

High-Voltage Protection Power Delivery Switch

Features

- 50mΩ ON Resistance
- 28V Absolute Ratings at IN/OUT
- Operating Range: 4V to 20V
- 1.5mS Typical Rise Time (5V)
- Under Voltage Lockout
- Adjustable Over Voltage Lockout
- Fast Overcurrent Response
- Logic Level Enable Pin, Available with Active-High or Active-Low Version
- No Reverse Current when Power Off
- Deglitched Open-Drain Over-Current Flag Output (FLAG)
- Output Reverse-Voltage/Current Protection
- TSOT-23-8 FC Package
- UL 2367 Recognition-File No. E232223
- IEC 62368-1 Certified

Applications

- USB Power Management
- USB Host and Self-Powered Bubs
- USB Bus-Powered Hubs
- Hot Plug-In Power Supplies
- Battery-Charger Circuits

General Description

The G516 is an uni-directional switch for self-powered and bus-powered Universal Serial Bus (USB) applications with high input/output absolute rating of 28V.

Several Protection features include current limiting and thermal shutdown to prevent G516 switch failure caused by increasing power dissipation when continuous heavy loads or short circuit occurs. A built-in charge pump is used to drive the common-source back-to-back N-channel MOSFET that is free of parasitic body diode to eliminate any reversed current flow across the switch when it is powered off. When the output voltage/current is higher than input voltage, the power switch is turned off by internal output reverse-voltage/current comparator.

FLAG is an open-drain output report over-current, over-voltage, or over-temperature events and has typical 9ms deglitch timeout period.

Ordering Information

ORDER NUMBER	MARKING	ENABLE	Current Limit	OC Deglitch	TEMP. RANGE	PACKAGE (Green)
G516A1Y51U	516Ax	Active High	3.7A	No	-40°C to +85°C	TSOT-23-8 FC
G516A2Y51U	516Bx	Active Low	3.7A	No	-40°C to +85°C	TSOT-23-8 FC
G516A3Y51U	516Cx	Active High	3.7A	Yes	-40°C to +85°C	TSOT-23-8 FC

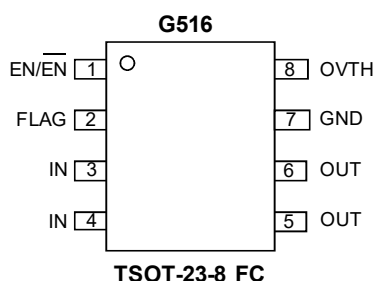
Note: Y5: TSOT-23-8 FC

1: Bonding Code

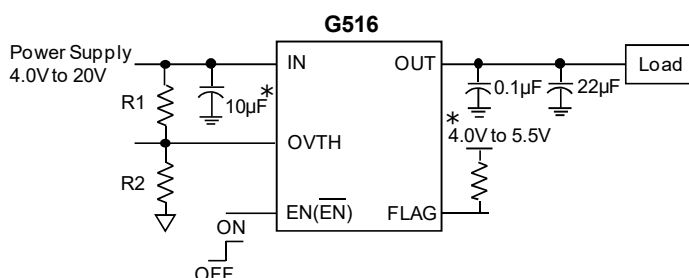
U: Tape & Reel

Green: Lead Free / Halogen Free.

Pin Configuration



Typical Application Circuit



*: 10µF of input capacitor is enough in most application cases.
If the PCB trace of power rail to IN is long, larger input capacitor is necessary.

*: The voltage should be less than power supply.

Absolute Maximum Ratings

Supply Voltage (V_{IN}) -0.3V to 28V
 Output Voltage (V_{OUT}) -0.3V to 28V
 Output Current (I_{OUT}) Internally Limited
 Enable Input (V_{EN}) -0.3V to 28V
 OVTH Voltage (V_{OVTH}) -0.3V to 28V
 FLAG Output (FLAG) -0.3V to 6V
 Thermal Resistance Junction to Ambient, (θ_{JA}) *
 TSOT-23-8. 125°C/W
 Continuous Power Dissipation ($T_A = +25^\circ\text{C}$) *
 TSOT-23-8. 0.9W
 Thermal Resistance Junction to Case, (θ_{JC})
 TSOT-23-8. 33°C/W

Junction Temperature 150°C
 Storage Temperature (T_S) -65°C to +150°C
 Reflow Temperature (soldering, 10sec) 260°C
 HBM ESD Protection 2kV
 CDM ESD Protection 0.5kV
 SYSTEM LEVEL ESD Protection (AIR).....15kV
 SYSTEM LEVEL ESD Protection (Contact).....8kV

Operating Ratings

Supply Voltage (V_{IN}) 4V to 20V
 Operating Temperature (T_A) -40°C to +85°C

* Please refer to Minimum Footprint PCB Layout Section

Electrical Characteristics

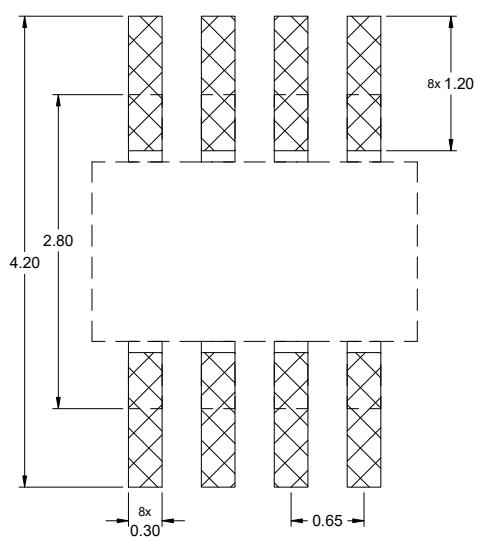
$V_{IN} = 5V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $R_L=10\Omega$ $T_A = 25^\circ\text{C}$.

The device is not guaranteed to function outside its operating conditions. Parameters with MIN and/or MAX limits are 100% tested at +25°C, unless otherwise specified.

PARAMETER	SYMBOL	CONDITION		MIN	TYP	MAX	UNIT
Input Voltage Range	V _{IN}			4	---	20	V
Quiescent Current	I _Q	V _{IN} =5.5V		---	100	130	μA
Off Supply Current	I _{Q(OFF)}	V _{IN} =5.5V, EN($\overline{EN}$) =Inactive		---	5	20	μA
V _{IN} Under Voltage Lockout	V _{UVLO}			3.0	3.4	3.8	V
Over-Voltage Protection(OVP)	V _{OVP}	V _{IN} Rising Threshold, OVTH=GND		21.8	23	24.2	V
		V _{IN} Falling Threshold, OVTH=GND		---	22.5	---	V
OVTH Threshold	V _{OVTH}	OVTH=Adjustable		1.18	1.24	1.30	V
Output MOS R _{DS(ON)}	R _{DS(ON)}	G516A, I _{OUT} =3A		---	50	--	mΩ
Over Current Trigger Point	I _{LIM}	G516A		3.4	3.7	4	A
EN Input Threshold-High V _{IH}	V _{EN(H)}			1.2	---	---	V
EN Input Threshold-Low V _{IL}	V _{EN(L)}			---	---	0.6	V
Output Rising Time	Tr	I _{LOAD} =100mA, C _{OUT} =10μF, 90% Settling	V _{IN} =5V	1	1.5	2	ms
			V _{IN} =20V	2	3.5	7	ms
Output Turn-On Time	T _{on}	I _{LOAD} =100mA, C _{OUT} =10μF, EN($\overline{EN}$) =Inactive to active, V _{OUT} =90%V _{IN}	V _{IN} =5V	---	3.5	---	ms
			V _{IN} =20V	---	8	---	
FLAG Deglitch	T _{FLAG}	FLAG assertion or deassertion		6	9	12	ms
OC Deglitch	T _{OCD}			9	12	15	ms
Output Leakage Current	I _{OUTL}	EN="0", V _{OUT} =0V		---	0.1	1	μA
Output Reverse-Current threshold				0.25	---	---	A
Output Reverse-Current Deglitch Time	T _{RPD}	V _{IN} =5V		---	5	---	ms
Thermal Limit	OT			---	150	---	°C
Thermal Limit Hysteresis	OT _{HYS}			---	40	---	°C

Minimum Footprint PCB Layout Section

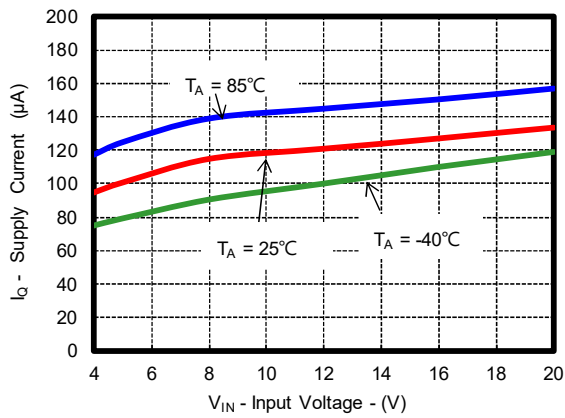
TSOT-23-8



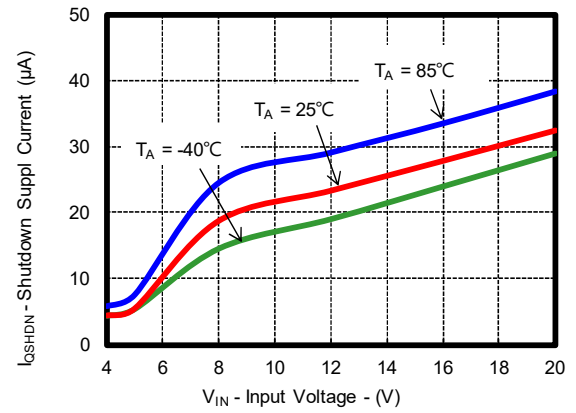
Typical Performance Characteristics

($V_{IN}=5V$, $C_{IN}=1\mu F$, $C_{OUT}=1\mu F$, $T_A=25^\circ C$, unless otherwise noted.)

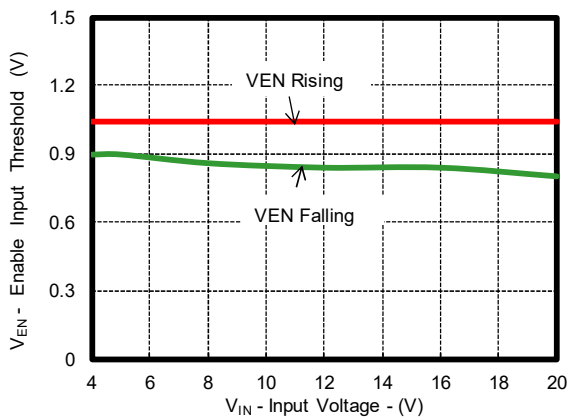
Supply Current vs. Input Voltage



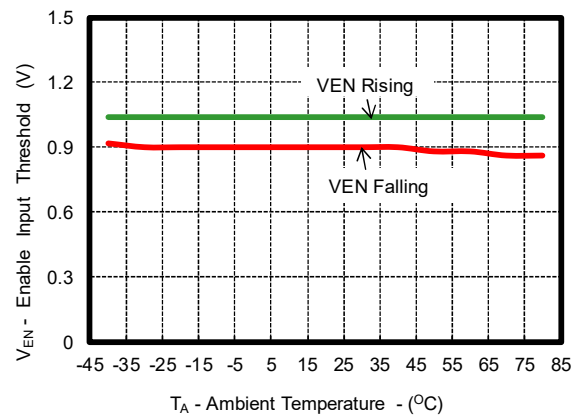
Shutdown Supply Current vs. Input Voltage



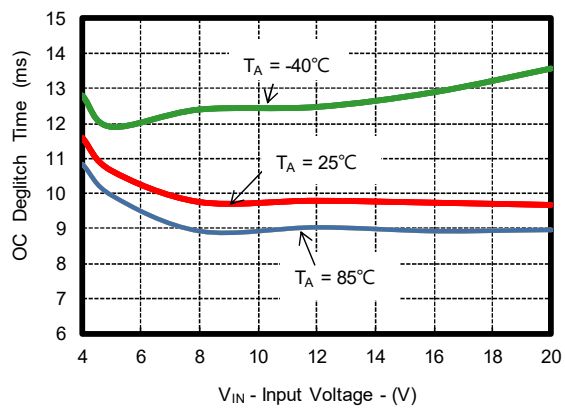
Enable Input Threshold vs. Input Voltage



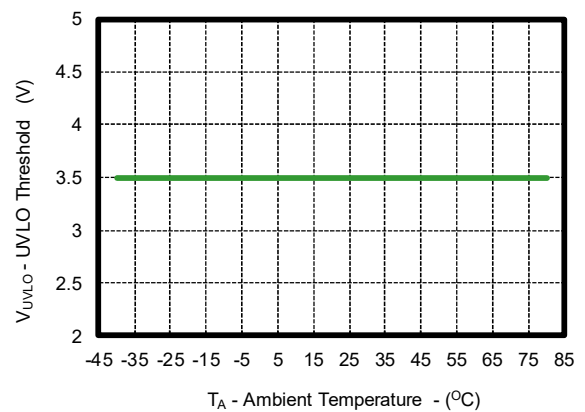
Enable Input Threshold vs. Temperature



OC Deglitch Time vs. Input Voltage

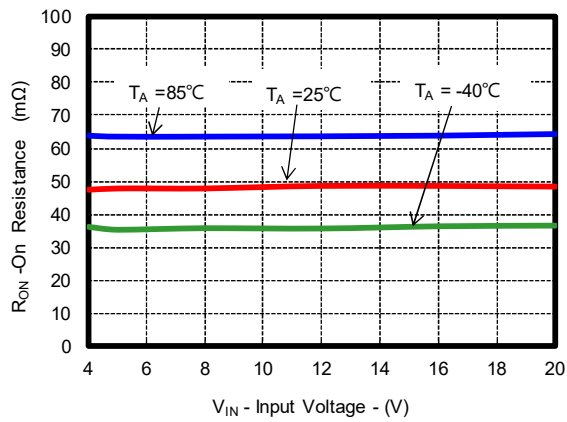


UVLO Threshold vs. Temperature

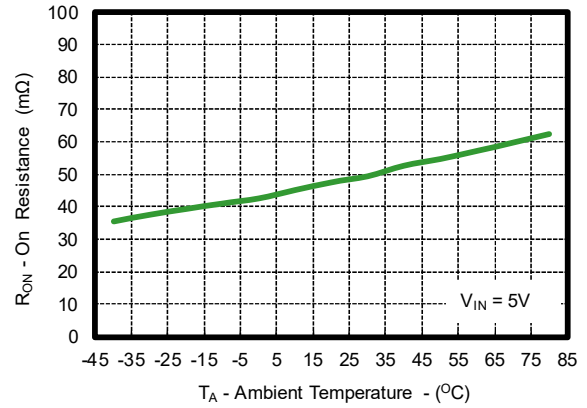


Typical Performance Characteristics (continued)

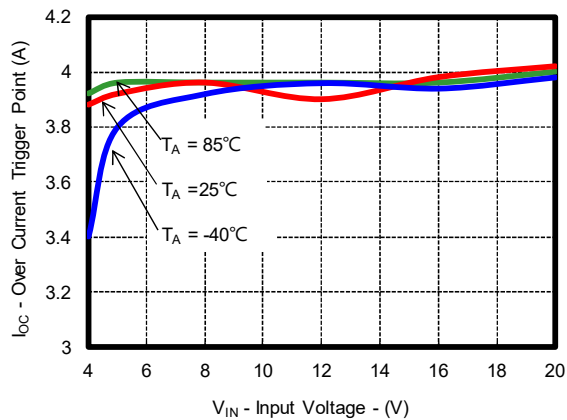
ON-Resistance vs. Input Voltage



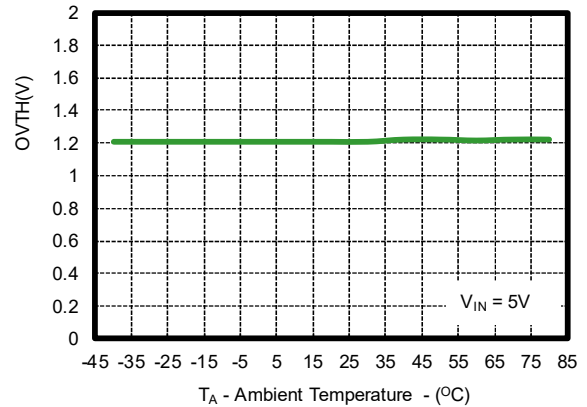
ON-Resistance vs. Temperature



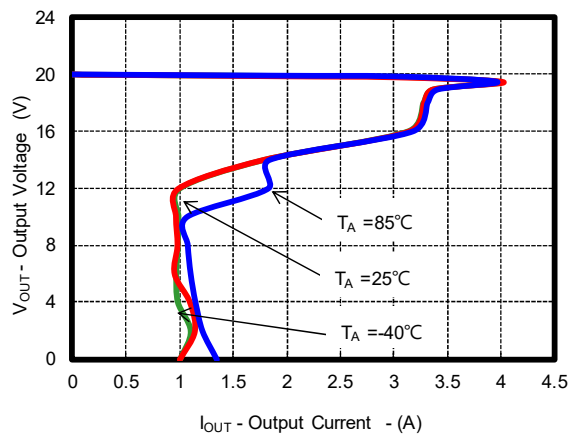
Over Current Trigger Point vs. Input Voltage



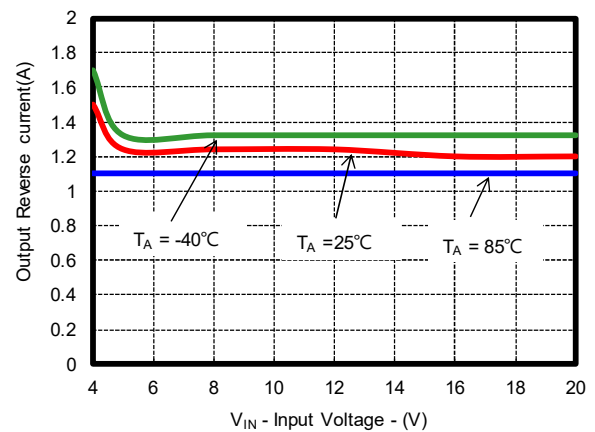
OVTH threshold vs. Temperature



Overcurrent Protection Characteristics

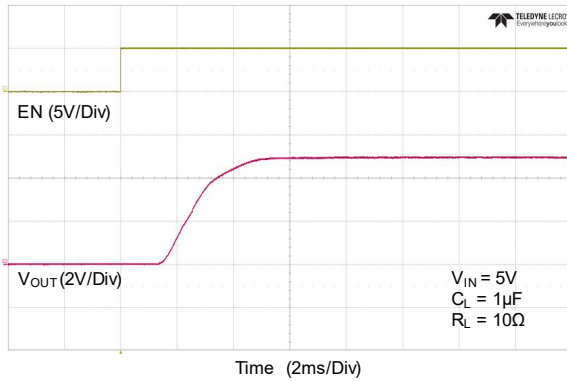


Output Reverse current vs. Input Voltage

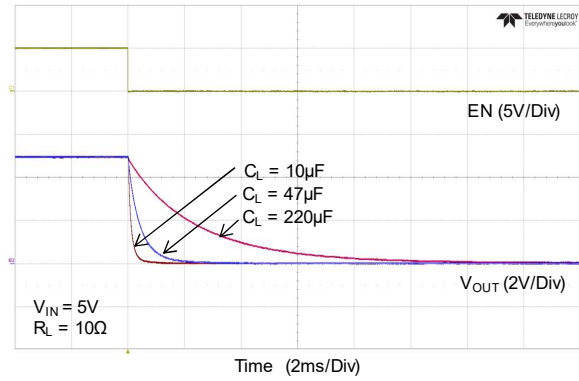


Typical Performance Characteristics (continued)

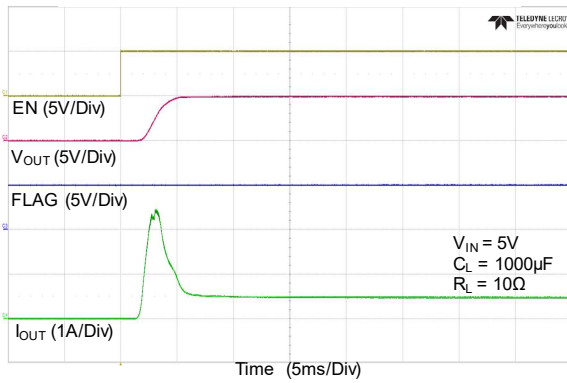
Turn on Delay Time and Rise Time



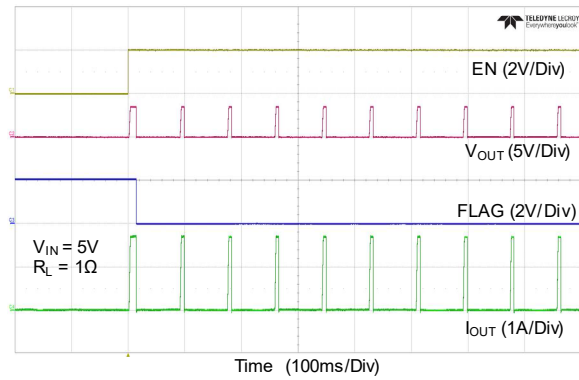
Turn off Delay Time and Fall Time



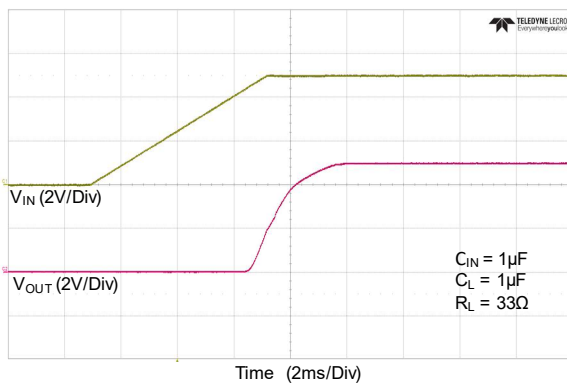
Inrush Current with Load Capacitance



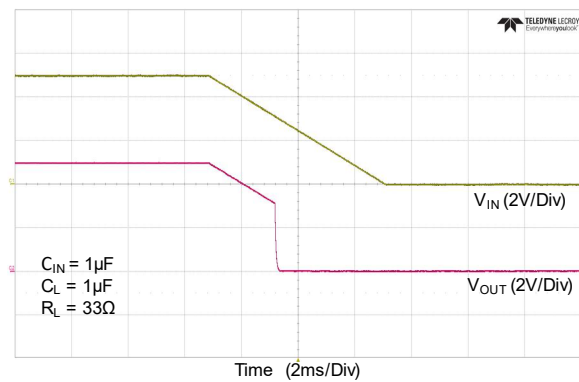
Thermal Shutdown Response



UVLO Protection at Rising

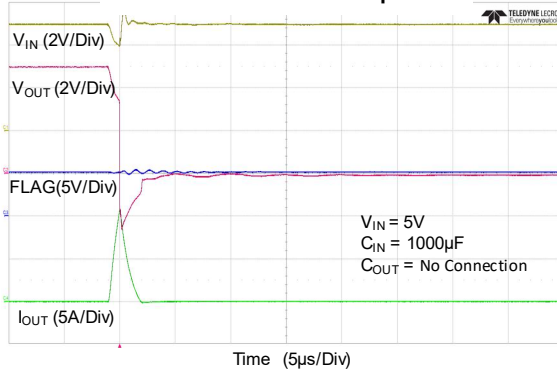


UVLO Protection at Falling

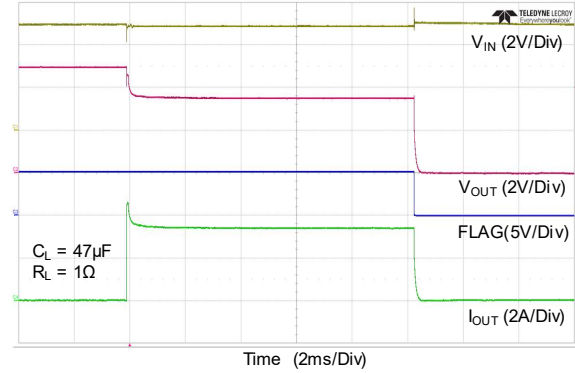


Typical Performance Characteristics (continued)

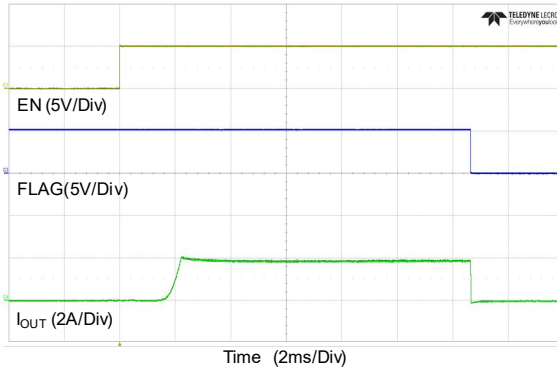
Inrush Short Circuit Response



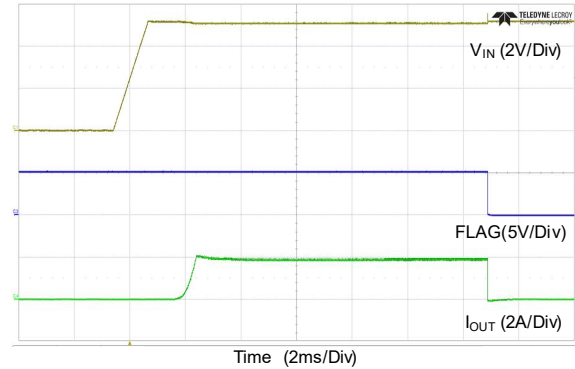
Resistance Load Inrush Response



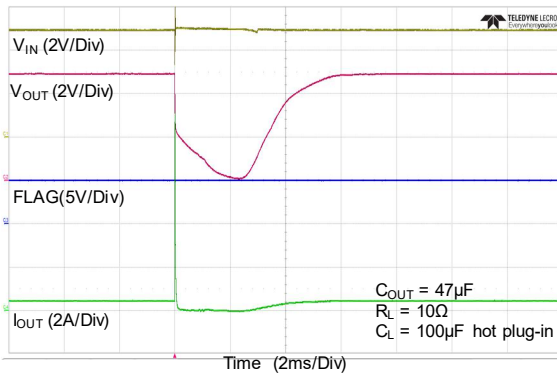
Short Circuit Current, Device Enable into Short



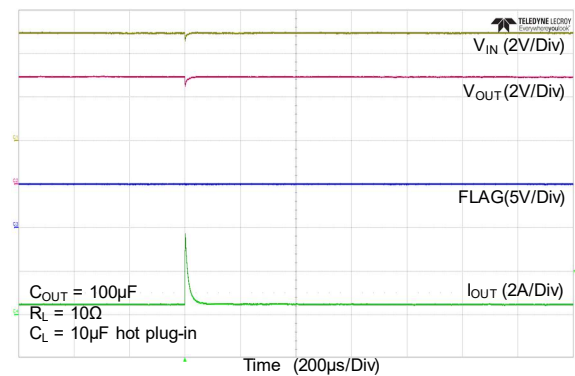
Short Circuit Response at Start up



Capacitance Load Inrush Response

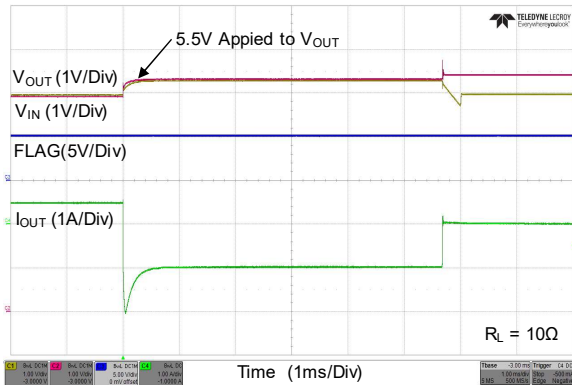


Capacitance Load Inrush Response

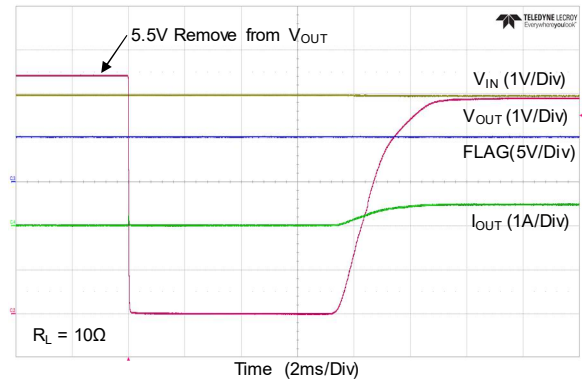


Typical Performance Characteristics (continued)

Reverse-Voltage Protection Response



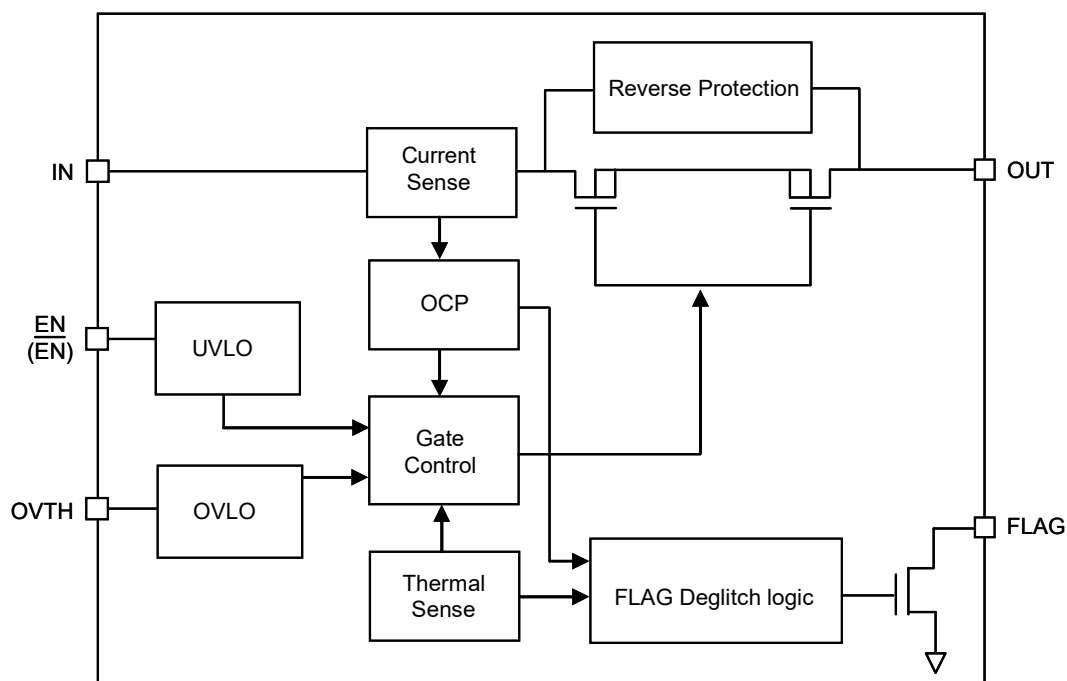
Reverse-Voltage Protection Recovery



Pin Description

PIN	NAME	FUNCTION
1	EN($\overline{\text{EN}}$)	Enable: Logic level enable input. Make sure EN pin never floating.
2	FLAG	Over-Current: Open-Drain FLAG output.
3,4	IN	Input Supply: Connect to positive supply.
5,6	OUT	Switch Output: Typically connect to switched side of load.
7	GND	Ground
8	OVTH	Over-Voltage Lockout threshold input

Block Diagram



Functional Description

Input and Output

IN (input) is the power supply connection to the logic circuitry and the drain of the common-source back-to-back MOSFET. OUT (output) is the other drain of the MOSFET. In a typical application, current flows through the switch from IN to OUT toward the load. Both OUT pins must be connected together to the load.

Thermal Shutdown

Thermal shutdown protects G516 from excessive power dissipation. If the die temperature exceeds aforementioned OT spec., the MOSFETS switch is shut off. The hysteresis prevents the switch from turning on until the die temperature drops to OT_{HYS}. Thermal shutdown circuit functions only when the switch is enabled.

Undervoltage Lockout

UVLO (undervoltage lockout) prevents the output MOSFET from turning on until IN (input voltage) exceeds 3.4V typically. After the switch turns on, if the voltage drops below 3.4V typically, UVLO shuts off the output MOSFET.

Over Current Trigger Point

The typical over current trigger point of G516 is 3.7A. (See Typical Performance Characteristics)

Output Reverse-Voltage/Current Protection

The output reverse-voltage protection turns off the MOSFET switch whenever the output voltage is higher than the input voltage by 20mV (typ) for 5ms (typ) and the MOSFET switch will turn on when output reverse-voltage/current condition is removed for 5ms (typ). If the output voltage is greater than the input voltage by 100mV, the output reverse-voltage protection will turn off MOSFET switch immediately.

Over-Voltage Protection (OVP)

When input voltage is higher than 23V (typ), the MOSFET switch is turned off to prevent IN from high-voltage stress. OVTH PIN is utilized to set over-voltage threshold according to formula shown below. When OVTH PIN is connected to GND, default OVP threshold is 23V. The OVTH is adjustable from 4V to 23V. The recommended R1 value is 1M ohm.

$$V_{IN_OVTH} \times \left(\frac{R2}{R1 + R2} \right) = 1.24$$

FLAG Function

The FLAG open-drain output is asserted (active low) when an over current condition is encountered after a 9-ms deglitch timeout. The output remains asserted until the overcurrent condition is removed. Over temperature and over voltage conditions are also reported immediately by FLAG open-drain output.

Over Current Regulation and Protection

In over current condition, the temperature of the chip will rise. It results in thermal shutdown of the MOSFETs switch as over current condition is not removed. Then, the device enters in over current regulation and protection modes. In over current regulation mode, the current is regulated to the desired over current level and the MOSFETs switch is turned off in over current protection mode. The over current regulation and protection modes allow the device to release high thermal dissipation within temperature operation condition.

Over Current Deglitch Time

The over current condition must be last for 12ms (typ.) in G516A3, then overcurrent protection begins to work.

Applications Information

Supply Filtering

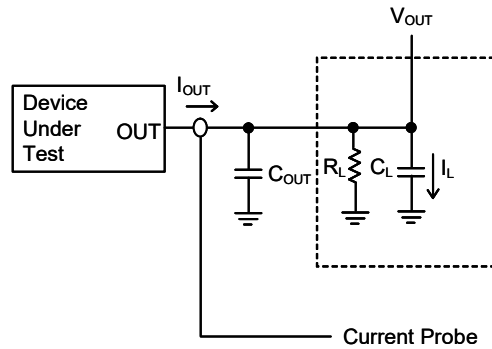
A 10μF bypass capacitor from IN to GND, located near the G516, is strongly recommended to control supply transients. Without a bypass capacitor, an output short may cause sufficient ringing on the input (from supply lead inductance) to damage internal control circuitry.

Input transients must not exceed the absolute maximum supply voltage ($V_{IN\ max} = 28V$) even for a short duration.

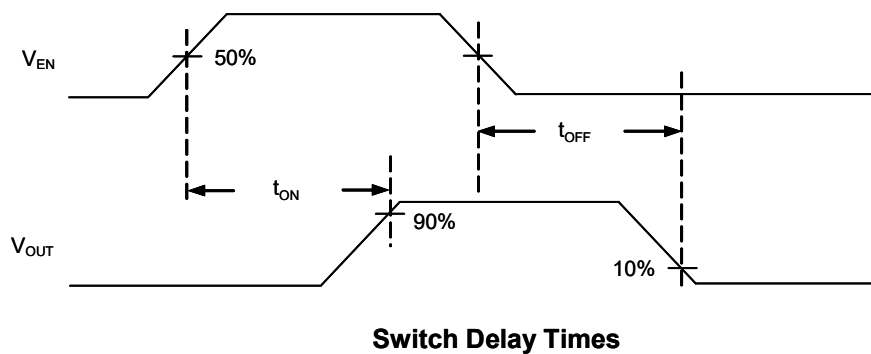
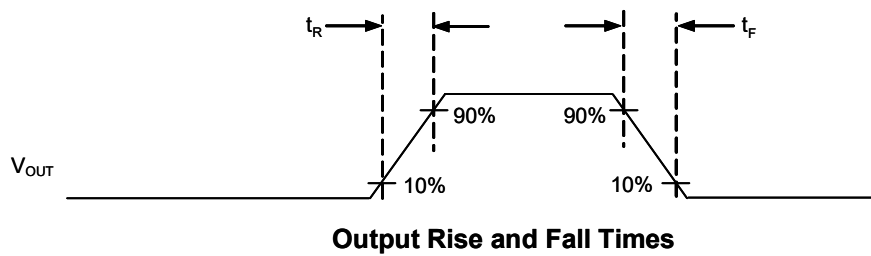
EN, the Enable Input

EN must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation. EN should not be allowed to go negative with respect to GND.

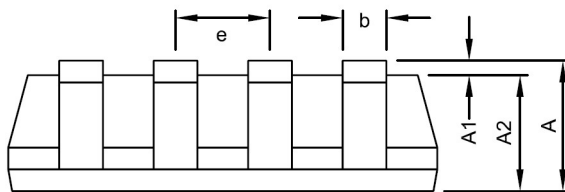
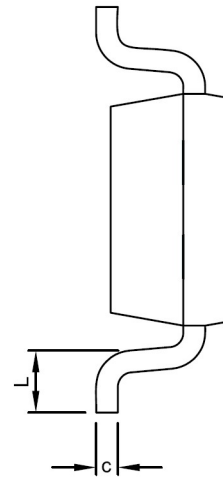
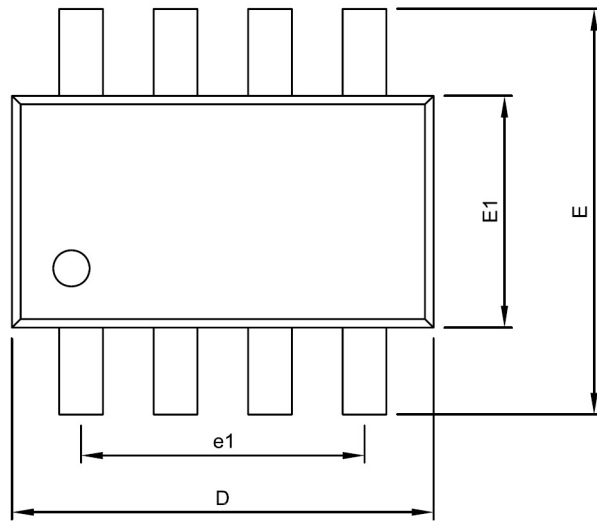
Test Circuit



Timing Diagrams



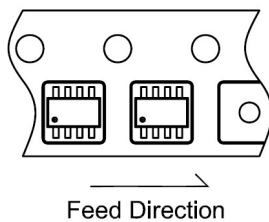
Package Information



TSOT-23-8 Package

Symbol	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.70	0.80	0.90	0.028	0.031	0.035
A1	0.00	0.05	0.10	0.000	0.002	0.004
A2	0.70	0.75	0.80	0.028	0.030	0.031
D	2.80	2.90	3.00	0.110	0.114	0.118
E	2.70	2.80	2.90	0.106	0.110	0.114
E1	1.50	1.60	1.70	0.059	0.063	0.067
c	0.08	0.15	0.25	0.003	0.006	0.010
b	0.22	0.30	0.40	0.009	0.012	0.016
e	0.55	0.65	0.75	0.022	0.026	0.030
e1	1.85	1.95	2.05	0.073	0.077	0.081
L	0.30	0.45	0.60	0.012	0.018	0.024

Taping Specification



PACKAGE	Q'TY/REEL
TSOT-23-8	3,000 ea