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1ch Gate Driver Providing Galvanic Isolation 2500Vrms Isolation Voltage

BM60051FV-C

General Description

The BM60051FV-C is a gate driver with an isolation voltage of 2500Vrms, I/O delay time of 260ns, minimum input pulse width of 180ns, and incorporates the fault signal output function, under voltage lockout (UVLO) function, short circuit protection (SCP) function, active miller clamping function, temperature monitoring function, switching controller function and output state feedback function.

Key Specifications

- Isolation Voltage: 2500 [Vrms] (Max)
- Maximum Gate Drive Voltage: 24 [V] (Max)
- I/O Delay Time: 260 [ns] (Max)
- Minimum Input Pulse Width: 180 [ns] (Max)

Packages

	W(Typ) x D(Typ) x H(Max)
SSOP-B28W	9.2mm x 10.4mm x 2.4mm

Features

- Fault signal output function
- Under voltage lockout function
- Short circuit protection function
- Active Miller Clamping
- Temperature monitor
- Switching controller
- Output State Feedback Function
- UL1577 Recognized:File No. E356010
- AEC-Q100 Qualified (Note 1)
  (Note 1:Grade1)

Applications

- Automotive isolated IGBT/MOSFET inverter gate drive.
- Automotive DC-DC converter.
- Industrial inverters system.
- UPS system.

Typical Application Circuit

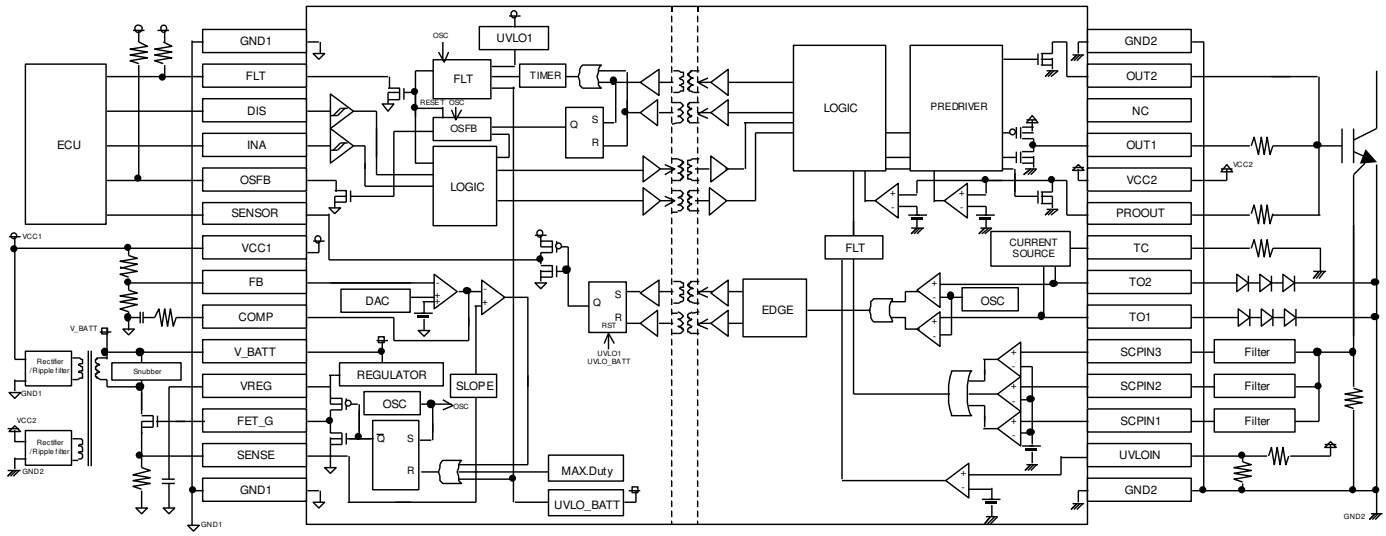

Figure 1. Typical Application Circuit

○Product structure : Silicon integrated circuit ○This product has no designed protection against radioactive rays

Recommended Range Of External Constants

Pin Name	Symbol	Recommended Value			Unit
		Min	Typ	Max	
TC(Note2)	R_{TC}	1.25	-	50	kΩ
TC(Note3)	R_{TC}	0.1	1	10	MΩ
VBATT	C_{VBATT}	3	-	-	μF
VCC1	C_{VCC1}	0.2	-	-	μF
VCC2	C_{VCC2}	0.4	-	-	μF
VREG	C_{VREG}	0.1	1	10	μF

(Note2) Use Temperature monitor
(Note3) No use Temperature monitor

Pin Configuration
(TOP VIEW)

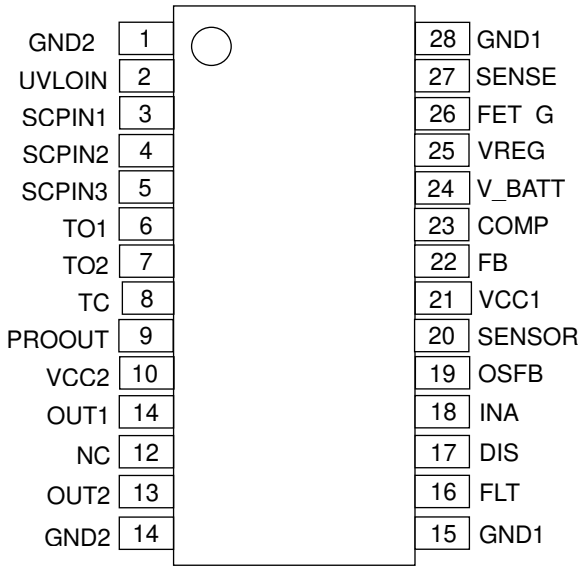

Figure 2. Pin configuration

Pin Descriptions

Pin No.	Pin Name	Function
1	GND2	Output-side ground pin
2	UVLOIN	Output-side UVLO setting pin
3	SCPIN1	Short circuit current detection pin 1
4	SCPIN2	Short circuit current detection pin 2
5	SCPIN3	Short circuit current detection pin 3
6	TO1	Constant current output pin / sensor voltage input pin 1
7	TO2	Constant current output pin / sensor voltage input pin 2
8	TC	Constant current setting resistor connection pin
9	PROOUT	Soft turn-OFF pin /Gate voltage input pin
10	VCC2	Output-side power supply pin
11	OUT1	Output pin
12	NC	No connect
13	OUT2	Output pin for Miller Clamp
14	GND2	Output-side ground pin
15	GND1	Input-side ground pin
16	FLT	Fault output pin
17	DIS	Input enabling signal input pin
18	INA	Control input pin
19	OSFB	Output state feedback output pin
20	SENSOR	Temperature information output pin
21	VCC1	Input-side power supply pin
22	FB	Error amplifier inverting input pin for switching controller
23	COMP	Error amplifier output pin for switching controller
24	V_BATT	Main power supply pin
25	VREG	Power supply pin for driving MOS FET for switching controller
26	FET_G	MOS FET control pin for switching controller
27	SENSE	Current feedback resistor connection pin for switching controller
28	GND1	Input-side ground pin

Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Main Power Supply Voltage	$V_{BATTMAX}$	-0.3 to+40.0(Note 4)	V
Input-Side Control Block Supply Voltage	V_{CC1MAX}	-0.3 to +7.0(Note 4)	V
Output-Side Supply Voltage	V_{CC2MAX}	-0.3 to +30.0(Note 5)	V
INA, DIS Pin Input Voltage	V_{INMAX}	-0.3 to +V_{CC1}+0.3V or +7.0V(Note 4)	V
FLT, OSFB Pin Input Voltage	V_{FLTMAX}	-0.3 to +7.0V (Note 4)	V
FLT Pin, OSFB Pin Output Current	I_{FLT}	10	mA
SENSOR Pin Output Current	I_{SENSOR}	10	mA
FB Pin Input Voltage	V_{FBMAX}	-0.3 to +V_{CC1}+0.3V or +7.0V(Note 4)	V
FED_G Pin Output Current (Peak5μs)	I_{FET_GPEAK}	1000	mA
SCPIN1 Pin, SCPIN2 Pin, SCPIN3 Pin Input Voltage	$V_{SCPINMAX}$	-0.3 to +6.0(Note 5)	V
UVLOIN Pin Input Voltage	$V_{UVLOINMAX}$	-0.3 to V_{CC2}+0.3(Note 5)	V
TO1 Pin, To2 Pin Input Voltage	V_{TOMAX}	-0.3 to V_{CC2}+0.3(Note 5)	V
TO1 Pin, TO2 Pin Output Current	I_{TOMAX}	8	mA
OUT1 Pin Output Current (Peak5μs)	$I_{OUT1PEAK}$	5000(Note 6)	mA
OUT2 Pin Output Current (Peak5μs)	$I_{OUT2PEAK}$	5000(Note 6)	mA
PROOUT Pin Output Current (Peak5μs)	$I_{PROOUTPEAK5}$	2500(Note 6)	mA
PROOUT Pin Output Current (Peak10μs)	$I_{PROOUTPEAK10}$	1000(Note 6)	mA
Power Dissipation	Pd	1.12(Note 7)	W
Operating Temperature Range	Topr	-40 to +125	°C
Storage Temperature Range	Tstg	-55 to +150	°C
Junction Temperature	Tjmax	+150	°C

(Note 4) Relative to GND1
(Note 5) Relative to GND2
(Note 6) Should not exceed Pd and Tj=150°C
(Note 7) Derate above Ta=25°C at a rate of 9.0mW/°C. Mounted on a glass epoxy of 114.3 mm × 76.2 mm × 1.6 mm.
Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Recommended Operating Conditions

Parameter	Symbol	Min	Max	Units
Main Power Supply Voltage	V_{BATT}(Note 8)	4.5	24.0	V
Input-side Control Block Supply Voltage	V_{CC1}(Note 8)	4.5	5.5	V
Output-side Supply Voltage	V_{CC2}(Note 9)	9	24	V
Output side UVLO voltage	V_{UV2TH}(Note 9)	6	-	V

(Note 8) GND1 reference
(Note 9) GND2 reference

Insulation Related Characteristics

Parameter	Symbol	Characteristic	Unit
Insulation Resistance (V_{IO}=500V)	R_S	$>10^9$	Ω
Insulation Withstand Voltage / 1min	V_{ISO}	2500	Vrms
Insulation Test Voltage / 1sec	V_{ISO}	3000	Vrms

Electrical Characteristics

(Unless otherwise specified Ta=-40°C to125°C, V_{BATT}=5V to 24V, V_{CC1}=4.5V to 5.5V, V_{CC2}=9V to 24V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
General						
Main Power Supply Circuit Current 1	I_{BATT1}	0.37	0.84	1.47	mA	FET_G Pin switching operating
Main Power Supply Circuit Current 2	I_{BATT2}	0.34	0.77	1.35	mA	FET_G Pin No Switching
Input Side Circuit Current 1	I_{CC11}	0.13	0.31	0.49	mA	OUT=L
Input Side Circuit Current 2	I_{CC12}	0.13	0.31	0.49	mA	OUT=H
Input Side Circuit Current 3	I_{CC13}	0.25	0.42	0.59	mA	INA =10kHZ, Duty=50%
Input Side Circuit Current 4	I_{CC14}	0.31	0.53	0.74	mA	INA =20kHZ, Duty=50%
Output Side Circuit Current	I_{CC2}	2.7	4.7	7.1	mA	R_{TC}=10kΩ
Switching Power Supply Controller						
FET_G Output Voltage H1	V_{FETGH1}	4.5	5.0	5.5	V	I_{OUT}=0A(open)
FET_G Output Voltage H2	V_{FETGH2}	4.0	4.5	-	V	V_BATT=4.5V I_{OUT}=0A(open)
FET_G Output Voltage L	V_{FETGL}	0	-	0.3	V	I_{OUT}=0A(open)
FET_G ON-Resistance (Source-side)	R_{ONGH}	3	6	12	Ω	10mA
FET_G ON-Resistance (Sink-side)	R_{ONGL}	0.3	0.6	1.3	Ω	10mA
Oscillation Frequency	f_{OSC_SW}	80	100	120	kHz	
Soft-start Time	t_{SS}	-	-	50	ms	
FB Pin Threshold Voltage	V_{FB}	1.47	1.50	1.53	V	
FB Pin Input Current	I_{FB}	-0.8	0	+0.8	μA	
COMP Pin Sink Current	$I_{COMPSINK}$	-160	-80	-40	μA	
COMP Pin Source Current	$I_{COMPSOURCE}$	40	80	160	μA	
V_BATT UVLO OFF Voltage	$V_{UVLOBATTH}$	4.05	4.25	4.45	V	
V_BATT UVLO ON Voltage	$V_{UVLOBATTL}$	3.95	4.15	4.35	V	
Maximum ON DUTY	D_{ONMAX}	75	85	95	%	
Logic Block						
Logic High Level Input Voltage	V_{INH}	$0.7\times V_{CC1}$	-	V_{CC1}	V	INA、DIS
Logic Low Level Input Voltage	V_{INL}	0	-	$0.3\times V_{CC1}$	V	INA、DIS
Logic Pull-Down Resistance	R_{IND}	25	50	100	kΩ	INA
Logic Pull-Up Resistance	R_{INU}	25	50	100	kΩ	DIS
Logic Input Filtering Time	t_{INFIL}	80	130	180	ns	INA
DIS Input Filtering Time	T_{DISFIL}	4	10	20	μs	
DIS Input Delay Time	t_{DDIS}	4	10	20	μs	
Output						
OUT1 ON-Resistance (Source-side)	R_{ONH}	0.2	0.55	1.3	Ω	I_{OUT}=40mA
OUT1 ON-Resistance (Sink-side)	R_{ONL}	0.2	0.55	1.3	Ω	I_{OUT}=40mA
OUT1 Maximum Current	I_{OUTMAX}	5.0	-	-	A	V_{CC2}=15V Guaranteed by design
PROOUT ON-Resistance	R_{ONPRO}	0.5	1.2	2.7	Ω	I_{PROOUT}=40mA
Turn ON time	t_{PON}	140	200	260	ns	
Turn OFF time	t_{POFF}	140	200	260	ns	
Propagation Distortion	t_{PDIST}	-60	0	+60	ns	t_{POFF} - t_{PON}
Rise Time	t_{RISE}	-	30	50	ns	Load=1nF
Fall Time	t_{FALL}	-	30	50	ns	Load=1nF
OUT2 ON-Resistance	R_{ON2}	0.4	0.9	2.0	Ω	I_{OUT}=40mA
OUT2 ON Threshold Voltage	V_{OUT2ON}	1.8	2.0	2.2	V	
OUT2 Output Delay Time	t_{OUT2ON}	-	15	50	ns	
Common Mode Transient Immunity	CM	100	-	-	kV/μs	Design assurance

Electrical Characteristics - continued

(Unless otherwise specified Ta=-40°C to125°C, V_{BATT}=5V to 24V, V_{CC1}=4.5V to 5.5V, V_{CC2}=8V to 24V)

Parameter	Symbol	Min	Typ	Max	Unit	Conditions
Temperature Monitor						
TC Pin Voltage	V_{TC}	0.975	1.000	1.025	V	
TOx Pin Output Current	I_{TO}	0.97	1.00	1.03	mA	R_{TC}=10kΩ
SENSOR Output Frequency	f_{OSC_TO}	8	10	14	kHz	
SENSOR Output Duty1	$D_{SENSOR1}$	87	90	93	%	V_{TOx}=1.35V
SENSOR Output Duty2	$D_{SENSOR2}$	47	50.0	53	%	V_{TOx}=2.59V
SENSOR Output Duty3	$D_{SENSOR3}$	5	10	15	%	V_{TOx}=3.84V
TOx Pin Disconnect Detection Voltage	V_{TOH}	7	8	9	V	
SENSOR ON Resistance (Source-side)	$R_{SENSORH}$	-	60	160	Ω	I_{SENSOR}=5mA
SENSOR ON Resistance (Sink-side)	$R_{SENSORL}$	-	60	160	Ω	I_{SENSOR}=5mA
Protection Functions						
Input-side UVLO OFF Voltage	V_{UVLO1H}	4.05	4.25	4.45	V	
Input-side UVLO ON Voltage	V_{UVLO1L}	3.95	4.15	4.35	V	
Input-side UVLO Filtering Time	$t_{UVLO1FIL}$	2	10	30	µs	
Input-side UVLO Delay Time (OUT)	$t_{DUVLO1OUT}$	2	10	30	µs	
Input-side UVLO Delay Time (FLT)	$t_{DUVLO1FLT}$	2	10	30	µs	
Output-side UVLO OFF Threshold Voltage	V_{UVLO2H}	0.95	1.00	1.05	V	
Output-side UVLO ON Threshold Voltage	V_{UVLO2L}	0.85	0.90	0.95	V	
Output-side UVLO Filtering Time	$t_{UVLO2FIL}$	2	10	30	µs	
Output-side UVLO Delay Time (OUT)	$t_{DUVLO2OUT}$	2	10	30	µs	
Output-side UVLO Delay Time (FLT)	$t_{DUVLO2FLT}$	3	-	65	µs	
Short Current Detection Voltage	V_{SCDET}	0.67	0.70	0.73	V	
Short Current Detection Filtering Time	t_{SCPFIL}	0.15	0.30	0.45	µs	
Short Current Detection Delay time (OUT)	$t_{DSCPOUT}$	0.16	0.33	0.50	µs	OUT1=30kΩ Pull down
Short Current Detection Delay Time (PROOUT)	$t_{DSCPPRO}$	0.17	0.35	0.53	µs	PROOUT=30kΩ Pull up
Short Current Detection Delay Time (FLT)	$t_{DSCPFLT}$	1	-	35	µs	
Soft Turn OFF Release Time	t_{SCPOFF}	30	-	110	µs	OUT1=30kΩ Pull up
FLT Output ON-Resistance	R_{FLTL}	-	30	80	Ω	I_{FLT}=5mA
Fault Output Holding Time	t_{FLTRLS}	20	40	60	ms	
Gate State H Detection Threshold Voltage	V_{OSFBH}	4.5	5.0	5.5	V	
Gate State L Detection Threshold Voltage	V_{OSFBL}	4.0	4.5	5.0	V	
OSFB Output Filtering Time	$t_{OSFBFIL}$	1.5	2.0	2.5	µs	
OSFB Output ON-Resistance	R_{OSFB}	-	30	80	Ω	I_{OSFB}=5mA
OSFB Output Holding Time	$t_{OSFBRLS}$	20	40	60	ms	

UL1577 Ratings Table

Following values are described in UL Report.

Parameter	Values	Units	Conditions
Side 1 (Input Side) Circuit Current	1.37	mA	V_BATT=14V,VCC1=5.0V,OUT1=L
Side 2 (Output Side) Circuit Current	4.7	mA	VCC2=15V, OUT1=L
Side 1 (Input Side) Consumption Power	14.4	mW	V_BATT=14V,VCC1=5.0V,OUT1=L
Side 2 (Output Side) Consumption Power	70.5	mW	VCC2=15V, OUT1=L
Isolation Voltage	2500	Vrms	
Maximum Operating (Ambient) Temperature	125	℃	
Maximum Junction Temperature	150	℃	
Maximum Strage Temperature	150	℃	
Maximum Data Transmission Rate	2.7	MHz	

Typical Performance Curves

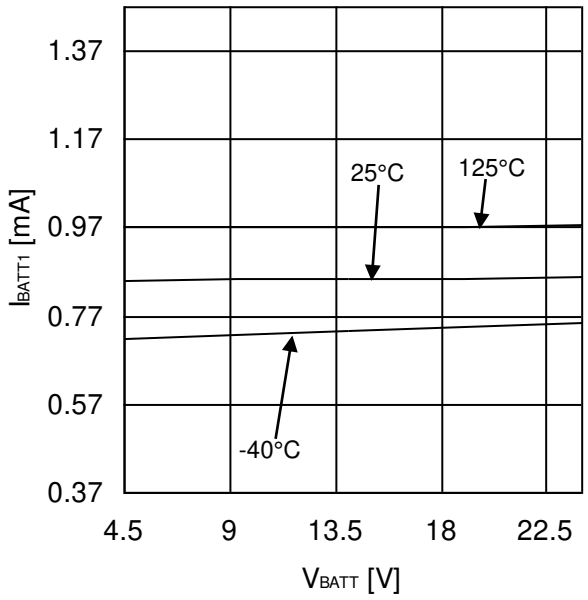

Figure 3. Main Power SupplyCircuit Current 1
(FET_G Pin switching operating)

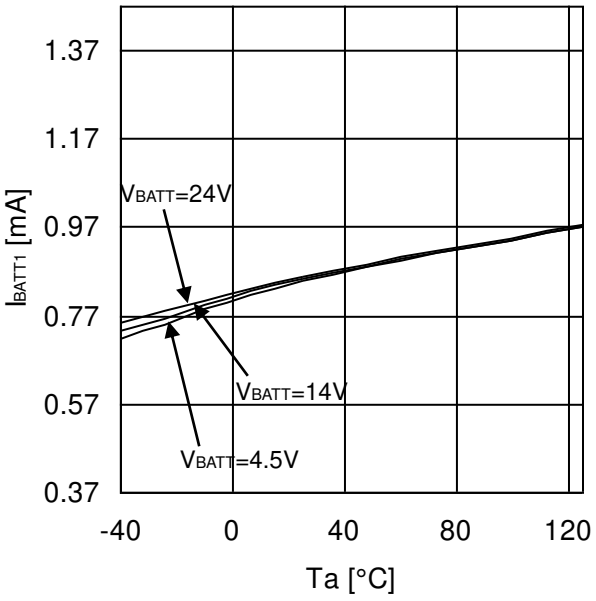

Figure 4. Main Power SupplyCircuit Current 1
(FET_G Pin switching operating)

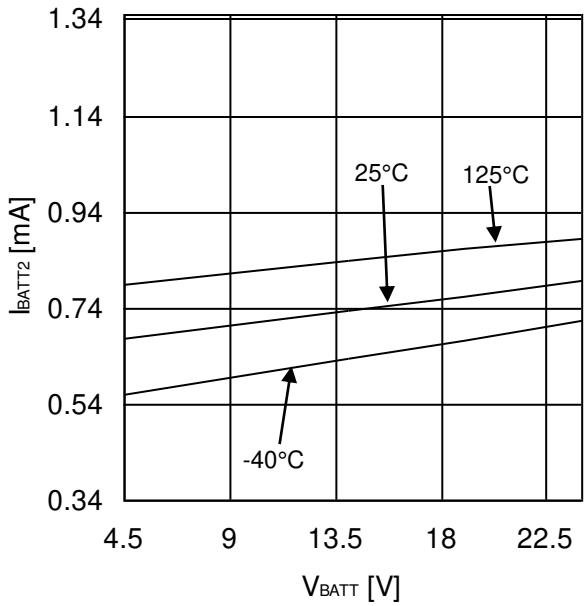

Figure 5. Main Power SupplyCircuit Current 2
(FET_G Pin no switching)

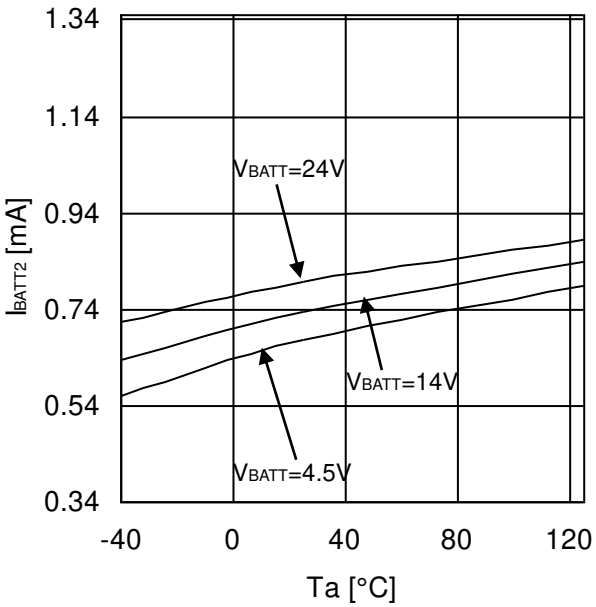

Figure 6. Main Power SupplyCircuit Current 2
(FET_G Pin no switching)

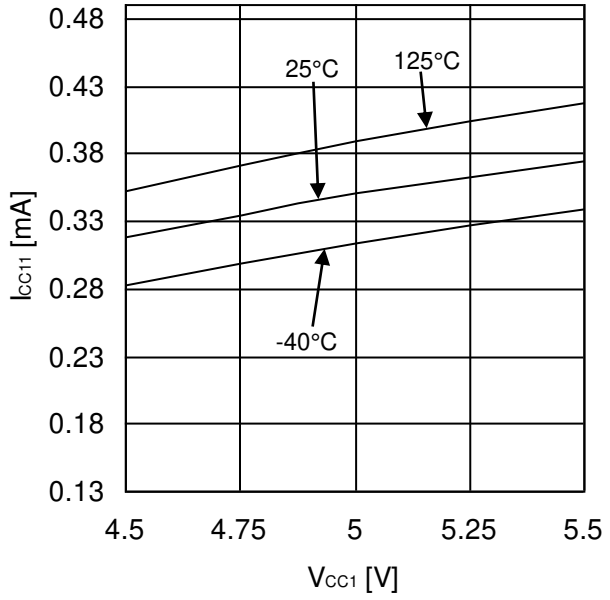

Figure 7. Input Side Circuit Current 1
(OUT1=L)

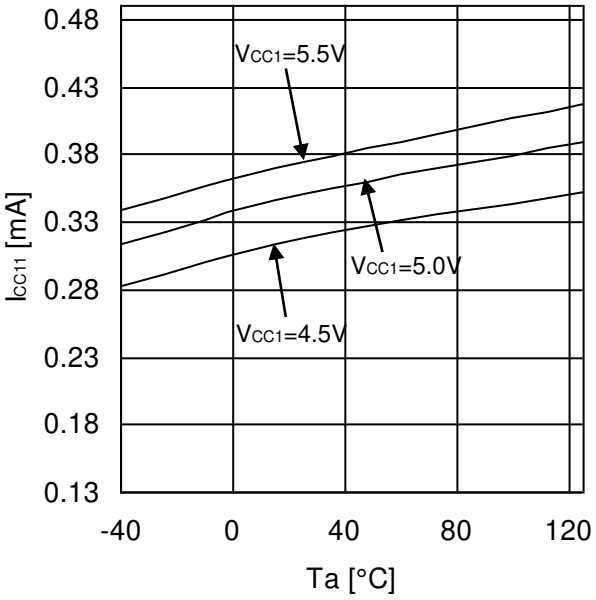

Figure 8. Input Side Circuit Current 1
(OUT1=L)

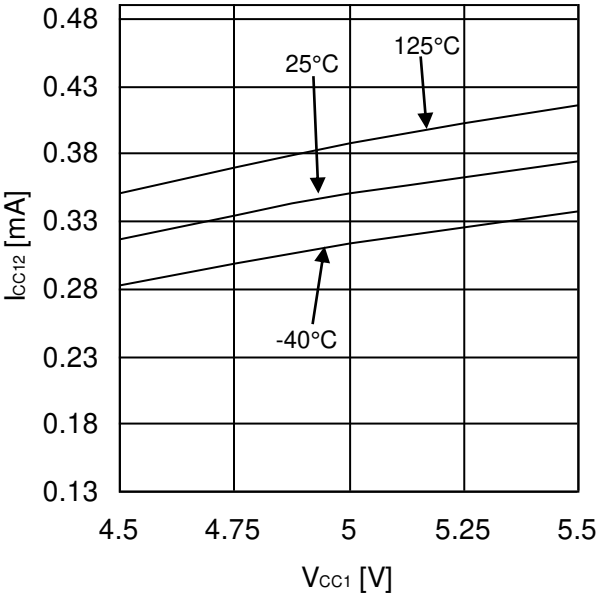

Figure 9. Input Side Circuit Current 2
(OUT1=H)

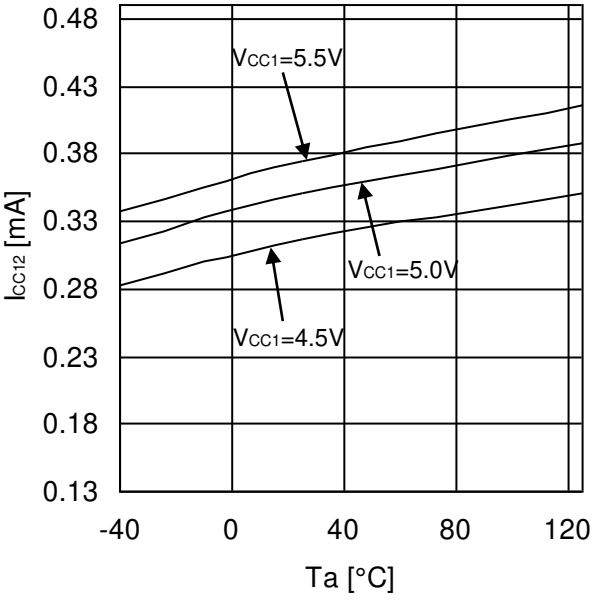

Figure 10. Input Side Circuit Current 2
(OUT1=H)

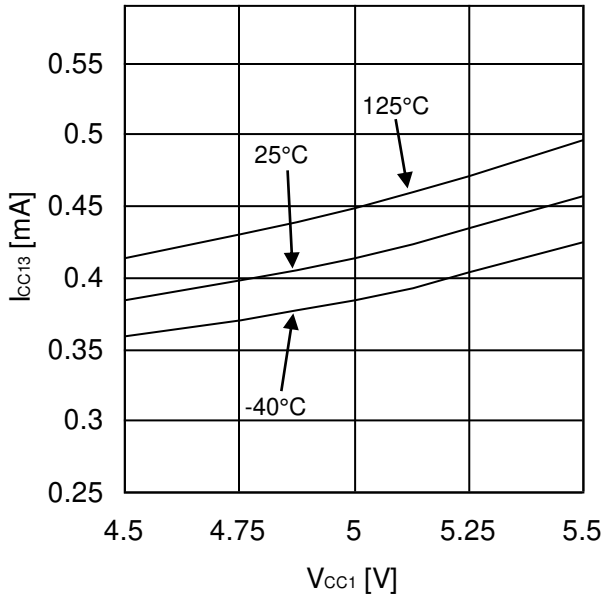

Figure 11. Input Side Circuit Current 3
(INA=10kHz, Duty=50%)

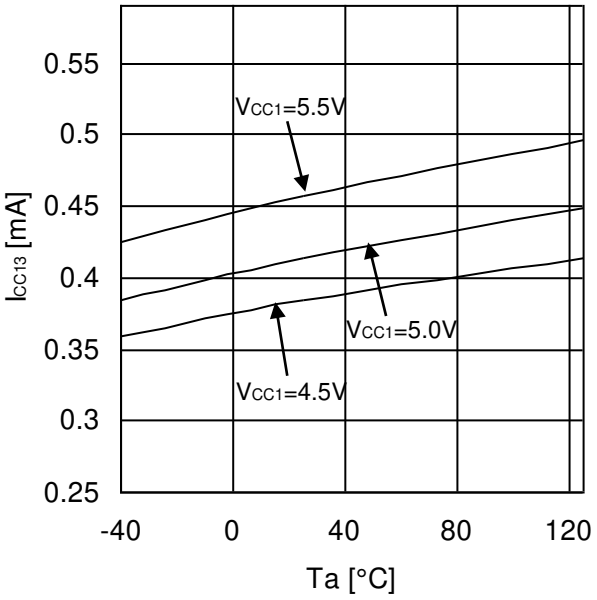

Figure 12. Input Side Circuit Current 3
(INA=10kHz, Duty=50%)

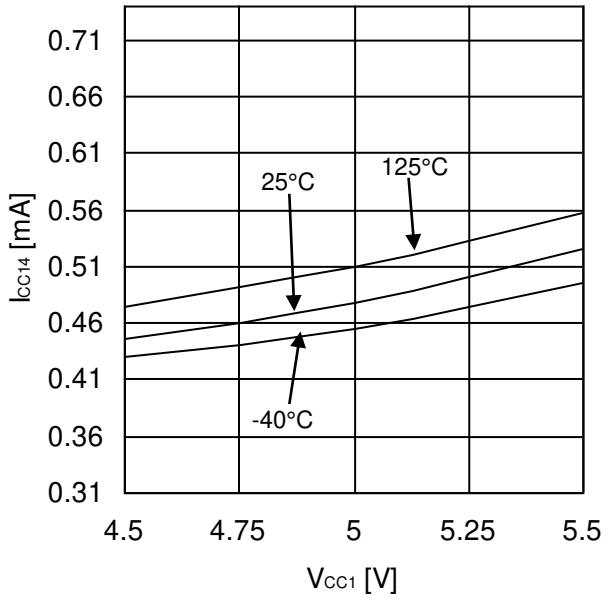

Figure 13. Input Side Circuit Current 4
(INA=20kHz, Duty=50%)

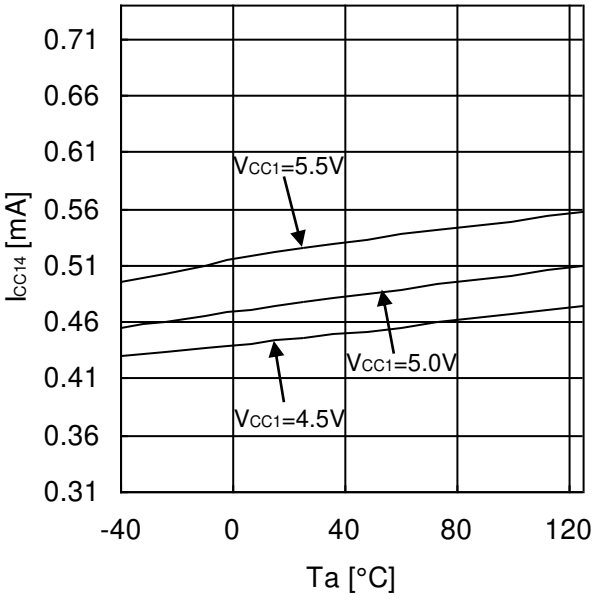

Figure 14. Input Side Circuit Current 4
(INA=20kHz, Duty=50%)

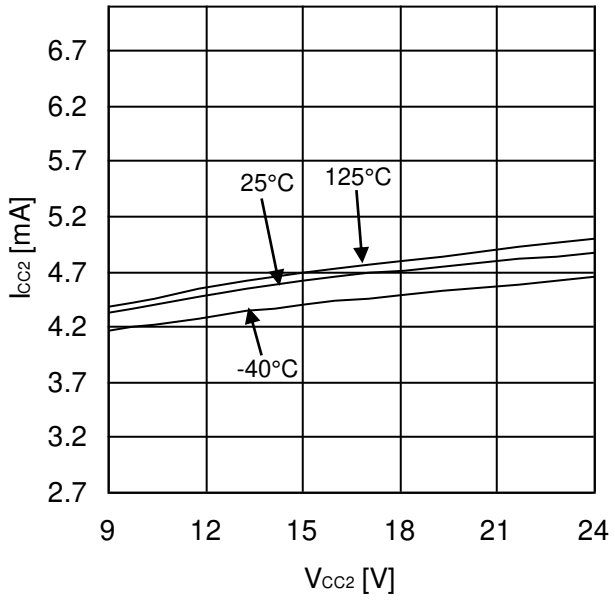

Figure 15. Output Side Circuit Current
(OUT=L, R_{TC}=10kΩ)

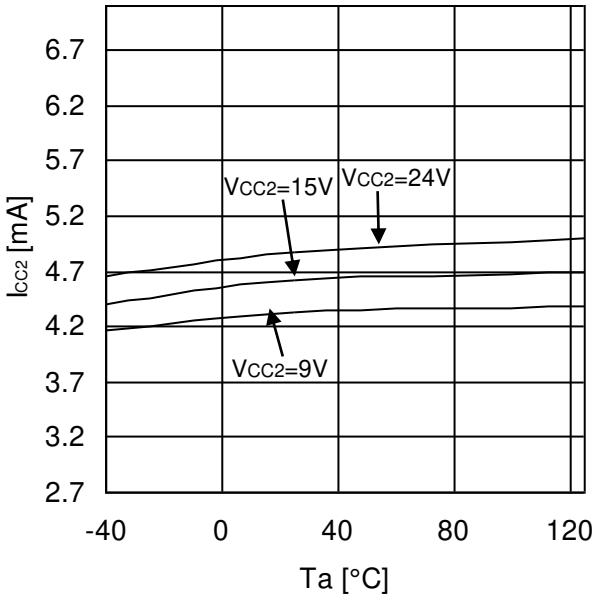

Figure 16. Output Side Circuit Current
(OUT=L, R_{TC}=10kΩ)

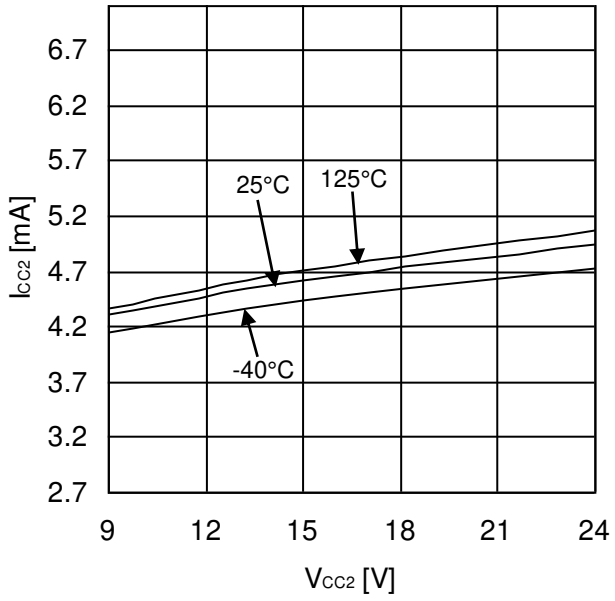

Figure 17. Output Side Circuit Current
(OUT=H, R_{TC}=10kΩ)

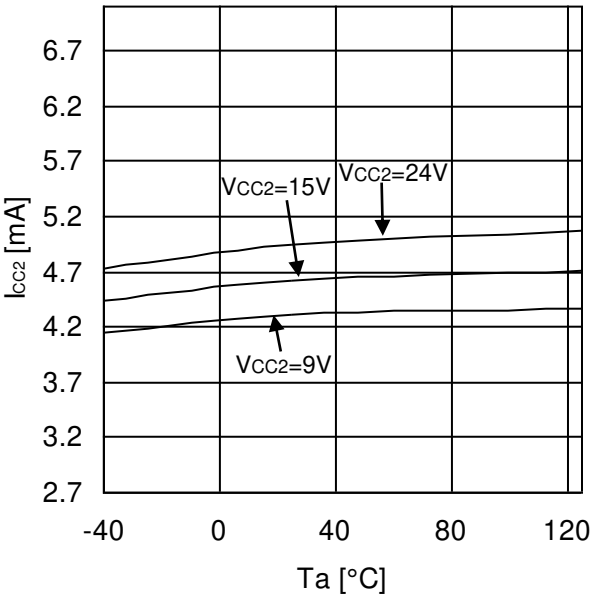

Figure 18. Output Side Circuit Current
(OUT=H, R_{TC}=10kΩ)

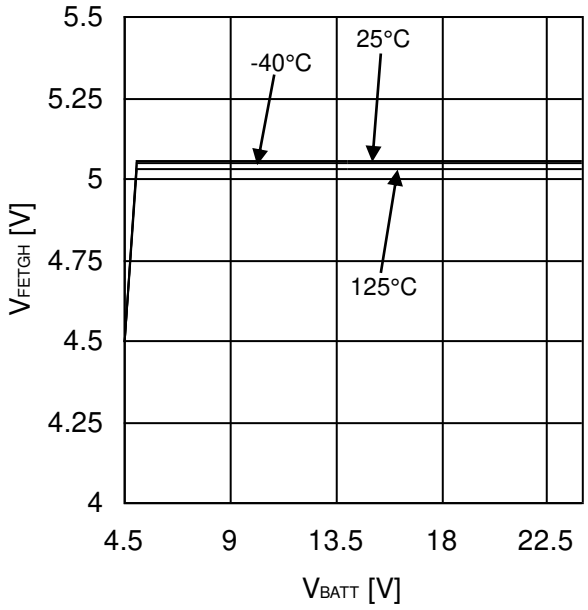

Figure 19. FET_G Output Voltage H1/H2

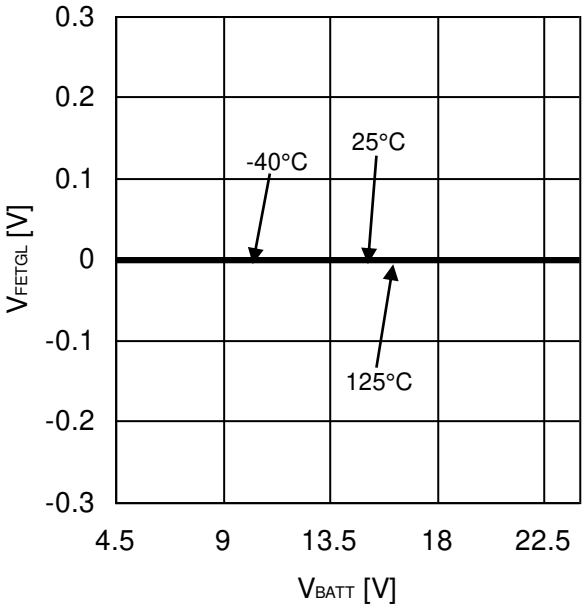

Figure 20. FET_G Output Voltage L

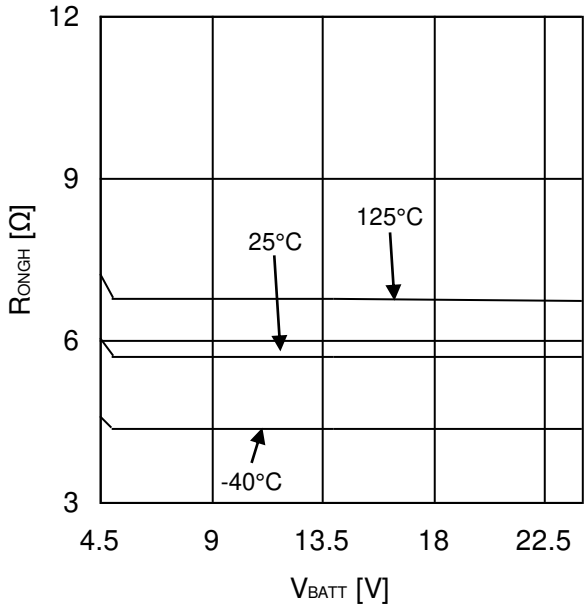

Figure 21. FET_G ON-Resistance (Source-side)

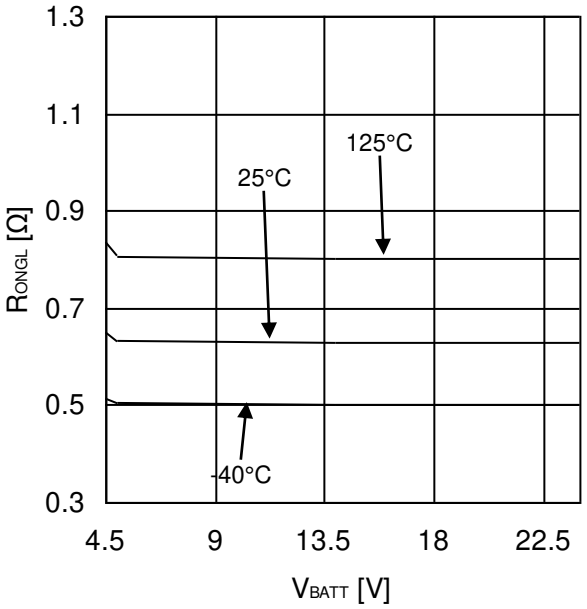

Figure 22. FET_G ON-Resistance (Sink-side)

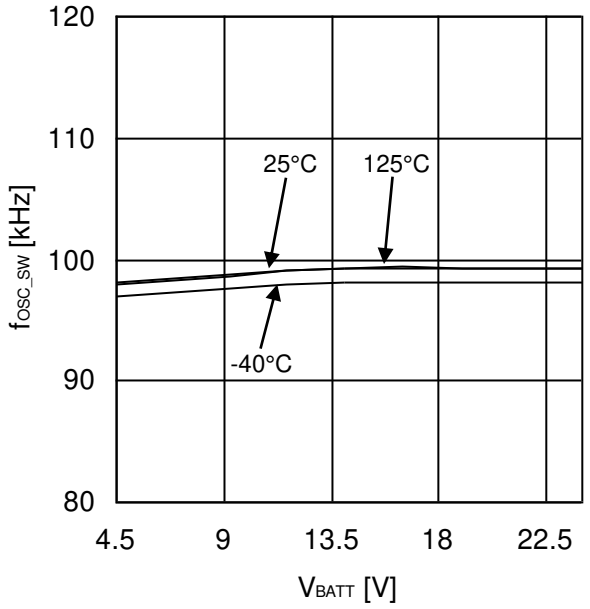

Figure 23. Oscillation Frequency

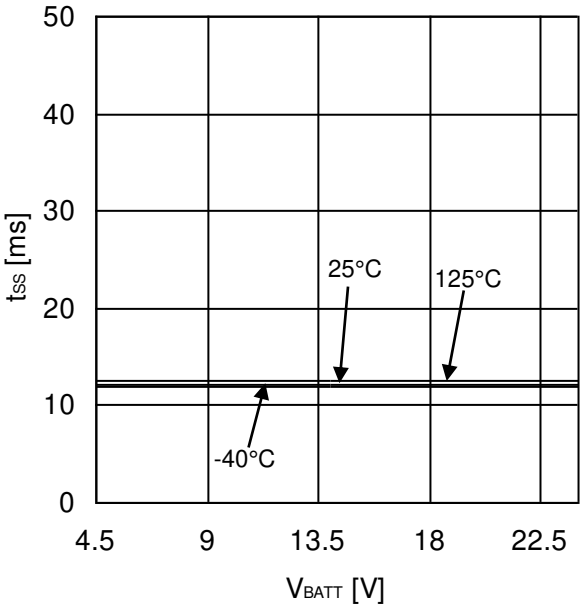

Figure 24. Soft-start Time

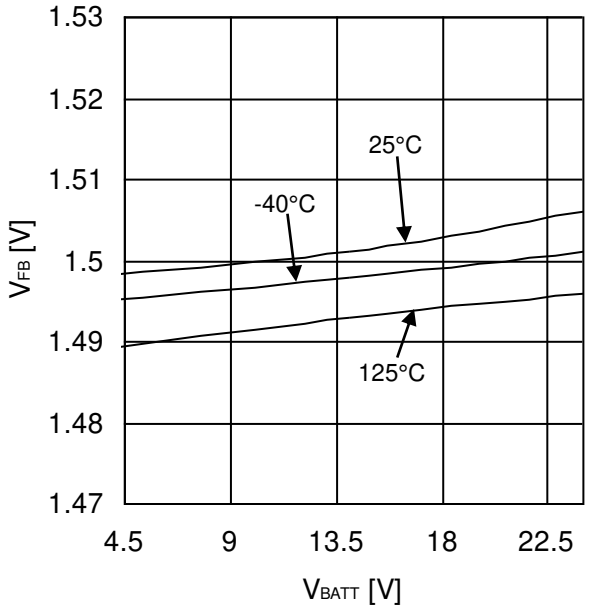

Figure 25. FB Pin Threshold Voltage

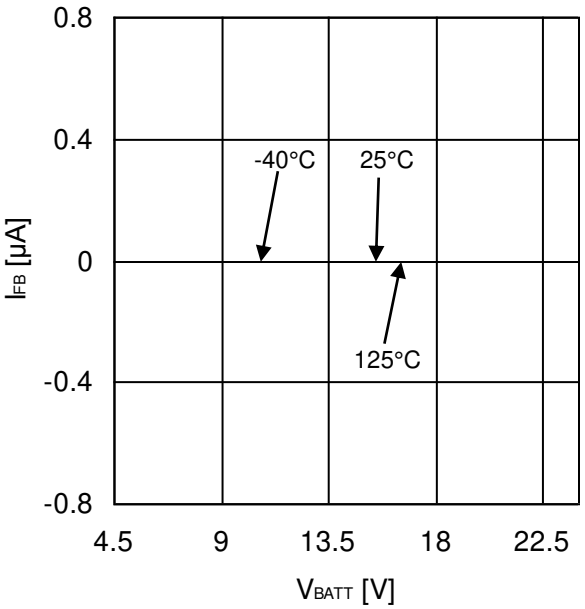

Figure 26. FB Pin Input Current

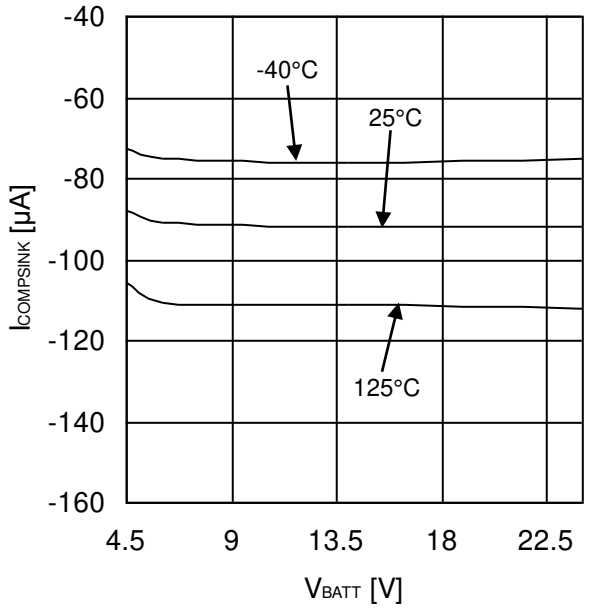

Figure 27. COMP COMP Pin Sink Current

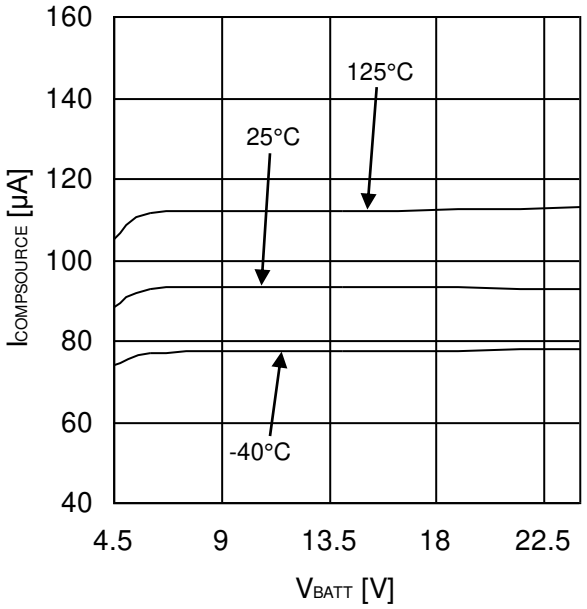

Figure 28. COMP Pin Source Current

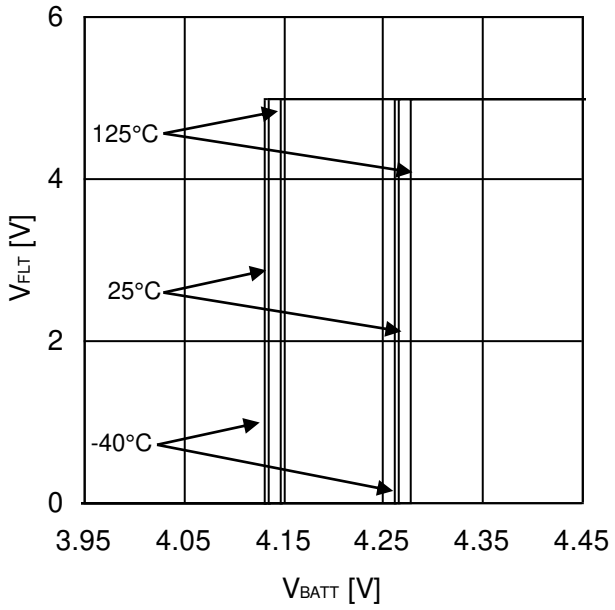

Figure 29. V_BATT UVLO ON/OFFVoltage

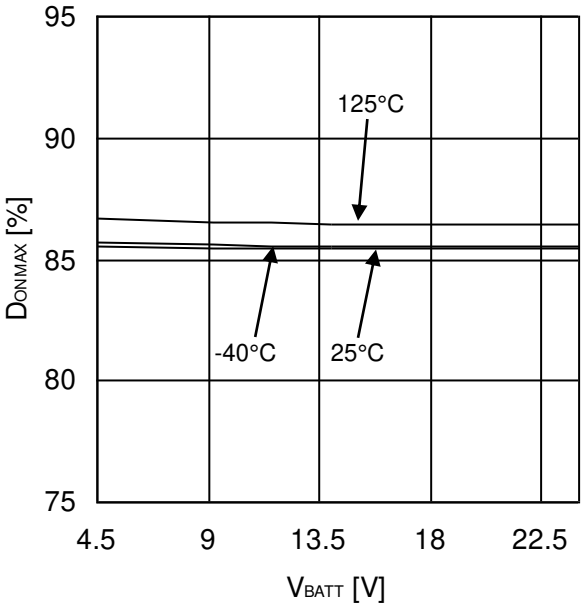

Figure 30. Maximum ON DUTY

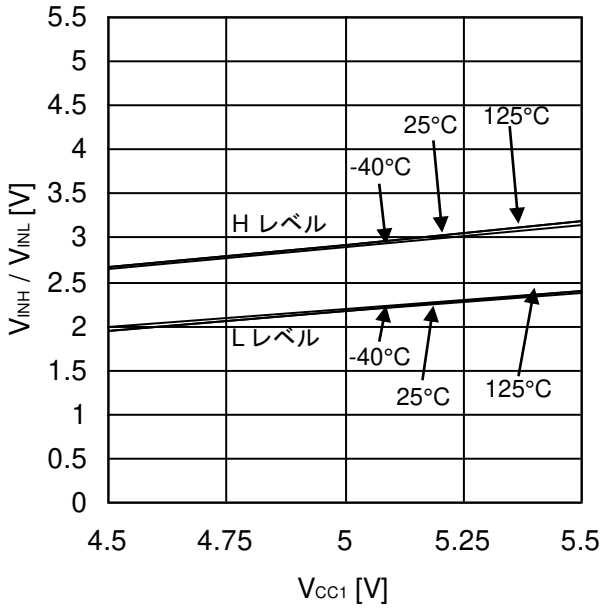

Figure 31. Logic High / Low Level Input Voltage (INA, DIS)

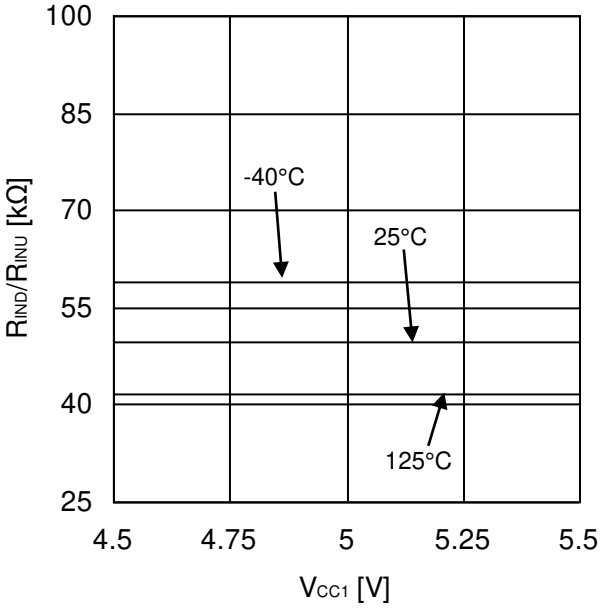

Figure 32. Logic Pull-Down Resistance (INA) Pull-Up Resistance (DIS)

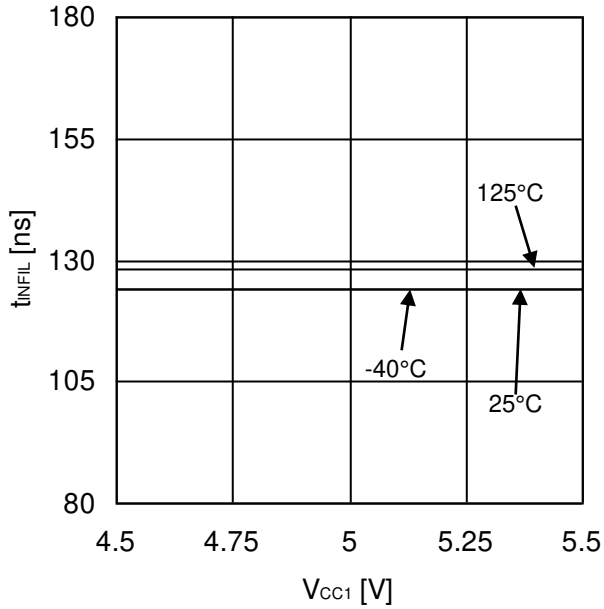

Figure 33. Logic Input Filtering Time (L pulse)

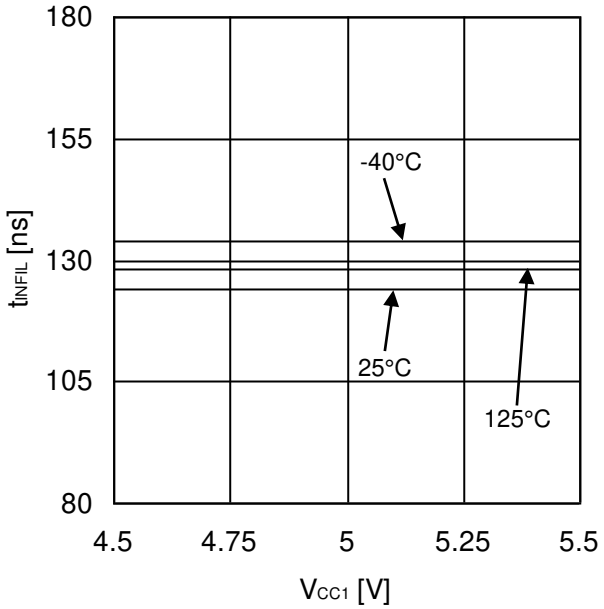

Figure 34. Logic Input Filtering Time (H pulse)

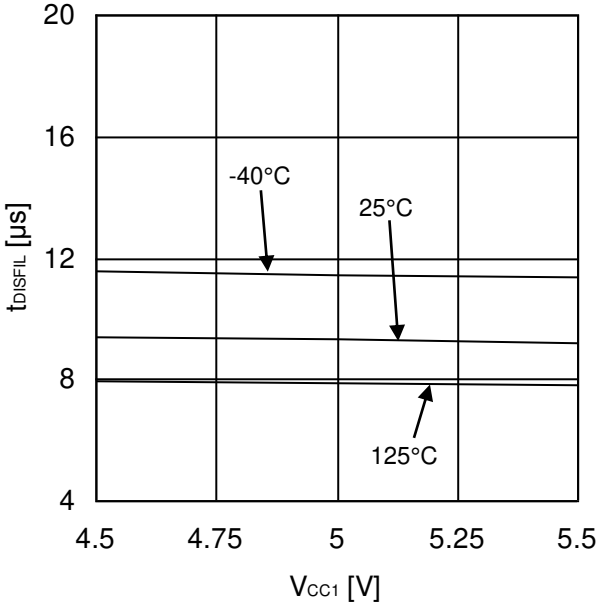

Figure 35. DIS Input Filtering Time

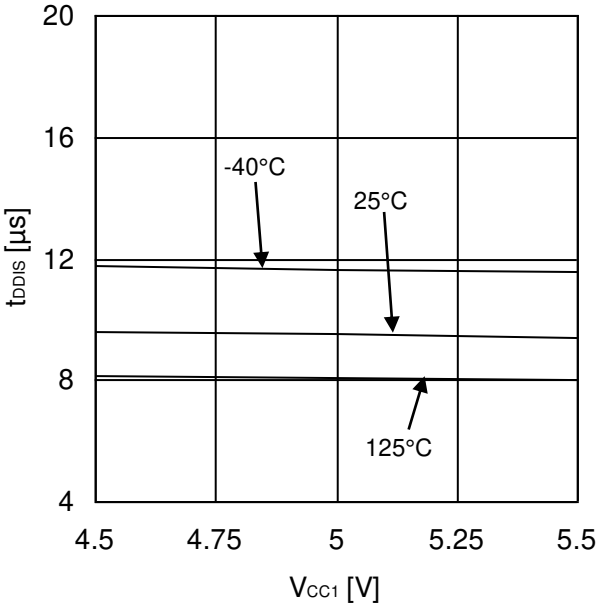

Figure 36. DIS Input Delay Time

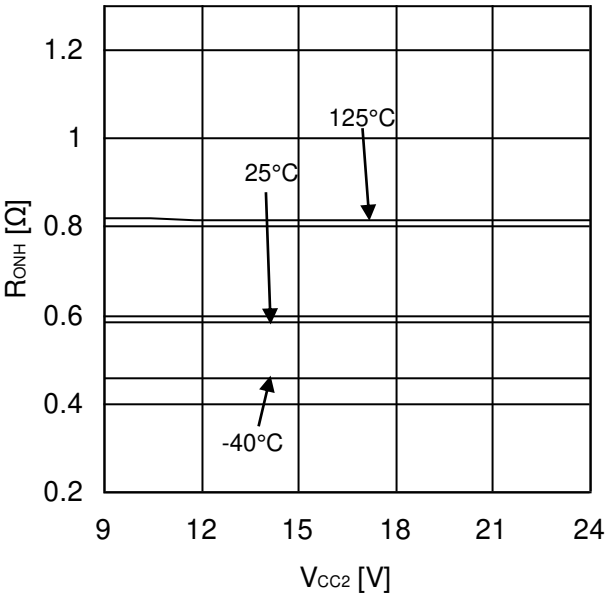

Figure 37. OUT1 ON-Resistance(Source-side)
(I_{OUT1}=40mA)

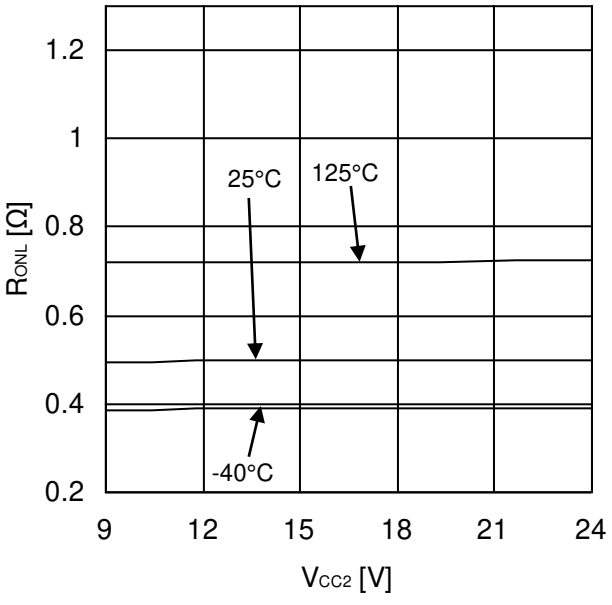

Figure 38. OUT1 ON-Resistance (Sink-side)
(I_{OUT1}=40mA)

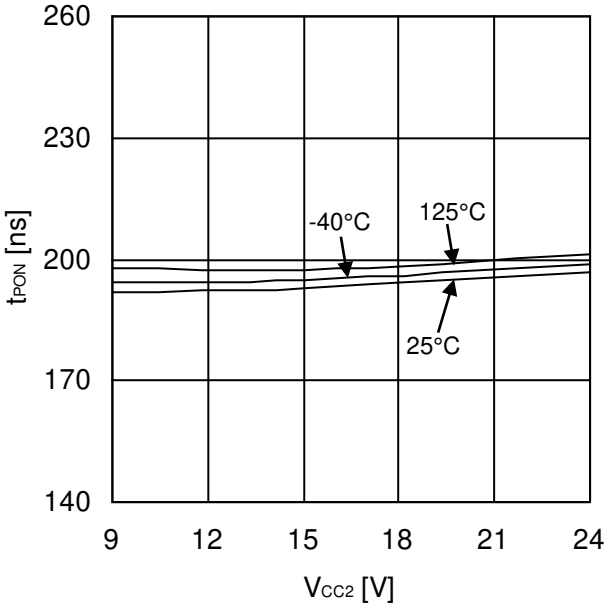

Figure 39. Turn ON time

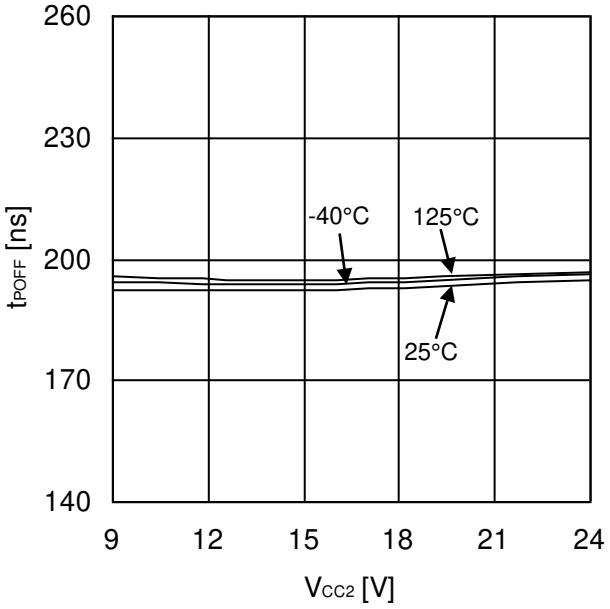

Figure 40. Turn OFF time

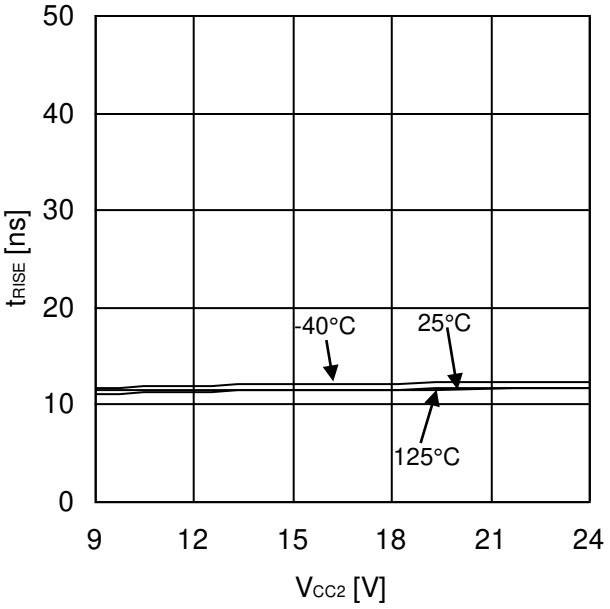

Figure 41. Rise time

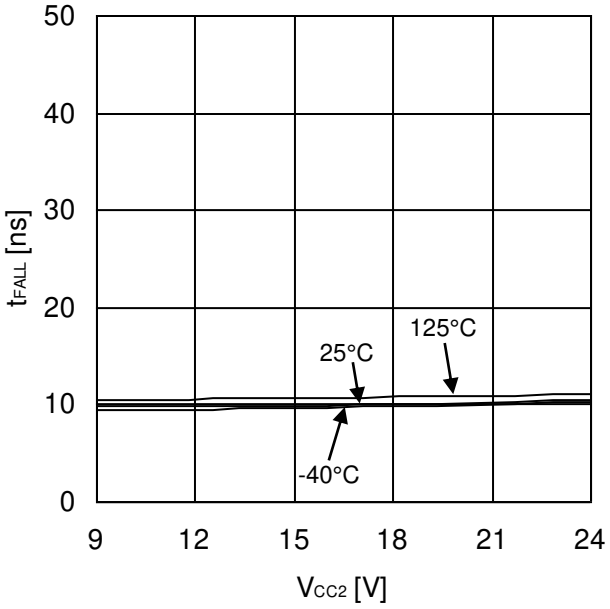

Figure 42. Fall time

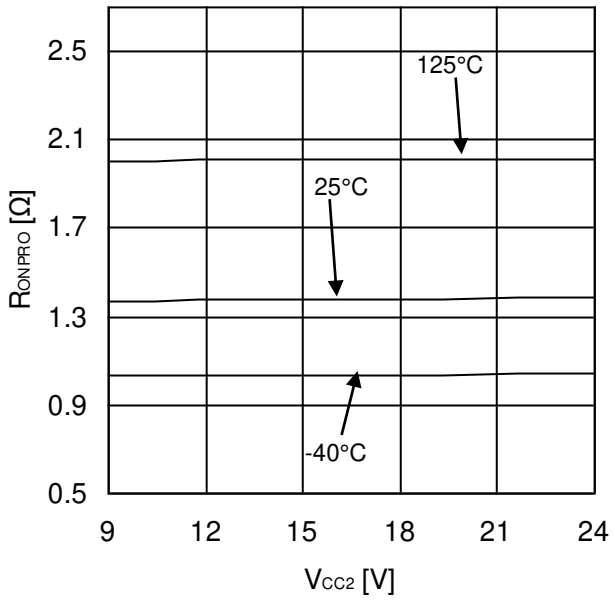

Figure 43. PROOUT ON-Resistance
(I_{PROOUT}=40mA)

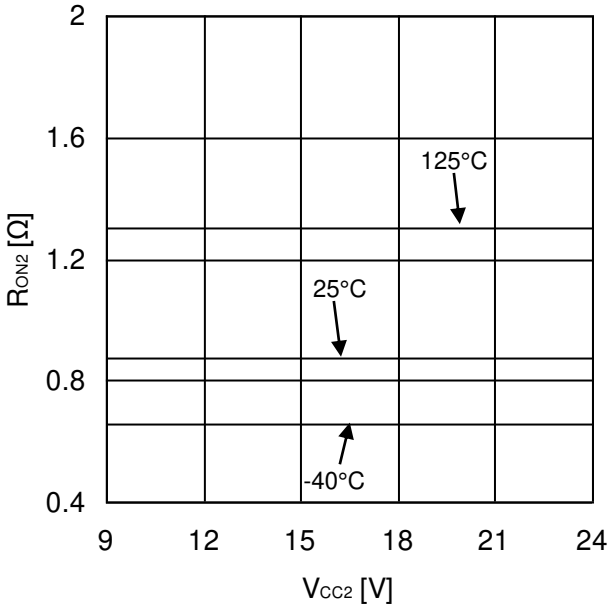

Figure 44. OUT2 ON-Resistance
(I_{OUT2}=40mA)

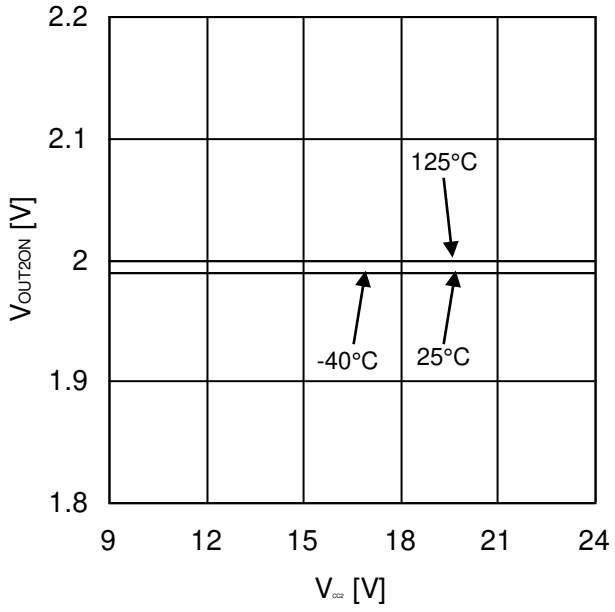

Figure 45. OUT2 ON Threshold Voltage

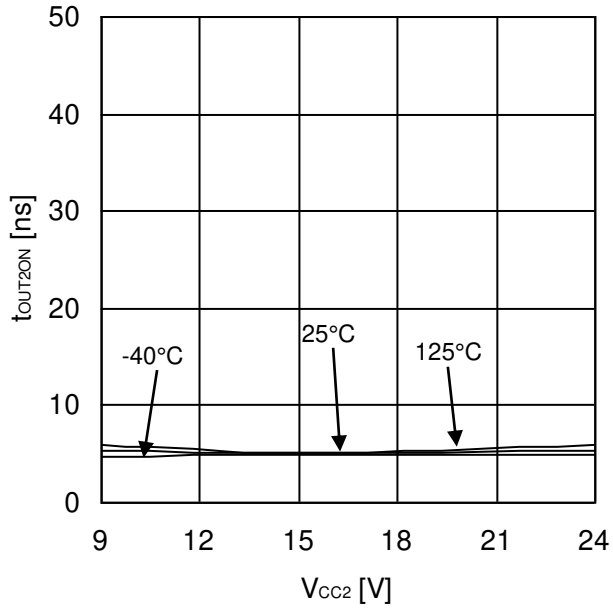

Figure 46. OUT2 Output Delay Time

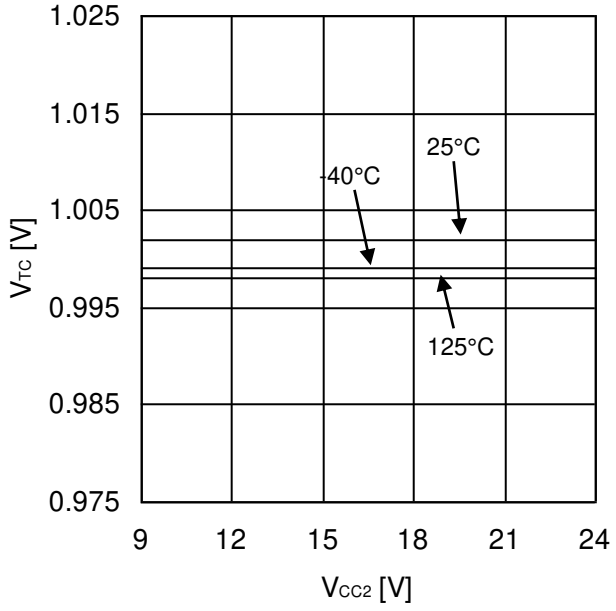

Figure 47. TC Pin Voltage

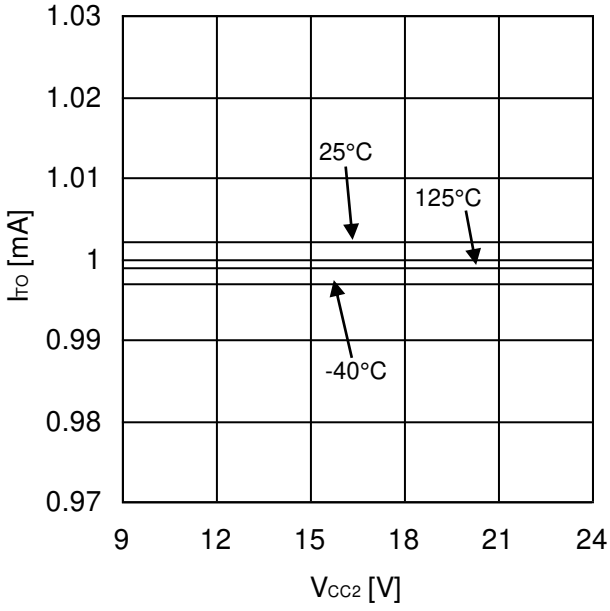

Figure 48. TOx Pin Output Current (RTC=10kΩ)

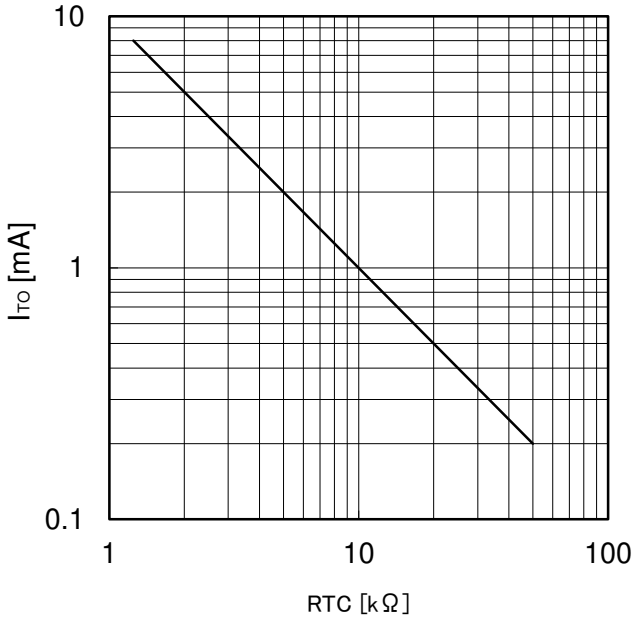

Figure 49. TOx Pin Output Current

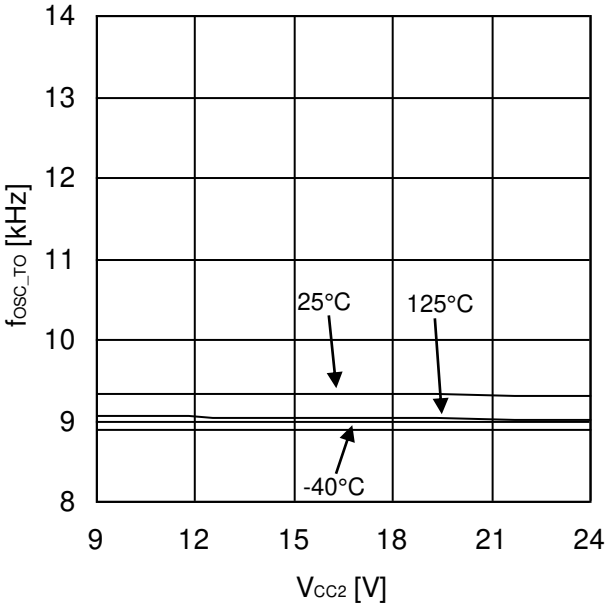

Figure 50. SENSOR Output Frequency

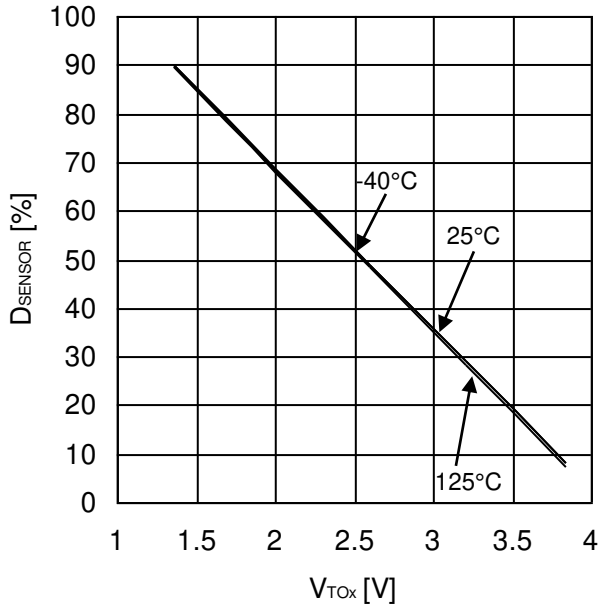

Figure 51. SENSOR Output Duty

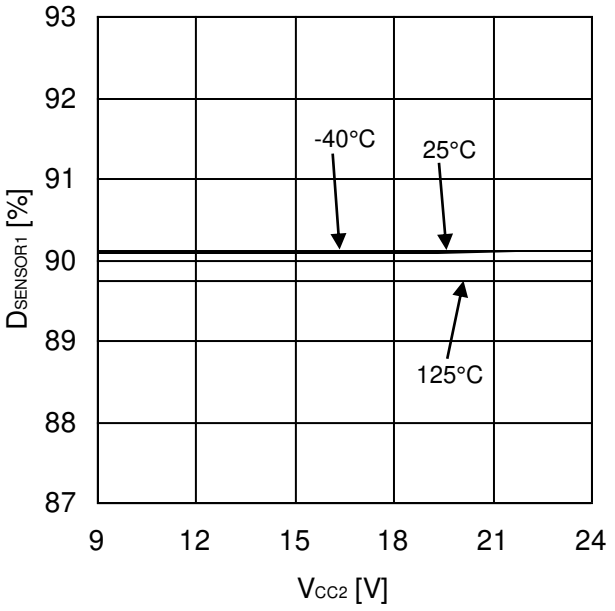

Figure 52. SENSOR Output Duty1
(VTOx=1.35V)

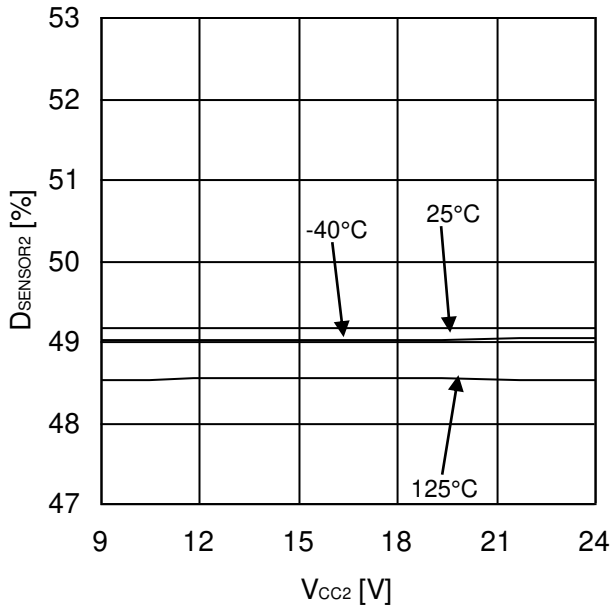

Figure 53. SENSOR Output Duty2
(VTOx=2.59V)

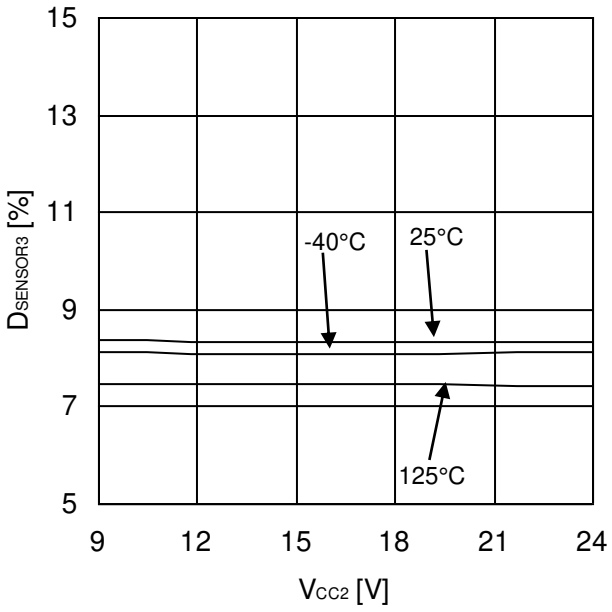

Figure 54. SENSOR Output Duty3
(VTOx=3.84V)

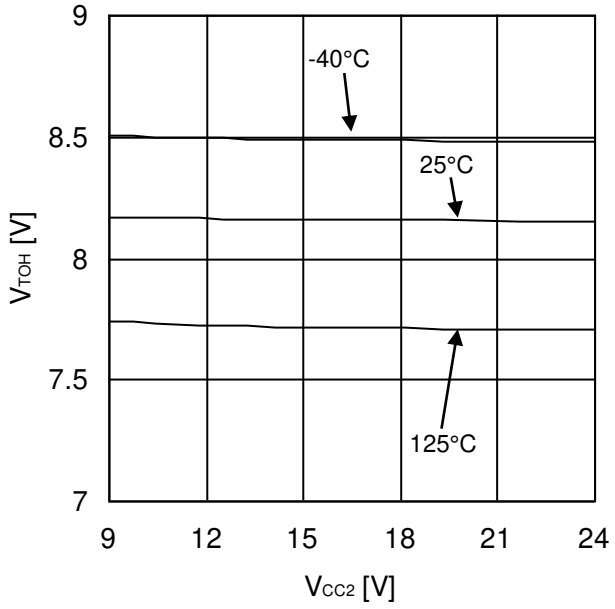

Figure 55. TOx Pin Disconnect Detection Voltage

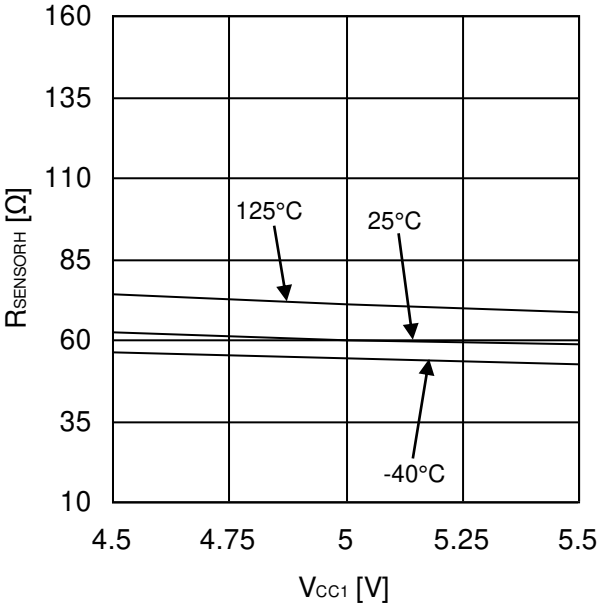

Figure 56. SENSOR ON Resistance(Source-side)
(I_{SEBSOR}=5mA)

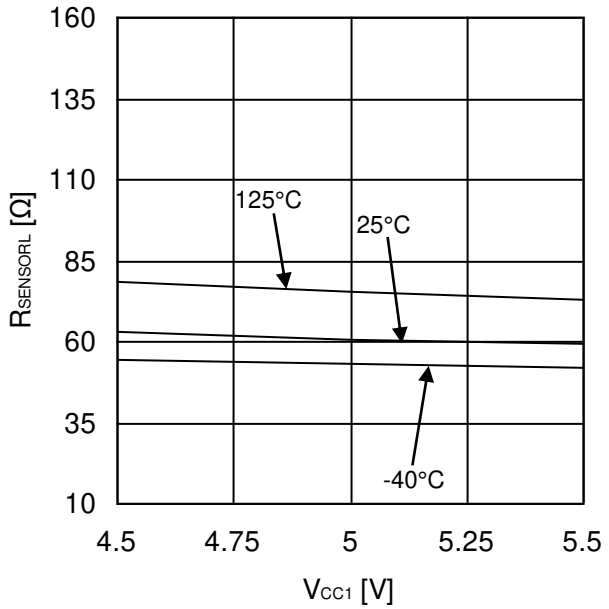

Figure 57. SENSOR ON Resistance (Sink-side)
(I_{SENSOR}=5mA)

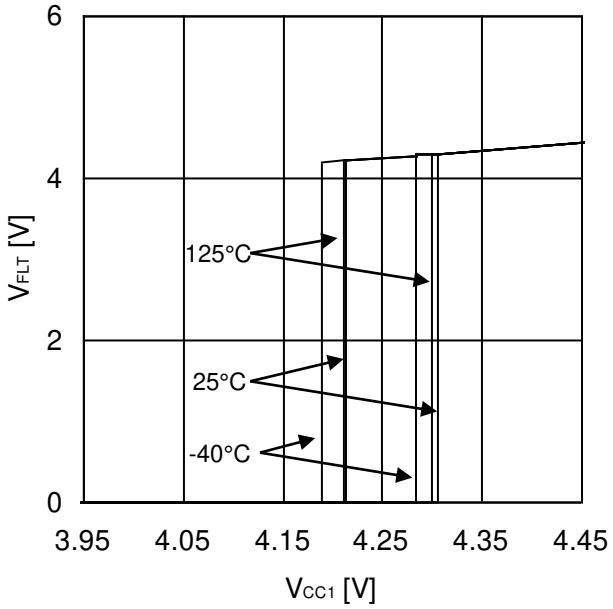

Figure 58. Input-side UVLO ON/OFF Voltage

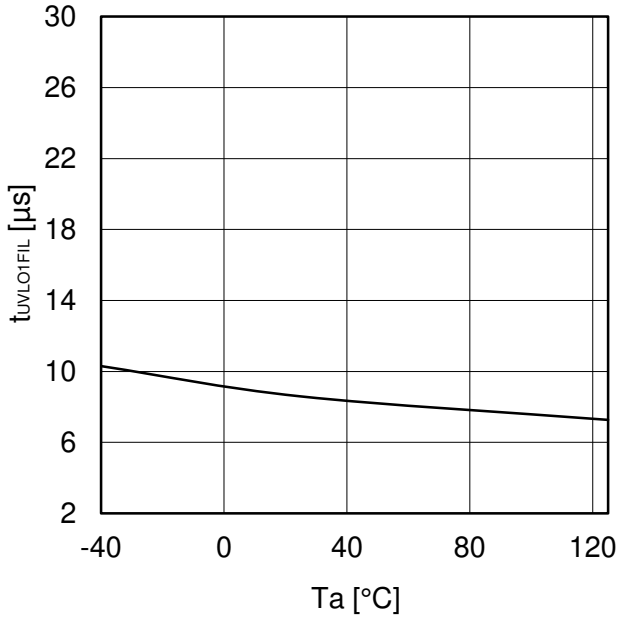

Figure 59. Input-side UVLO Filtering Time

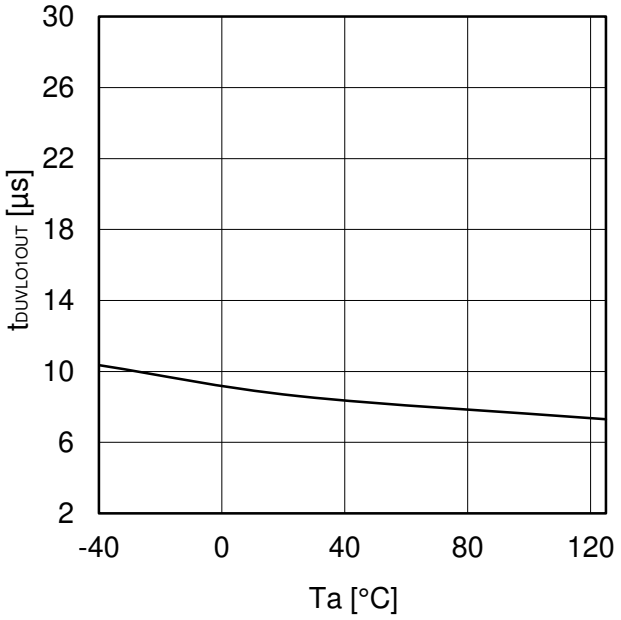

Figure 60. Input-side UVLO Delay Time (OUT1)

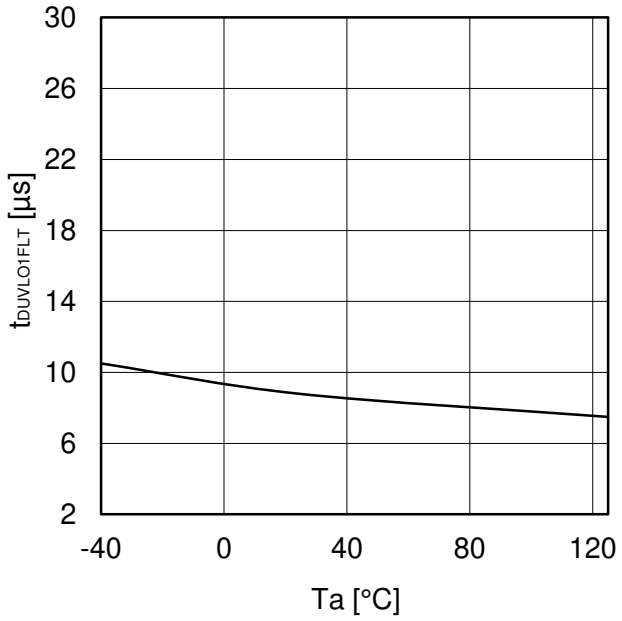

Figure 61. Input-side UVLO Delay Time (FLT)

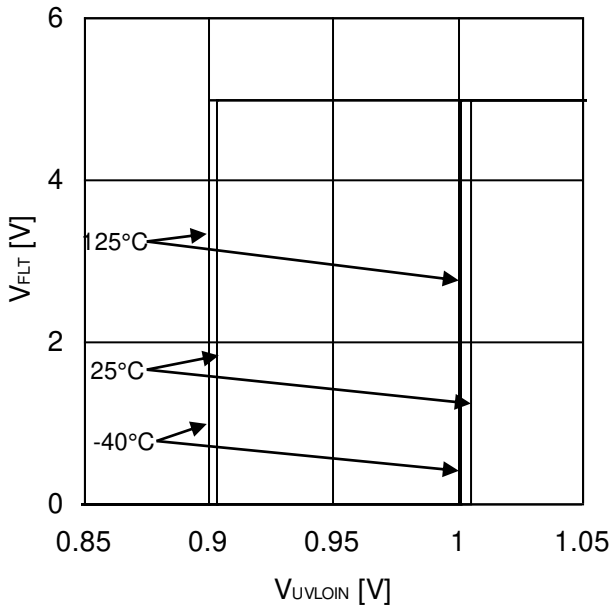

Figure 62. Output-side UVLO ON / OFF Threshold Voltage

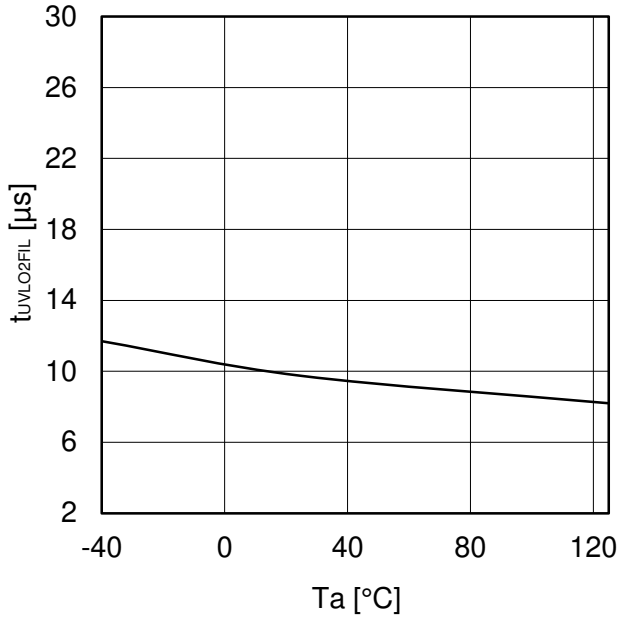

Figure 63. Output-side UVLO Filtering Time

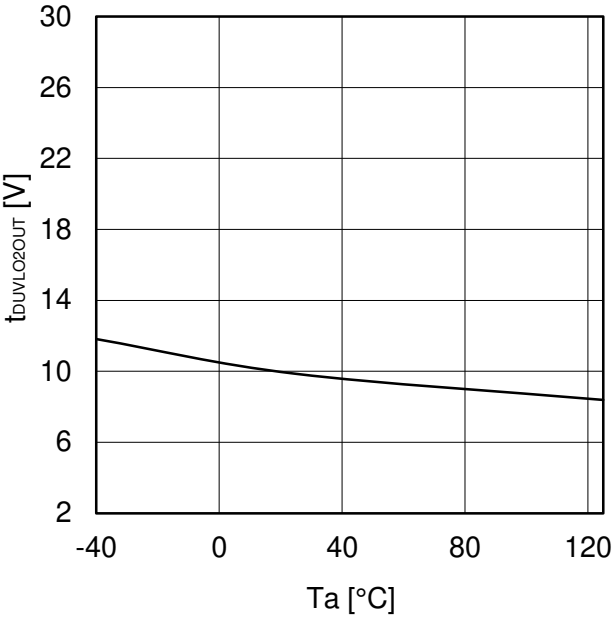

Figure 64. Output-side UVLO Delay Time (OUT1)

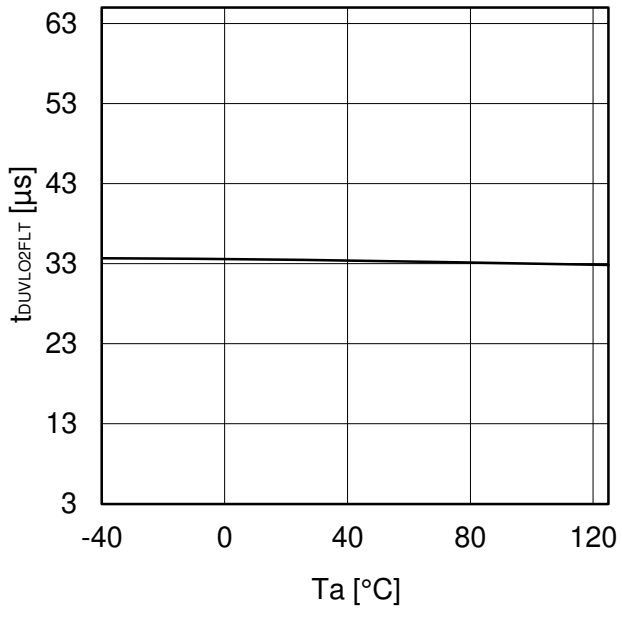

Figure 65. Output-side UVLO Delay Time (FLT)

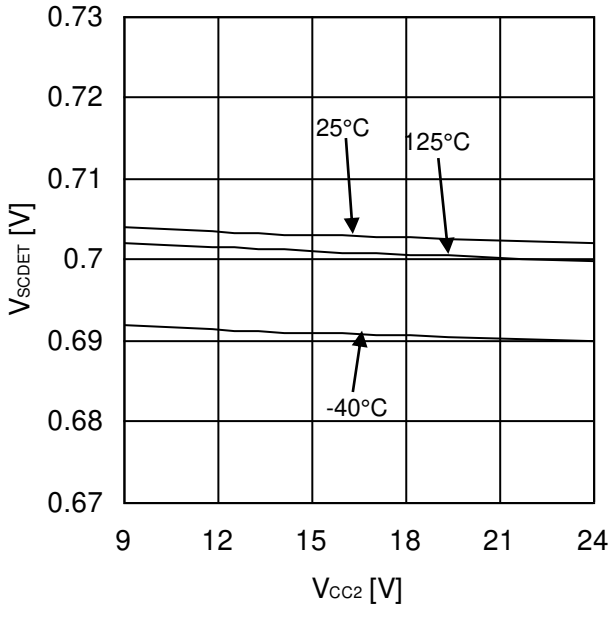

Figure 66. Short Current Detection Voltage

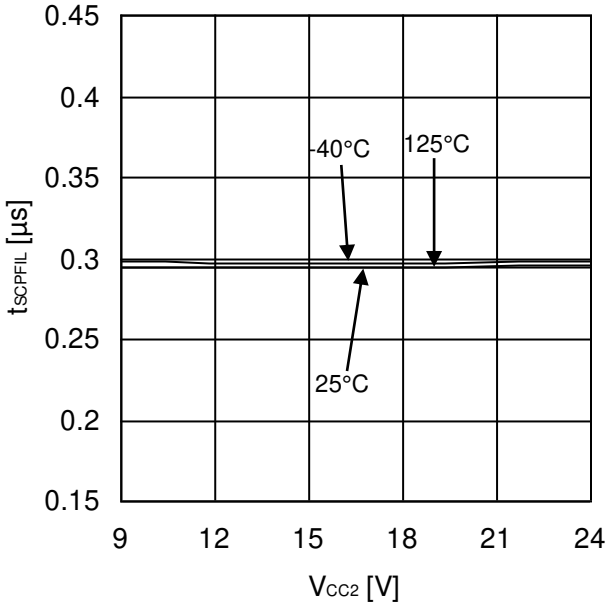

Figure 67. Short Current Detection Filtering Time

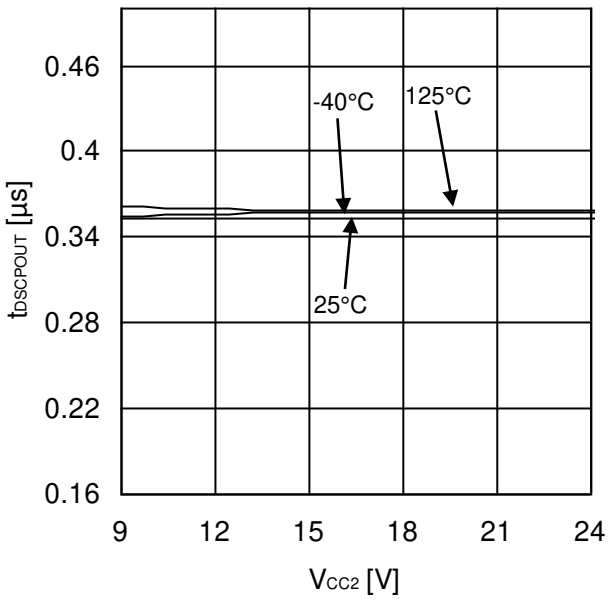

Figure 68. Short Current Detection Delay time (OUT1)

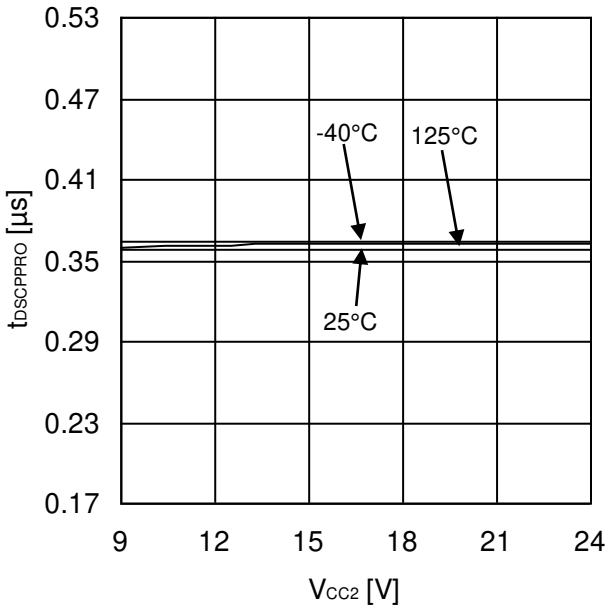

Figure 69. Short Current Detection Delay time (PROOUT)

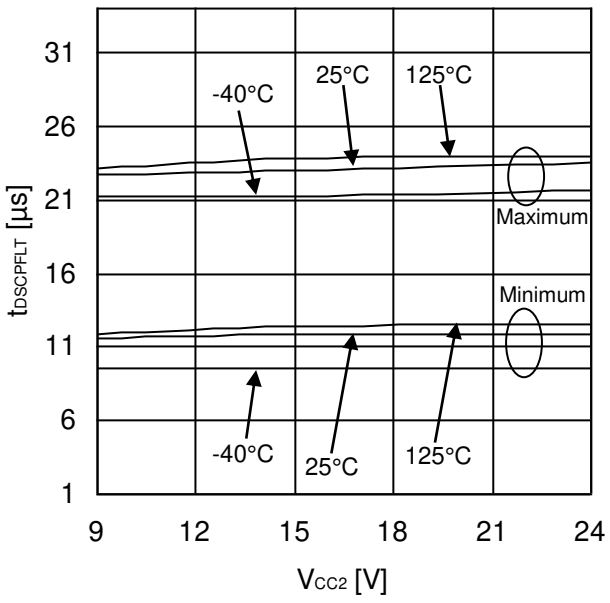

Figure 70. Short Current Detection Delay time (FLT)

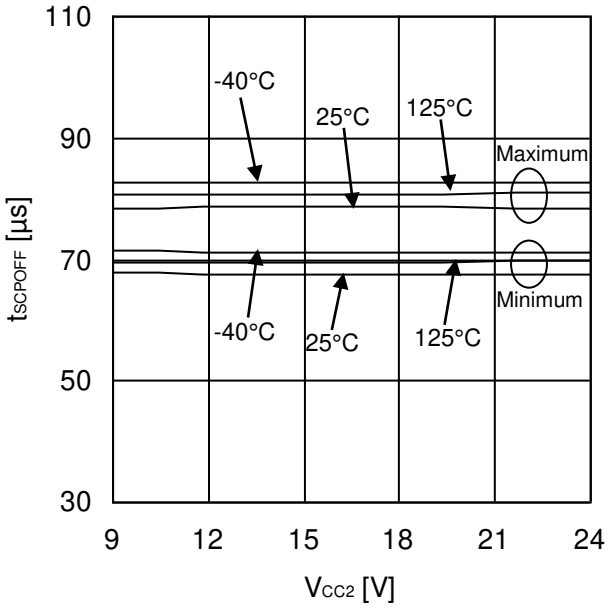

Figure 71. Soft Turn OFF Release Time

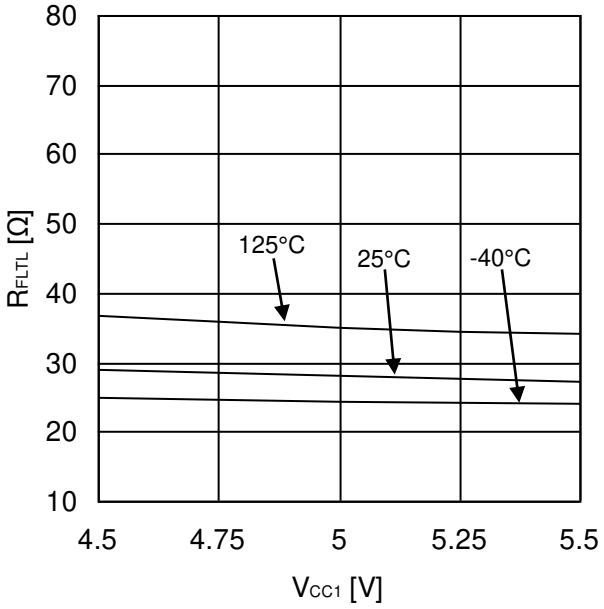

Figure 72. FLT Output ON-Resistance
(I_{FLT}=5mA)

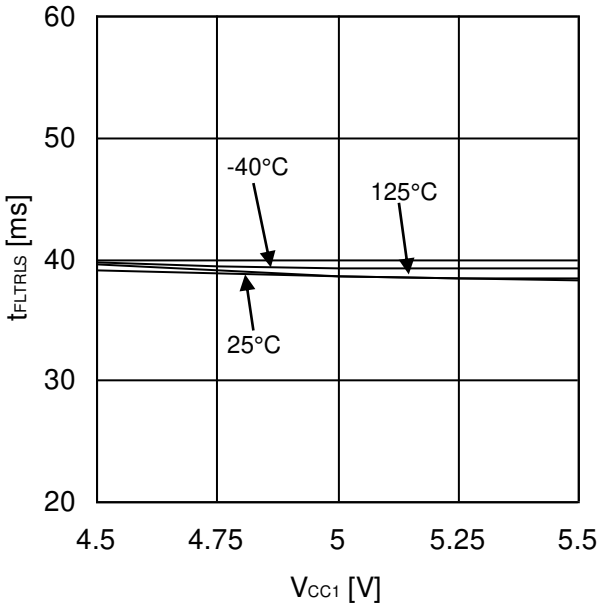

Figure 73. Fault Output Holding Time

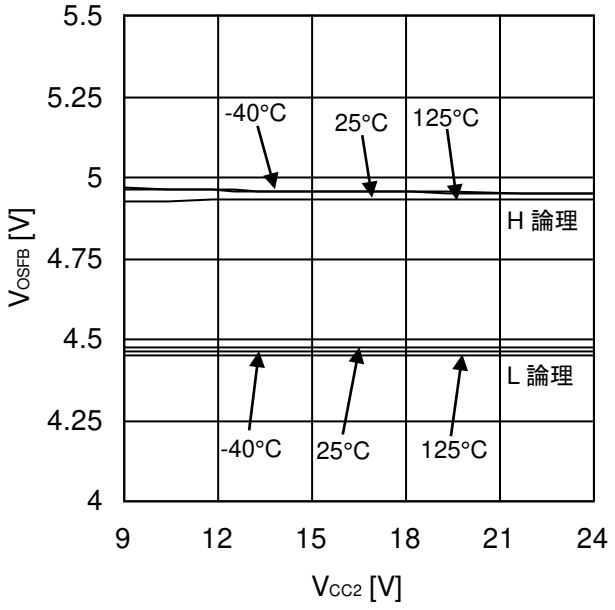

Figure 74. Gate State H /L
Detection Threshold Voltage

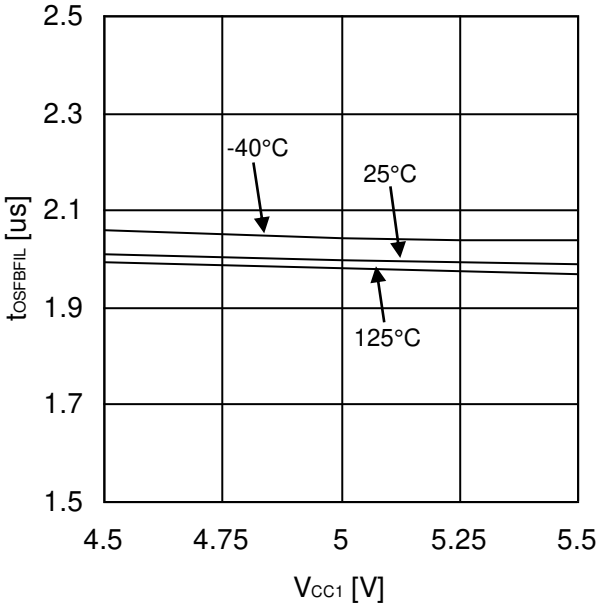

Figure 75. OSFB Output Filtering Time

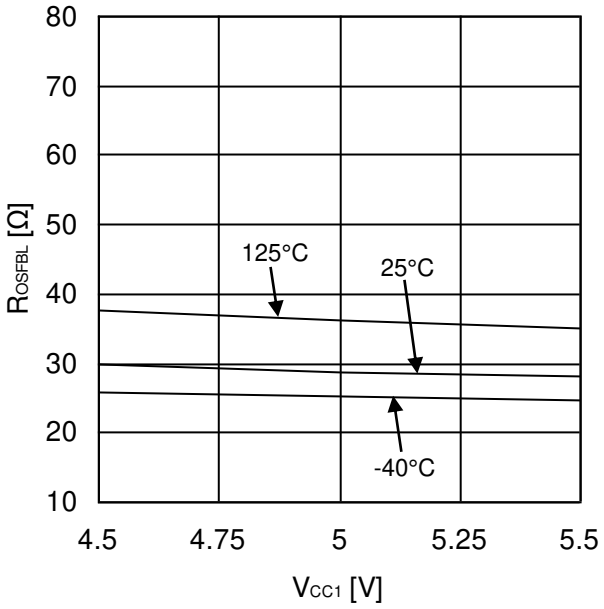

Figure 76. OSFB Output ON-Resistance
(I_{OSFB}=5mA)

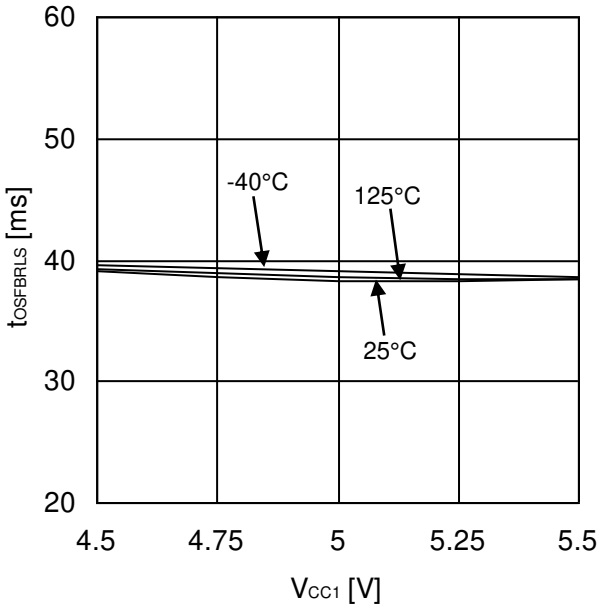

Figure 77. OSFB Output Holding Time