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High Side Switch ICs 2ch

BD651xF Series   BD20xxAFJ Series

● **General Description**

This High side switch IC for Universal Serial Bus (USB) is a high side switch that features over current protection used in power supply line of USB. Its switch unit has two channels of N-channel power MOSFET which are capable of current equal to 500mA for each channel. Moreover, it features over current detection, thermal shutdown, under voltage lockout and soft start circuit that are all built in.

● **Features**

■ Dual N-MOS high side switch
■ Continuous current load 0.5A
■ Control input logic
  Active-Low
  Active-High
■ Soft start circuit
■ Over current detection
■ Thermal shutdown
■ Under voltage lockout
■ Open drain error flag output
■ Reverse-current protection when switch off
■ Flag output delay filter built in

● **Applications**

USB hub in consumer appliances, Car accessory, PC, PC peripheral equipment, and so on.

● **Typical Application Circuit**
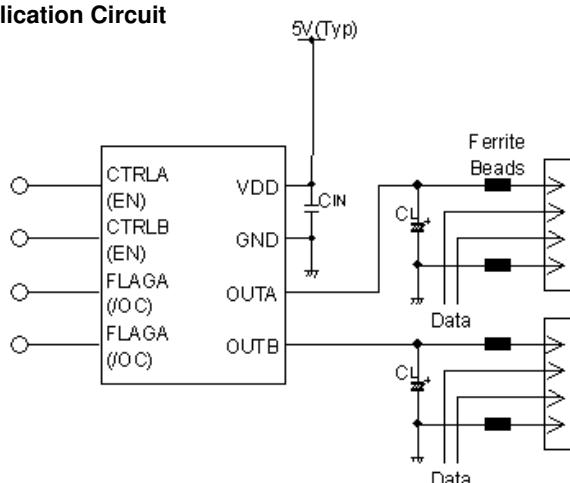

● **Key Specifications**

■ Input voltage range:
  BD651xF Series   3.0V to 5.5V
  BD20xxAFJ Series   2.7V to 5.5V
■ ON resistance :
  BD6512F/BD6513F   100mΩ or 120mΩ(Typ.)
  BD6516F/BD6517F   110mΩ or 140mΩ(Typ.)
  BD2042FAFJ/BD2052AFJ   100 mΩ(Typ.)
■ Over current threshold:
  BD6512F/BD6513F   1.25A min., 2.2A max.
  BD6516F/BD6517F   1.2A min., 2.5A max.
  BD2042FAFJ/BD2052AFJ   0.7A min., 1.8A max.
■ Standby current:
  BD20xxAFJ Series   0.01µA (Typ.)
■ Operating temperature range:
  BD651xF Series   -25℃ to +85℃
 BD20xxAFJ Series   -40℃ to +85℃

● **Packages**   W(Typ.)   D(Typ.)   H (Max.)
  SOP8   5.00mm x 6.20mm x 1.71mm
 SOP-J8   4.90mm x 6.00mm x 1.65mm

SOP8	**SOP-J8**
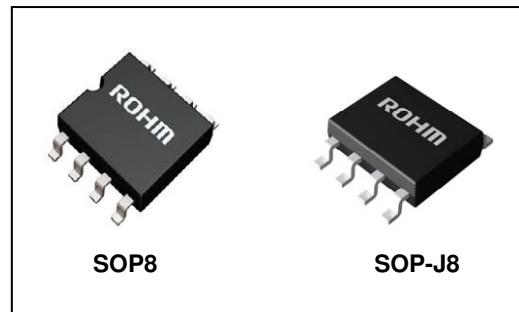
● **Lineup**

Over current threshold			Control input logic	Package		Orderable Part Number
Min.	**Typ.**	**Max.**				
1.25A	1.65A	2.2A	High	SOP8	Reel of 2500	BD6512F – E2
1.25A	1.65A	2.2A	Low			BD6513F – E2
1.2A	1.65A	2.5A	High			BD6516F – E2
1.2A	1.65A	2.5A	Low			BD6517F – E2
0.7A	1.0A	1.8A	High	SOP-J8		BD2042AFJ – E2
0.7A	1.0A	1.8A	Low			BD2052AFJ – E2

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

● **Block Diagrams**

◎BD651xF Series
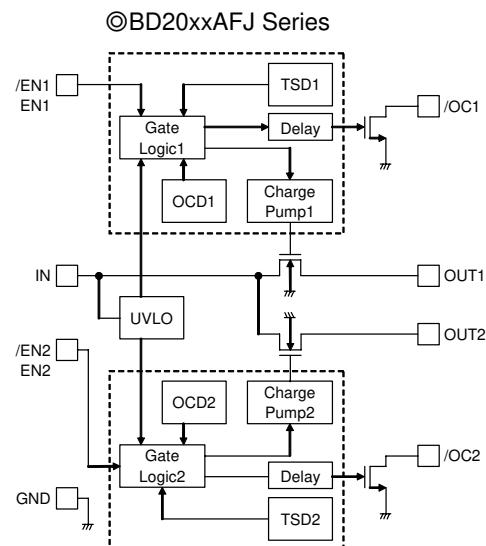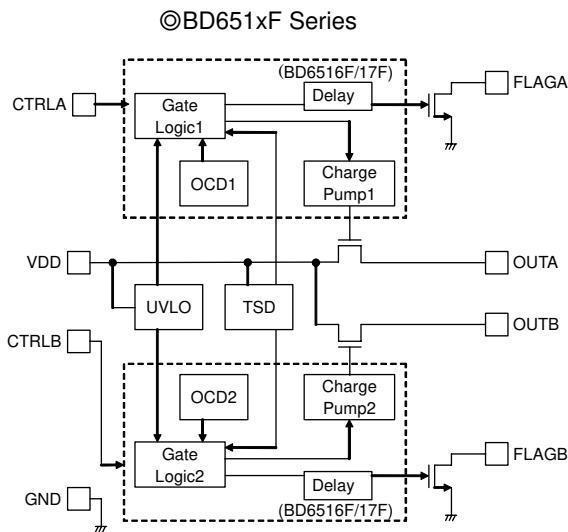

◎BD20xxAFJ Series

● **Pin Configurations**

BD651xF Series
TOP VIEW

BD20xxAFJ Series
TOP VIEW

● **Pin Descriptions**

◎BD651xF Series

Pin No.	Symbol	I / O	Pin function
1, 4	CTRLA CTRLB	I	Enable input. Switch ON at Low level. (BD6513F/BD6517F) Low level input < 0.7V. Switch ON at High level. (BD6512F/BD6516F) High level input > 2.5V.
2, 3	FLAGA FLAGB	O	Error flag output. Low at over current, thermal shutdown. Open drain output.
5, 8	OUTB OUTA	O	Switch output.
6	GND	I	Ground.
7	VDD	I	Power supply input. Input terminal of the switch and power supply of internal circuit.

◎BD20xxAFJ Series

Pin. No.	Symbol	I / O	Pin function
1	GND	I	Ground.
2	IN	I	Power supply input. Input terminal of the switch and power supply of internal circuit.
3, 4	/EN, EN	I	Enable input. Switch on at Low level. (BD2042AFJ) Low level input < 0.8V Switch On at High level. (BD2052AFJ) High level input > 2.0V. .
5, 8	/OC	O	Error flag output. Low at over current, thermal shutdown. Open drain output.
6, 7	OUT	O	Switch output.

●**Absolute Maximum Ratings**
　◎BD651xF Series

Parameter	Symbol	Ratings	Unit
Input voltage	V_{DD}	-0.3 to 6.0	V
CTRL voltage	V_{CTRL}	-0.3 to V_{DD}+0.3	V
Flag voltage	V_{FLAG}	-0.3 to 6.0	V
Output voltage	V_{OUT}	-0.3 to V_{DD}+0.3 (BD6512F/ BD6513F)	V
		-0.3 to 6.0 (BD6516F/ BD6517F)	V
Storage temperature	T_{STG}	-55 to 150	ºC
Power dissipation [*1]	Pd	560 [*1]	mW

　◎BD20xxAFJ Series

Parameter	Symbol	Ratings	Unit
Input voltage	V_{IN}	-0.3 to 6.0	V
EN,/EN voltage	V_{EN}, $V_{/EN}$	-0.3 to 6.0	V
/OC voltage	$V_{/OC}$	-0.3 to 6.0	V
/OC current	$I_{S/OC}$	10	mA
OUT voltage	V_{OUT}	-0.3 to 6.0	V
Storage temperature	T_{STG}	-55 to 150	ºC
Power dissipation [*1]	Pd	560 [*1]	mW

　*1 This value decreases by 4.48mW/℃ above Ta=25℃.

●**Recommended Operation Ratings**
　◎BD651xF Series

Parameter	Symbol	Ratings	Unit
Input voltage	V_{DD}	3.0 to 5.5	V
Operation temperature	T_{OPR}	-25 to 85	°C
Continuous output current	I_{LO}	0 to 500	mA

　◎BD20xxAFJ Series

Parameter	Symbol	Ratings	Unit
Input voltage	V_{IN}	2.7 to 5.5	V
Operation temperature	T_{OPR}	-40 to 85	ºC
Continuous output current	I_{LO}	0 to 500	mA

●**Electrical Characteristics**
◎BD6512F/BD6513F(V$_{DD}$ =5V, Ta=25℃, unless otherwise specified.)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Operating current	I$_{DD}$	-	85	120	µA	V$_{CTRL}$=5V(BD6512F), 0V(BD6513F) OUT=OPEN
		-	0.01	2	µA	V$_{CTRL}$=0V(BD6512F), 5V(BD6513F) OUT=OPEN
Control input voltage	V$_{CTRL}$	-	-	0.7	V	CTRL Low Level Input
		2.5	-	-	V	CTRL High Level Input
Control input current	I$_{CTRL}$	-1	0.01	1	µA	V$_{CTRL}$=0V or 5V
On resistance	R$_{ON}$	-	100	130	mΩ	V$_{DD}$=5V,I$_{OUT}$=500mA
		-	120	160	mΩ	V$_{DD}$=3.3V,I$_{OUT}$=500mA
Turn on delay	T$_{RD}$	100	600	2000	µs	RL=10Ω
Turn on rise time	T$_R$	200	1500	6000	µs	RL=10Ω
Turn off delay	T$_{FD}$	-	3	20	µs	RL=10Ω
Turn off fall time	T$_F$	-	1	20	µs	RL=10Ω
UVLO threshold voltage	V$_{UVLOH}$	2.3	2.5	2.7	V	V$_{DD}$ increasing
	V$_{UVLOL}$	2.1	2.3	2.5	V	V$_{DD}$ decreasing
Thermal shutdown threshold	T$_{TS}$	-	135	-	ºC	
Flag output resistance	R$_{FLAG}$	-	16	40	Ω	I$_{FLAG}$=5mA
Flag off current	I$_{FLAG}$	-	0.01	1	µA	
Current limit threshold	ITH$_{LIM}$	1.25	1.65	2.20	A	
Over current limit level	I$_{LIM}$	0.6	1.1	1.6	A	

◎BD6516F/BD6517F (V$_{DD}$ =5V, Ta=25℃, unless otherwise specified.)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Current consumption	I$_{DD}$	-	100	140	µA	V$_{CTRL}$=5V(BD6516F), 0V(BD6517F) OUT=OPEN
		-	0.01	2	µA	V$_{CTRL}$=0V(BD6516F), 5V(BD6517F) OUT=OPEN
CTRL input voltage	V$_{CTRL}$	-	-	0.7	V	Low level input voltage
		2.5	-	-	V	High level input voltage
CTRL input current	I$_{CTRL}$	-1	0.01	1	µA	V$_{CTRL}$=0V or 5V
FLAG output resistance	R$_{FLAG}$	-	250	450	Ω	I$_{FLAG}$=1mA
FLAG output leak current	I$_{FLAG}$	-	0.01	1	µA	V$_{FLAG}$=5V
FLAG output delay	TD$_{FL}$	-	1	4	ms	
ON resistance	R$_{ON}$	-	110	150	mΩ	V$_{DD}$=5V,I$_{OUT}$=500mA
		-	140	180	mΩ	V$_{DD}$=3.3V,I$_{OUT}$=500mA
Over-current Threshold	I$_{TH}$	1.2	1.65	2.5	A	
Short circuit output current	I$_{SC}$	1.2	1.65	2.2	A	V$_{OUT}$=0V
Output leak current	I$_{LEAK}$	-	-	10	µA	V$_{CTRL}$=0V(BD6516F), 5V(BD6517F)
Thermal shutdown threshold	T$_{TS}$	-	135	-	ºC	At Tj increase
Output rise time	T$_{ON1}$	100	1300	4000	µs	RL=10Ω
Output turn on delay time	T$_{ON2}$	200	1500	6000	µs	RL=10Ω
Output fall time	T$_{OFF1}$	-	1	20	µs	RL=10Ω
Output turn off delay time	T$_{OFF2}$	-	3	20	µs	RL=10Ω

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◎BD20xxAFJ Series (V$_{DD}$ =5V, Ta=25℃, unless otherwise specified.)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Operating Current	I$_{DD}$	-	110	140	µA	V$_{/EN}$ = 0V, OUT = OPEN (BD2042AFJ) V$_{EN}$ = 5V, OUT = OPEN (BD2052AFJ)
Standby Current	I$_{STB}$	-	0.01	1	µA	V$_{/EN}$ = 5V, OUT = OPEN (BD2042AFJ) V$_{EN}$ = 0V, OUT = OPEN (BD2052AFJ)
/EN input voltage	V$_{/EN,EN}$	2.0	-	-	V	High input
		-	-	0.8	V	Low input
		-	-	0.4	V	Low input 2.7V≤ V$_{IN}$ ≤4.5V
/EN input current	I$_{/EN,EN}$	-1.0	0.01	1.0	µA	V$_{/EN,EN}$ = 0V or V$_{/EN,EN}$ = 5V
/OC output LOW voltage	V$_{/OC}$	-	-	0.5	V	I$_{/OC}$ = 5mA
/OC output leak current	IL$_{/OC}$	-	0.01	1	µA	V$_{/OC}$ = 5V
ON resistance	R$_{ON}$	-	100	130	mΩ	I$_{OUT}$ = 500mA
Over Current Threshold	I$_{TH}$	0.7	1.0	1.8	A	
Output current at short	I$_{SC}$	0.7	1.0	1.3	A	V$_{IN}$ = 5V, V$_{OUT}$ = 0V, C$_L$ = 100µF (RMS)
Output rise time	T$_{ON1}$	-	1.8	10	ms	R$_L$ = 10Ω , C$_L$ = OPEN
Output turn on time	T$_{ON2}$	-	2.1	20	ms	
Output fall time	T$_{OFF1}$	-	1	20	µs	
Output turn off time	T$_{OFF2}$	-	3	40	µs	
UVLO threshold	V$_{TUVH}$	2.1	2.3	2.5	V	Increasing V$_{IN}$
	V$_{TUVL}$	2.0	2.2	2.4	V	Decreasing V$_{IN}$

●**Measurement Circuit**
◎BD651xF Series
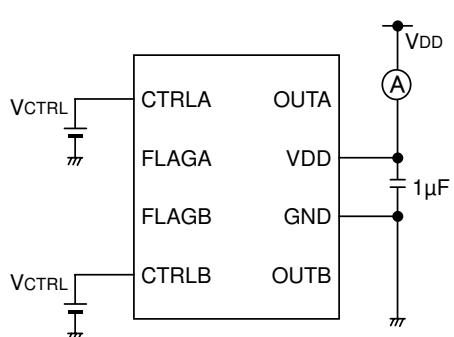
A.   Operating current
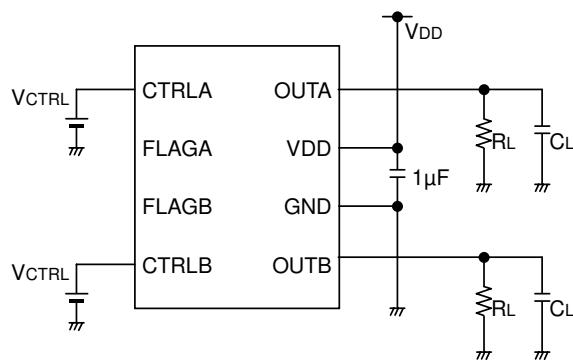
B. CTRL input voltage, Output rise, fall time
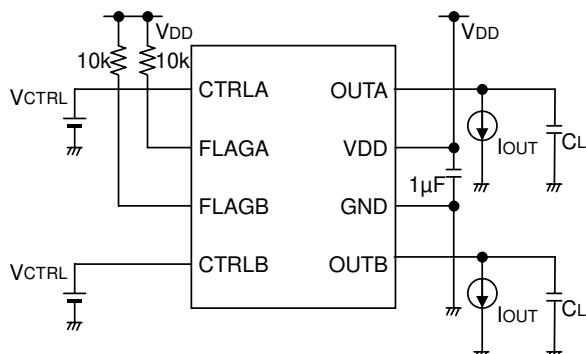
C. ON resistance, Over current detection
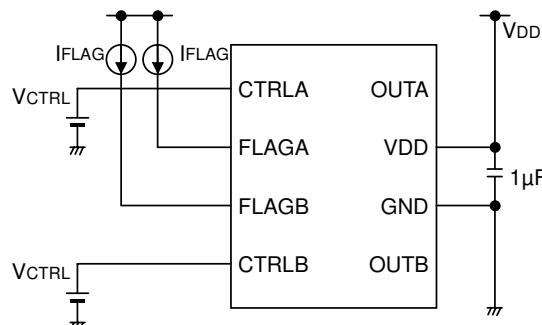
D. FLAG output resistance

◎BD20xxAFJ Series
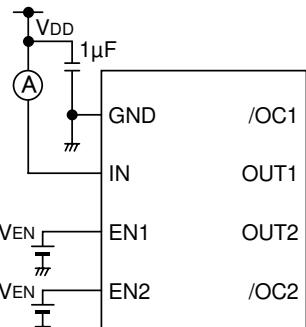
E. Operating current
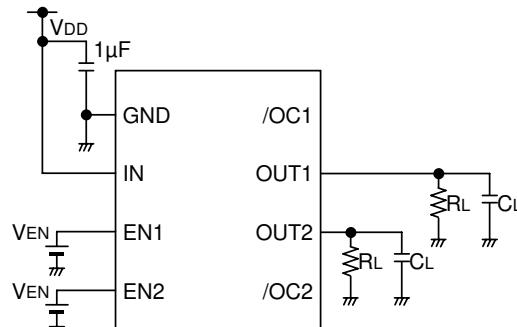
F. EN, /EN input voltage, Output rise, fall time
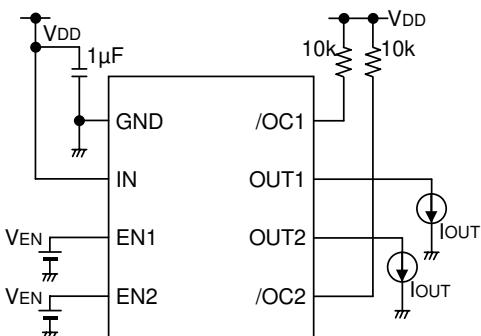
G. ON resistance, Over current detection
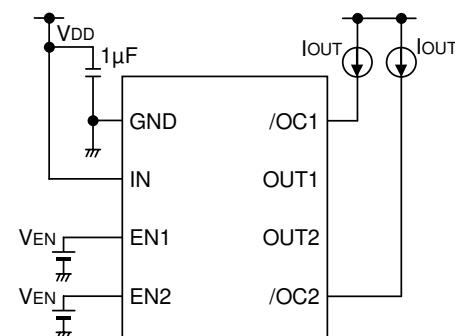
H. /OC output LOW voltage

Figure 1. Measurement circuits

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●**Timing Diagram**
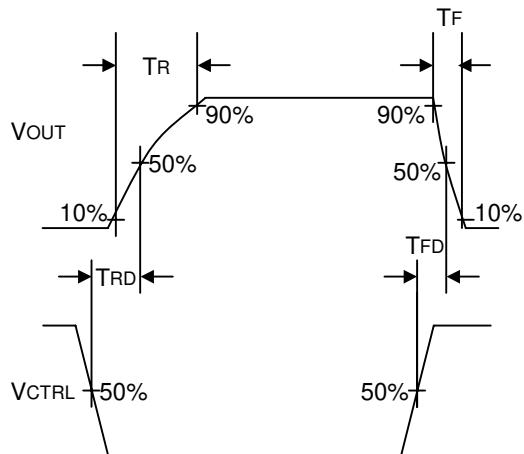
◎BD6513F

◎BD6512F
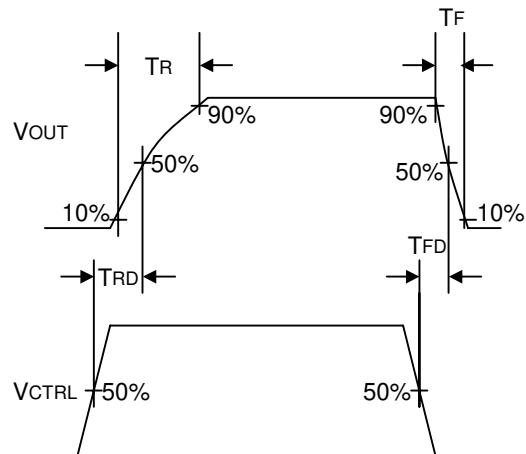
◎BD6516F/BD2042AFJ
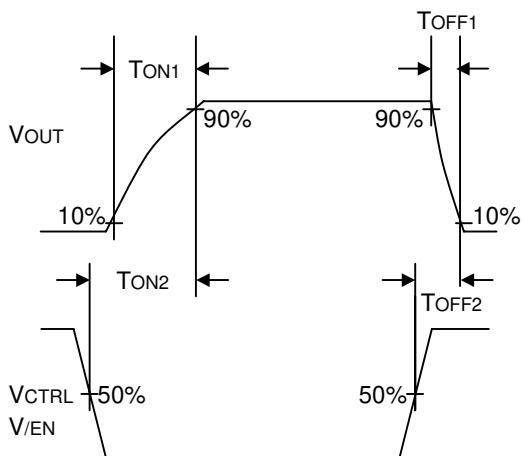
◎BD6517F/BD2052AFJ
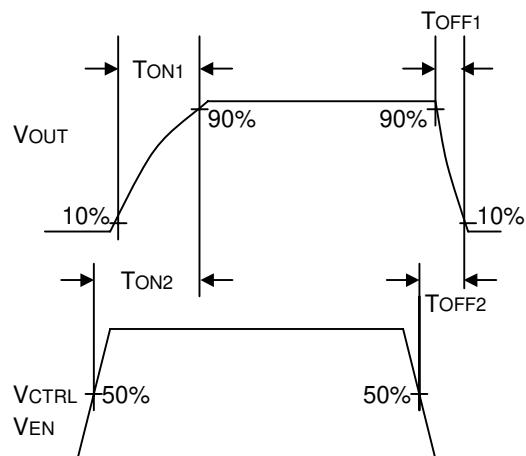
Figure 2. Timing Diagram

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●**Typical Performance Curves**
　◎BD6512F/ BD6513F
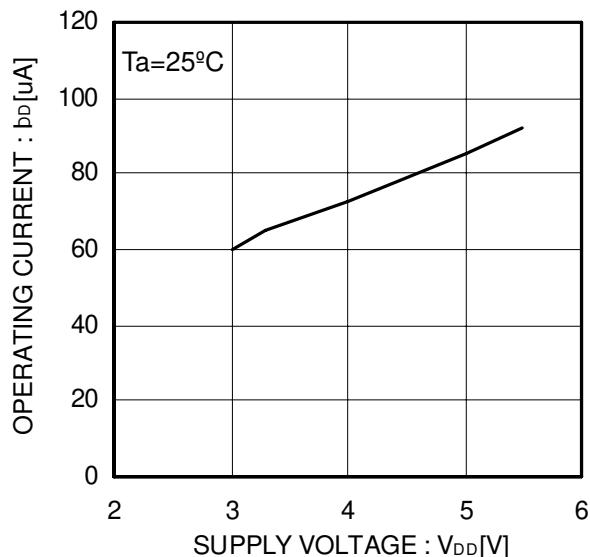
Figure 3. Operating current
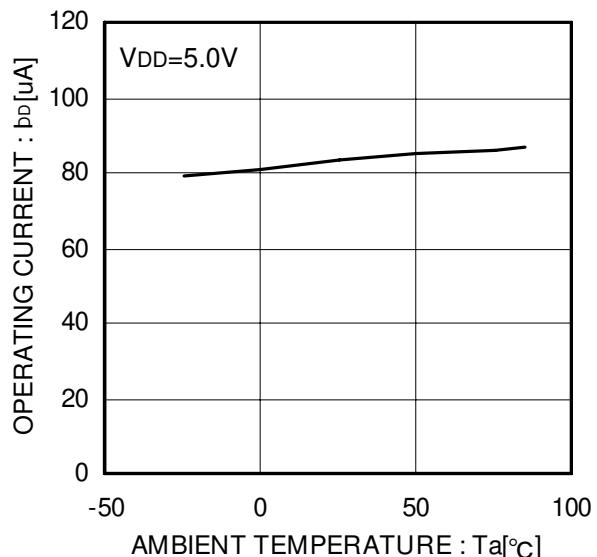
Figure 4. Operating current
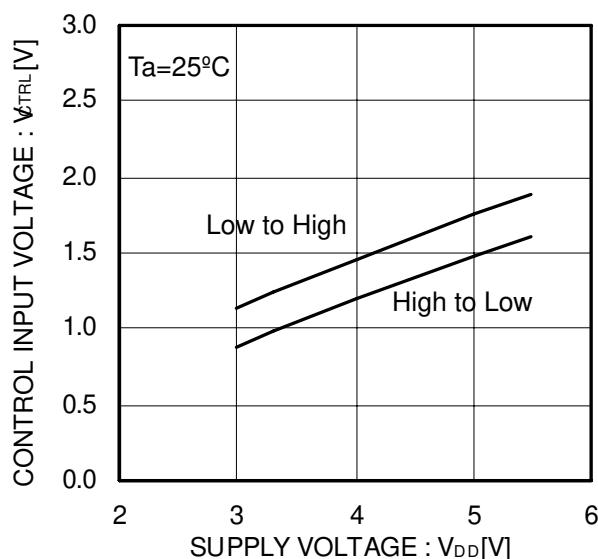
Figure 5. CTRL input voltage
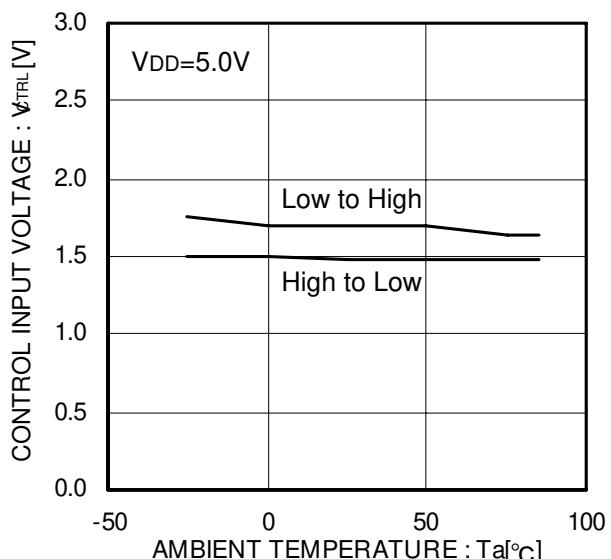
Figure 6. CTRL input voltage

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●**Typical Performance Curves - continued**
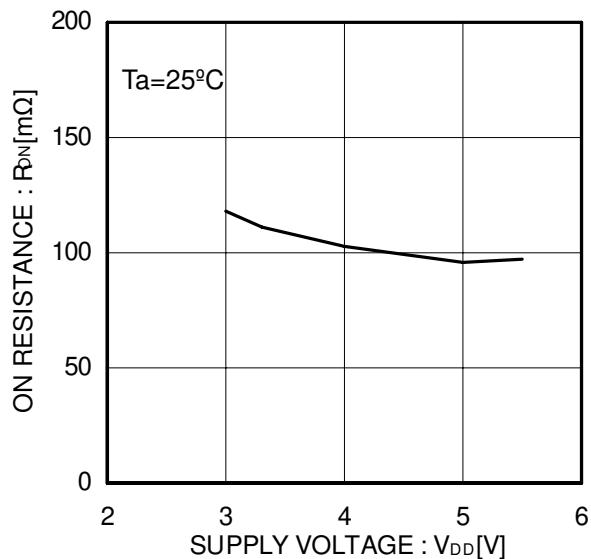
Figure 7. ON resistance
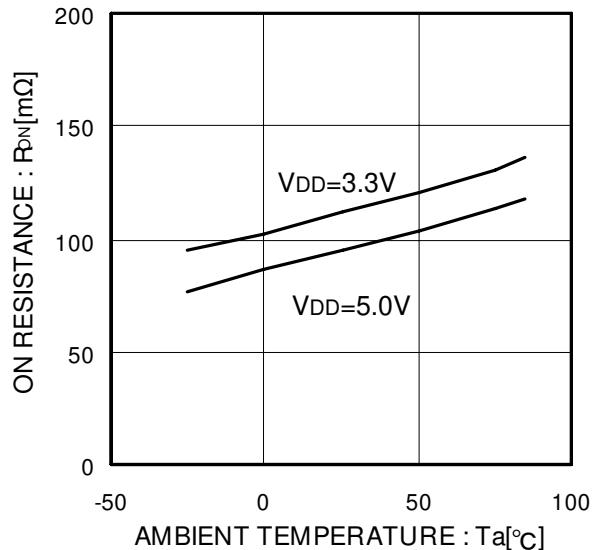
Figure 8. ON resistance
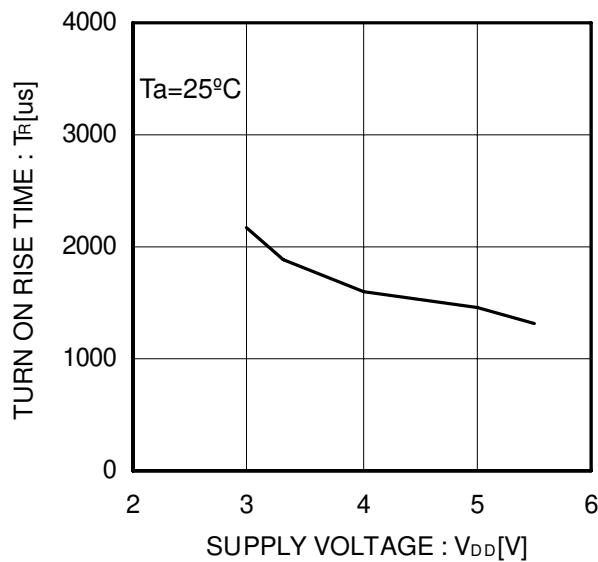
Figure 9. Output rise time
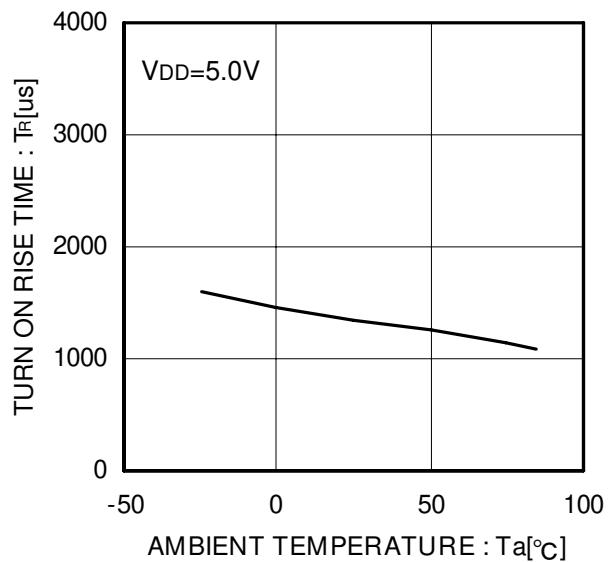
Figure 10. Output rise time

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●**Typical Performance Curves - continued**
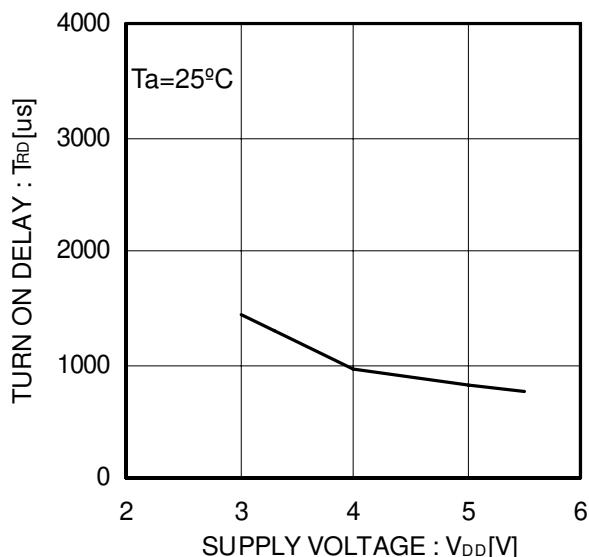
Figure 11. Output rise delay time
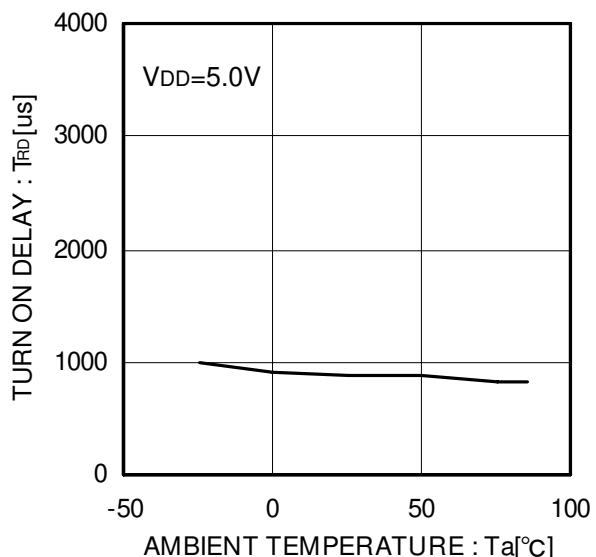
Figure 12. Output rise delay time
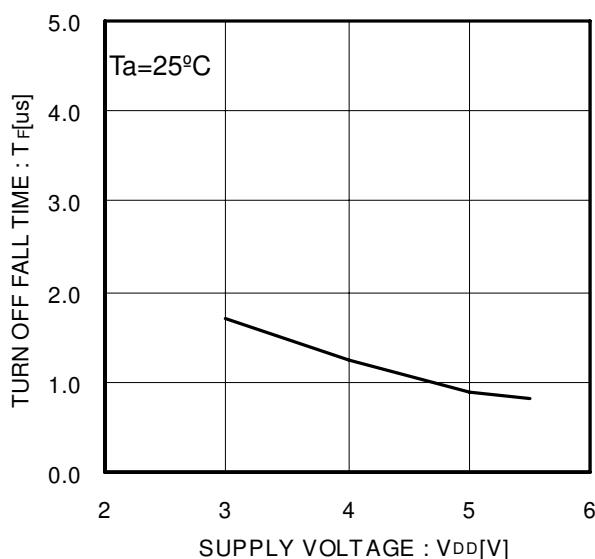
Figure 13. Output fall time
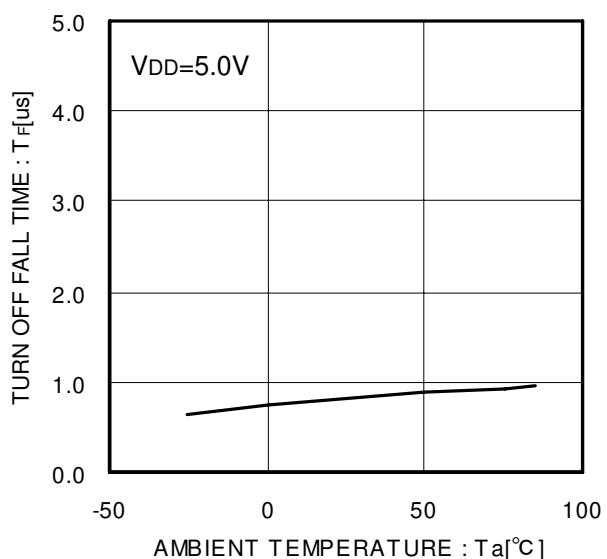
Figure 14. Output fall time

●**Typical Performance Curves - continued**
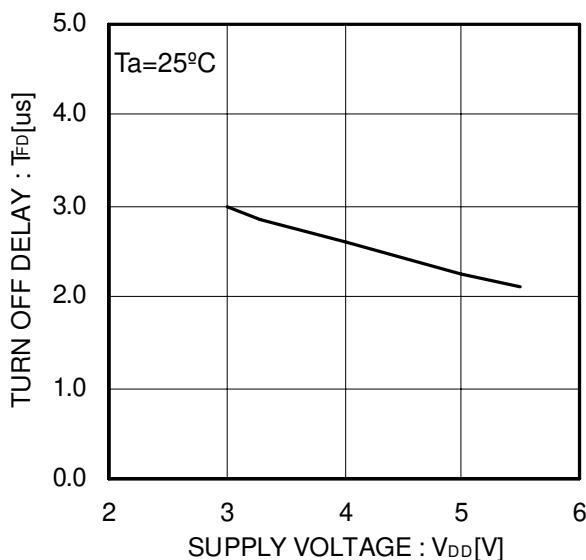
Figure 15. Output fall delay time
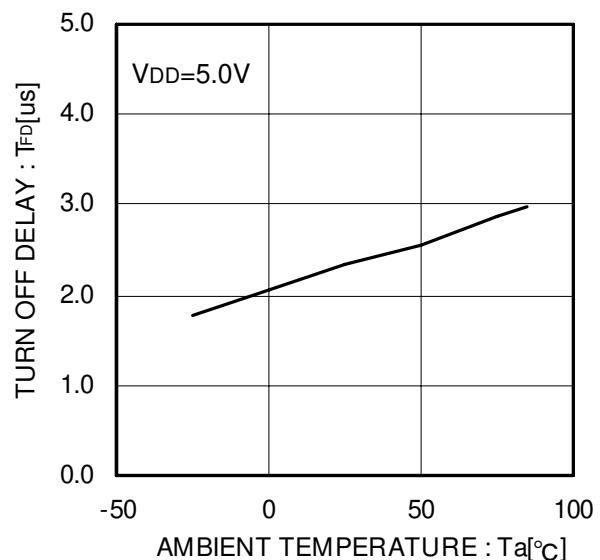
Figure 16. Output fall delay time
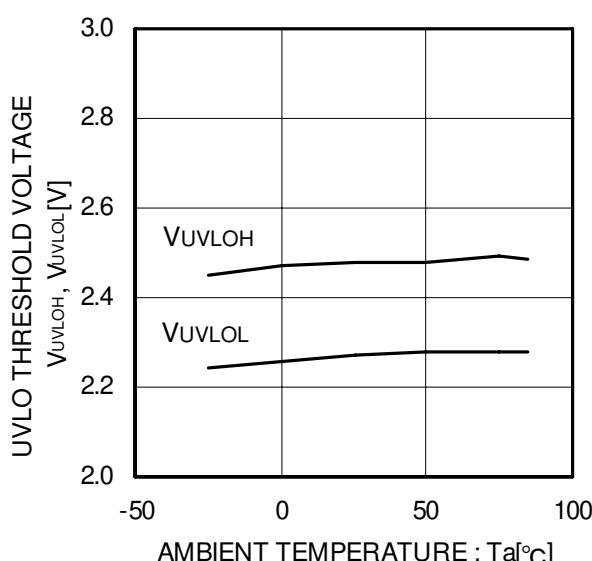
Figure 17. UVLO threshold voltage
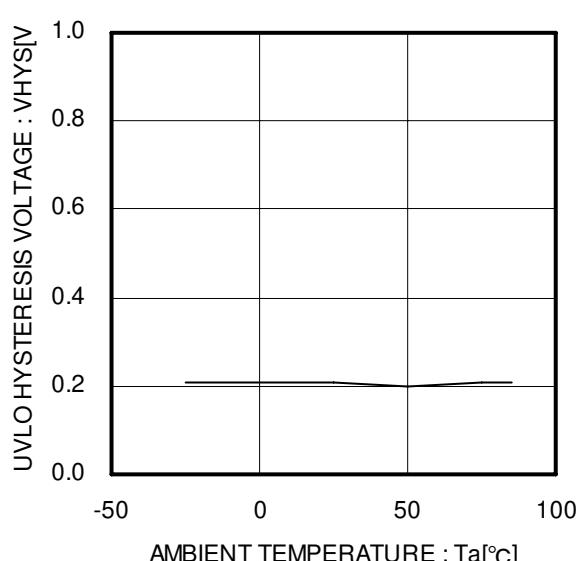
Figure 18. UVLO hysteresis voltage

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●**Typical Performance Curves - continued**
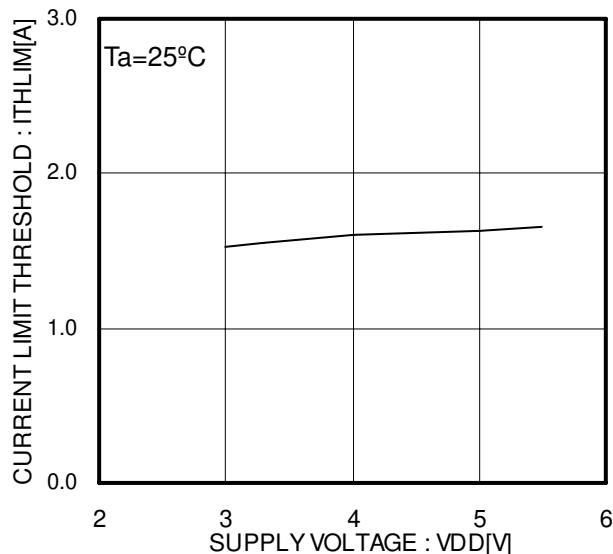
Figure 19. Over current threshold
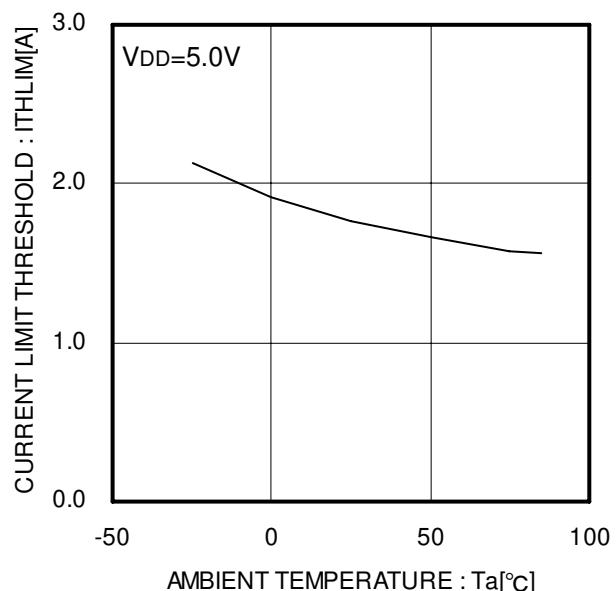
Figure 20. Over current threshold
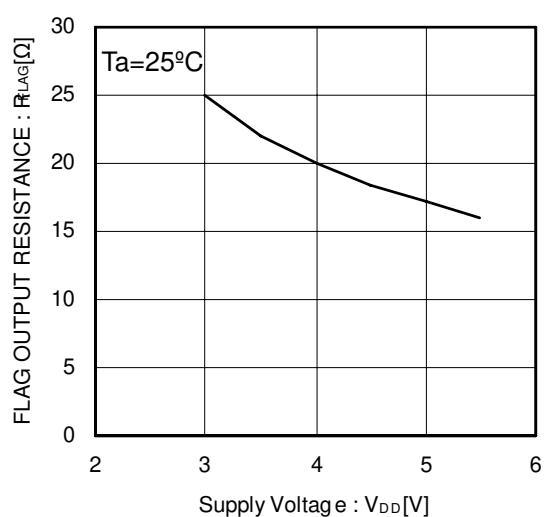
Figure 21. Flag output resistance
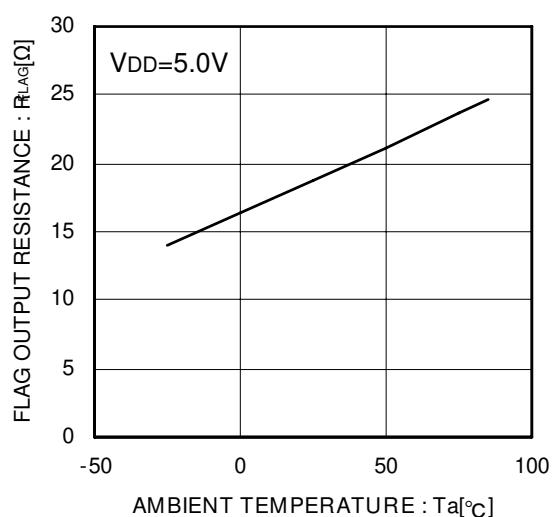
Figure 22. Flag output resistance

●**Typical Performance Curves - continued**
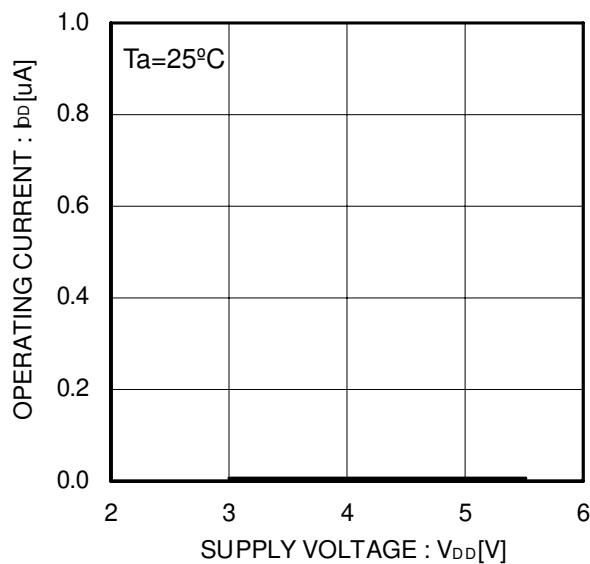

Figure 23. Operating current
CTRL Disable
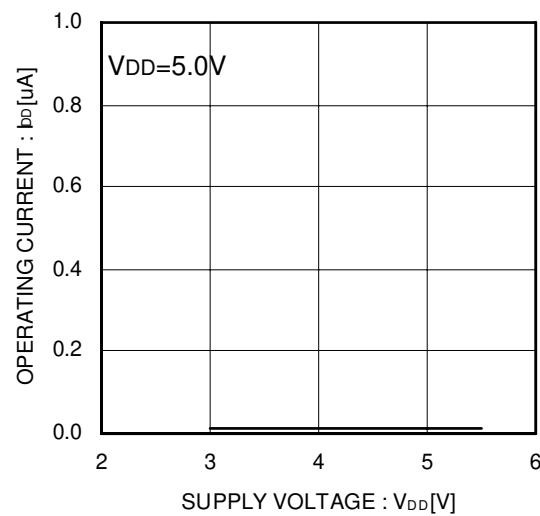
Figure 24. Operating current
CTRL Disable

●**Typical Performance Curves – continued**
　◎BD6516F/ BD6517F
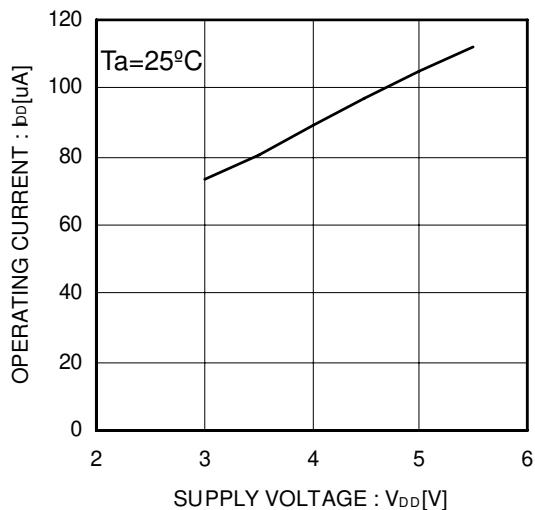
Figure 25. Operating current
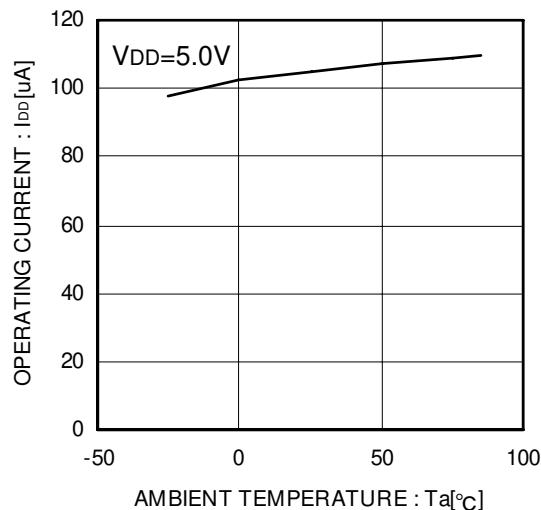
Figure 26. Operating current
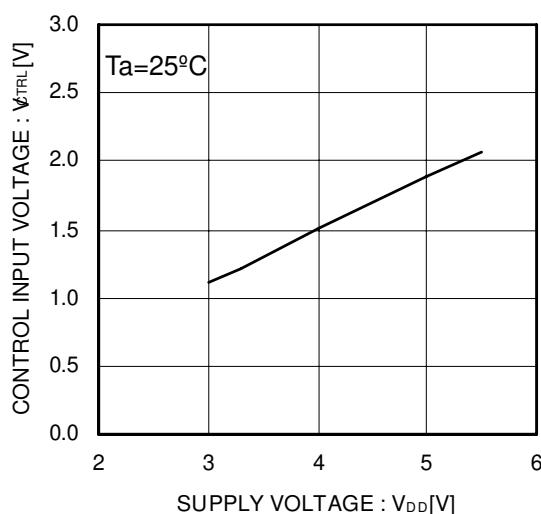
Figure 27. CTRL input voltage
(BD6516F)
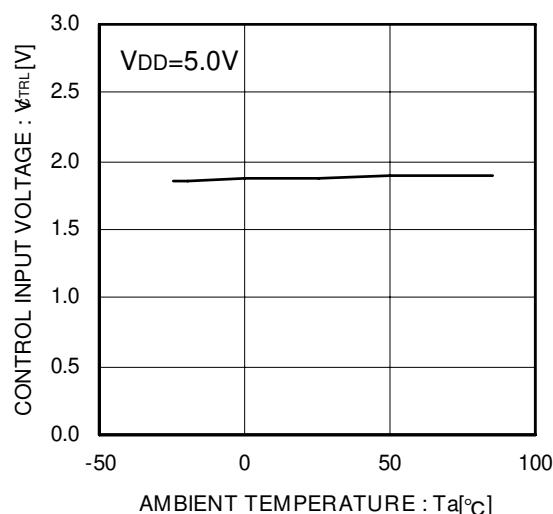
Figure 28. CTRL input voltage
(BD6516F)

●**Typical Performance Curves - continued**

Figure 29. CTRL input voltage
(BD6517F)

Figure 30. CTRL input voltage
(BD6517F)

Figure 31. ON resistance

Figure 32. ON resistance

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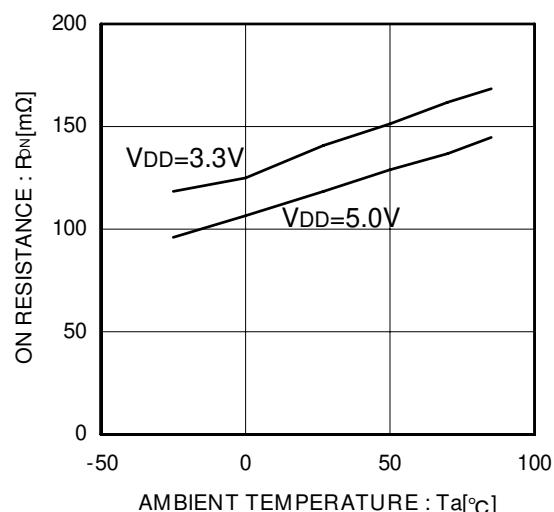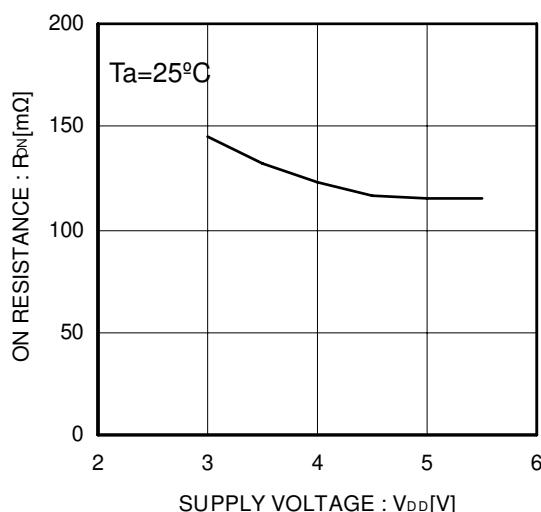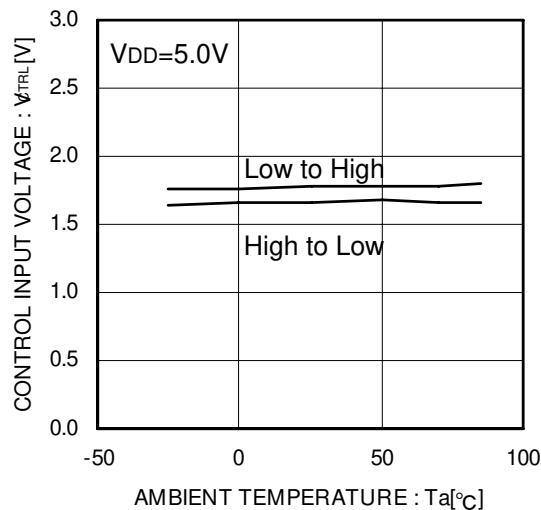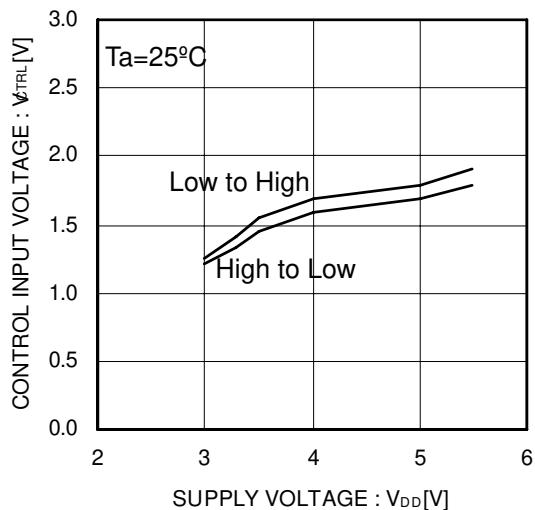
●**Typical Performance Curves - continued**
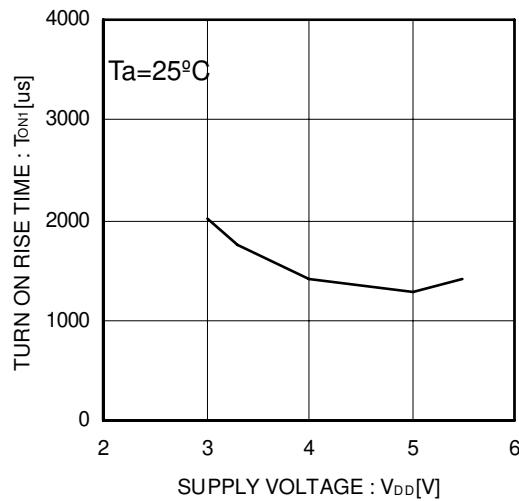
Figure 33. Output rise time
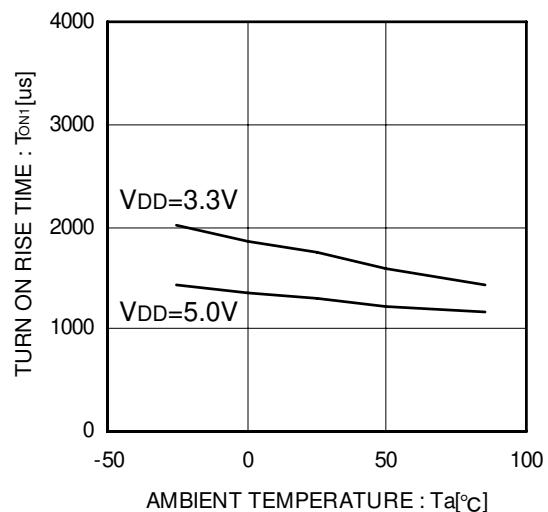
Figure 34. Output rise time
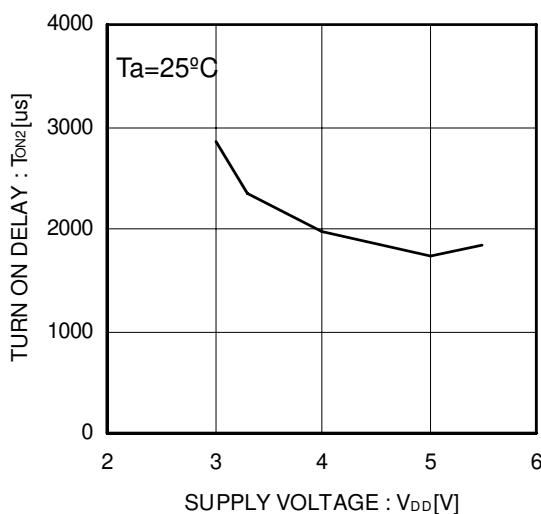
Figure 35. Output rise delay time
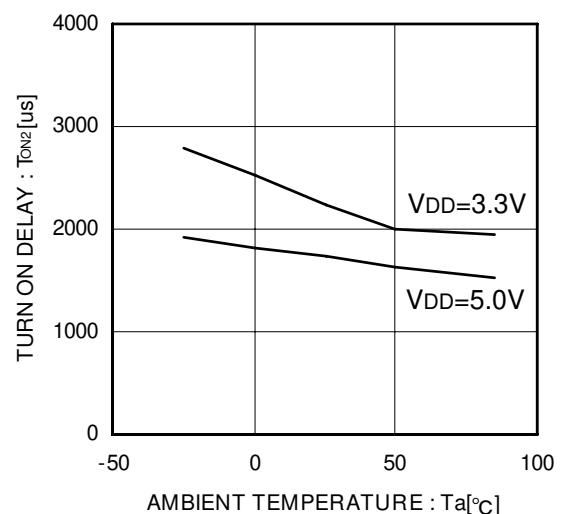
Figure 36. Output rise delay time

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●**Typical Performance Curves - continued**
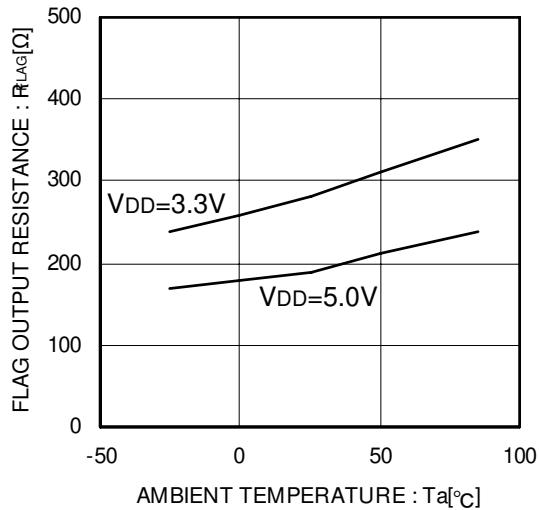
Figure 37. Flag output resistance
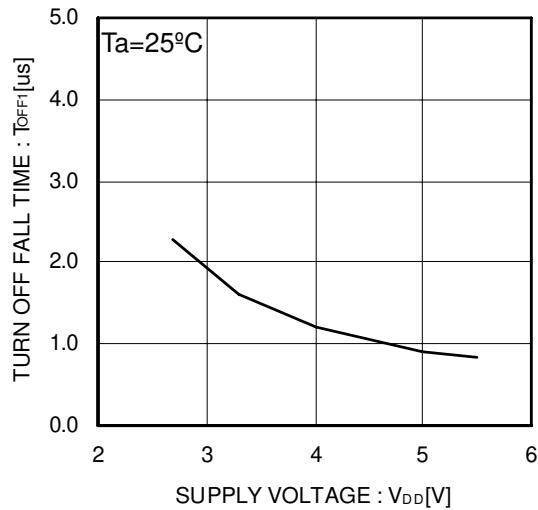
Figure 38. Output fall time
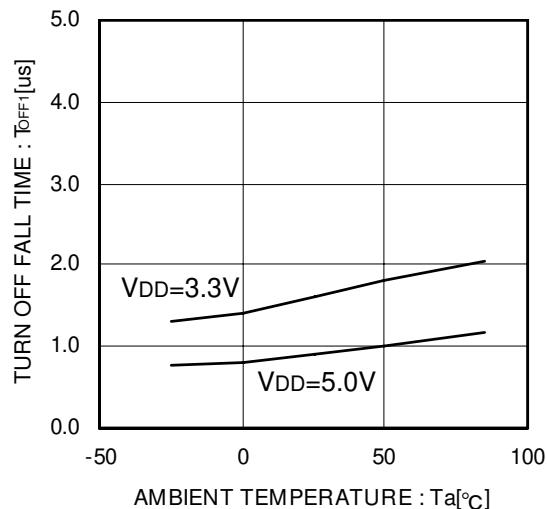
Figure 39. Output fall time
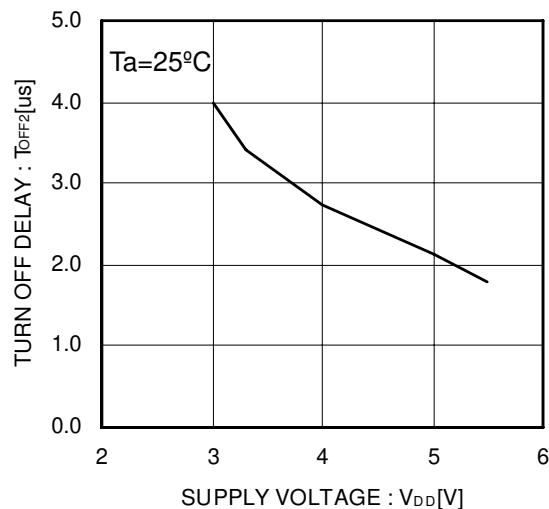
Figure 40. Output fall delay time

●**Typical Performance Curves - continued**
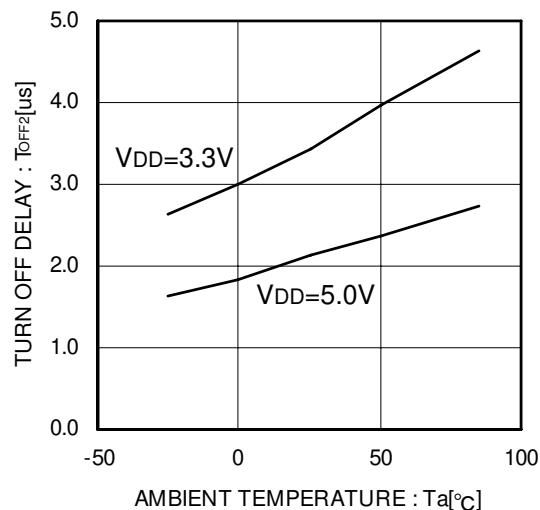
Figure 41. Output fall delay time
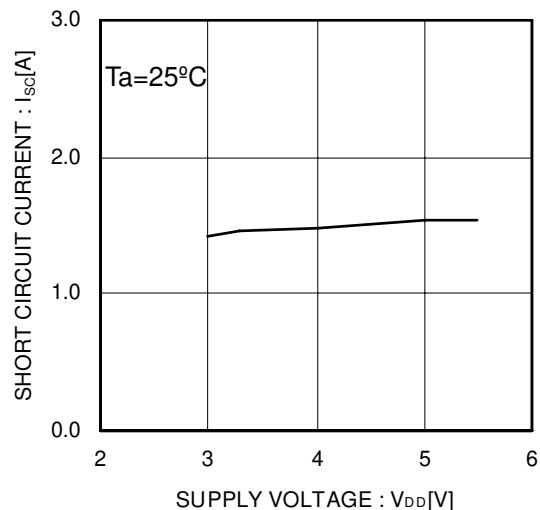
Figure 42. Short-circuit output
current
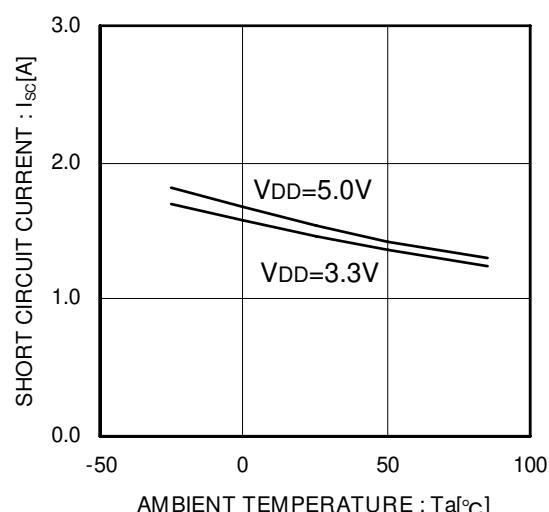
Figure 43. Short-circuit output current
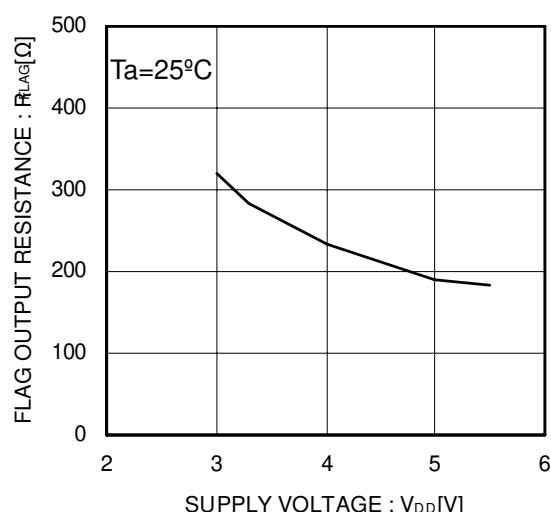
Figure 44. Flag output resistance

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●**Typical Performance Curves - continued**

Figure 45. Flag output delay
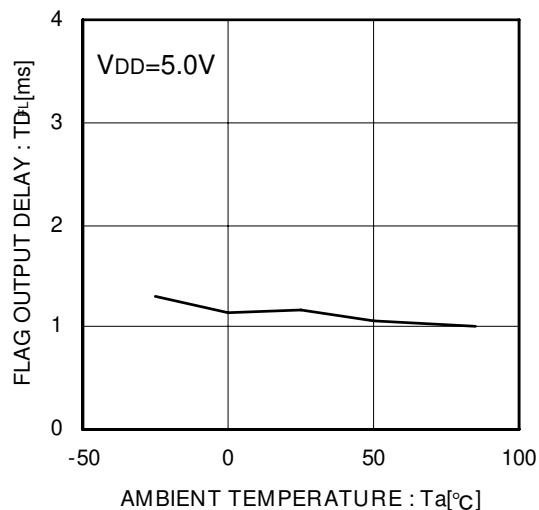
Figure 46. Flag output delay
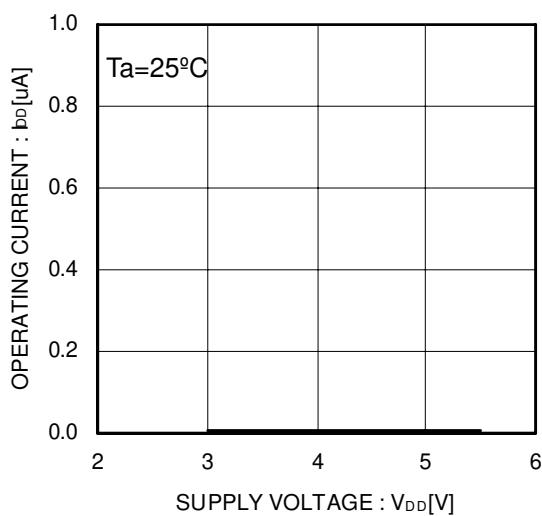
Figure 47. Operating current
CTRL Disable
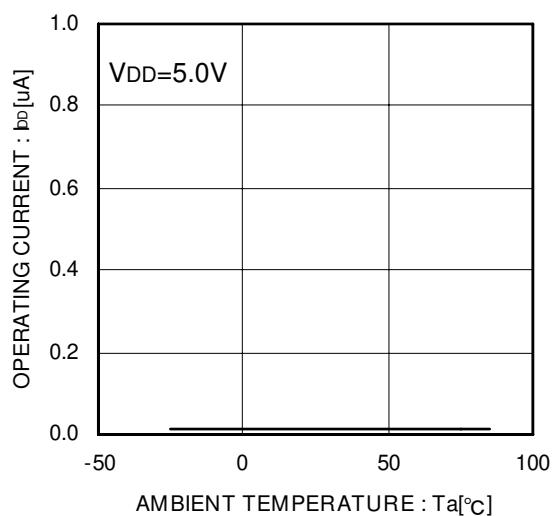
Figure 48. Operating current
CTRL Disable

● **Typical Performance Curves – continued**
◎ BD2042AFJ/ BD2052AFJ
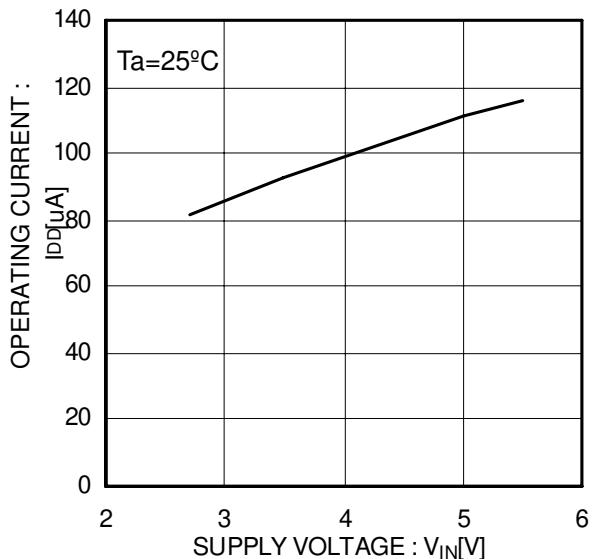
Figure 49. Operating current
EN,/EN Enable
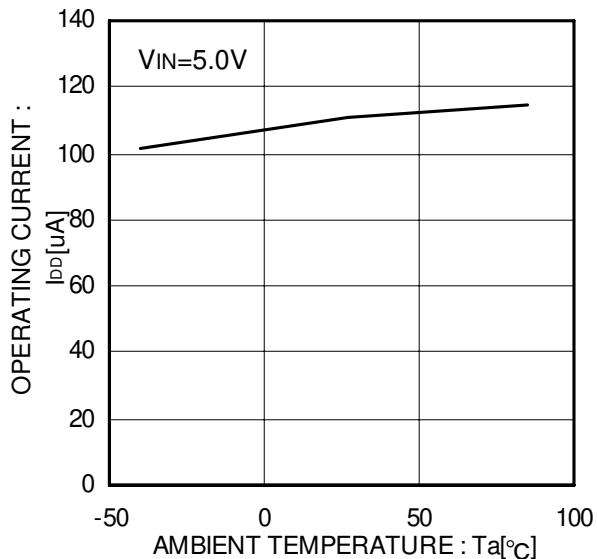
Figure 50. Operating current
EN,/EN Enable
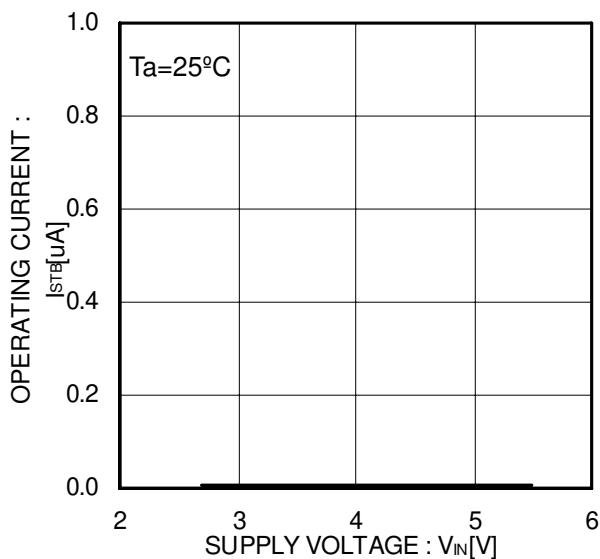
Figure 51. Operating current
EN,/EN Disable
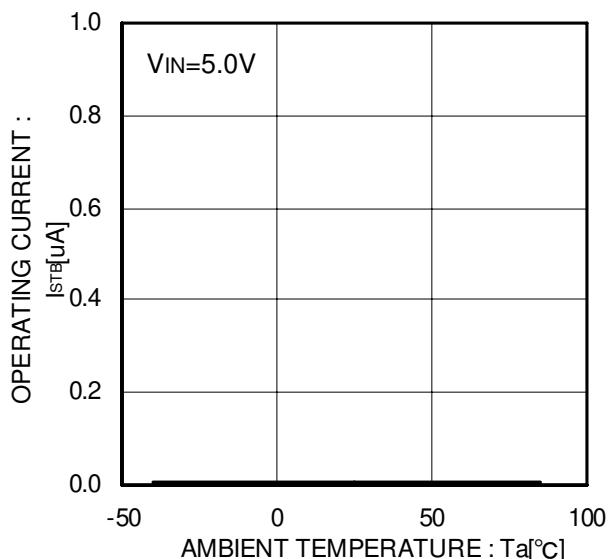
Figure 52. Operating current
EN,/EN Disable

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●**Typical Performance Curves - continued**
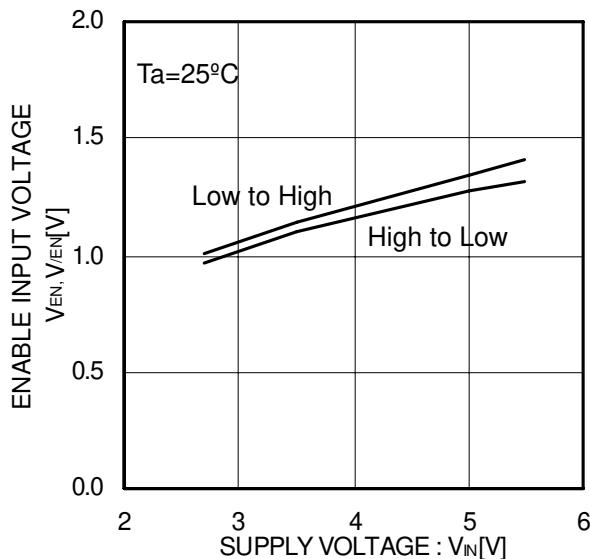
Figure 53. EN,/EN input voltage
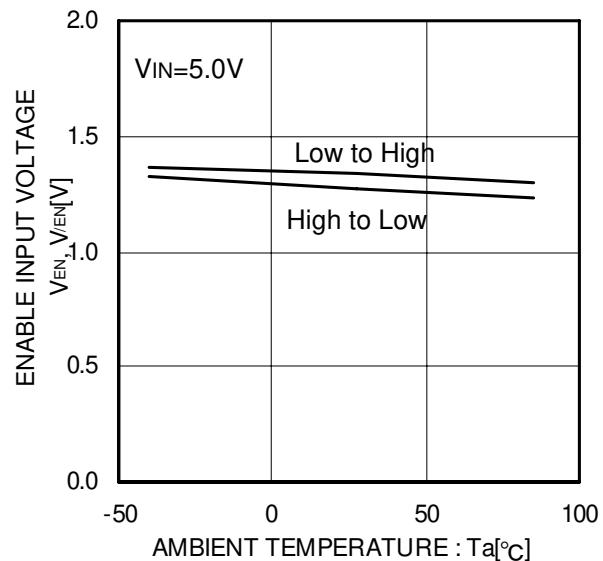
Figure 54. EN,/EN input voltage
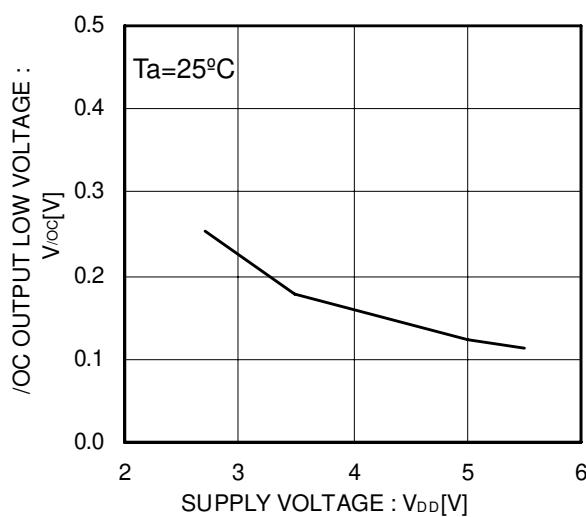
Figure 55. /OC output LOW voltage
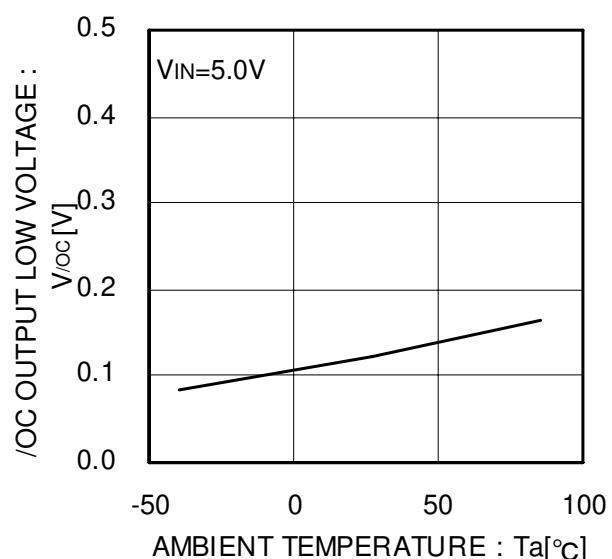
Figure 56. /OC output LOW voltage

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●**Typical Performance Curves - continued**
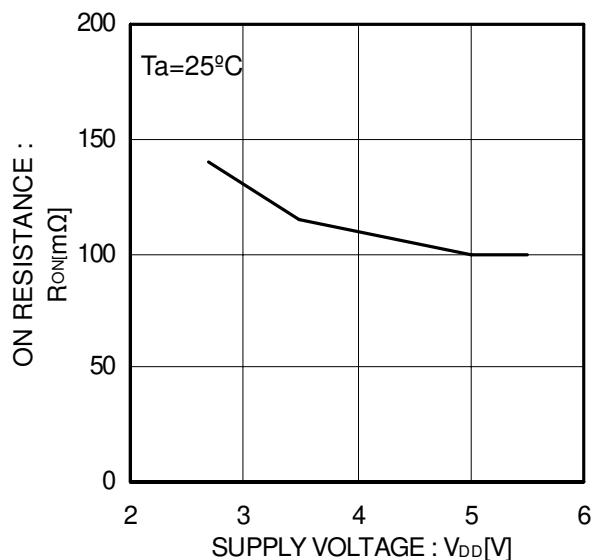
Figure 57. ON resistance
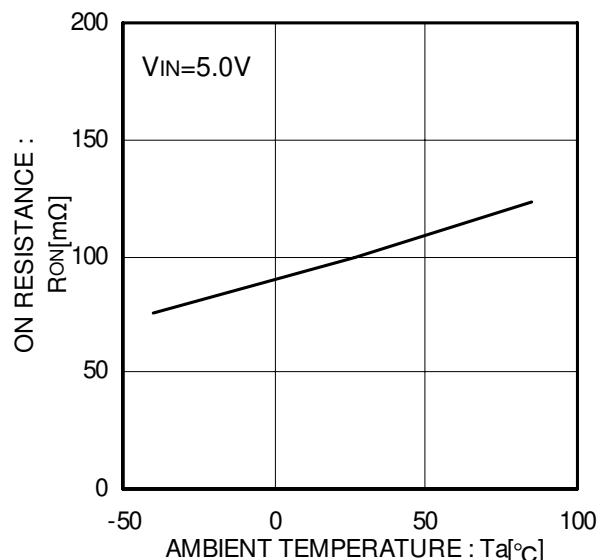
Figure 58. ON resistance
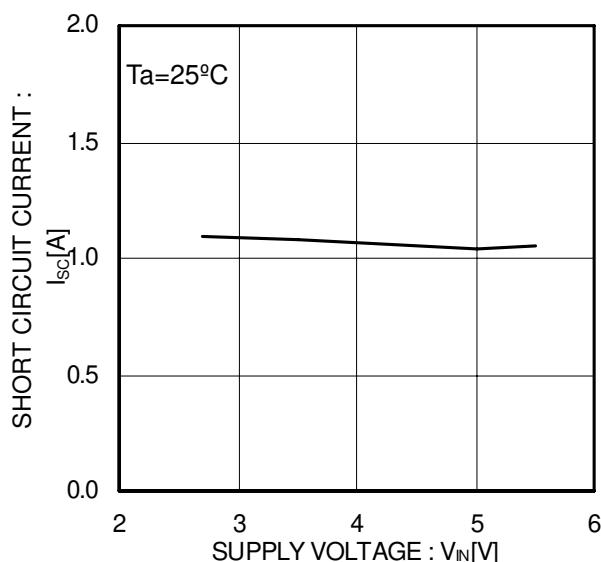
Figure 59. Output current at short-circuit
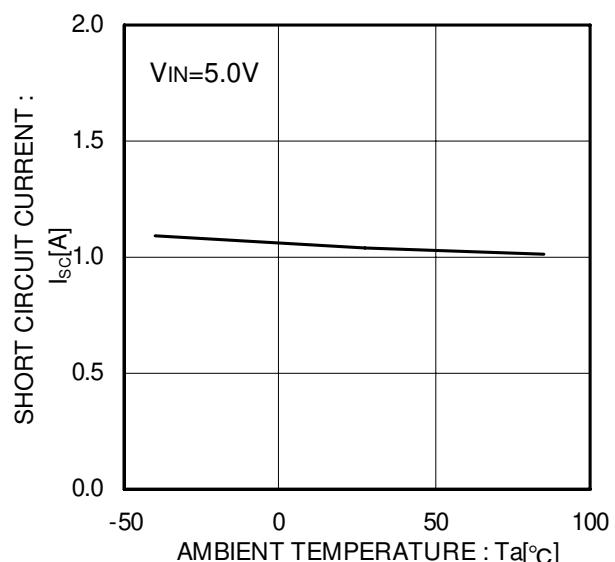
Figure 60. Output current at short-circuit

●**Typical Performance Curves - continued**
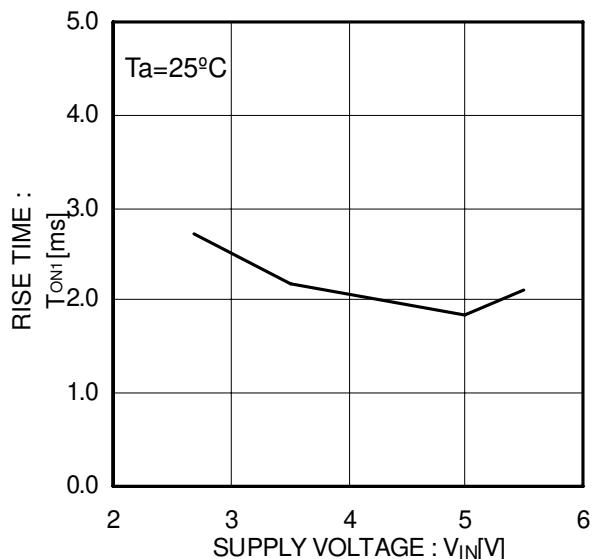
Figure 61. Output rise time
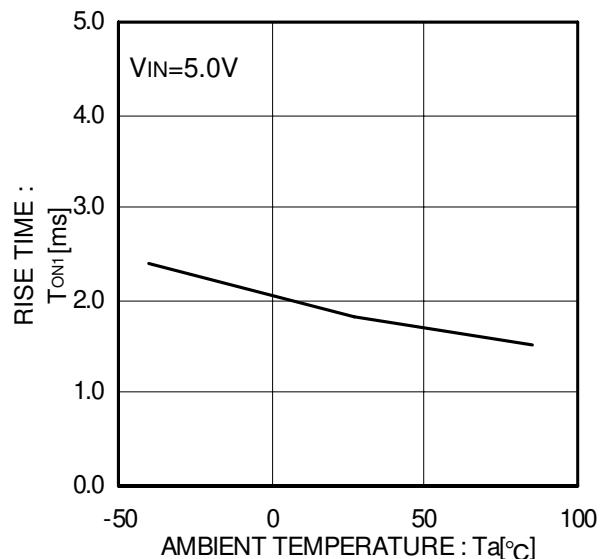

Figure 62. Output rise time
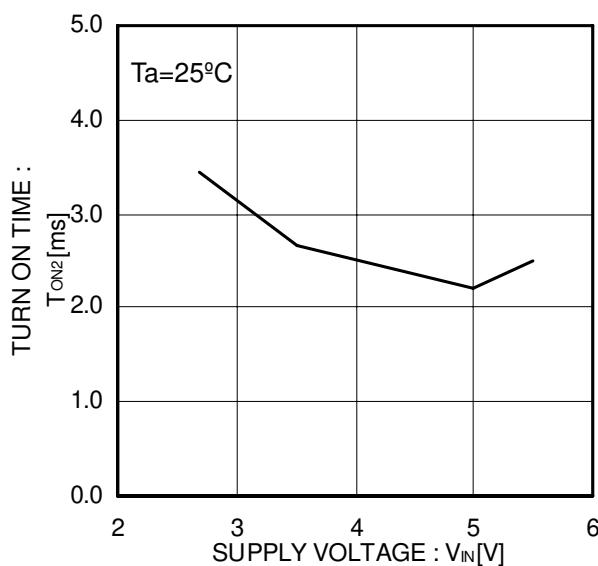
Figure 63. Output turn on time
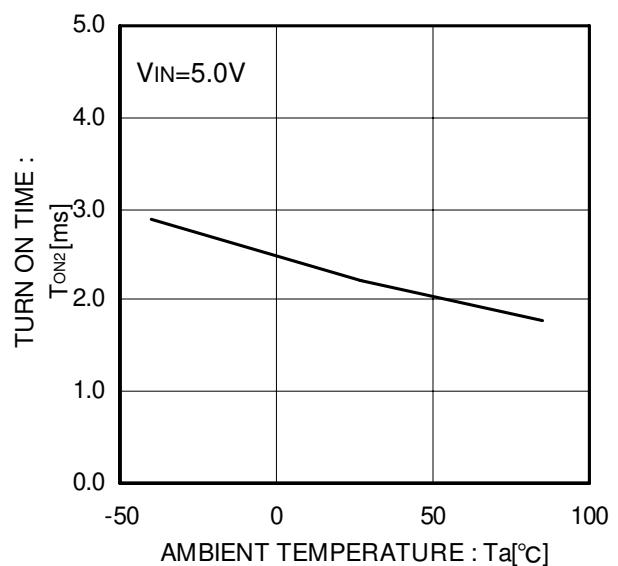
Figure 64. Output turn on time

●**Typical Performance Curves - continued**
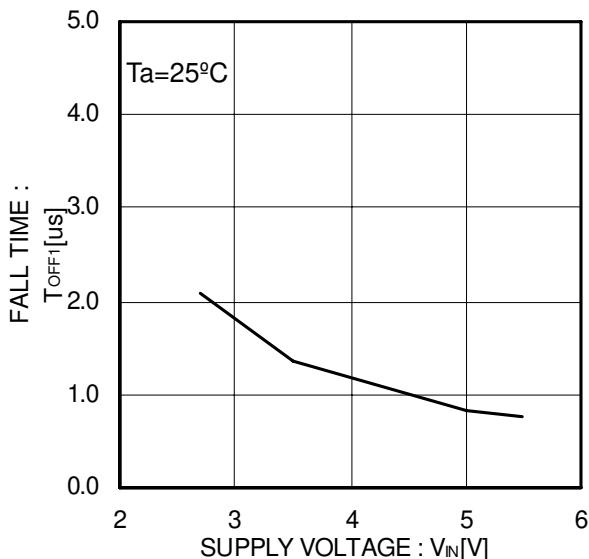

Figure 65. Output fall time
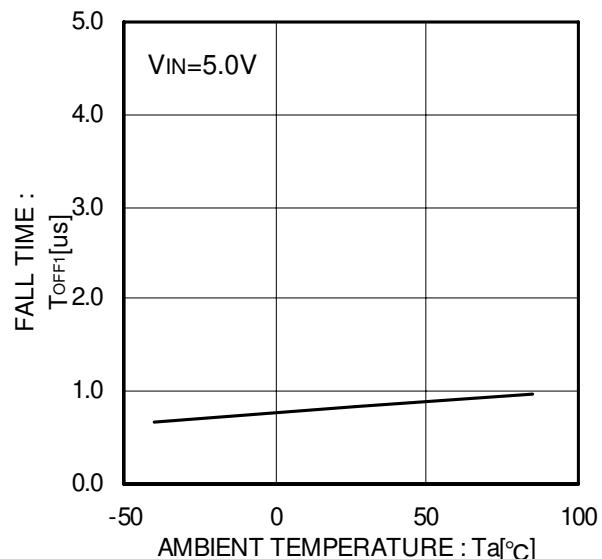
Figure 66. Output fall time
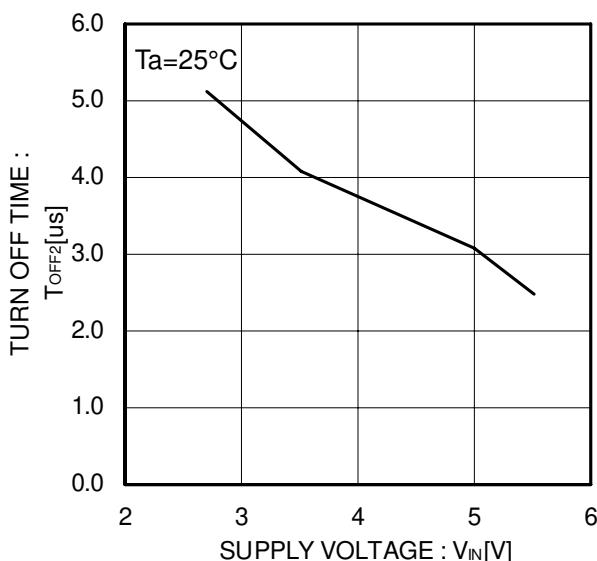
Figure 67. Output turn off time
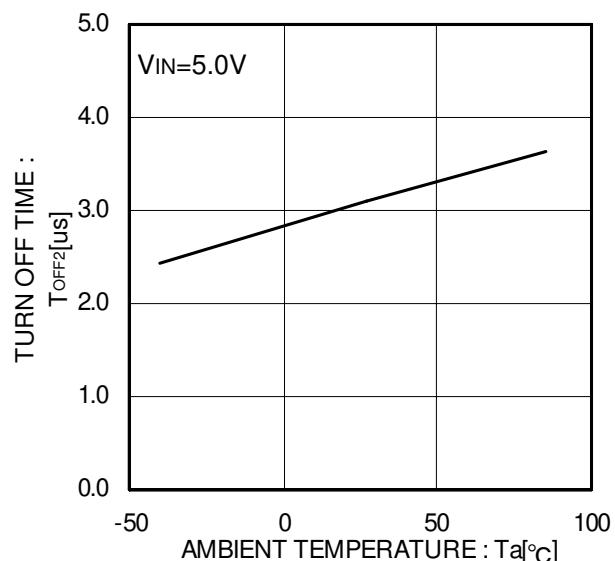
Figure 68. Output turn off time

●**Typical Performance Curves - continued**
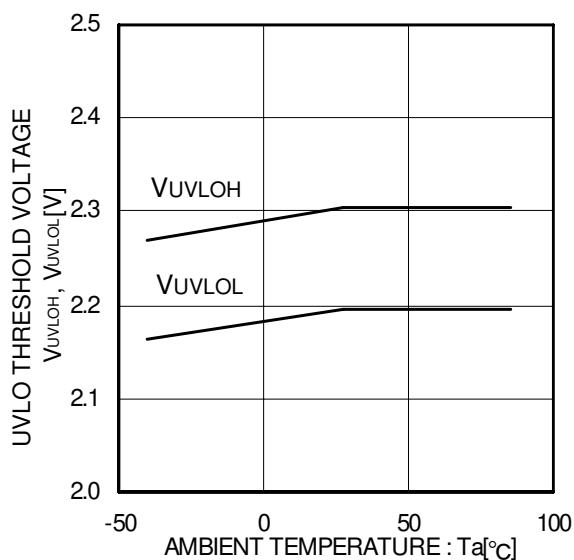
Figure 69. UVLO threshold voltage
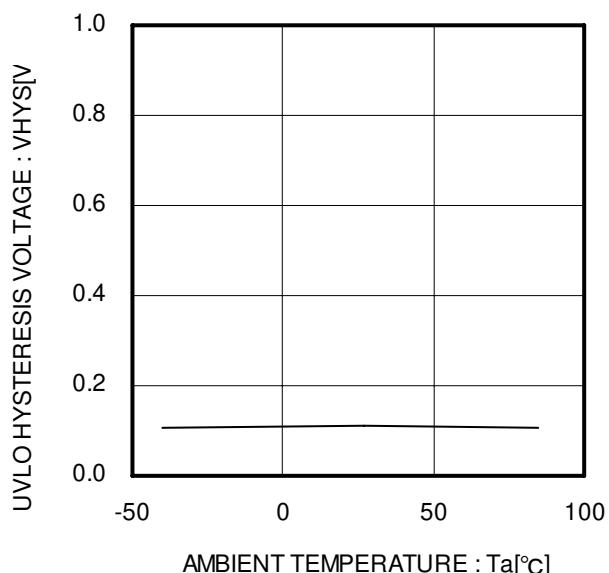
Figure 70. UVLO hysteresis voltage

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