x 0.620mm
WLCSP Package

Top Mark
WW = Device ID Code,
XX = Date Code, YY = Assembly Code,
ZZZZ = Serial Number

Absolute Maximum Ratings[1]

(T_A = 25°C unless otherwise noted)

Symbol	Description	Value	Units
VBUS[2]	VBUS to GND, VBUS to OUT	-0.3V to 28	V
OUT	OUT to GND	-0.3 to VBUS+0.3	V
BAT	BAT to GND	-0.3 to 6	V
SEL, EN1, EN2, SNS, FLAG	Select, Enable, Sense and Flag pins	-0.3 to 6	V
VBUS-OUT Current	VBUS to OUT Continuous Current	3.5	A
	VBUS to OUT Peak Current (5ms)	7.0	A
VBUS-BAT Current	VBUS to BAT Continuous Current	6.0	A
	VBUS to BAT Peak Current (5ms)	12.0	A
T_J	Operating Temperature Range	-40 to 150	°C
T_S	Storage Temperature Range	-55 to 150	°C
T_{LEAD}	Maximum Soldering Temperature (at leads, 10 sec)	260	°C

Thermal Capabilities[3]

Symbol	Description	Value	Units
Θ_{JA}	Thermal Resistance – Junction to Ambient	55	°C/W
P_D	Maximum Power Dissipation at 25°C	2.27	W
$\Delta P_D/\Delta_T$	Derating Factor Above T_A = 25°C	-41.3	mW/°C

Ordering Information

Part Number[4]	Marking	SEL	VBUS to OUT OVP	VBUS to BAT OVP	Operating Temperature	Package
KTS1679EUQ-TR	JZXXYYZZZZ[5]	FLOAT	13.9V ±0.4V	5.8V ±0.2V	-40°C to +85°C	WLCSP28
		GND	5.8V ±0.2V			
KTS1679EUQ-1-TR	JZXXYYZZZZ[5]	FLOAT	10.4V ±0.3V			
		GND	5.8V ±0.2V			

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. Survives burst pulse up to 100V with 2Ω series impedance
3. Junction to Ambient thermal resistance is highly dependent on PCB layout. Values are based on thermal properties of the device when soldered to an EV board.
4. For part numbers in Italic, please contact your local sales representative for availability.
5. XX = Date Code, YY = Assembly Code, ZZZZ = Serial Number.

Electrical Characteristics[6]

Unless otherwise noted, the *Min* and *Max* specs are applied over the full operation temperature range of -40°C to +85°C, V_{BUS} = 2.7V to 13.5V. Typical values are specified at room temperature (25°C) with V_{BUS} = 5V, I_{VBUS} ≤ 2A, EN1 = EN2 = LOW, CIN = 0.1µF and T_A = 25°C.

Symbol	Description		Conditions	Min	Typ	Max	Units
Input							
I_Q	Input Quiescent Current		V_{BUS} = 5V, EN1 = EN2 = LOW		123	TBD	µA
I_{OVLO_Q}	Input Supply Current in Over-voltage mode		V_{BUS} = 15V, OUT = 0V, EN1 = EN2 = LOW		144	290	µA
			V_{BUS} = 6V, BAT = 0V, EN1 = EN2 = HIGH		129	210	µA
V_{IN_CLAMP}	Input Clamp Voltage		I_{IN} = 10mA, T_A = 25°C		32.4		V
V_{BUS_UVLO}	Under Voltage Lockout		V_{BUS} Rising	2.35	2.53	2.65	V
			V_{BUS} Falling	2.20	2.36	2.50	V
OVP VBUS to OUT							
R_{ON_OUT}	ON-Resistance VBUS to OUT	KTS1679	V_{BUS} = 5V, I_{OUT} = 1A, T_A = 25°C		21		mΩ
			V_{BUS} = 12V, I_{OUT} = 1A, T_A = 25°C		21		mΩ
		KTS1679-1	V_{BUS} = 5V, I_{OUT} = 1A, T_A = 25°C		21		mΩ
			V_{BUS} = 9V, I_{OUT} = 1A, T_A = 25°C		21		mΩ
V_{OUT_OVLO}	Over-Voltage Trip Level, SEL = FLOAT	KTS1679	V_{BUS} Rising		13.9		V
			V_{BUS} Falling		13.75		V
		KTS1679-1	V_{BUS} Rising	10.0	10.5	10.8	V
			V_{BUS} Falling		10.35		V
	Over-Voltage Trip Level, SEL = GND		V_{BUS} Rising	5.6	5.88	6.0	V
			V_{BUS} Falling		5.80		V
OVP VBUS to BAT							
R_{ON_BAT}	ON-Resistance VBUS to BAT		V_{BUS} = 3V, I_{OUT} = 1A, T_A = 25°C		12.5		mΩ
V_{BAT_OVLO}	Over-Voltage Trip Level		V_{BUS} Rising	5.6	5.88	6.0	V
			V_{BUS} Falling		5.80		V
I_{BAT_RB}	BAT Reverse Current		V_{BUS} = 0V, V_{BAT} = 4.4V, T_A = 25°C			1	µA
SNS							
SNS	SNS Over-Voltage Trip Level		T_A = 20°C to +85°C	1.140	1.155	1.170	V
DIGITAL SIGNALS (FLAG, EN1, EN2)							
V_{FLAG_OH}	FLAG Output HIGH Voltage		V_{BUS} = 5V, EN2 = HIGH	1.6	1.82	2.0	V
V_{FLAG_OL}	FLAG Output LOW Voltage		V_{BUS} = 5V, EN2 = LOW			0.5	V
V_{IH}	Logic EN1, EN2, HIGH Voltage		V_{BUS} = 2.7V to 13.5V	1.2			V
V_{IL}	Logic EN1, EN2, LOW Voltage					0.35	V
I_{EN}	EN1, EN2, Leakage Current		VBUS = 5V, OUT, BAT = Float		4	8	µA
R_{PD}	EN1, EN2, Internal Pull-down Resistor				1		MΩ

6. KTS1679 is guaranteed to meet performance specifications over the –40°C to +85°C operating temperature range by design, characterization and correlation with statistical process controls.

Electrical Characteristics[7]

Unless otherwise noted, the *Min* and *Max* specs are applied over the full operation temperature range of -40°C to +85°C, V_{BUS} = 2.7V to 13.5V. Typical values are specified at room temperature (25°C) with V_{BUS} = 5V, I_{VBUS} ≤ 2A, EN1 = EN2 = LOW, CIN = 0.1µF and T_A = 25°C.

Symbol	Description	Conditions	Min	Typ	Max	Units
TIMING CHARACTERISTICS (Figures 1-6)						
OUT						
t_{DEB_OUT}	OUT Debounce Time	Time from V_{BUS_UVLO} <V_{BUS}<V_{OUT_OVLO} to 10% of V_{OUT}		16		ms
t_{ON_OUT}	OUT Switch Turn-on Time	V_{OUT} from 10% of V_{BUS} to 90% of V_{BUS}, R_L = 100Ω, C_L = 10µF		2.2		ms
t_{OFF_OUT}	OUT Switch Turn-off Time[8]	V_{BUS} > V_{OUT_OVLO} to V_{OUT} Stop rising, R_L = 100Ω, No C_L		250		ns
BAT						
V_{BAT_SS}	VBAT Soft-Start Time	Time from V_{BUS} = V_{BUS_UVLO} to 10% of FLAG		30		ms
t_{DEB_BAT}	BAT Debounce Time	Time from V_{BUS_UVLO} <V_{BUS}<V_{OUT_OVLO} to 10% of V_{BAT}		16		ms
t_{ON_BAT}	BAT Switch Turn-on Time	V_{BAT} from 10% of V_{BUS} to 90% of V_{BUS}, R_L = 100Ω, C_L = 10µF		2.5		ms
t_{OFF_BAT}	BAT Switch Turn-off Time[8]	V_{BUS} > V_{OUT_OVLO} to V_{OUT} Stop rising, R_L = 100Ω, No C_L		400		ns
THERMAL SHUTDOWN[8]						
t_{J_TH}	IC Junction Thermal Shutdown			150		°C
	IC Junction Thermal Shutdown Hysteresis			20		°C
ESD PROTECTION[8]						
V_{ESD}	Human Body Model (HBM)	All pins		±2		kV
	IEC61000-4-2 Contact Discharge	VBUS Pin		±8		kV
	IEC61000-4-2 Air Discharge	VBUS Pin		±15		kV

7. KTS1679 is guaranteed to meet performance specifications over the –40°C to +85°C operating temperature range by design, characterization and correlation with statistical process controls.

8. Guaranteed by characterization and design

Timing Diagrams

VBUS to OUT

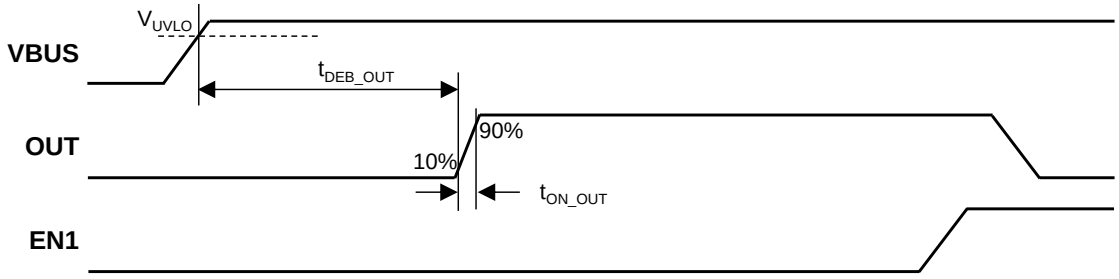


Figure 1. VBUS to OUT Timing Power Up/Down and Normal Operation

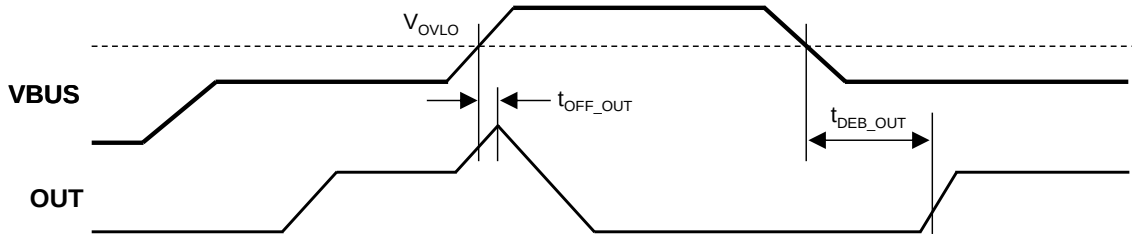


Figure 2. VBUS to OUT Timing OVLO Operation (EN1 = LOW)

VBUS to BAT

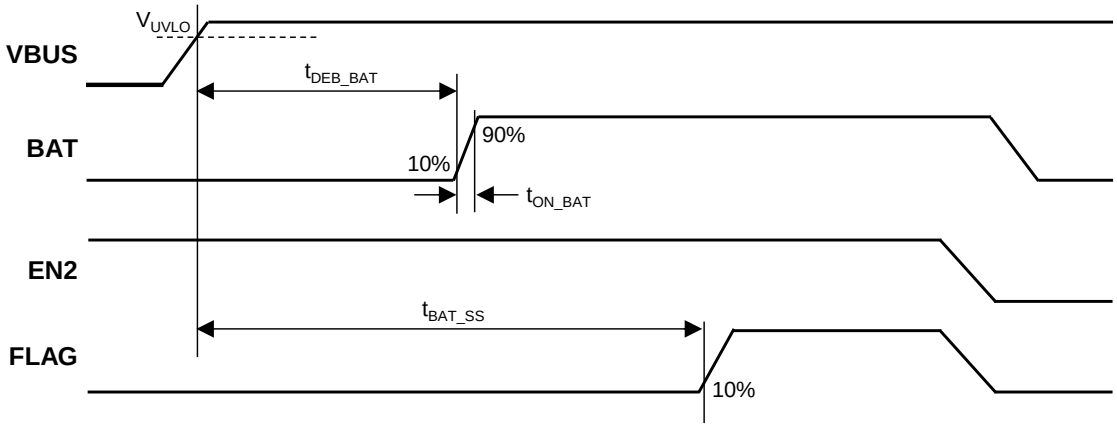


Figure 3. VBUS to BAT Timing Power Up/Down and Normal Operation

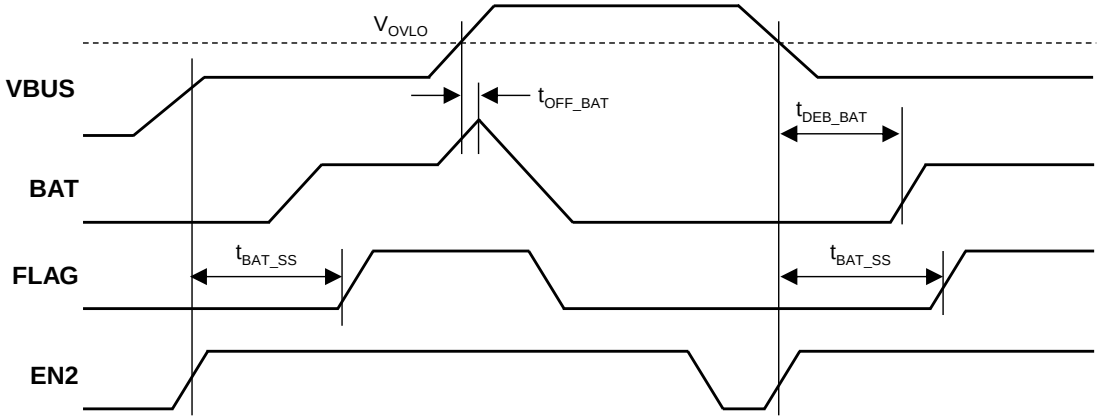


Figure 4. VBUS to BAT Timing OVLO Operation (EN2 = HIGH)

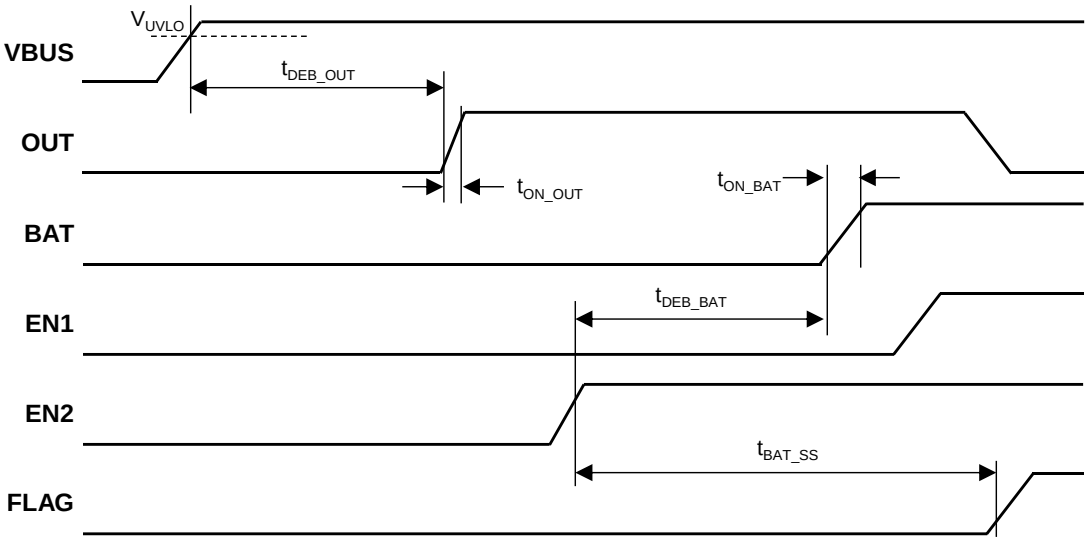
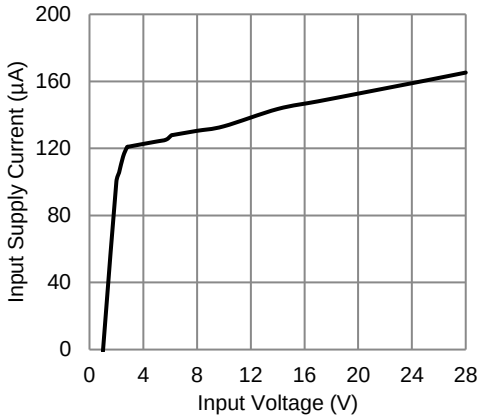


Figure 5. ON to OFF Timing Normal Operation

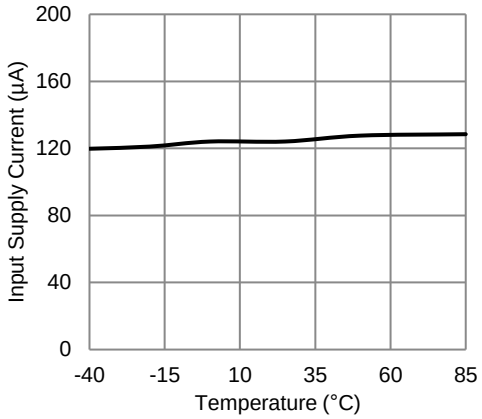
Typical Characteristics

V_{BUS} = 5V, C_{VBUS} = 0.1µF, C_{OUT} = 1µF, C_{BAT} = 10µF, T_A = 25°C unless otherwise specified.

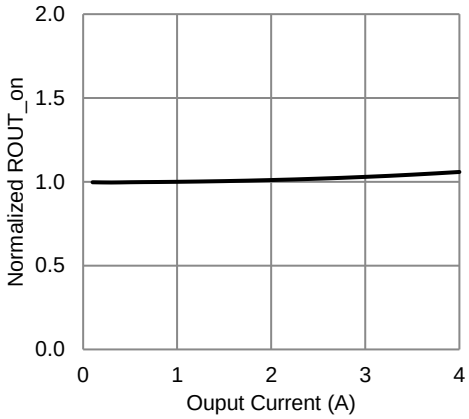
Input Supply Current vs. VBUS Voltage
(No Load, EN1 = EN2 = low)



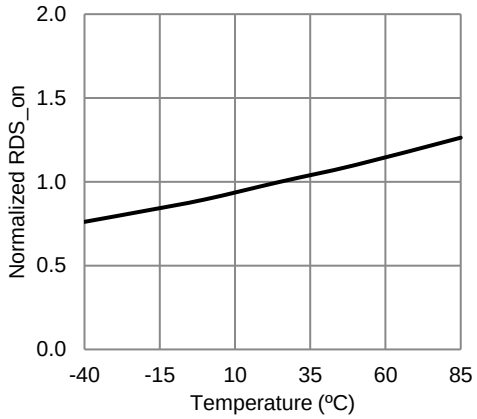
Input Supply Current vs. Temperature
(No Load, EN1 = EN2 = low)



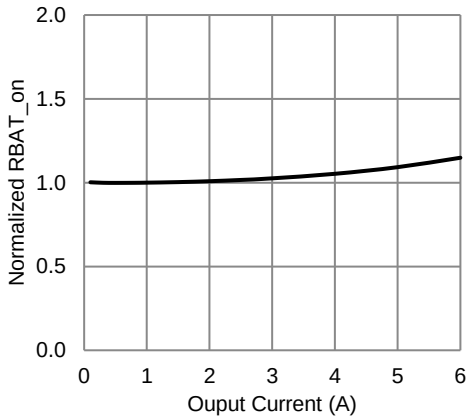
Normalized R_{OUT_ON} vs Output Current



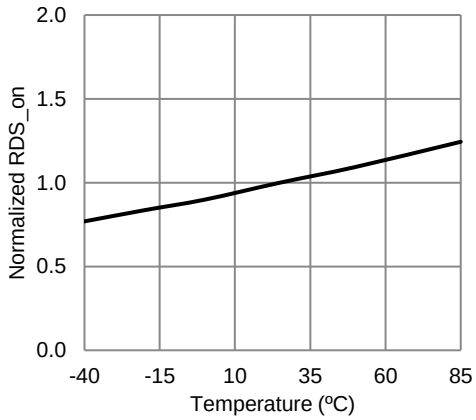
Normalized R_{OUT_ON} vs. Temperature
(I_{OUT} = 1A)



Normalized R_{BAT_ON} vs Output Current



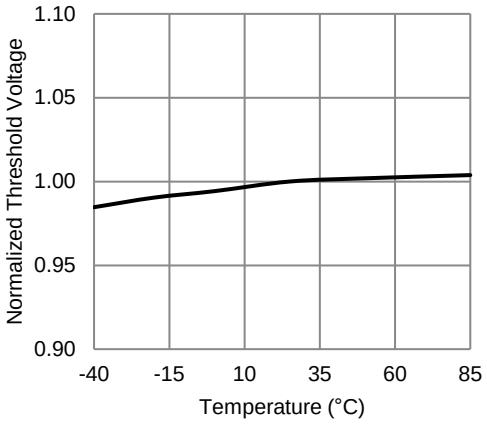
Normalized R_{BAT_ON} vs. Temperature
(I_{BAT} = 1A)



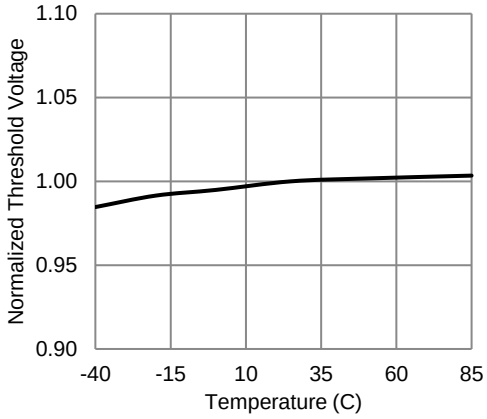
Typical Characteristics (continued)

V_{BUS} = 5V, C_{VBUS} = 0.1µF, C_{OUT} = 1µF, C_{BAT} = 10µF, T_A = 25°C unless otherwise specified.

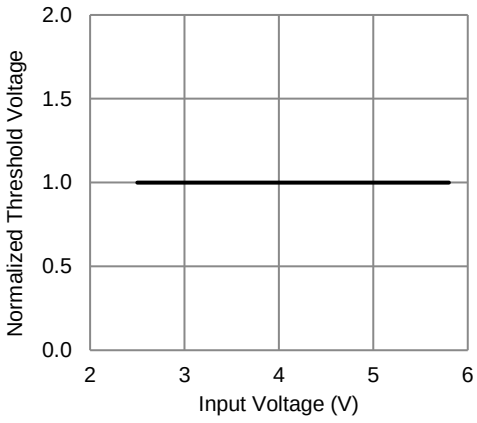
Normalized VOUT OVLO vs Temperature



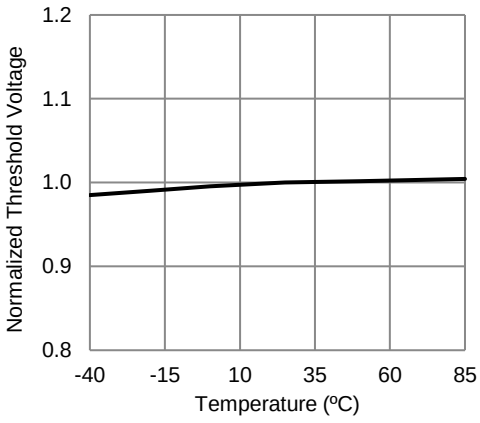
Normalized VBAT OVLO Threshold vs Temperature



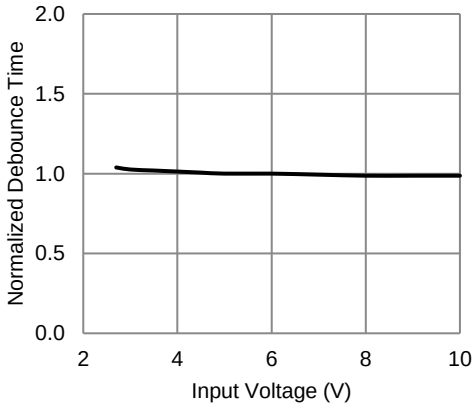
Normalized SNS OVLO vs VBUS Voltage



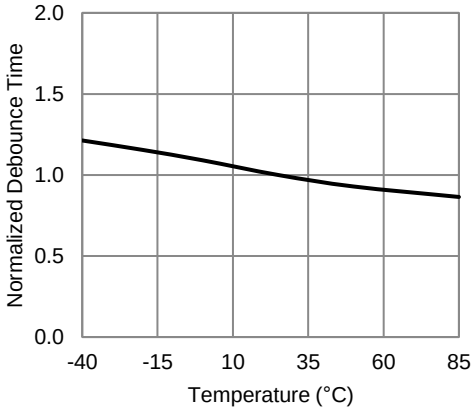
Normalized SNS OVLO vs. Temperature



Normalized Debounce Time vs. VBUS



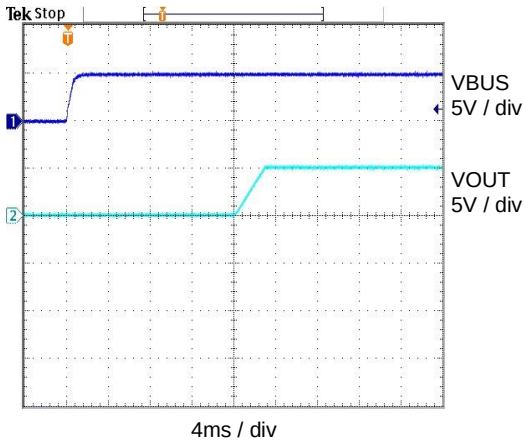
Normalized Debounce Time vs. Temperature



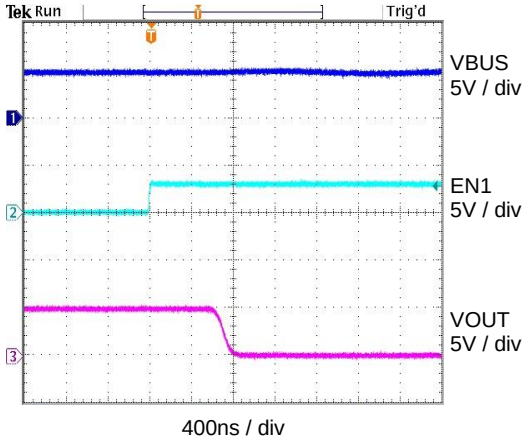
Typical Characteristics (continued)

V_{BUS} = 5V, C_{VBUS} = 0.1µF, C_{OUT} = 1µF, C_{BAT} = 10µF, T_A = 25°C unless otherwise specified.

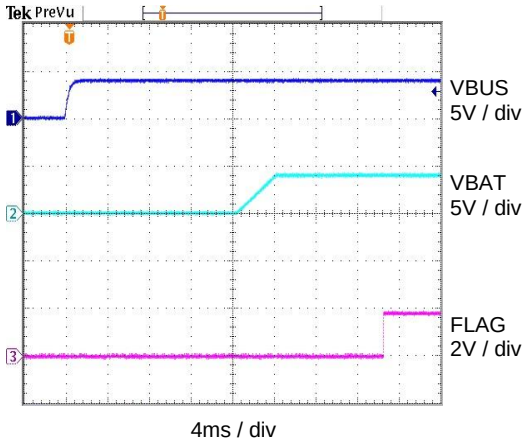
Power-up to VOUT
(EN1 = Low)



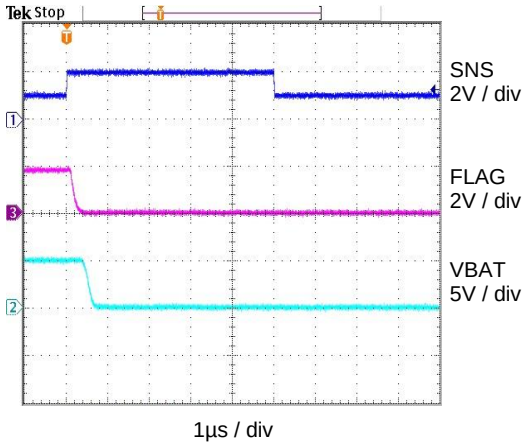
Turn off VOUT
(COUT = 0)



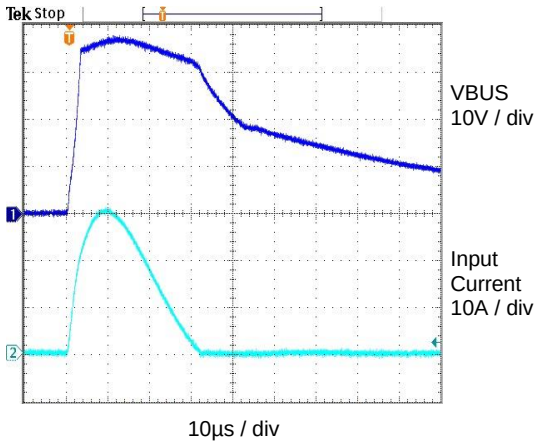
Power-up to VBAT
(VBUS = 4V, EN2 = High)



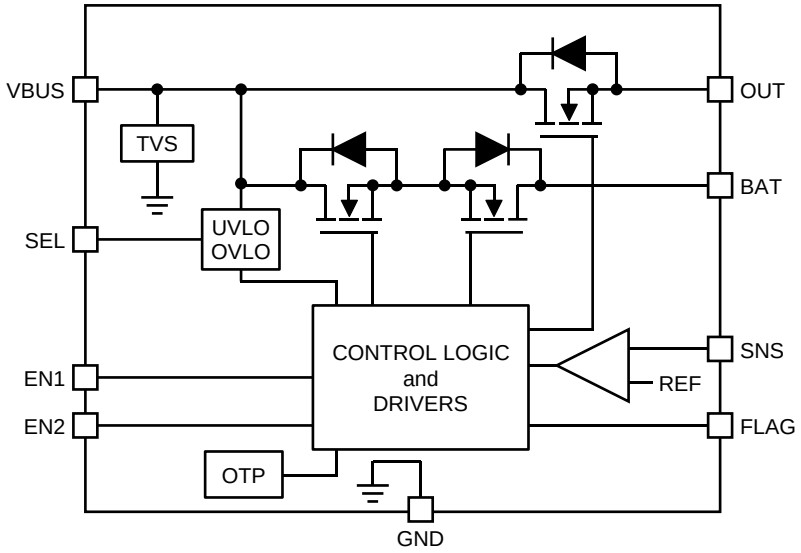
SNS OVP Response to BAT
(No CBAT)



Surge Transient
(100V)



Functional Block Diagram



Functional Description

The KTS1679 and KTS1679-1 features two low resistance power switches configured as single input, dual output, change-over switch. The input to both switches is protected against VBUS surge voltages of up to ±100V, and is also protected against over-voltage, with preset trip points on both the VBUS to OUT and VBUS to BAT paths, providing protection to downstream components from abnormal input conditions. A select pin SEL is used to configure the OVLO trip point by either shorting the pin to GND or allowing the pin to FLOAT.

The main switch (VBUS to OUT) features a unidirectional active–LOW enabled 3.5A rated MOSFET, with an OVP trip point of 13.9V ±400mV (10.4V ±400mV for the -1) when the SEL pin is floating or 5.8V ±200mV when the SEL pin is connected to GND. The secondary switch (VBUS to BAT) is an active-HIGH enabled, reverse-blocking 6.0A rated MOSFET, with an OVP trip point of 5.8V ±200mV. The input to both switches is rated up to a maximum of 28V and includes a 16ms debounce time, ensuring that the VBUS input is stable.

As a secondary protection to the internal battery protection, KTS1679 and KTS1679-1 include an OVLO trip function (SNS). This is provided by an internal comparator with a trip point of typically 1.155V. The battery should be connected via a suitable external resistive divider to select the desired trip point. If the SNS voltage exceeds the over-voltage trip point, the VBUS-BAT switch will be latched OFF until EN2 is toggled.

An active HIGH, CMOS FLAG is asserted whenever the BAT switch is active and is in a normal operating mode. The FLAG is de-asserted when the BAT switch is OFF due to either EN2 = LOW, VBUS is in UVLO or OVLO, thermal shutdown or when SNS is in OVLO.

The truth table for KTS1679 and KTS1679-1 is shown in Figure 6 below.

EN1 (for OUT)	EN2 (for BAT)	OUT Switch	BAT Switch	FLAG
0	0	ON	OFF	LOW
1	0	OFF	OFF	LOW
0	1	ON	ON	HIGH
1	1	OFF	ON	HIGH

Figure 6. Output Truth Table

Application Information

Input Capacitor

A 0.1μF capacitor is typically recommended for C_{VBUS}. C_{VBUS} should be located as close to the device VBUS pin as practically possible. 50V rated capacitors are generally good for most OVP applications to support any surge transient voltage.

Output Capacitors

The soft-start function provides a slow turn-on that allows the KTS1679 to charge large C_{SYS}/C_{OUT} output capacitors with minimum in-rush current. It is recommended to bypass SYS/OUT outputs with a 1μF minimum ceramic capacitor.

Recommended PCB Layout

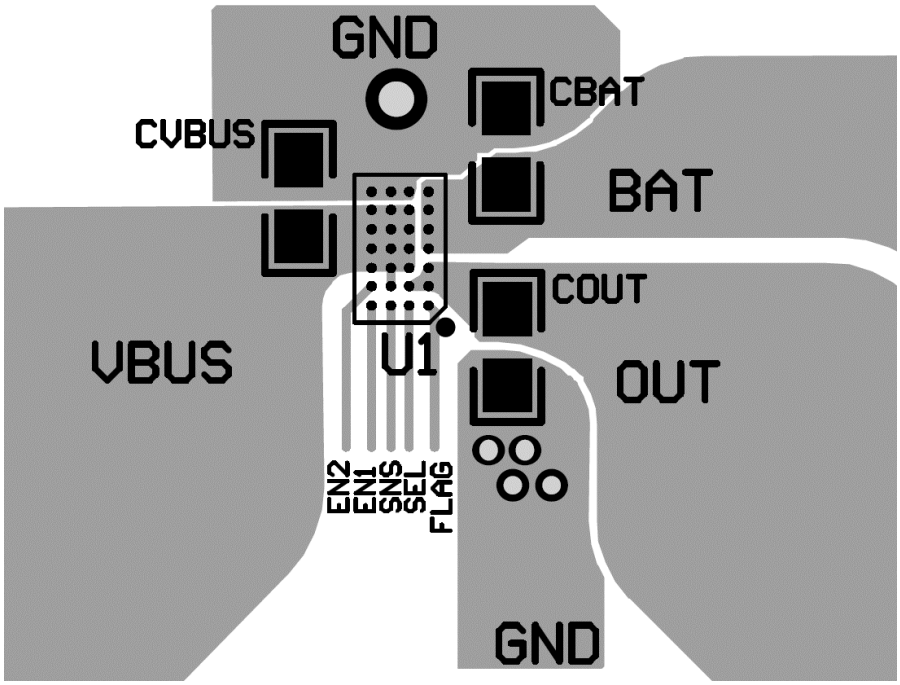
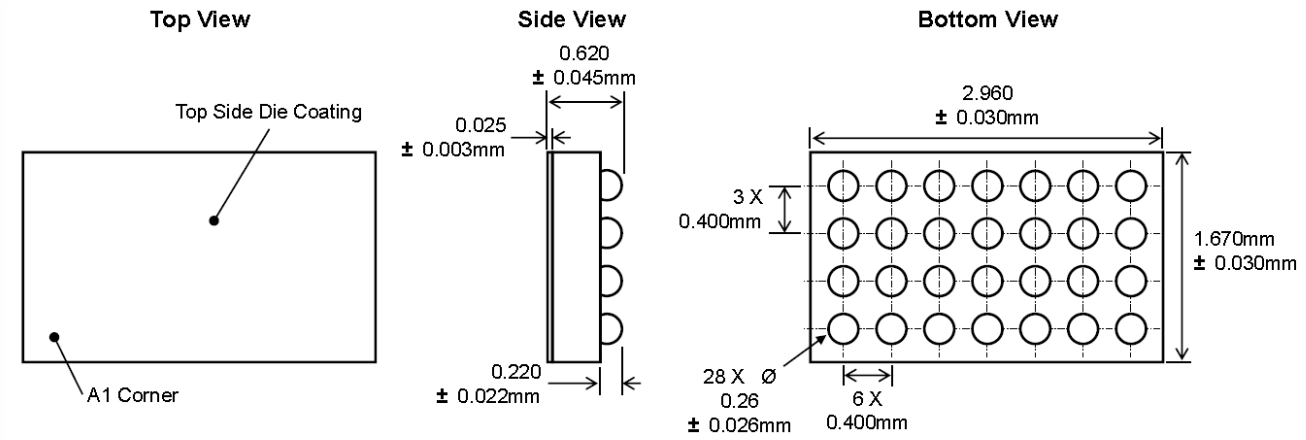


Figure 1. Recommended PCB Layout

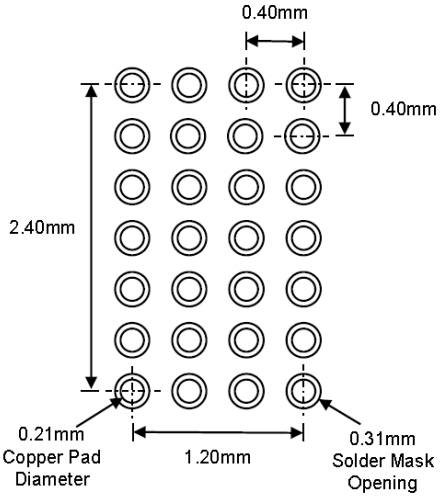
Packaging Information

WLCSP-28



Recommended Footprint

(NSMD Pad Type)



* Dimensions are in millimeters.