



# USB High-Side Power Switch Advance Information

## Features

- Typical 110mΩ, Low MOSFET on resistance, at 5.0V
- 1A minimum continuous load current
- 3.0V to 5.5V operating range
- 100 μA typical on-state supply current
- 1 μA 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-high or active-low version
- 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 G525A is an integrated high-side power switch optimized for self-powered and bus-powered Universal Serial Bus (USB) applications.

The G525A satisfies the USB standards. The switch's low on-resistance meets USB voltage drop requirements. When the output load exceeds current-limit threshold, G525A switches into constant mode and limit the output current to a safe level, which is typically 1.4A, well below the UL 25VA safety requirements. 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.

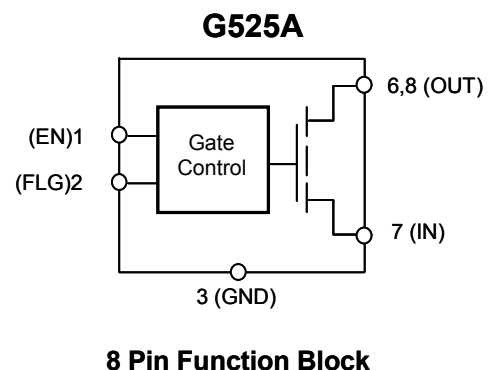
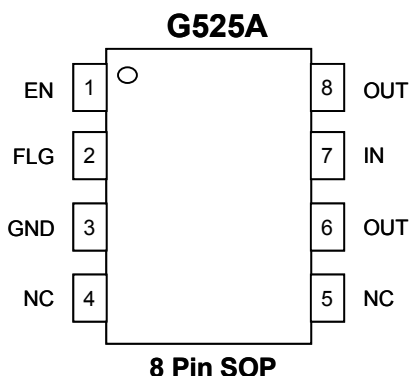
Besides, a thermal shutdown circuit is included to prevent catastrophic switch failure caused by increasing power dissipation when continuous heavy loads or short circuit occurs. A under-voltage lockout (UVLO) circuit ensures that the device remains off unless there is a valid input voltage present,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

The G525A is a UL recognized component and is available in active-high and active-low versions in 8-pin SOP packages.

## Ordering Information

PART	ENABLE	TEMP. RANGE	PACKAGE
G525A1	Active High	-40°C to +85°C	8-Pin SOP
G525A2	Active Low	-40°C to +85°C	8-Pin SOP

## Pin Configuration



UL Recognized Component

**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 ( $V_{EN}$ ).....	-0.3V to 6V
Storage Temperature ( $T_S$ ).....	-65°C to +150°C
Lead Temperature (Soldering 5 sec.).....	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 ( $\theta_{JA}$ ).....	160°C/W

**Electrical Characteristics ( $V_{IN}=+5V$ ;  $T_A=25^\circ C$ .)**

PARAMETER	CONDITION	MIN	TYP	MAX	UNITS
IN Supply Current	**switch off, OUT = open		1	5	$\mu A$
	**switch on, OUT = open		100	160	$\mu A$
EN Enable Threshold	low to high transition			2.5	V
	high to low transition **	0.8			V
EN Input Current	$V_{EN} = V_{OH(min)} = 2.5V$		0.01	1	$\mu A$
	$V_{EN} = V_{OL(max)} = 1.0V$		0.01	1	$\mu A$
EN Input Capacitance			1		pF
Switch Resistance	$V_{IN} = 5V, I_{OUT} = 500mA$		110	140	m $\Omega$
	$V_{IN} = 3.3V, I_{OUT} = 500mA$		130	180	m $\Omega$
OUT Turn-On Delay	$R_L = 10\Omega$		0.03		ms
OUT Turn-On Rise Time	$R_L = 10\Omega, C_L=100\mu F$		0.5		ms
OUT Turn-Off Delay	$R_L = 10\Omega$		1	20	$\mu s$
OUT Turn-Off Fall Time	$R_L = 10\Omega$		1	20	$\mu s$
OUT Leakage Current			1	10	$\mu A$
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		$^\circ C$
	$T_J$ decreasing		125		$^\circ C$
FLG Output Resistance	$V_{IN} = 5V, I_L=10mA$		10	25	$\Omega$
	$V_{IN} = 3.3V, I_L=10mA$		15	40	$\Omega$
FLG Off Current	$V_{FLAG} = 5V$		0.01	1	$\mu A$
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 G525A1, off is  $\leq 1.0$  and on is  $\geq 2.5V$ . For the G525A2, off is  $\geq 2.5V$  and on is  $\leq 1.0V$ . The enable input, CTRL, has approximately 200mV of hysteresis.

**Pin Description**

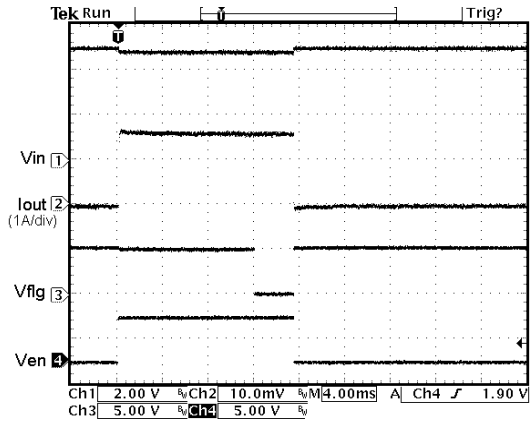
PIN NUMBER	PIN NAME	PIN FUNCTION
1	EN	<b>Enable (input):</b> Logic level enable input. High input >2.4V typical. Low input <2.2V typical (1 for active high, 2 for active low). Make sure EN never floating.
2	FLG	<b>Open-Drain Fault Flag (Output):</b> Active-low, open-drain output. Indicates overcurrent, thermal shutdown and UVLO.
3	GND	<b>Ground.</b>
4,5	NC	Not internally connected.
7	IN	<b>Input Supply:</b> Output MOSFET source, which also supplies IC's internal circuitry. Connect to positive supply.
6,8	OUT	<b>Switch Output:</b> Output MOSFET drain. Typically connect to switched side of load.



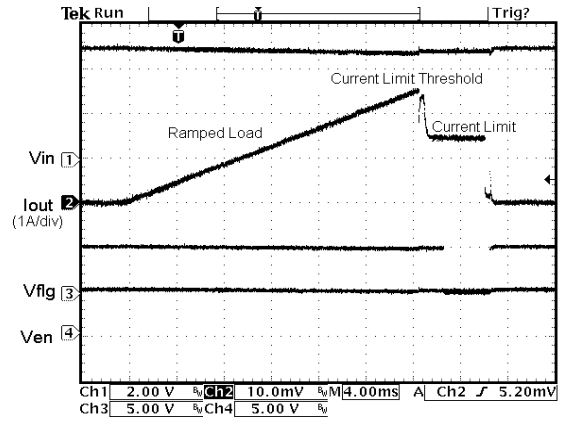
TYPICAL PERFORMANCE CHARACTERISTICS

(VIN= 5V, TA=25°C, G525A1, unless otherwise noted.)

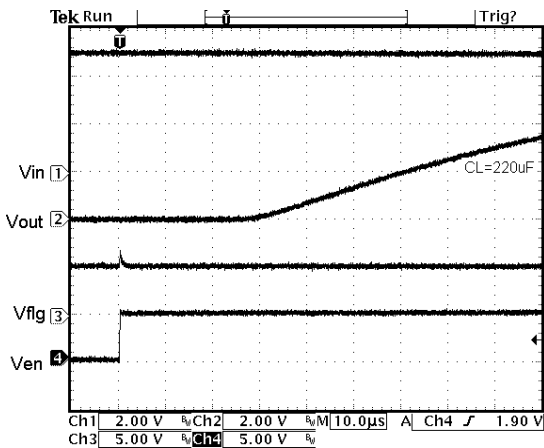
Flag Delay After OC



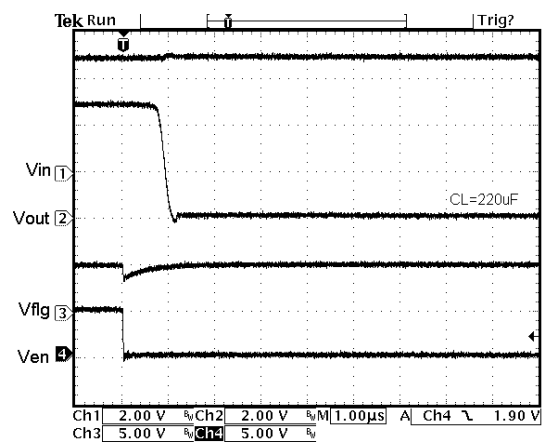
Iout Ramp Chart



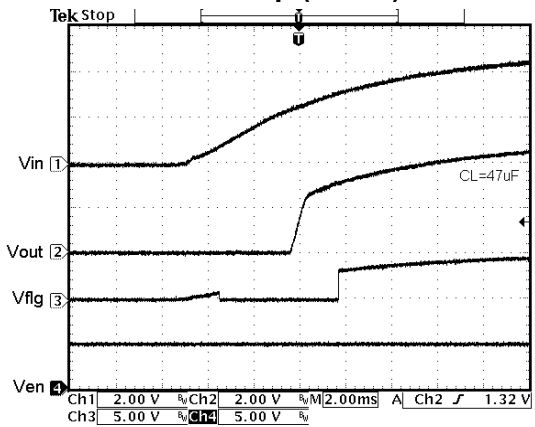
Output Turn-On Delay



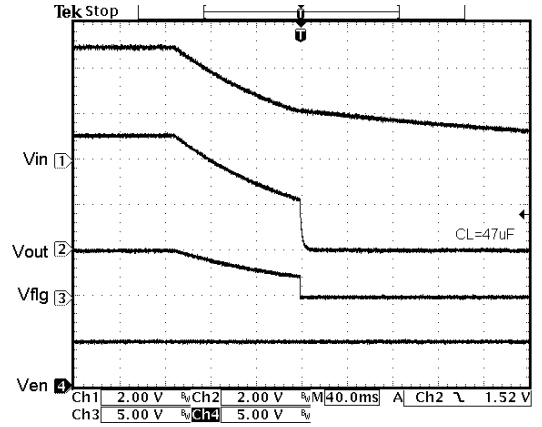
Output Turn-Off Delay



Power Up (UVLO)



Power Down (UVLO)

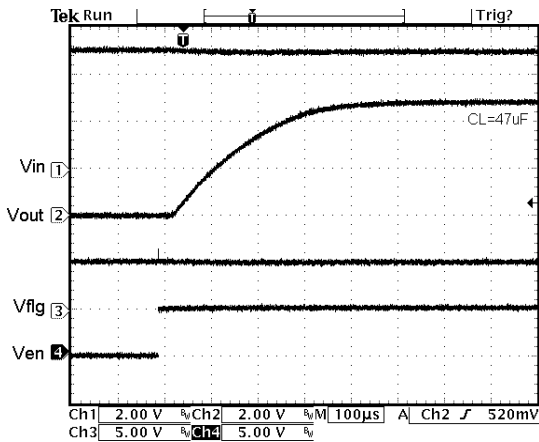




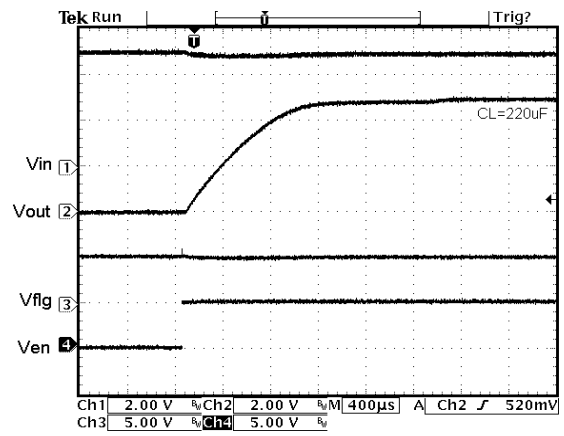
TYPICAL PERFORMANCE CHARACTERISTICS

(VIN= 5V,TA=25°C, G525A1, unless otherwise noted.)

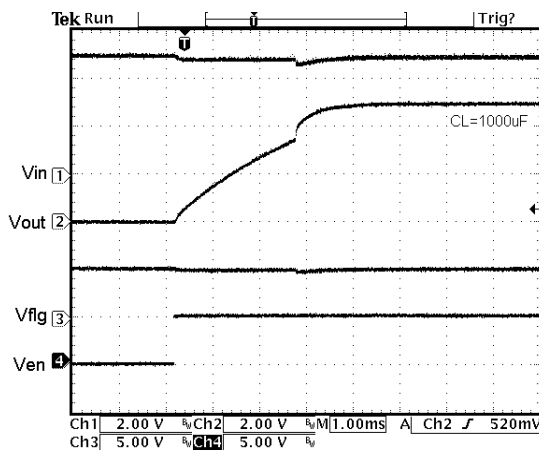
Turn-On Characteristics



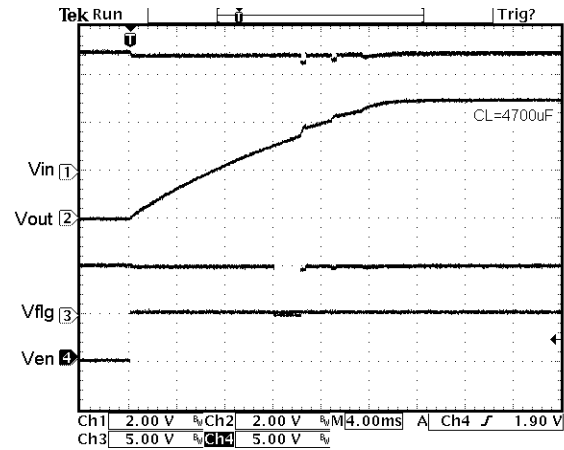
Turn-On Characteristics



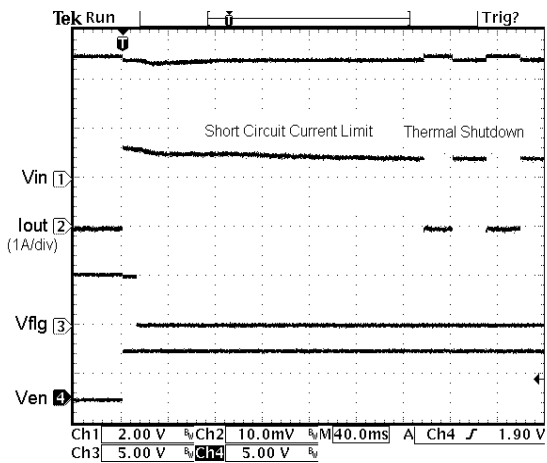
Turn-On Characteristics



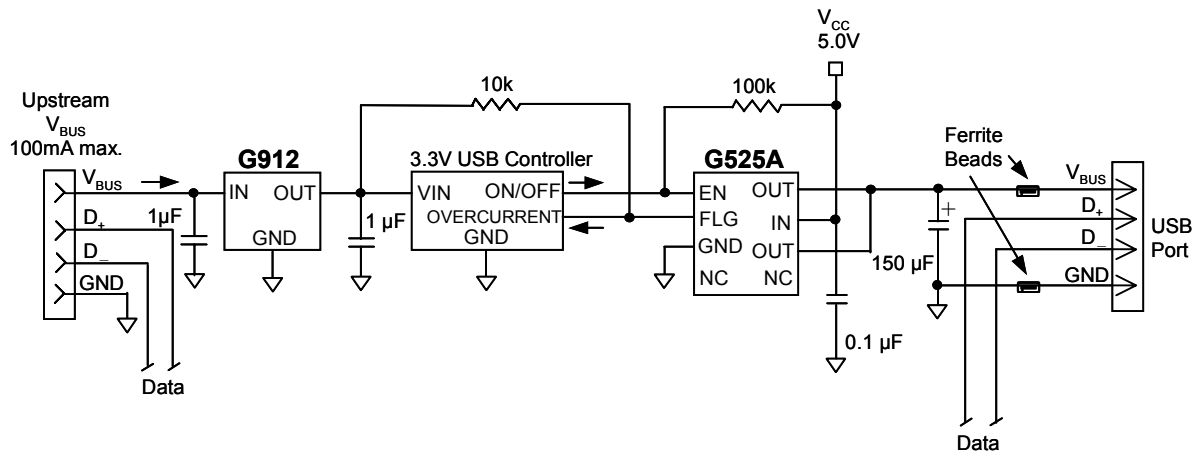
Turn-On Characteristics



Short Circuit Response  
(Short Applied to Output)

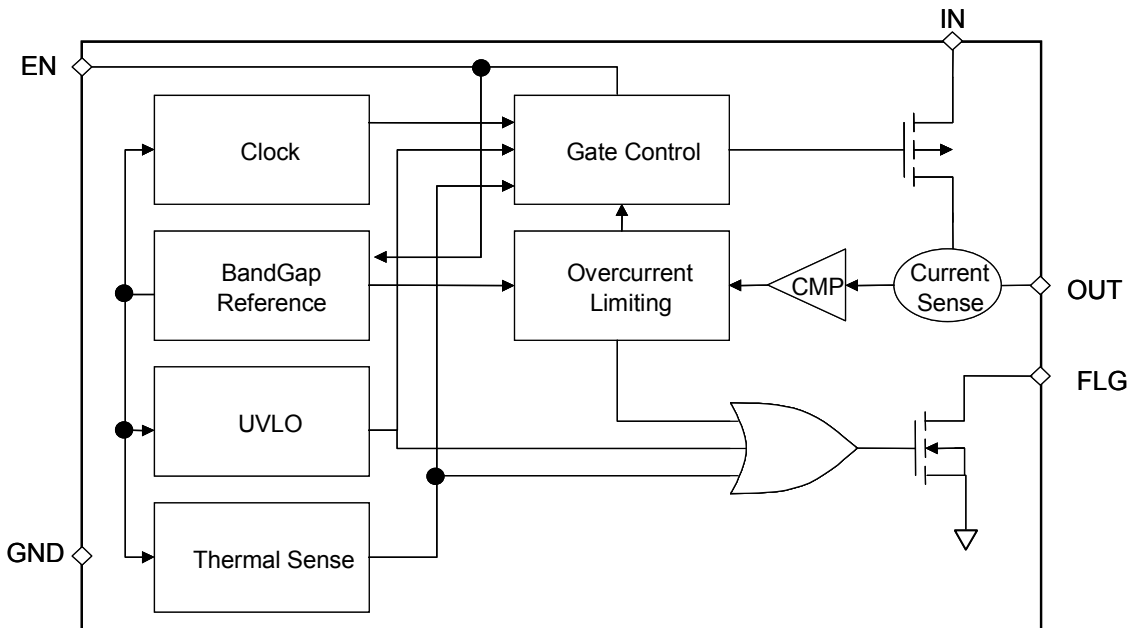


## Typical Applications



Single-Port Self-Powered USB Hub Application

## Function Block Diagrams



### Functional Description

The G525A1 and G525A2 are high-side 1-channel switches with active-high and active-low enable inputs, respectively. Fault conditions turn off or inhibit turn-on of the output transistors and activate the open-drain error flag transistors to pull FLG pin to ground.

#### 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. Both 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 G525A 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 G525A from excessive power dissipation. If the die temperature exceeds 135°C, the MOSFETS switch is shut off and a fault flag is activated. 10°C of hysteresis 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 and signals the fault flag. 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 and a fault flag is pulled low. The reaction to an over-current 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. The fault flag goes low until the load is reduced or thermal shutdown occurs. 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. In that case, the fault flag falls until the load is reduced. 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. The fault-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, located near the G525A, 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

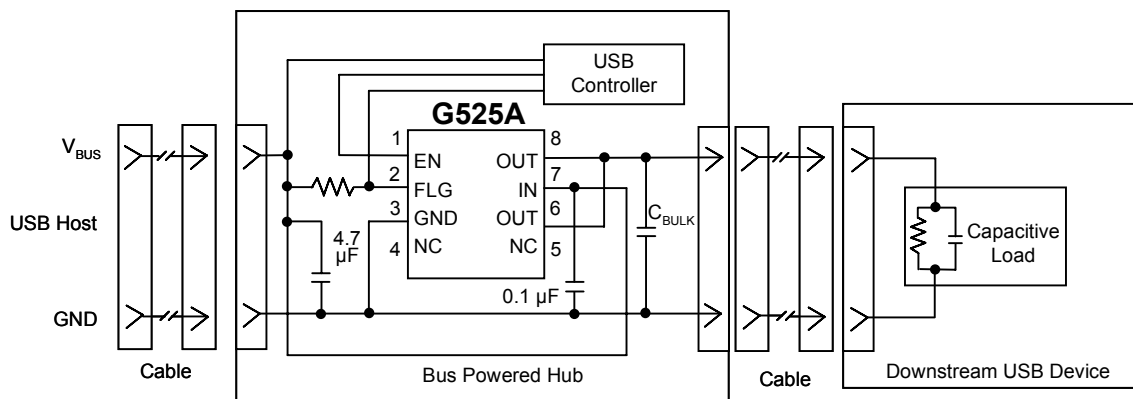
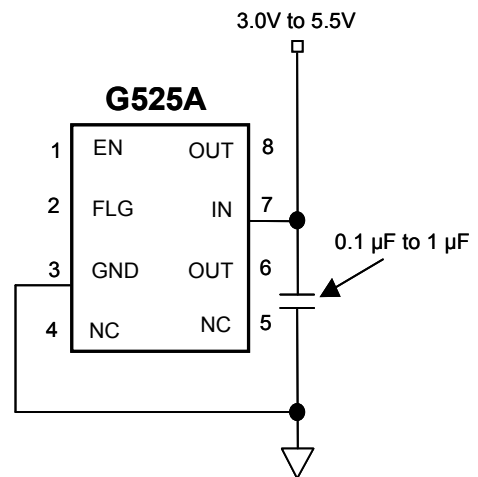
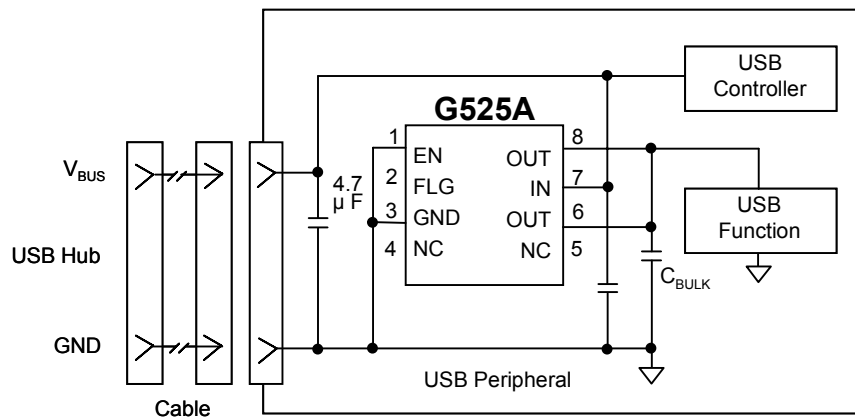


Figure 2. Soft Start



**Figure 3. Inrush Current-Limit Application**

**EN, the enable Input**

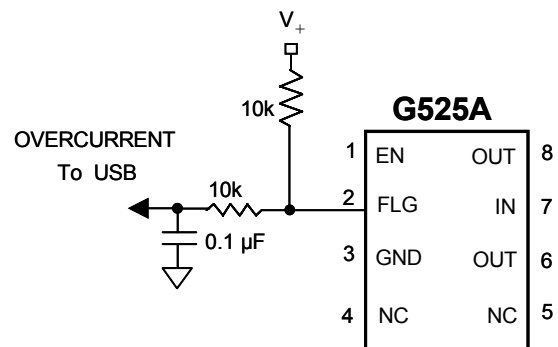
EN, with 0.2V hysteresis, must be driven logic high or logic low for a clearly defined input. Floating the input may cause unpredictable operation. EN should not be allowed to go negative with respect to GND.

**Soft Start**

The G525A 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 ( $C_{BULK} > 10\mu F$ ). The G525A will provide inrush current limiting for these applications.

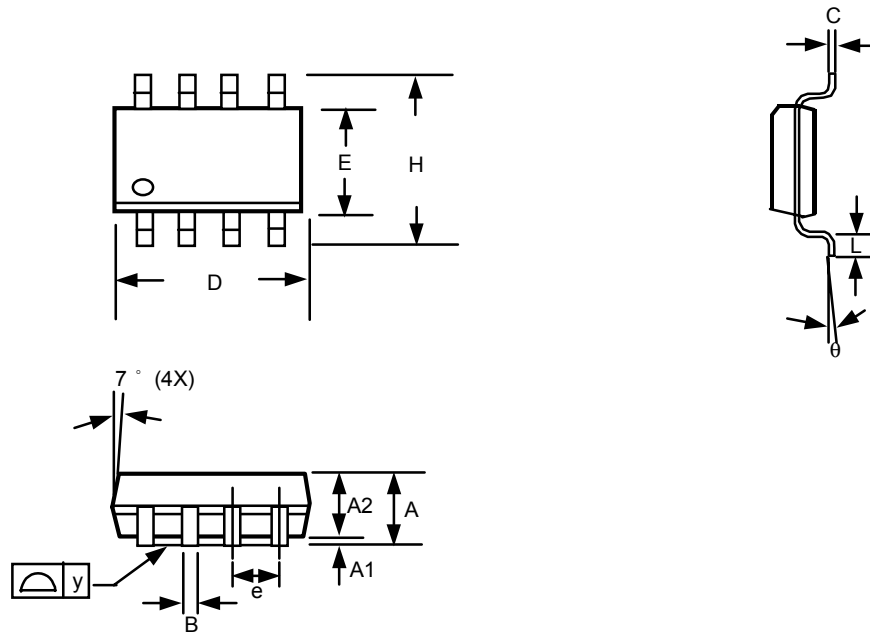
**Transient Overcurrent Filter**



**Figure 4. Transient Filter**

The inrush current from the connection of a heavy capacitive load may cause the fault flag to fall for a short duration while the switch is in a constant-current mode, for charging the capacitance. If needed, a simple 1ms RC low-pass filter in series with the fault flag circuit will prevent erroneous overcurrent reporting (see Figure 4).

## 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
$\theta$	0°	----	8°	0°	----	8°

## Taping Specification

