Global Mixed-mode Technology Inc. **G528/G528A**

USB High-Side Power Switch Advance Information

Features

- **Typical 110mΩ, Low MOSFET on resistance, at 5.0V**
- **3.0V to 5.5V operating range**
- **100 µA typical on-state supply current**
- **1µA typical standby supply current**
- **Output can be forced higher than input when operating in off state.**
- **1.4A Typical current limit**
- **Thermal shutdown protection**
- **2.4V typical under-voltage lockout (UVLO)**
- **Open-drain fault flag pin**
- **Slow turn-on (soft-start) and fast turnoff**
- **Logic level enable pin, available with active-low version (G528), or available with active-high version (G528A)**
- **UL Approved_#E232223**

Applications

- **High-side power protection switch**
- **USB power management**
- **USB host and self-powered hubs**
- **USB Bus-powered hubs**
- **Hot plug-in power supplies**
- **Battery-charger circuits**

General Description

The G528/G528A is an integrated high-side power switch optimized for self-powered and bus-powered Universal Serial Bus (USB) applications.

The G528/G528A satisfies the USB standards. The switch's low on-resistance meets USB voltage drop requirements. When the output load exceeds current-limit threshold, G528/G528A switches into constant-current mode and limit the output current to a safe level, which is typically 1.4A. An open-drain flag output is also available to indicate fault conditions to the local USB controller. Soft start eliminates the momentary voltage drop on the upstream port that may occur when the switch is enabled in bus-powered applications.

Besides, a thermal shutdown circuit is included to prevent catastrophic switch failure caused by increasing power dissipation when continuous heavy loads or short circuit occurs. A under-voltage lockout (UVLO) circuit ensures that the device remains off unless there is a valid input voltage present, and an enable input that is compatible with both 3.3V and 5V logic.

Ordering Information

ORDER NUMBER	ORDER NUMBER (Pb free)	ENABLE	TEMP. RANGE	PACKAGE
G528P1U	G528P1Uf	Active Low	-40°C to +85°C	SOP-8
G528AP1U	G528AP1Uf	Active High	-40°C to +85°C	SOP-8

Note: P1: SOP-8L

U: Tape & Reel

Pin Configuration

G528/G528A

Pin		
GND	1	8 OUT
IN	2	7 OUT
IN	3	6 OUT
$\overline{EN}$ (EN)	4	5 FLG

SOP-8
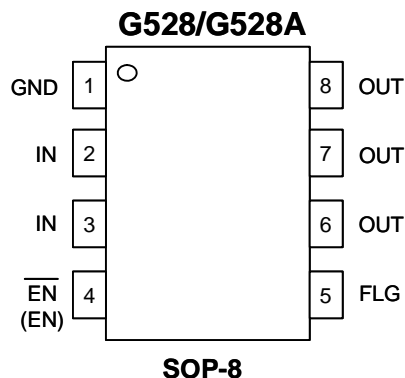
Absolute Maximum Ratings

Supply Voltage (V_{IN})..……….….…………...…..…+6.0V
Fault Flag Voltage (V_{FLG})..………..…….…...……..+6.0V
Fault Flag Current (I_{FLG})…………………….………50mA
Output Voltage (V_{OUT})..……………………………+6.0V
Output Current (I_{OUT})…………………Internally Limited
Enable Input ($V_{\overline{EN}}$)……………...….………-0.3V to 6V
Storage Temperature (T_S)….…….…....-65°C to +150°C
Reflow Temperature (soldering, 10sec)……..…..260°C
ESD protection*………….…..…………….…….…..2kV

Operating Ratings

Supply Voltage (V_{IN})………………………+3V to +5.5V
Operating Temperature (T_A)…………….-40°C to +85°C
Thermal Resistance
   SOIC (θ_{JA})………………………………………160°C/W

Electrical Characteristics (V_{IN}=+5V; T_A=25°C.)

PARAMETER	CONDITION	MIN	TYP	MAX	UNIT
IN Supply Current	**switch off, OUT = open	---	1	5	µA
	**switch on, OUT = open	---	100	160	µA
$\overline{EN}$ Enable Threshold	low to high transition	---	---	2.5	V
	high to low transition **	0.8	---	---	V
$\overline{EN}$ Input Current	$V_{\overline{EN}}$ = $V_{OH(min)}$ = 2.5V	---	0.01	1	µA
	$V_{\overline{EN}}$ = $V_{OL(max)}$ = 1.0V	---	0.01	1	µA
$\overline{EN}$ Input Capacitance		---	1	---	pF
Switch Resistance	V_{IN} = 5V, I_{OUT} = 500mA	---	110	140	mΩ
	V_{IN} = 3.3V, I_{OUT} = 500mA	---	130	180	mΩ
OUT Turn-On Delay	R_L = 10Ω	---	0.03	---	ms
OUT Turn-On Rise Time	R_L = 10Ω, C_L=100µF	---	0.5	---	ms
OUT Turn-Off Delay	R_L = 10Ω	---	1	20	µs
OUT Turn-Off Fall Time	R_L = 10Ω	---	1	20	µs
OUT Leakage Current		---	1	10	µA
Short Circuit Current Limit	Enable into load	1.0	1.4	2.0	A
Circuit Limit Threshold	Ramped load applied to enabled output	2.0	2.7	3.5	A
Overtemperature Shutdown Threshold	T_J increasing	---	135	---	°C
	T_J decreasing	---	125	---	°C
FLG Output Resistance	V_{IN} = 5V, I_L=10mA	---	10	25	Ω
	V_{IN} = 3.3V, I_L =10mA	---	15	40	Ω
FLG Off Current	V_{FLAG} = 5V	---	0.01	1	µA
UVLO Threshold	V_{IN} = increasing	---	2.5	---	V
	V_{IN} = decreasing	---	2.3	---	V

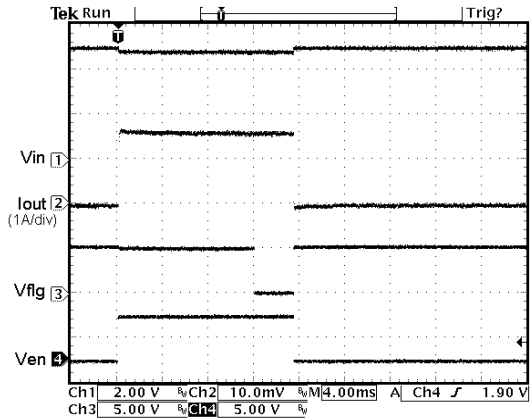* Devices are ESD protected, however, handling precautions are recommended.

** For the G528/G528A, off is $\geq$ 2.5V and on is $\leq$ 0.8V. The enable input, $\overline{EN}$ has approximately 200mV of hysteresis.
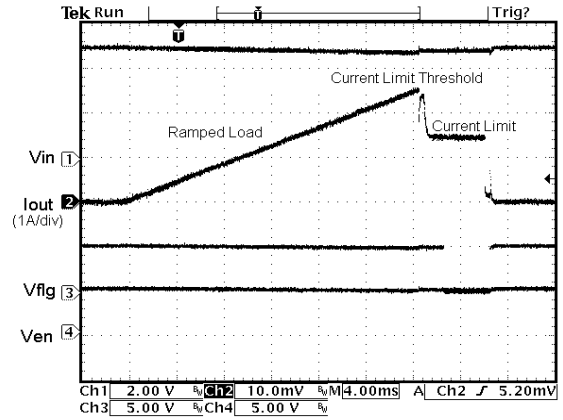
Typical Performance Characteristics

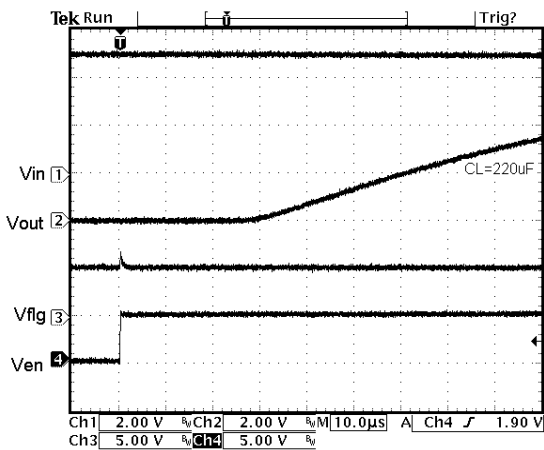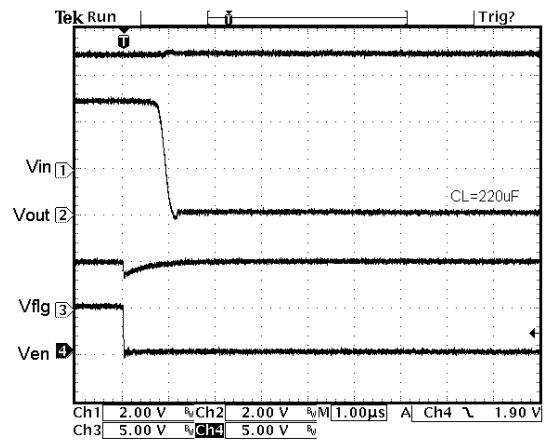(V_{IN}= 5V, T_A=25°C, G528A, unless otherwise noted.)

Flag Delay After OC

I_{OUT} Ramp Chart

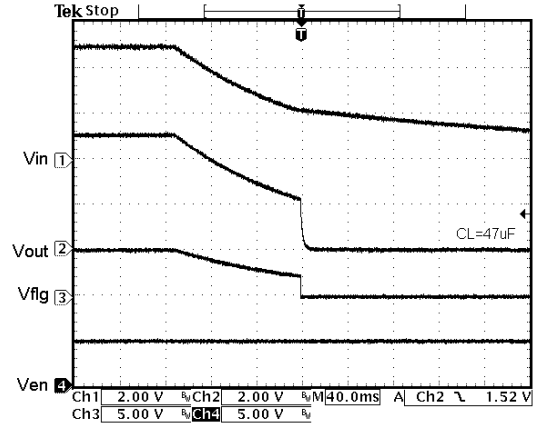### Output Turn-On Delay

Output Turn-Off Delay

Power Up (UVLO)
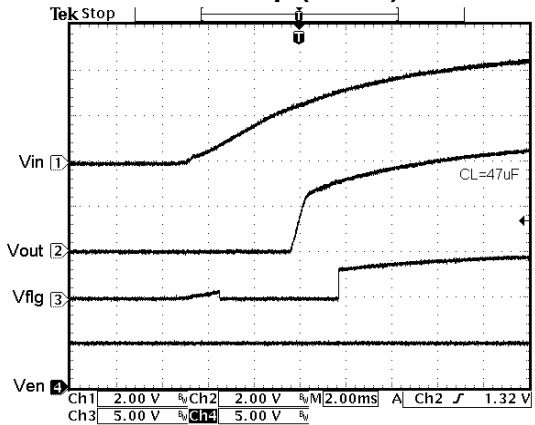
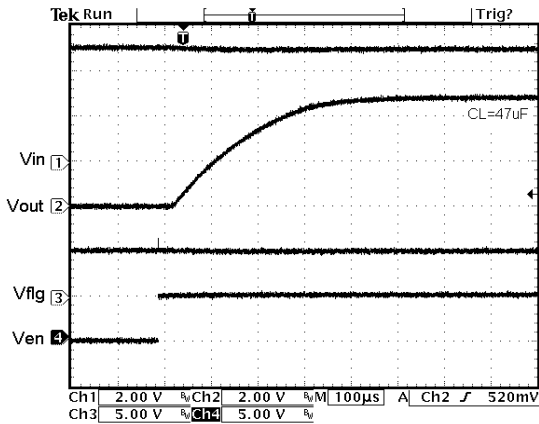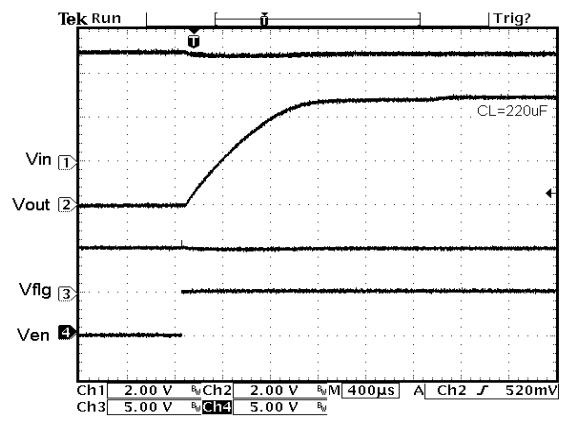

Power Down (UVLO)

Typical Performance Characteristics

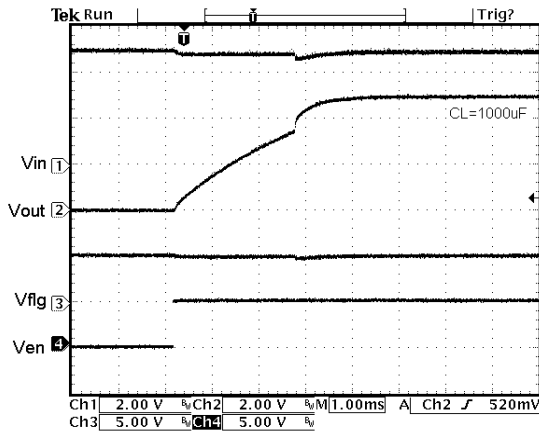(V_{IN}= 5V, T_A=25°C, G528A, unless otherwise noted.)

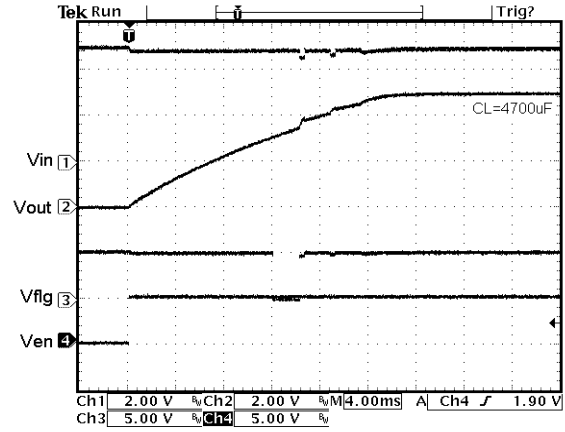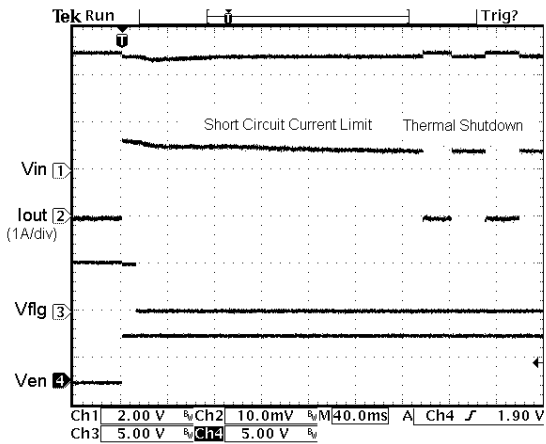**Turn-On Characteristics**

Turn-On Characteristics

Turn-On Characteristics

Turn-On Characteristics

Short Circuit Response
**(Short Applied to Output)**

Pin Description

PIN		NAME	PIN FUNCTION
G528	G528A		
1	1	GND	**Ground**.
2,3	2,3	IN	**Input Supply**: Output MOSFET source, which also supplies IC's internal circuitry. Connect to positive supply.
4		$\overline{\text{EN}}$	**Active-low switch enable input.** A logic low turns on the switch.
	4	EN	**Active-High switch enable input.** A logic High turns on the switch.
5	5	FLG	**Open-Drain Fault Flag (Output)**: Active-low, open-drain output. Indicates overcurrent, thermal shutdown and UVLO.
6,7,8	6,7,8	OUT	**Switch Output**: Output MOSFET drain. Typically connect to switched side of load.

Typical Applications
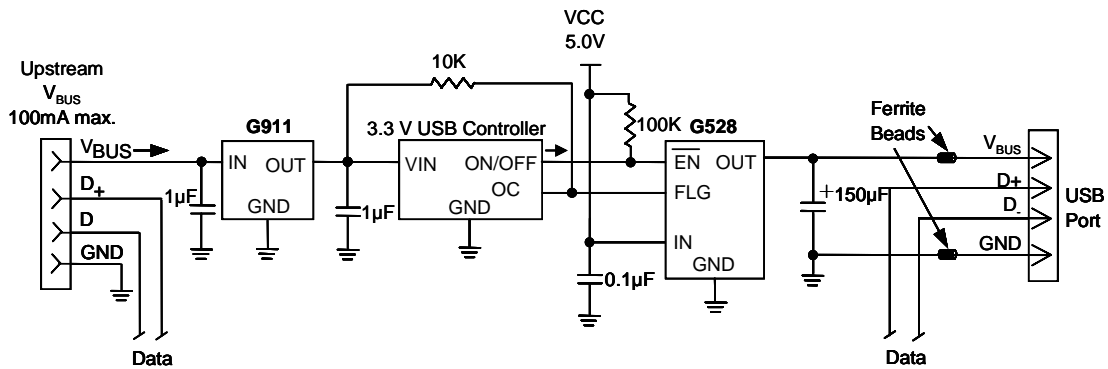
Single-Port Self-Powered USB Hub Application

Function Block Diagrams
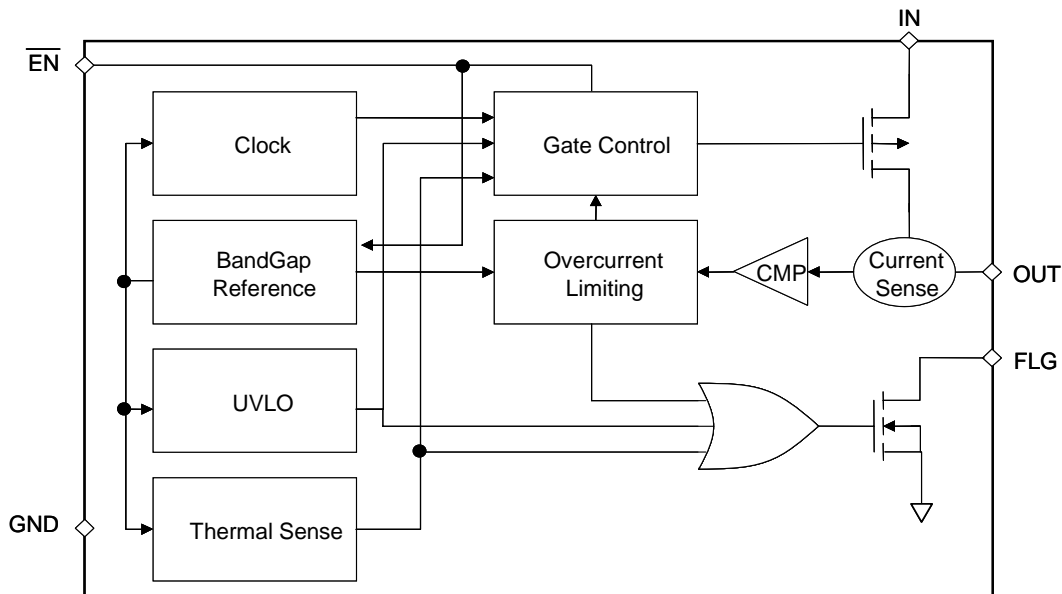
Functional Description

The G528/G528A is high-side 1-channel switch with active-low enable input. Fault conditions turn off or inhibit turn-on of the output transistors.

Input and Output

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

The output MOSFET and driving circuit are also designed to allow the MOSFET drain to be externally forced to a higher voltage than the source ($V_{OUT} > V_{IN}$) when the switch is off. In this situation, the G528/G528A avoids undesirable drain-to-body diode current flow by connecting the body to the most positive voltage. If $V_{OUT} > V_{IN}$ when switch is enabled, current will flow from V_{OUT} to V_{IN}.

Thermal Shutdown

Thermal shutdown protects G528/G528A from excessive power dissipation. If the die temperature exceeds 135°C, the MOSFETS switch is shut off. 10°C of hystersis prevents the switch from turning on until the die temperature drops to 125°C. 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 2.5V typically. After the switch turns on, if the voltage drops below 2.3V typically, UVLO shuts off the output MOSFET. UVLO detection functions only when the switch is enabled.

Current Sensing and Limiting

The current limit threshold is preset internally. The preset level prevents damage to the output MOSFET and external load but allows a minimum current of 0.5A through the output MOSFET.

A current sense circuit senses the output current of MOSFET switch. If output current exceeds the current limit threshold, the output MOSFET switch is shut off. The reaction to an overcurrent is measured with the following scenarios:

Switch Enabled into Heavy Load

If the switch is powered on or enabled into a heavy load or short-circuit, the switch immediately goes into a constant-current mode, reducing the output voltage. See the "Enable into Short Circuit" graph.

Heavy Load Applied to Enabled Switch

When a heavy load is applied, a large current may flow from the switch. The current limit circuit may shut the switch off briefly, then fold back into constant-current mode. See the "Short Applied to Output" graph and the "Ramped Load to Enable Device" graph.

Fault Flag

FLG is a 2-channel, open-drain MOSFET output. Thefault-flag is active (low) for one or more of the following conditions: current limiting, undervoltage, or thermal shutdown. The flag output MOSFET is capable of sinking a 10mA load to typically 100mV above ground.

Applications Information

Supply filtering

A 0.1µF to 1µF bypass capacitor from IN to GND as shown in Figure 1, located near the G528/G528A, 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.

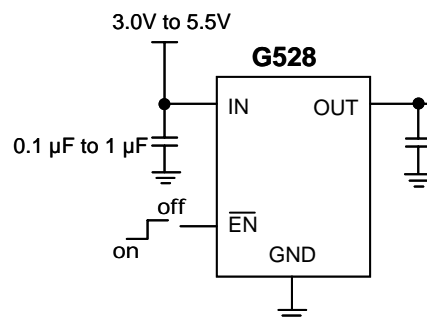Input transients must not exceed the absolute maximum supply voltage ($V_{IN\,max} = 6V$) even for a short duration.
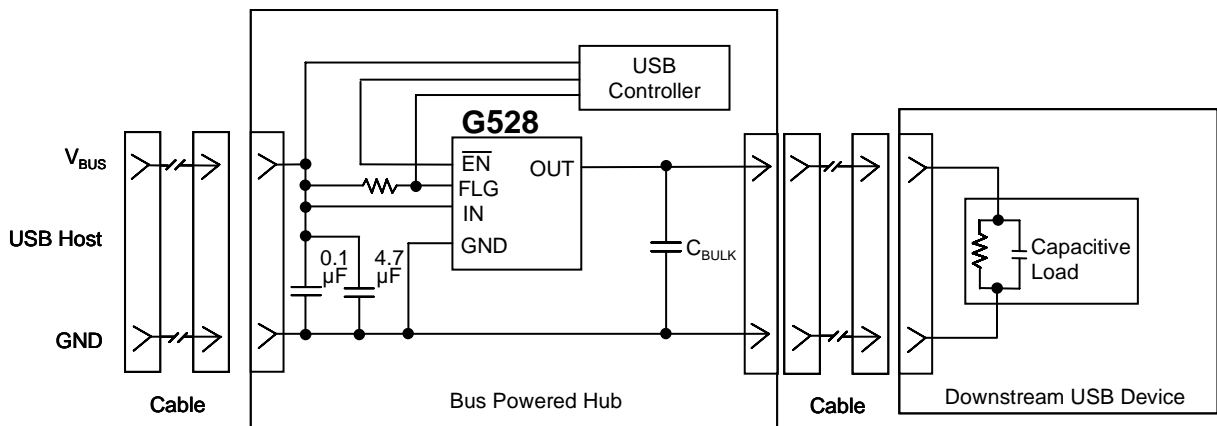

Figure 1. Supply Bypassing
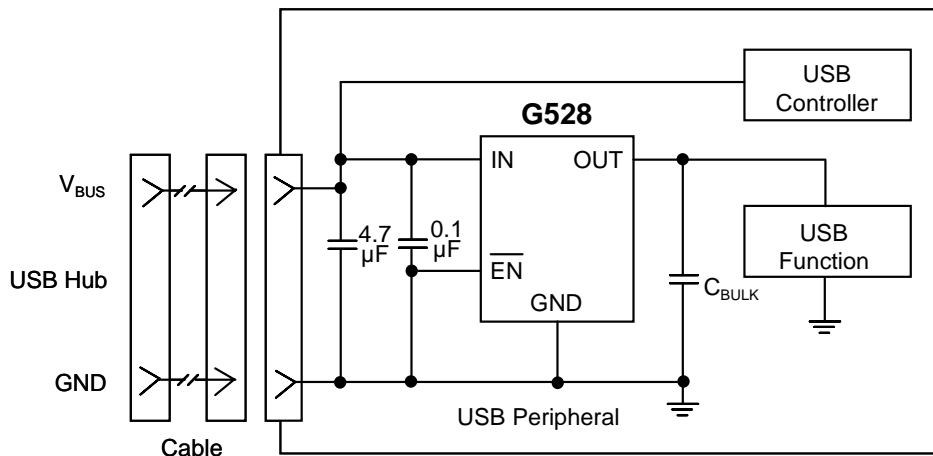
Figure 2. Soft Start

Figure 3. Inrush Current-Limit Application

$\overline{EN}$, the active-low enable Input

$\overline{EN}$, with 0.2V hysteresis, must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation. $\overline{EN}$ should not be allowed to go negative with respect to GND.

Soft Start

The G528/G528A is high impedance when off and slowly becomes a low impedance as it turns on. This reduces inrush current and related voltage drop that results from charging a capacitive load, satisfying the USB voltage drop requirements, for bus-powered applications as shown in Figure 2.

The soft start circuit shown in Figure 3 can be utilized to meet USB transient regulation specifications with large load capacitances (C_{BULK} >10µF). The G528/G528A will provide inrush current limiting for these applications.
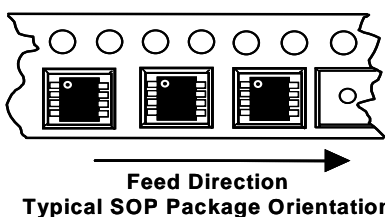
Package Information
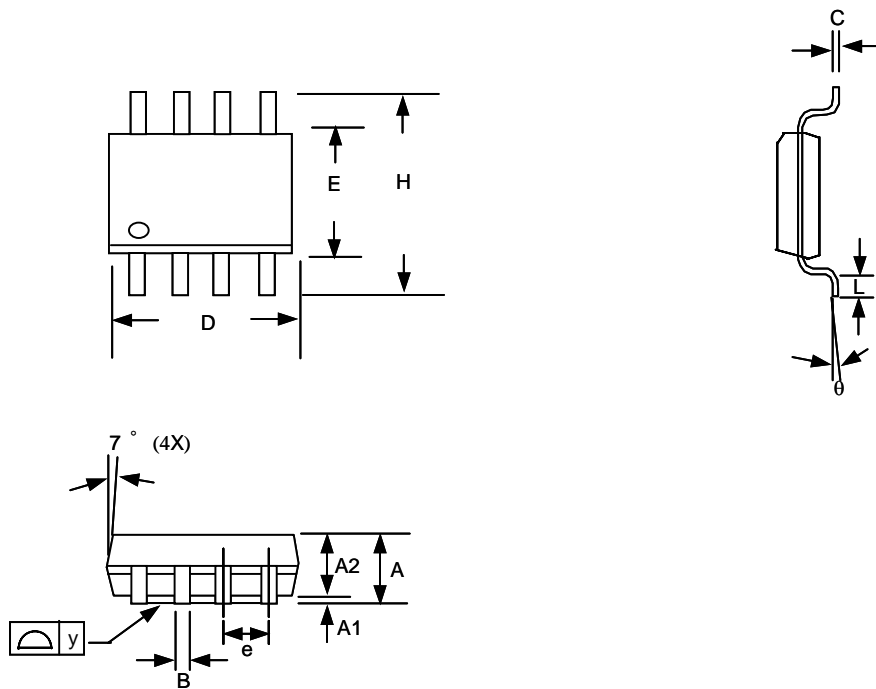
Note:
1. Package body sizes exclude mold flash and gate burrs
2. Dimension L is measured in gage plane
3. Tolerance 0.10mm unless otherwise specified
4. Controlling dimension is millimeter converted inch dimensions are not necessarily exact.

SYMBOL	DIMENSION IN MM			DIMENSION IN INCH		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	1.35	1.60	1.75	0.053	0.063	0.069
A1	0.10	---	0.25	0.004	---	0.010
A2	----	1.45	---	---	0.057	---
B	0.33	---	0.51	0.013	---	0.020
C	0.19	---	0.25	0.007	---	0.010
D	4.80	---	5.00	0.189	---	0.197
E	3.80	---	4.00	0.150	---	0.157
e	-----	1.27	----	---	0.050	---
H	5.80	---	6.20	0.228	---	0.244
L	0.40	----	1.27	0.016	---	0.050
y	-----	----	0.10	---	---	0.004
θ	0º	----	8º	0º	---	8º

Taping Specification

Feed Direction
Typical SOP Package Orientation

PACKAGE	Q'TY/REEL
SOP-8	2,500 ea

Ver: 1.2
May 17, 2005

TEL: 886-3-5788833
http://www.gmt.com.tw