

PRELIMINARY - February 18, 2000

TEL:805-498-2111 FAX:805-498-3804 WEB:http://www.semtech.com

## DESCRIPTION

USB power distribution switches are high-side n-channel MOSFET switches with built-in overcurrent protection and low on-state resistance. The SC5826 switch is designed to meet the USB requirements for power switching and maintenance-free fault protection for self-powered & bus-powered hub applications. The SC5826 features low on-state resistance to meet the USB requirement for voltage drop and regulation. The switch is controlled by an enable input that is compatible with 3V and 5V logic. The enable input is available with an active high or active low input for maximum design flexibility. The device provides short circuit current limiting at a value of less than 1.6A, well below the USB limit of 5A. During an overcurrent condition the device provides a fault notification to signal the USB controller. An integrated thermal protection circuit automatically shuts the switch off when the junction temperature reaches its thermal limit. The switch remains off until the junction temperature drops approximately 10°C. The switch will continue to cycle on and off until the fault is removed. Inrush current limiting prevents the voltage drop on an upstream port when the switch is enabled. An undervoltage lockout circuit guarantees the switch is initially off during start-up.

## FEATURES

- Designed to meet **USB specification 1.1** power management requirements
- 500mA continuous load current
- High-side MOSFET switch with low  $R_{DS(ON)}$
- Short-circuit current protection
- Internal thermal shutdown
- Undervoltage lockout
- Logic overcurrent output
- Soft start circuit with slow turn-on time

## APPLICATIONS

- Universal Serial Bus (USB) power management
- Self-powered or bus-powered USB hubs
- Root hubs in desktop PCs & servers
- Notebook PCs
- Peripherals

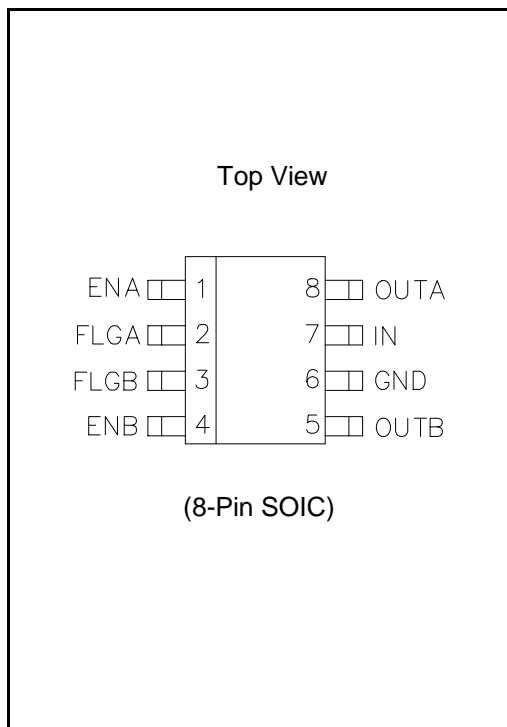
## ORDERING INFORMATION

DEVICE <sup>(1)</sup>	ENABLE	PACKAGE
SC5826-1CS	Active High	SO-8
SC5826-2CS	Active Low	SO-8

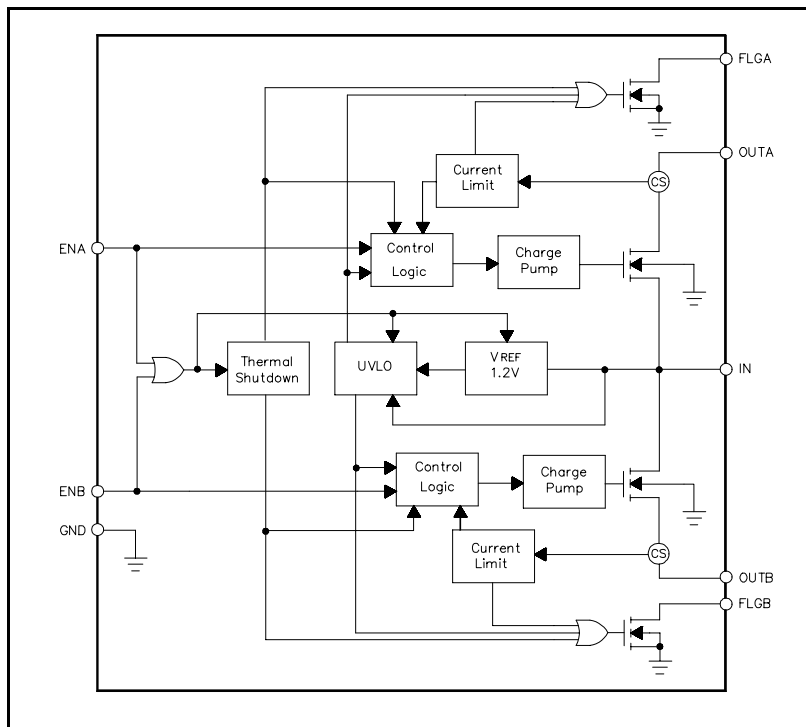
Note:

(1) Add suffix 'TR' for tape and reel.

## PIN CONFIGURATION



## BLOCK DIAGRAM



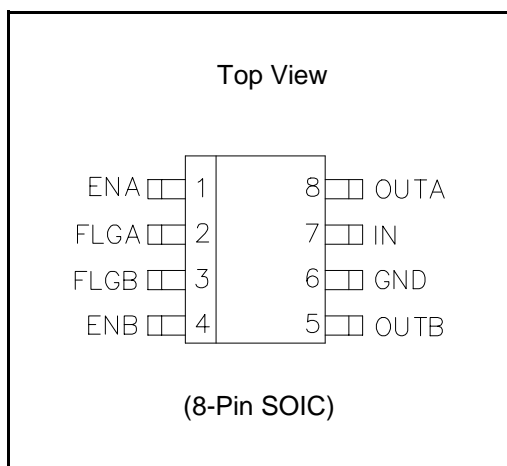
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**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Maximum	Units
Input Voltage Range	$V_{IN}$	-0.3 to +7	V
Output Voltage Range	$V_{OUT}$	-0.3 to +7	V
Enable Input	$V_{EN}$	-0.3 to +7	V
Continuous Output Current	$I_O$	Internally Limited	mA
Operating Ambient Temperature Range	$T_A$	-40 to +85	°C
Operating Junction Temperature Range	$T_J$	-40 to +125	°C
Storage Temperature Range	$T_{STG}$	-65 to +150	°C
Lead Temperature (Soldering) 10 seconds	$T_L$	300	°C

**PIN DESCRIPTION**

Pin #	Pin Name	Pin Function
1, 4	ENA/ENB	Enable input: TTL compatible switch enable input.
2, 3	FLGA/FLGB	Error flag output: FLG is asserted active low during fault condition.
6	GND	Ground.
7	IN	Input voltage: Output MOSFET Drain. Connect to supply voltage.
5, 8	OUTA/OUTB	Power switch output: Output MOSFET Source. Connect to switched side of load.

**PIN CONFIGURATION**


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**ELECTRICAL CHARACTERISTICS<sup>(1)(2)</sup>**

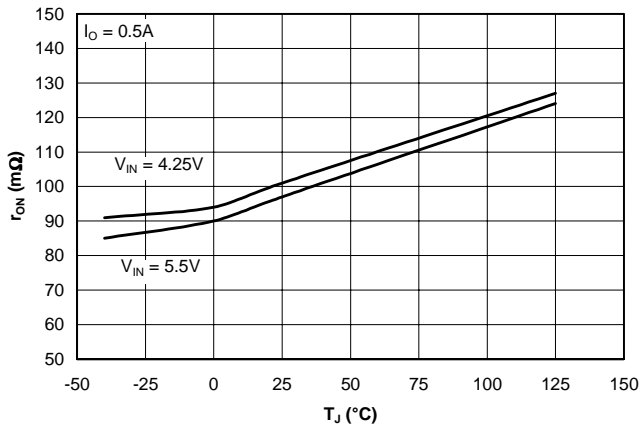
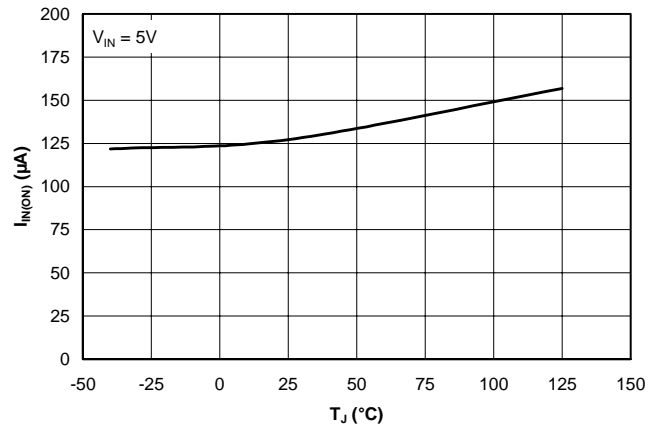
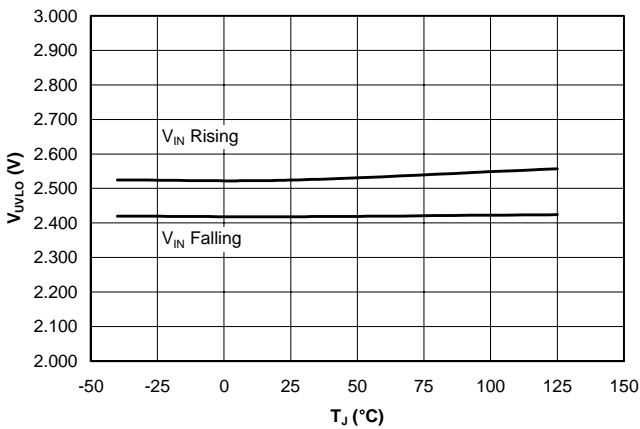
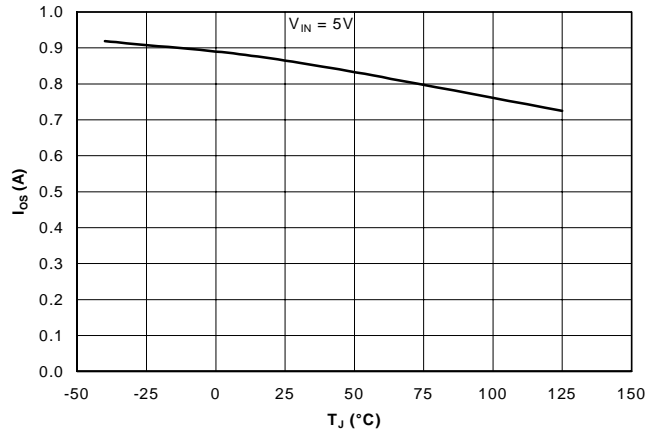
 Unless specified:  $T_A = 25^\circ\text{C}$ ,  $V_{IN} = 5\text{V}$ ,  $I_{OA}/I_{OB} = 500\text{mA}$  (Switches ON).

Parameter	Symbol	Conditions	Min	Typ	Max	Units
<b>Power Switch</b>						
On Resistance	$r_{ON}$	$4.25\text{V} \leq V_{IN} \leq 5.50\text{V}$		100	140	$\text{m}\Omega$
Output Leakage Current	$I_{L(OFF)}$	$V_O = 5.5\text{V}$ , Switches OFF			1	$\mu\text{A}$
Output Turn On Rise Time	$t_R$	$C_O = 1\mu\text{F}$ , $R_O = 10\Omega$		1		ms
Output Turn Off Fall Time	$t_F$	$C_O = 1\mu\text{F}$ , $R_O = 10\Omega$		0.1	1	ms
<b>Enable Input</b>						
High Level Input Voltage	$V_{EN(HI)}$	$4.25\text{V} \leq V_{IN} \leq 5.50\text{V}$	2.4			V
Low Level Input Voltage	$V_{EN(LO)}$	$4.25\text{V} \leq V_{IN} \leq 5.50\text{V}$			0.8	V
Input Current	$I_{EN}$	$EN = V_{IN}$ , $OUTA/B = \text{OPEN}$		0	1	$\mu\text{A}$
		$EN = 0\text{V}$ , $I_{OA}/I_{OB} = 0\text{mA}$ , $OUTA/B = \text{OPEN}$		0	1	
Output Turn On Delay	$t_{D(ON)}$			0.25		ms
Output Turn Off Delay	$t_{D(OFF)}$			25	50	$\mu\text{s}$
<b>Current Limit</b>						
Short Circuit Current Limit	$I_{OS}$	$V_{OA}/V_{OB} = \text{GND}$ , Switches ON	0.65	0.90	1.60	A
<b>Supply Current</b>						
Outputs Off	$I_{IN(OFF)}$	Switches OFF		0.02	1	$\mu\text{A}$
Outputs On	$I_{IN(ON)}$	$I_{OA}/I_{OB} = 0\text{mA}$		130	200	$\mu\text{A}$
<b>Undervoltage Lockout</b>						
UVLO Threshold	$V_{UVLO}$		2.2		2.7	V
Hysteresis	$V_{HYST}$			90		mV
<b>Error Flag</b>						
Output Resistance	$r_{FLG}$	$I_{FLG} = 10\text{mA}$ , $V_{OA}/V_{OB} = \text{GND}$ , Switches ON		10	50	$\Omega$
Leakage Current (Off)	$I_{FLG}$	$V_{FLG} = 5.0\text{V}$ , Switches OFF		0.01	1	$\mu\text{A}$
<b>Over Temperature Protection</b>						
High Trip Level	$T_{HI}$			160		$^\circ\text{C}$
Hysteresis	$T_{HYST}$			10		$^\circ\text{C}$

**NOTE:**

- (1) For SC5826-1, Switch OFF is  $V_{EN} \leq 0.8\text{V}$  and Switch ON is  $V_{EN} \geq 2.4\text{V}$  ("Active High").  
 For SC5826-2, Switch ON is  $V_{EN} \leq 0.8\text{V}$  and Switch OFF is  $V_{EN} \geq 2.4\text{V}$  ("Active Low").  
 For testing purposes EN will be 0V or  $V_{IN}$  as applicable, unless otherwise specified.
- (2) This device is ESD sensitive. Use of standard ESD handling precautions is required.

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**TYPICAL CHARACTERISTICS**
**On Resistance vs. Junction Temperature vs. Input Voltage**

**Supply Current (Outputs On) vs. Junction Temperature**

**UVLO Threshold vs. Junction Temperature**

**Short Circuit Output Current vs. Junction Temperature**


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## DETAILED DESCRIPTION

The SC5826 HotSwitch™ is a dual port, high-side switch optimized for power control & distribution in Universal Serial Bus (USB) applications. It features an n-channel power MOSFET with a low on-state resistance for meeting USB voltage regulation requirements. It is available with active high (SC5826-1) or active low (SC5826-2) inputs.

### In/Out

The input is the supply voltage connection to the drain of the power switch MOSFET. The output is connected to the source of the MOSFET. Under normal operating conditions when the power switch is enabled, current flows from the input to the output towards the load. The power switch is designed to sustain a minimum load current of 500mA in accordance with USB specifications.

### Charge Pump

An internal charge pump powers the MOSFET gate drive circuit and provides the necessary voltage to pull the gate above the source.

### Control Logic

The gate drive circuit controls the gate voltage of the MOSFET power switch. The gate drive circuit also controls the rise & fall times of the power switch output voltage. The typical "soft start" or output voltage rise time is 1ms.

### Enable Input

A logic signal at the enable (EN) pin activates the power MOSFET switch. A logic 1 (SC5826-1) or logic 0 (SC5826-2) will bias the charge pump, gate drive, and control circuitry turning on the power switch. A logic signal of opposite polarity turns off the switch. If both outputs are off, the device powers down. The enable input is compatible with 3V & 5V logic levels.

### Error Flag

The error flag (FLG) output is an n-channel, open drain MOSFET. The FLG pin is an active low during short circuit, undervoltage, or thermal shutdown conditions. The output remains low until the fault condition is removed.

### Thermal Sense

An internal thermal shutdown circuit turns off the power switch output MOSFET when the die junction temperature exceeds 160°C. The output FLG pin is asserted to a logic low signaling a fault condition. A built in hys-

teresis prevents the switch from turning on until the die temperature has cooled approximately 10°C. The switch will continue to cycle on and off until the fault condition is removed. The thermal sense circuit functions only when the switch is enabled.

### Undervoltage Lockout

An undervoltage lockout circuit monitors the input voltage and prevents the power switch MOSFET from turning on until the input voltage (IN) exceeds 2.5V (typical). If the input voltage falls 90mV (typical) below that point after the switch has been turned on, the undervoltage lockout turns off the power switch output MOSFET and asserts the FLG output to logic low. The undervoltage lockout functions only when the switch is enabled.



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**TYPICAL APPLICATIONS**
**Bus-powered hub, ganged port power management:**

A bus-powered hub distributes power and data from an input port to downstream ports. It must supply a continuous 100mA of current to each downstream port. A bus-powered hub must be able to switch power to downstream ports to prevent illegal device hook-up. Inrush current limiting is also required to prevent power supply drooping. The circuit below utilizes the SC5826 to provide ganged port power switching, inrush current limiting and overcurrent protection for maximum port protection. In a ganged switch configuration, all ports are switched simultaneously. Under fault conditions, the USB controller will remove power to all of the

ganged ports. For individual port management, an additional SC5826 may be used.

Since USB is a hot insertion and removal system, USB ports are subject to electrostatic discharge (ESD). The SRDA05-4 provides ESD protection on the downstream data and power lines. Each device will protect two USB ports. With proper layout the port is hardened to greater than 15kV, meeting the requirements of IEC 1000-4-2. On the upstream port, the LCDA05 provides ESD protection to the above levels for one line pair. The SC5203 (or SC5205) LDO regulator is used to power the hub controller from the upstream bus.

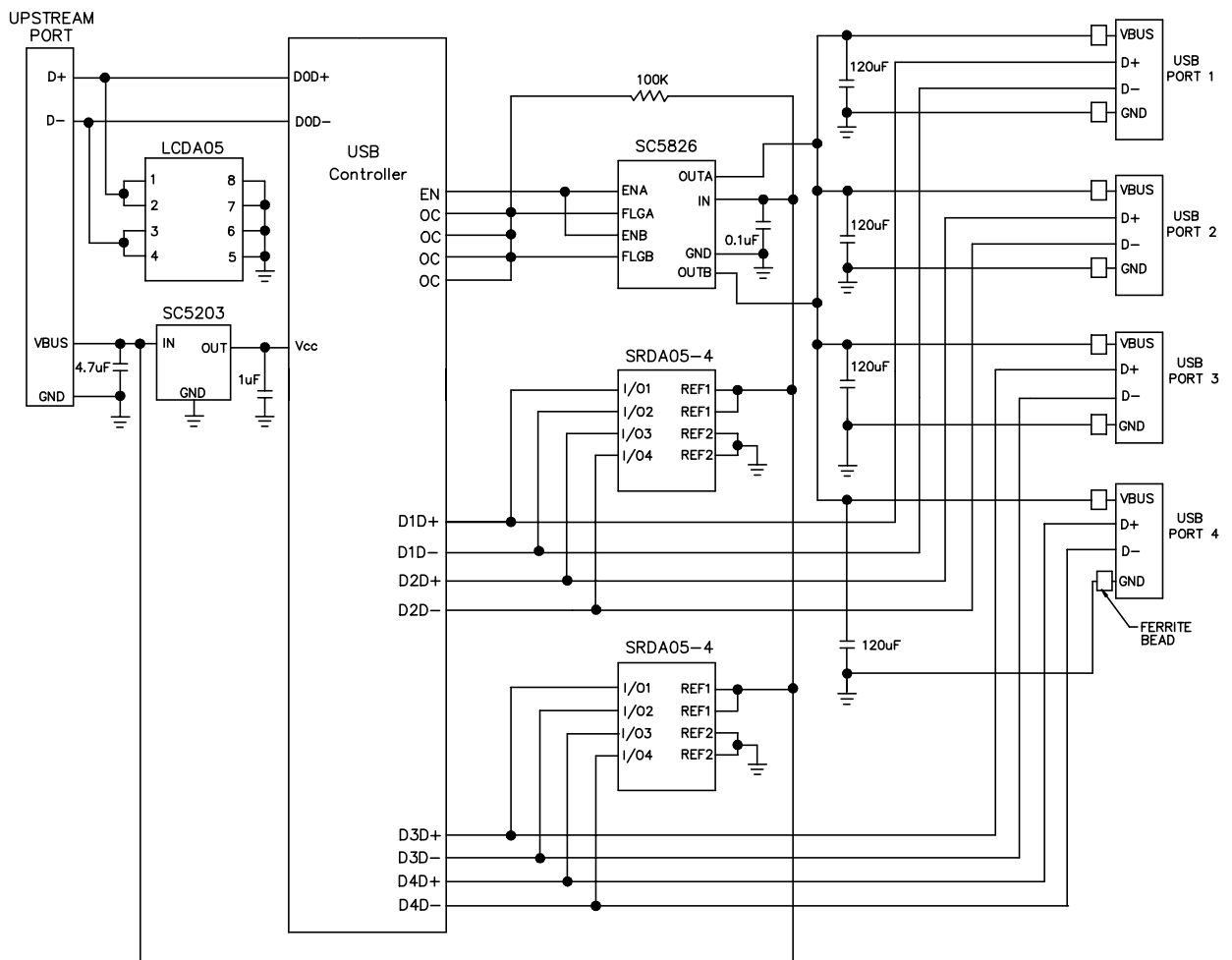
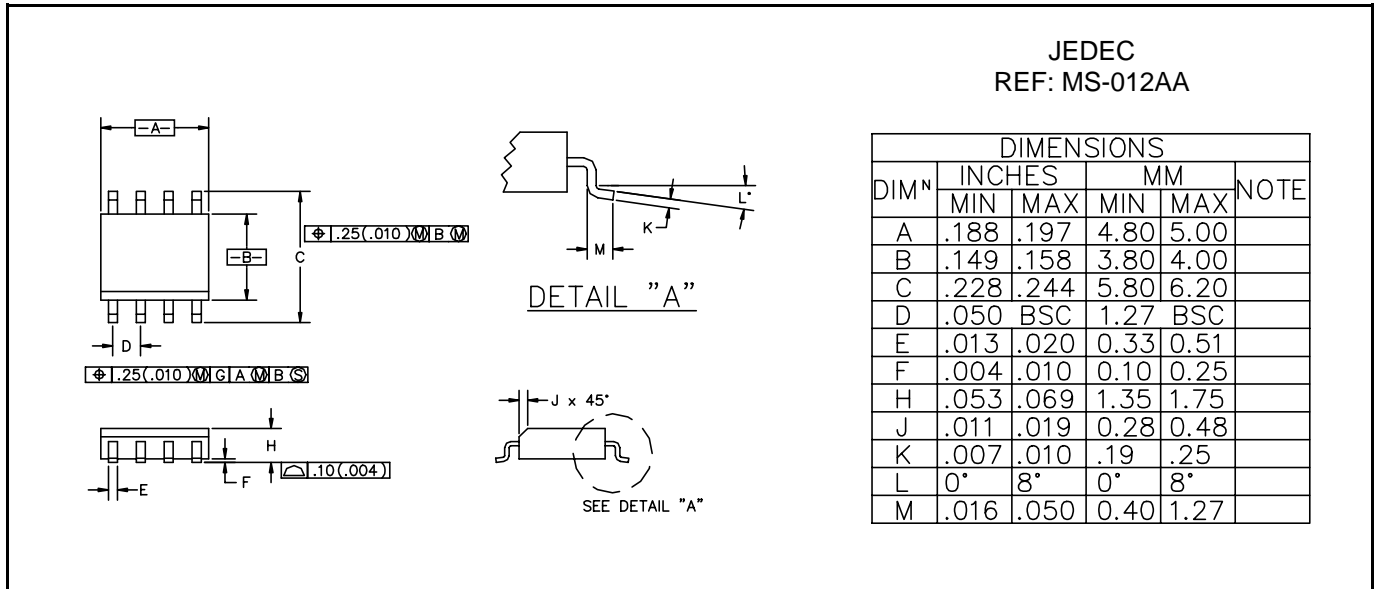
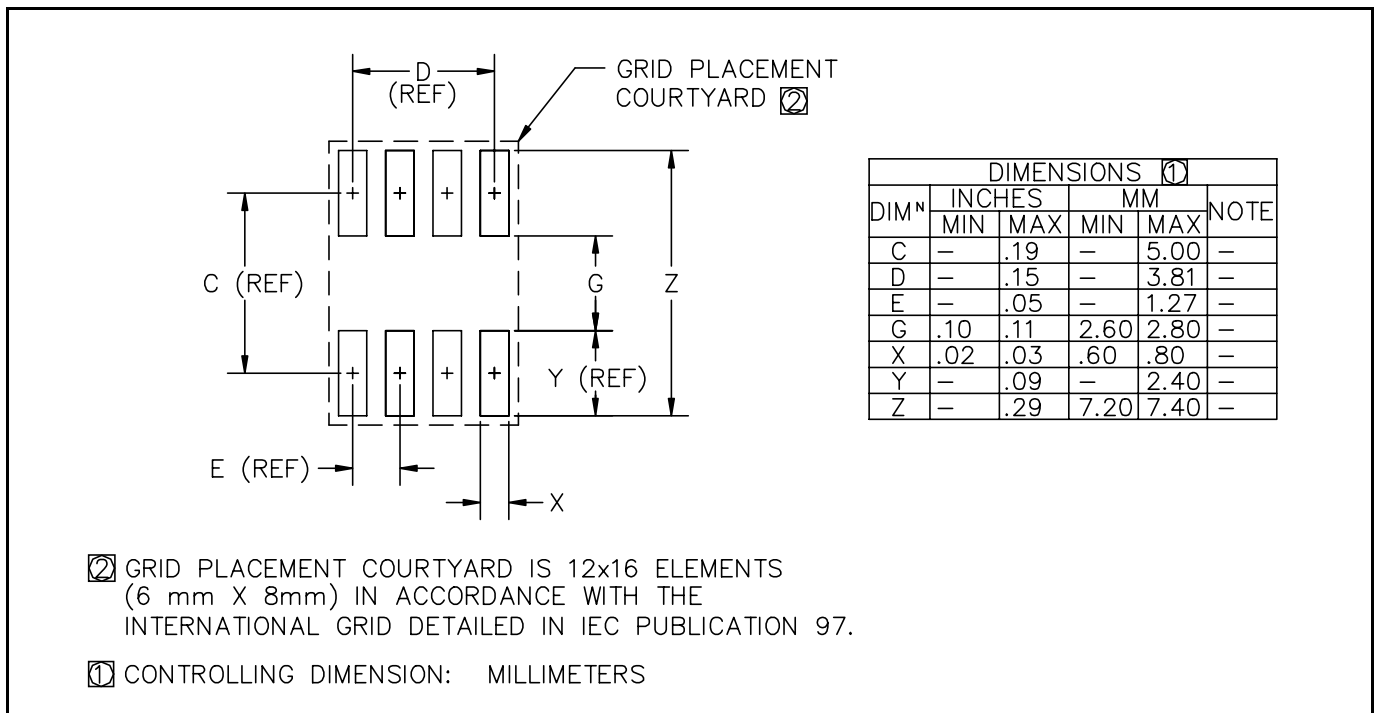


Figure 2 - Bus-powered hub with ganged port power management

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**OUTLINE DRAWING - SO-8**

**LAND PATTERN - SO-8**


ECN00-886