FUJITSU SEMICONDUCTOR
DATA SHEET

DS04-27603-1E

ASSP For Power Supply Applications

Power Management Switch IC

MB3841

■ DESCRIPTION

The FUJITSU MB3841 is a one-channel power management switch IC with extremely low on resistance.

The MB3841 is designed for a variety of switching applications, featuring operation from low input voltages (V_{IN} > 2.2 V) and stable on resistance that does not depend on input voltage. The switch current limit can be externally set over a wide range from 100 mA to 2 A. A safety function detects overcurrent conditions, immediately sets the switch to off mode and sends an external notification signal. The MB3841 is therefore ideal for power management switching applications with USB specifications.

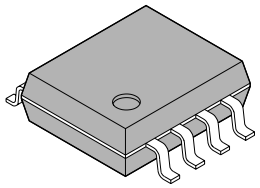
In addition, the MB3841 has features that ensure accurate on-off switching by preventing reverse current in off mode, as well as rapid discharge of capacitors connected to output.

■ FEATURES

- Low on resistance switch (typ. 45 mΩ)
- Low input voltage operation (2.2 V to 5.5 V)
- Switch current (max. 2 A)
- UVLO (V_{TH} = 1.9 V)
- External settings for soft start time and switch current limit
- On-chip overheating and overcurrent detection (output off latching)
- On-chip abnormal state detection circuit (O.C. pin)
- On-chip output pin discharge control circuit
- Supply current = 0 μA in standby mode (CONTROL < 0.8 V)
- Reverse current protection function in off mode

■ PACKAGE

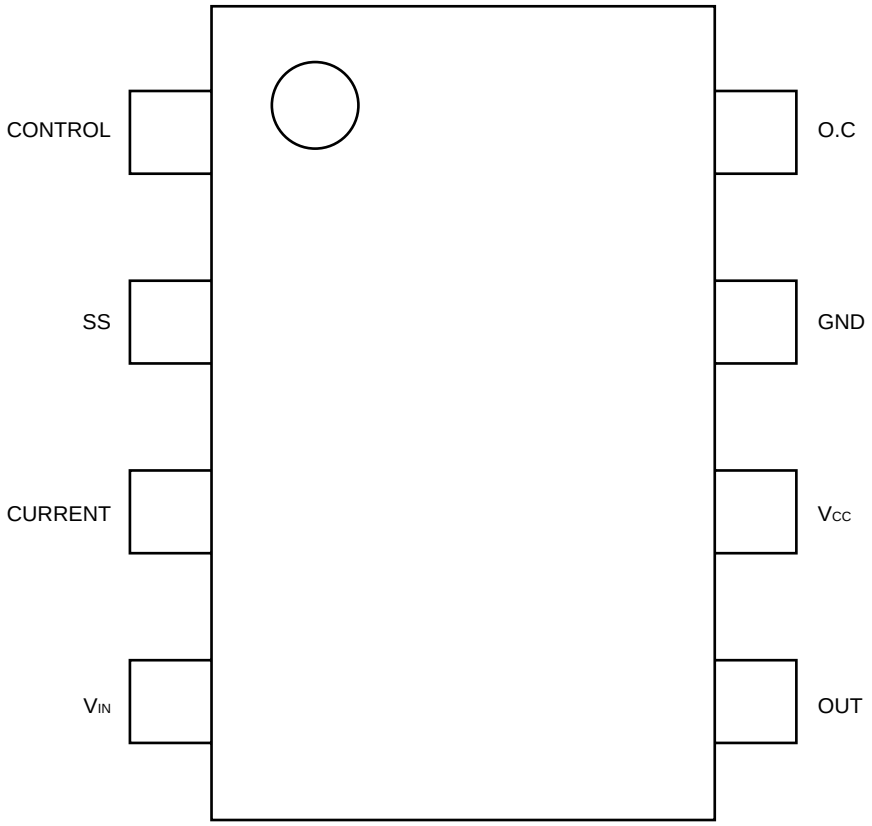
8-pin Plastic SOP



(FPT-8P-M01)

MB3841

■ PIN ASSIGNMENT



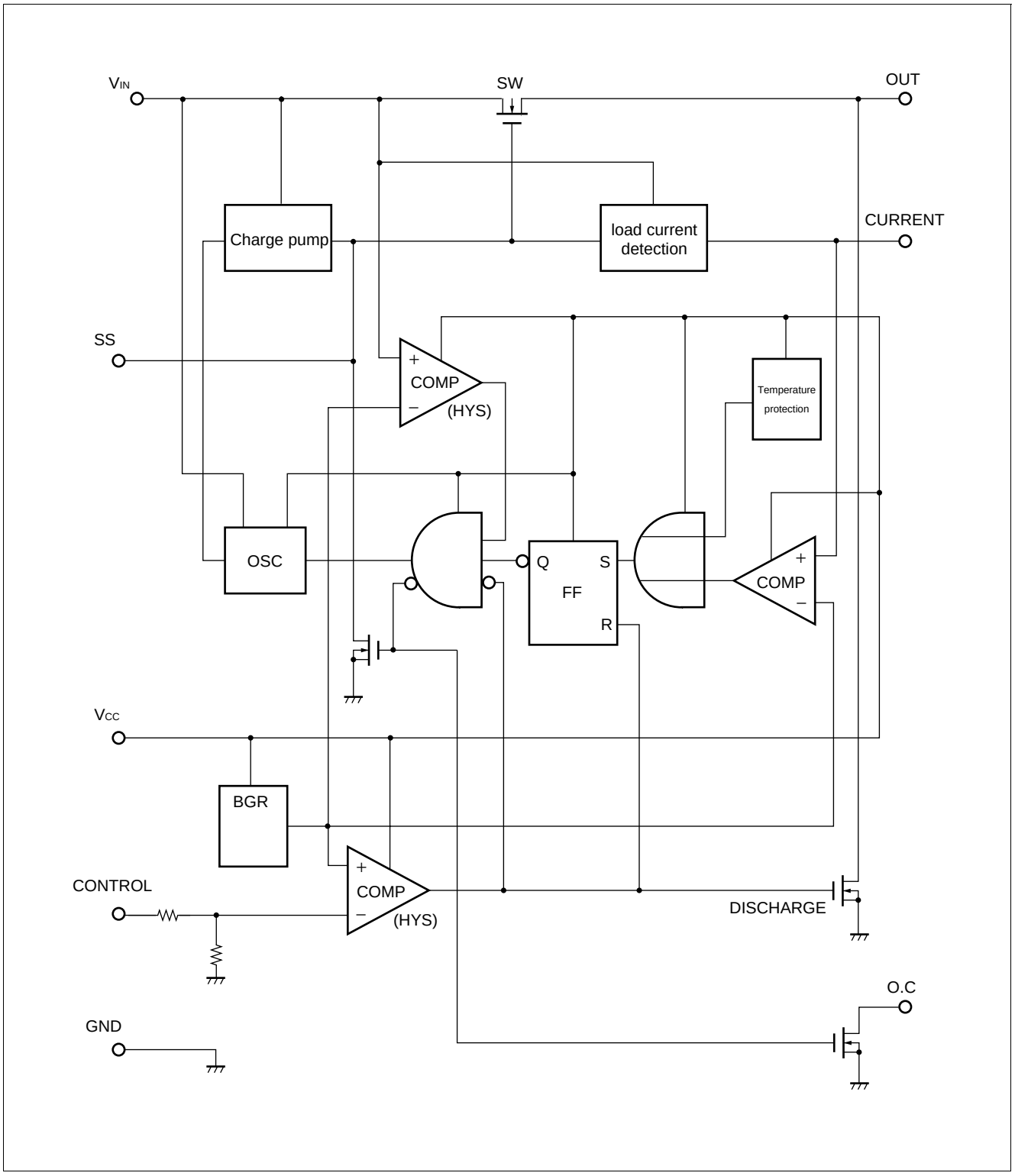
(TOP VIEW)

■ PIN DESCRIPTION

Pin no.	Symbol	Descriptions
1	CONTROL	Control signal input pin. Set “H” to turn the switch on, “L” to turn the switch off. At 0.8 V or less, the chip is in STBY state and current consumption is less than1μA.
2	SS	Slow start setting pin. Used to adjust the switch on/off timing. Add external capacitance to delay operation. Leave open when not in use. In open mode voltages up to 10 V are present. Care should be taken in mounting to prevent leak current generation because high impedance is required.
3	CURRENT	Current limit setting pin. The limit current level is set by connecting this pin to external resistance. If this pin is connected to GND, no current limit is applied.
4	V_{IN}	Switch input pin. The V_{IN} voltage monitoring function enables switch operation at 1.9 V or higher. If the V_{IN} voltage drops to 1.8 V or lower switch operation is disabled.
5	OUT	Switch output pin. The discharge function will immediately discharge the capacitance charge connected to the OUT pin when the switch is in off position and 350 Ω resistance (with V_{CC} = 5 V) is connected to the GND terminal.
6	V_{CC}	Control power supply input pin. This pin supplies power to the control circuit. The input voltage level must be stable.
7	GND	Ground pin.
8	O.C	External signal pin. When the switch is in on mode this pin normally outputs a “H” level signal, but changes to “L” level when an overcurrent, overheating, or UVLO condition is detected. When the switch is in off mode this signal is output at “L” level at all times. This is an open drain connection, and should be pulled up to high potential using resistance.

MB3841

■ BLOCK DIAGRAM



■ ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Condition	Rating		Unit
			Max.	Min.	
Input voltage	V_{IN}	—	–0.3	7.0	V
Power supply voltage	V_{CC}	—	–0.3	7.0	V
Control voltage	V_{CTL}	—	–0.3	7.0	V
Switch current	I_{SW}	V_{IN} = 2.2 V to 5.5 V, Ta = +25°C	—	3 A (DC)	A
Allowable dissipation	P_D	Ta = +85°C	—	280	mW
Storage temperature	T_{STG}	—	–55	+125	°C

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

■ RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	Condition	Value			Unit
			Min.	Typ.	Max.	
Input voltage	V_{IN}	—	0	—	5.5	V
Power supply voltage	V_{CC}	—	0	—	5.5	V
Control voltage	V_{CTL}	$V_{CTL} \leqq V_{CC}$	0	—	5.5	V
Switch current	I_{SW}	V_{IN} = 2.2 V to 5.5 V, V_{CTL} = 2.2 V to 5.5 V	—	—	2.0	A
SS pin capacitance	C_{SS}	—	—	—	10	nF
Current limit resistance	R_{LIN}	V_{IN} = 5.0 V (I_{SW} = 2 A to 0.1 A)	1.8	—	24	kΩ
		V_{IN} = 2.2 V (I_{SW} = 2 A to 0.1 A)	2.2	—	51	kΩ
O.C sync current	I_{OC}	V_{IN} = 2.2 V to 5.5 V, $V_{CC} \geqq$ 2.2 V	—	—	1.0	mA
Operating temperature	T_{OP}	—	–20	—	+85	°C

Note: For C_{SS}, R_{LIN} settings, see p. 9.

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

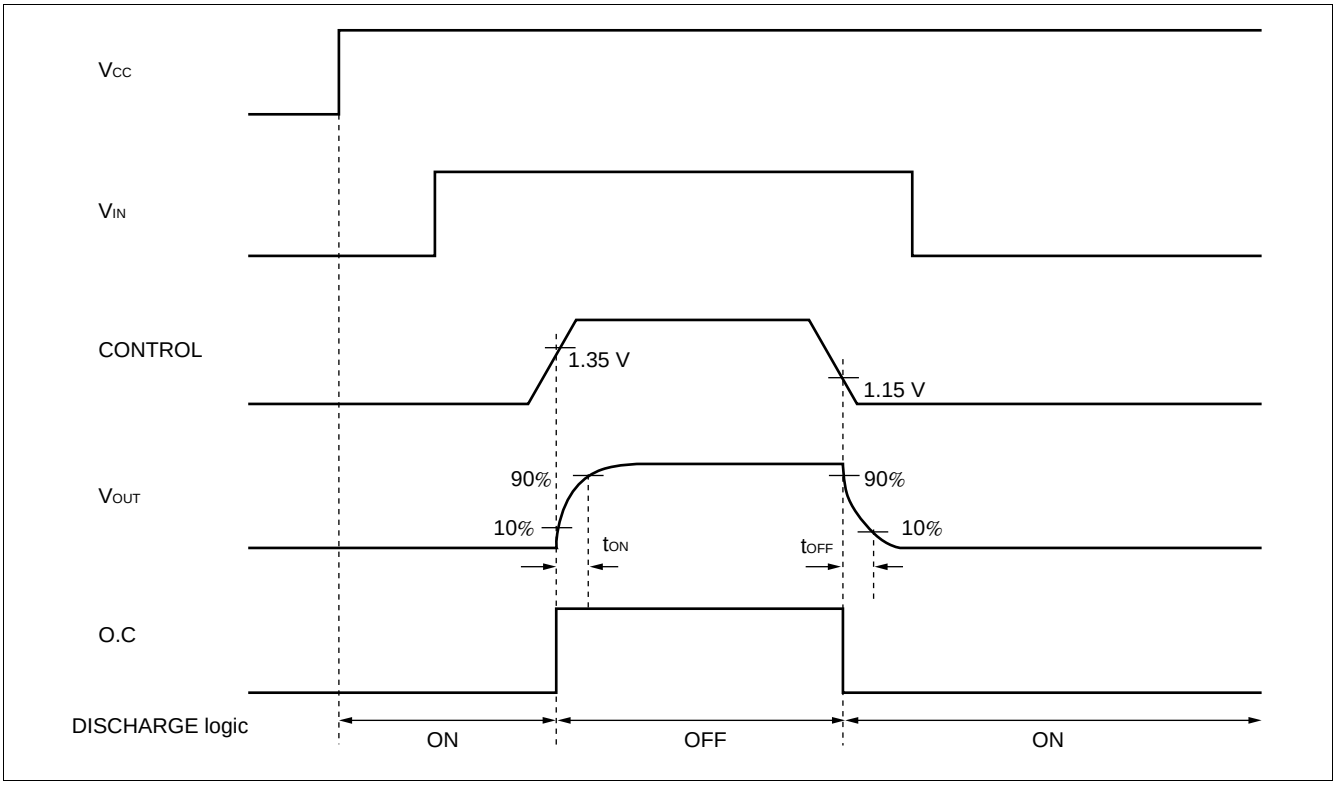
■ ELECTRICAL CHARACTERISTICS

(V_{IN} = 5 V, V_{CC} = 5 V, Ta = +25°C)

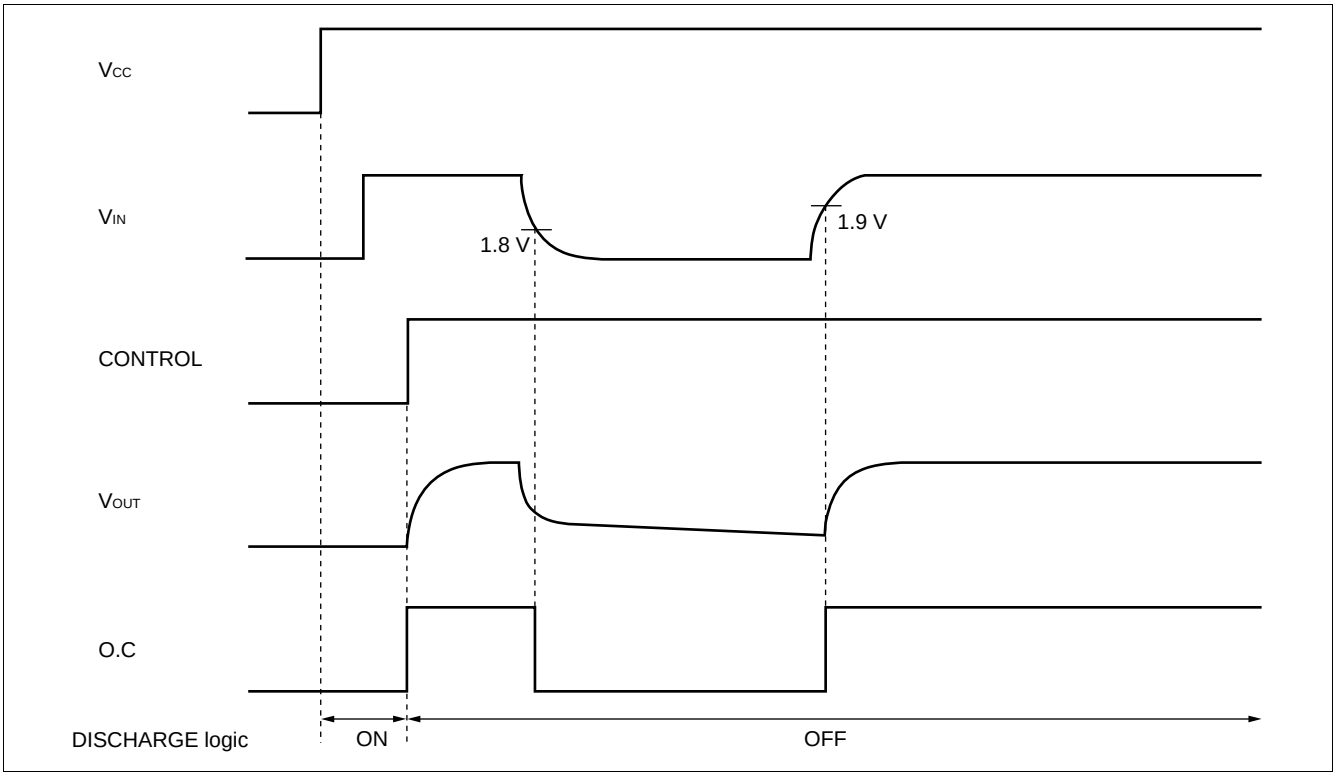
Parameter	Symbol	Condition		Value			Unit
				Min.	Typ.	Max.	
Switch resistance	R_{ON}	V_{IN} = 5 V, V_{CTL} = 3 V, I_{SW} = 2 A		—	45	70	mΩ
IN pin disable current	I_{IN1}	V_{IN} = 5 V, V_{CTL} = 3 V, I_{SW} = 0 A		—	170	340	μA
	I_{IN2}	V_{IN} = 5 V, V_{CTL} = 3 V, I_{SW} = 2 A		—	0.9	1.8	mA
	I_{IN3}	V_{IN} = 5 V, V_{CTL} = 0.4 V		—	—	1.0	μA
V_{CC} power supply current	I_{CC1}	V_{IN} = 5 V, V_{CTL} = 3 V, I_{SW} = 2 A		—	105	210	μA
	I_{CC2}	V_{IN} = 5 V, V_{CTL} = 0.4 V		—	—	1.0	μA
UVLO threshold	V_{IUH}	V_{CC} = 5 V, V_{IN} at O.C. = L → H		1.7	1.9	2.1	V
	V_{IUL}	V_{CC} = 5 V, V_{IN} at O.C. = H → L		1.6	1.8	2.0	V
UVLO histeresis spread	V_{IUHY}	V_{IUHY} = V_{IUH} – V_{IUL}		50	100	150	mV
CONTROL pin input current	I_{CTL}	V_{CTL} = 5 V, I_{SW} = 0 A		—	5.0	10	μA
CONTROL pin threshold	V_{THCTL}	V_{CC} = 2.2 V, V_{CTL} at O.C. = L → H		1.2	1.35	1.5	V
	V_{TLCTL}	V_{CC} = 2.2 V, V_{CTL} at O.C. = H → L		1.0	1.15	1.3	V
CONTROL pin histeresis spread	V_{CTLHY}	V_{CTLHY} = V_{THCTL} – V_{TLCTL}		100	200	300	mV
Switch current limit	I_{SWLL1}	V_{IN} = 5 V	R_{LIM} = 24 kΩ, V_{CTL} = 2.2 V	73	105	137	mA
	I_{SWLH1}		R_{LIM} = 1.8 kΩ, V_{CTL} = 2.2 V	1.57	1.97	2.37	A
	I_{SWLL2}	V_{IN} = 2.2 V	R_{LIM} = 51 kΩ, V_{CTL} = 2.2 V	68	98	128	mA
	I_{SWLH2}		R_{LIM} = 2.2 kΩ, V_{CTL} = 2.2 V	1.53	1.92	2.31	A
O.C sync current	I_{OCS}	V_{CC} = 5 V, V_{CTL} = 0.8 V, V_{OC} = 0.4 V		1.0	—	—	mA
O.C leak current	I_{OCL}	V_{CC} = 5 V, V_{CTL} = 3 V, V_{OC} = 5.0 V		—	—	2.0	μA
Switch discharge resistance	R_{DCG}	V_{CC} = 5 V, V_{CTL} = 0.8 V, V_{OUT} = 5.0 V		—	350	700	Ω
Temperature protection (T_j)	T_{LIM}	V_{CC} = 5 V, V_{CTL} = 2.2 V		+125	—	—	°C
OUT pin rise time	t_{ON1}	V_{CC} = 5 V, V_{IN} = 5 V, SS, OUT: Open		—	300	900	μs
	t_{ON2}	V_{CC} = 5 V, V_{IN} = 2.2 V, SS, OUT: Open		—	610	1830	μs
OUT pin fall time	t_{OFF1}	V_{IN} = 5 V, V_{CC} = 5 V, SS, OUT: Open		—	10	50	μs
	t_{OFF2}	V_{IN} = 5 V, V_{CC} = 2.2 V, SS, OUT: Open		—	50	250	μs

■ DIAGRAM

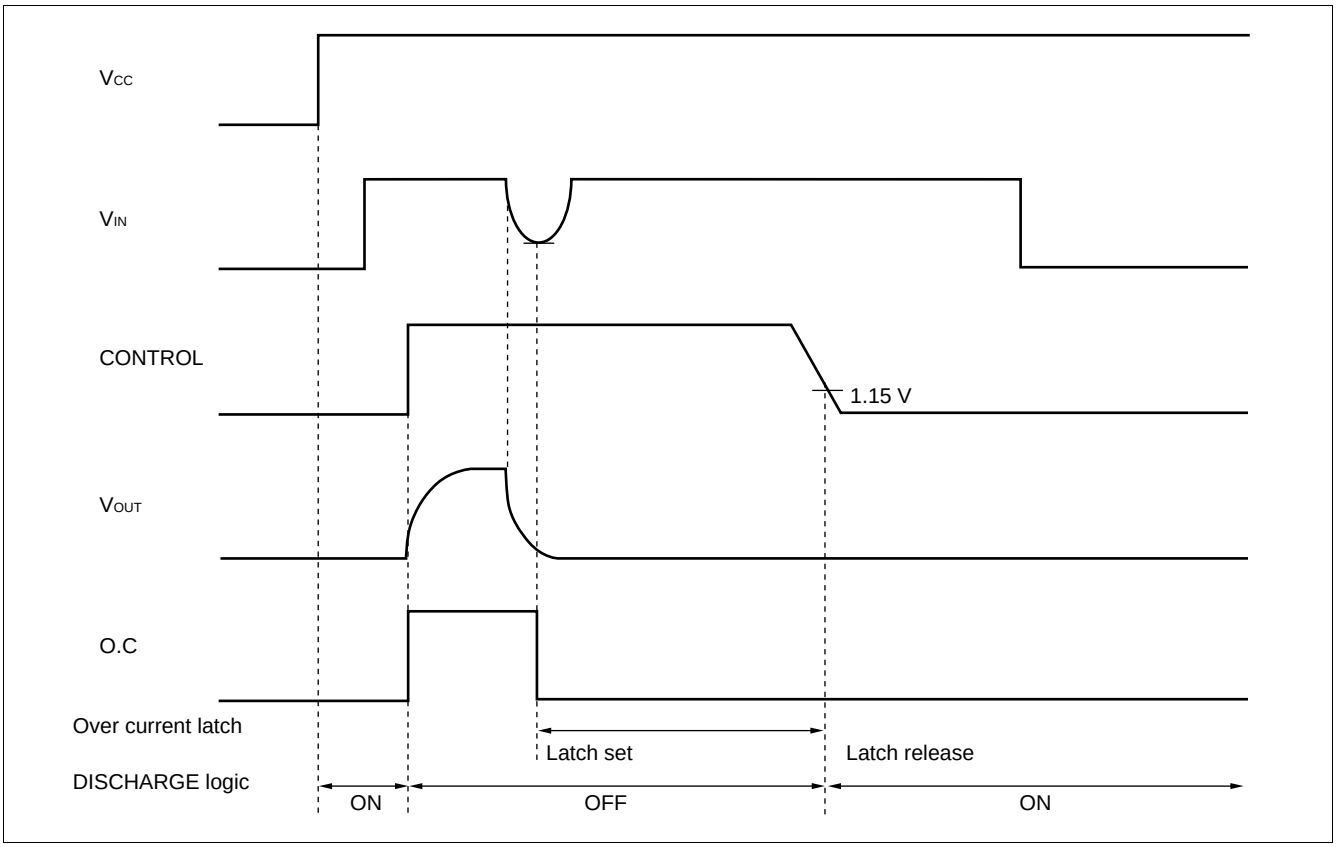
1. Normal operation



2. At VIN Fall

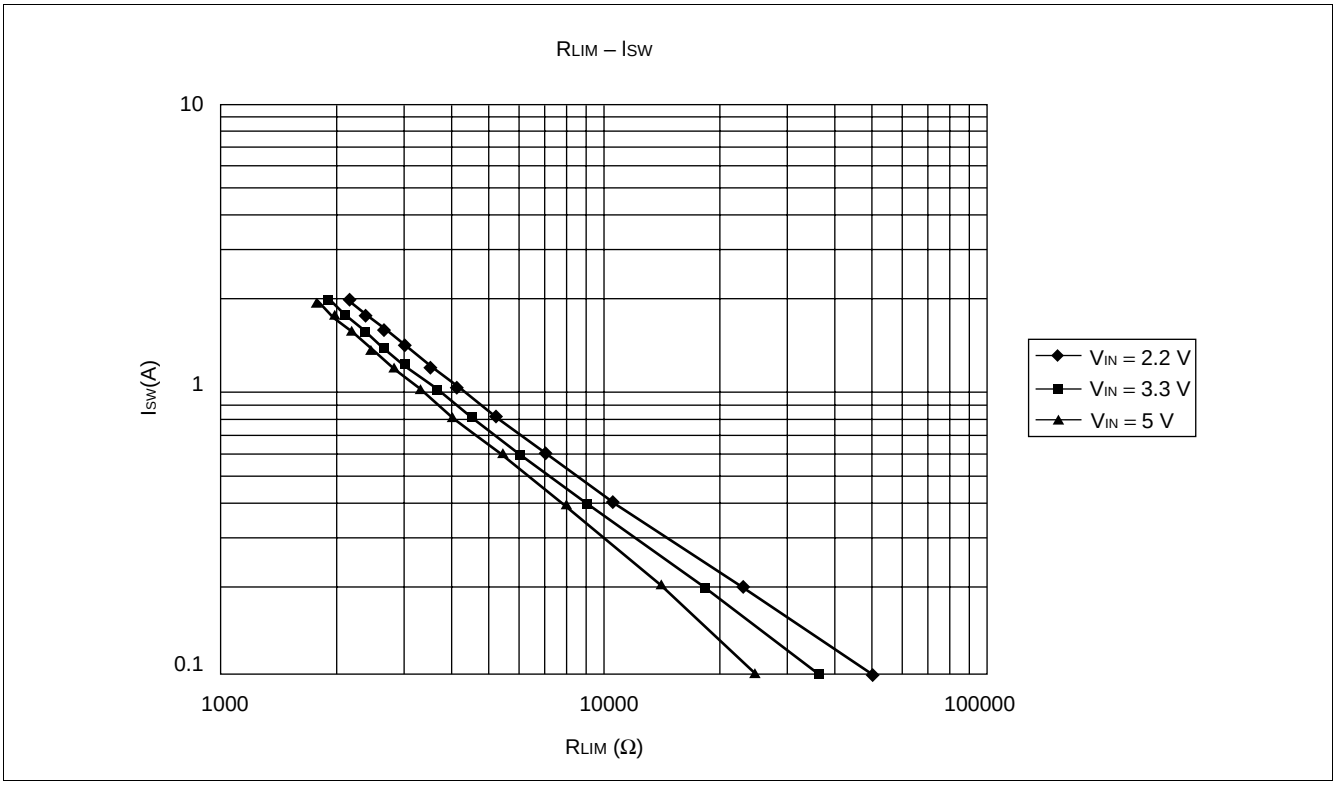


3. At V_{OUT} short

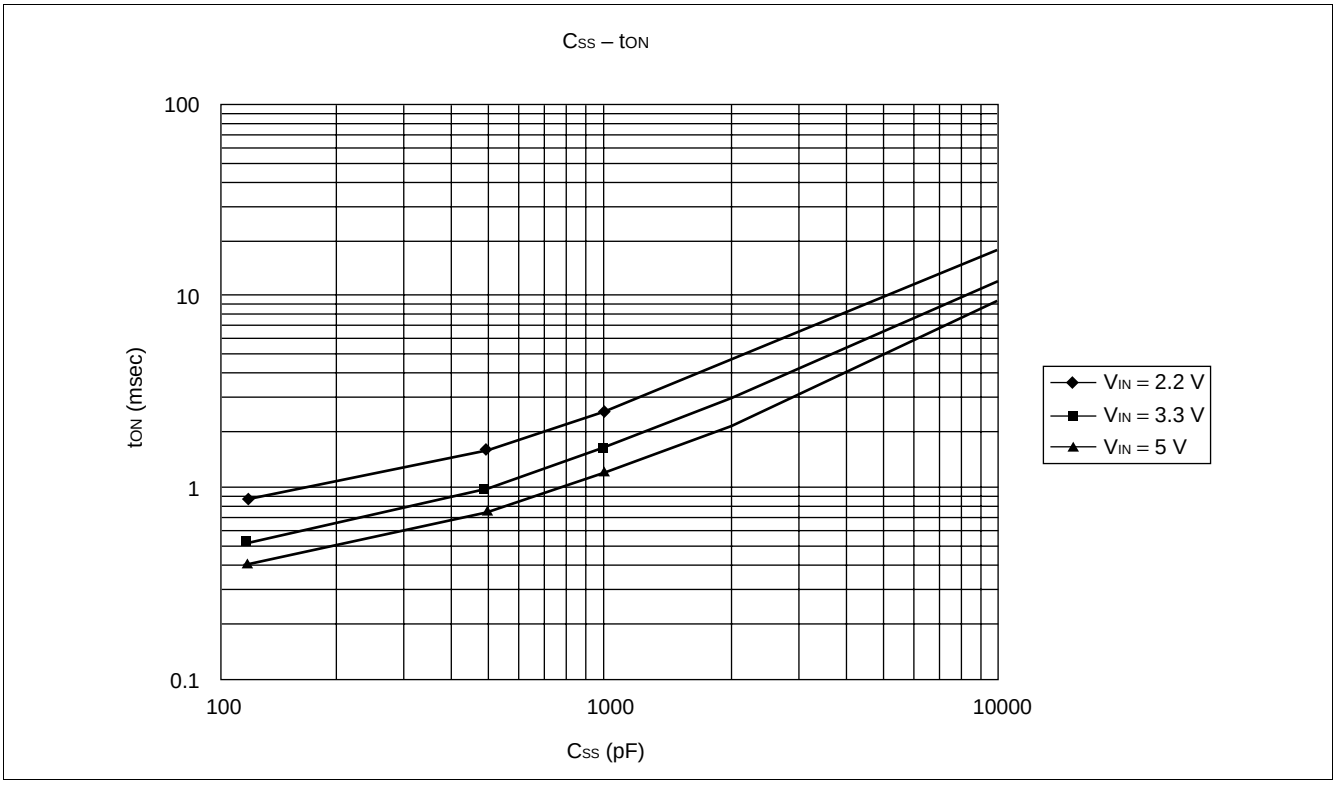


■ TYPICAL CHARACTERISTICS

1. R_{LIM} vs. Limit Current Characteristics

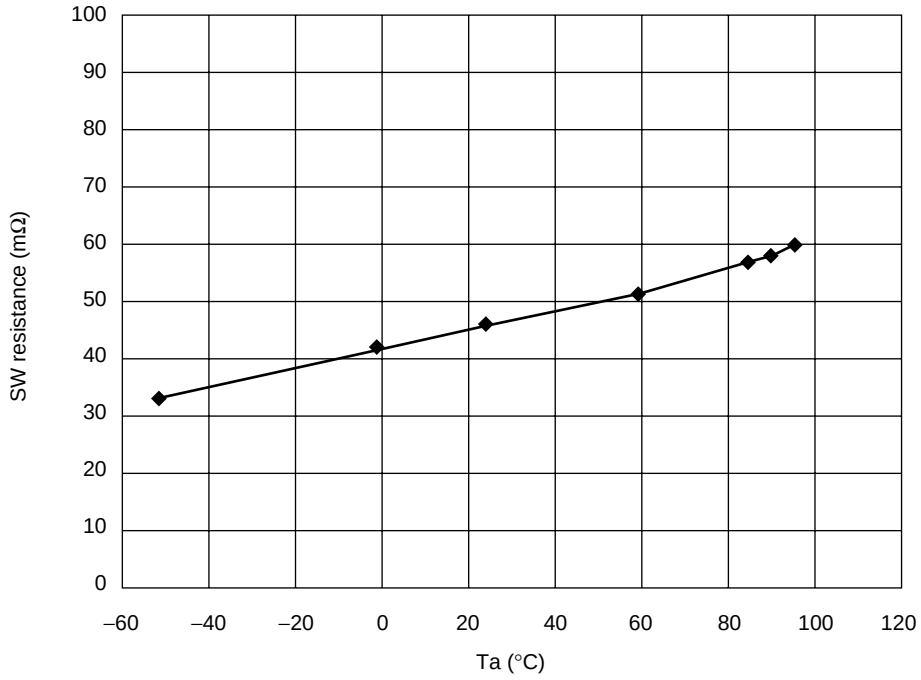


2. C_{SS} vs. T_{ON} (SS) Characteristics

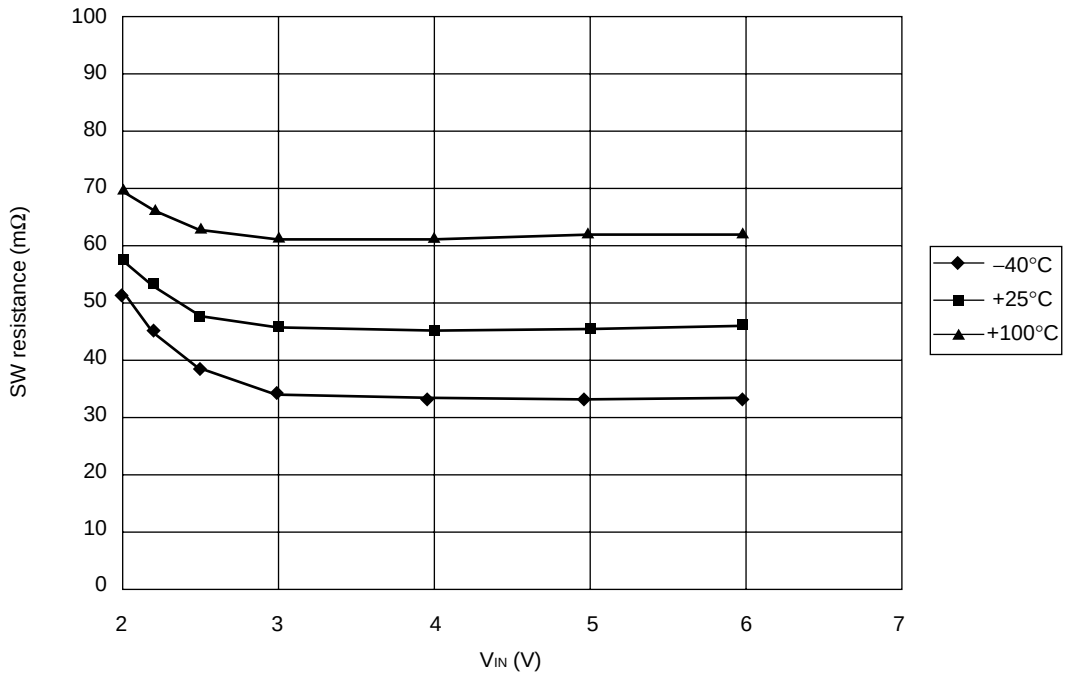


3. SW Resistance Temperature Characteristics

Temperature dependency of SW resistance (V_{IN} = 5 V, I_{OUT} = 2 A, Ta: Ambient temperature)



V_{IN} voltage dependency of SW resistance (I_{OUT} = 2 A, Ta = Ð40, +25, +100°C)



■ FUNCTIONAL DESCRIPTION

Current Limit Setting

The MB3841 provides highly accurate switching current setting, in the range 100 mA to 2 A ±20% (with limit setting current at 2 A) by placing resistance between the CURRENT and GND pins.

Because the setting is dependent on the V_{IN} voltage, it is important that the appropriate resistance be connected to the V_{IN} pin.

The following approximation formula (1) may be used to calculate the limit setting when V_{IN} = 5V.

For details, see “R_{LIM} vs. Limit Current Characteristics” on p. 9.

$$I_{SW} = \frac{7450}{(R_{LIM}[\Omega])^{1.1}} \text{ [A]} \quad \cdots\cdots (1)$$

When the switch limit level is exceeded, the switch turns off and then latch is set to protect the device.

At the same time the O.C output signal goes to “L” level to notify external systems.

When a “L” level signal is applied to the CONTROL switch, the latch is released, so that normal operation is resumed at the next “H” level signal to the CONTROL switch.

Thermal Shutdown

The MB3841 has a thermal shutdown function which turns the switch off and sets the latch to protect the device when junction temperature exceeds 125°C.

At the same time the O.C output signal goes to “L” level to notify external systems.

When a “L” level signal is applied to the CONTROL switch, the latch is released,so that normal operation is resumed at the next “H” level signal to the CONTROL switch.

Slow Start

The on/off switching time of the MB3841 can be delayed by applying capacitance between the SS and GND pins. Controlling the on time can soften surge current to the load side capacitance when power is turned on. (t_{ON}, t_{off} are measured at 90% of V_{OUT}.)

The following approximation formula (2) may be used to set on time when V_{IN} = 5 V.

For details, see “Css vs. t_{ON} (SS) Characteristics” on p. 9.

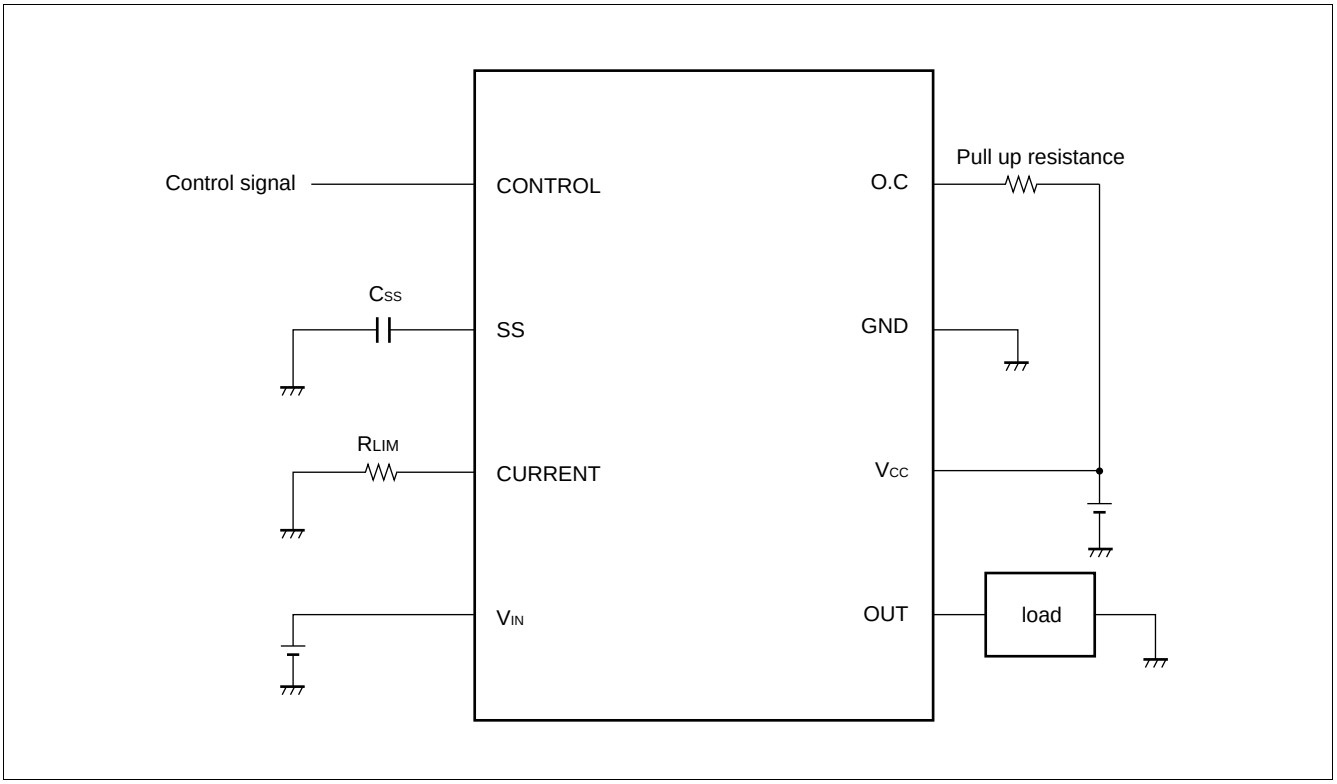
$$t_{ON} = 0.87 \times 10^{-3} \times C_{SS}[pF] + 0.3 \text{ [msec]} \quad \cdots\cdots (2)$$

DISCHARGE

The MB3841 has a DISCHARGE pin function that immediately discharges electric charge on the load side when the switch is turned off.

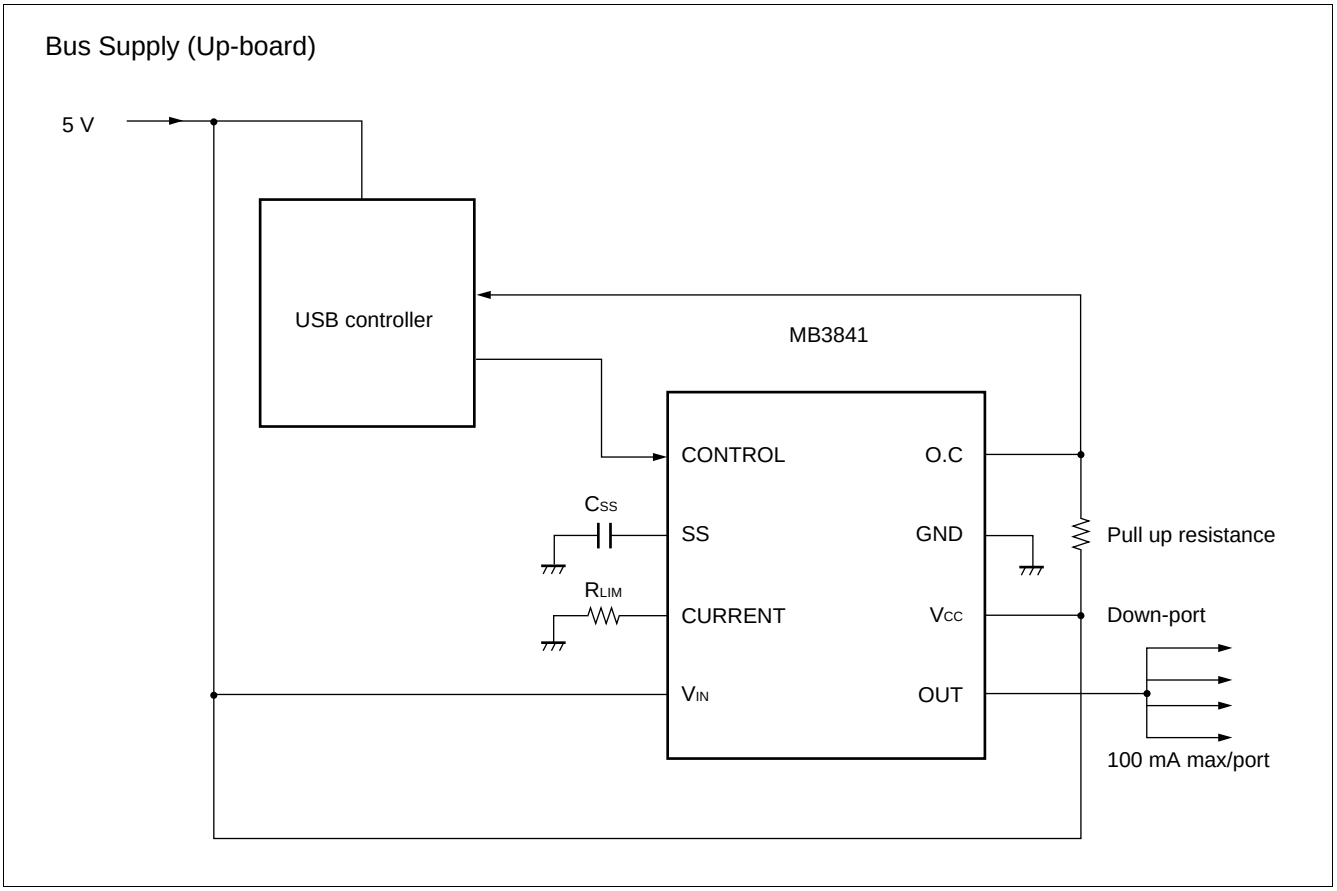
MB3841

■ TYPICAL APPLICATION



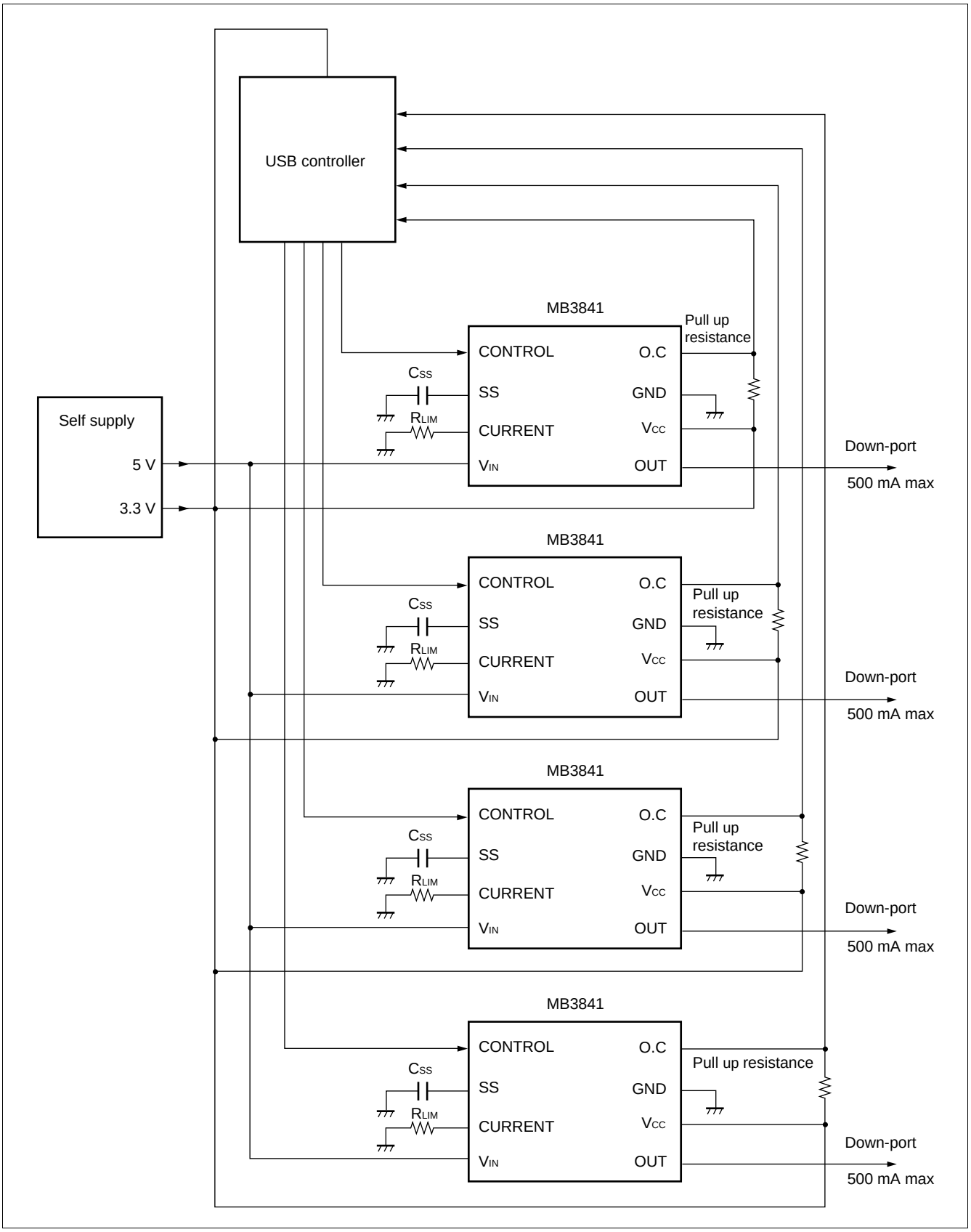
■ SAMPLE APPLICATIONS

(1) Bus Supplied Hub (GANG Mode Connection)



MB3841

(2) Self Supplied Hub (NON-GANG Mode Connection)



■ USAGE PRECAUTION

1. Never use settings exceeding maximum rated conditions.

Exceeding maximum rated conditions may cause permanent damage to the LSI.

Also, it is recommended that recommended operating conditions be observed in normal use. Exceeding recommended operating conditions may adversely affect LSI reliability.

2. Use this device within recommended operating conditions.

Recommended operating conditions are values within which normal LSI operation is warranted.

Standard electrical characteristics are warranted within the range of recommended operating conditions and within the listed conditions for each parameter.

3. Printed circuit board ground lines should be set up with consideration for common impedance.

4. Take appropriate static electricity measures.

- Containers for semiconductor materials should have anti-static protection or be made of conductive material.
- After mounting, printed circuit boards should be stored and shipped in conductive bags or containers.
- Work platforms, tools, and instruments should be properly grounded.
- Working personnel should be grounded with resistance of 250 kΩ to 1 mΩ between body and ground.

5. Do not apply negative voltages.

The use of negative voltages below –0.3 V may create parasitic transistors on LSI lines, which can cause abnormal operation.

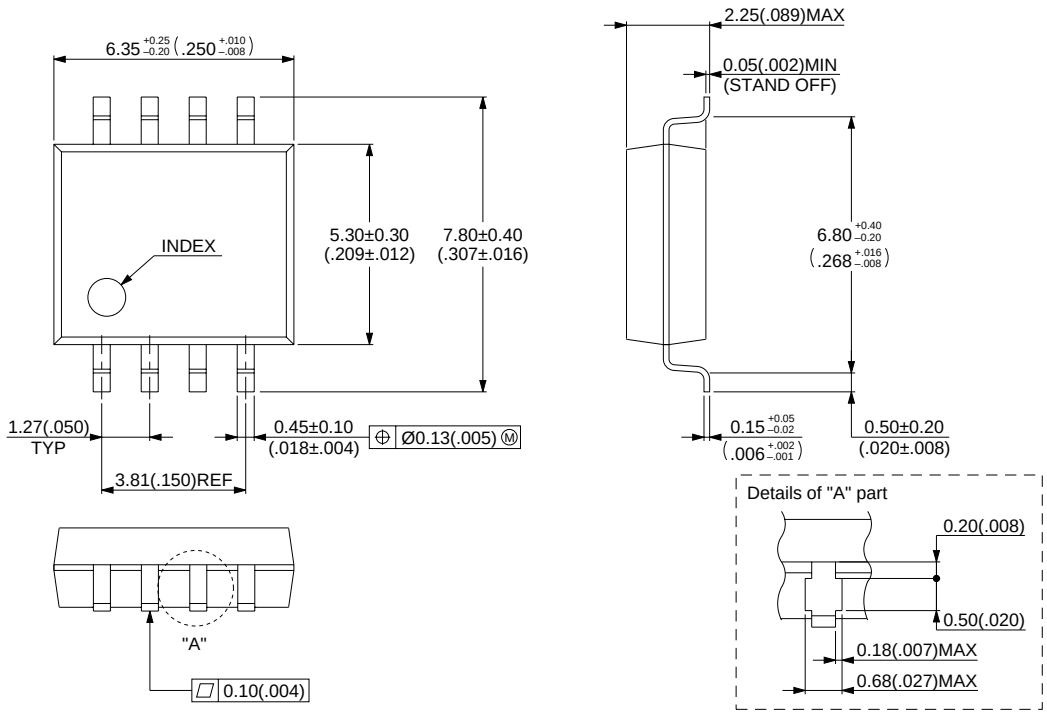
■ ORDERING INFORMATION

Part number	Package	Remarks
MB3841 PF-G-BND	8-pin Plastic SOP (FPT-8P-M01)	

MB3841

■ PACKAGE DIMENSION

8-pin Plastic SOP
(FPT-8P-M01)



Dimensions in mm (inches)

FUJITSU LIMITED

For further information please contact:

Japan
FUJITSU LIMITED
Corporate Global Business Support Division
Electronic Devices
KAWASAKI PLANT, 4-1-1, Kamikodanaka
Nakahara-ku, Kawasaki-shi
Kanagawa 211-8588, Japan
Tel: 81(44) 754-3763
Fax: 81(44) 754-3329

http://www.fujitsu.co.jp/

North and South America
FUJITSU MICROELECTRONICS, INC.
Semiconductor Division
3545 North First Street
San Jose, CA 95134-1804, USA
Tel: (408) 922-9000
Fax: (408) 922-9179

Customer Response Center
Mon. - Fri.: 7 am - 5 pm (PST)
Tel: (800) 866-8608
Fax: (408) 922-9179

http://www.fujitsumicro.com/

Europe
FUJITSU MIKROELEKTRONIK GmbH
Am Siebenstein 6-10
D-63303 Dreieich-Buchschlag
Germany
Tel: (06103) 690-0
Fax: (06103) 690-122

http://www.fujitsu-ede.com/

Asia Pacific
FUJITSU MICROELECTRONICS ASIA PTE LTD
#05-08, 151 Lorong Chuan
New Tech Park
Singapore 556741
Tel: (65) 281-0770
Fax: (65) 281-0220

http://www.fmap.com.sg/

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