
RICOH

USB HIGH-SIDE POWER SWITCH

R5523N SERIES

DESCRIPTION

The R5523N is CMOS-based high-side MOSFET switch IC for Universal Serial Bus (USB) applications. Low ON Resistance (Typ. 130m Ω) and low supply current (Typ. 20 μ A at active mode) are realized in this IC. An over-current limit circuit, a thermal shutdown circuit, and an under voltage lockout circuit are built-in as protection circuits. Further, a delay circuit for flag signal after detecting over-current, is embedded to prevent miss-operation of error flag because of inrush current. The R5523N is ideal for applications of protection for USB power supply. Since the package is small SOT23-5, high density mounting on board is possible.

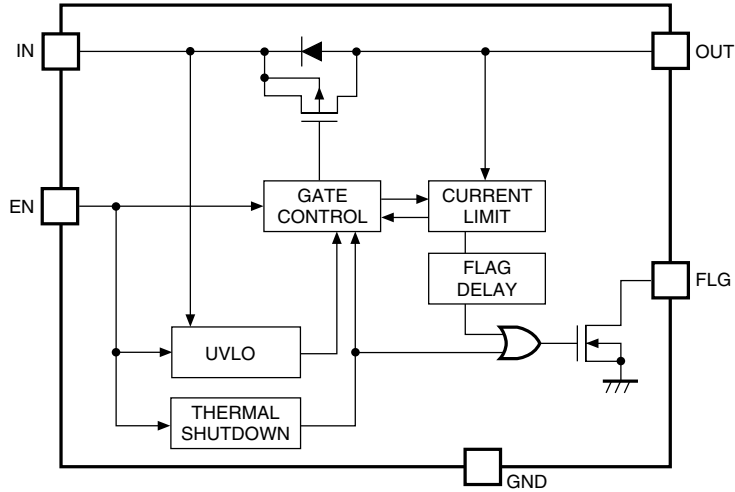
FEATURES

- Built-in 130 m Ω (Typ.) P-channel MOSFET Switch
- Low Supply Current Typ. 20 μ A (at Active Mode)
- Output Current Min. 500mA/ Min. 250mA 2 types are available.
- Flag Delay Time Typ. 10ms.
- Over- Current Limit / Short Circuit Protection
- Under Voltage Lockout
- Thermal Shutdown Protection
- Soft-start Function
- SOT23-5 pin Package

APPLICATIONS

- USB Peripherals
- Notebook PCs

BLOCK DIAGRAM



SELECTION GUIDE

In the R5523N Series, output current and the logic of the enable pin can be designated.

Part Number is designated as follows:

R5523N~~xxxx~~-TR ← Part Number

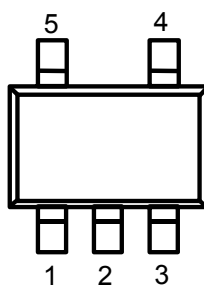
↑↑↑

a b c

Code	Description
a	Designation of the output current. 001: 500mA 002: 250mA (Under development)
b	Designation of the logic of the enable pin. A: active with "L" B: active with "H"
c	Designation of the taping type. TR (Refer to the taping specifications.)

PIN CONFIGURATION

SOT23-5



ABSOLUTE MAXIMUM RATINGS

T_{opt}=25°C

Symbol	Item	Ratings	Unit
V _{IN}	Input Voltage	6.5	V
V _{EN}	Enable Pin Input Voltage	-0.3 ~ V _{IN} +0.3	V
V _{FLG}	Flag Voltage	-0.3 ~ 6.5	V
I _{FLG}	Flag Current	14	mA
V _{OUT}	Output Voltage	-0.3 ~ V _{IN} +0.3	V
I _{OUT}	Output Current	Internal Limited	
P _D	Power Dissipation	Internal Limited	
T _{opt}	Operating Temperature	-40 ~ +85	°C
T _{stg}	Storage Temperature	-55 ~ +125	°C

ABSOLUTE MAXIMUM RATINGS

Absolute Maximum ratings are threshold limit values that must not be exceeded ever for an instant under any conditions. Moreover, such values for any two items must not be reached simultaneously. Operation above these absolute maximum ratings may cause degradation or permanent damage to the device. These are stress ratings only and do not necessarily imply functional operation below these limits.

PIN DESCRIPTION

Pin No.	Symbol	description
1	EN	Enable Pin
2	GND	Ground Pin
3	FLG	FLG pin (Open Drain Output)
4	V _{IN}	Power Supply Pin
5	V _{OUT}	Output pin

ELECTRICAL CHARACTERISTICS

• R5523N001A/B

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V _{IN}	Input Voltage		2.2		5.5	V
I _{DD1}	Supply Current 1	*Note1 V _{OUT} = open (Note1)		20	45	μA
I _{DD2}	Supply Current 2	*Note2 OUT = open, (Note2)		0.1	1.0	μA
R _{ON}	Switch On Resistance	V _{IN} = 5V, I _{OUT} =500mA		130	180	mΩ
t _{ON}	Output Turn-on Delay	V _{IN} = 5V, R _L =60Ω		400		μs
t _{OFF}	Output Turn-off Delay	V _{IN} = 5V, R _L =60Ω		5		μs
V _{UVLO}	UVLO Threshold	V _{IN} = increasing	1.6	1.9		V
V _{HYS}	UVLO Hysteresis Range	V _{IN} = decreasing		0.1		V
I _{TH}	Current Limit Threshold			1.0	1.5	A
I _{LIM}	Short Current Limit	V _{OUT} =0V	0.50	0.75	1.30	A
t _{FD}	Over Current Flag Delay	From Over Current to FLG = "L"	5	10	20	ms
T _{TS}	Thermal Shutdown Temperature Threshold	T _j =increasing		135		°C
		T _j =decreasing		120		
I _{EN}	Enable Pin Input Current			0.01	1.00	μA
V _{EN1}	Enable Pin Input Voltage 1	V _{EN} = increasing	2.0			V
V _{EN2}	Enable Pin Input Voltage 2	V _{EN} = decreasing			0.8	V
I _{LO}	Output Leakage Current			0.1	1.0	μA
V _{LF}	Flag "L" Output Voltage	I _{SINK} = 1mA			0.4	V
I _{FOF}	Flag Off Current	V _{FLAG} = 5.5V		0.01	1.00	μA

• R5523N002A/B

T_{opt}=25°C

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V _{IN}	Input Voltage		2.2		5.5	V
I _{DD1}	Supply Current 1	*Note1 V _{OUT} = open (Note1)		20	45	μA
I _{DD2}	Supply Current 2	*Note2 O _{UT} = open, (Note2)		0.1	1.0	μA
R _{ON}	Switch On Resistance	V _{IN} = 5V, I _{OUT} =500mA		130	180	mΩ
t _{ON}	Output Turn-on Delay	R _L =60Ω		400		μs
V _{UVLO}	UVLO Threshold	V _{IN} = increasing	1.6	1.9		V
		V _{IN} = decreasing		1.8		V
I _{TH}	Current Limit Threshold			0.50	0.75	A
I _{LIM}	Short Current Limit	V _{OUT} =0V	0.25	0.35	0.50	A
t _{FD}	Over Current Flag Delay	From Over Current to FLG = "L"	5	10	20	ms
T _{TS}	Thermal Shutdown Temperature Threshold	T _j =increasing		135		°C
		T _j =decreasing		120		
I _{EN}	Enable Pin Input Current			0.01	1.00	μA
V _{EN1}	Enable Pin Input Voltage 1	V _{EN} = increasing	2.0			V
V _{EN2}	Enable Pin Input Voltage 2	V _{EN} = decreasing			0.8	V
I _{LO}	Output Leakage Current			0.1	1.0	μA
V _{LF}	Flag "L" Output Voltage	I _{SINK} = 1mA			0.4	V
I _{FOF}	Flag Off Current	V _{FLAG} = 5.5V		0.01	1.00	μA

(Note1) EN=L (R5523NXXXXA), EN=H (R5523NXXXXB)

(Note2) EN=H (R5523NXXXXA), EN=L (R5523NXXXXB)

OPERATION

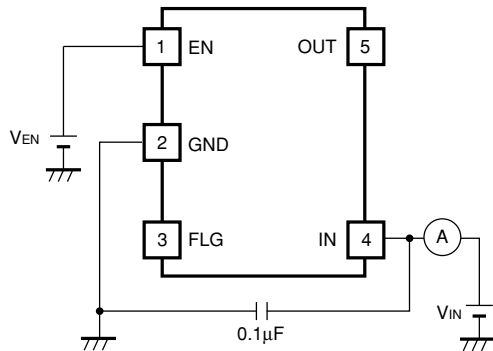
This explanation is based on the typical application.

Over-current limit Function

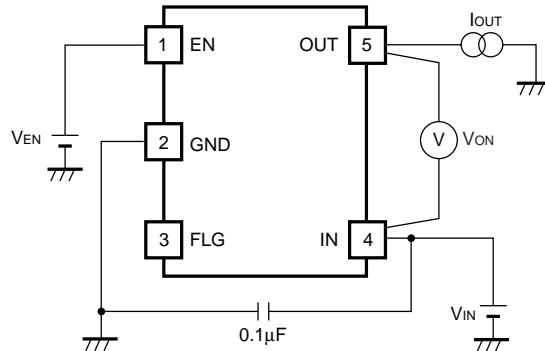
In case that OUT pin and GND is short, if over-current would continue, the temperature of the IC would increase drastically. If the temperature of the IC is equal or more than 135°C (Typ.), the switch transistor turns off because of thermal shutdown protection. In other words, when the temperature of the IC becomes equal or more than 135°C (Typ.), both the over-current limit circuit and thermal shutdown circuit work for the protection of the IC.

TEST CIRCUITS

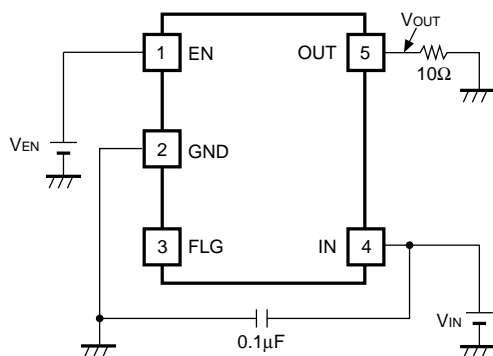
(1) Supply Current Test Circuit



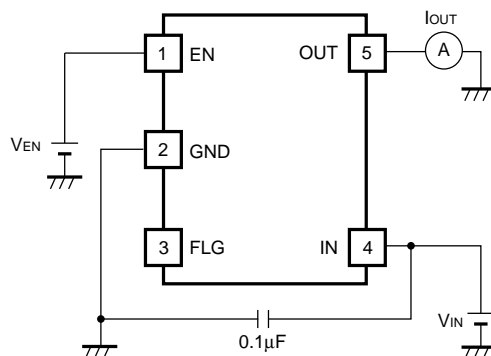
(2) Switch On Resistance Test Circuit



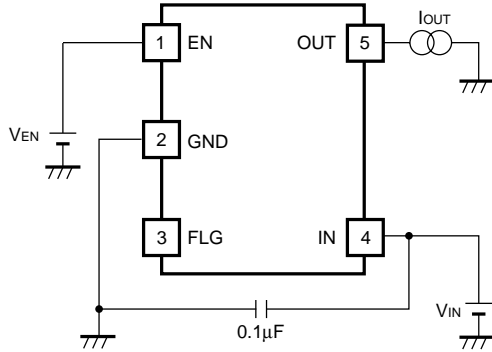
(3) Output On Time Test Circuit



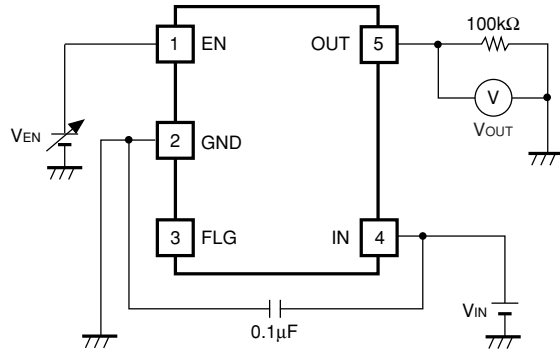
(4) Over-current Limit Test Circuit



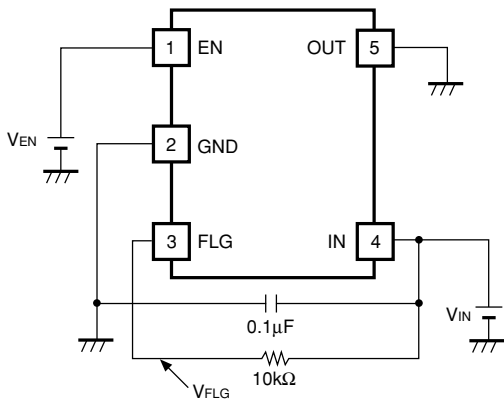
(5) Over-current Threshold Test Circuit



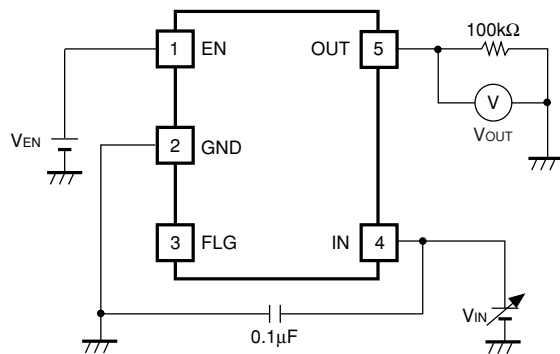
(6) Enable Input Voltage



(7) Flag Output Delay Time Test

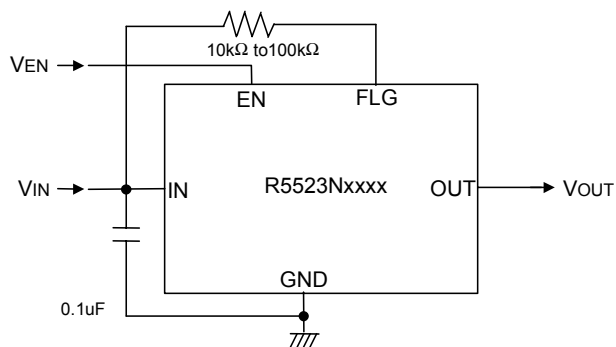


(8) UVLO Threshold Test



TYPICAL APPLICATION AND TECHNICAL NOTES

- R5523N00XX

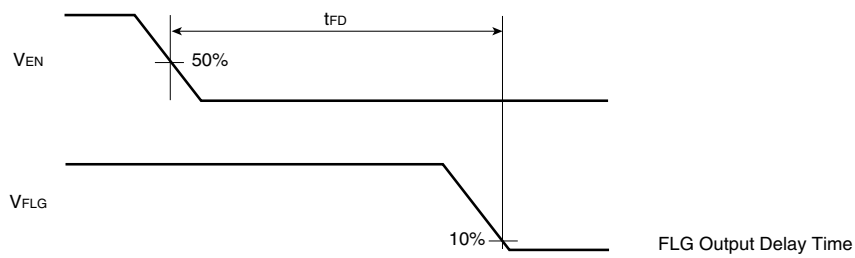
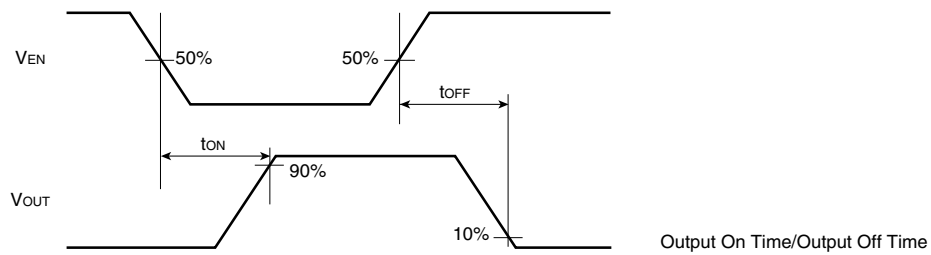


- Put a capacitance range from 0.1µF to 1µF bypass capacitor between IN pin and GND pin of the IC.

Without a bypass capacitor, in case of output short, because of the high side inductance of IN pin, the ringing may be generated and it might be a cause of an unstable operation.

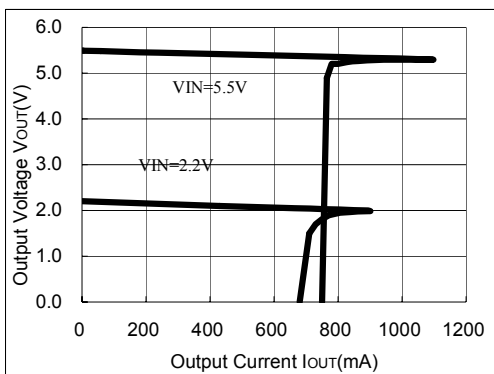
- Recommended pull-up resistance value range of flag pin is from 10kΩ to 100kΩ.

TIMING CHART

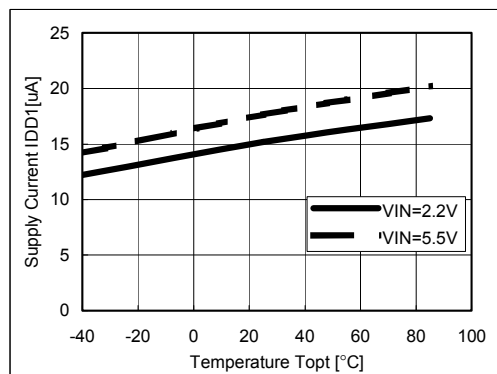


TYPICAL CHARACTERISTICS

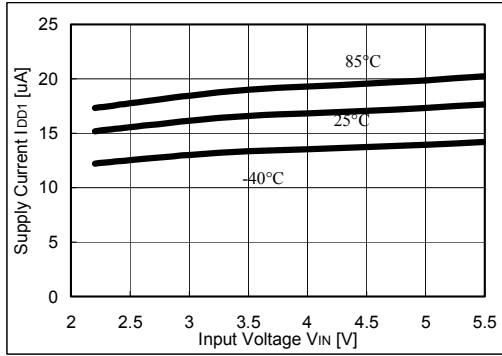
1) Output Voltage vs. Output Current



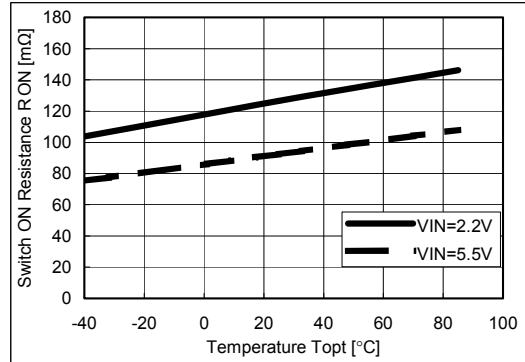
2) Supply Current vs. Temperature



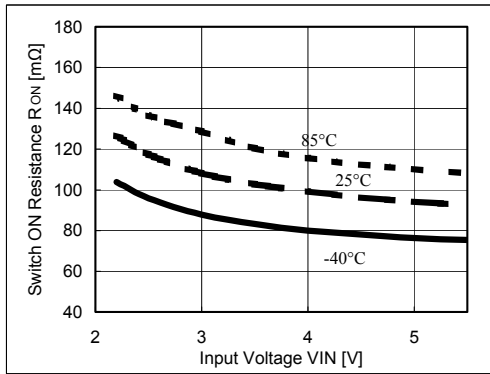
3) Supply Current vs. Input Voltage



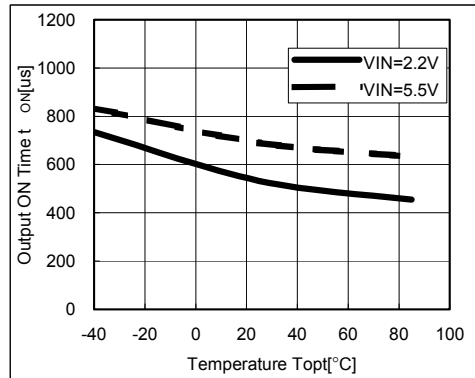
4) On Resistance vs. Temperature



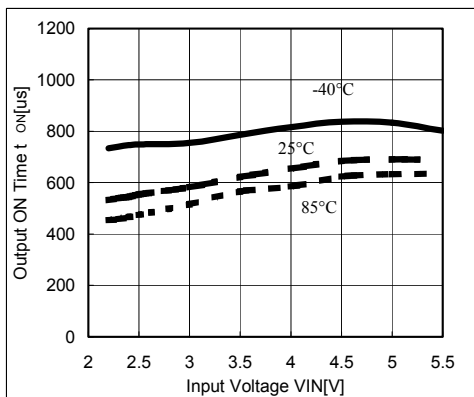
5) On Resistance vs. Input Voltage



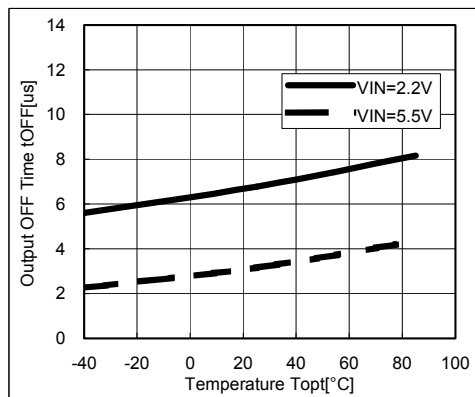
6) Output On Time vs. Temperature



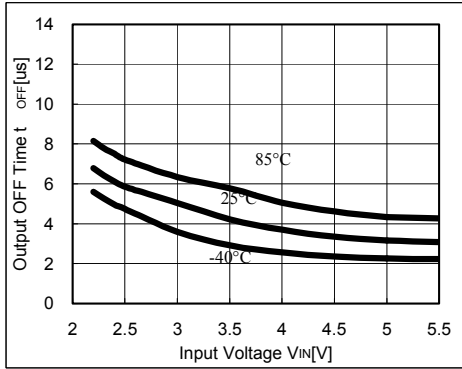
7) Output On Time vs. Input Voltage



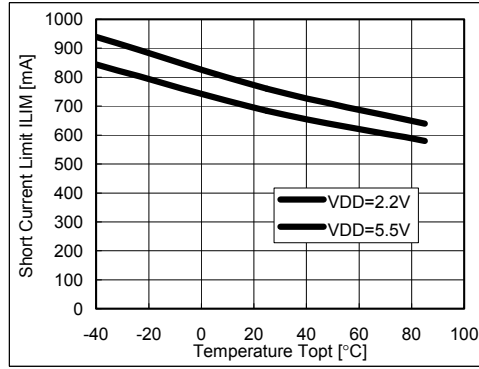
8) Output Off Time vs. Temperature



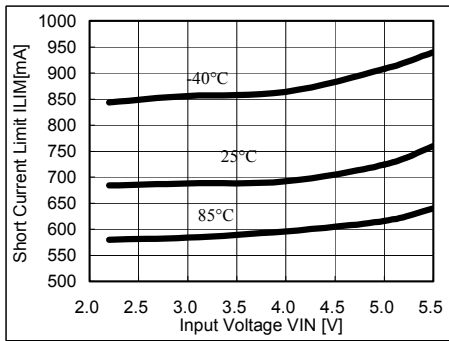
9) Output Off Time vs. Input Voltage



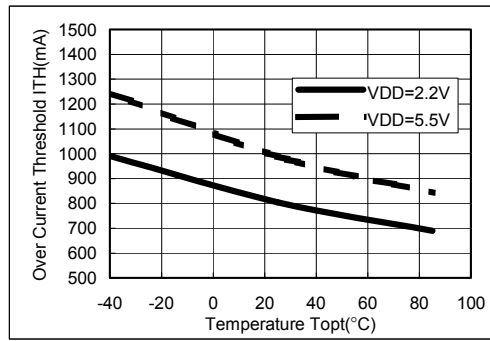
10) Short-current Limit vs. Temperature



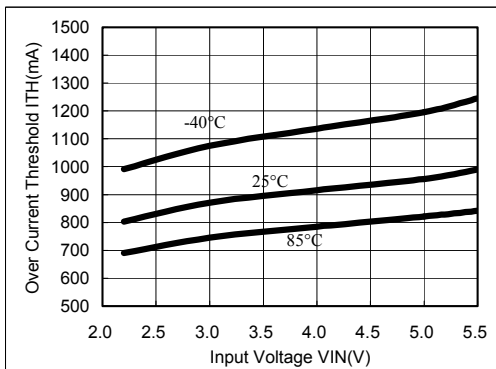
11) Short Current Limit vs. Input Voltage



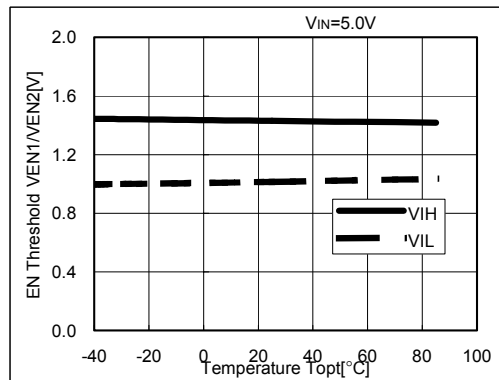
12) Over Current Threshold vs. Temperature



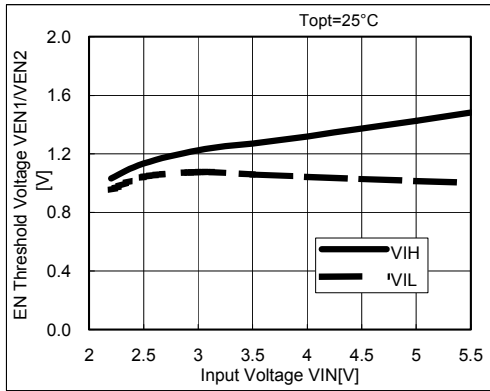
13) Over Current Threshold vs. Input Voltage



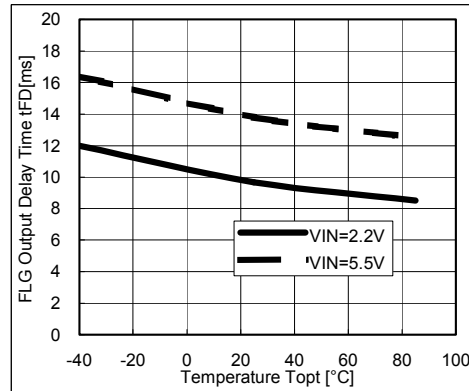
14) Enable Input Voltage vs. Temperature



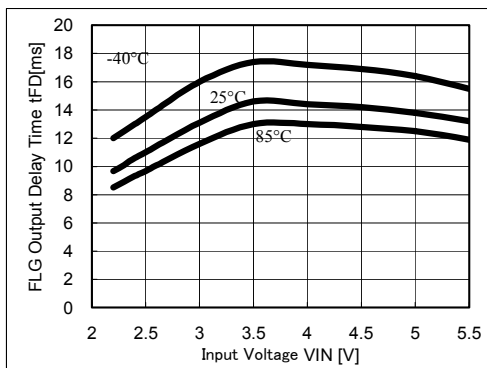
15) Enable Input Voltage vs. VIN Input Voltage



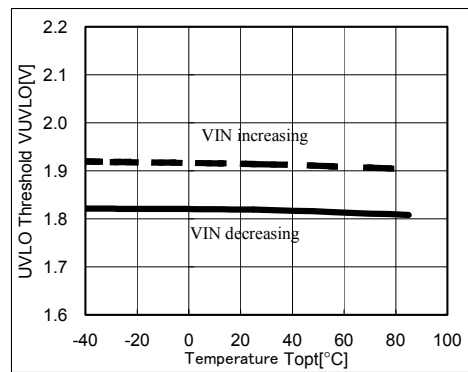
16) Flag Output Delay Time vs. Temperature



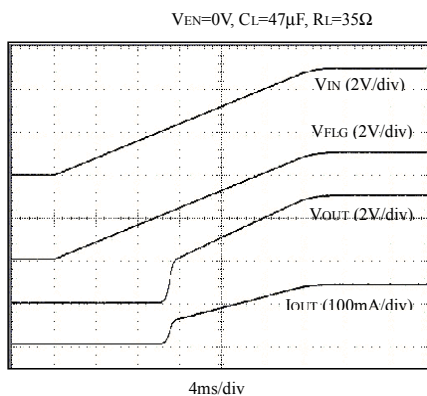
17) Flag Output Delay Time vs. VIN Input Voltage



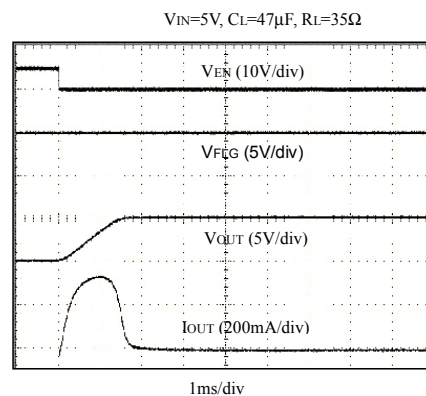
18) UVLO Threshold vs. Temperature



19) UVLO Characteristic at Vin increasing

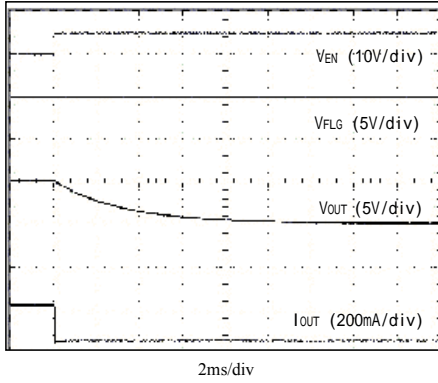


20) Turn on Response



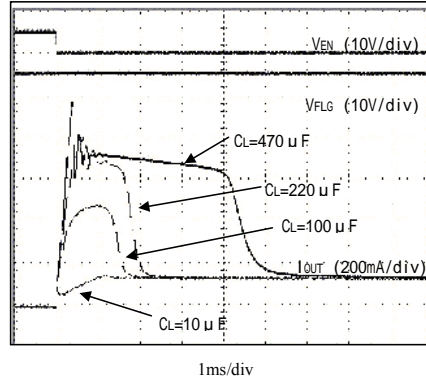
21) Turn off Response

$V_{IN}=5V, C_L=47\mu F, R_L=35\Omega$



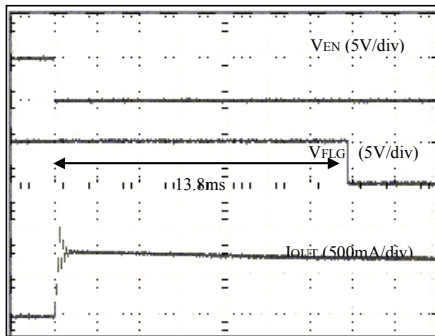
22) Inrush current

$V_{IN}=5V, R_L=35\Omega$



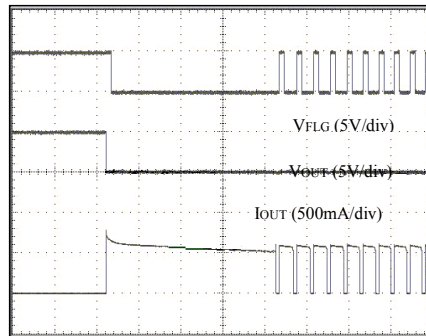
23) Current Limit Transient Response
(Case: Enable to Short)

$V_{IN}=5V$
2ms/div



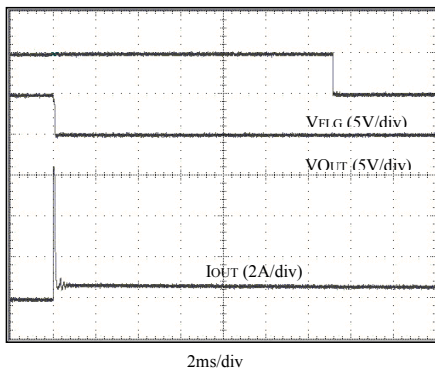
24) Thermal Shutdown Operation

$V_{IN}=5V, C_L=47\mu F$
100ms/div



25) Current Limit Transient Response
(Case: Output short during enable)

$V_{IN}=5V, C_L=47\mu F$



26) Zoomed in 25)

$V_{IN}=5V, C_L=47\mu F$

