XC641A Series

VR x 4, VD x 2 Multi Power Supply

- **CMOS Low Power Consumption**
- **4 Voltage Regulators and 2 Voltage Detectors Built-In.**
- **Output Control Circuit**
- **Output Voltage and Detect Voltage Range : 2V to 5V**
- **Output Voltage Accuracy and Detect Voltage Range: ±2%**
- **16 Pin TSSOP Package**

Applications

- Battery Operated Power Supply Systems
- Mobile Phones, Cordless Phones, and other Portable Communication Systems.

General Description

The XC641A series are highly precise, low power consumption, multi power supply IC s, manufactured using CMOS and laser trimming technologies. The IC consists of a highly precise reference, 4 voltage regulators, 2 voltage detectors, and an output control circuit.

Because the regulators can be disabled through the EN pins, in stand-by, current consumption can be greatly reduced.

The minimal input / output differential supports efficient voltage circuit design. The XC641A is particularly suitable for use with battery powered equipment where power supply control is all important.

The series comes in a small TSSOP-16 package.

Features

Output Voltage / Detect Voltage Range :

2V to 5V : Selectable in 0.1V increments (Semi-Custom)

Highly Accurate :

Setup voltage ± 2%

Low power consumption :

TYP 25µA

TYP 6µA [When the EN input is OFF (standard products)]

Output voltage temperature characteristics :

TYP± 100ppm/ °C

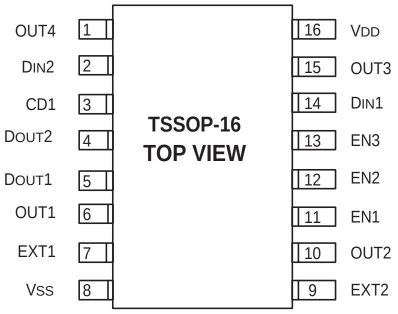
Small Package :

TSSOP-16

Pin Assignment

PIN NUMBER	PIN NAME	FUNCTION
1	OUT4	Voltage Regulator 4 Output
2	DIN2	Voltage Detector 2 Input
3	CD1	Delay Generating Circuit Output
4	DOUT2	Voltage Detector 2 Output
5	DOUT1	Voltage Detector 1 Output
6	OUT1	Voltage Regulator 1 Output Voltage Monitor
7	EXT1	Voltage Regulator 1 External Transistor Connection
8	VSS	Ground
9	EXT2	Voltage Regulator 2 External Transistor Connection
10	OUT2	Voltage Regulator 2 Output Voltage Monitor
11	EN1	Voltage Regulator 1 Enable (Positive Logic)
12	EN2	Voltage Regulator 2 Enable (Positive Logic)
13	EN3	Voltage Regulator 3 Enable (Positive Logic)
14	DIN1	Voltage Detector 1 Input
15	OUT3	Voltage Regulator 3 Output
16	VDD	Power Supply

Pin Configuration

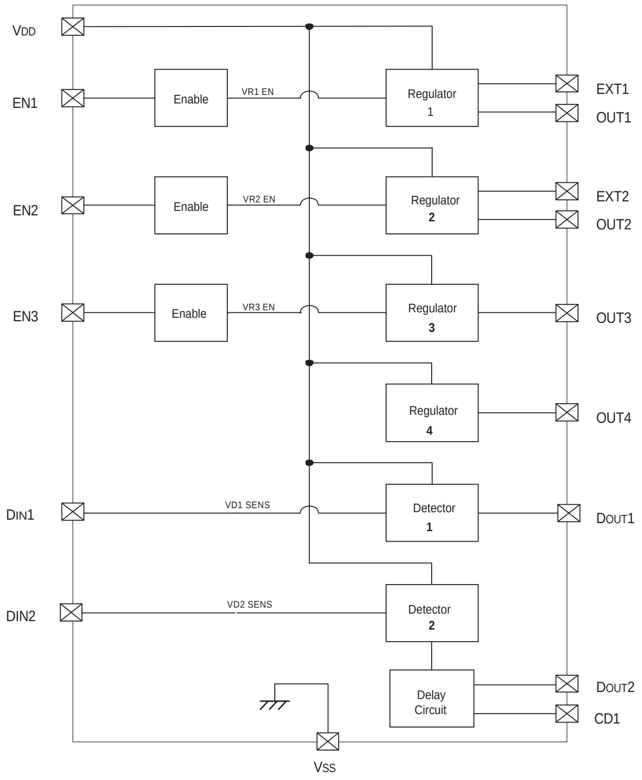


Functions

INPUT			VOLTAGE REGULATOR OUTPUT		
EN1	EN2	EN3	VR1	VR2	VR3
H	-	-	ON	-	-
L	-	-	OFF	-	-
-	H	-	-	ON	-
-	L	-	-	OFF	-
-	-	H	-	-	ON
-	-	L	-	-	OFF

H = High Level : L = Low Level

Block Diagram



Absolute Maximum Ratings

Ta = 25 °C

PARAMETER	SYMBOL	RATINGS	UNITS
Input Voltage	VIN	-0.3 to 12	V
Output Voltage	VOUT	-0.3 to VIN +0.3	V
EXT Pin Voltage	VEXT	-0.3 to 12	V
DIN Pin Voltage	VDIN	-0.3 to VIN +0.3	V
DOUT Pin Voltage	VDOUT	-0.3 to 12	V
CD1 Pin Voltage	VCD1	-0.3 to VIN +0.3	V
EN Pin Voltage	VEN	-0.3 to VIN +0.3	V
Output Current	IOUT	200	mA
EXT Pin Current	IEXT	50	mA
DOUT Pin Current	IDOUT	20	mA
Power Dissipation	Pd	350	mW
Power Dissipation (mounted)	Pd	630	mW
Operating Ambient Temperature	Topr	-30 to +80	°C
Storage Temperature	Tstg	-40 to +125	°C

All voltage is ground standardised.

Note :

Please ensure that the sum total of power used within the IC does not exceed the continuous total power dissipation (Pd) figure.
The figure for total continuous power dissipation (mounted) represents the value when tested on a single sided glass epoxy board of dimensions :
21mm x 32mm ; t = 1.6mm

Electrical Characteristics (XC641A0001V)

Voltage Conditions

CONDITIONS	SYMBOL	VALUE	UNITS
Input Voltage	VINDEF	4.4	V

Set-Up Voltage Table

Ta = 25 °C

CIRCUIT	PARAMETER	SYMBOL	VALUE	UNITS
Voltage Regulator 1	Output Voltage	VOUT(T)	3.0	V
Voltage Regulator 2	Output Voltage	VOUT(T)	3.0	V
Voltage Regulator 3	Output Voltage	VOUT(T)	3.0	V
Voltage Regulator 4	Output Voltage	VOUT(T)	3.0	V
Voltage Detector 1	Detect Voltage	VDF1	3.4	V
Voltage Detector 2	Detect Voltage	VDF2	2.5	V

Voltage Regulator 1

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	VOUT(E)	IOUT=50mA VIN=VINDEF	2.94	3.0	3.06	V	1
Maximum Output Current *	IOUT max	VIN=VINDEF		1000		mA	1
Load Stability *	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{IOUT}}$	VIN=VINDEF 1mA ≤ IOUT ≤ 100mA	-50		50	mV	1
Input-Output Voltage Diff. *	VDIF	IOUT=100mA		100		mV	1
Supply Current	ISS	VIN=VINDEF, (No Load)		8	12	µA	2
Input Stability *	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{VIN} \bullet \mathrm{VOUT}}$	IOUT=50mA		0.04	0.3	%/V	1
Output Voltage Temperature Characteristics *	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{Topr} \bullet \mathrm{VOUT}}$	IOUT=10mA		±100		ppm/°C	1
EXT Output Voltage	VEXT				7	V	-
EXT Leak Current	ILEAK				0.5	µA	3

Note : 1. VOUT(T) = Specified Output Voltage : VOUT(E) = Effective Output Voltage.

2. Parameter characteristics marked with an asterisk may vary according to which type of external transistor is used.
   A transistor with a value of hFE = 100 or greater and a low saturation voltage is recommended.
   Unless otherwise stated, use of the following external components are recommended :
   PNP Transistor, 2SA1213-Y : RBE, 200K Ω : CL, 10µF Tantalum Capacitor.
3. The values given for ISS refer to the actual IC values (see application circuits)
4. The IC's supply current is calculated as follows :
   Supply Current = ISS + (Load Current / hFE) + (0.6 / RBE)
5. VDIF = { VIN1 - VOUT1 }
   VOUT1 = A voltage equal to 98% of the Output Voltage whenever an amply stabilised IOUT {VOUT(T)+1.0V} is input.
   VIN1 = The Input Voltage when VOUT1 appears as Input Voltage is gradually decreased.
6. The Maximum Output Current value represents the value at the time the Output Voltage has decreased to VOUT (E) x 0.9.
   Due to the limitations of Continuous Total Power Dissipation with the 2SA1213 transistor, the Maximum Output Current Value cannot be continually achieved.

Voltage Regulator 2

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	VOUT(E)	IOUT=50mA VIN=VINDEF	2.94	3.0	3.06	V	1
Maximum Output Current *	IOUT max	VIN=VINDEF		1000		mA	1
Load Stability *	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{IOUT}}$	VIN=VINDEF 1mA ≤ IOUT ≤ 100mA	-50		50	mV	1
Input-Output Voltage Diff. *	VDIF	IOUT=100mA		100		mV	1
Supply Current	ISS	VIN=VINDEF, (No Load)		8	12	µA	2
Input Stability *	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{VIN} \bullet \mathrm{VOUT}}$	IOUT=50mA		0.04	0.3	%/V	1
Output Voltage Temperature Characteristics *	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{Topr} \bullet \mathrm{VOUT}}$	IOUT=10mA		±100		ppm/°C	1
EXT Output Voltage	VEXT				7	V	-
EXT Leak Current	ILEAK				0.5	µA	3

Note : Characteristics are the same as for Regulator 1.

Voltage Regulator 3

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	VOUT(E)	IOUT=35mA VIN=VINDEF	2.94	3.0	3.06	V	1
Load Stability	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{IOUT}}$	VIN=VINDEF 1mA ≤ IOUT ≤ 35mA			50	mV	1
Input-Output Voltage Diff.	VDIF	IOUT=35mA			0.3	V	1
Supply Current	ISS	VIN=VINDEF, (No Load)		3.0	4.5	µA	2
Input Stability	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{VIN} \bullet \mathrm{VOUT}}$	IOUT=35mA VINDEF ≤ VIN ≤ 10.0V		0.1	0.3	%/V	1
Output Voltage Temperature Characteristics	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{Topr} \bullet \mathrm{VOUT}}$	IOUT=35mA -30°C ≤ Topr ≤ 80°C		±100		ppm/°C	1

Note : 1. VOUT(T) = Specified Output Voltage : VOUT(E) = Effective Output Voltage.

2. VDIF = { VIN1 - VOUT1 }

VOUT1 = A voltage equal to 98% of the Output Voltage whenever an amply stabilised IOUT {VOUT(T)+1.0V} is input.

VIN1 = The Input Voltage when VOUT1 appears as Input Voltage is gradually decreased.

Voltage Regulator 4

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Output Voltage	VOUT(E)	IOUT=15mA VIN =VIN DEF	2.94	3.0	3.06	V	1
Load Stability	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{IOUT}}$	VIN =VIN DEF 1mA ≤ IOUT ≤ 15mA			50	mV	1
Input-Output Voltage Diff.	VDIF	IOUT=15mA			0.3	V	1
Input Stability	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{VIN} \bullet \mathrm{VOUT}}$	IOUT=15mA VIN DEF ≤ VIN ≤ 10.0V		0.1	0.3	%/V	1
Output Voltage Temperature Characteristics	$\frac{\Delta \mathrm{VOUT}}{\Delta \mathrm{Topr} \bullet \mathrm{VOUT}}$	IOUT=15mA -30°C ≤ Topr ≤ 80°C		±100		ppm/°C	1

Note : 1. VOUT(T) = Specified Output Voltage : VOUT(E) = Effective Output Voltage.

2. VDIF = { VIN1 - VOUT1 }

VOUT1 = A voltage equal to 98% of the Output Voltage whenever an amply stabilised IOUT {VOUT(T)+1.0V} is input.

VIN1 = The Input Voltage when VOUT1 appears as Input Voltage is gradually decreased.

3. As operational shutdown cannot be achieved with Voltage Regulator 4, please standardize to the IC circuit's stand-by current parameters.

Voltage Detector 1

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Detect Voltage	VDF	VIN = VINDEF	3.332	3.4	3.468	V	4
Hysteresis Range	VHYS	VIN = VINDEF	x 0.02	VDF x 0.05	x 0.08	V	4
Input Current	IIN	VIN = VINDEF		0.8	1.4	µA	4
Output Current	IOUT	Nch VDS = 0.5V VIN = VINDEF	6.0	11.5		mA	3
Detect Voltage Temperature Characteristics	$\frac{\Delta V_{DF}}{\Delta Topr \bullet V_{OUT}}$			±100		ppm/°C	4

Voltage Detector 2

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Detect Voltage	VDF	VIN = VINDEF	2.450	2.5	2.550	V	4
Hysteresis Range	VHYS	VIN = VINDEF	x 0.02	VDF x 0.05	x 0.08	V	4
Input Current	IIN	VIN = VINDEF		0.8	1.4	µA	4
Output Current	IOUT	Nch VDS = 0.5V VIN = VINDEF	6.0	11.5		mA	3
Delay Circuit Current	ICDO	VIN = VINDEF	0.25	0.50	0.80	µA	5
Detect Voltage Temperature Characteristics	$\frac{\Delta V_{DF}}{\Delta Topr \bullet V_{OUT}}$			±100		ppm/°C	4

Note :

The delay circuit current is controlled by the set current circuit within the IC.

Delay time depends upon the capacity of the external condensor. Approximate delay time can be calculated using the following formula :

TD (msec) = 1.8 x C (nF)

Input Pin

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
EN 'High Level' Voltage	VENH		1.3			V	1
EN 'Low Level' Voltage	VENL				0.4	V	1
EN 'High Level' Current	IENH				0.1	µA	1
EN 'Low Level' Voltage	IENL		-0.5		0	µA	1

Entire Circuit

Ta=25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	CIRCUIT
Supply Current	ISS	VIN = 8V, No Load		25	37.5	µA	2
(Stand-By)	ISTB	VIN = 8V, VR1 = VR2 = VR3 = OFF		6.0	9.0	µA	2

Note :

The supply current (ISS) value of the entire IC is the IC's internal supply current value.
(This does not include current flowing through externally connected components nor
the input current through the detect pins of voltage detectors 1, 2)

Notes on Use :

IC

1. Please sufficiently strengthen the GND wiring and the power supply (V_{DD}) line, as when the power supply line impedance is high, the voltage regulators and detectors are prone to oscillation leading to possible instability.
2. In order to lower the power supply line impedance, we recommend that a capacitor of 10µF (Tantalum) or more be connected at the shortest point possible between the V_{DD} pin and the GND pin.
3. To protect the IC from surge at the input pin, an input protect diode is built-in. Therefore, do not apply voltages that exceed the V_{DD} pin voltage.
4. Please ensure that the sum total of the IC's power consumption does not exceed the stipulated figure for total continuous power dissipation (Pd).

   $$Pd < P1 + P2 + P3 + P4 + P5 + P6$$

   The following equations can be used to calculate the IC's power consumption :

   Regulator 1 : P1 = (V_{DD} - 0.6V) x I_{EXT1}, I_{EXT1} to I_{OUT1} / hFE
   Regulator 2 : P2 = (V_{DD} - 0.6V) x I_{EXT2}, I_{EXT2} to I_{OUT2} / hFE
   Regulator 3 : P3 = (V_{DD} - V_{OUT3}) x I_{OUT3}
   Regulator 4 : P4 = (V_{DD} - V_{OUT4}) x I_{OUT4}
   Detector 1 : P5 = V_{DOUT1} x I_{DOUT1}
   Detector 2 : P6 = V_{DOUT2} x I_{DOUT2}

Voltage Regulator 1, 2 (external transistor type)

1. In order to prevent regulator oscillation (caused by power supply impedance), we recommend that a capacitor of 10µF (Tantalum) or more be connected between the external transistor's emitter and the GND pin.
2. In order to prevent regulator phase compensation, we recommend that a capacitor of 10µF (Tantalum) or more be connected between the I_{OUT1}, I_{OUT2} pins and the GND pin.
3. In order to prevent oscillation we recommend that a resistor of around 200kΩ be connected between the external transistor's base pin and emitter pin.

Voltage Regulator 3, 4 (built-in transistor type)

1. Please connect a capacitor of 1µF (Tantalum) or more between the voltage regulator's output pins (OUT3, OUT4) and the GND pin.
2. In order to prevent regulator oscillation (caused by power supply impedance), we recommend that a capacitor be connected between the V_{DD} pin and the GND pin.
3. Since a short circuit protector is not built-in, when the OUT3 or OUT4 pin is short circuited to the GND pin, resulting surge current may damage the IC.

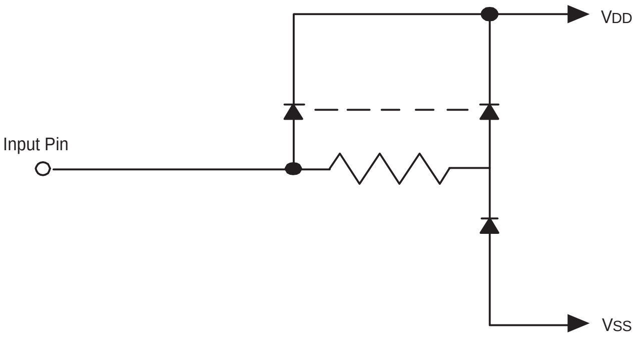
Voltage Detectors

1. In order to prevent regulator oscillation (caused by power supply impedance), we recommend that a capacitor be connected between the V_{DD} pin and the GND pin.
2. Should the V_{DD} pin voltage become excessively low, we recommend that a Schottky Diode be connected between the CD1 pin and the V_{DD} pin, in order to prevent voltages over the established V_{DD} + 0.3V being applied to the capacitor connection pin (CD1).

   Please use a Schottky Diode of V_F = 0.3V (I_F = 10mA). If a large reverse current, I_R (max.), is used, the delay circuit current will increase and delay time will be shortened.
3. When not using the delay circuit, please use the IC with the CD1 pin open.

Notes on Use (contd.) :

Input Protection Circuit (equivalent circuit)



The XC641A has a built-in circuit to protect the IC against surge at the input pin.

Should a voltage higher than VDD be applied at the input pin, please note that current will flow from the input pin to VDD. (Use within the stipulated absolute maximum ratings).

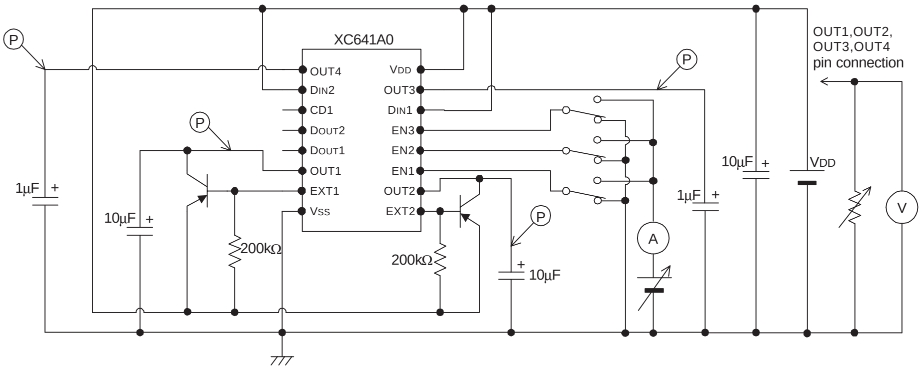
Ordering Information :

$$\mathrm{XC641A}\,\underbrace{x\ x\ x\ x}_{a}\ \underset{b}{x}\ \underset{c}{x}$$

SYMBOL	DESCRIPTION	SYMBOL	DESCRIPTION
a	Voltage Characteristics : Based on internal standards	b	Package Type : V = TSSOP-16
		c	Device Orientation : R = Embossed Tape (Right) L = Embossed Tape (Left)

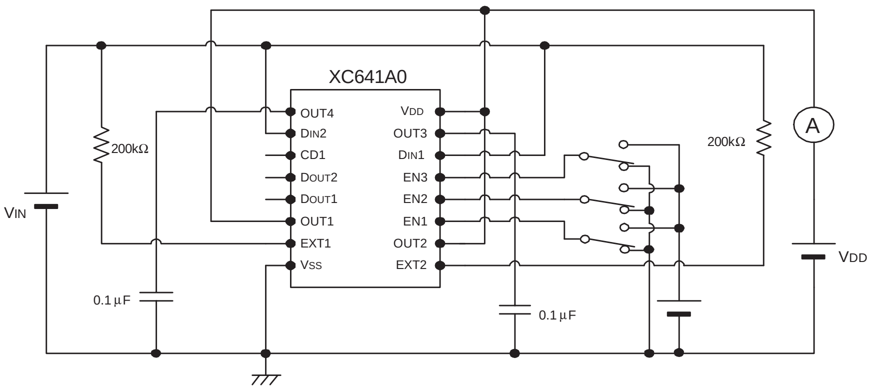
■ Application Circuits

Application Circuit 1

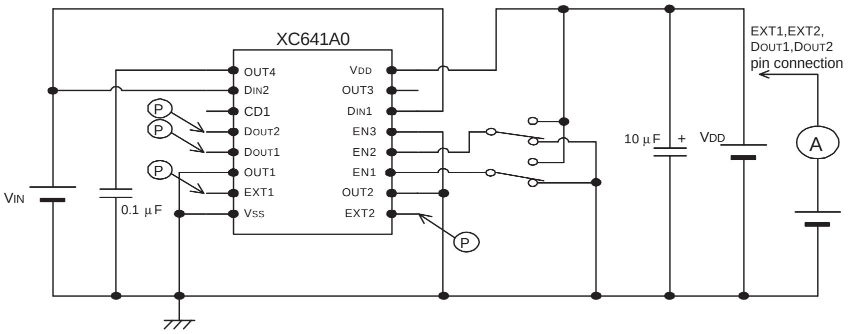


OUT1,OUT2,
OUT3,OUT4
pin connection

Application Circuit 2

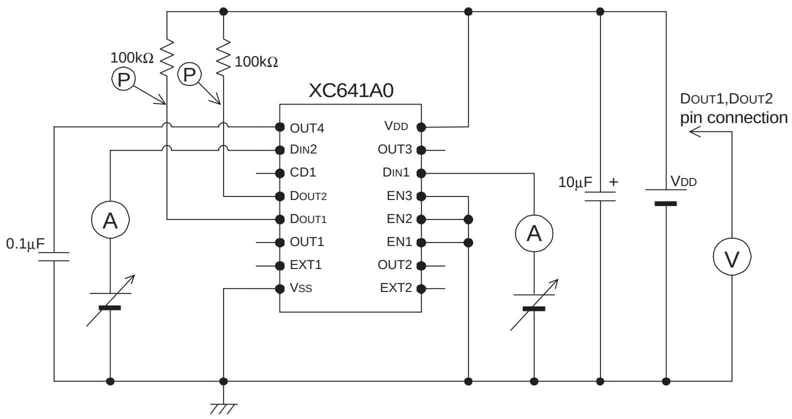


Application Circuit 3

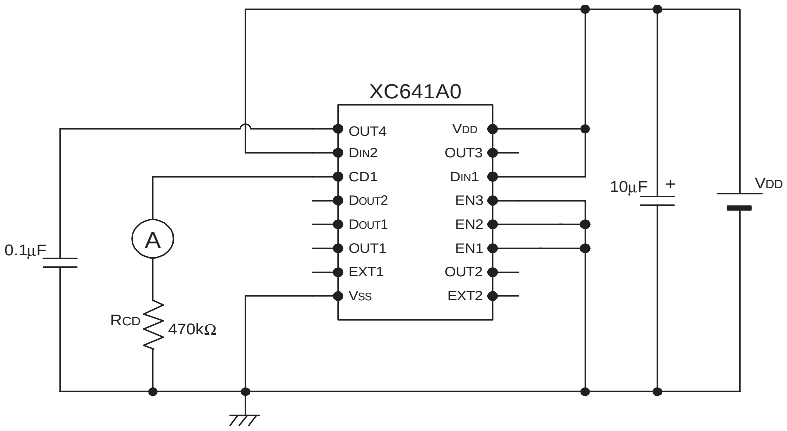


EXT1,EXT2,
DOUT1,DOUT2
pin connection

Application Circuit 4



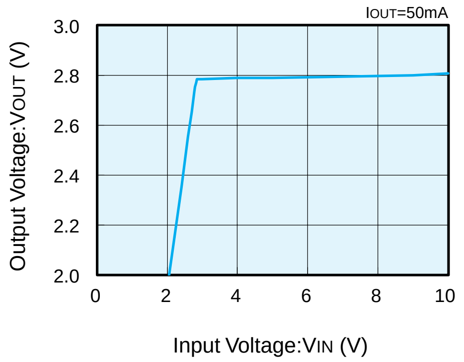
Application Circuit 5



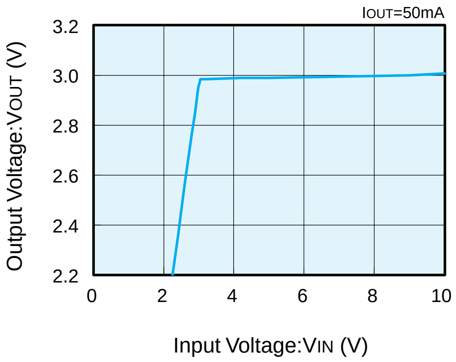
■ XC641A Series Electrical Characteristics

(1) Output Voltage vs. Input Voltage

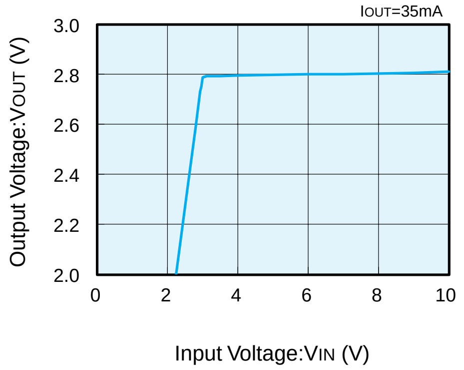
VR1 (2.8V)



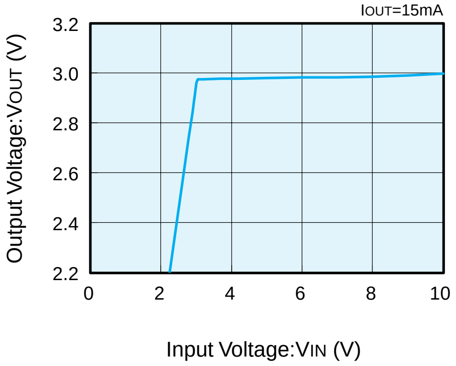
VR2 (3.0V)



VR3 (2.8V)

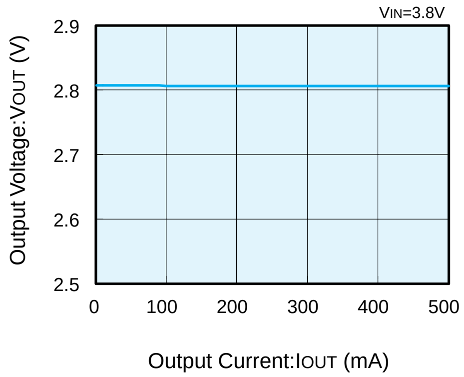


VR4 (3.0V)

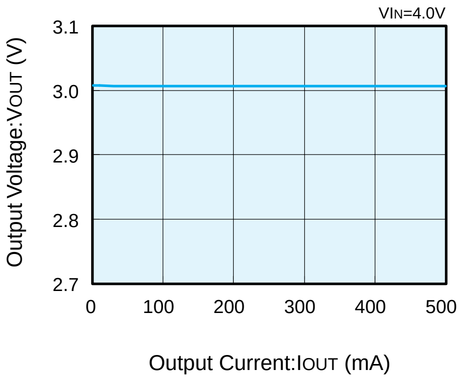


(2) Output Voltage vs. Output Current

VR1 (2.8V)

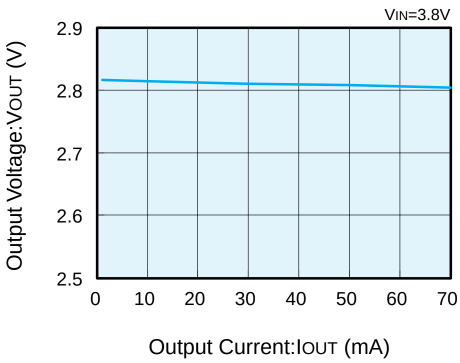


VR2 (3.0V)

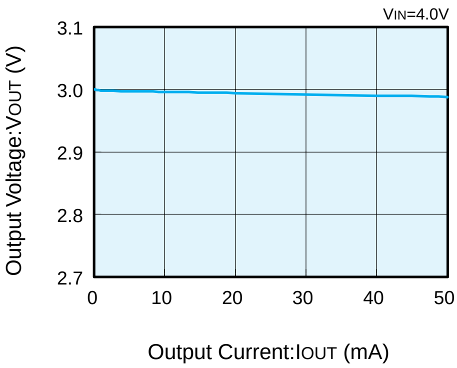


(2) Output Voltage vs. Output Current (contd.)

VR3 (2.8V)

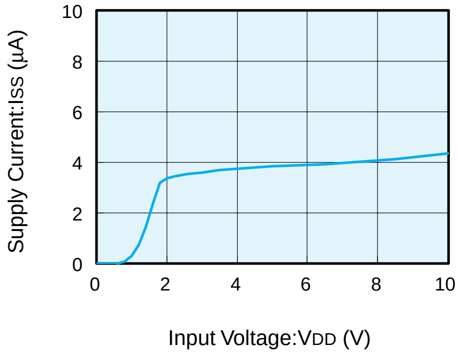


VR4 (3.0V)

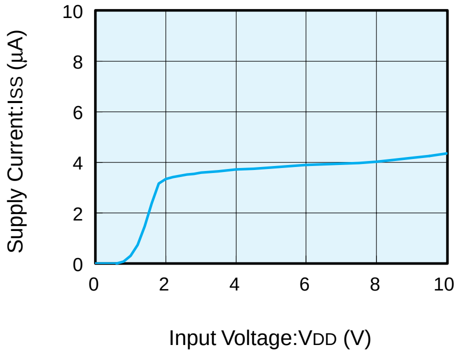


(3) Supply Current vs. Input Voltage

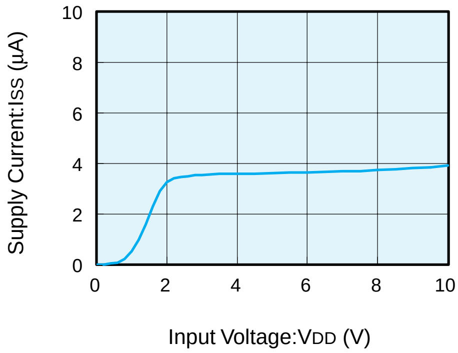
VR1 (2.8V)



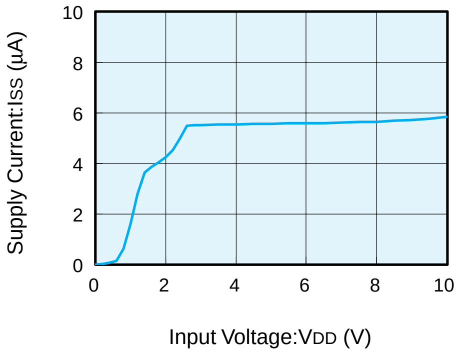
VR2 (3.0V)



VR3 (2.8V)



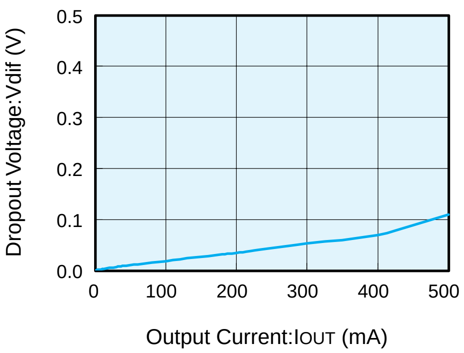
Stand-By (EN1=EN2=EN3=0V)



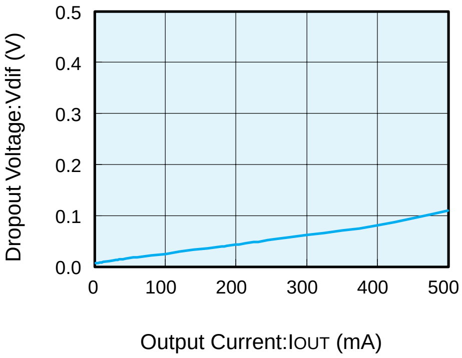
Input Voltage VDD (V)

(4) Dropout Voltage vs. Output Current

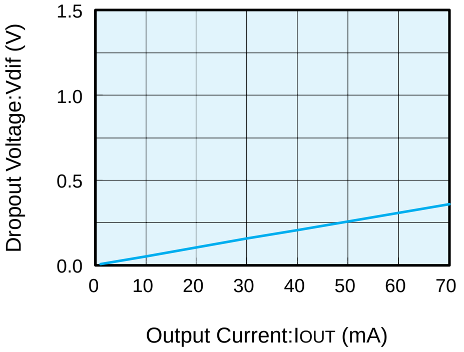
VR1 (2.8V)



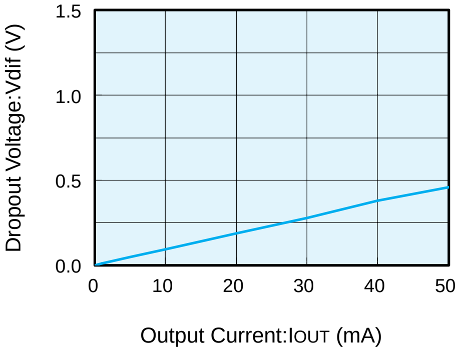
VR2 (3.0V)



VR3 (2.8V)

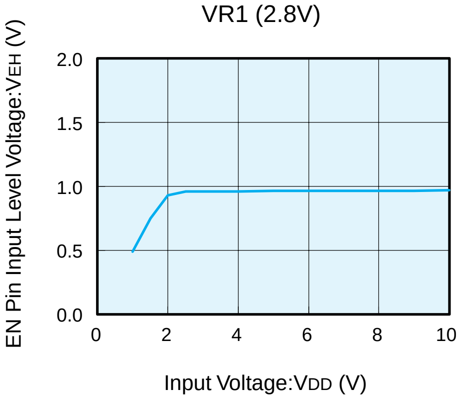


VR4 (3.0V)

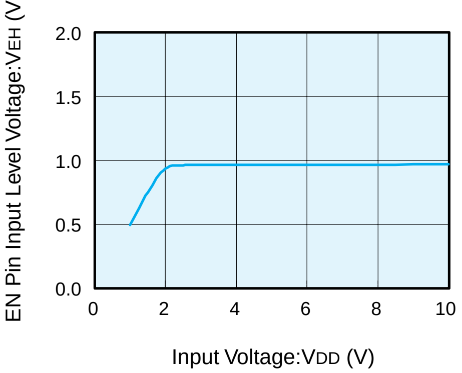


(5) EN Pin Input Level Voltage vs. Input Voltage

VR1 (2.8V)

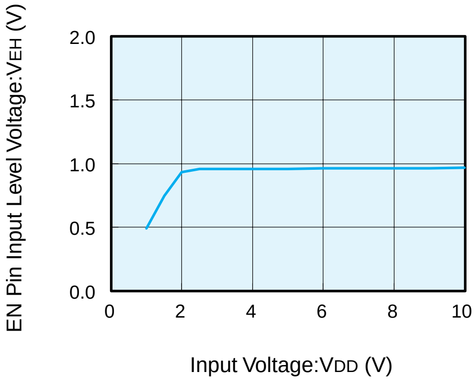


VR2 (3.0V)



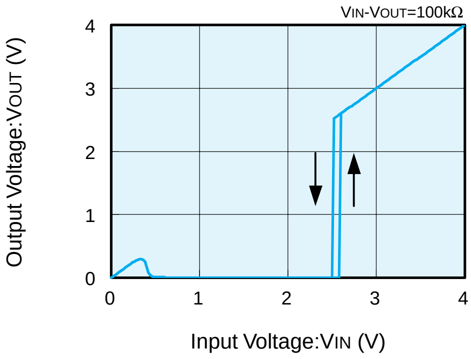
(5) EN Pin Input Level Voltage vs. Input Voltage (contd.)

VR3 (2.8V)

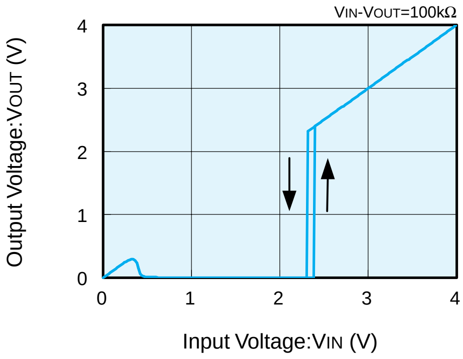


(6) VD Output Voltage vs. Input Voltage

VD1 (2.5V)

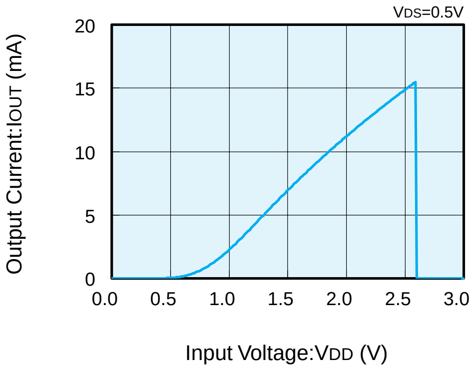


VD2 (2.3V)

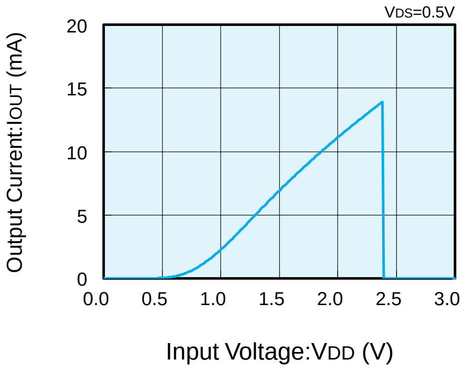


(7) Output Current vs. Input Voltage

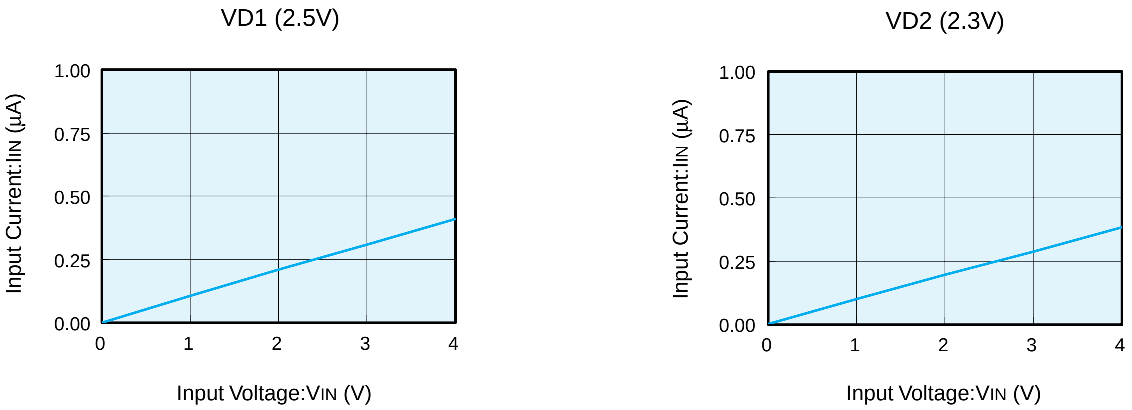
VD1 (2.5V)



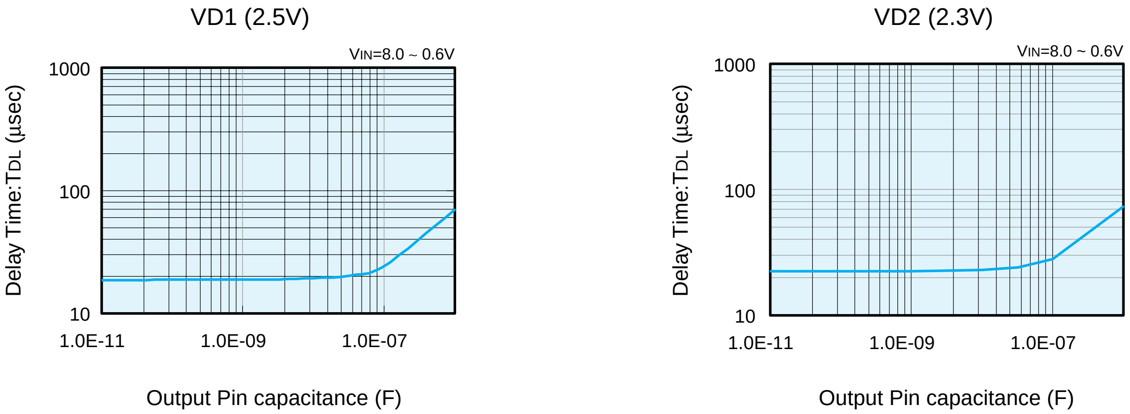
VD2 (2.3V)



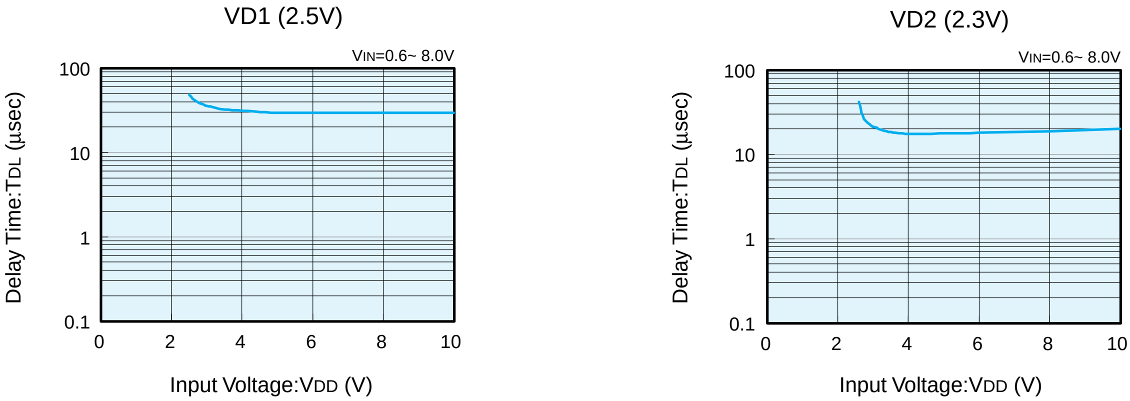
(8) VD Input Current vs. Input Voltage



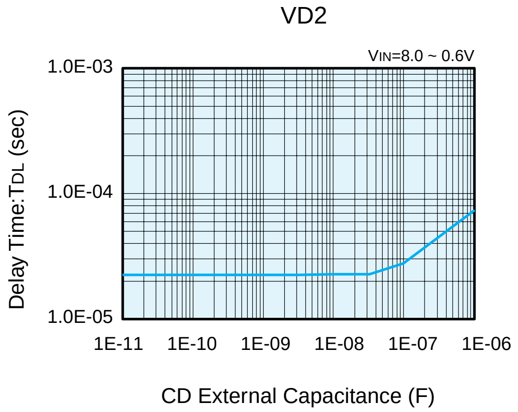
(9) Delay Time (fall) vs. Output Pin Capacitance



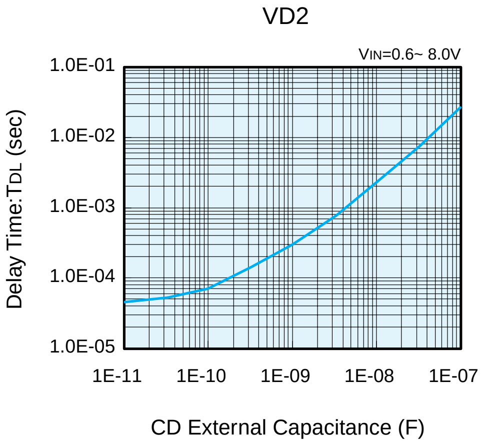
(10) Delay Time (rise) vs. Input Voltage



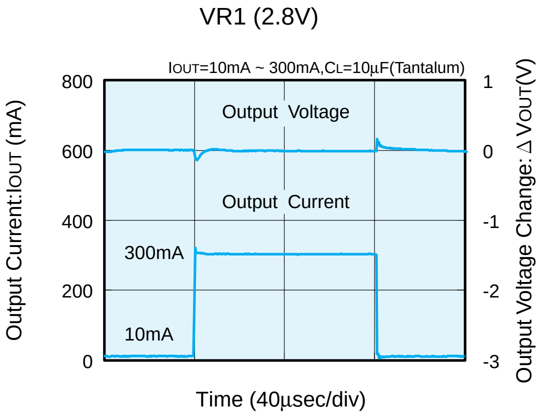
(11) Delay Time (fall) vs. CD Pin External Capacitance

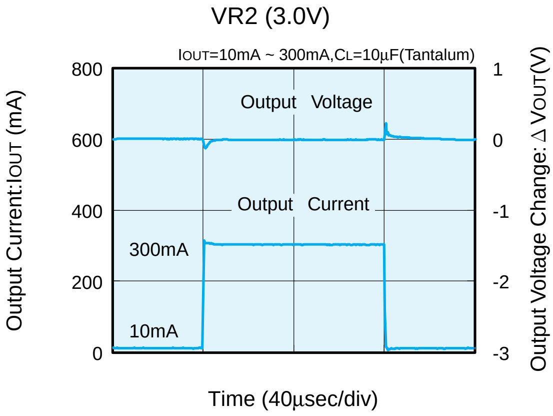


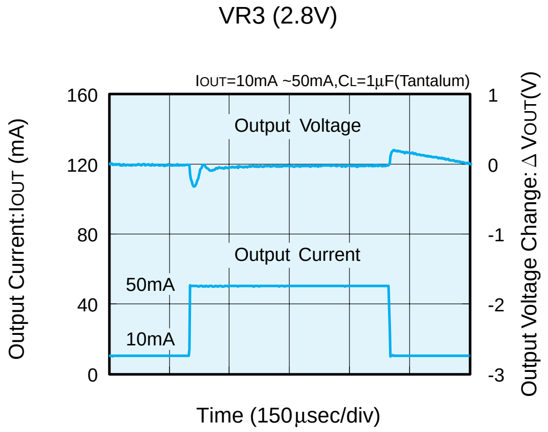
(12) Delay Time (rise) vs. CD Pin External Capacitance

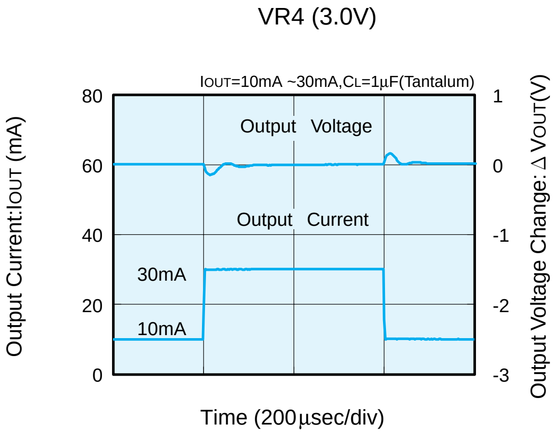


(13) Load Transient Response



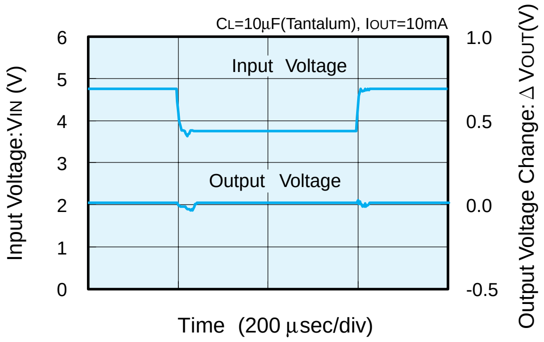




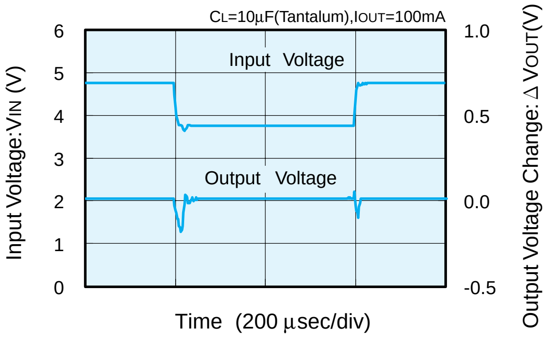


(14) Input Transient Response 1

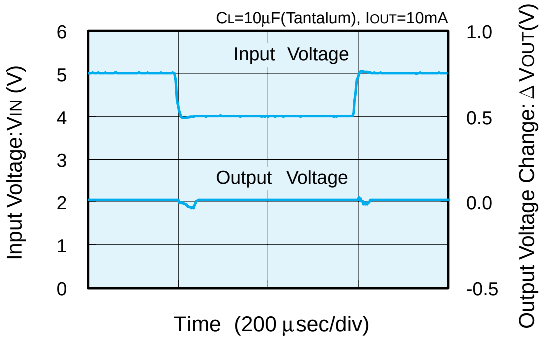
VR1 (2.8V)



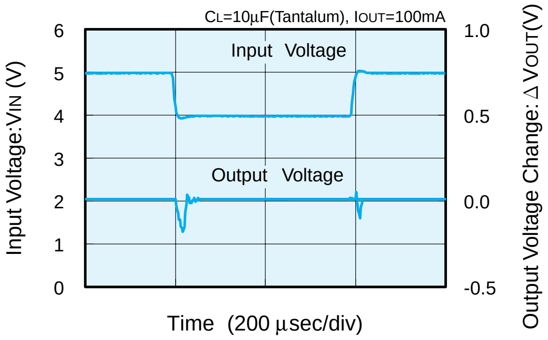
VR1 (2.8V)



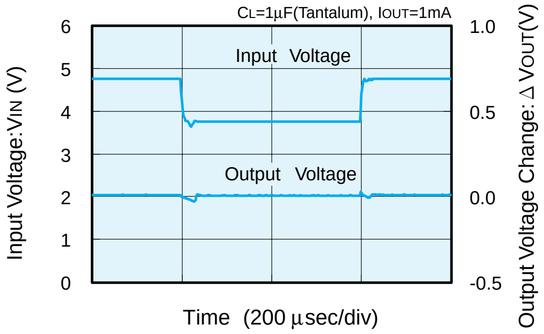
VR2 (3.0V)



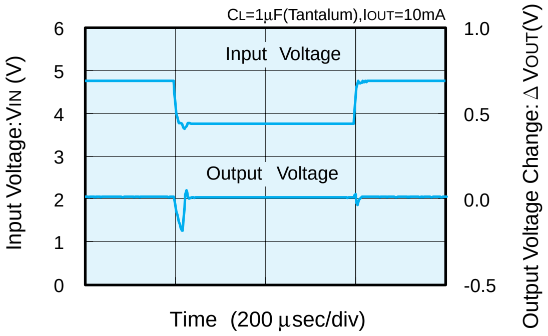
VR2 (3.0V)



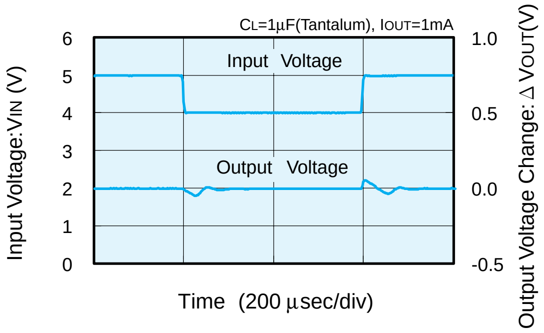
VR3 (2.8V)



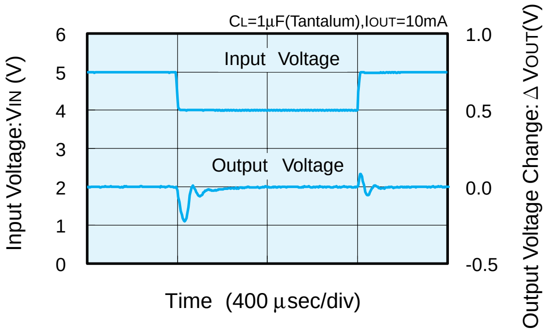
VR3 (2.8V)



VR4 (3.0V)

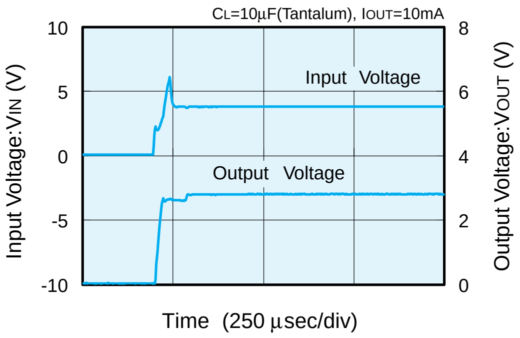


VR4 (3.0V)

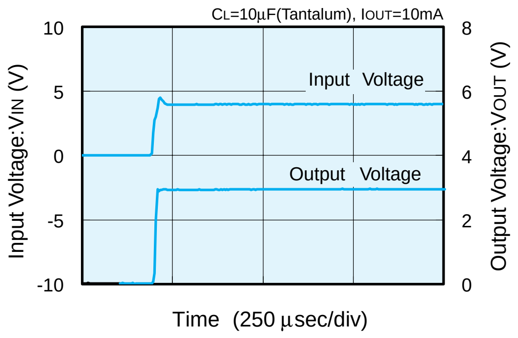


(15) Input Transient Response 2

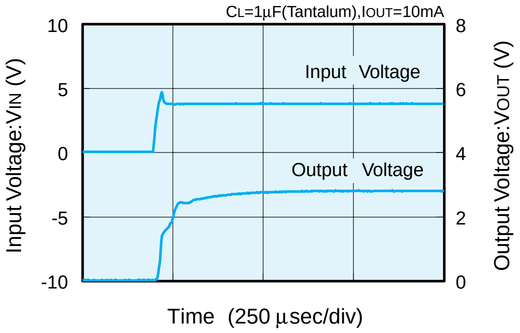
VR1 (2.8V)



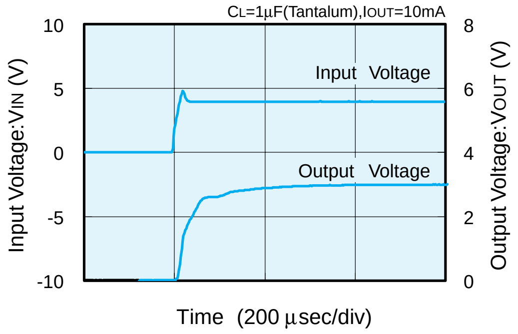
VR2 (3.0V)



VR3 (2.8V)

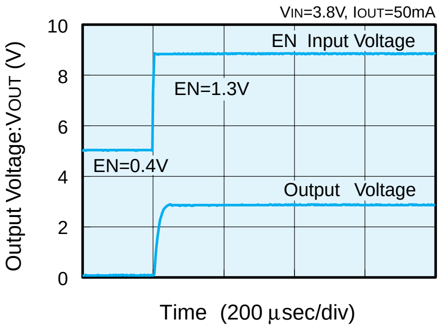


VR4 (3.0V)

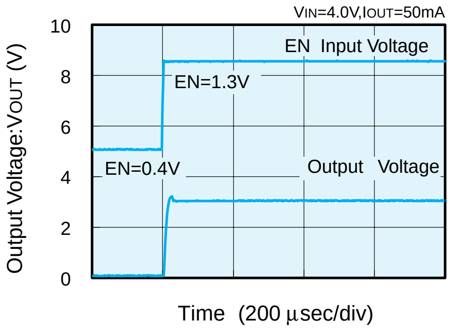


(16) EN Transient Response

VR1 (2.8V)



VR2 (3.0V)



VR3 (2.8V)