3-Mode 150 mA LDO Regulator with the Reverse Current Protection for Automotive Applications

NO.EC-118-190320

OUTLINE

The R1163x is a voltage regulator IC with high output voltage accuracy and low supply current that is developed with CMOS process technology. This IC performs with the chip enable function and realizes a standby mode with ultra low supply current. To prevent the destruction by over current, the current limit circuit is included. The R1163x has three modes. One is standby mode with CE or standby control pin. Other two modes are realized with ECO pin. Fast Transient Mode (FT mode) and Low Power Mode (LP mode) are alternative with ECO pin. Consumption current is reduced at Low Power Mode compared with Fast Transient Mode. The output voltage is maintained between FT mode and LP mode.

Further, the reverse current protection circuit is built-in. Therefore, if a higher voltage than V_{DD} pin is forced to the output pin, the reverse current to V_{DD} pin is very small (Max. 0.1 µA) , so it is suitable for backup circuit.

The R1163x is offered in a 5-pin SOT-23-5 package which can achieve the smallest possible footprint solution on boards where area is limited.

FEATURES

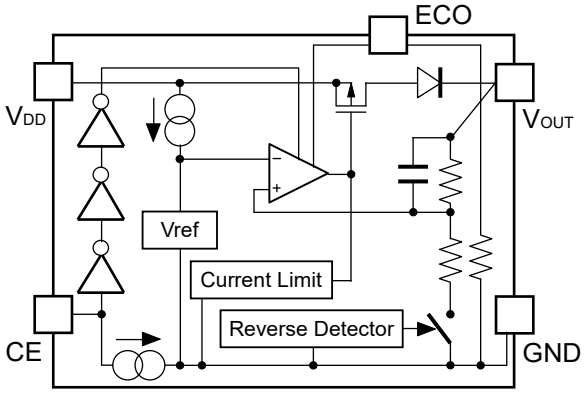
- Input Voltage Range (Maximum Rating)..... 2.0 V to 6.0 V (6.5 V)
- Supply Current ..... Typ. 6.0 µA (Low Power Mode),
  Typ. 70 µA (Fast Transient Mode)
- Reverse Current..... Max. 0.1 µA
- Standby Mode ..... Typ. 0.6 µA
- Ripple Rejection ..... Typ. 70 dB (f = 1 kHz, Fast Transient Mode)
- Output Voltage Range..... 1.5 V to 5.0 V (0.1 V step)
  For other voltages, please refer to *MARK SPECIFICATION TABLE*
- Output Voltage Accuracy..... ±1.5% (±2.5% at Low Power Mode)
- Temperature-Drift Coefficient of Output Voltage .. Typ. ±100 ppm/°C
- Dropout Voltage ..... Typ. 0.25 V (I_{OUT} = 150 mA, V_{OUT} = 2.8 V)
- Line Regulation ..... Typ. 0.02%/V (Fast Transient Mode)
- Output Noise "H" (FT Mode) ..... TYP. 30 µVrms (BW = 10 Hz to 100 kHz)
  Output Noise "L" (LP Mode)..... TYP. 40 µVrms (BW = 10 Hz to 100 kHz)
- Package SOT-23-5
- Built-in fold-back protection circuit ..... Typ. 40 mA (Current at short mode)
- Performs with Ceramic Capacitors ..... C_{IN} = Ceramic 1.0 µF, C_{OUT} = Ceramic 0.47 µF

APPLICATIONS

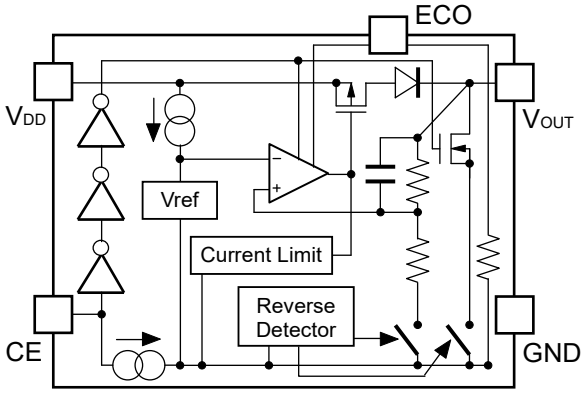
- Power source for accessories such as car audios, car navigation systems, and ETC systems

BLOCK DIAGRAM

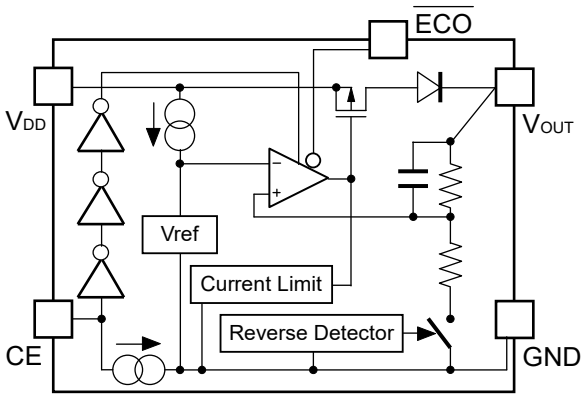
R1163xxx1B



R1163xxx1D



R1163xxx1E



SELECTION GUIDE

The output voltage and auto discharge function for the IC can be selected at the user's request.

Product Name	Package	Quantity per Reel	Pb Free	Halogen Free
R1163Nxx1∗-TR-#E	SOT-23-5	3,000 pcs	Yes	Yes

xx: The output voltage can be designated in the range from 1.5 V (15) to 5.0 V (50) in 0.1 V step.
For other voltages, please refer to *MARK SPECIFICATION TABLE*

∗ : The auto discharge function at off state options are as follows.
(B) without auto discharge function at off state
(D) with auto discharge function at off state
(E) without auto discharge function at off state, ECO logic reverse type (Low Power mode at ECO = "H")

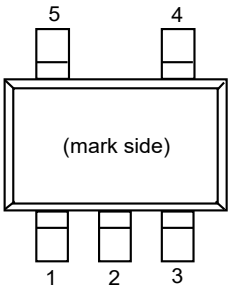
: Specify Automotive Class Code

	Operating Temperature Range	Guaranteed Specs Temperature Range	Screening
A	−40°C to 85°C	25°C	High Temperature

Auto-discharge function quickly lowers the output voltage to 0 V, when the chip enable signal is switched from the active mode to the standby mode, by releasing the electrical charge accumulated in the external capacitor.

PIN DESCRIPTIONS

SOT-23-5



- **SOT-23-5**

Pin No	Symbol	Pin Description
1	V_{DD}	Input Pin
2	GND	Ground Pin
3	CE	Chip Enable Pin ("H" Active)
4	ECO	R1163xxx1B/D：FT/LP Mode Alternative Pin（"L" LP）
	$\overline{ECO}$	R1163xxx1E：FT/LP Mode Alternative Pin（"H" LP）
5	V_{OUT}	Output pin

ABSOLUTE MAXIMUM RATINGS

Symbol	Item		Rating	Unit
V_{IN}	Input Voltage		6.5	V
V_{ECO}	Input Voltage (ECO/$\overline{ECO}$ Pin)		−0.3 to 6.5	V
V_{CE}	Input Voltage (CE Pin)		−0.3 to 6.5	V
V_{OUT}	Output Voltage		−0.3 to 6.5	V
I_{OUT}	Output Current		180	mA
P_D	Power Dissipation (SOT-23-5)*	Standard Land Pattern	420	mW
Tj	Junction Temperature		−40 to 125	°C
Tstg	Storage Temperature Range		−55 to 125	°C

* Refer to *PACKAGE INFORMATION* for detailed information.

ABSOLUTE MAXIMUM RATINGS

Electronic and mechanical stress momentarily exceeded absolute maximum ratings may cause the permanent damages and may degrade the life time 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

Symbol	Item	Rating	Unit
V_{IN}	Input Voltage	2.0 to 6.0	V
Ta	Operating Temperature Range	−40 to 85	°C

RECOMMENDED OPERATING CONDITIONS

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} = Set V_{OUT} + 1.0 V, I_{OUT} = 1 mA, C1 = 1.0 µF, C2 = 0.47 µF, unless otherwise noted.
The specifications surrounded by ⬚ are guaranteed by design engineering at −40°C ≤ Ta ≤ 85°C.

R1163xxx1B/D

(Ta = 25°C)

Symbol	Item		Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	FT Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = V_{IN} 1 mA ≤ I_{OUT} ≤ 30 mA		×0.985		×1.015	V
		LP Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = GND 1 mA ≤ I_{OUT} ≤ 30 mA		×0.975		×1.025	
ΔV_{OUT}	Output Voltage Deviation between FT Mode and LP Mode		V_{IN} = Set V_{OUT} + 1 V, I_{OUT} = 30 mA	V_{OUT} > 2.0 V	−1.2	0	1.2	%
				V_{OUT} ≤ 2.0 V	−24	0	24	mV
I_{OUT}	Output Current		V_{IN} − V_{OUT} = 1.0 V		150			mA
ΔV_{OUT}/ ΔI_{OUT}	Load Regulation	FT Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = V_{IN} 1 mA ≤ I_{OUT} ≤ 150 mA			20	40	mV
		LP Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = GND 1 mA ≤ I_{OUT} ≤ 150 mA			20	45	
V_{DIF}	Dropout Voltage		I_{OUT} = 150 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{SS1}	Supply Current (FT Mode)		V_{IN} = Set V_{OUT} + 1 V V_{ECO} = V_{IN}			70	100	µA
I_{SS2}	Supply Current (LP Mode)		V_{IN} = Set V_{OUT} + 1 V V_{ECO} = GND			6.0	10.0	µA
Istandby	Supply Current (Standby)		V_{IN} = Set V_{OUT} + 1 V, V_{CE} = GND V_{ECO} = GND or V_{IN}			0.6	1.0	µA
ΔV_{OUT}/ ΔV_{IN}	Line Regulation	FT Mode	Set V_{OUT} + 0.5 V ≤ V_{IN} ≤ 6.0 V I_{OUT} = 30 mA, V_{ECO} = V_{IN} If V_{OUT} ≤ 1.6 V, then 2.2 V ≤ V_{IN} ≤ 6.0 V			0.02	0.10	%/V
		LP Mode	Set V_{OUT} + 0.5 V ≤ V_{IN} ≤ 6.0 V I_{OUT} = 30 mA, V_{ECO} = GND If V_{OUT} ≤ 1.6 V, then 2.2 V ≤ V_{IN} ≤ 6.0 V			0.05	0.20	
I_{SC}	Short Current Limit		V_{OUT} = 0 V			40		mA
I_{PD}	CE Pull-down Current					0.3	0.6	µA
R_{PDE}	ECO Pull-down Resistance				2	5	30	MΩ
V_{CEH}	CE, ECO Input Voltage "H"				1.0		6.0	V
V_{CEL}	CE, ECO Input Voltage "L"				0		0.35	V
R_{LOW}	Low Output Nch Tr. ON Resistance (of D version)		V_{CE} = 0 V			60		Ω
I_{REV}	Reverse Current		V_{OUT} > 0.5 V, 0 V ≤ V_{IN} ≤ 6 V			0	0.1	µA

All test items listed under *Electrical Characteristics* are done under the pulse load condition (Tj ≈ Ta = 25°C).

V_{IN} = Set V_{OUT} + 1.0 V, I_{OUT} = 1 mA, C1 = 1.0 µF, C2 = 0.47 µF, unless otherwise noted.
The specifications surrounded by ⌇⌇ are guaranteed by design engineering at −40°C ≤ Ta ≤ 85°C.

R1163xxx1E (Ta = 25°C)

Symbol	Item		Conditions		Min.	Typ.	Max.	Unit
V_{OUT}	Output Voltage	FT Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = GND 1 mA ≤ I_{OUT} ≤ 30 mA		×0.985		×1.015	V
		LP Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = V_{IN} 1 mA ≤ I_{OUT} ≤ 30 mA		×0.975		×1.025	
ΔV_{OUT}	Output Voltage Deviation between FT Mode and LP Mode		V_{IN} = Set V_{OUT} + 1 V, I_{OUT} = 30 mA	V_{OUT} > 2.0 V	−1.2	0	1.2	%
				V_{OUT} ≤ 2.0 V	−24	0	24	mV
I_{OUT}	Output Current		V_{IN} − V_{OUT} = 1.0 V		150			mA
$\Delta V_{OUT}/\Delta I_{OUT}$	Load Regulation	FT Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = GND 1 mA ≤ I_{OUT} ≤ 150 mA			20	40	mV
		LP Mode	V_{IN} = Set V_{OUT} + 1 V, V_{ECO} = V_{IN} 1 mA ≤ I_{OUT} ≤ 150 mA			20	45	
V_{DIF}	Dropout Voltage		I_{OUT} = 150 mA		Refer to the *Product-specific Electrical Characteristics*			
I_{SS1}	Supply Current (FT Mode)		V_{IN} = Set V_{OUT} + 1 V V_{ECO} = GND			70	100	µA
I_{SS2}	Supply Current (LP Mode)		V_{IN} = Set V_{OUT} + 1 V V_{ECO} = V_{IN}			6.0	10	µA
$I_{standby}$	Supply Current (Standby)		V_{IN} = Set V_{OUT} + 1 V, V_{CE} = GND V_{ECO} = GND or V_{IN}			0.6	1.0	µA
$\Delta V_{OUT}/\Delta V_{IN}$	Line Regulation	FT Mode	Set V_{OUT} + 0.5 V ≤ V_{IN} ≤ 6.0 V I_{OUT} = 30 mA, V_{ECO} = GND If V_{OUT} ≤ 1.6 V, then 2.2 V ≤ V_{IN} ≤ 6.0 V			0.02	0.10	%/V
		LP Mode	Set V_{OUT} + 0.5 V ≤ V_{IN} ≤ 6.0 V I_{OUT} = 30 mA, V_{ECO} = V_{IN} If V_{OUT} ≤ 1.6 V, then 2.2 V ≤ V_{IN} ≤ 6.0 V			0.05	0.20	
I_{SC}	Short Current Limit		V_{OUT} = 0 V			40		mA
I_{PD}	CE Pull-down Current					0.3	0.6	µA
V_{CEH}	CE, $\overline{ECO}$ Input Voltage "H"				1.0		6.0	V
V_{CEL}	CE, $\overline{ECO}$ Input Voltage "L"				0		0.4	V
I_{REV}	Reverse Current		V_{OUT} > 0.5 V, 0 V ≤ V_{IN} ≤ 6 V			0	0.1	µA

All test items listed under *Electrical Characteristics* are done under the pulse load condition (Tj ≈ Ta = 25°C).

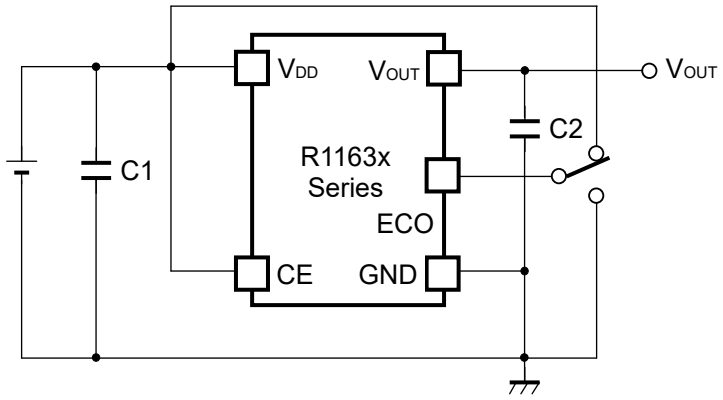
Product-specific Electrical Characteristics

The specifications surrounded by ⬚ are guaranteed by design engineering at −40°C ≤ Ta ≤ 85°C.

(Ta = 25°C)

Product Name	V_{OUT} [V]					V_{DIF} [mV]			
	(FT Mode)			(LP Mode)		(FT Mode)		(LP Mode)	
	MIN.	TYP.	MAX.	MIN.	MAX.	TYP.	MAX.	TYP.	MAX.
R1163N151x	1.478	1.500	1.522	1.463	1.537	400	680	420	680
R1163N161x	1.576	1.600	1.624	1.560	1.640	380	550	390	550
R1163N171x	1.675	1.700	1.725	1.658	1.742	350	520	370	520
R1163N181x	1.773	1.800	1.827	1.755	1.845	340	490	350	490
R1163N181x5	1.823	1.850	1.877	1.804	1.896				
R1163N191x	1.872	1.900	1.928	1.853	1.947				
R1163N201x	1.970	2.000	2.030	1.950	2.050	290	425	300	430
R1163N211x	2.069	2.100	2.131	2.048	2.152				
R1163N221x	2.167	2.200	2.233	2.145	2.255				
R1163N231x	2.266	2.300	2.334	2.243	2.357				
R1163N241x	2.364	2.400	2.436	2.340	2.460				
R1163N251x	2.463	2.500	2.537	2.438	2.562				
R1163N261x	2.561	2.600	2.639	2.535	2.665				
R1163N271x	2.660	2.700	2.740	2.633	2.767				
R1163N271x5	2.709	2.750	2.791	2.682	2.818				
R1163N281x	2.758	2.800	2.842	2.730	2.870	250	350	250	350
R1163N281x5	2.808	2.850	2.892	2.779	2.921				
R1163N291x	2.857	2.900	2.943	2.828	2.972				
R1163N301x	2.955	3.000	3.045	2.925	3.075				
R1163N311x	3.054	3.100	3.146	3.023	3.177				
R1163N321x	3.152	3.200	3.248	3.120	3.280				
R1163N331x	3.251	3.300	3.349	3.218	3.382				
R1163N341x	3.349	3.400	3.451	3.315	3.485				
R1163N351x	3.448	3.500	3.552	3.413	3.587				
R1163N361x	3.546	3.600	3.654	3.510	3.690				
R1163N371x	3.645	3.700	3.755	3.608	3.792				
R1163N381x	3.743	3.800	3.857	3.705	3.895				
R1163N391x	3.842	3.900	3.958	3.803	3.997				
R1163N401x	3.940	4.000	4.060	3.900	4.100				
R1163N411x	4.039	4.100	4.161	3.998	4.202				
R1163N421x	4.137	4.200	4.263	4.095	4.305				
R1163N431x	4.236	4.300	4.364	4.193	4.407				
R1163N441x	4.334	4.400	4.466	4.290	4.510				
R1163N451x	4.433	4.500	4.567	4.388	4.612				
R1163N461x	4.531	4.600	4.669	4.485	4.715				
R1163N471x	4.630	4.700	4.770	4.583	4.817				
R1163N481x	4.728	4.800	4.872	4.680	4.920				
R1163N491x	4.827	4.900	4.973	4.778	5.022				
R1163N501x	4.925	5.000	5.075	4.875	5.125				

TYPICAL APPLICATION



External Components

Symbol	Description
C1 (C_{IN})	1.0 µF, Ceramic Capacitor
C2 (C_{OUT})	0.47 µF, Ceramic Capacitor Murata GRM40B474K, Kyocera CM105B474K

TECHNICAL NOTES

When using these ICs, consider the following points:

Phase Compensation

In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a 0.47 µF or more ceramic capacitor C2.

(Test these ICs with as same external components as ones to be used on the PCB).

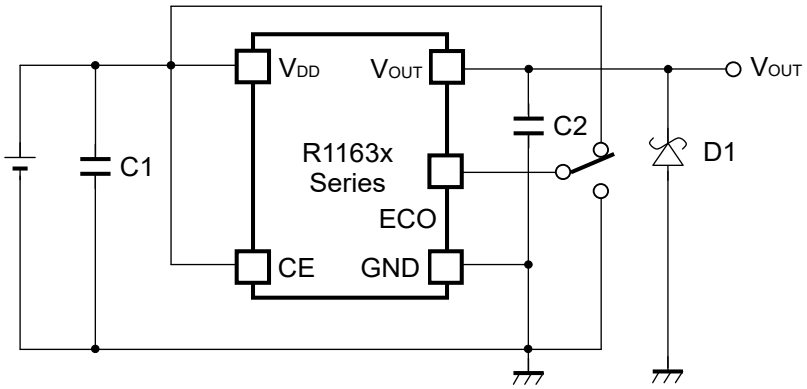
When a tantalum capacitor is used with this IC, if the equivalent series resistor (ESR) of the capacitor is large, output voltage may be unstable.

PCB Layout

Make V_{DD} and GND lines sufficient. If their impedance is high, noise pickup or unstable operation may result. Connect a capacitor C1 with as much as 1.0 µF capacitor between V_{DD} and GND as close as possible.

Set external components such as an output capacitor C2, as close as possible to the ICs and make wiring as short as possible.

TYPICAL APPLICATION FOR IC CHIP BREAKDOWN PREVENTION



When a sudden surge of electrical current travels along the V_{OUT} pin and GND due to a short-circuit, electrical resonance of a circuit involving an output capacitor (C2) and a short circuit inductor generates a negative voltage and may damage the device or the load devices. Connecting a schottky diode (D1) between the V_{OUT} pin and GND has the effect of preventing damage to them.

PACKAGE INFORMATION

POWER DISSIPATION (SOT-23-5)

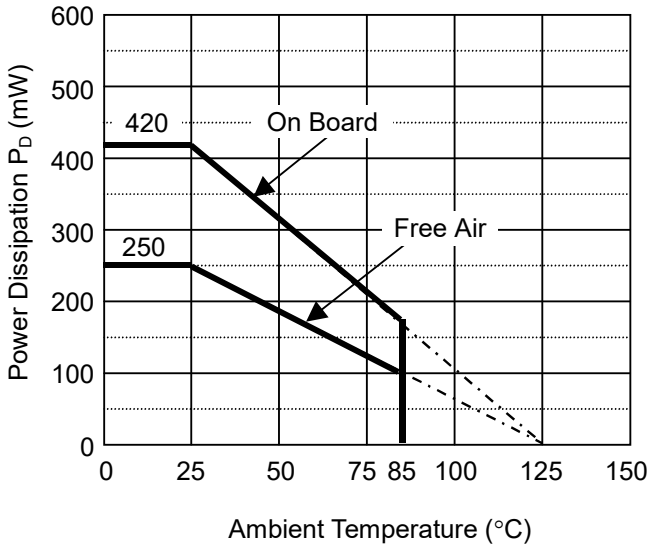
Power Dissipation (P_D) depends on conditions of mounting on board. This specification is based on the measurement at the condition below:
(Power Dissipation (SOT-23-5) is substitution of SOT-23-6).

* Measurement Conditions

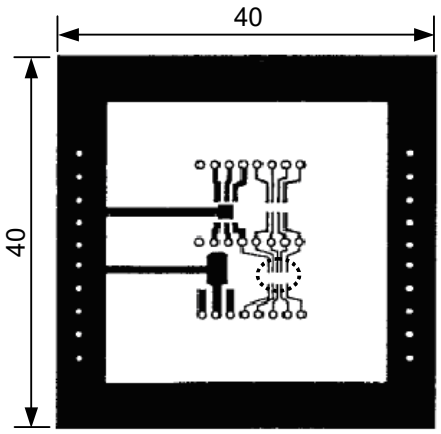
	Standard Test Land Pattern
Environment	Mounting on Board (Wind velocity = 0 m/s)
Board Material	Glass cloth epoxy plastic (Double sided)
Board Dimensions	40 mm x 40 mm x 1.6 mm
Copper Ratio	Top side: Approx. 50%, Back side: Approx. 50%
Through-holes	ϕ 0.5 mm x 44 pcs

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

	Standard Land Pattern	Free Air
Power Dissipation	420 mW	250 mW
Thermal Resistance	θja = (125-25°C)/0.42 W= 238°C/W	400°C/W



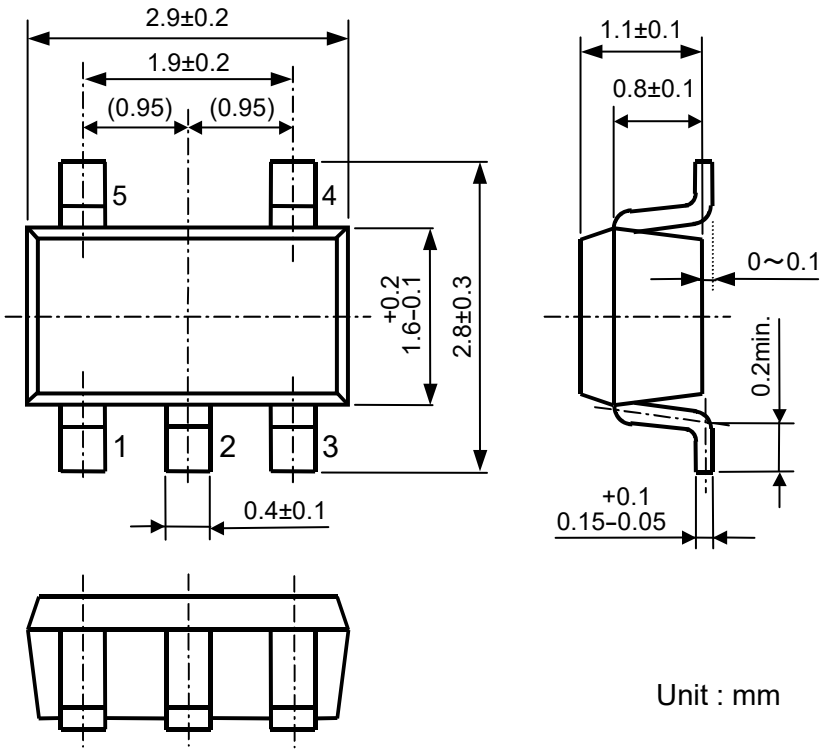
Power Dissipation



Measurement Board Pattern

IC Mount Area (Unit: mm)

PACKAGE DIMENSIONS (SOT-23-5)

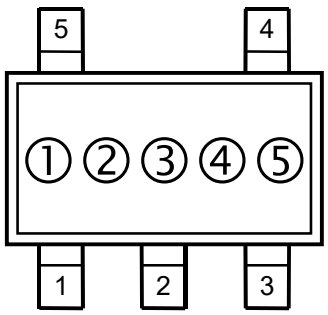


SOT-23-5 Package Dimensions

MARK SPECIFICATION (SOT-23-5)

①②③: Product Code … **Refer to *MARK SPECIFICATION TABLE (SOT-23-5)***

④⑤: Lot Number … Alphanumeric Serial Number



SOT-23-5 Mark Specification

MARK SPECIFICATION TABLE (SOT-23-5)

R1163Nxx1B

Product Name	①②③	V_{SET}
R1163N151B	V 1 5	1.5 V
R1163N161B	V 1 6	1.6 V
R1163N171B	V 1 7	1.7 V
R1163N181B	V 1 8	1.8 V
R1163N191B	V 1 9	1.9 V
R1163N201B	V 2 0	2.0 V
R1163N211B	V 2 1	2.1 V
R1163N221B	V 2 2	2.2 V
R1163N231B	V 2 3	2.3 V
R1163N241B	V 2 4	2.4 V
R1163N251B	V 2 5	2.5 V
R1163N261B	V 2 6	2.6 V
R1163N271B	V 2 7	2.7 V
R1163N281B	V 2 8	2.8 V
R1163N291B	V 2 9	2.9 V
R1163N301B	V 3 0	3.0 V
R1163N311B	V 3 1	3.1 V
R1163N321B	V 3 2	3.2 V
R1163N331B	V 3 3	3.3 V
R1163N341B	V 3 4	3.4 V
R1163N351B	V 3 5	3.5 V
R1163N361B	V 3 6	3.6 V
R1163N371B	V 3 7	3.7 V
R1163N381B	V 3 8	3.8 V
R1163N391B	V 3 9	3.9 V
R1163N401B	V 4 0	4.0 V
R1163N181B5	V 4 1	1.85 V
R1163N281B5	V 4 2	2.85 V
R1163N271B5	V 4 3	2.75 V
R1163N501B	V 4 4	5.0 V
R1163N411B	V 4 5	4.1 V
R1163N421B	V 4 6	4.2 V
R1163N431B	V 4 7	4.3 V
R1163N441B	V 4 8	4.4 V
R1163N451B	V 4 9	4.5 V
R1163N461B	V 5 0	4.6 V
R1163N471B	V 5 1	4.7 V
R1163N481B	V 5 2	4.8 V
R1163N491B	V 5 3	4.9 V

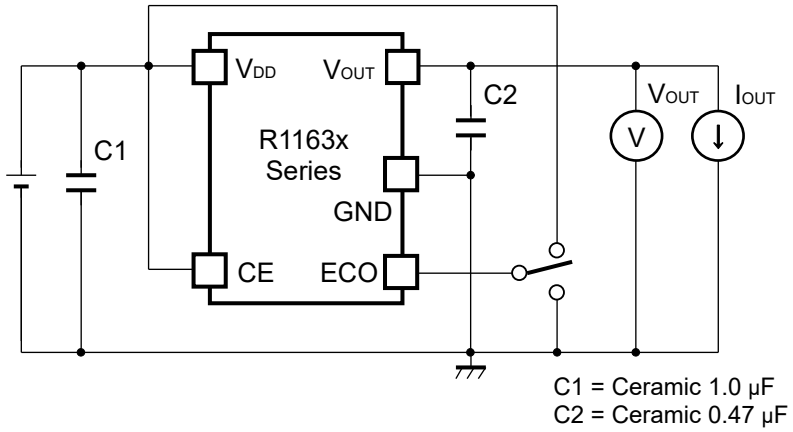
R1163Nxx1D

Product Name	①②③	V_{SET}
R1163N151D	W 1 5	1.5 V
R1163N161D	W 1 6	1.6 V
R1163N171D	W 1 7	1.7 V
R1163N181D	W 1 8	1.8 V
R1163N191D	W 1 9	1.9 V
R1163N201D	W 2 0	2.0 V
R1163N211D	W 2 1	2.1 V
R1163N221D	W 2 2	2.2 V
R1163N231D	W 2 3	2.3 V
R1163N241D	W 2 4	2.4 V
R1163N251D	W 2 5	2.5 V
R1163N261D	W 2 6	2.6 V
R1163N271D	W 2 7	2.7 V
R1163N281D	W 2 8	2.8 V
R1163N291D	W 2 9	2.9 V
R1163N301D	W 3 0	3.0 V
R1163N311D	W 3 1	3.1 V
R1163N321D	W 3 2	3.2 V
R1163N331D	W 3 3	3.3 V
R1163N341D	W 3 4	3.4 V
R1163N351D	W 3 5	3.5 V
R1163N361D	W 3 6	3.6 V
R1163N371D	W 3 7	3.7 V
R1163N381D	W 3 8	3.8 V
R1163N391D	W 3 9	3.9 V
R1163N401D	W 4 0	4.0 V
R1163N181D5	W 4 1	1.85 V
R1163N281D5	W 4 2	2.85 V
R1163N501D	W 4 4	5.0 V
R1163N411D	W 4 5	4.1 V
R1163N421D	W 4 6	4.2 V
R1163N431D	W 4 7	4.3 V
R1163N441D	W 4 8	4.4 V
R1163N451D	W 4 9	4.5 V
R1163N461D	W 5 0	4.6 V
R1163N471D	W 5 1	4.7 V
R1163N481D	W 5 2	4.8 V
R1163N491D	W 5 3	4.9 V

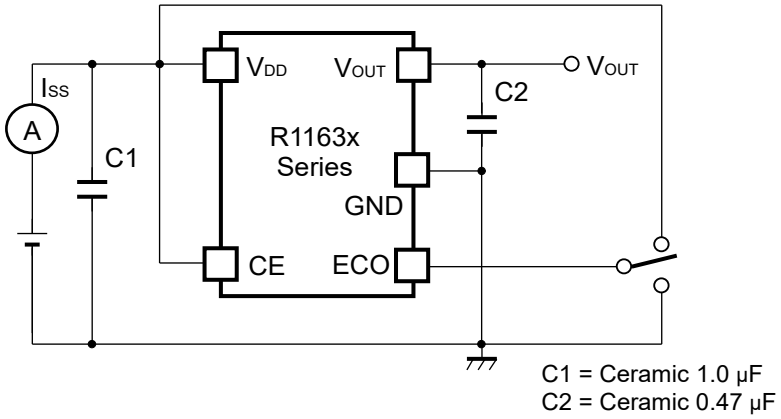
R1163Nxx1E

Product Name	①②③	V_{SET}
R1163N151E	3 1 F	1.5 V
R1163N161E	3 1 G	1.6 V
R1163N171E	3 1 H	1.7 V
R1163N181E	3 1 J	1.8 V
R1163N191E	3 1 K	1.9 V
R1163N201E	3 2 A	2.0 V
R1163N211E	3 2 B	2.1 V
R1163N221E	3 2 C	2.2 V
R1163N231E	3 2 D	2.3 V
R1163N241E	3 2 E	2.4 V
R1163N251E	3 2 F	2.5 V
R1163N261E	3 2 G	2.6 V
R1163N271E	3 2 H	2.7 V
R1163N281E	3 2 J	2.8 V
R1163N291E	3 2 K	2.9 V
R1163N301E	3 3 A	3.0 V
R1163N311E	3 3 B	3.1 V
R1163N321E	3 3 C	3.2 V
R1163N331E	3 3 D	3.3 V
R1163N341E	3 3 E	3.4 V
R1163N351E	3 3 F	3.5 V
R1163N361E	3 3 G	3.6 V
R1163N371E	3 3 H	3.7 V
R1163N381E	3 3 J	3.8 V
R1163N391E	3 3 K	3.9 V
R1163N401E	3 4 A	4.0 V
R1163N181E5	3 4 B	1.85 V
R1163N281E5	3 4 C	2.85 V
R1163N271E5	3 4 D	2.75 V
R1163N501E	3 4 E	5.0 V
R1163N411E	3 4 F	4.1 V
R1163N421E	3 4 G	4.2 V
R1163N431E	3 4 H	4.3 V
R1163N441E	3 4 J	4.4 V
R1163N451E	3 4 K	4.5 V
R1163N461E	3 5 A	4.6 V
R1163N471E	3 5 B	4.7 V
R1163N481E	3 5 C	4.8 V
R1163N491E	3 5 D	4.9 V

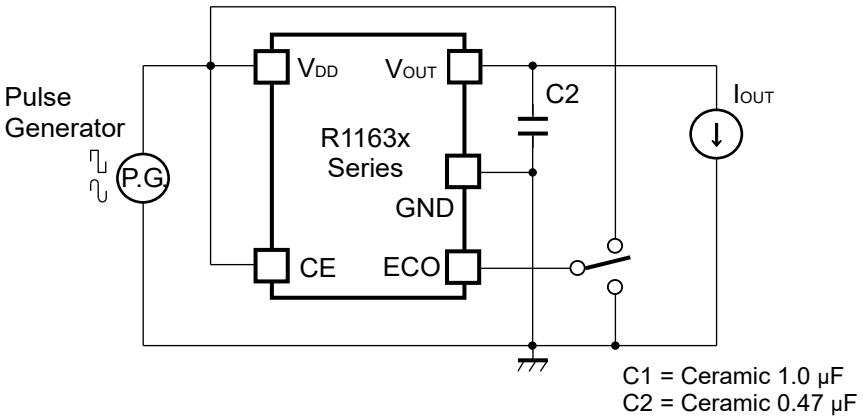
TEST CIRCUITS



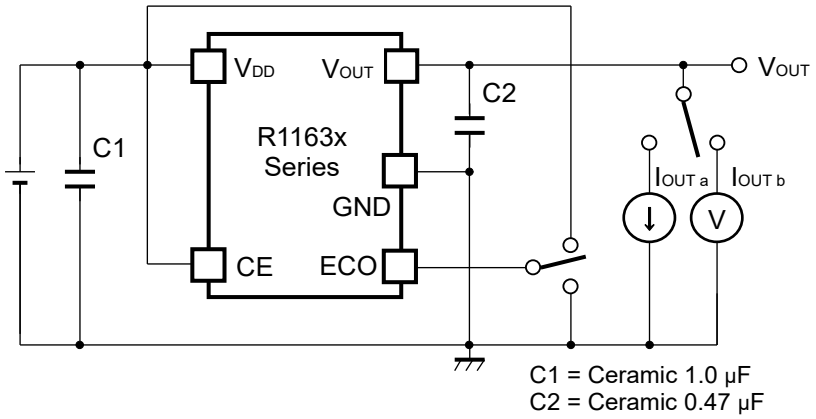
Basic Test Circuit



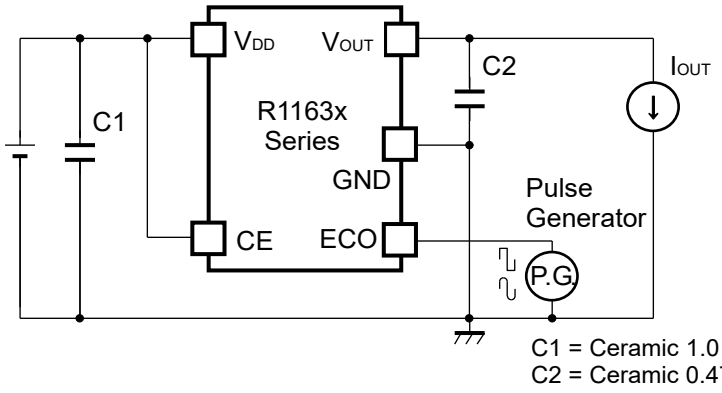
Test Circuit for Supply Current



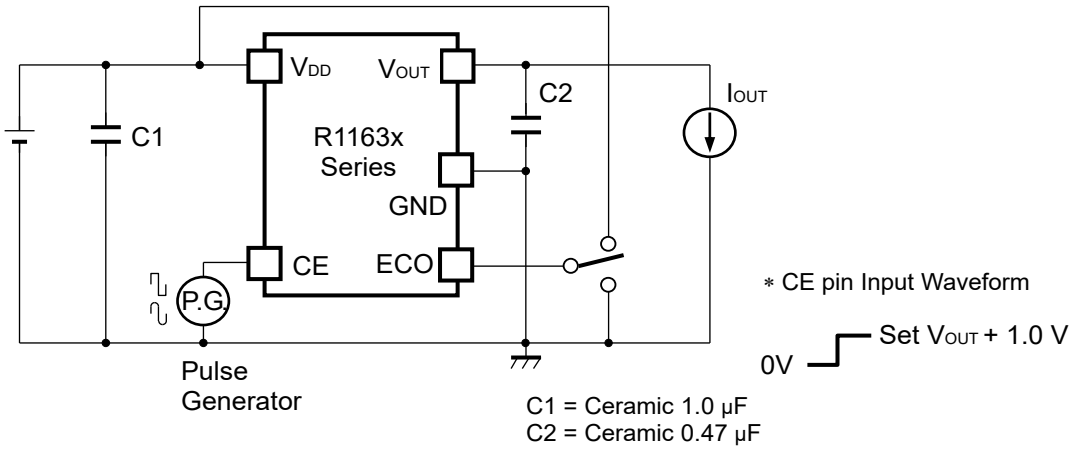
Test Circuit for Ripple Rejection, Line Transient Response



Test Circuit for Load Transient Response



Test Circuit for Output Voltage at Mode alternative point



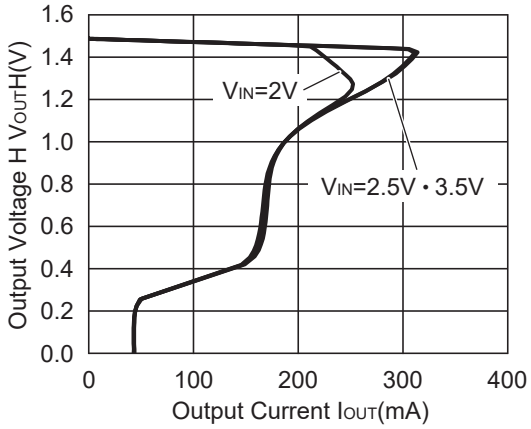
Test Circuit for Turn On Speed with CE pin

TYPICAL CHARACTERISTICS

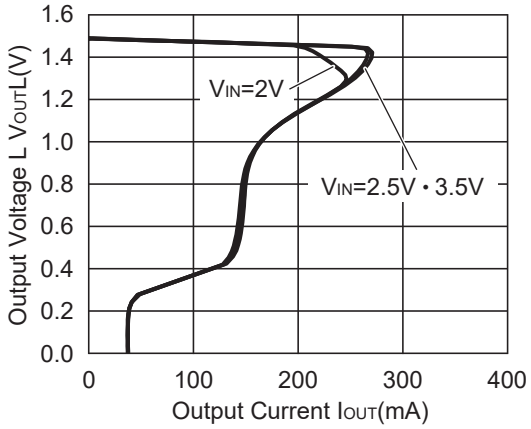
Note: Typical Characteristics are intended to be used as reference data; they are not guaranteed.
Unless otherwise provided, capacitors are ceramic type.

1) Output Voltage vs. Output Current

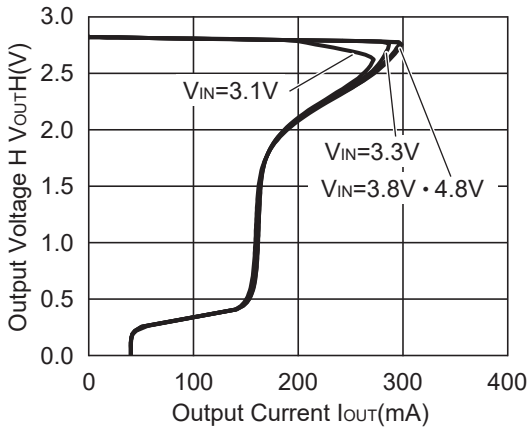
R1163x151x FT Mode



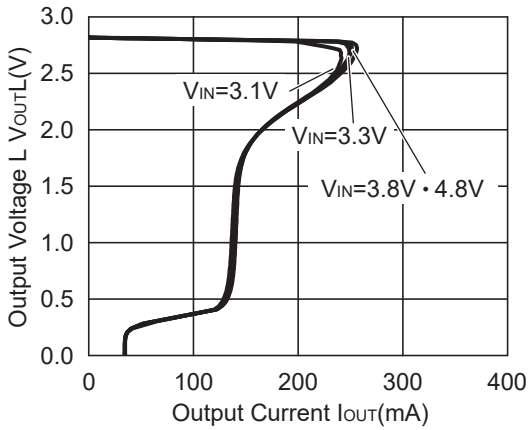
R1163x151x LP Mode



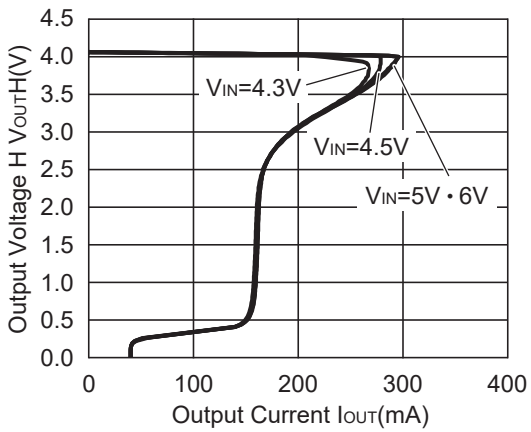
R1163x281x FT Mode



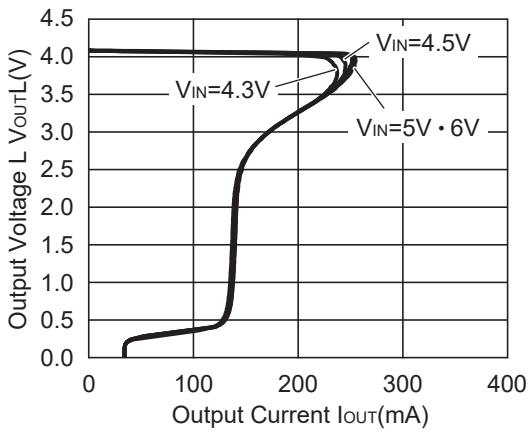
R1163x281x LP Mode



R1163x40x FT Mode

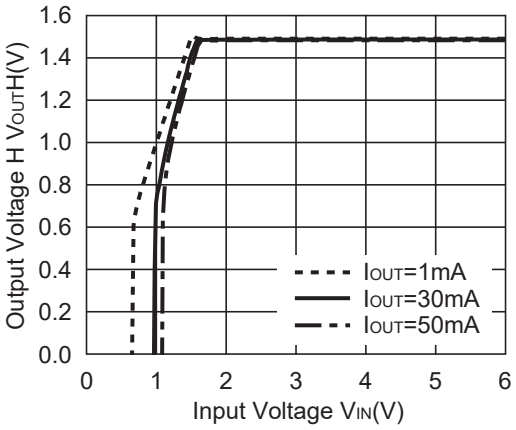


R1163x40x LP Mode

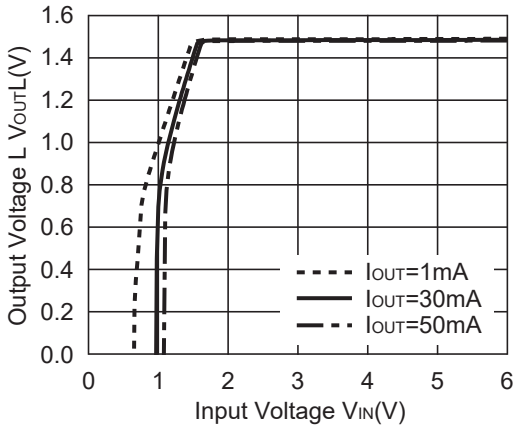


2) Output Voltage vs. Input Voltage

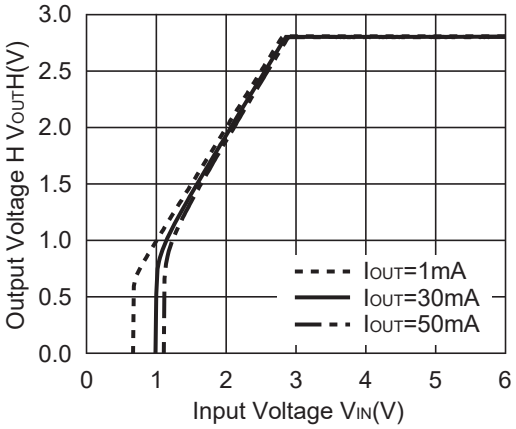
R1163x151x FT Mode



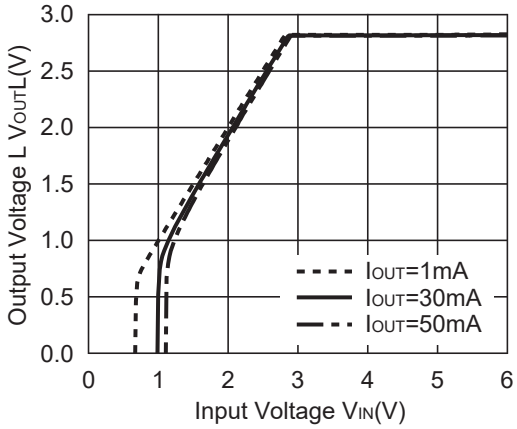
R1163x15x LP Mode



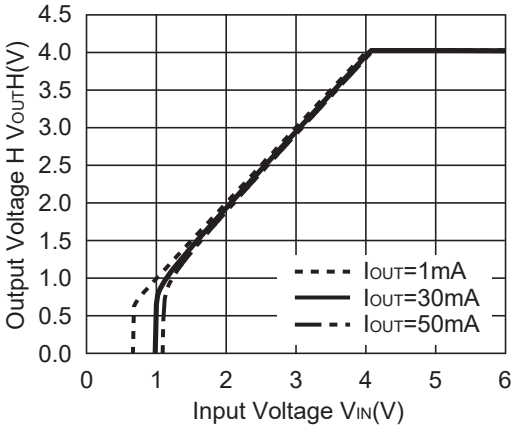
R1163x28x FT Mode



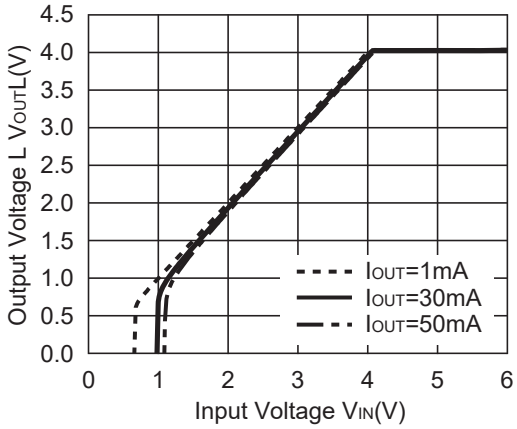
R1163x28x LP Mode



R1163x40x FT Mode

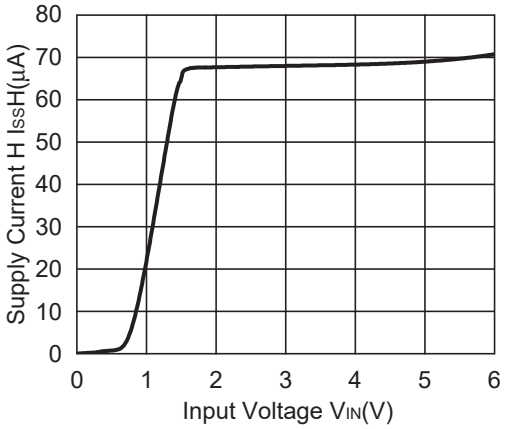


R1163x40x LP Mode

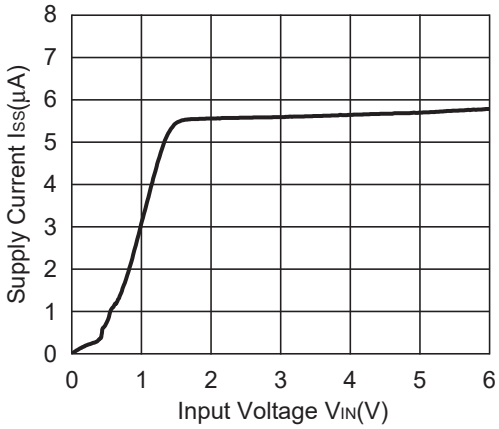


3) Supply Current vs. Input Voltage

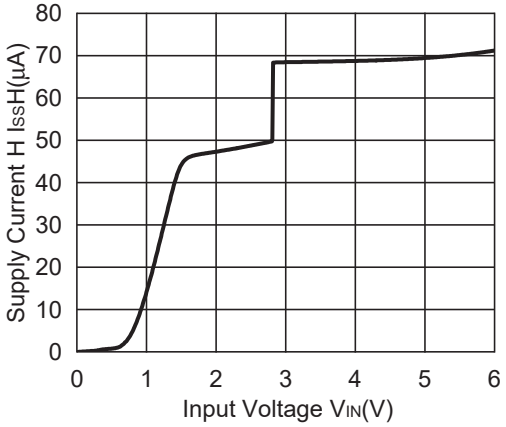
R1163x151x FT Mode



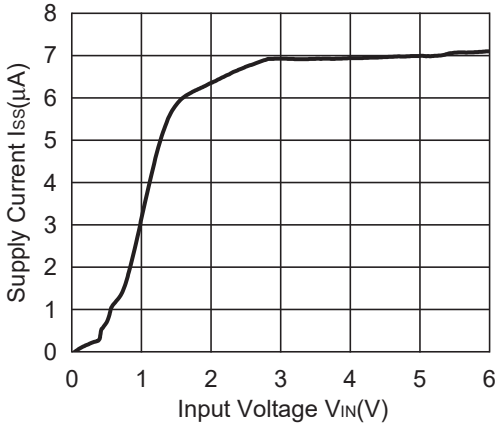
R1163x151x LP Mode



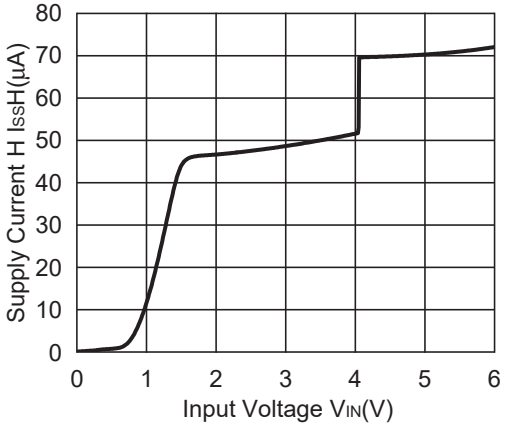
R1163x281x FT Mode



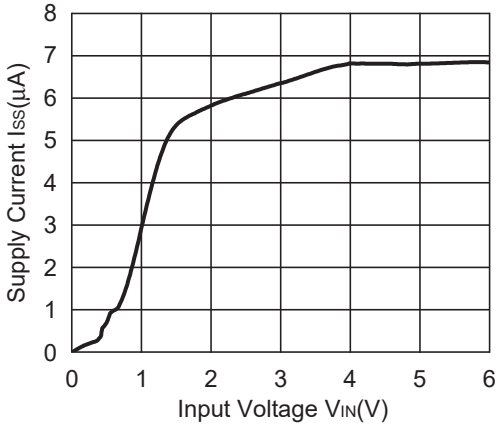
R1163x281x LP Mode



R1163x401x FT Mode

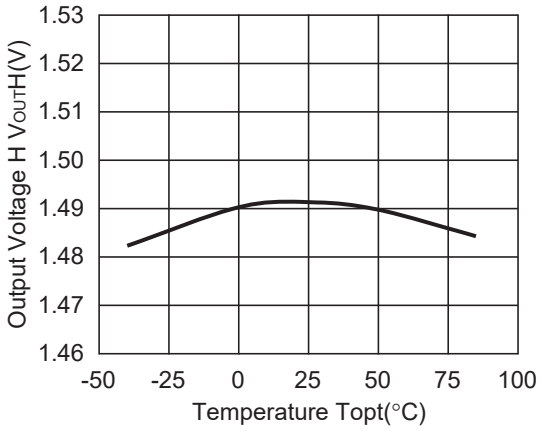


R1163x401x LP Mode

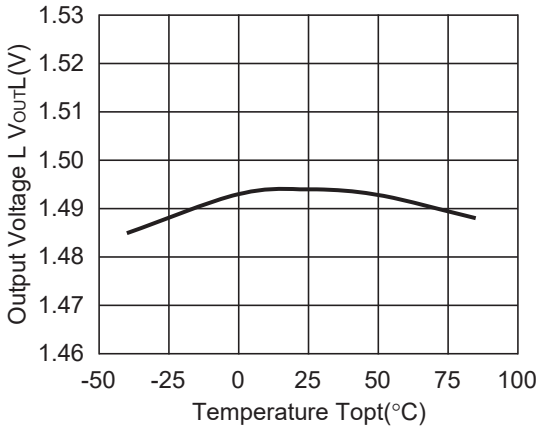


4) Output Voltage vs. Temperature

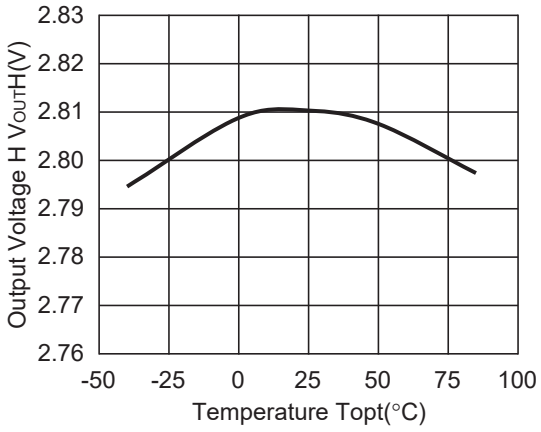
R1163x151x FT Mode



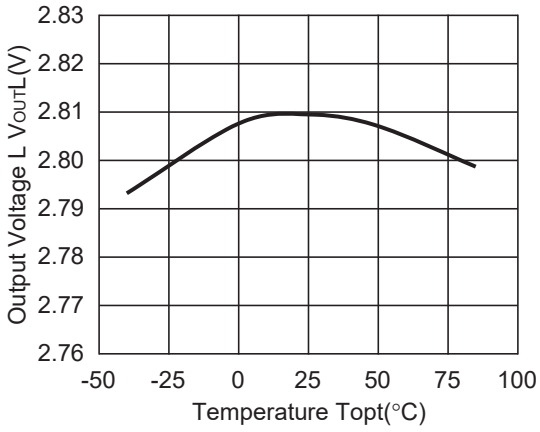
R1163x151x LP Mode



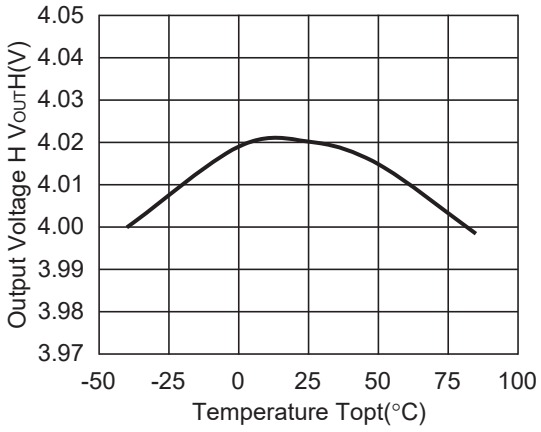
R1163x281x FT Mode



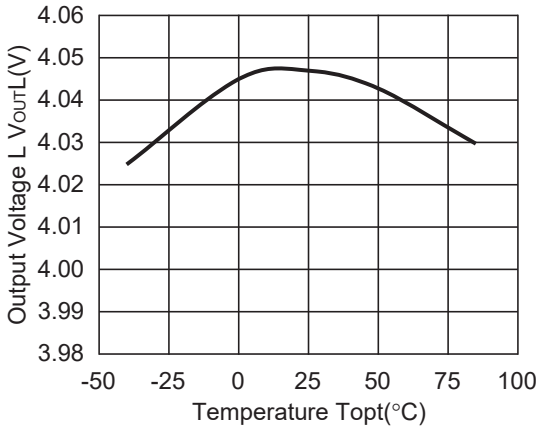
R1163x281x LP Mode



R1163x401x FT Mode

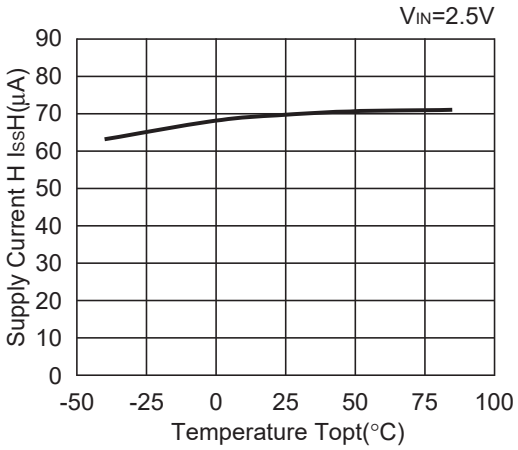


R1163x401x LP Mode

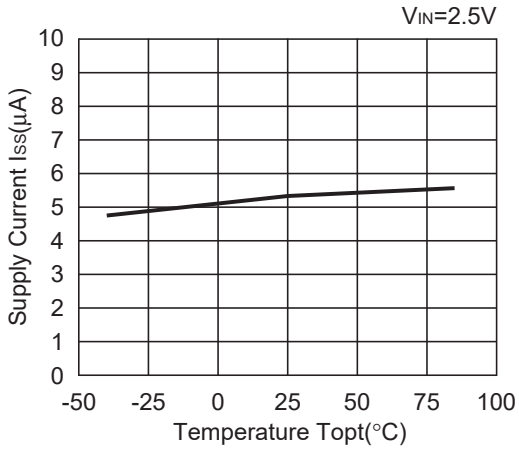


5) Supply Current vs. Temperature

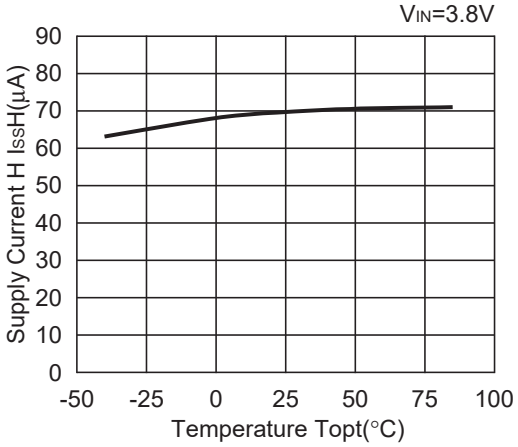
R1163x151x FT Mode



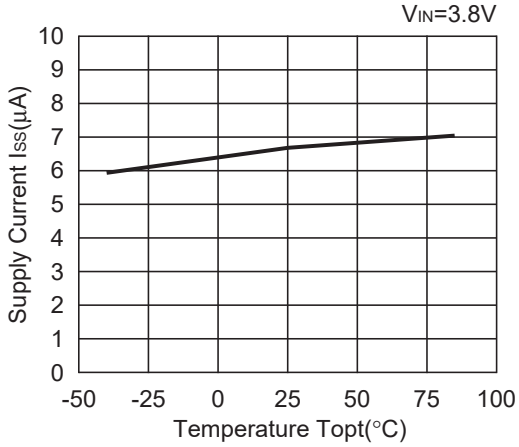
R1163x151x LP Mode



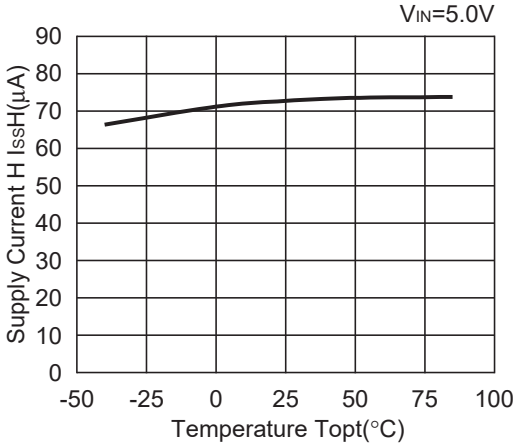
R1163x281x FT Mode



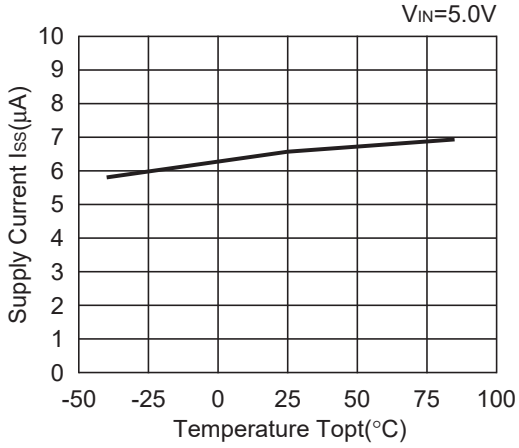
R1163x281x LP Mode



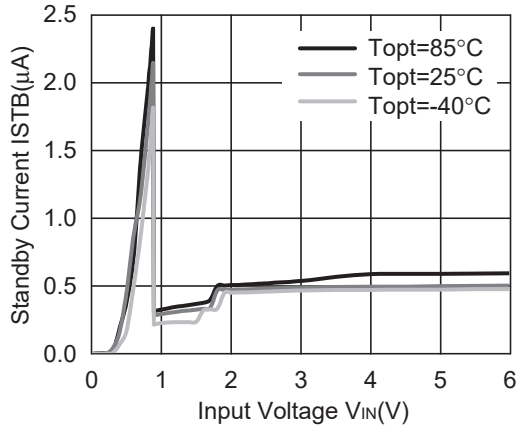
R1163x401x FT Mode



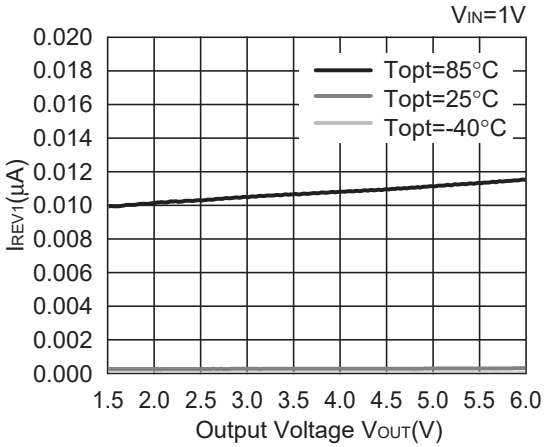
R1163x401x LP Mode

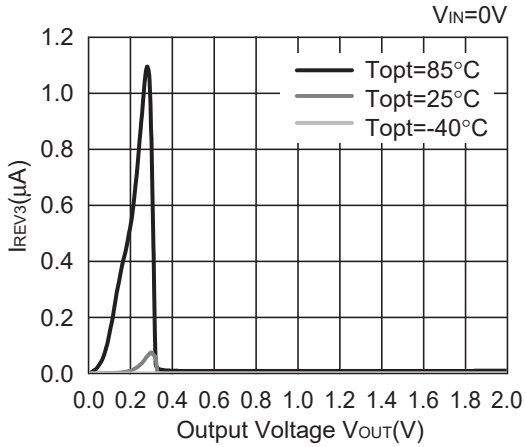


6) Standby Current vs. Input Voltage



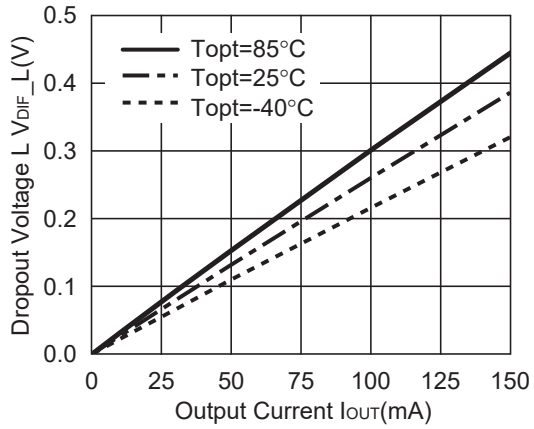
7) Reverse Current vs. Output Voltage



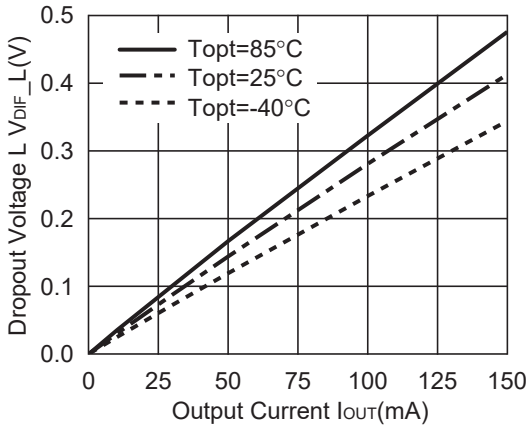


8) Dropout Voltage vs. Output Current

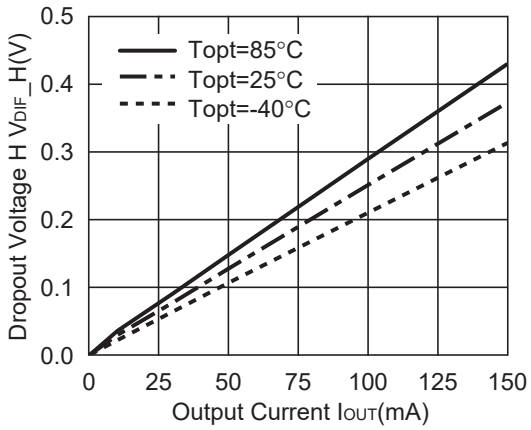
R1163x151x FT Mode



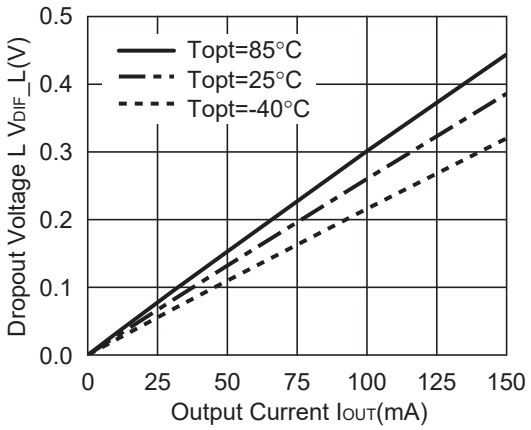
R1163x151x LP Mode



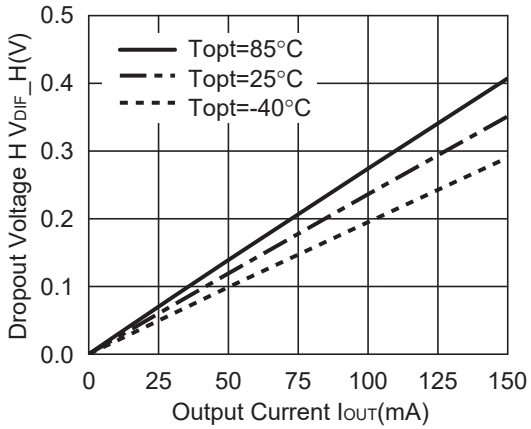
R1163x161x FT Mode



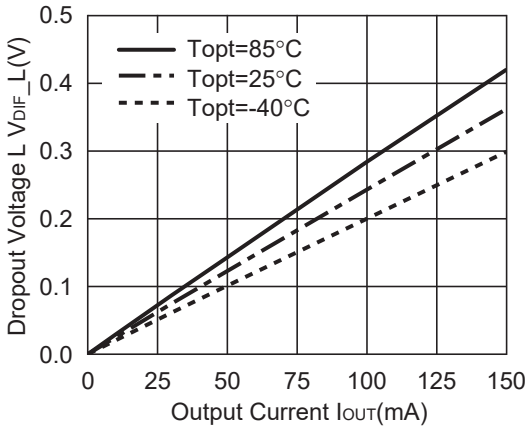
R1163x161x LP Mode



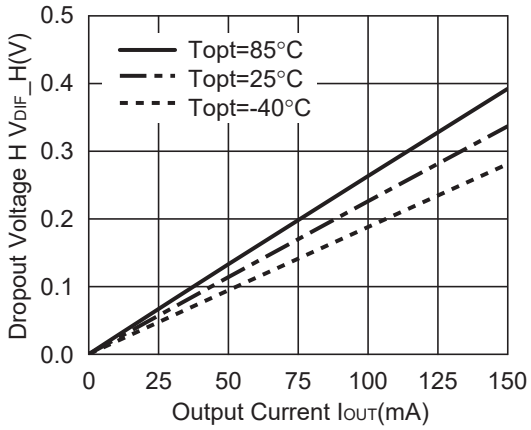
R1163x171x FT Mode



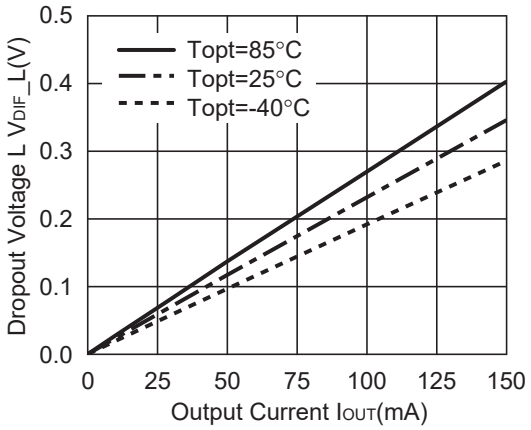
R1163x171x LP Mode



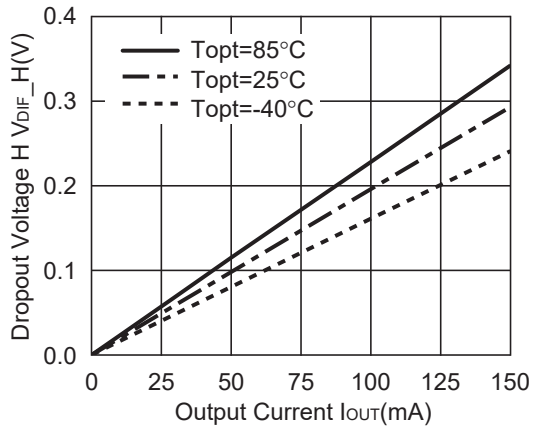
R1163x181x FT Mode



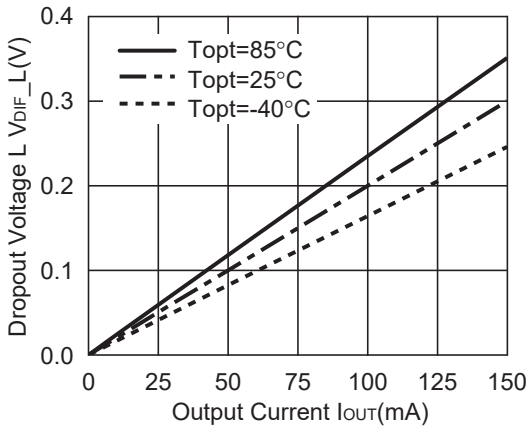
R1163x181x LP Mode



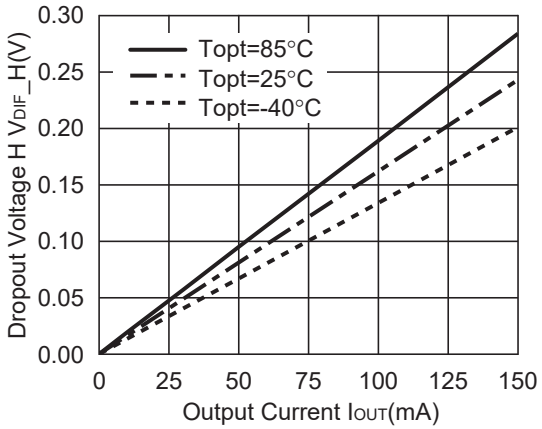
R1163x211x FT Mode



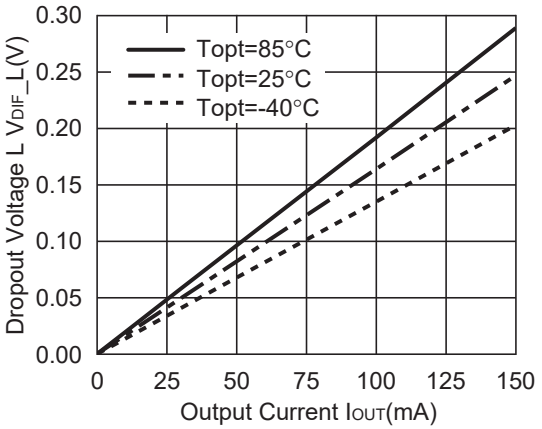
R1163x211x LP Mode



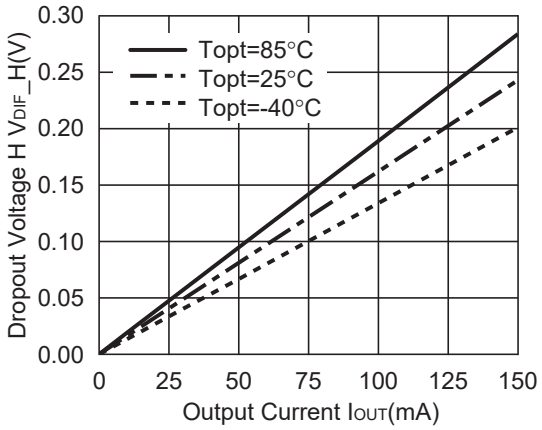
R1163x281x FT Mode



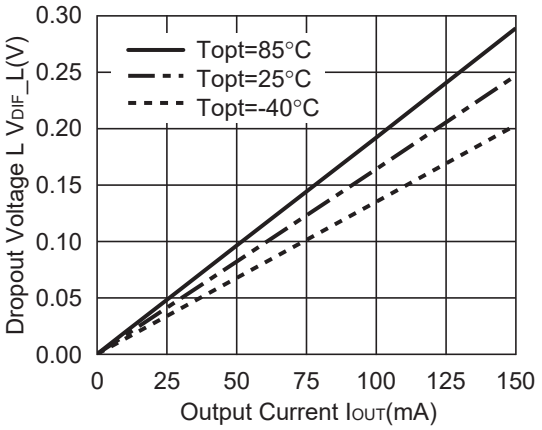
R1163x281x LP Mode



R1163x401x FT Mode

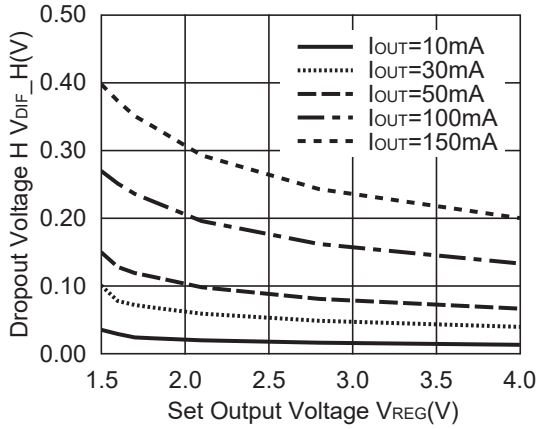


R1163x401x LP Mode

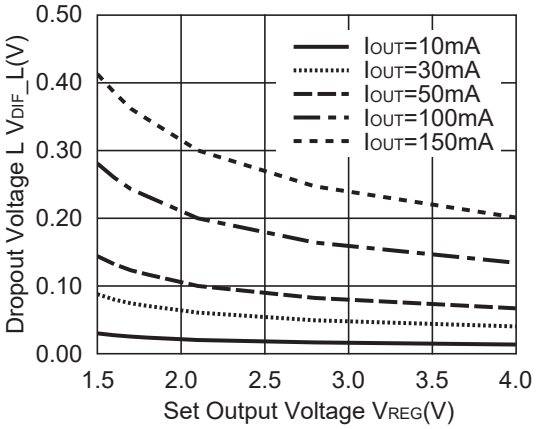


9) Dropout Voltage vs. Set Output Voltage

R1163x FT Mode



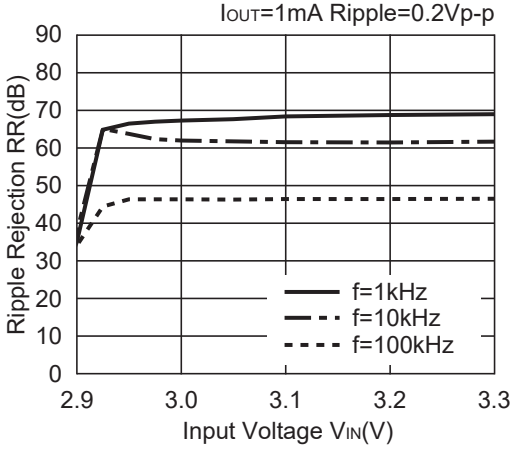
R1163x LP Mode



10) Ripple Rejection vs. Input Bias Voltage

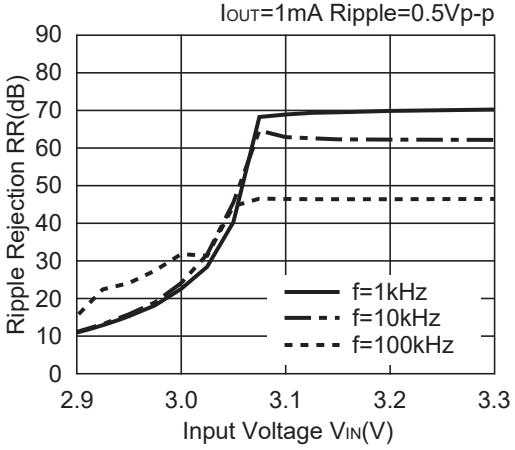
R1163x281x FT Mode

CIN=none, COUT=0.47µF,
IOUT=1mA Ripple=0.2Vp-p



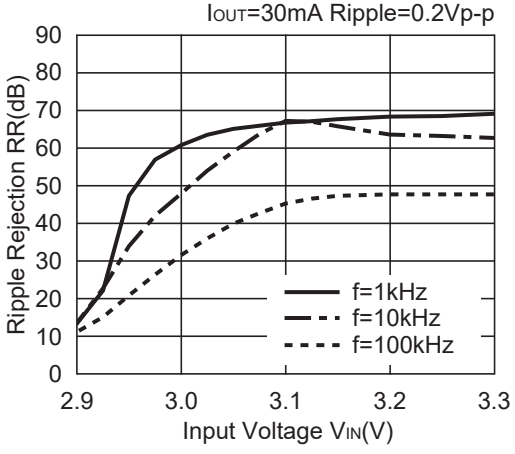
R1163x281x FT Mode

CIN=none, COUT=0.47µF,
IOUT=1mA Ripple=0.5Vp-p



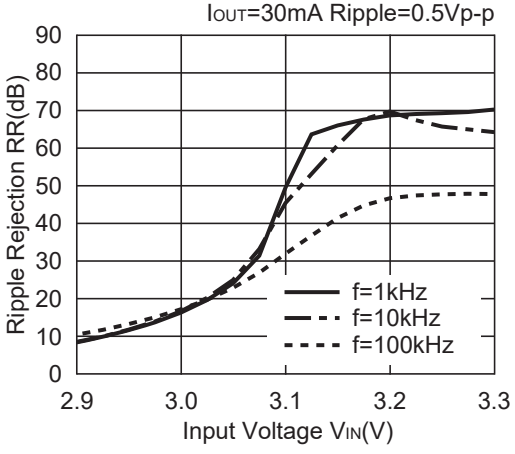
R1162x281x FT Mode

CIN=none, COUT=0.47µF,
IOUT=30mA Ripple=0.2Vp-p

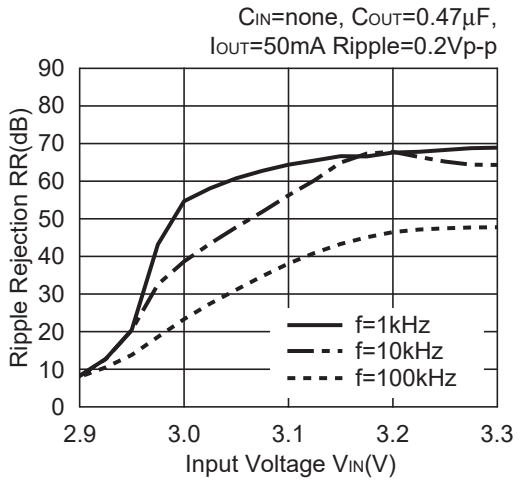


R1162x281x FT Mode

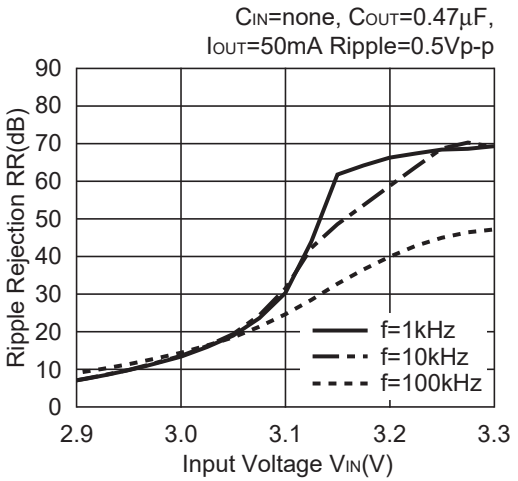
CIN=none, COUT=0.47µF,
IOUT=30mA Ripple=0.5Vp-p



R1163x281x FT Mode

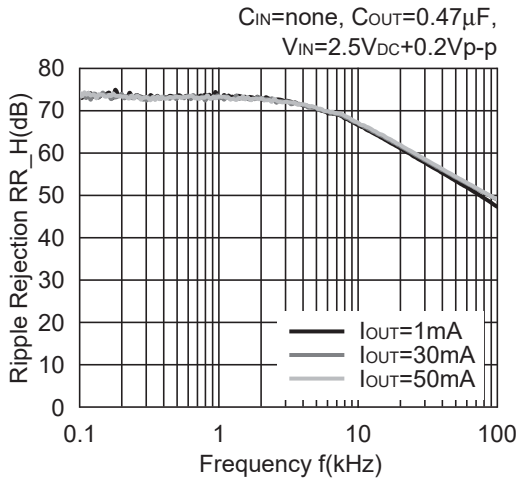


R1163x281x FT Mode

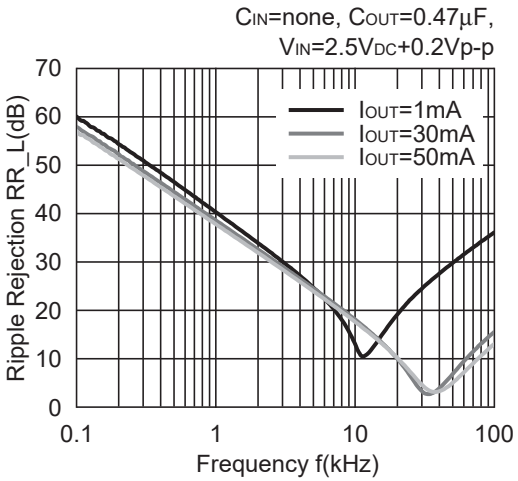


11) Ripple Rejection vs. Frequency

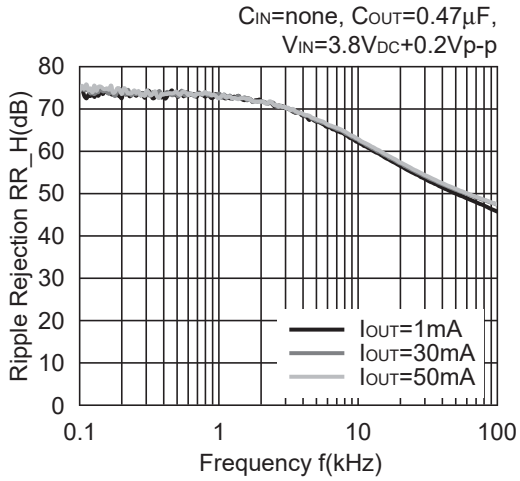
R1163x151x FT Mode



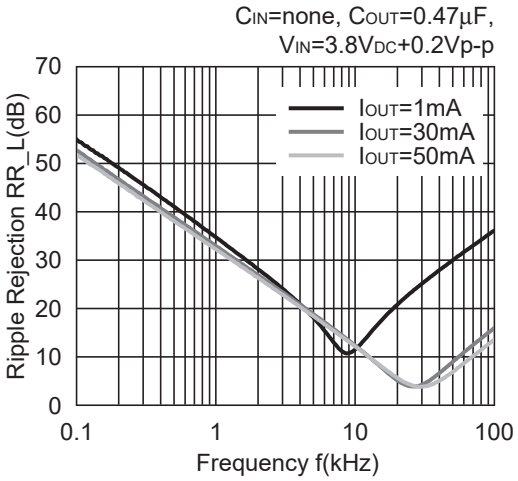
R1163x151x LP Mode



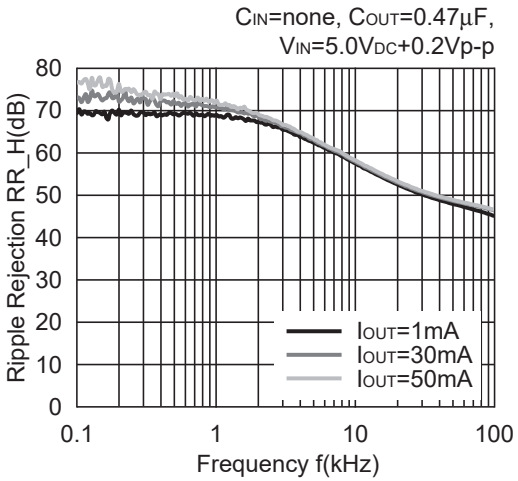
R1163x281x FT Mode



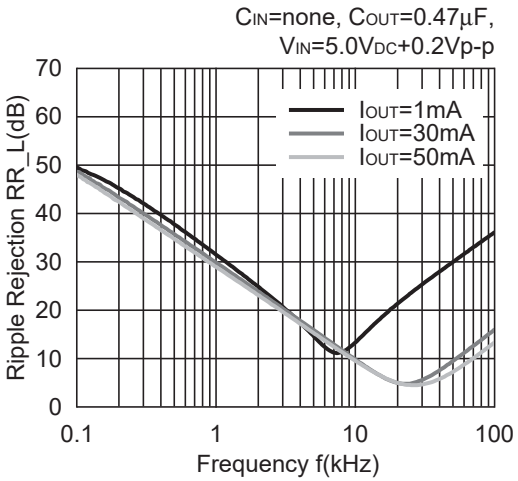
R1163x281x LP Mode



R1163x401x FT Mode

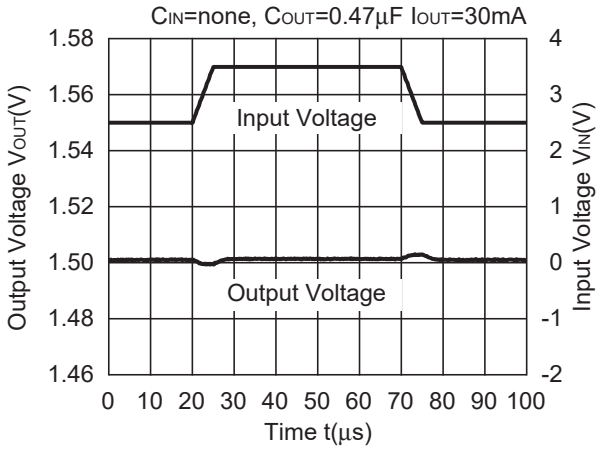


R1163x401x LP Mode

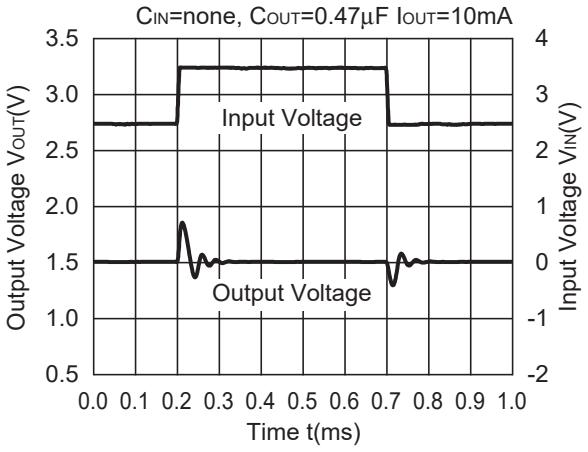


12) Input Transient Response

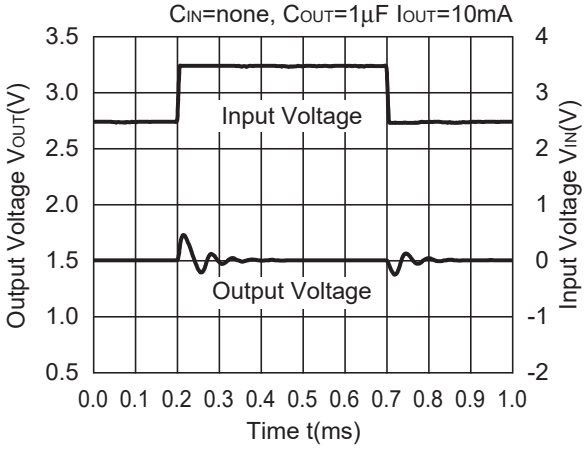
R1163x151x FT Mode



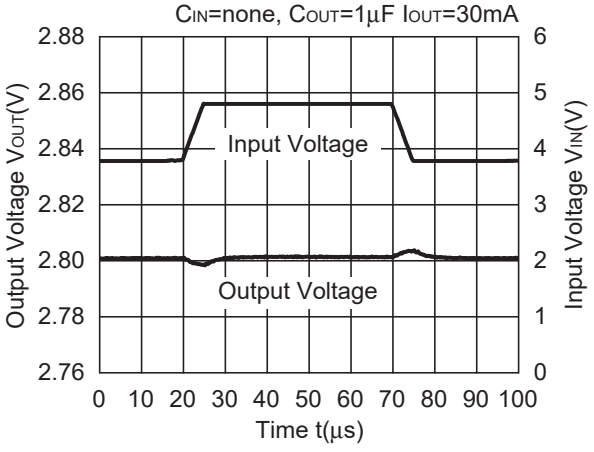
R1163x151x LP Mode



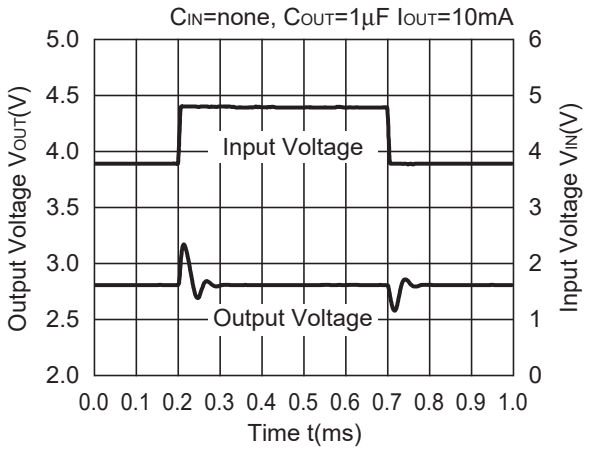
R1163x151x LP Mode



R1163x281x FT Mode

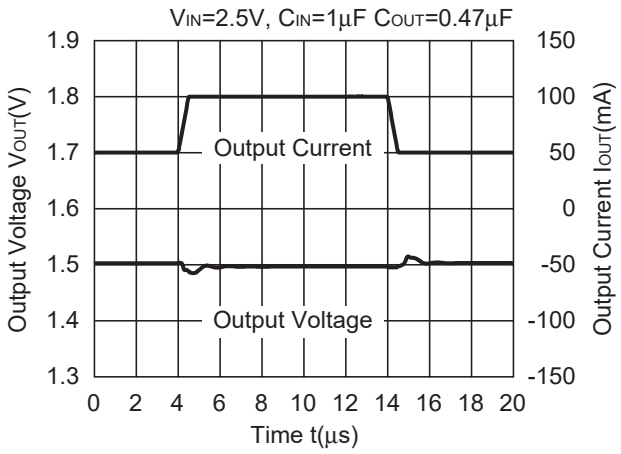


R1163x281x FT Mode

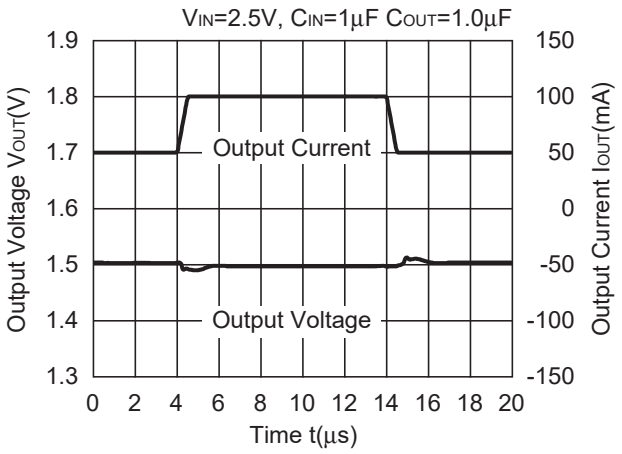


13) Load Transient Response

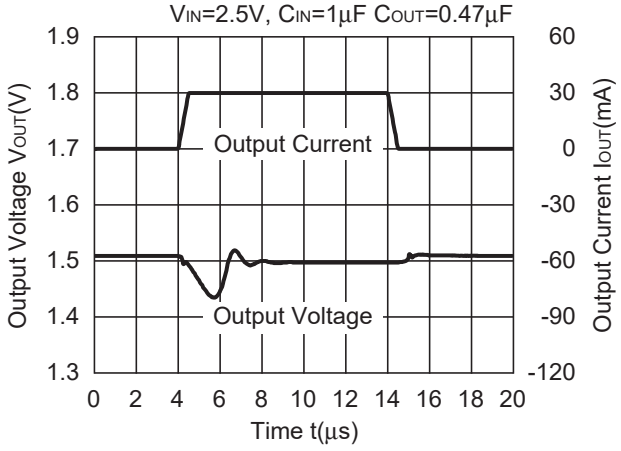
R1163x151x FT Mode



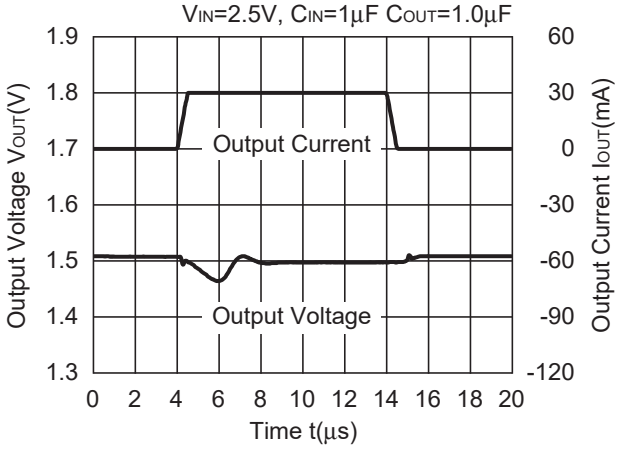
R1163x151x FT Mode



R1163x151x FT Mode

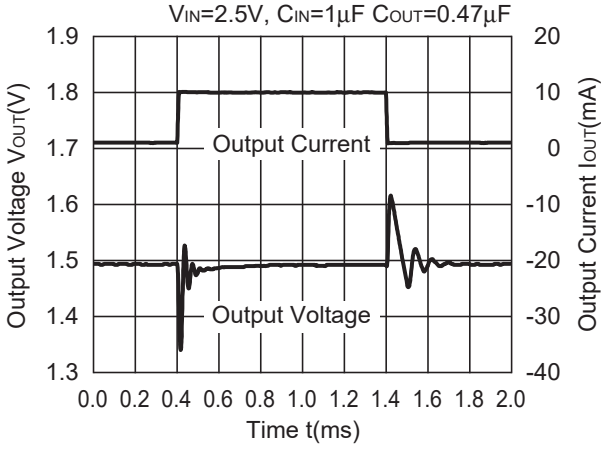


R1163x151x FT Mode



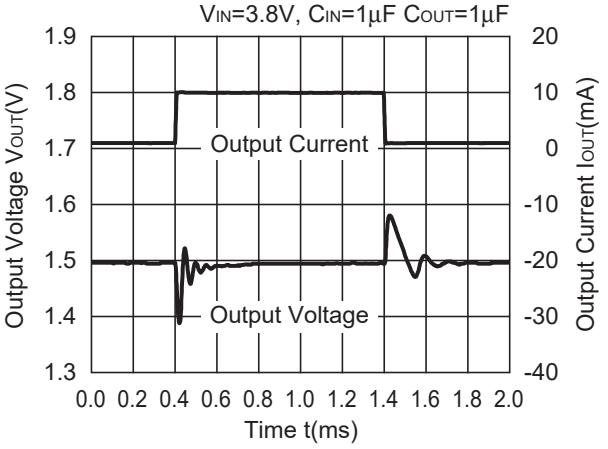
R1163x151x LP Mode

V_{IN}=2.5V, C_{IN}=1µF C_{OUT}=0.47µF



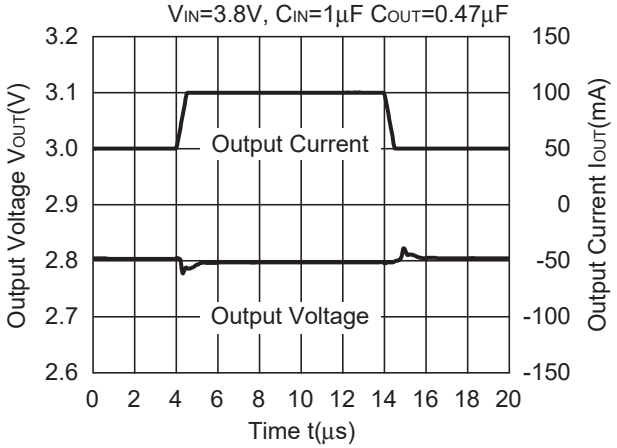
R1163x151x LP Mode

V_{IN}=3.8V, C_{IN}=1µF C_{OUT}=1µF



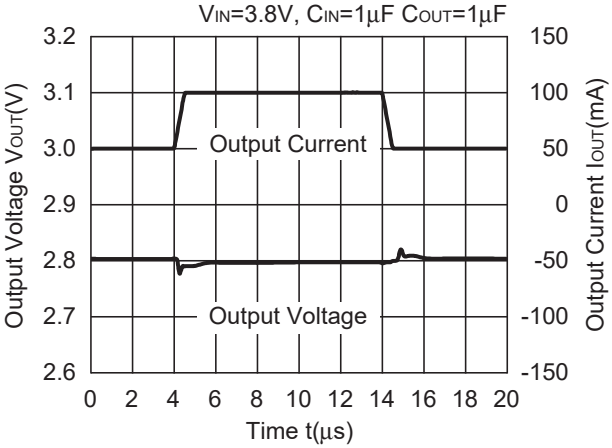
R1163x281x FT Mode

V_{IN}=3.8V, C_{IN}=1µF C_{OUT}=0.47µF



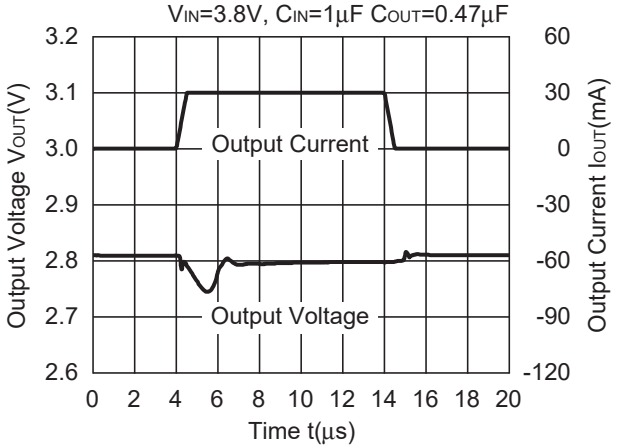
R1163x281x FT Mode

V_{IN}=3.8V, C_{IN}=1µF C_{OUT}=1µF



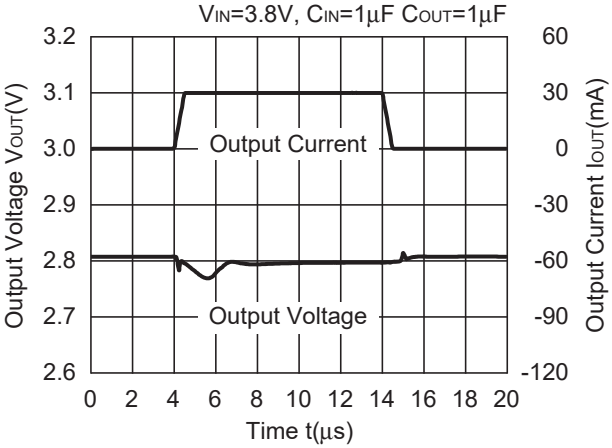
R1163x281x FT Mode

V_{IN}=3.8V, C_{IN}=1µF C_{OUT}=0.47µF

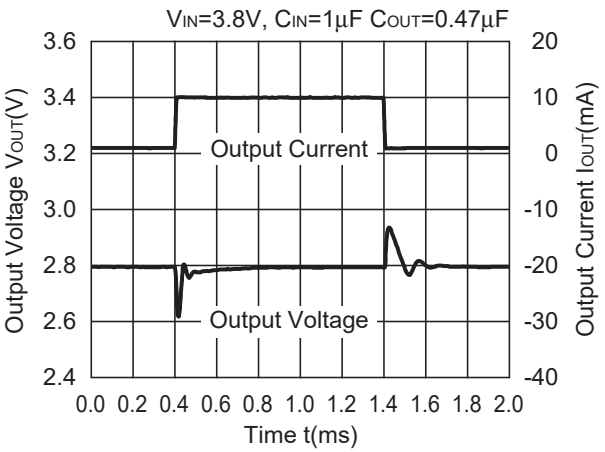


R1163x281x FT Mode

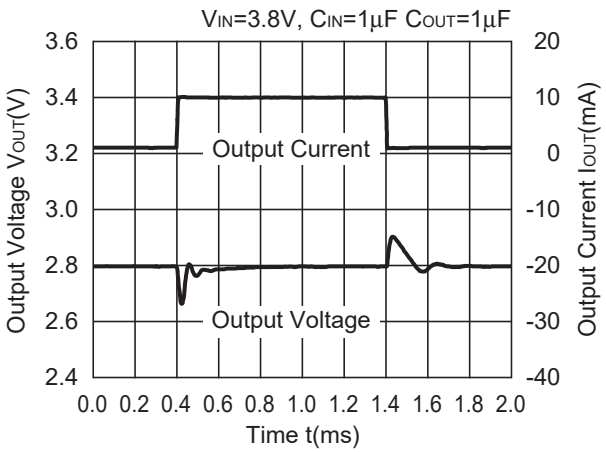
V_{IN}=3.8V, C_{IN}=1µF C_{OUT}=1µF



R1163x281x LP Mode

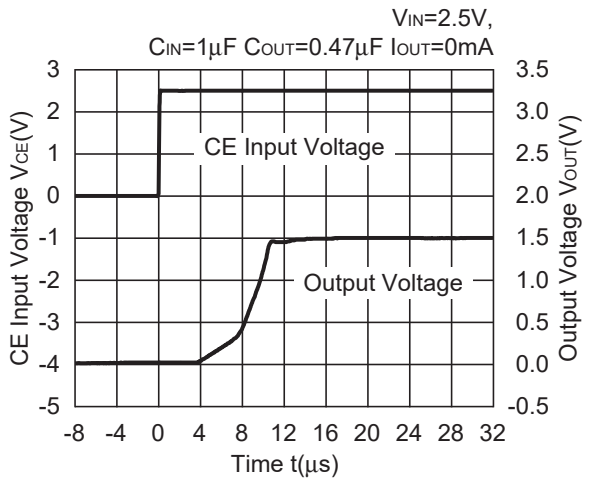


R1163x281x LP Mode

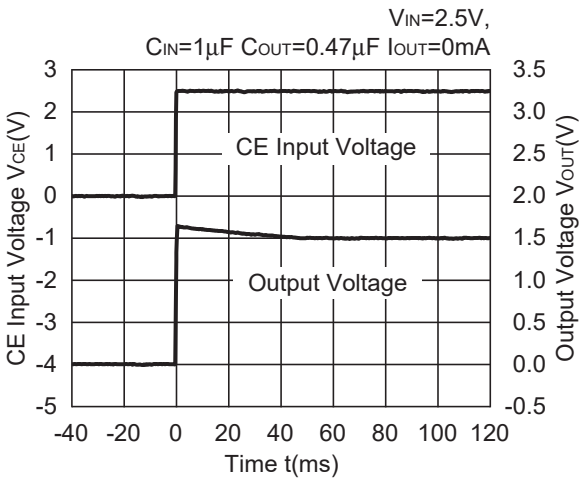


14) Turn on speed with CE pin

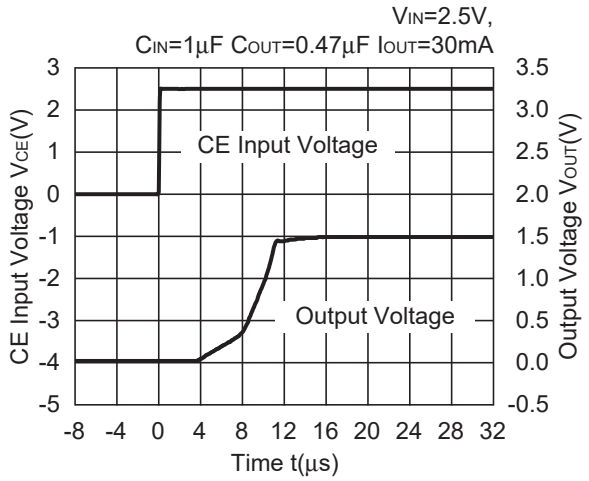
R1163x151x FT Mode



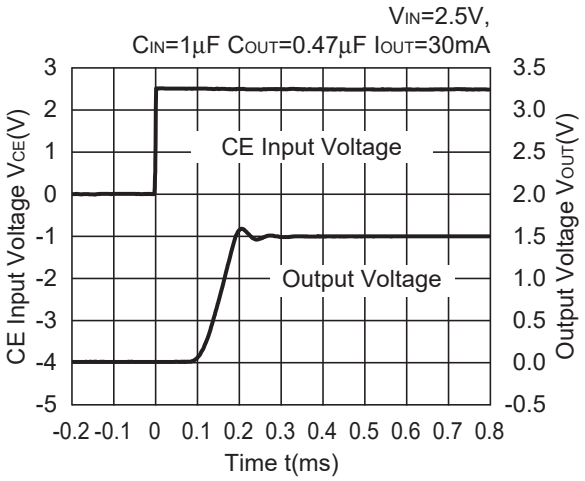
R1163x151x LP Mode



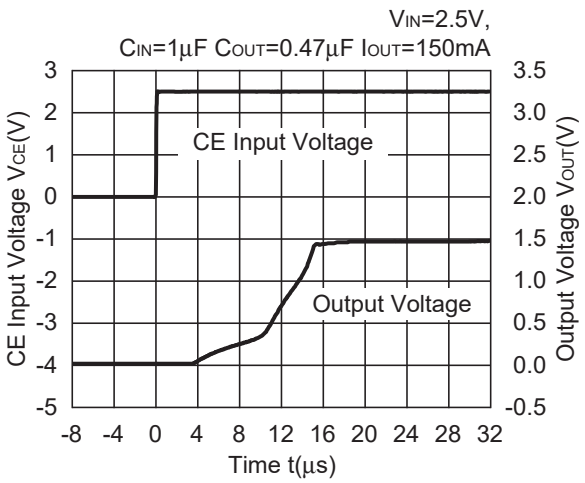
R1163x151x FT Mode



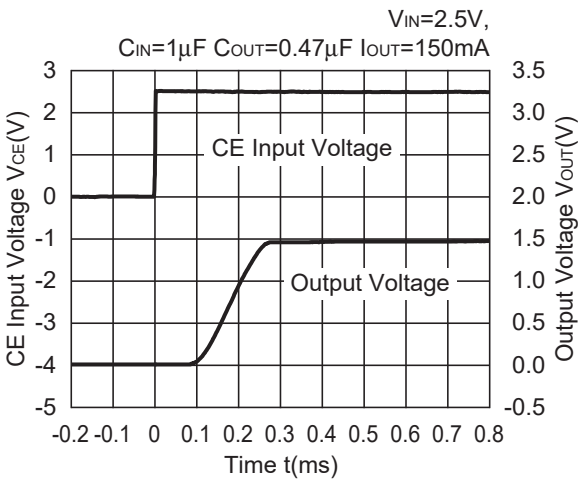
R1163x151x LP Mode



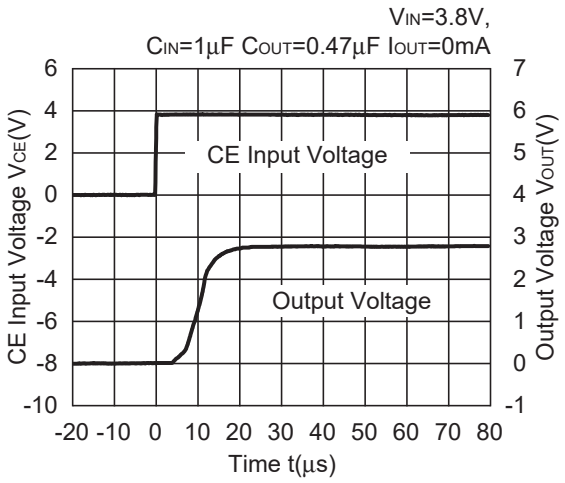
R1163x151x FT Mode



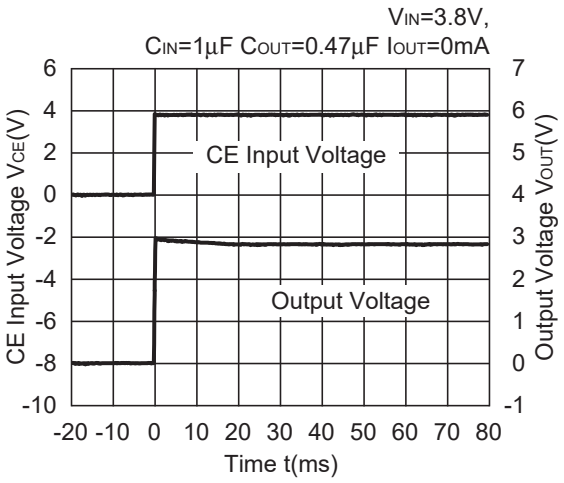
R1163x151x LP Mode



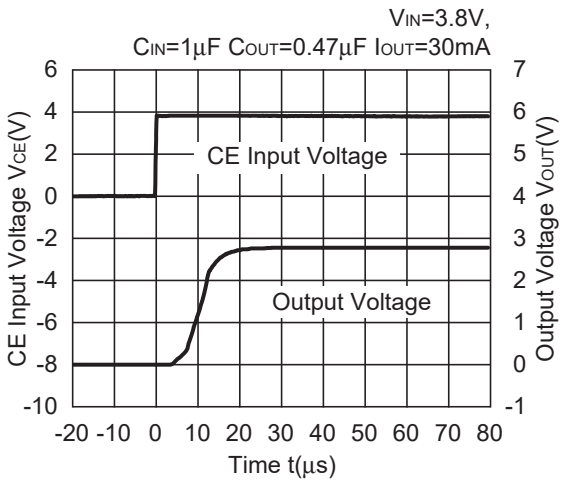
R1163x281x FT Mode



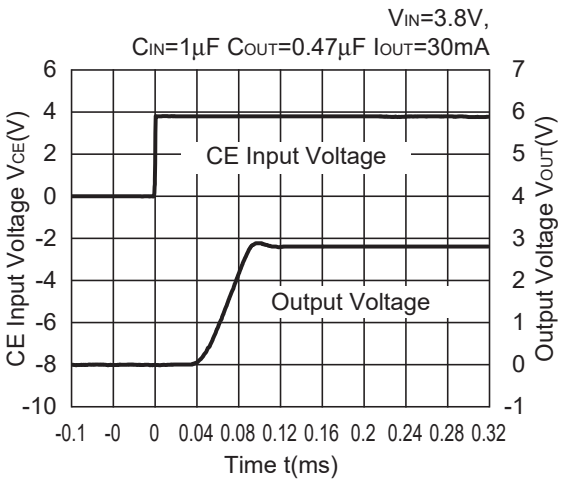
R1163x281x LP Mode



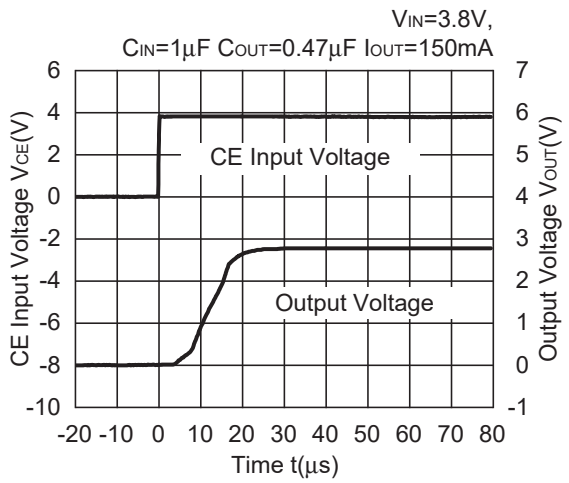
R1163x281x FT Mode



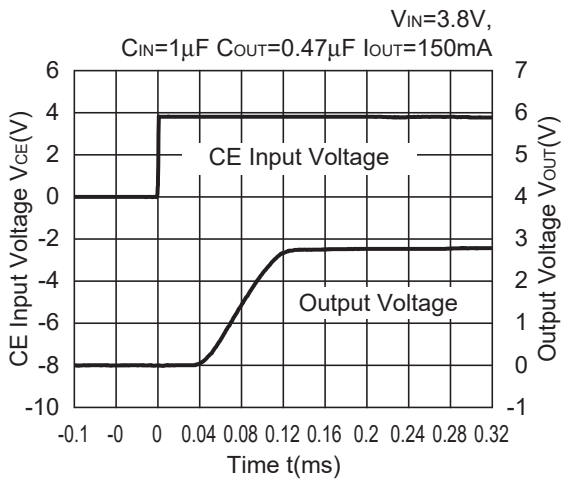
R1163x281x LP Mode



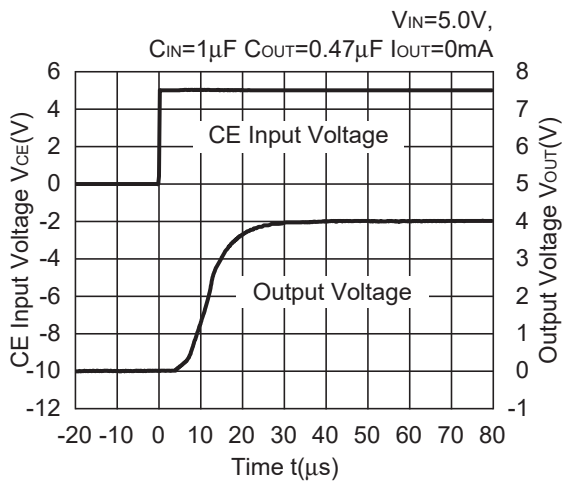
R1163x281x FT Mode



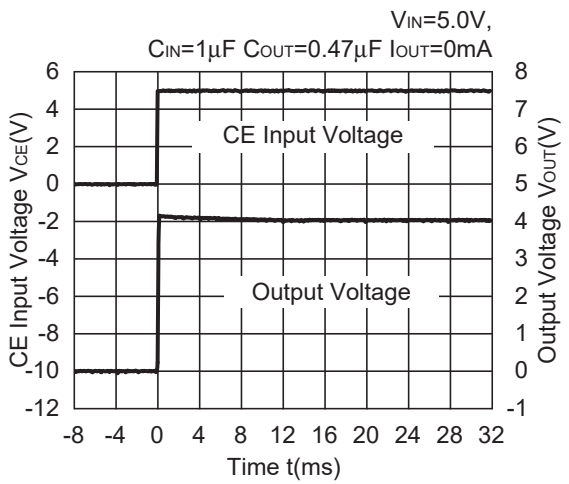
R1163x281x LP Mode



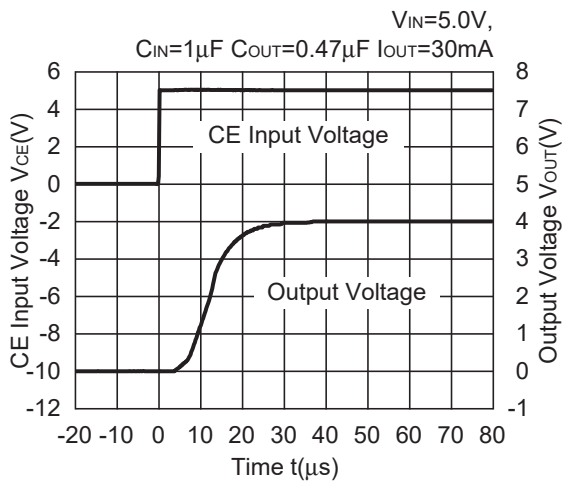
R1163x401x FT Mode



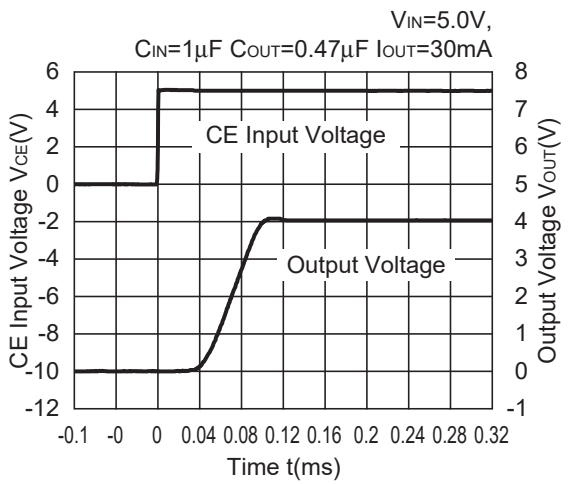
R1163x401x LP Mode



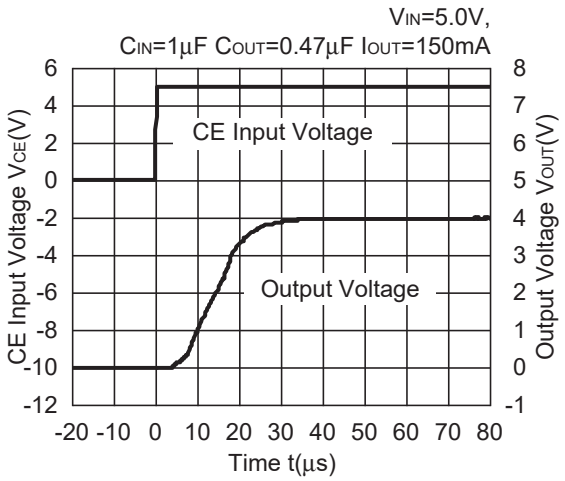
R1163x401x FT Mode



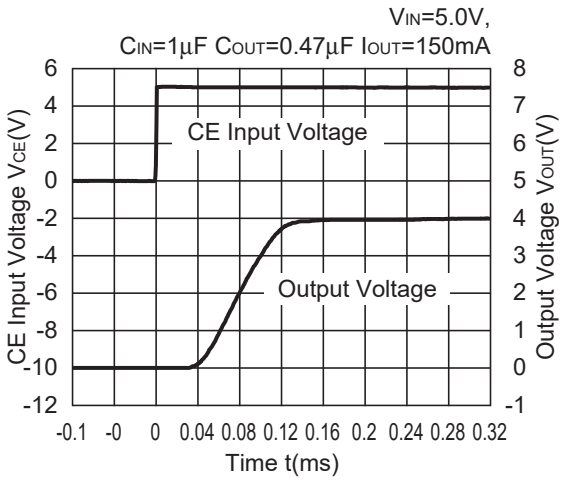
R1163x401x LP Mode



R1163x401x FT Mode

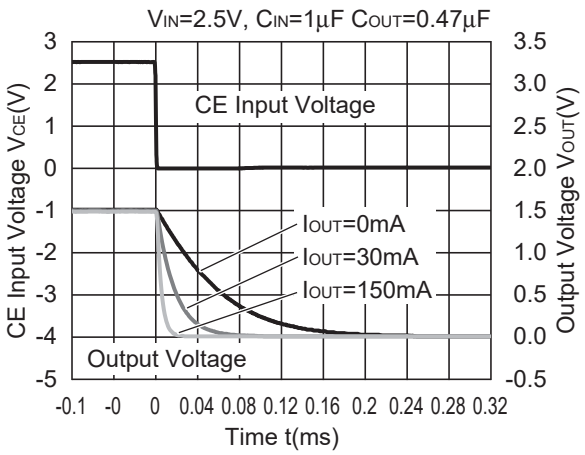


R1163x401x LP Mode

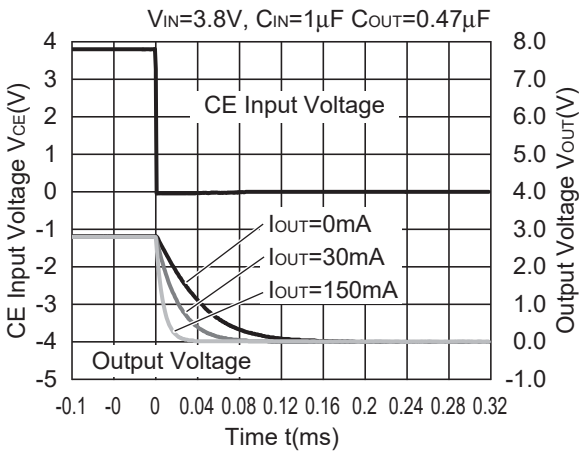


15) Turn off speed with CE pin

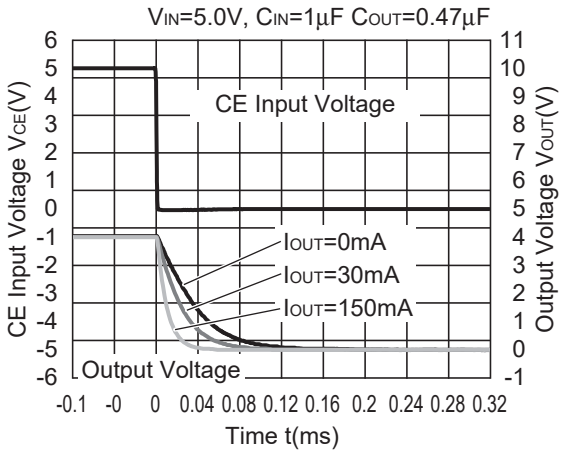
R1163x151xD



R1163x281xD



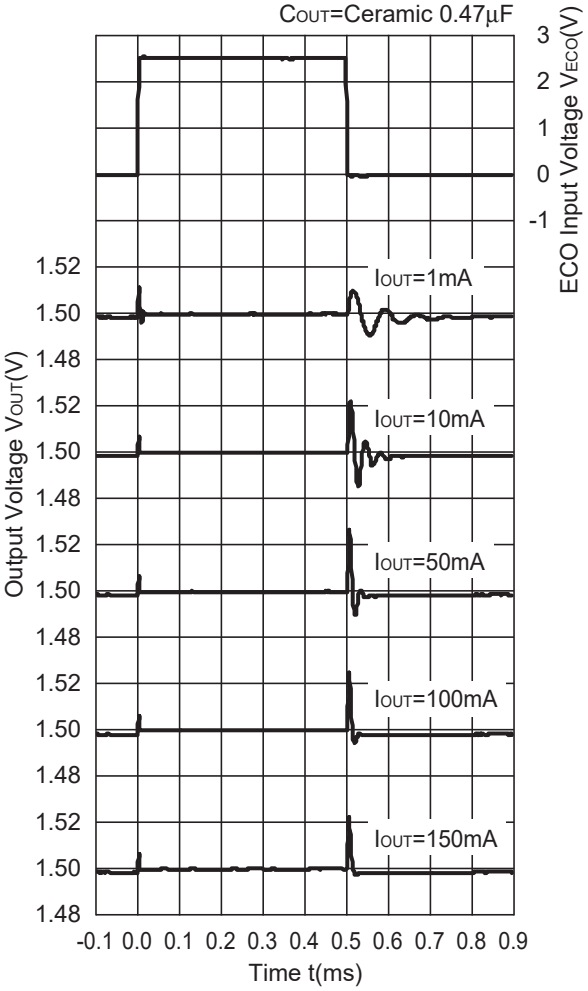
R1163x401xD



16) Output Voltage at Mode alternative point

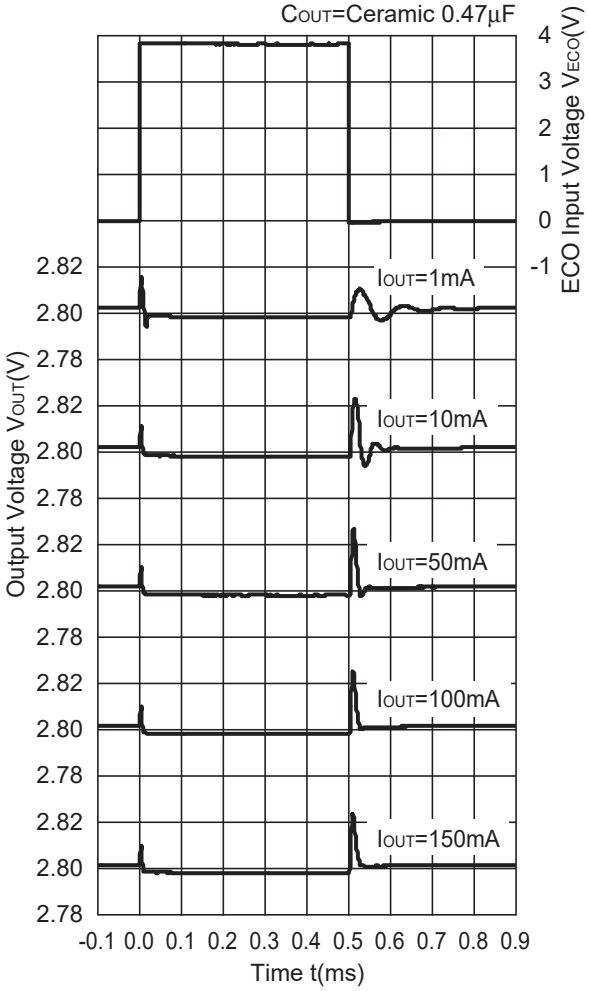
R1163x151B/D

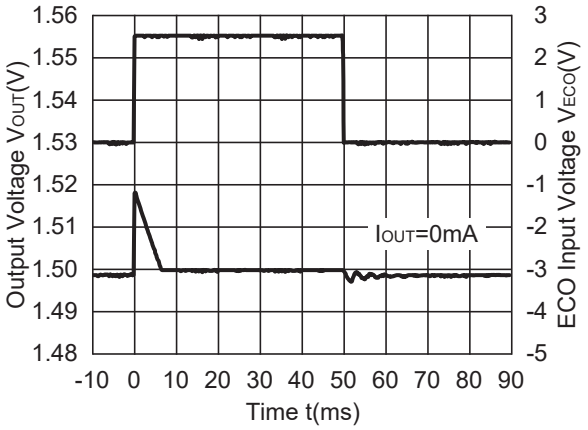
V_{IN}=2.5V, C_{IN}=Ceramic 1.0µF,
C_{OUT}=Ceramic 0.47µF

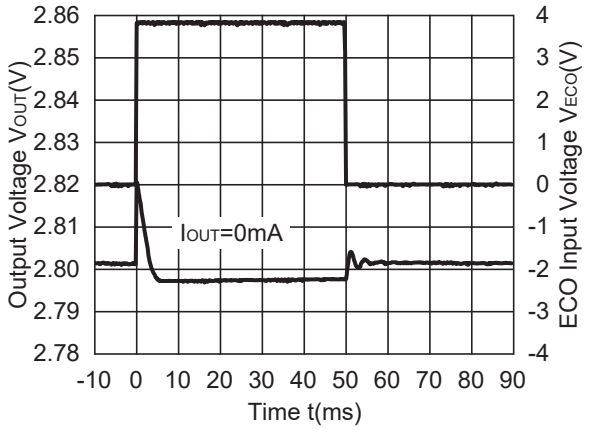


R1163x281B/D

V_{IN}=3.8V, C_{IN}=Ceramic 1.0µF,
C_{OUT}=Ceramic 0.47µF







TECHNICAL NOTES

When using these ICs, consider the following points:

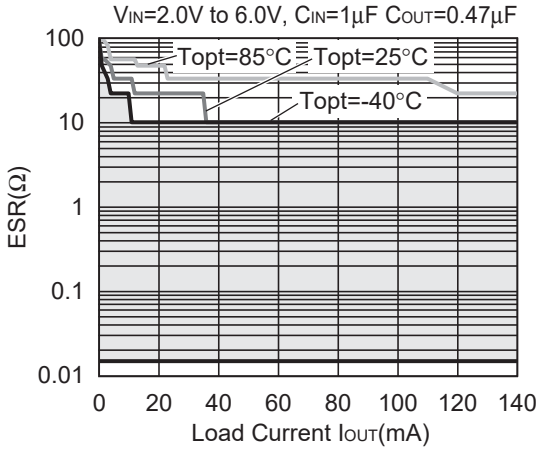
In these ICs, phase compensation is made for securing stable operation even if the load current is varied. For this purpose, be sure to use a capacitor C_{OUT} with good frequency characteristics and ESR (Equivalent Series Resistance) in the range described as follows:

The relations between I_{OUT} (Output Current) and ESR of Output Capacitor are shown below. The conditions when the white noise level is under 40 μV (Avg.) are marked as the hatched area in the graph.

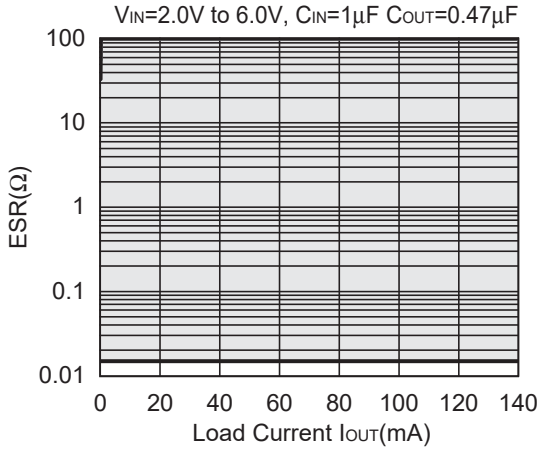
<Test conditions>

(1) Frequency band: 10 Hz to 2 MHz

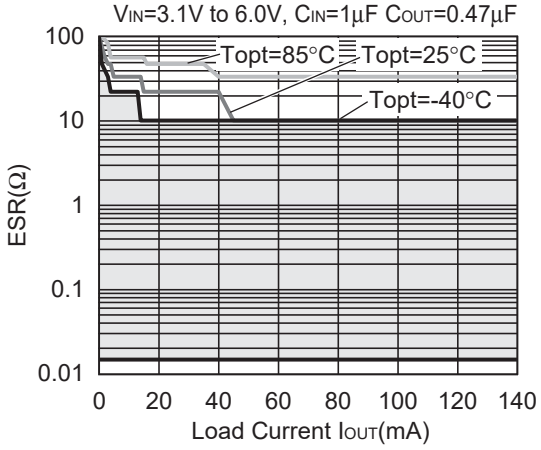
R1163x151x FT Mode



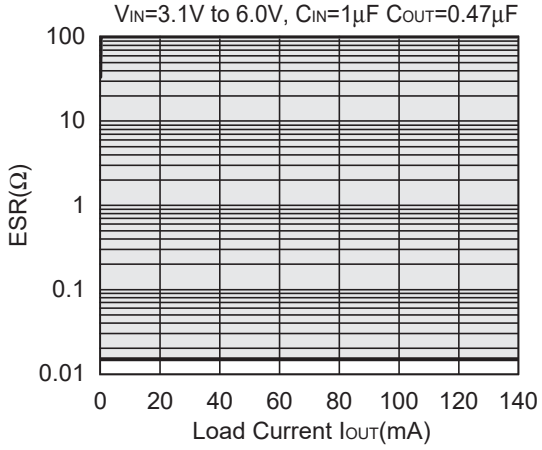
R1163x151x LP Mode



R1163x281x FT Mode



R1163x281x LP Mode



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