G5289/G5289A

40V Electronic Fuse

Features

- **4.5V to 40V Input Range**
- **Continuous current (typ): 7A**
- **N-channel on-resistance (typ): 15mΩ**
- **En/Fault functions**
- **Programmable output overvoltage clamping**
- **Internal undervoltage lockout**
- **Short-circuit limit**
- **Programmable overload current limit up to 9A**
- **Controlled output voltage ramp**
- **Programmable soft start function**
- **Thermal latch (typ): 150°C (G5289)**
- **Auto restart after thermal shutdown (G5289A)**
- **Operating junction temp. - 40°C to 125°C**
- **Available in DFN10 (3x3 mm) package**

Applications

- **Car Charger**
- **Hard disk drives**
- **Solid state drives (SSD)**
- **DVD and Blue-ray disc drivers**
- **Mother Board Power Management**

General Description

The G5289/A is an integrated, cost-effective, electronic fuse optimized for monitoring output current and input voltage. Connected in series to a 4.5V~40V power-rail, it is capable of protecting the electronic circuitry on its output from overcurrent and overvoltage during output load transient and input voltage transient. If a continuous short-circuit is present on the board, when power is re-applied, G5289/A initially limits the output current to a safe value to lower the power on G5289/A and a thermal protection circuit is integrated as well. There is no degradation on G5289 after short-circuit/thermal protection events and it is reset either by recycling the supply voltage or using the En/Fault pin. For G5289A it will restart after the junction temperature falling below the hysteresis. G5289/A also has a programmable delay to control turn on time.

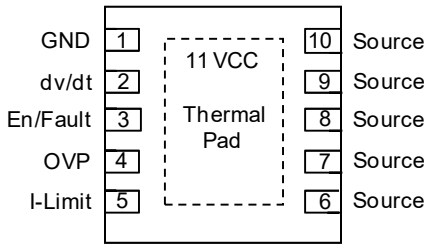
Ordering Information

ORDER NUMBER	MARKING	TEMP. RANGE	PACKAGE (Green)
G5289QE1U	5289	-40°C~ +125°C	DFN3X3-10
G5289AQE1U	5289A	-40°C~ +125°C	DFN3X3-10

Note: QE: DFN3X3-10
1: Bonding Code
U: Tape & Reel
Green : Lead Free / Halogen Free

Pin Configuration

G5289/G5289A



DFN3X3-10

Note: Thermal Pad is the VCC Pin.

Absolute Maximum Ratings

Positive power supply voltage (steady state)
VCC. . . . . .-0.3V to +45V
Positive power supply voltage (max 100ms)
VCC . . . . . .-0.3V to +50V
VOUT/source (max 100ms) . . . . . -0.3V to VCC+0.3V
I-Limit (max 100ms) . . . . . .-0.3V to +50V
En/Fault. . . . . -0.3V to +7V
dv/dt . . . . . .-0.3V to +7V
OVP . . . . . .-0.3V to +7V
Thermal Resistance Junction to Ambient, (θ_{JA}) (1)
DFN3X3-10. . . . . .45°C/W
Continuous Power Dissipation (T_A = +25°C) (1)
DFN3X3-10. . . . . 2.5W

Thermal Resistance Junction to Case (top), (θ_{JCtop})
DFN3X3-10. . . . . .24.5°C/W
Thermal Resistance Junction to Case (bottom), (θ_{JCbot})
DFN3X3-10. . . . . .4.5°C/W

Operating junction temperature range(2)
. . . . . .-40°C to 125°C
Storage Temperature Range . . . . . .-65°C to 150°C
Lead temperature (soldering) 10 sec. . . . . 260°C
ESD (HBM). 2kV
ESD (MM) 200V
ESD (CDM) 500V

(1) The thermal data is measured from EV board.
(2) The thermal limit is set above the maximum thermal rating. It is not recommended to operate the device at temperatures greater than the maximum ratings for extended periods of time.

Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.

Electrical Characteristics

(V_{CC} =12V, $V_{En/Fault}$ =3.3V, C_I =10µF, C_O =47µF, T_J =25°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	CONDITIONS	MIN	TYP	MAX	UNITS
Under/Overvoltage protection						
Overvoltage threshold	V_{Clamp}		1.22	1.26	1.3	V
Under voltage lockout	V_{UVLO}	Turn-on, voltage rising	3.5	3.7	3.9	V
UVLO hysteresis	V_{Hyst}		---	0.3	---	V
Power MOSFET						
Delay time	T_{DLY}	Enabling of chip to I_D = 100mA with an 1A resistive load	---	350	---	µs
ON resistance	R_{DS_ON}	(1)	---	15	18	mΩ
		-40°C < T_J < 125°C(2)	---	---	30	
Off state output voltage	V_{OFF}	V_{CC}=18V, V_{GS}=0, R_L=infinite	---	190	300	mV
Continuous current	I_D	0.5in² pad, T_A=25°C (1)	---	7	---	A
		Minimum copper, T_A=80°C	---	3.5	---	
Current limit						
Short-circuit current limit	I_{Short}	R_{LIMIT} = 15Ω, SOURCE < 0.5V	---	1	---	A
Hold current limit	I_{Hold}	R_{LIMIT} = 15Ω	---	5	---	A
Trip current limit	I_{Lim}	R_{LIMIT} = 15Ω	6.1	7.6	9.1	A
dv/dt circuit						
Output voltage ramp time	dv/dt	Enable to V_{OUT}=11.7V, No $C_{dv/dt}$	0.5	0.9	1.8	ms

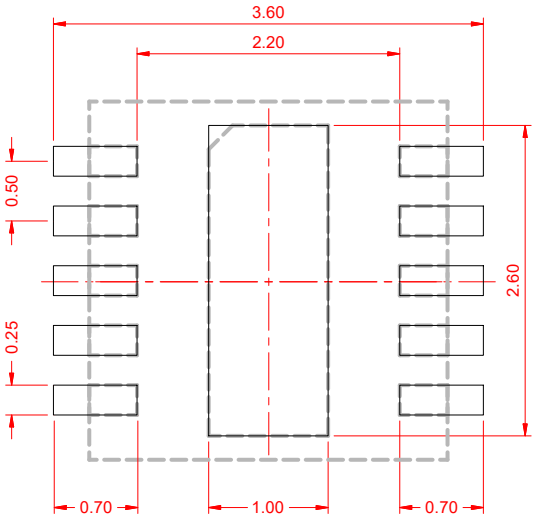
Electrical Characteristics (Continued)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
En/Fault						
Low level input voltage	V_{IL}	Output disabled	---	---	0.5	V
Intermediate level input voltage	$V_{I(INT)}$	Thermal fault, output disabled	0.82	1.4	1.95	V
High level input voltage	V_{IH}	Output enabled	2.5	---	---	V
High state maximum voltage	$V_{I(MAX)}$		3.4	4.3	5.4	V
Low level input current (sink)	I_{IL}	$V_{En/Fault}$=0V	---	-16	-25	μA
Maximum fan-out for fault signal		Total numbers of chips that can be connected to this pin for simulta-neous shutdown	---	---	3	Units
Total device						
Bias current	I_{Bias}	Device operational	---	420	---	μA
		Shutdown	---	360	---	
Minimum operating voltage	V_{min}		---	---	3.5	V
Thermal protection						
Shutdown temperature	TSD	(2)	---	150	---	°C
Hysteresis (only in G5289A)	T_{hys}		---	20	---	°C

1. Pulse test: Pulse width = 300μs, Duty cycle = 2%
2. Guaranteed by design, but not tested in production

Minimum Footprint PCB Layout Section (Unit:mm)

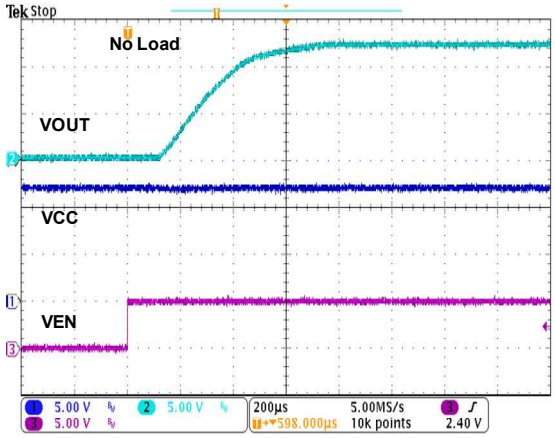
DFN3X3-10



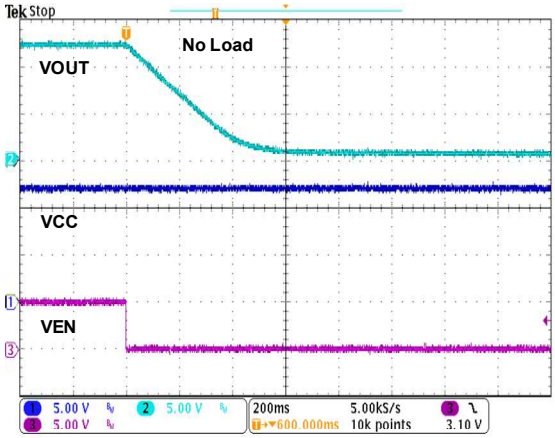
Typical Performance Characteristics

V_{CC}=12V , V_{EN}=5V,R_{LIMIT}=15Ω , C_L=47uF ,Cdv/dt=open, Direct Sense, T_A=T_J=25°C.

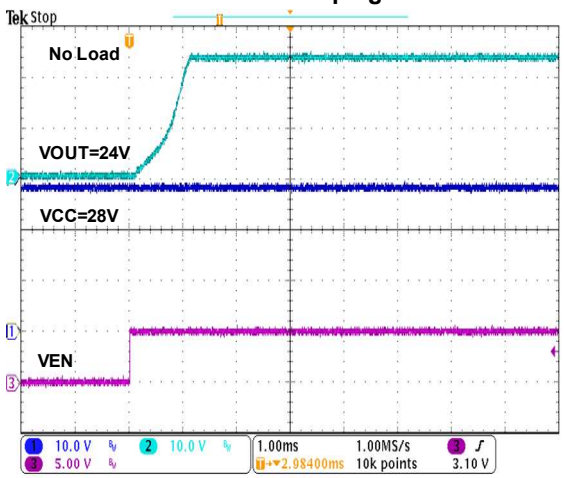
Startup through Enable



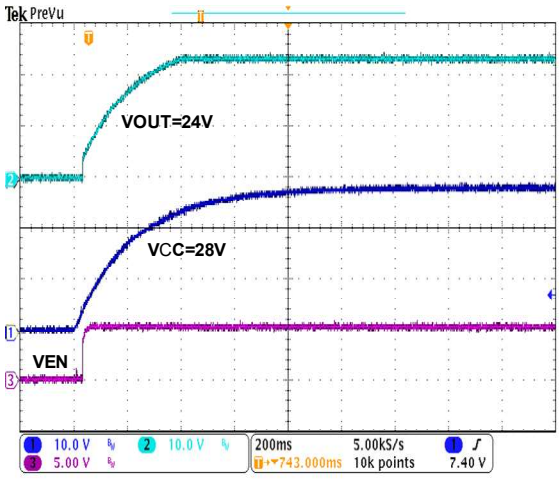
Shutdown through Enable



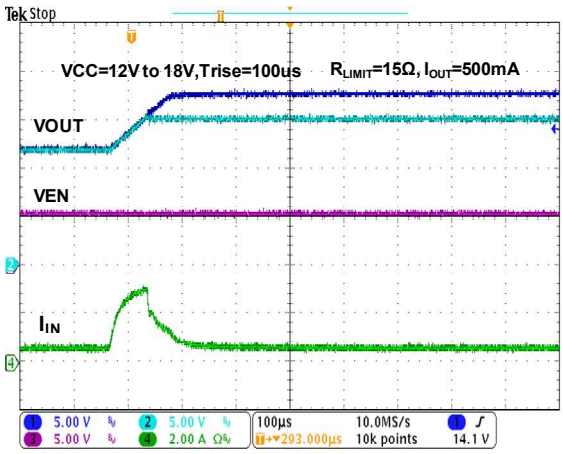
VOUT Clamping



Startup into VOUT Clamping

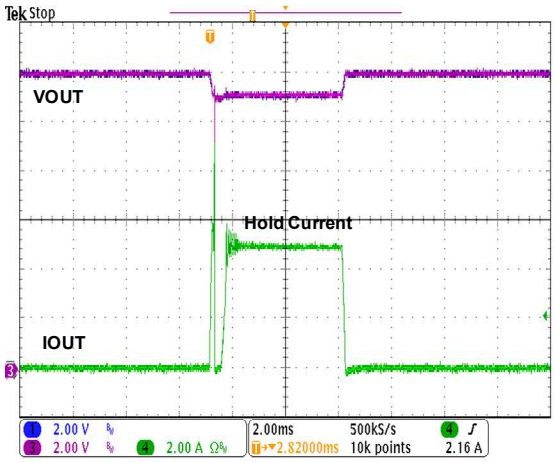


Line Transient

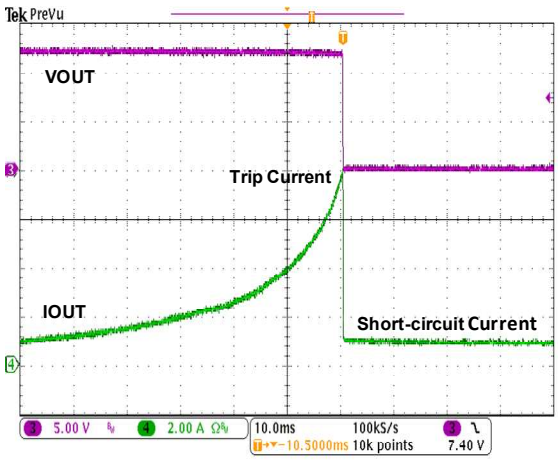


Typical Performance Characteristics (continued)

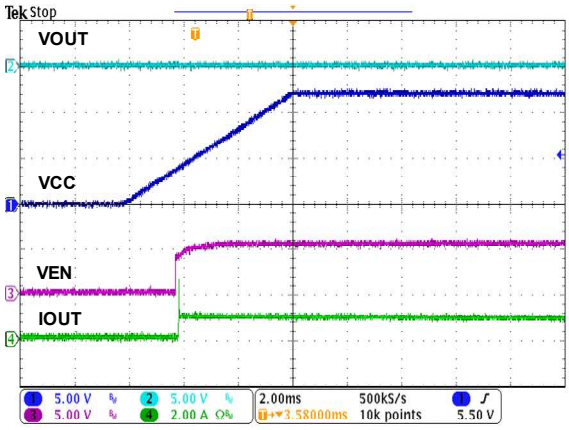
Current Limit



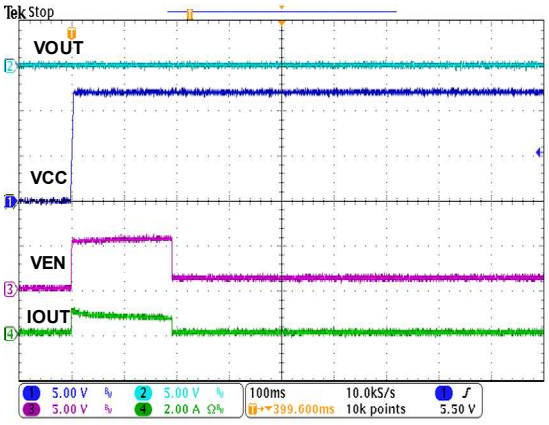
Current Limit



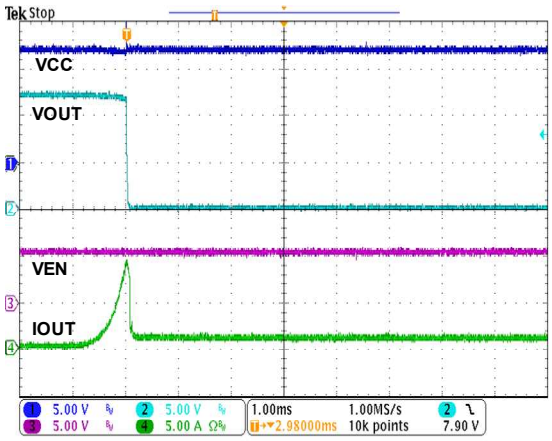
G5289 Startup into Short Circuit



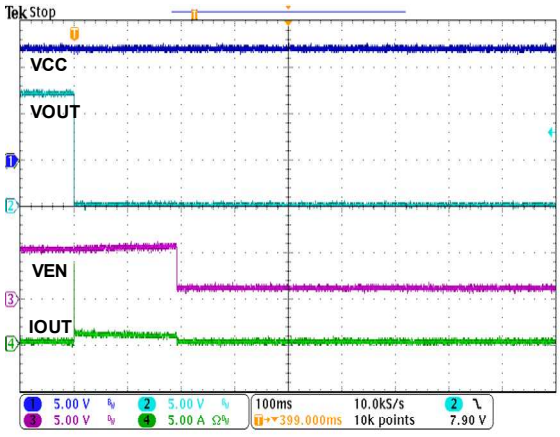
G5289 Startup into Short Circuit



G5289 Short Circuit during Normal Operation

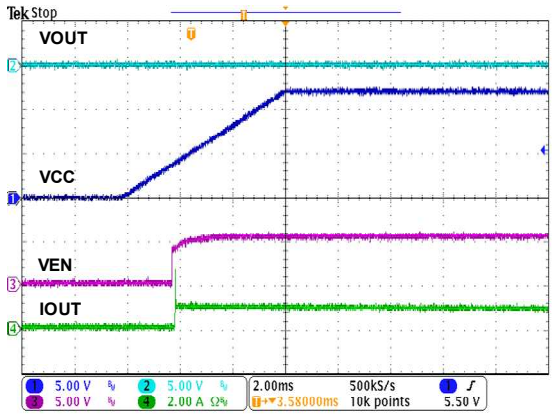


G5289 Short Circuit during Normal Operation

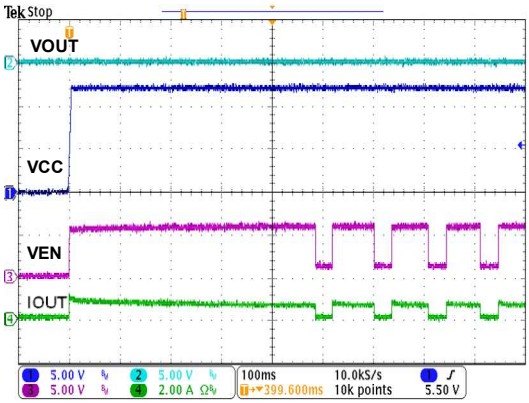


Typical Performance Characteristics (continued)

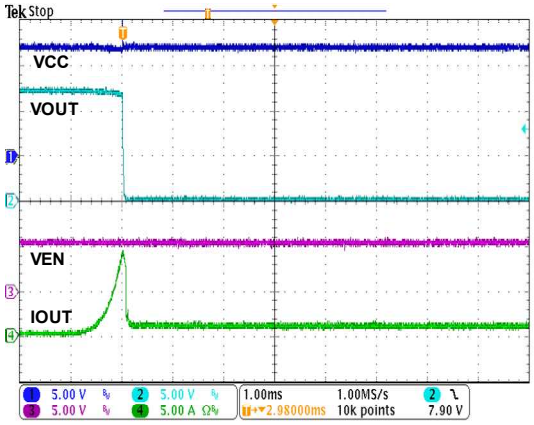
G5289A Startup into Short Circuit



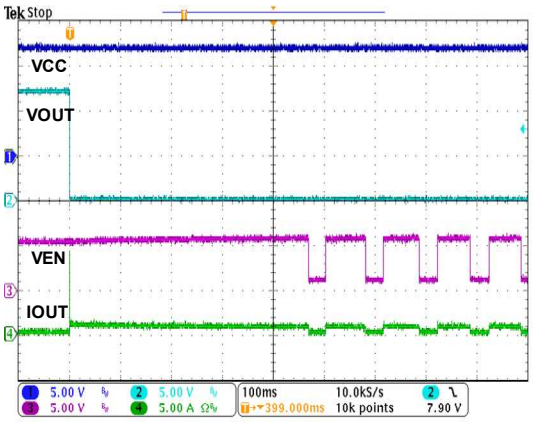
G5289A Startup into Short Circuit



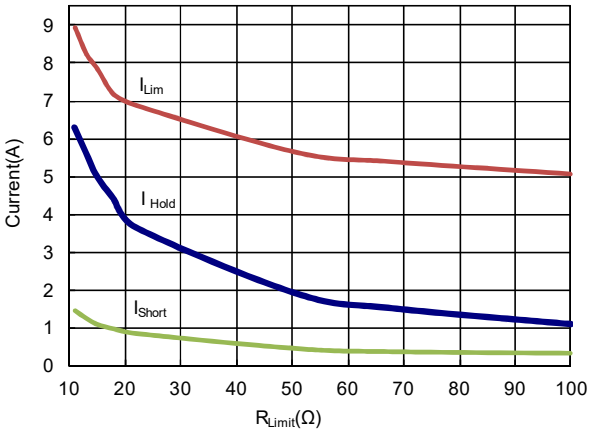
G5289A Short Circuit during Normal Operation



G5289A Short Circuit during Normal Operation

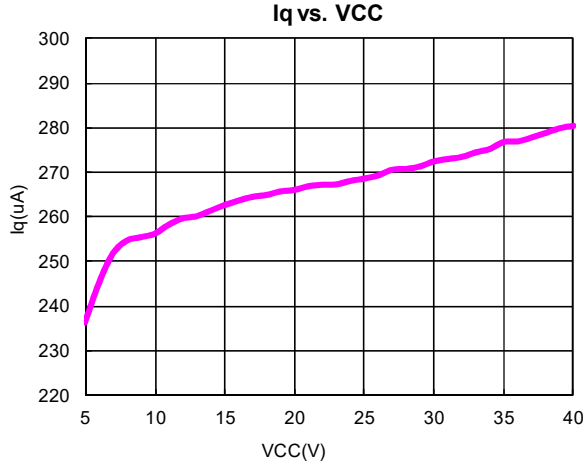


Trip Current, Hold Current, and Short Current vs. R_{LIMIT} VCC=12V

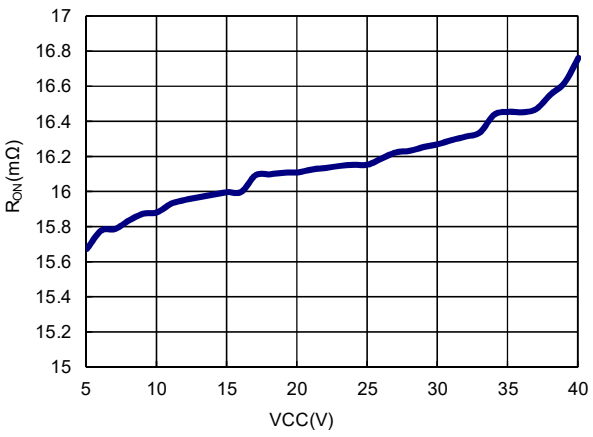


Typical Performance Characteristics (continued)

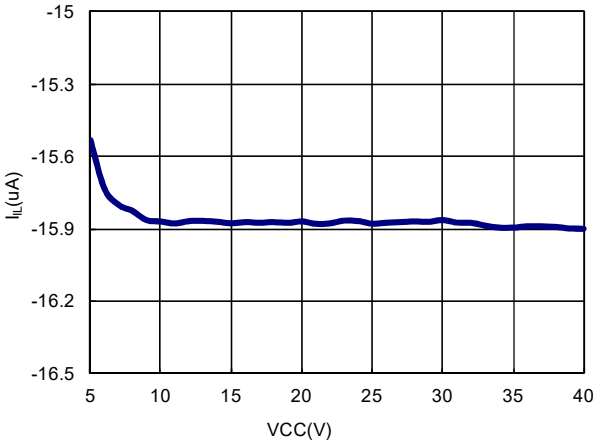
Iq vs. VCC



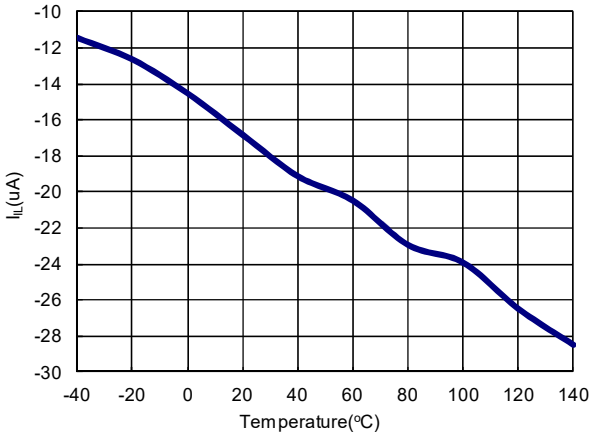
R_{DSon} vs. VCC



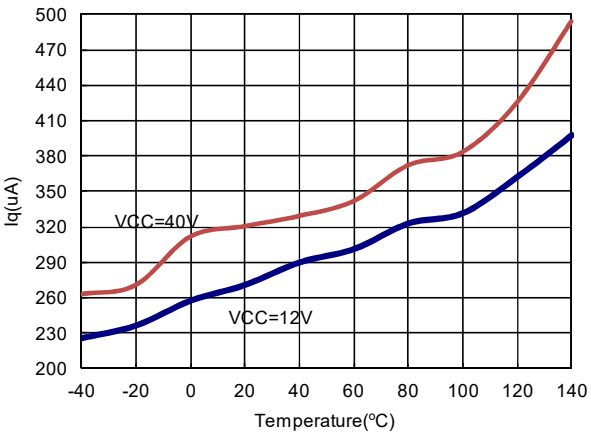
I_{IL} vs. VCC



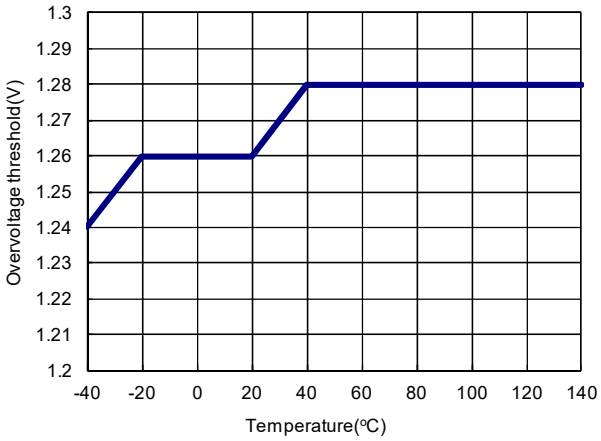
I_{IL} vs. Temperature



Iq vs. Temperature

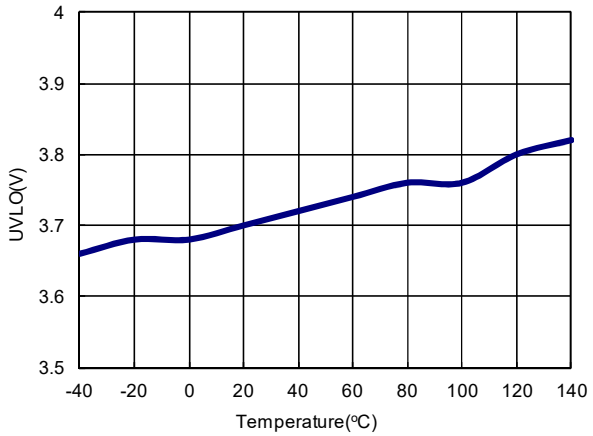


Overvoltage threshold vs. Temperature

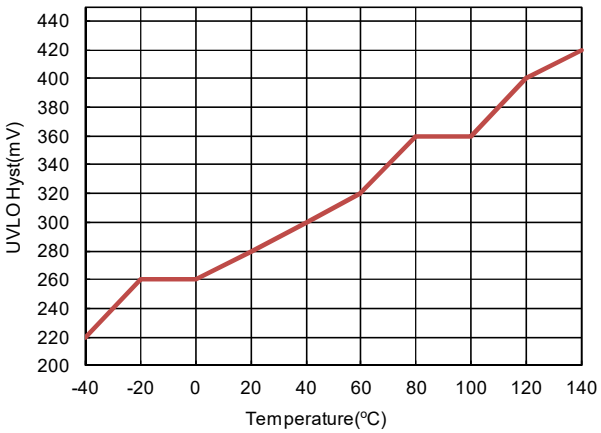


Typical Performance Characteristics (continued)

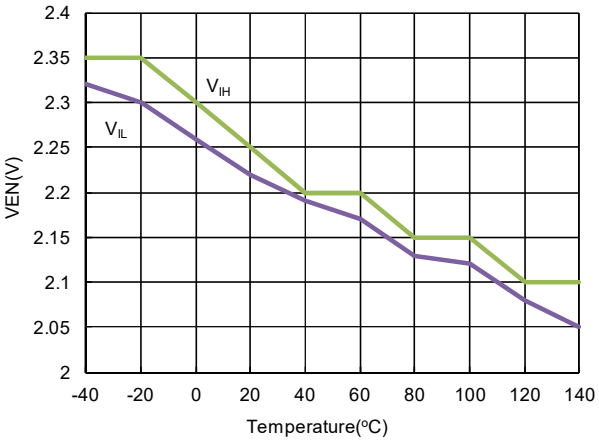
UVLO vs. Temperature



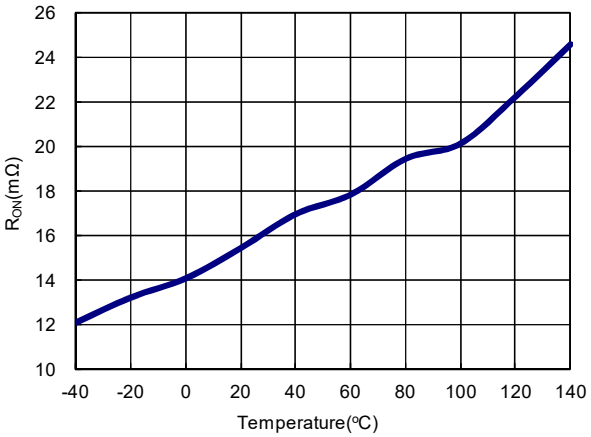
UVLO Hyst vs. Temperature



V_{IL}, $V_{I(INT)}$, V_{IH}, $V_{I(MAX)}$ vs. Temperature



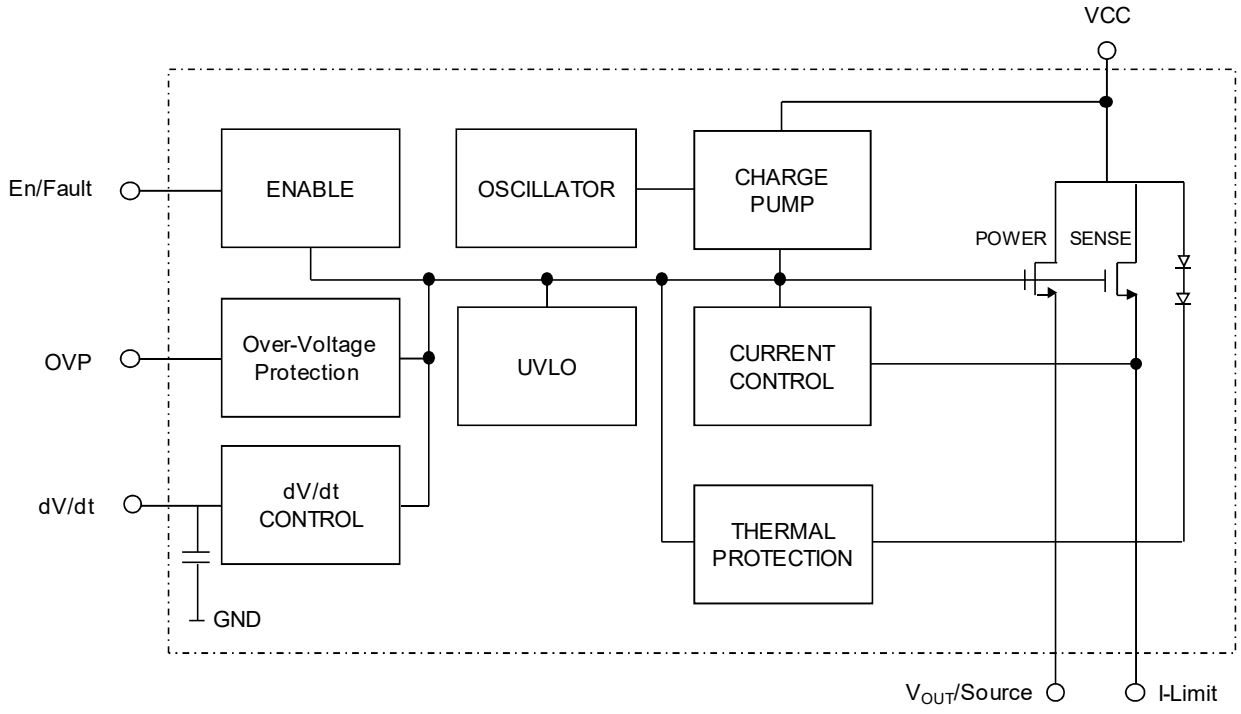
R_{DSon} vs. Temperature



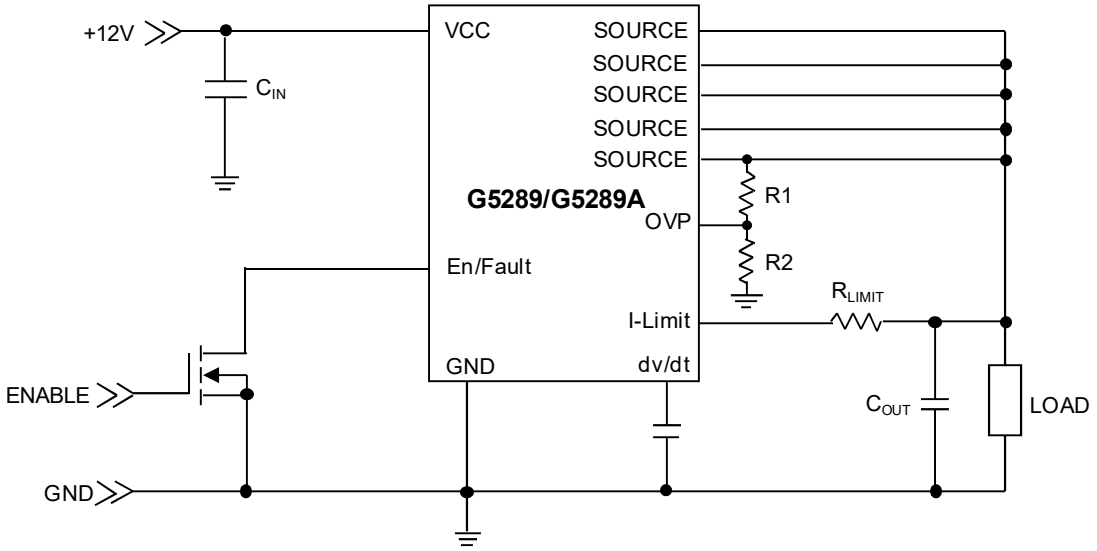
Pin Description

PIN	NAME	FUNCTION
1	GND	Ground pin
2	dv/dt	The internal dv/dt circuit controls the slew rate of the output voltage at turn-on. The internal capacitor allows a ramp-up time of around 1ms. An external capacitor can be added to this pin to increase the ramp time. If an additional capacitor is not required, this pin should be left open.
3	En/Fault	The En/Fault pin is a tri-state, bi-directional interface. During normal operation the pin must be left floating, or it can be used to disable the output of the device by pulling it to ground using an open drain or open collector device. If a thermal fault occurs, the voltage on this pin goes into an intermediate state to signal a monitor circuit that the device is in thermal shutdown. It can be connected to another device of this family to cause a simultaneous shutdown during thermal events.
4	OVP	Output overvoltage clamping threshold setting input.
5	I-Limit	A resistor between this pin and the Source pin sets the overload and short-circuit current limit levels.
6~10	Source	Connected to the source of the internal power MOSFET and to the output terminal of the fuse
11	VCC	Exposed pad. Positive input voltage must be connected to VCC.

Block Diagram



Typical application



Application Circuit with Direct Sense

Operating modes

Turn-on

When the input voltage is applied, the En/Fault pin goes up to the high state, enabling the internal control circuit. After an initial delay time of typically 350 μs, the output voltage is supplied with a slope defined by the internal dv/dt circuit. If no additional capacitor is connected to dv/dt pin, the total time from the Enable signal going high and the output voltage reaching the nominal value is around 1 ms (Fig. 1)

Normal operating condition

The G5289/A buffers the circuitry on its output with the same voltage shown at its input, with a small voltage drop due to the N-channel MOSFET resistance.

Current limiting

When an overload event occurs, the current limiting circuit reduces the conductivity of the power MOSFET in order to clamp the output current at the value selected externally by means of the limiting resistor R_{LIMIT} which connected between the current limit pin (I-limit) and the load.

Rough formulas for current limiting are shown below:

For trip current,

$$I_{Trip} = 15.1 \times R_{Limit}^{-0.25}$$

For hold current,

$$I_{Hold} = 44.6 \times R_{Limit}^{-0.8}$$

Where R_{LIMIT} is expressed in Ohm, and Table1 shows some recommended R_{limit} with respective current limit value.

Over-Voltage Protection(OVP)

OVP PIN is utilized to set over-voltage clamping threshold according to formula shown below:

$$VO\_OVTH \times \left(\frac{R2}{R1 + R2} \right) = 1.26$$

The output voltage will be clamped at setting voltage when input voltage continues rising. This function can be disabled by connecting this pin to GND.

Thermal shutdown

If the device temperature exceeds the thermal shutdown threshold, typically 150°C, the circuitry turns the power MOSFET off, thus disconnecting the load. The En/Fault pin of the device is automatically set at an intermediate voltage, in order to signal the over temperature event. In this condition, G5289 can be reset either by cycling the supply voltage or by pulling down the En/Fault pin below the V_{IL} threshold and then releasing it. For G5289A it will restart after the junction temperature falling below the hysteresis.

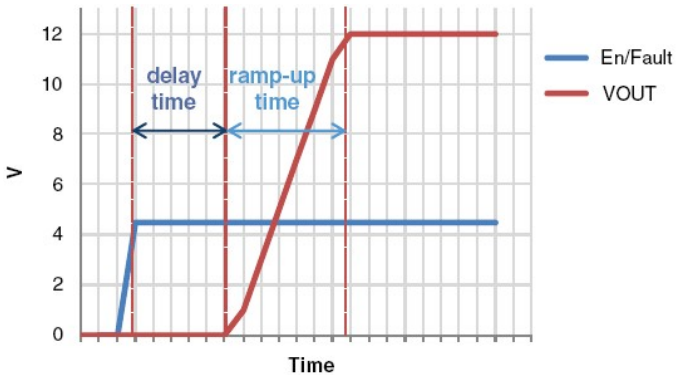
Cdv/dt calculation

Connecting a capacitor between the dv/dt pin and GND allows the modification of the output voltage ramp-up time. Given the desired time interval Δt during which the output voltage goes from zero to its maximum value, the capacitance to be added on the dv/dt pin can be calculated using the following theoretical formula:

$$t_{slew} = \frac{10^6}{12} \times C_{dv/dt} \times V_{IN}$$

Where $C_{dv/dt}$ is expressed in Farads, V_{in} is input voltage and the time is in seconds.

Fig. 1 Delay time and VOUT ramp-up time



En/Fault pin

The En/Fault pin has the dual function of controlling the output of the device and, at the same time, of providing information about the device status to the application.

When it is used as a standard Enable pin, it should be connected to an external open-drain or open-collector device. In this case, when it is pulled at low logic level, it turns the output of the E-Fuse off.

If this pin is left floating, since it has internal pull-up circuitry, the output of G5289/A is hold ON, in normal operating conditions.

In case of thermal fault, the pin is pulled to an intermediate state (Fig. 2). This signal can be provided to a monitor circuit, informing it that a thermal shutdown has occurred, or it can be directly connected to the En/Fault pins of other devices on the same application in order to achieve a simultaneous enable/disable feature.

When a thermal fault occurs, the device can be reset either by cycling the supply voltage or by pulling down the En/Fault pin below the V_{IL} threshold and then releasing it.

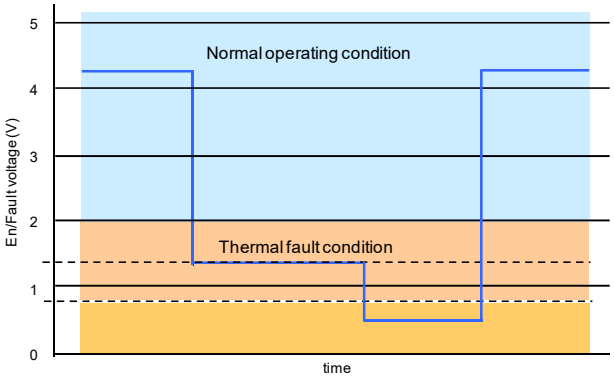
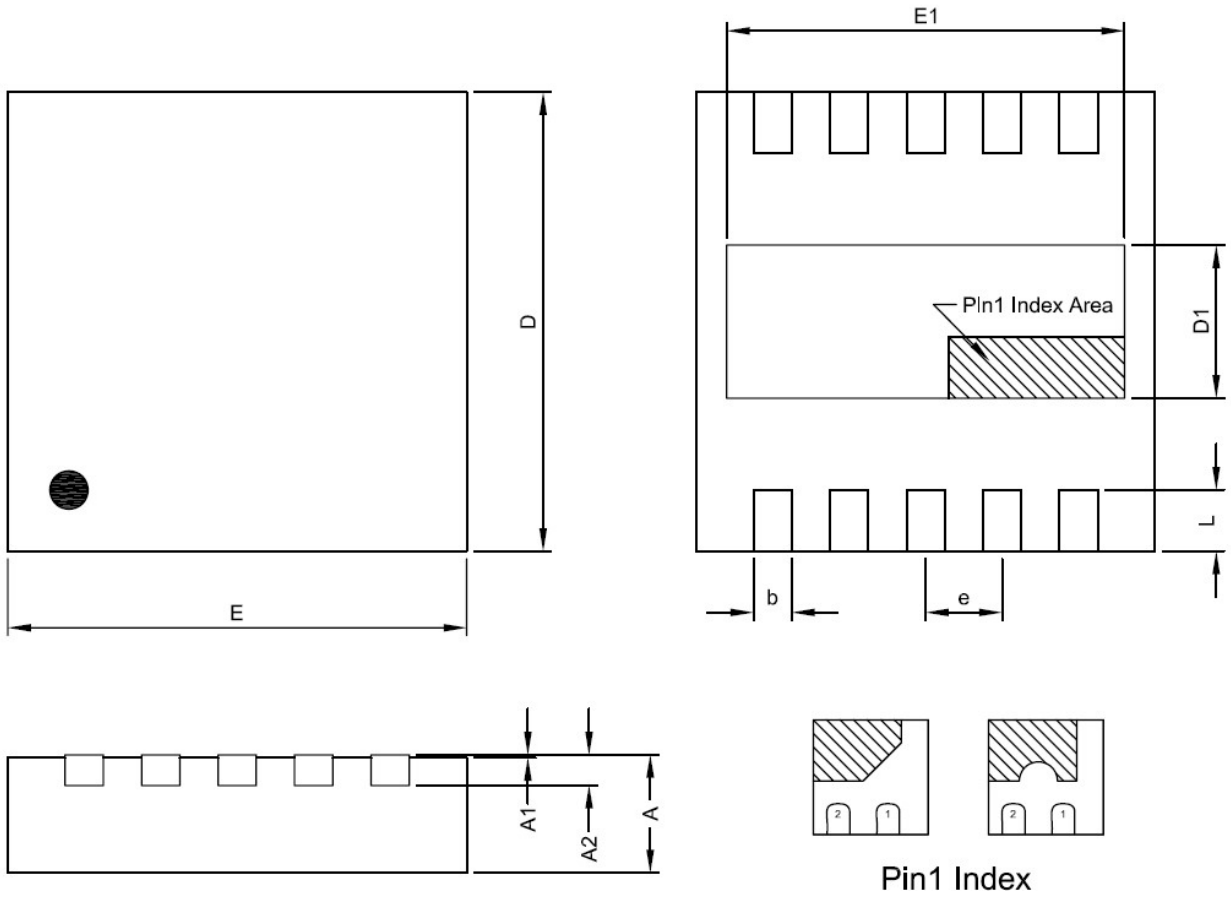


Fig. 2 En/Fault pin status

Table1:Current Limit vs. Current Limit Resistor (VCC=12V)

$R_{LIMIT}(\Omega)$	11	13	15	18	22	51	68	100
Trip Current (A)	8.9	8.2	7.6	7	6.8	5.6	5.4	5
Hold Current (A)	6.5	5.7	5	4.4	3.7	1.9	1.5	1.1

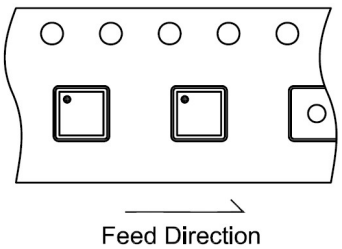
Package Information



DFN3X3-10 Package

Symbol	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.80	0.90	1.00	0.0315	0.0354	0.0394
A1	0.00	- - -	0.05	0.0000	- - -	0.0020
A2	0.20 REF			0.0080 REF		
D	2.95	3.00	3.05	0.1161	0.1181	0.1201
E	2.95	3.00	3.05	0.1161	0.1181	0.1201
D1	0.95	1.00	1.05	0.0374	0.0394	0.0413
E1	2.55	2.60	2.65	0.1004	0.1024	0.1043
b	0.18	0.25	0.30	0.0071	0.0098	0.0118
e	0.50 BSC			0.0197 BSC		
L	0.30	0.40	0.45	0.0118	0.0157	0.0177

Taping Specification



PACKAGE	Q'TY/REEL
DFN3X3-10	3,000 ea