Pch Load Switch IC with Current Sense and Voltage Sense

NO.EA-292-201202

OUTLINE

The R5550K Series are CMOS-based load switch ICs. Pch Tr. is used to achieve low On resistance (TYP.180mΩ) and low supply current (TYP. 2.6μA at no-load operation). Internally, a single IC consists of a voltage reference unit, an error amplifier, resistors for setting output voltage and a current limit circuit. Output voltage is fixed inside the IC with high accuracy. The R5550K is suitable for monitoring abnormal current which may flow from lithium ion battery (one cell) to power lines connected to each load. If the abnormal current is detected, the switch turns off after a certain period of time (Dead-time).

If overcurrent is detected, switch turns off after dead-time of 10ms. If the output current exceeds the output current limit, the output current limit circuit immediately controls the output current after the short current response time of 4μs. Then, switch turns off after dead-time of 1.33ms.

The R5550K also includes a voltage sense pin which monitors abnormal voltage. If abnormal voltage is detected, switch turns off after dead-time of 10ms.

As protection circuits, the R5550K contains an output current limit circuit, a short-current protection circuit, and an undervoltage lockout (UVLO) circuit.

The R5550K is available in a DFN(PL)1010-4F package which enables the high-density mounting.

FEATURES

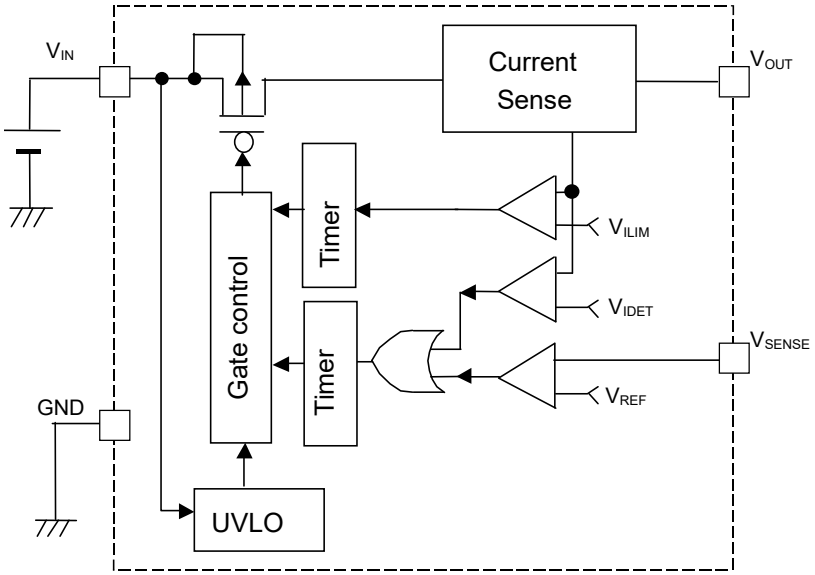
- A single built-in Pch MOSFET
- Input Voltage Range ····· 2.3V to 5.25V
- Supply Current (I_{OUT}=0mA) ·····TYP. 2.6μA
- Switch On Resistance ·····TYP. 180mΩ (V_{IN}=3.3V)
- Output Current ····· MIN. 1000mA
- Package ·····DFN(PL)1010-4F
- Current Limit Threshold ····· MIN. 300mA
- Output Current Limit ····· MIN. 1000mA
- Switching Operation (After turn-off) ····· Automatic Recovery Type

APPLICATIONS

- Load Switch for portable communication equipments

BLOCK DIAGRAMS

R5550K001A



SELECTION GUIDE

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R5550K001A-TR	DFN(PL)1010-4F	10,000 pcs	Yes	Yes

001: Designation of current limit threshold, output current limit and protection delay time

Current Limit Threshold: 300mA

Output Current Limit: 1000mA

Protection Delay Time: Refer to Table 1 below.

Table 1. Protection Delay Time

Setting No.	Delay Time	Protection Delay Time		
		Dead-time [ms]	Off-time [ms]	On-time [ms]
001	Current Limit Threshold/ SENSE Pin Voltage	10	80	2.5
	Output Current Limit	1.33	80	1.33

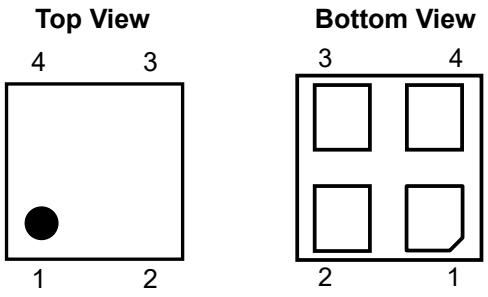
As for Dead-time, OFF-time and ON-time, refer to *Theory of Operation*.

A : Designation of version

Automatic recovery type protection, Voltage SENSE pin

PIN DESCRIPTION

DFN(PL)1010-4F



R5550K001A

Pin No.	Symbol	Description
1	GND	Ground Pin
2	V_{SENSE}	Voltage SENSE Pin
3	V_{IN}	Input Pin
4	V_{OUT}	Output Pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	-0.3 to 6.0	V
V_{SENSE}	SENSE Pin Voltage	-0.3 to 6.0	V
V_{OUT}	Output Voltage	-0.3 to V_{IN} + 0.3	V
I_{OUT}	Output Current	1000	mA
P_D	Power Dissipation (Standard Land Pattern)*1	300	mW
Ta	Operating Temperature Range	-40 to +85	ºC
Tstg	Storage Temperature Range	-55 to +125	ºC

*1 For more information about Power Dissipation and Standard Land Pattern, please refer to *POWER DISSIPATION*.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the lifetime and safety for both device and system using the device in the field. The functional operation at or over these absolute maximum ratings is not assured.

RECOMMENDED OPERATING CONDITIONS (ELECTRICAL CHARACTERISTICS)

All of electronic equipment should be designed that the mounted semiconductor devices operate within the recommended operating conditions. The semiconductor devices cannot operate normally over the recommended operating conditions, even if when they are used over such conditions by momentary electronic noise or surge. And the semiconductor devices may receive serious damage when they continue to operate over the recommended operating conditions.

ELECTRICAL CHARACTERISTICS

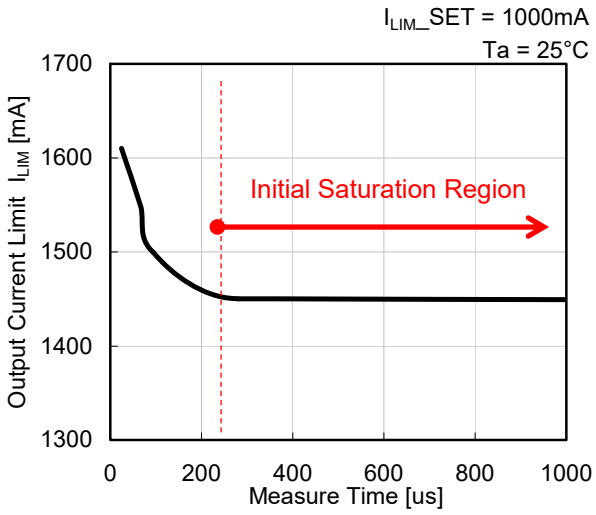
V_{IN}=3.7V, I_{OUT}=1mA, C_{IN}=0.1µF, C_{OUT}=none, unless otherwise noted.
The specifications surrounded by [ ] are guaranteed by Design Engineering at - 40ºC ≤ Ta ≤ 85ºC.

R5550K001A (Ta=25ºC)

Symbol	Item	Conditions	Min.	Typ.	Max.	Unit
V_{IN}	Input Voltage		[2.3]		[5.25]	V
R_{ON}	Switch On Resistance	I_{OUT}=100mA*1, V_{IN}=3.3V		180		mΩ
I_{OUT}	Output Current		[1000]			mA
I_{SS}	Supply Current	I_{OUT}=0mA, V_{SENSE}=2.0V		2.6	15	µA
I_{DET}	Current Limit Threshold*3		[300]	460	[624]	mA
I_{LIM}	Output Current Limit*3	Initial Saturation Region*4	[1130]	1470	[1790]	mA
I_{SC}	Short Current Limit	V_{OUT}=0V		300		mA
V_{DET}	SENSE Pin Detector Threshold	V_{SENSE} falling	x 0.97	0.5	x 1.03	V
V_{HYS}	SENSE Pin Hysteresis	V_{SENSE} rising	0.63	0.9	1.2	V
T_{DET1}	Dead-time 1	$V_{SENSE} \le V_{DET}$ or $I_{DET} \le I_{OUT} < I_{LIM}$	[x 0.72]	10	[x 1.32]	ms
T_{OFF1}	OFF-time 1		[x 0.71]	80	[x 1.34]	ms
T_{ON1}	ON-time 1		[x 0.72]	2.5	[x 1.35]	ms
T_{DET2}	Dead-time 2	V_{OUT}=0V or $I_{OUT} > I_{LIM}$	[x 0.65]	1.33	[x 1.35]	ms
T_{OFF2}	OFF-time 2		[x 0.65]	80	[x 1.35]	ms
T_{ON2}	ON-time 2		[x 0.65]	1.33	[x 1.35]	ms
Tr	Start-up Time	V_{OUT}=10% to 90%, C_{OUT}=0.1µF		12		µs
Trdelay	Start-up Delay Time	"V_{IN}=V_{UVLO}" to "V_{OUT}=10%"		60		µs
T_{SC}	Short Current Response Time*2	V_{OUT}=0V		4		µs
V_{UVLO}	UVLO Release Voltage	V_{IN} rising	[2.0]	2.1	[2.2]	V
V_{HYSUV}	UVLO Hysteresis	V_{IN} falling		0.2		V

All test items listed under *ELECTRICAL CHARACTERISTICS* are done under the pulse load condition (Tj≈Ta=25ºC) except Start-up Time, Start-up Delay Time, Short Current Response Time, Dead-time 2, OFF-time 2 and ON-time 2.
*1 As for R_{ON} when I_{OUT}>100mA, refer to *12) Switch ON Resistance vs. Output Current of TYPICAL CHARACTERISTICS*.
*2 Refer to *36) Short-Protection-Circuit Transient Response* of *TYPICAL CHARACTERISTICS*.
*3 Each set value should be "Max. I_{DET} < Min. I_{LIM}". Note: Do not use with I_{DET}=400mA and I_{LIM}=500mA.
*4 I_{LIM} could be influenced by the measurement time. All products were tested within the initial saturation region as shown in the following page.

R5550KxxxA



Measurement Board Information

- Board Size: 27.5mm x 40.0mm
- IC Mounting Position: Center of the board
- Board Material: Glass Cloth Epoxy Plastic (Single layer)
- Board Thickness: 1.6mm
- Diameter of Through-hole: 1.0mm
- Number of Through-holes: 12

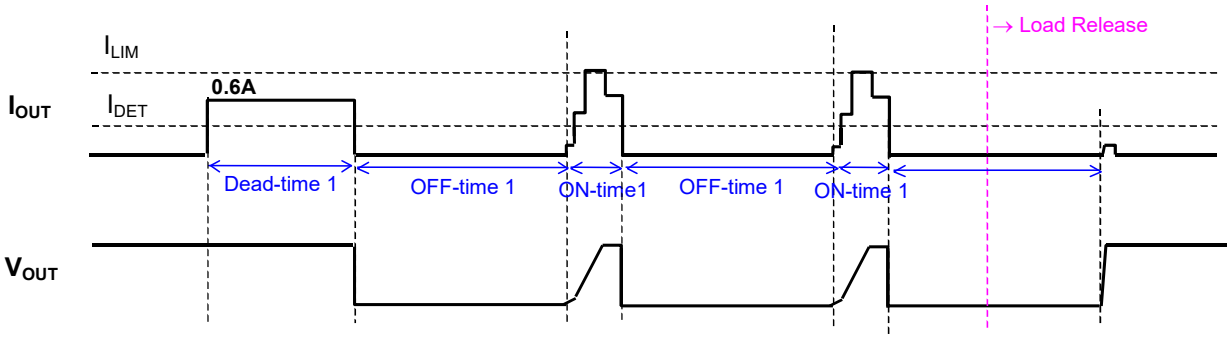
THEORY OF OPERATION

Operation Example: R5550K001A with Automatic Recovery Protection and Voltage SENSE Pin

[1] Operation of Current Limit Detector Threshold (I_{DET})

If I_{OUT} exceeds I_{DET}, Timer 1 starts to operate and the switch turns off after Dead-time 1. After OFF-time 1, the switch automatically turns on. If $I_{OUT} \geq I_{DET}$ continues, the switch turns off again after ON-time 1. Afterwards, the switch repeats intermittent operation. If $I_{OUT} < I_{DET}$, the IC recognizes it as back in normal operation and start to outptut as usual.

Even if $I_{OUT} < I_{DET}$ during OFF-time1, the switch automatically turns on after OFF-time 1.

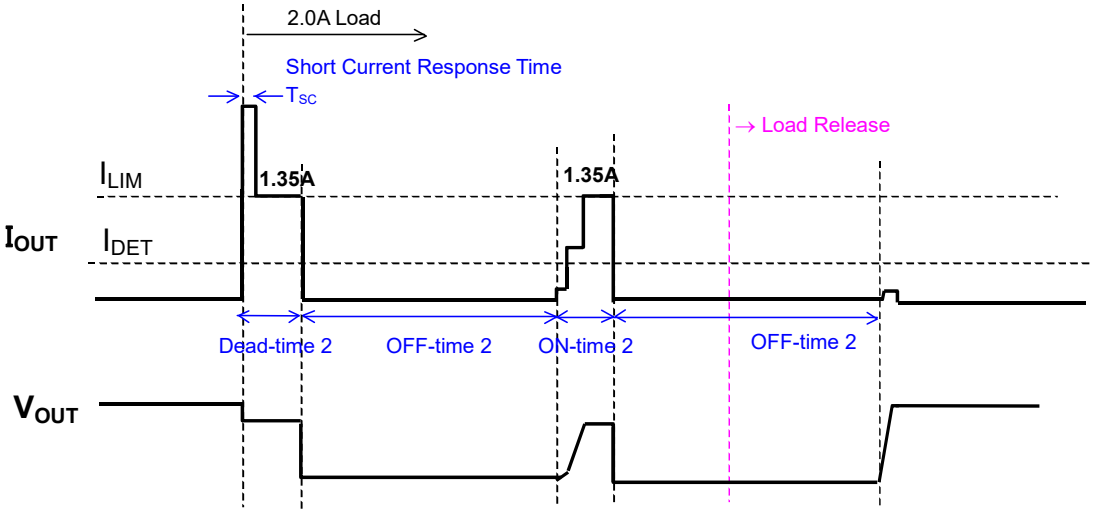


[2] Operation of Output Current Limit (I_{LIM})

If I_{OUT} exceeds I_{LIM} (including output short-circuit), I_{OUT} becomes limited by I_{LIM} or I_{SC}. So, Timer 2 starts to operate and the switch turns off after Dead-time 2.

After OFF-time 2, the switch automatically turns on. If $I_{OUT} \geq I_{LIM}$ or short current condition continues, the switch turns off again after ON-time 2. Afterwards, I_{OUT} the switch repeats intermittent operation. If $I_{OUT} < I_{LIM}$, the IC recognizes it as back in normal operation and start to outptut as usual.

Even if $I_{OUT} < I_{LIM}$ during OFF-time2, the switch automatically turns on after OFF-time 2.

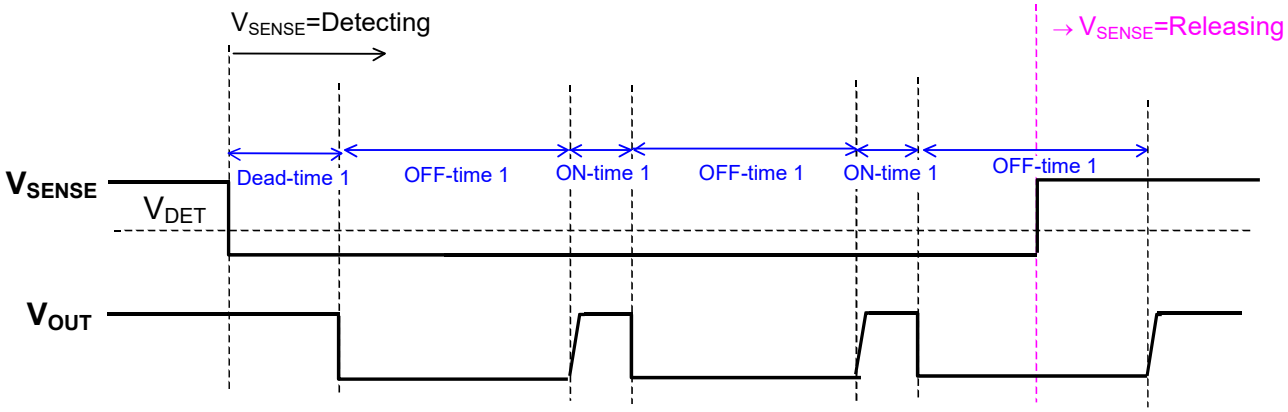


[3] Operation of SENSE Pin Voltage (V_{SENSE})

If V_{SENSE} falls below V_{DET}, Timer 1 starts to operate and the switch turns off after Dead-time 1. After OFF-time 1, the switch automatically turns on. If $V_{SENSE} \leq V_{DET}$ continues, the switch turns off again after ON-time 1. Afterwards, I_{OUT} repeats intermittent operation.

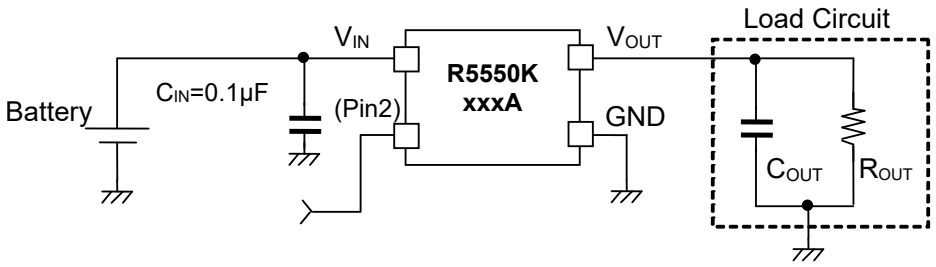
If $V_{SENSE} > (V_{DET}+V_{HYS})$, when the switch is automatically turning on after OFF-time 1, the IC recognizes it as back in normal operation and start to outptut as usual.

Even if $V_{SENSE} > (V_{DET}+V_{HYS})$ during OFF-time 1, the switch automatically turns on after OFF-time 1.



TYPICAL APPLICATIONS AND TECHNICAL NOTES

Typical Application



Technical Notes

The R5550K does not require any bypass capacitor between V_{IN} and GND. However, it is recommended that a 0.1µF or more capacitor be connected between V_{IN} and GND. Especially, if there's any possibility of generating spike noise due to the parasitic element (inductance) of V_{IN}, connect a proper size capacitor between V_{IN} and GND.

POWER DISSIPATION (DFN(PL)1010-4F)

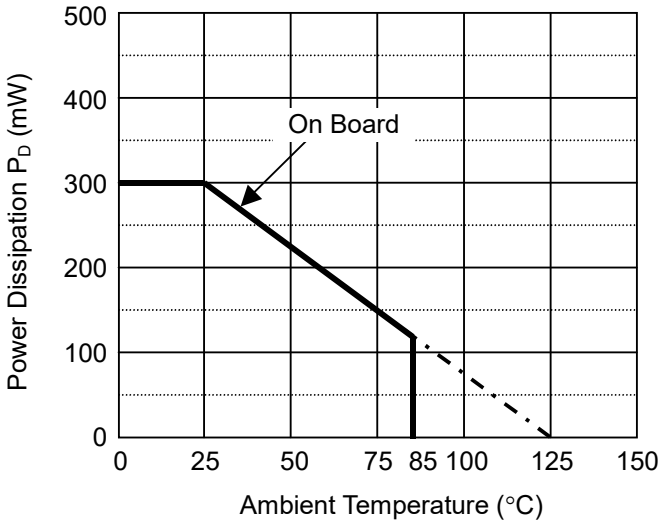
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement conditions below.

Measurement Conditions

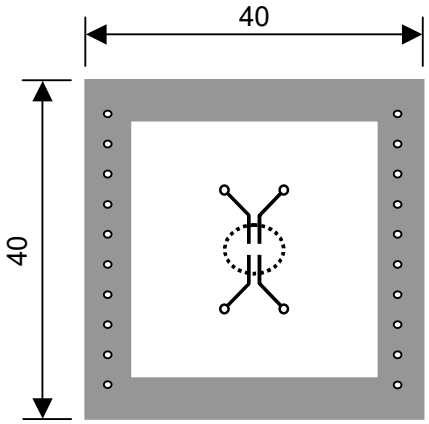
	Standard Land Pattern
Environment	Mounting on Board (Wind Velocity=0m/s)
Board Material	Glass Cloth Epoxy Plastic (Double-sided)
Board Dimensions	40mm x 40mm x 1.6mm
Copper Ratio	Topside: Approx. 50%, Backside: Approx. 50%
Through-holes	ϕ 0.54mm x 24pcs

Measurement Result: (Ta=25°C, Tjmax=125°C)

	Standard Land Pattern
Power Dissipation	300mW
Thermal Resistance	θja = (125-25°C)/0.3W = 330°C/W
	θjc = 48 °C/W



Power Dissipation



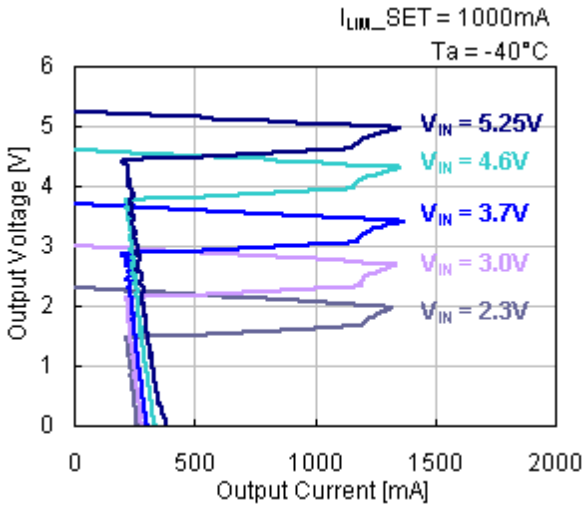
Measurement Board Pattern

IC Mount Area (Unit : mm)

TYPICAL CHARACTERISTICS

1) Output Voltage vs. Output Current

R5550K001A



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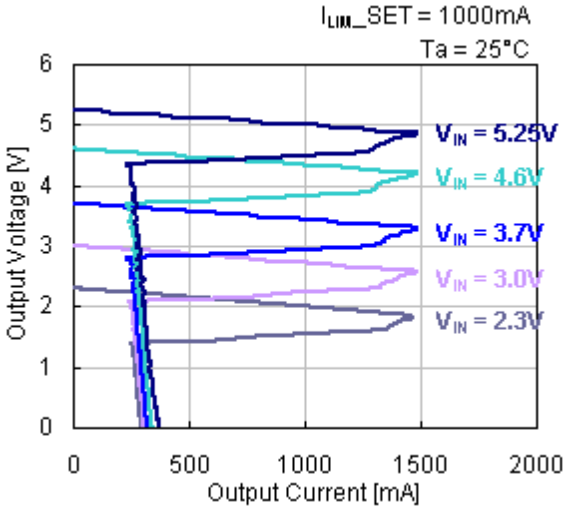

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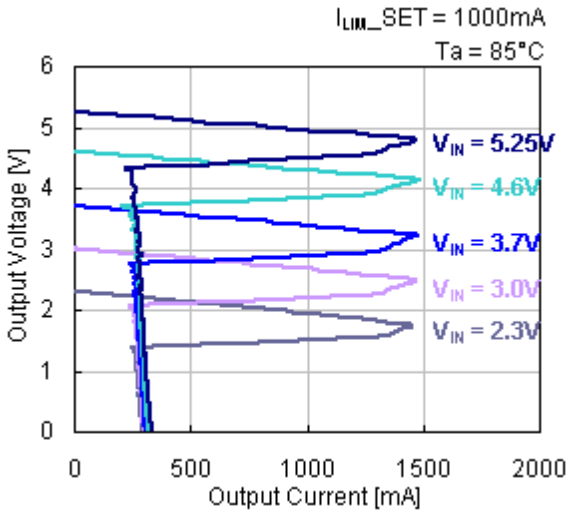
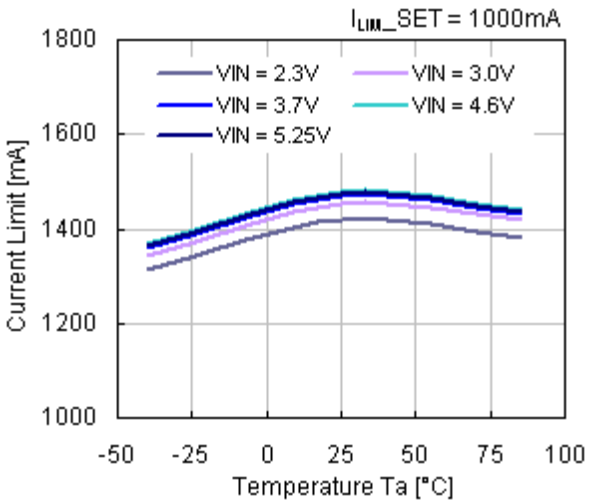


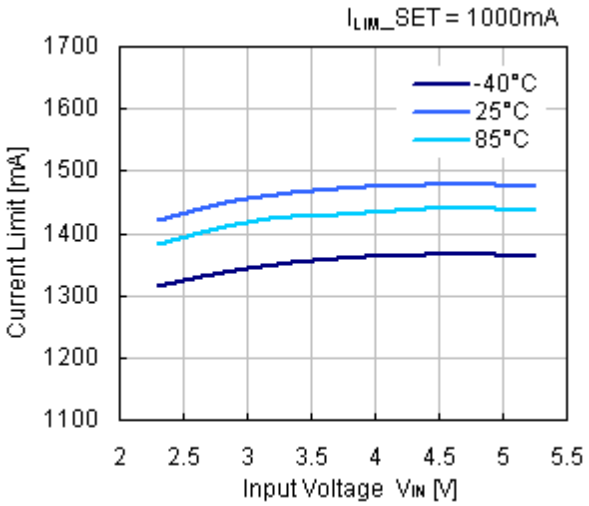
2) Current Limit vs. Temperature

R5550K001A



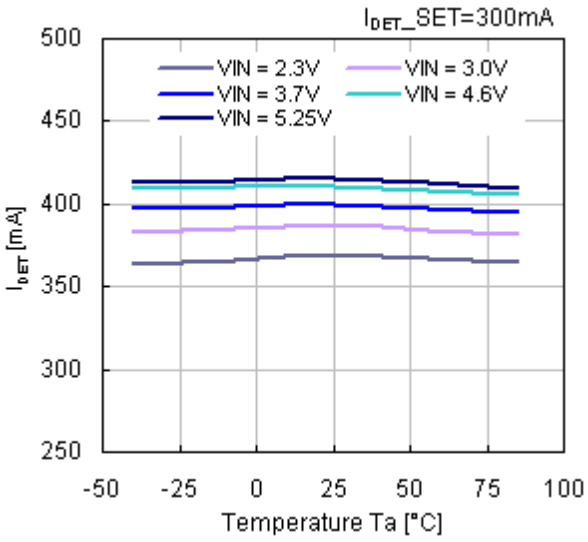
3) Current Limit vs. Input Voltage

R5550K001A



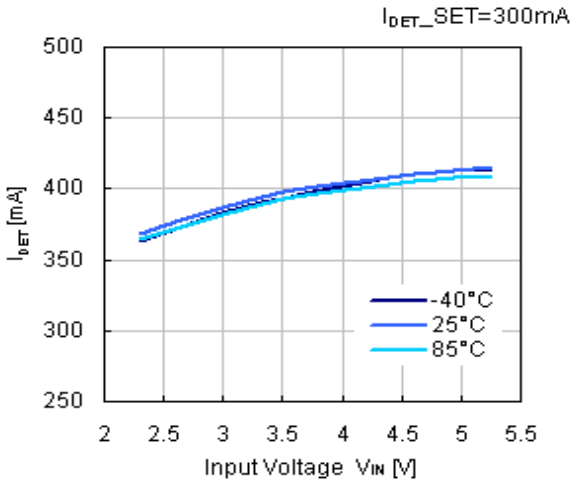
4) Output Current Detector Threshold vs. Temperature

R5550K001A



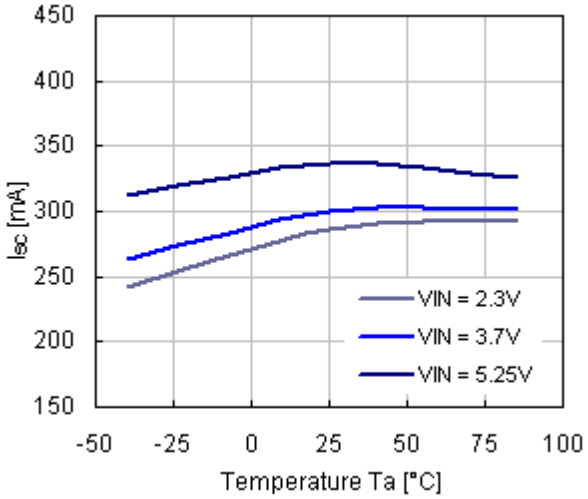
5) Output Current Detector Threshold vs. Input Voltage

R5550K001A



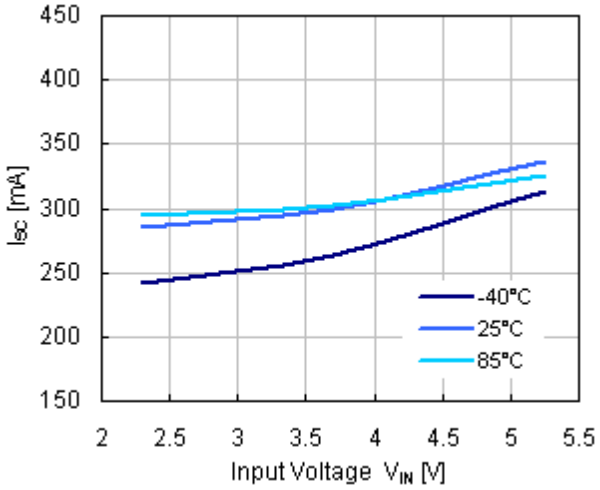
6) Short Current Limit vs. Temperature

R5550K001A



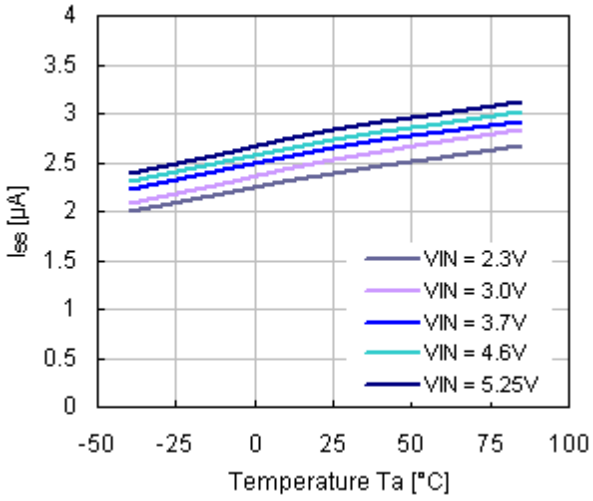
7) Short Current Limit vs. Input Voltage

R5550K001A



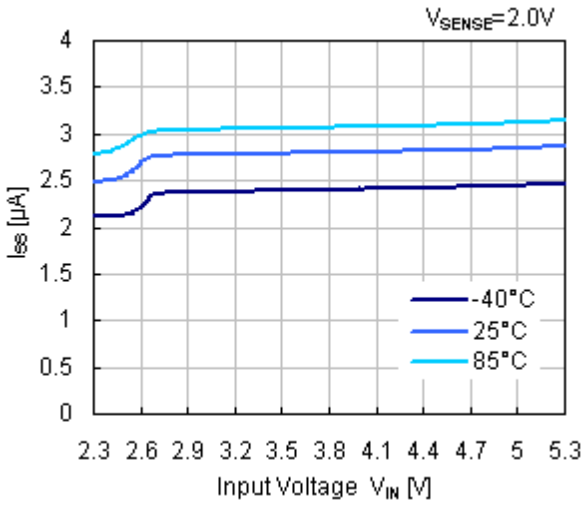
8) Supply Current Limit vs. Input Voltage

R5550K001A



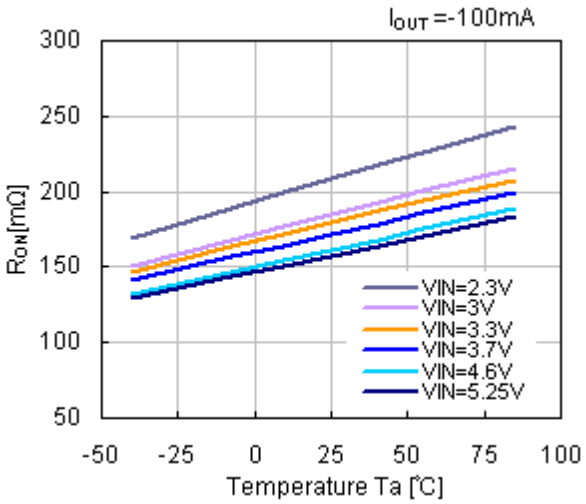
9) Supply Current vs. Input Voltage

R5550K001A



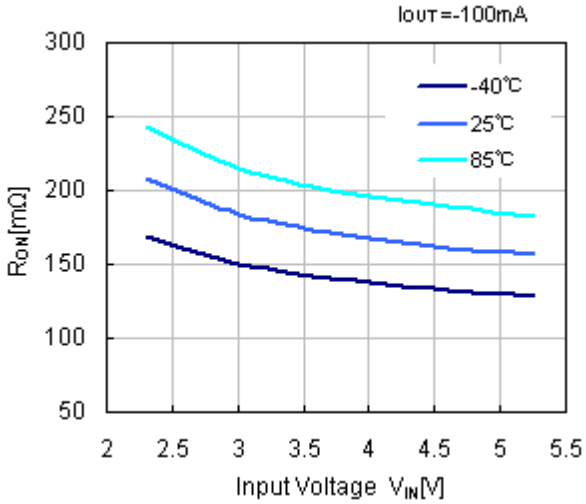
10) Switch ON Resistance vs. Temperature

R5550K001A



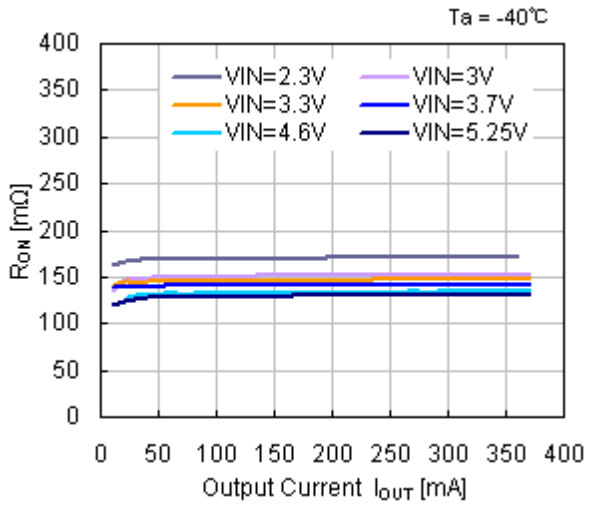
11) Switch ON Resistance vs. Input Voltage

R5550K001A



12) Switch ON Resistance vs. Output Current

R5550K001A



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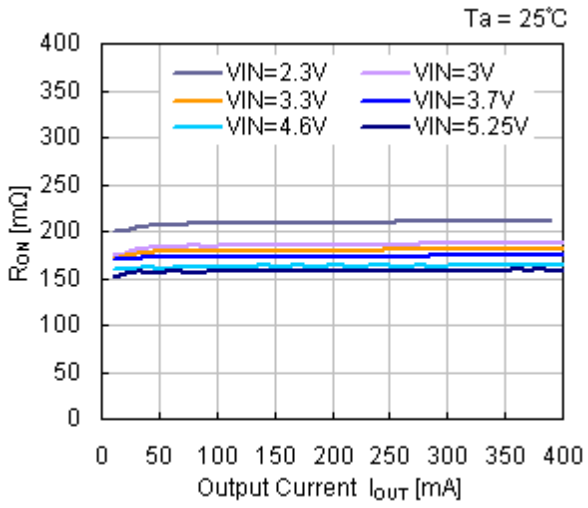

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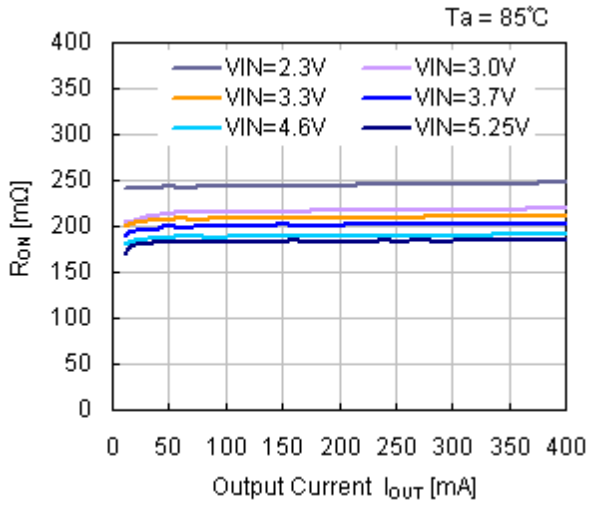
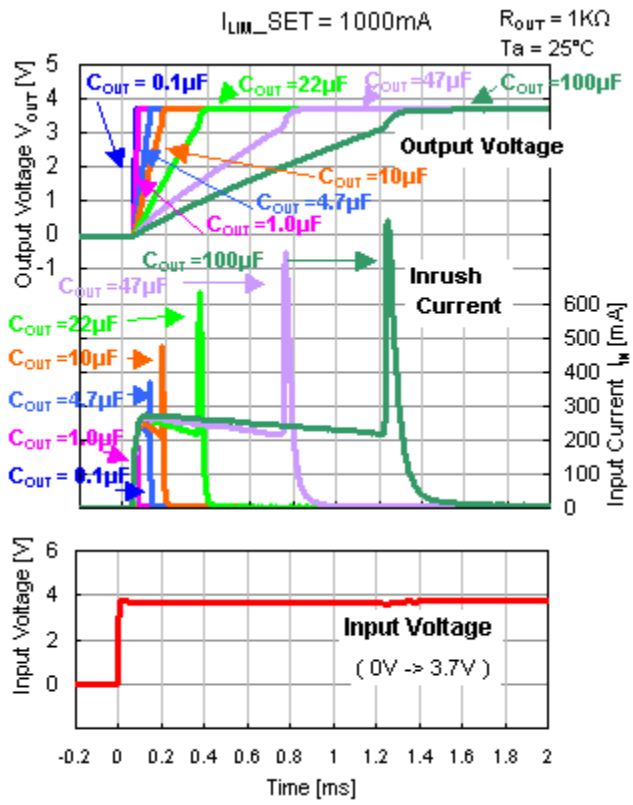


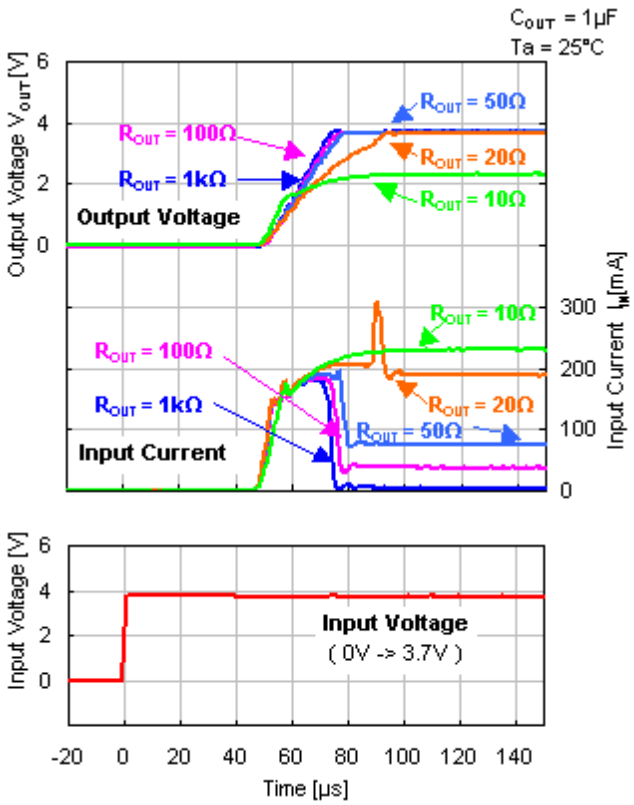
13) Inrush Current vs. Output Capacitor (C_{IN}=NONE)

R5550K001A



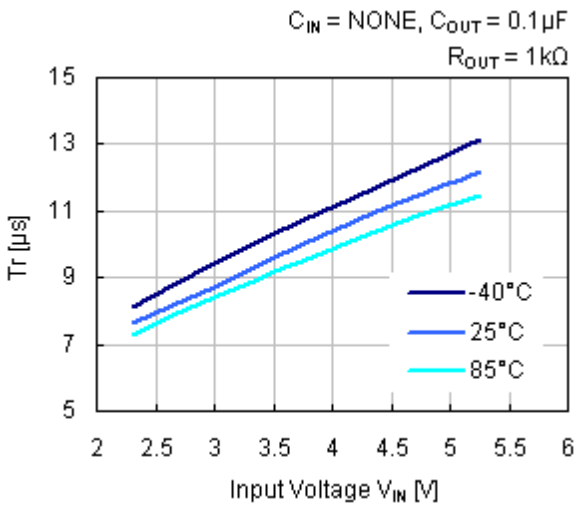
14) Inrush Current vs. Output Capacitor (C_{IN}=NONE, C_{OUT}=1µF)

R5550K001A



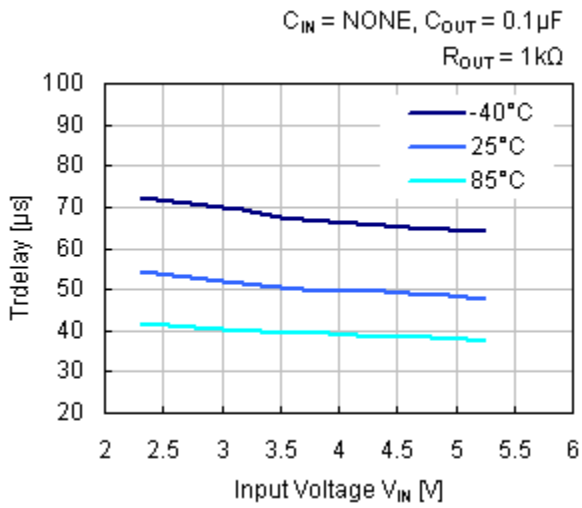
15) Output Rise Time vs. Input Voltage

R5550K001A



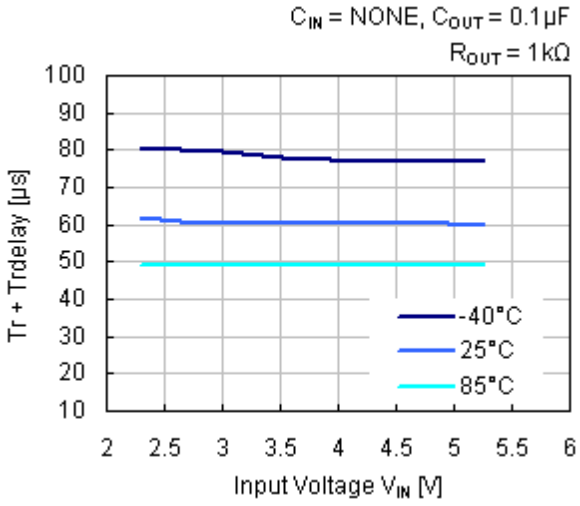
16) Output Delay Time vs. Input Voltage

R5550K001A



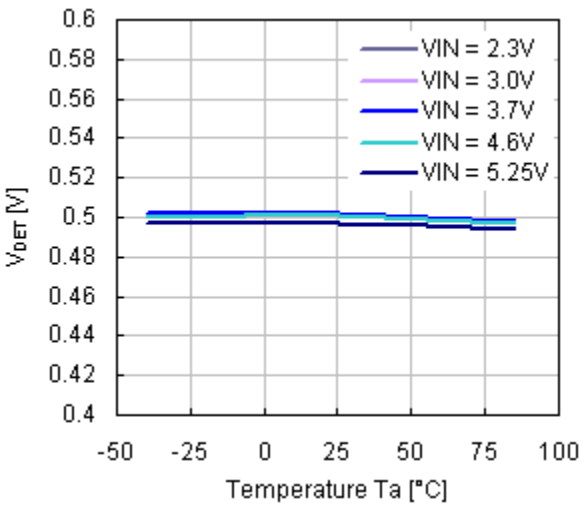
17) Output Rise Time + Output Delay Time vs. Input Voltage

R5550K001A



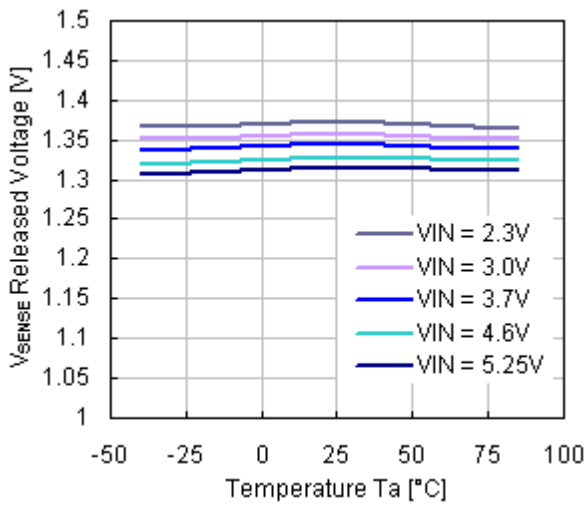
18) V_{SENSE} Detector Threshold vs. Temperature

R5550K001A



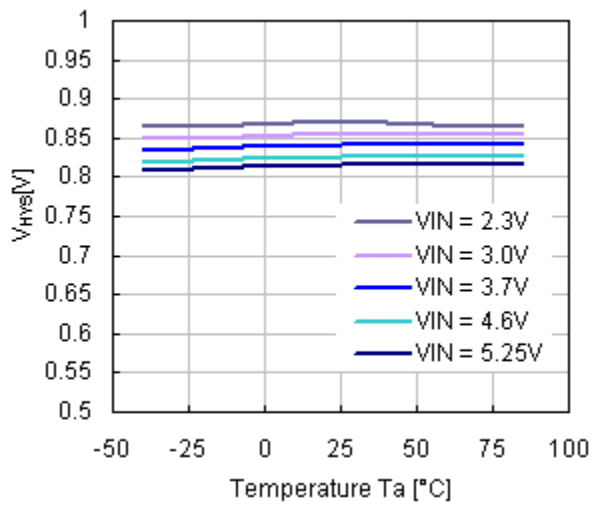
19) V_{SENSE} Released Voltage vs. Temperature

R5550K001A



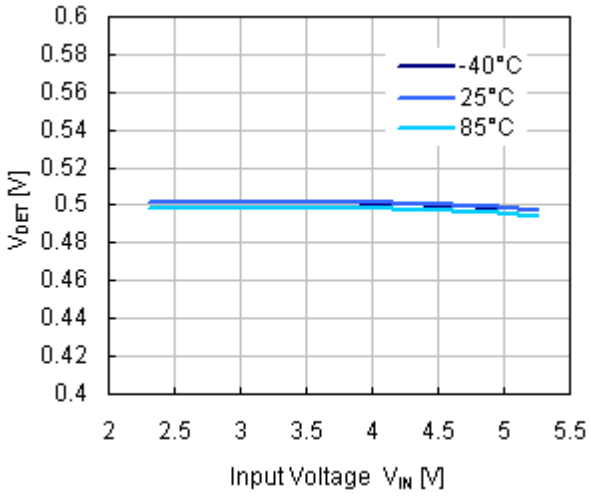
20) V_{SENSE} Hysterisis vs. Temperature

R5550K001A



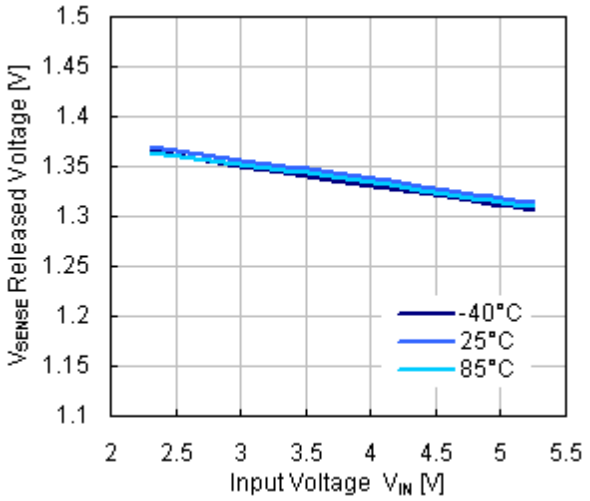
21) V_{SENSE} Detector Threshold vs. Input Voltage

R5550K001A



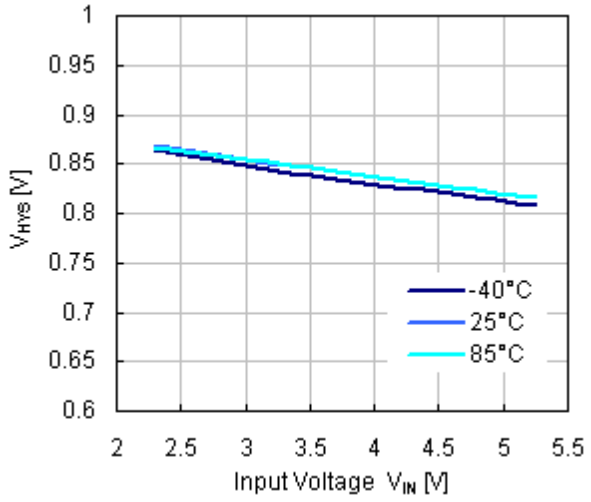
22) V_{SENSE} Released Voltage vs. Input Voltage

R5550K001A



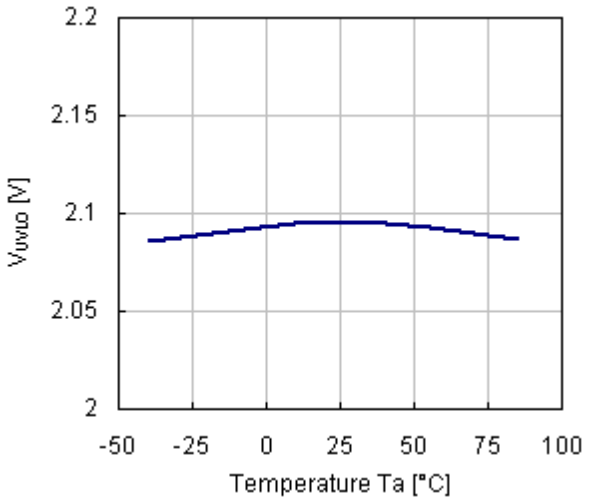
23) V_{SENSE} Hysterisis vs. Input Voltage

R5550K001A



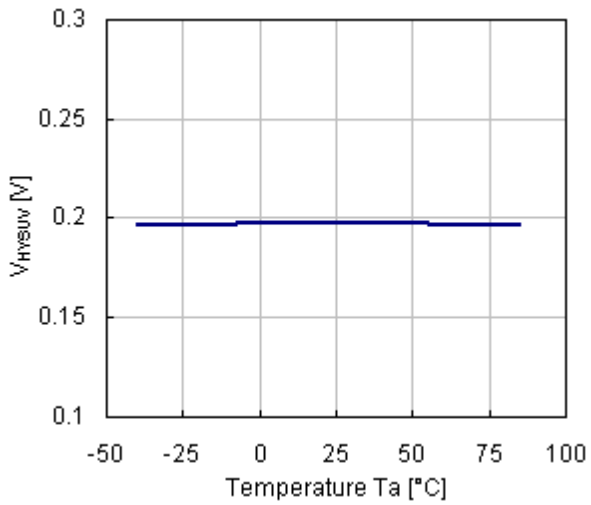
24) UVLO Released Voltage vs. Temperature

R5550K001A



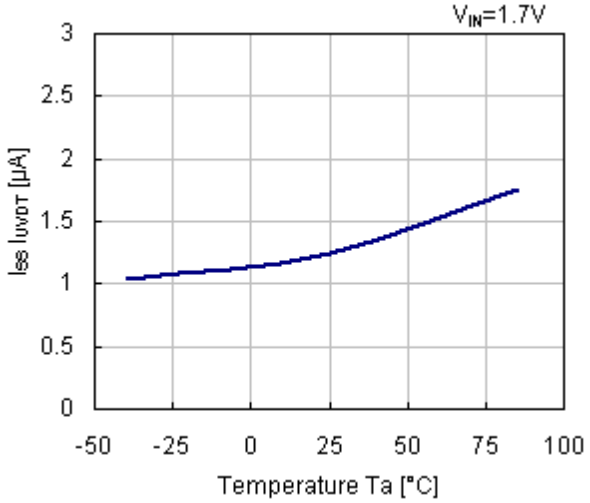
25) UVLO Hysterisis vs. Temperature

R5550K001A



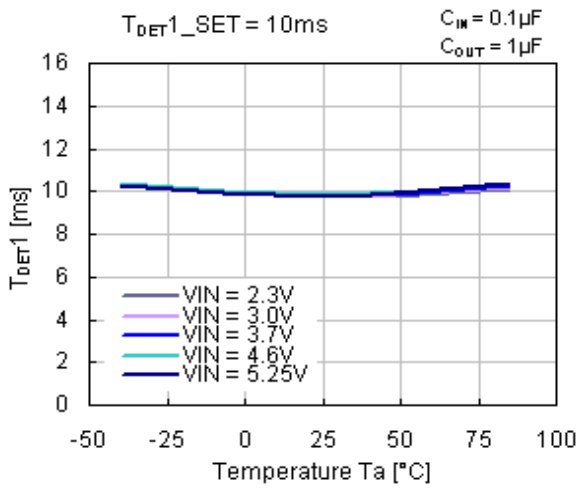
26) Supply Current at UVLO Detected vs. Temperature

R5550K001A



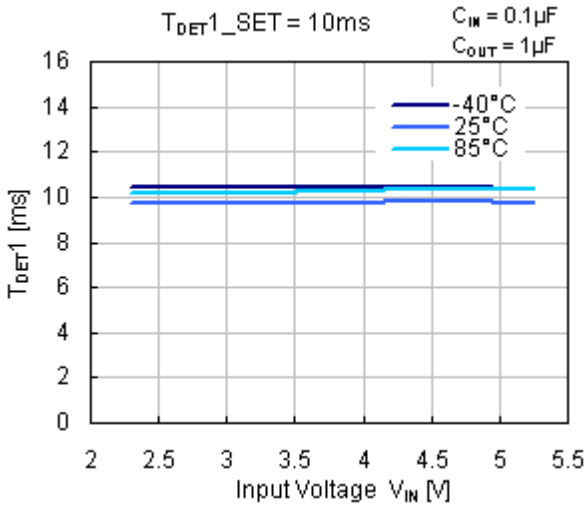
27) Limit Ignoring Time1 vs. Temperature

R5550K001A



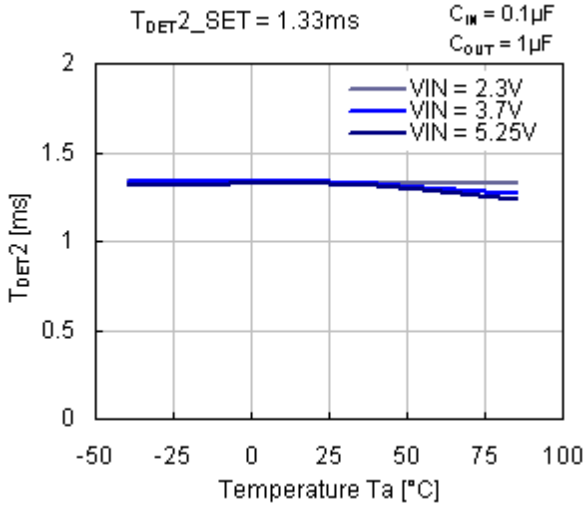
28) Limit Ignoring Time1 vs. Input Voltage

R5550K001A



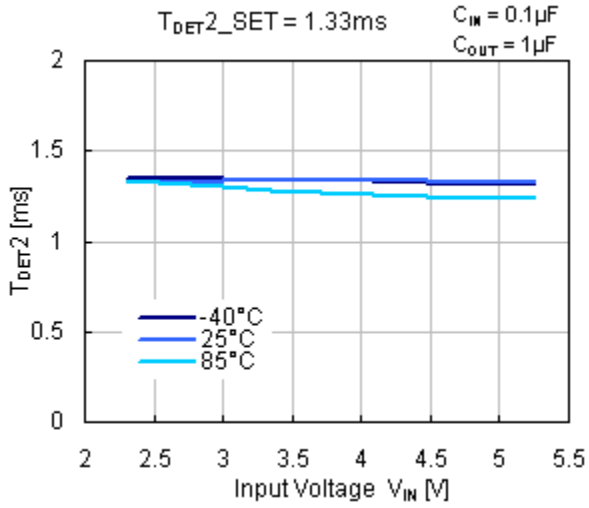
29) Limit Ignoring Time 2 vs. Temperature

R5550K001A



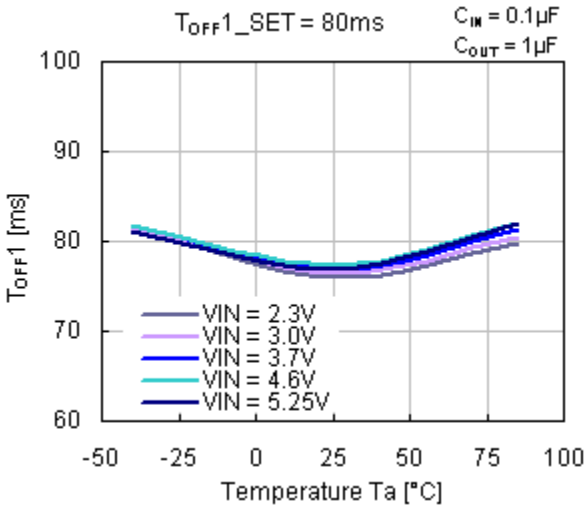
30) Limit Ignoring Time2 vs. Input Voltage

R5550K001A



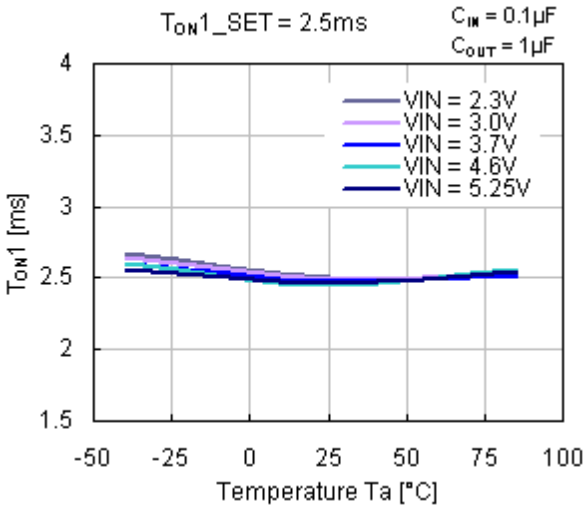
31) OFF Time1 vs. Temperature

R5550K001A



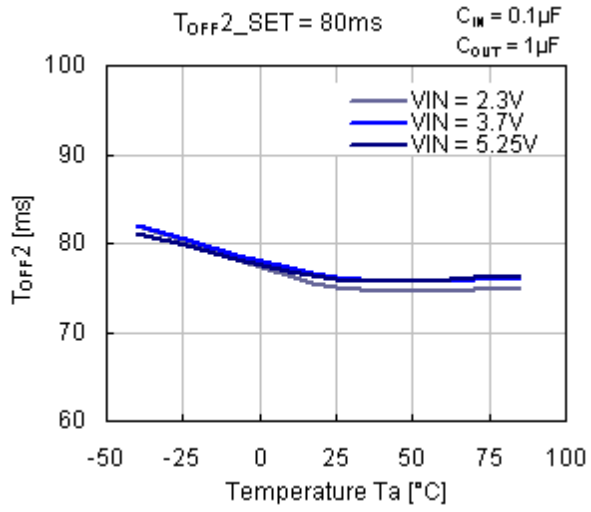
32) ON Time1 vs. Temperature

R5550K001A



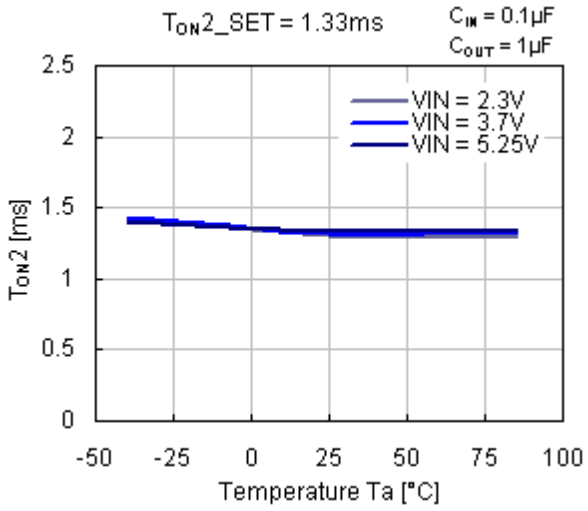
33) OFF Time2 vs. Temperature

R5550K001A



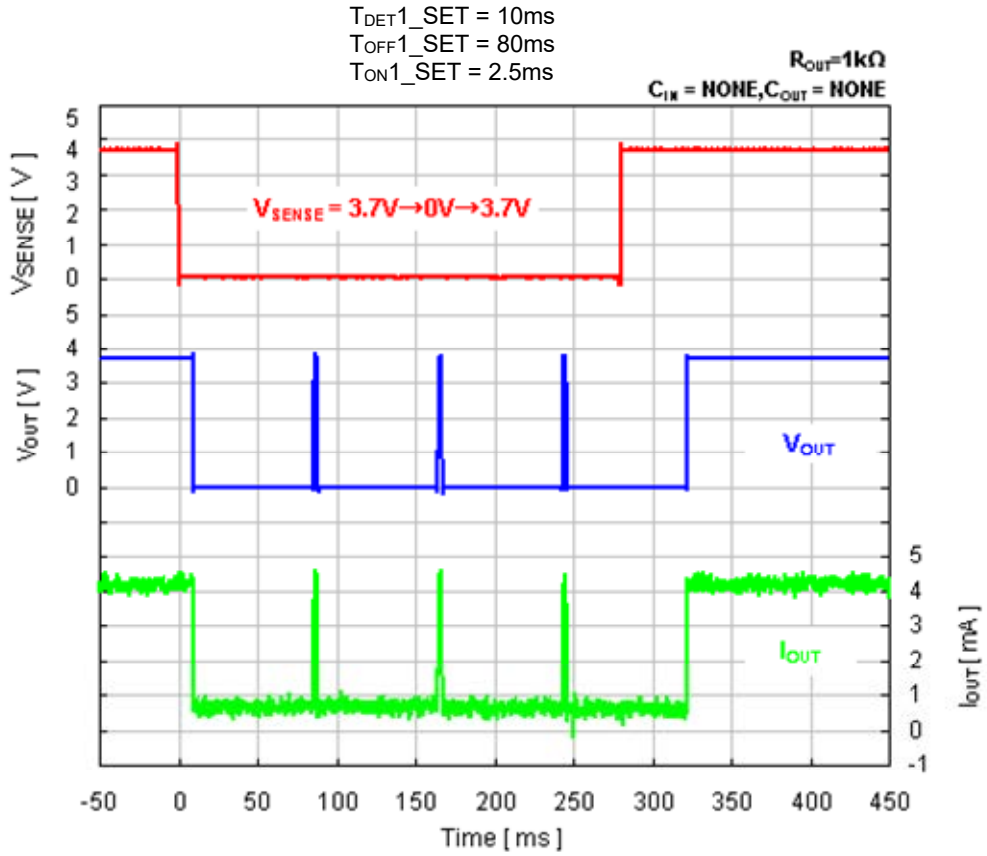
34) ON Time2 vs. Temperature

R5550K001A



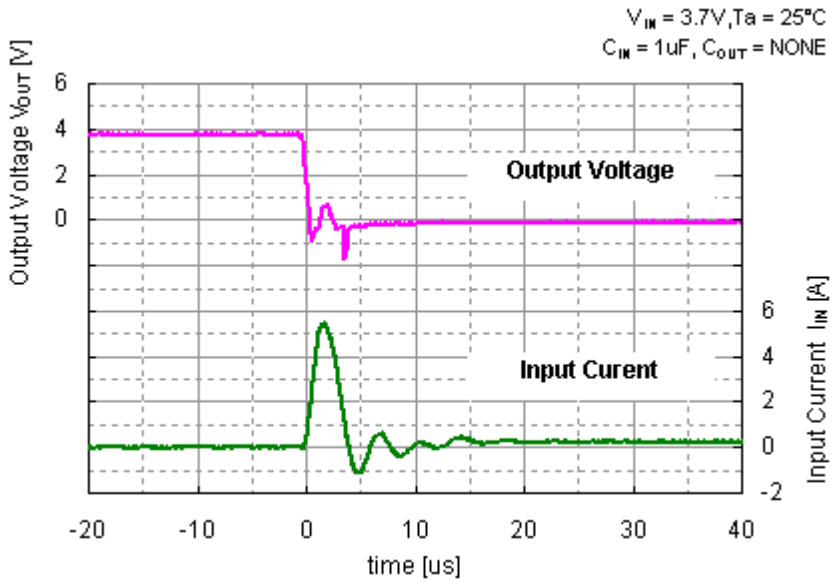
35) Operation Waveform with SENSE Pin

R5550K001A



36) Short-Protection-Circuit Transient Response

R5550K001A



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