

**Nuvoton**  
**3-Channel, SMBus™, 7-Bit**  
**Sink/Source Current DAC**  
**NCT3933U**

**-Table of Content-**

1.	GENERAL DESCRIPTION.....	1
2.	FEATURES.....	1
3.	APPLICATIONS.....	1
4.	BLOCK DIAGRAM.....	2
5.	PIN CONFIGURATION AND TYPICAL APPLICATION CIRCUIT.....	2
6.	PIN DESCRIPTION .....	3
7.	FUNCTIONAL DESCRIPTION .....	4
8.	CONTROL AND STATUS REGISTER.....	8
9.	ELECTRICAL CHARACTERISTIC.....	12
10.	TYPICAL OPERATION CHARACTERISTICS .....	16
11.	PACKAGE DIMENSION.....	20
12.	ORDERING INFORMATION.....	21
13.	TOP MAYKING SPECIFICATION.....	21
14.	REVISION HISTORY .....	22

## 1. GENERAL DESCRIPTION

The NCT3933U includes three adjustable current DACs that are each capable of sinking and sourcing current through SMBus™ interface. Each output has 128 sinking and sourcing settings that are programmed by the SMBus™ interface. The output current also can be programmable for twofold sinking/sourcing increase respectively. The NCT3933U features step speed controlled function which can easily interfacing with general DC/DC converter for voltage adjustment. The NCT3933U also provides power saving function to reduce 60% power consumption when system enters standby mode. The NCT3933U is available in SOT23-8 package.

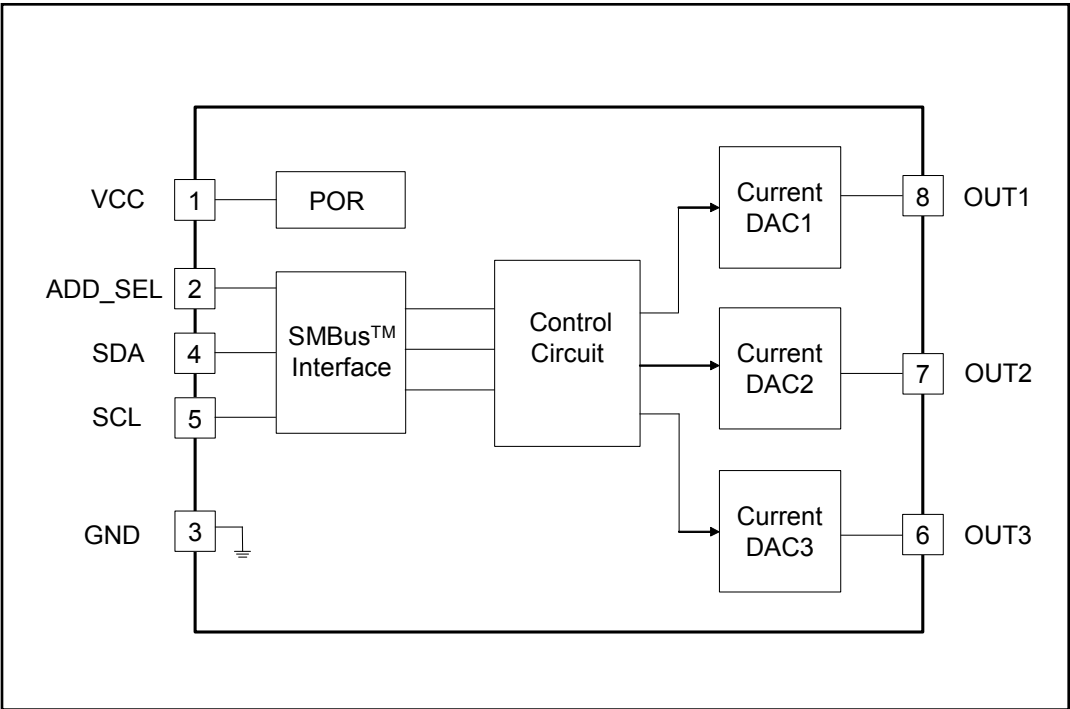
## 2. FEATURES

- 3-Channel Current DAC
- Programmable 128 Steps Sinking and Sourcing Current
- Full Scale Current 0 to  $\pm 1270\mu\text{A}$
- Programmable for Twofold Output Current
- 5% Output Accuracy
- Interface: SMBus™ Serial Interface
- SMBus™ 2.0 Compatible Interface
- Address Select Pin Allows Six Devices on Same SMBus
- 3V to 5.5V Operating Range
- Power Saving Function
- Watchdog Timer
- Programmable Step Speed Control
- Low External Component Count
- Low Cost and Easy to Use
- $-20^{\circ}\text{C}$  to  $125^{\circ}\text{C}$  Temperature Range
- SOT23-8 Green Package (Lead Free and Halogen Free)

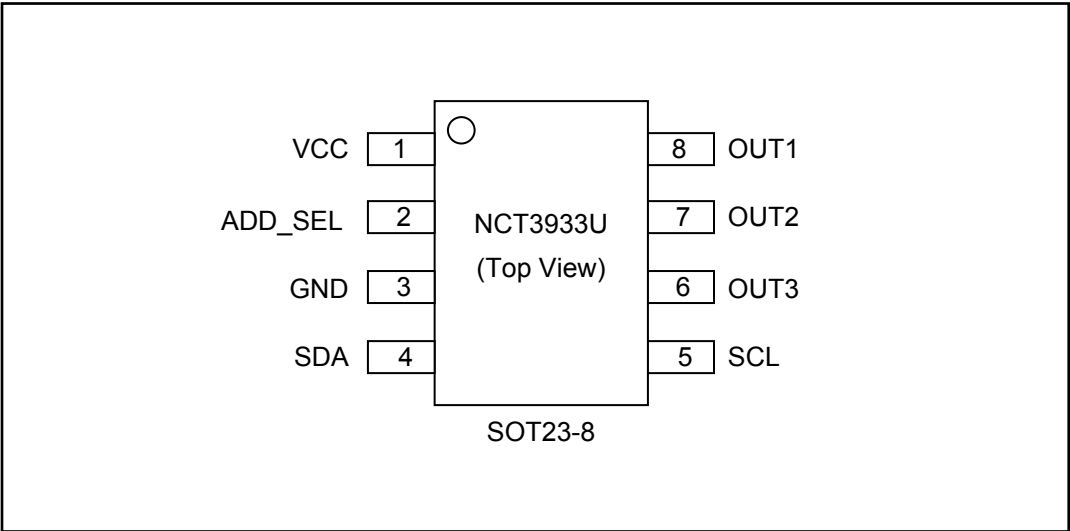
## 3. APPLICATIONS

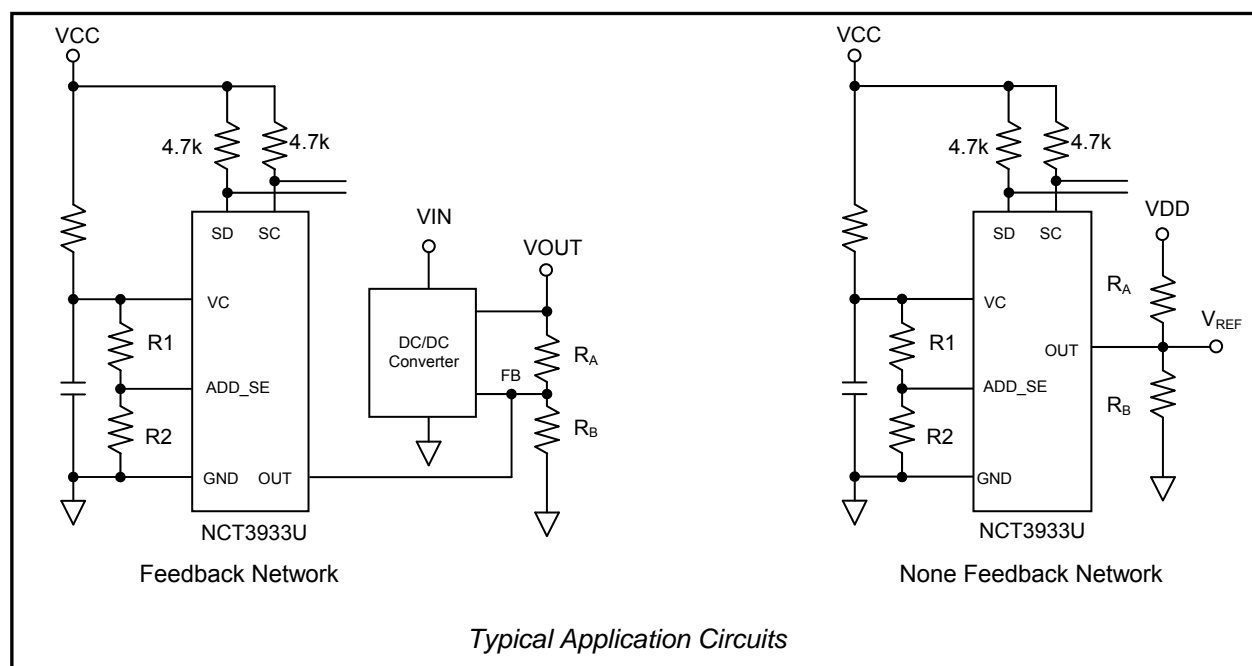
- Power Supply Adjustment for M/B and Graphic Card
- Power Supply Margining
- Adjustable Current Sink or Source
- LCD Brightness and Contrast Adjustment

4. BLOCK DIAGRAM



5. PIN CONFIGURATION AND TYPICAL APPLICATION CIRCUIT





## 6. PIN DESCRIPTION

PIN NAME	NO	PIN TYPE	DESCRIPTION
VCC	1	POWER	DC power supply, voltage input 3V to 5.5V.
ADD_SEL	2	AIN	SMBus Address Select Input. Connect a resistor divider to determine the SMBus slave address. See Table1 for the six available addresses.
GND	3	GROUND	Power supply ground.
SDA	4	I/OD <sub>12ts</sub>	Digital I/O (Open drain). SMBus™ bidirectional serial data. Requires a pull-up resistor.
SCL	5	I	Digital Input. SMBus™ serial clock input. Requires a pull-up resistor.
OUT3	6	AO	Current Output. Sinks or sources the current determined by the internal registers.
OUT2	7	AO	
OUT1	8	AO	

PIN TYPE	PIN Attribute
I/OD <sub>12ts</sub>	TTL level and Schmitt trigger open drain output with 12 mA sink capability
I	Input pin (Digital)

AO	Output pin (Analog)
AIN	Input pin (Analog)
POWER	Positive power supply input
GROUND	Power supply ground

## 7. FUNCTIONAL DESCRIPTION

### 7.1 General Description

The NCT3933U includes three adjustable current DACs that are each capable of sinking and sourcing current through SMBus™ interface. Each output has 128 sinking and sourcing settings that are programmed by the SMBus™ interface. The output current also can be programmable for twofold sinking/sourcing increase respectively. The NCT3933U features step speed controlled function which can easily interfacing with general DC/DC converter for voltage adjustment. The NCT3933U also provides power saving function to reduce 60% power consumption when system enters standby mode.

### 7.2 Power On Reset, POR

The NCT3933U continuously monitors supply voltage at VCC pin for power on reset circuit. The POR threshold at VCC rising is typically 2.6V. All of the outputs are disabled if the supply voltage is lower than the POR threshold level.

On power-up, the NCT3933U output zero current. This is done to prevent the device from sinking or sourcing an incorrect amount of current before the system host controller has had a chance to modify the device's setting.

### 7.3 Step Speed Controlled

The NCT3933U features step speed controlled function which can change output current gradually to the final value. The default setting of each step is about 10 us. This function makes the output voltage of DC/DC converter smooth transition to decrease inrush current from its power supply input and prevent false trigger of over current protection.

### 7.4 VCC Decoupling

To achieve the best results when using the NCT3933U, decouple the power supply with a 0.01uF or 0.1uF capacitor. Use a high quality ceramic surface mount capacitor if possible. Surface mount components minimize lead inductance, which improves performance, and ceramic capacitors tend to have adequate high frequency response for decoupling applications.

### 7.5 Power Supply Feedback Voltage

The feedback voltage for adjustable power supplies must be between 0.5V and VCC-1V for the NCT3933U to properly sink/source currents for adjusting the voltage.

## 7.6 Power Saving Function

The NCT3933U provides power saving function to lower power consumption. In power saving situation, the power consumption is about 40% off normal operation situation. Set CR05\_Bit 6 to 1 (default is 0) to enable this function. When the power saving function is enabled, the outputs would be turned off immediately. Hence, the register of CR01~CR03 must be reset to default value before power saving function is enabled. On the contrary, the power saving function has to be disabled before CR01~CR03 are enabled.

## 7.7 Example Calculation for an Adjusting Output Voltage of DC/DC Converter

Fig 7-1 shows an application circuit that using a general DC/DC converter. By selecting appropriate output current  $I_{OUT}$  of NCT3933U to adjust output voltage.

The equation of output voltage is:

$$V_{OUT} = V_{FB} \times (R_A + R_B) \div R_B$$

Summing the currents into the feedback node, we have the following:

$$I_{OUT} = I_{RB} - I_{RA}$$

Where:

$$I_{RB} = V_{FB} \div R_B$$

And

$$I_{RA} = (V_{OUT} - V_{FB}) \div R_A$$

Thus,

$$V_{OUT} = (I_{RA} \times R_A) + V_{FB}$$

Since  $I_{RB}$  is a constant, we can calculate the output voltage difference,

$$\Delta V_{OUT} = -I_{OUT} \times R_A$$

For example, if  $I_{OUT} = -500\mu A$  (sinking) and  $R_A = 1k\Omega$ , the output voltage will be increased as:

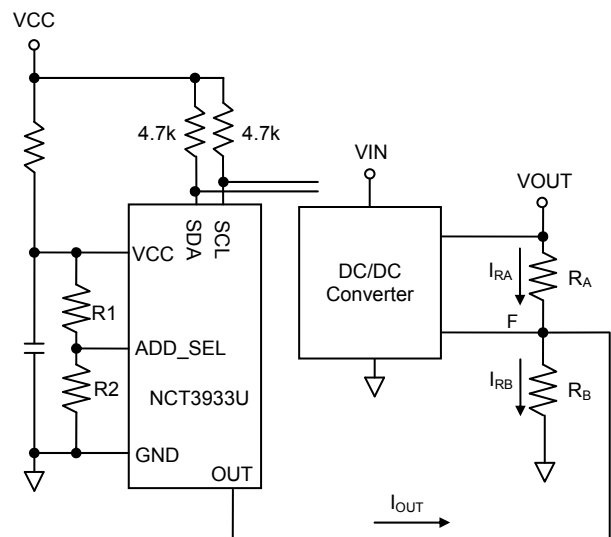


Fig. 7-

$$\Delta V_{OUT} = 500\mu A \times 1k\Omega = 0.5V$$

## 7.8 Example Calculation for an Adjusting Reference Voltage

Fig 7-2 shows an application circuit for reference voltage adjustment. By selecting appropriate output current  $I_{OUT}$  of NCT3933U to adjust output voltage. The equation of default reference voltage is:

$$V_{REF} = V_{DD} \times R_B \div (R_A + R_B)$$

Summing the currents into the voltage divider node, we have the following:

$$I_{RB} = I_{OUT} + I_{RA}$$

Where:

$$I_{RB} = V_{REF} \div R_B$$

And

$$I_{RA} = (V_{DD} - V_{REF}) \div R_A$$

Thus,

$$V_{REF} = [(I_{OUT} \times R_A \times R_B) + V_{DD} \times R_B] \div (R_A + R_B)$$

Then we can calculate the output voltage difference,

$$\Delta V_{REF} = I_{OUT} \times [(R_A \times R_B) \div (R_A + R_B)]$$

For example, if  $I_{OUT}=10\mu A$  (sourcing) and  $R_A=R_B=1k\Omega$ , the output voltage will be increased as:

$$\Delta V_{REF} = 10\mu A \times 0.5k\Omega = 5mV$$

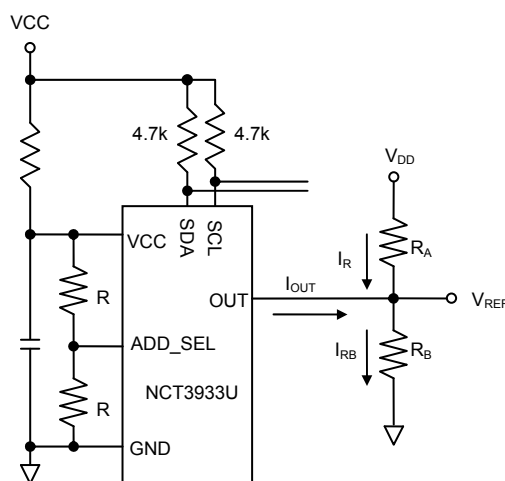


Fig. 7-

## 7.9 SMBus™ Slave Address

The NCT3933U responds to one of six SMBus™ slave addresses determined by external resistor divider as shown in the Typical Application Circuit. The voltage on ADD\_SEL pin is compared with internal reference voltage for address selecting.

Address	0x2A	0x28	0x26	0x24	0x22	0x20
R1 (kΩ)	open	3.9	3	2.2	1.3	10

R2 (kΩ)	10	1.3	2.2	3	3.9	open
ADD_SEL Voltage (% of VCC)	0	25	42	58	75	100

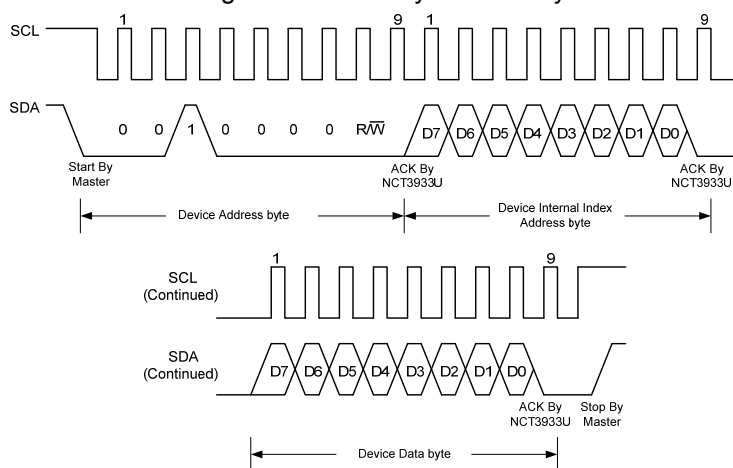
Table1. Recommended Slave Address Setting

### 7.10 Access Interface

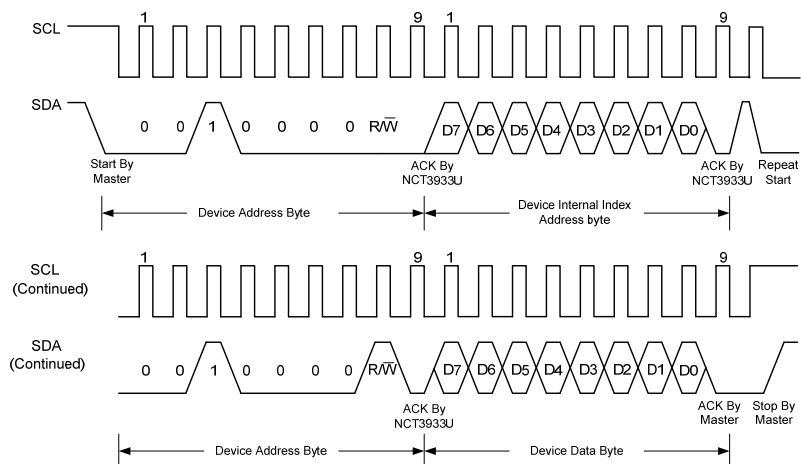
The NCT3933U provides SMBus™ serial interface to read/write internal registers, and the SMBus™ address for read and write, for example, is 00100001b and 00100000b, respectively.

The first serial bus access timing is shown as follows:

(a) Serial bus write to internal address register followed by the data byte



(b) Serial bus read form internal address register followed by the data byte



## 8. CONTROL AND STATUS REGISTER

### 8.1. NCT3933U Registers

Register	Description	Default
CR01h	OUT1 Current DAC	00h
CR02h	OUT2 Current DAC	00h
CR03h	OUT3 Current DAC	00h
CR04h	(1) Watchdog Function (2) Step Speed Controlled Function (3) Version ID	00h
CR05h	(1) OUT1~3 Current DAC Control Function for twofold (2) Power Saving Function	00h
CR5Dh	Vendor ID1	39h
CR5Eh	Vendor ID2	33h

### 8.2. Output Control Registers, CR01~CR03

Bit	Name	Function	Power On Default
-----	------	----------	------------------

7	Sign Bit	Determine if DAC sources or sinks current. For sink S=0, for source S=1.	0b
6~0	Data	7 bit Data Controlling DAC Output. Setting 000_0000b outputs zero current regardless of the state of the sign bit.	000_0000b

CR01~03 Sinking Current															
STEP	Bits [7:0]	Hex	Output Current (uA)	STEP	Bits [7:0]	Hex	Output Current (uA)	STEP	Bits [7:0]	Hex	Output Current (uA)	STEP	Bits [7:0]	Hex	Output Current (uA)
0	0000 0000	00h	-0	32	0010 0000	20h	-320	64	0100 0000	40h	-640	96	0110 0000	60h	-960
1	0000 0001	01h	10	33	0010 0001	21h	-330	65	0100 0001	41h	-650	97	0110 0001	61h	-970
2	0000 0010	02h	-20	34	0010 0010	22h	-340	66	0100 0010	42h	-660	98	0110 0010	62h	-980
3	0000 0011	03h	-30	35	0010 0011	23h	-350	67	0100 0011	43h	-670	99	0110 0011	63h	-990
4	0000 0100	04h	-40	36	0010 0100	24h	-360	68	0100 0100	44h	-680	100	0110 0100	64h	-1000
5	0000 0101	05h	-50	37	0010 0101	25h	-370	69	0100 0101	45h	-690	101	0110 0101	65h	-1010
6	0000 0110	06h	-60	38	0010 0110	26h	-380	70	0100 0110	46h	-700	102	0110 0110	66h	-1020
7	0000 0111	07h	-70	39	0010 0111	27h	-390	71	0100 0111	47h	-710	103	0110 0111	67h	-1030
8	0000 1000	08h	-80	40	0010 1000	28h	-400	72	0100 1000	48h	-720	104	0110 1000	68h	-1040
9	0000 1001	09h	-90	41	0010 1001	29h	-410	73	0100 1001	49h	-730	105	0110 1001	69h	-1050
10	0000 1010	0Ah	-100	42	0010 1010	2Ah	-420	74	0100 1010	4Ah	-740	106	0110 1010	6Ah	-1060
11	0000 1011	0Bh	-110	43	0010 1011	2Bh	-430	75	0100 1011	4Bh	-750	107	0110 1011	6Bh	-1070
12	0000 1100	0Ch	-120	44	0010 1100	2Ch	-440	76	0100 1100	4Ch	-760	108	0110 1100	6Ch	-1080
13	0000 1101	0Dh	-130	45	0010 1101	2Dh	-450	77	0100 1101	4Dh	-770	109	0110 1101	6Dh	-1090
14	0000 1110	0Eh	-140	46	0010 1110	2Eh	-460	78	0100 1110	4Eh	-780	110	0110 1110	6Eh	-1100
15	0000 1111	0Fh	-150	47	0010 1111	2Fh	-470	79	0100 1111	4Fh	-790	111	0110 1111	6Fh	-1110
16	0001 0000	10h	-160	48	0011 0000	30h	-480	80	0101 0000	50h	-800	112	0111 0000	70h	-1120
17	0001 0001	11h	-170	49	0011 0001	31h	-490	81	0101 0001	51h	-810	113	0111 0001	71h	-1130
18	0001 0010	12h	-180	50	0011 0010	32h	-500	82	0101 0010	52h	-820	114	0111 0010	72h	-1140
19	0001 0011	13h	-190	51	0011 0011	33h	-510	83	0101 0011	53h	-830	115	0111 0011	73h	-1150
20	0001 0100	14h	-200	52	0011 0100	34h	-520	84	0101 0100	54h	-840	116	0111 0100	74h	-1160
21	0001 0101	15h	-210	53	0011 0101	35h	-530	85	0101 0101	55h	-850	117	0111 0101	75h	-1170
22	0001 0110	16h	-220	54	0011 0110	36h	-540	86	0101 0110	56h	-860	118	0111 0110	76h	-1180
23	0001 0111	17h	-230	55	0011 0111	37h	-550	87	0101 0111	57h	-870	119	0111 0111	77h	-1190
24	0001 1000	18h	-230	56	0011 1000	38h	-560	88	0101 1000	58h	-880	120	0111 1000	78h	-1200
25	0001 1001	19h	-250	57	0011 1001	39h	-570	89	0101 1001	59h	-890	121	0111 1001	79h	-1210
26	0001 1010	1Ah	-250	58	0011 1010	3Ah	-580	90	0101 1010	5Ah	-900	122	0111 1010	7Ah	-1220
27	0001 1011	1Bh	-270	59	0011 1011	3Bh	-590	91	0101 1011	5Bh	-910	123	0111 1011	7Bh	-1230
28	0001 1100	1Ch	-280	60	0011 1100	3Ch	-600	92	0101 1100	5Ch	-920	124	0111 1100	7Ch	-1240
29	0001 1101	1Dh	-290	61	0011 1101	3Dh	-610	93	0101 1101	5Dh	-930	125	0111 1101	7Dh	-1250
30	0001 1110	1Eh	-300	62	0011 1110	3Eh	-620	94	0101 1110	5Eh	-940	126	0111 1110	7Eh	-1260



31	0001 1111	1Fh	-310	63	0011 1111	3Fh	-630	95	0101 1111	5Fh	-950	127	0111 1111	7Fh	-1270
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CR01~03 Sourcing Current															
STEP	Bits [7:0]	Hex	Output Current (uA)	STEP	Bits [7:0]	Hex	Output Current (uA)	STEP	Bits [7:0]	Hex	Output Current (uA)	STEP	Bits [7:0]	Hex	Output Current (uA)
0	1000 0000	80h	0	32	1010 0000	A0h	320	64	1100 0000	C0h	640	96	1110 0000	E0h	960
1	1000 0001	81h	10	33	1010 0001	A1h	330	65	1100 0001	C1h	650	97	1110 0001	E1h	970
2	1000 0010	82h	20	34	1010 0010	A2h	340	66	1100 0010	C2h	660	98	1110 0010	E2h	980
3	1000 0011	83h	30	35	1010 0011	A3h	350	67	1100 0011	C3h	670	99	1110 0011	E3h	990
4	1000 0100	84h	40	36	1010 0100	A4h	360	68	1100 0100	C4h	680	100	1110 0100	E4h	1000
5	1000 0101	85h	50	37	1010 0101	A5h	370	69	1100 0101	C5h	690	101	1110 0101	E5h	1010
6	1000 0110	86h	60	38	1010 0110	A6h	380	70	1100 0110	C6h	700	102	1110 0110	E6h	1020
7	1000 0111	87h	70	39	1010 0111	A7h	390	71	1100 0111	C7h	710	103	1110 0111	E7h	1030
8	1000 1000	88h	80	40	1010 1000	A8h	400	72	1100 1000	C8h	720	104	1110 1000	E8h	1040
9	1000 1001	89h	90	41	1010 1001	A9h	410	73	1100 1001	C9h	730	105	1110 1001	E9h	1050
10	1000 1010	8Ah	100	42	1010 1010	AAh	420	74	1100 1010	CAh	740	106	1110 1010	EAh	1060
11	1000 1011	8Bh	110	43	1010 1011	ABh	430	75	1100 1011	CBh	750	107	1110 1011	EBh	1070
12	1000 1100	8Ch	120	44	1010 1100	ACH	440	76	1100 1100	CCh	760	108	1110 1100	ECh	1080
13	1000 1101	8Dh	130	45	1010 1101	ADh	450	77	1100 1101	CDh	770	109	1110 1101	EDh	1090
14	1000 1110	8Eh	140	46	1010 1110	Aeh	460	78	1100 1110	CEh	780	110	1110 1110	Eeh	1100
15	1000 1111	8Fh	150	47	1010 1111	Afh	470	79	1100 1111	Cfh	790	111	1110 1111	Efh	1110
16	1001 0000	90h	160	48	1011 0000	B0h	480	80	1101 0000	D0h	800	112	1111 0000	F0h	1120
17	1001 0001	91h	170	49	1011 0001	B1h	490	81	1101 0001	D1h	810	113	1111 0001	F1h	1130
18	1001 0010	92h	180	50	1011 0010	B2h	500	82	1101 0010	D2h	820	114	1111 0010	F2h	1140
19	1001 0011	93h	190	51	1011 0011	B3h	510	83	1101 0011	D3h	830	115	1111 0011	F3h	1150
20	1001 0100	94h	200	52	1011 0100	B4h	520	84	1101 0100	D4h	840	116	1111 0100	F4h	1160
21	1001 0101	95h	210	53	1011 0101	B5h	530	85	1101 0101	D5h	850	117	1111 0101	F5h	1170
22	1001 0110	96h	220	54	1011 0110	B6h	540	86	1101 0110	D6h	860	118	1111 0110	F6h	1180
23	1001 0111	97h	230	55	1011 0111	B7h	550	87	1101 0111	D7h	870	119	1111 0111	F7h	1190
24	1001 1000	98h	230	56	1011 1000	B8h	560	88	1101 1000	D8h	880	120	1111 1000	F8h	1200
25	1001 1001	99h	250	57	1011 1001	B9h	570	89	1101 1001	D9h	890	121	1111 1001	F9h	1210
26	1001 1010	9Ah	250	58	1011 1010	BAh	580	90	1101 1010	DAh	900	122	1111 1010	FAh	1220
27	1001 1011	9Bh	270	59	1011 1011	BBh	590	91	1101 1011	DBh	910	123	1111 1011	FBh	1230
28	1001 1100	9Ch	280	60	1011 1100	BCh	600	92	1101 1100	DCh	920	124	1111 1100	FCh	1240
29	1001 1101	9Dh	290	61	1011 1101	BDh	610	93	1101 1101	DDh	930	125	1111 1101	FDh	1250

30	1001 1110	9Eh	300	62	1011 1110	BEh	620	94	1101 1110	DEh	940	126	1111 1110	FEh	1260
31	1001 1111	9Fh	310	63	1011 1111	BFh	630	95	1101 1111	DFh	950	127	1111 1111	FFh	1270

### 8.3. Watchdog Timer/Step Speed Controller/Version ID Register, CR04

Bit	Name	Function	Power On Default
7	Enable Watchdog Timer	1: Start watchdog counter and reset all registers to default after time out. 0: Stop watchdog counter and reset watchdog timer.	0b
6	Watchdog Timer Status	Read Only. This bit is set to 1 when watchdog timeout happens. This bit is set to 0 once this register is read out.	0b
5~4	Watchdog Timer Delay	00: 1400ms, 01: 2800ms 10: 5500ms, 11: 11000ms	00b
3~2	Step Speed Controller Delay	00: 10us, 01: 20us 10: 30us, 11: 40us	00b
1~0	Version ID	Read Only	00b

### 8.4. OUT1~3 Twofold Output Current DAC Control Function/Power Saving Function Register, CR05

Bit	Name	Function	Power On Default
7	Reserved (For internal use only)	Reserved	0b
6	Power Saving Function	0: Disable; 1: Enable	0b
5	Reserved	Reserved	0b
4	OUT3 Output Current ×2	0: Disable; 1: Enable	0b
3	Reserved	Reserved	0b
2	OUT2 Output Current × 2	0: Disable; 1: Enable	0b
1	Reserved	Reserved	0b
0	OUT1 Output Current × 2	0: Disable; 1: Enable	0b

**Note:** Bit 7 is for internal use only and it is not allowed to change the default setting.

### 8.5. Vendor ID Register, CR5D & CR5E

Index	Name	Function	Power On Default
5D	Vendor ID1	Read Only	0011_1001b

5E	Vendor ID2	Read Only	0011_0011b
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## 9. ELECTRICAL CHARACTERISTIC

### 9.1. Absolute Maximum Ratings

PARAMETER		RATING	UNIT
Power Supply Voltage		-0.3 to 6V	V
Voltage on Other Pins		-0.3 to VCC+0.3	V
Storage Temperature		-50 to 150	°C
Soldering Temperature		Refer to IPC/JEDEC J-STD-020 Specification	
ESD Protection	Human Body Mode	2	kV
	Machine Mode	200	V
	Latch-up	100	mA

Note: Exposure to conditions beyond those listed under Absolute Maximum Ratings May adversely affect the life and reliability of the device.

### 9.2. Thermal Information

PARAMETER	RATING	UNIT
Power Dissipation, $P_D$ @ $T_A=25^\circ\text{C}$	0.4	W
Package Thermal Resistance, SOT23-8, $\theta_{JA}$	250	°C/W

### 9.3. Recommended Operating Conditions

PARAMETER	RATING	UNIT
Operating Temperature	-20 to 125	°C
Junction Temperature	-20 to 125	°C
Supply Voltage, VCC	3 to 5.5	V

### 9.4. DC Characteristics

(VCC = 3V to 5.5V,  $T_A$  = -20°C to 125°C, Typical Values are at  $T_A=25^\circ\text{C}$ . Unless otherwise specified.)

PARAMETER	SYM.	MIN.	TYP.	MAX.	UNIT	CONDITIONS
<b>Supply Input Voltage</b>						
Supply Input Voltage	V <sub>CC</sub>	3		5.5	V	

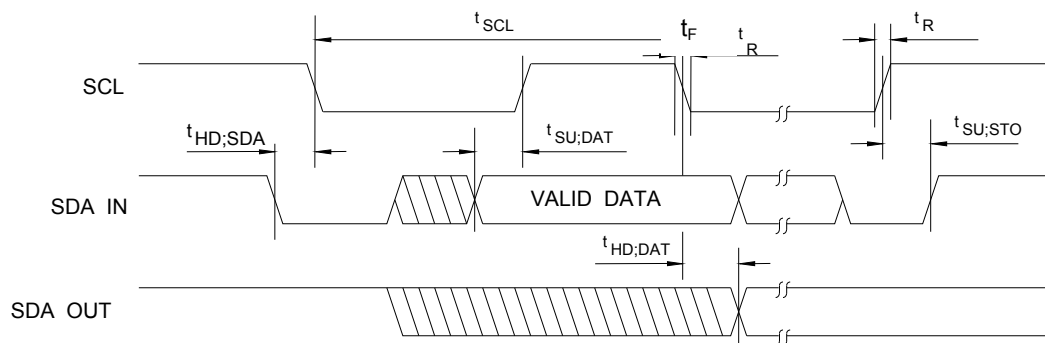
POR Threshold	V <sub>CC_POR</sub>		2.6		V	
Supply Input Current	I <sub>CC</sub>	0.5		1.5	mA	All I <sub>OUT</sub> = 0A, VCC = 5V SCL = SDA = 0V or 5V
Supply Input Current in Power Saving Mode	I <sub>CC_PSM</sub>	0.3		0.6	mA	All I <sub>OUT</sub> = 0A, VCC = 5V SCL = SDA = 0V or 5V, CR05 bit6=1
Input High Leakage	I <sub>IH</sub>			+1	μA	VIN = VCC
Input Low Leakage	I <sub>IL</sub>	-1			μA	VIN = 0V
<b>SMBUS Interface</b>						
Input High Voltage	V <sub>IH</sub>	2.1		V <sub>PULLUP</sub>	V	
Input Low Voltage	V <sub>IL</sub>			0.8	V	
Output Low Voltage	V <sub>OL</sub>			0.4	V	I <sub>OL</sub> = I <sub>PULLUP</sub>
Nominal Pullup Voltage	V <sub>PULLUP</sub>	2.7		5.5	V	
Current Sinking	I <sub>PULLUP</sub>	12			mA	V <sub>OL</sub> = 0.4V
<b>Current DAC Output</b>						
Output Leakage Current at Zero Current Setting	I <sub>ZERO</sub>	-1		+1	μA	V <sub>OUT</sub> <sup>(1)</sup> = 0~5V
Output Current Accuracy		-5		+5	%	I <sub>OUT</sub> = 110μA ~ 2540μA, V <sub>OUT</sub> <sup>(1)</sup> = 0.8V
		-5		+5	μA	I <sub>OUT</sub> = 0μA ~ 100μA, V <sub>OUT</sub> <sup>(1)</sup> = 0.8V
Output Current Variation due to Output Voltage Change <sup>(2)</sup>		-1.2		+1.2	%V	I <sub>OUT</sub> sinking, V <sub>OUT</sub> <sup>(1)</sup> = 0.5V~VCC
		-1		+1		I <sub>OUT</sub> sourcing, V <sub>OUT</sub> <sup>(1)</sup> = 0V~VCC-1V
Output Current Variation due to Power Supply Change <sup>(3)</sup>		-1		+1	%V	I <sub>OUT</sub> sinking, V <sub>OUT</sub> <sup>(1)</sup> = 0.5V, VCC = 3V~5.5V
		-1		+1		I <sub>OUT</sub> sourcing, V <sub>OUT</sub> <sup>(1)</sup> = 0.5V, VCC = 3V~5.5V
Step Speed Accuracy			80		%	
Watchdog Timer Delay Accuracy			80		%	
<b>Address Selection</b>						
Address 1 Voltage		--	--	15	%VCC	Address = 0x2A
Address 2 Voltage		20	25	30		Address = 0x28
Address 3 Voltage		37	42	47		Address = 0x26
Address 4 Voltage		53	58	62		Address = 0x24
Address 5 Voltage		70	75	80		Address = 0x22
Address 6 Voltage		85	--	--		Address = 0x20

Note(1) V<sub>OUT</sub> is defined as voltage on OUT pins.

Note(2) Output Current Variation due to Output Voltage Change is defined as  $(\Delta I_{OUT} / I_{OUT}) / \Delta V_{OUT}$ . I<sub>OUT</sub> is set at full scale value.

Note(3) Output Current Variation due to Power Supply Change is defined as  $(\Delta I_{OUT} / I_{OUT}) / \Delta V_{CC}$ . V<sub>OUT</sub> is measured at 0.5V and I<sub>OUT</sub> is set at full scale value.

## 9.5. AC Characteristics

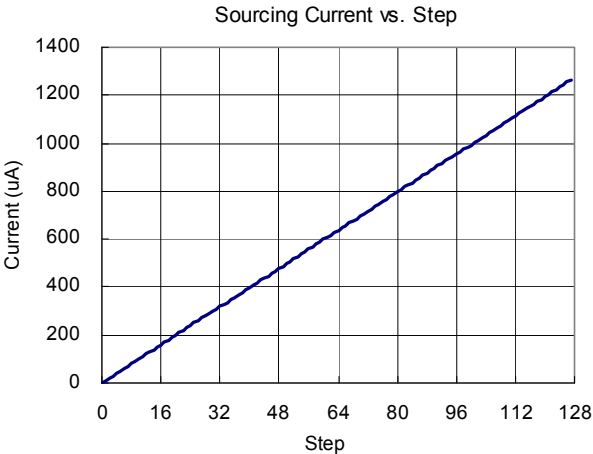
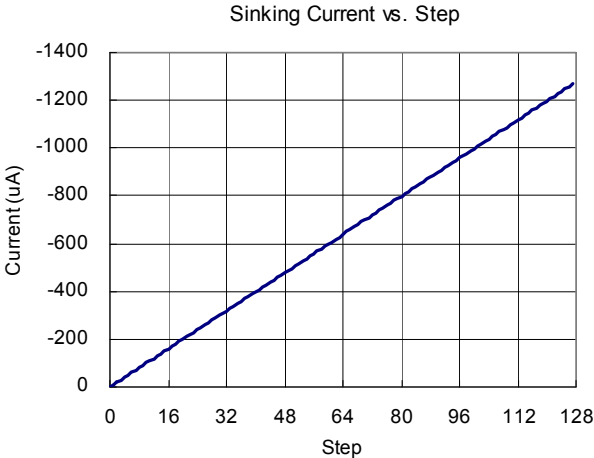
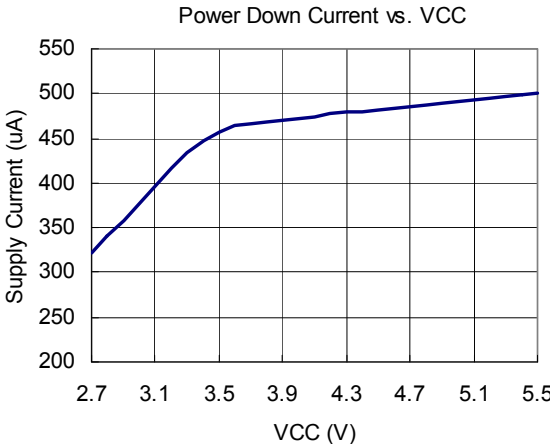
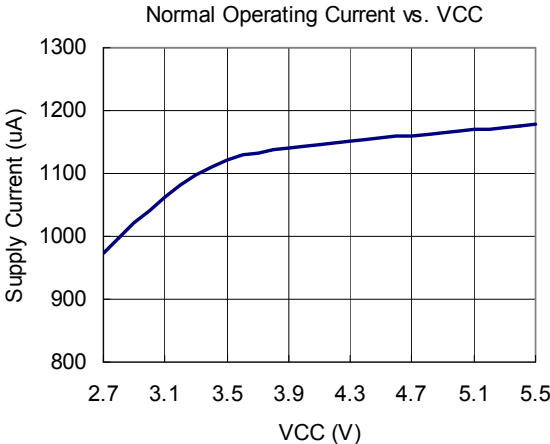


Serial Bus Timing Diagram

PARAMETER	SYMBOL	MIN.	MAX.	UNIT
SCL clock period	$t_{SCL}$	10	100	KHz
Start condition hold time	$t_{HD;SDA}$	4.0		$\mu$ S
Stop condition setup-up time	$t_{SU;STO}$	4.0		$\mu$ S
DATA to SCL setup time	$t_{SU;DAT}$	250		nS
DATA to SCL hold time	$t_{HD;DAT}$	300		nS
SCL and SDA rise time	$t_R$		1.0	$\mu$ S
SCL and SDA fall time	$t_F$		300	nS
Time to operate after POR	$t_{POR}$		500	mS

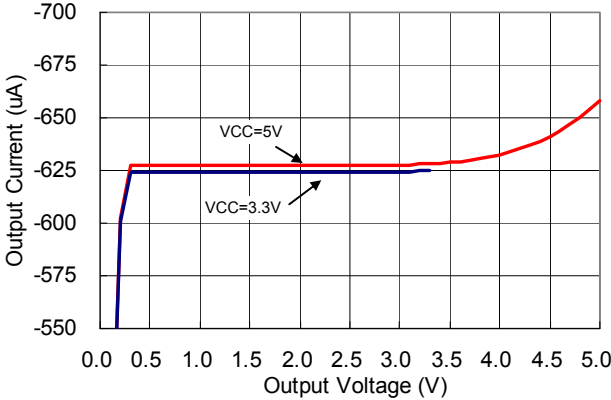


10. TYPICAL OPERATION CHARACTERISTICS

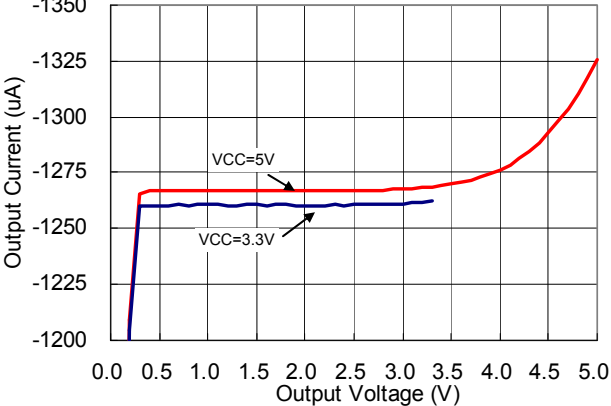




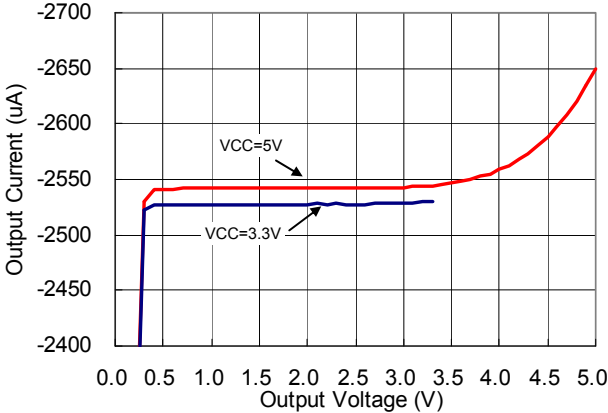
Output Voltage vs. Output Current  
CR01~03=3F (-630uA) Sinking



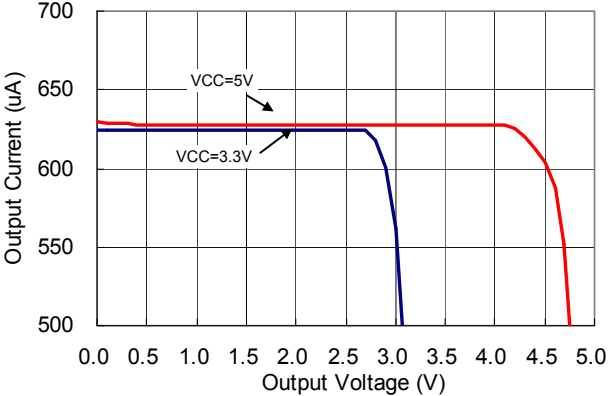
Output Voltage vs. Output Current  
CR01~03=BF (-1270uA) Sinking



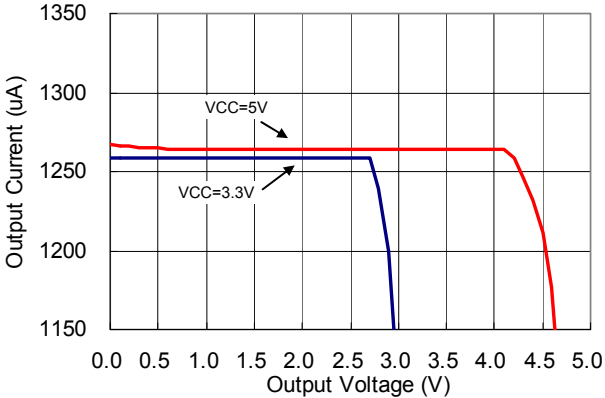
Output Voltage vs. Output Current  
CR01~03=FF CR05=15 (-2540uA) Sinking



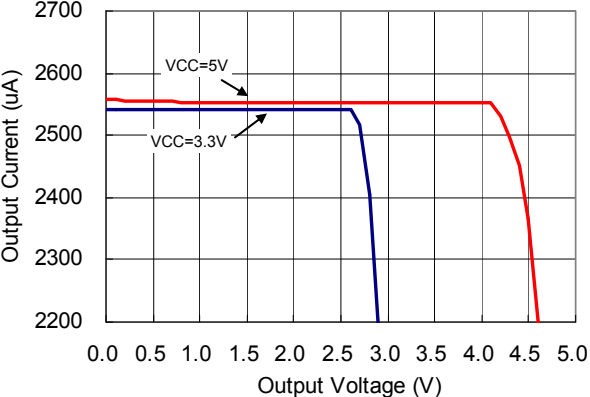
Output Voltage vs. Output Current  
CR01~03=BF (630uA) Sourcing

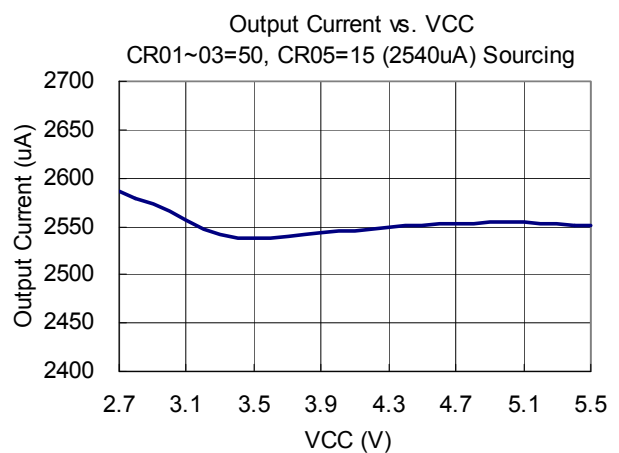
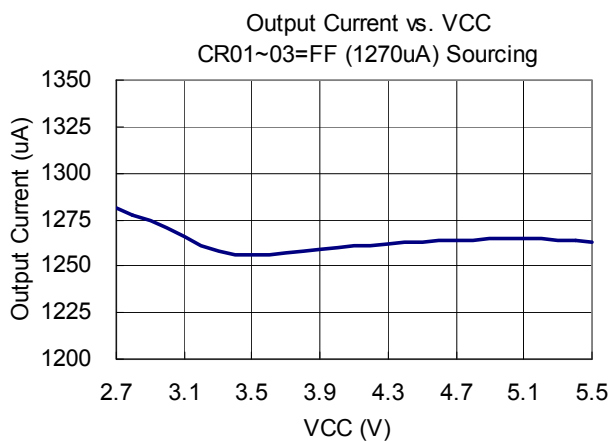
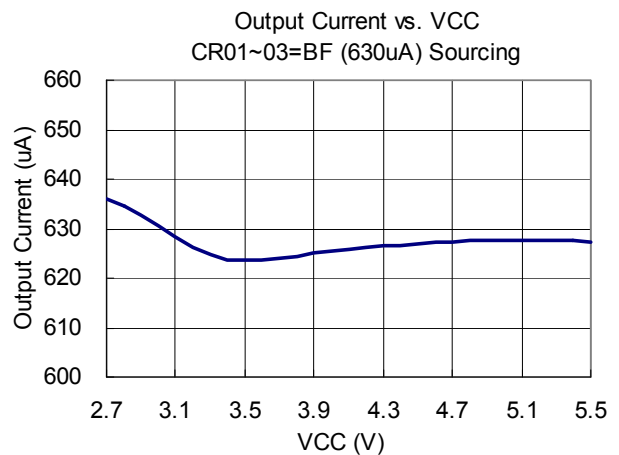
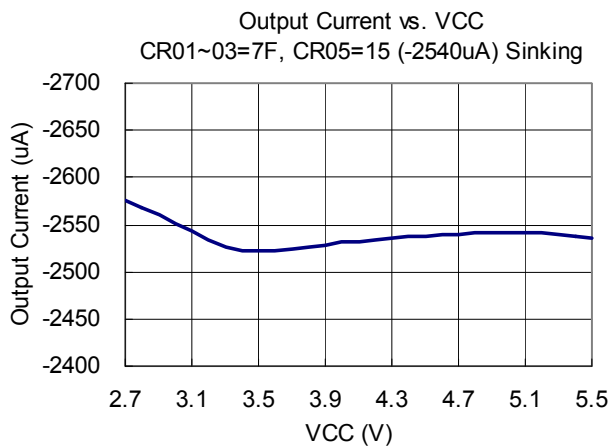
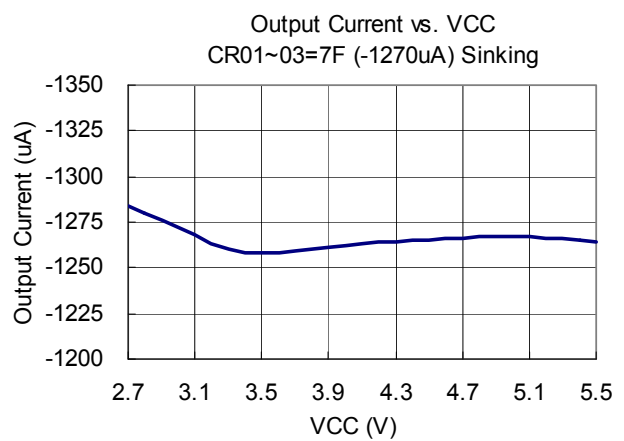
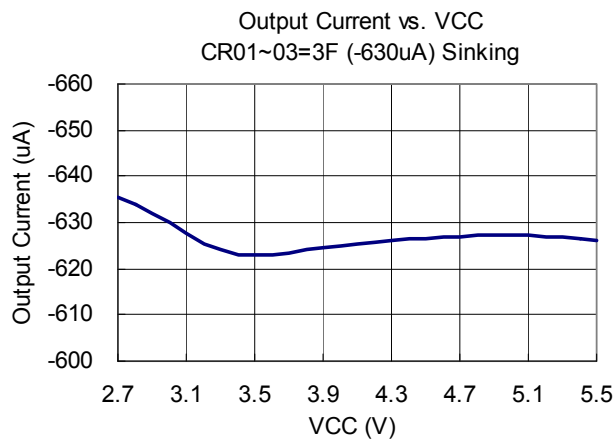


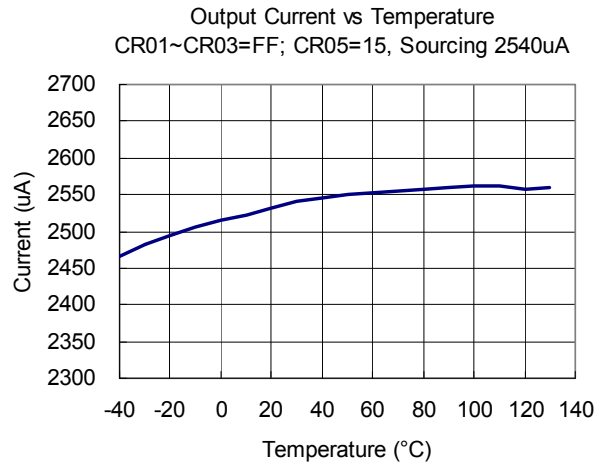
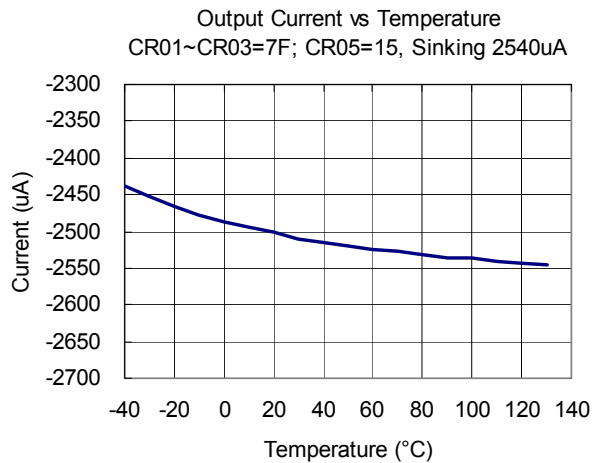
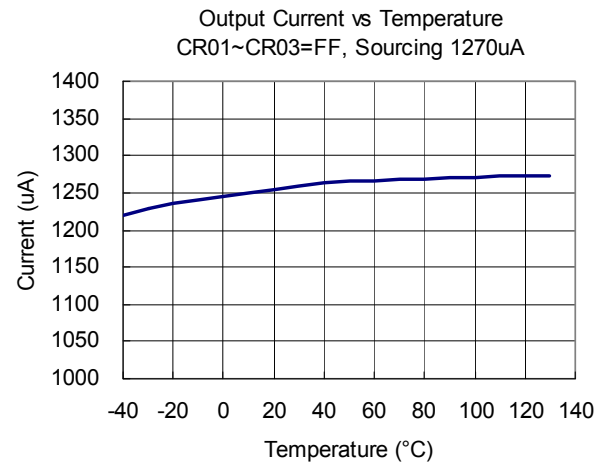
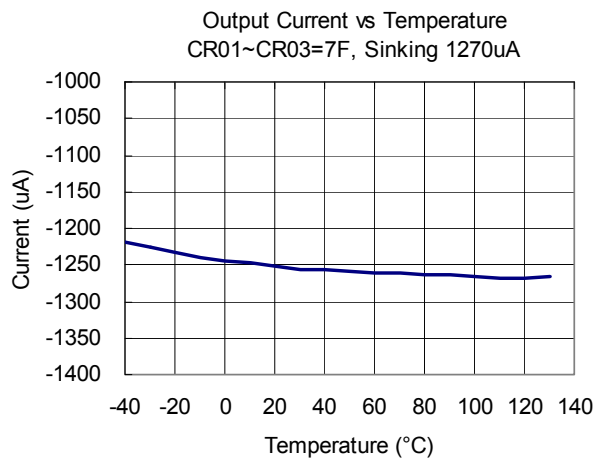
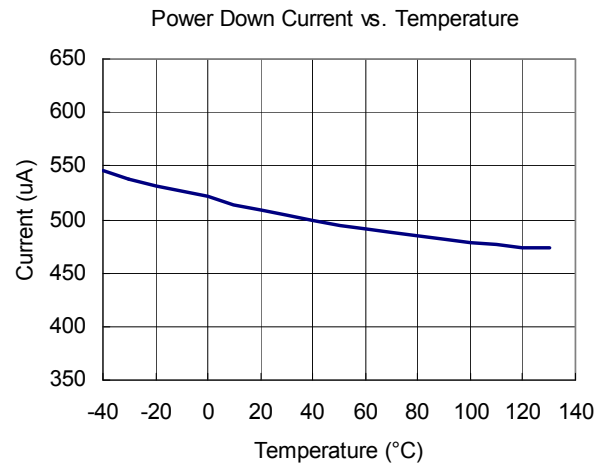
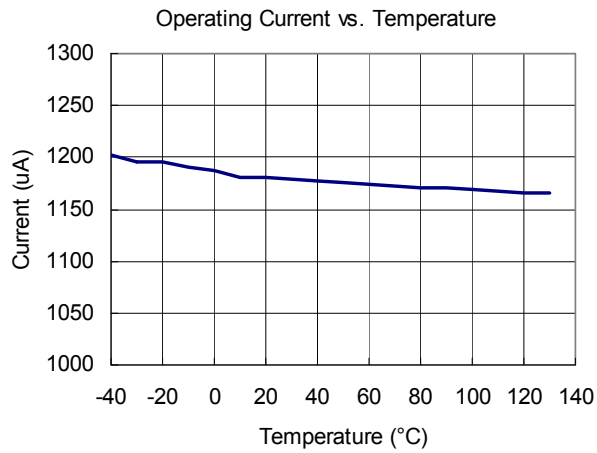
Output Voltage vs. Output Current  
CR01~03=FF (1270uA) Sourcing



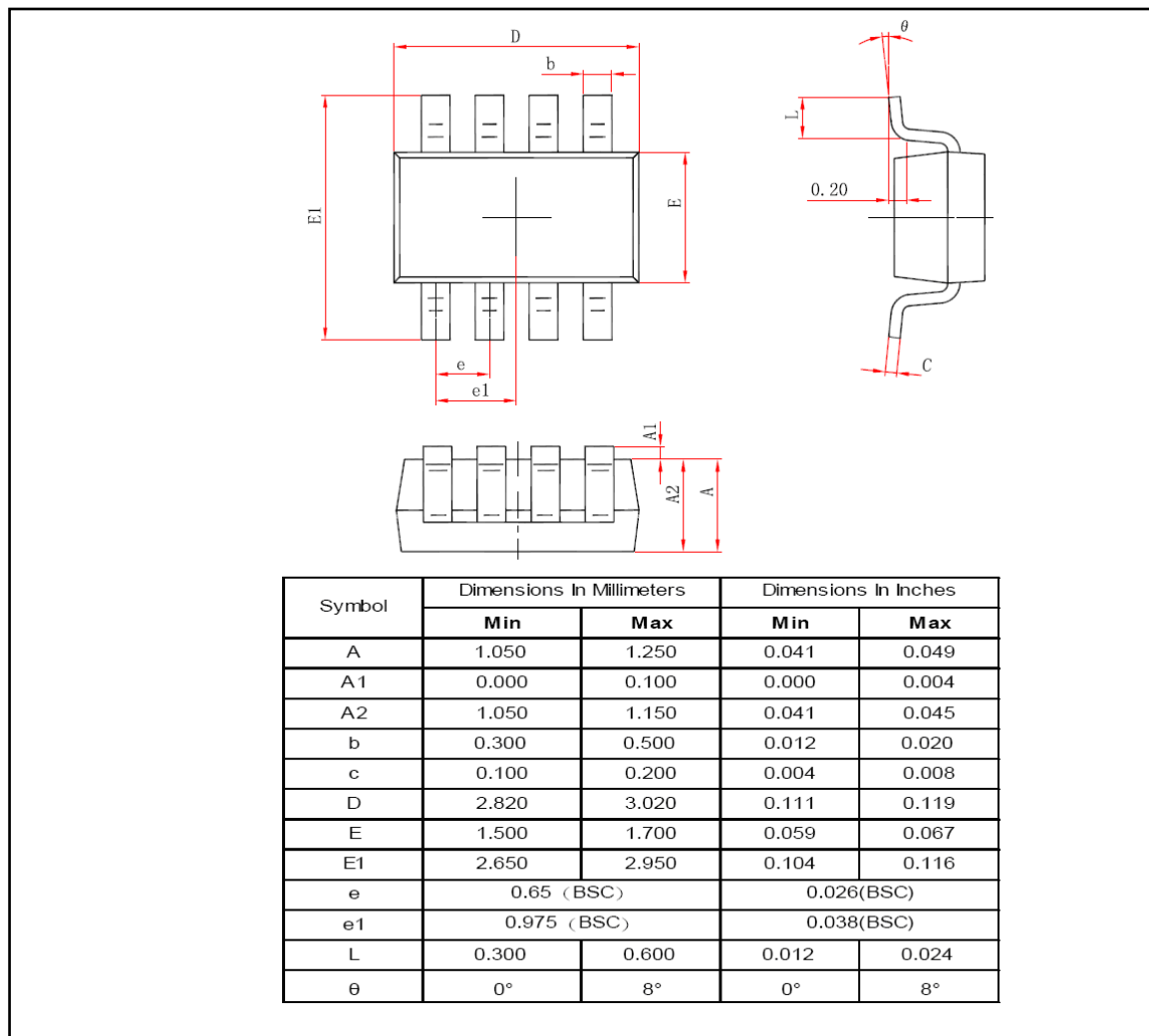
Output Voltage vs. Output Current  
CR01~03=FF, CR05=15 (2540uA) Sourcing



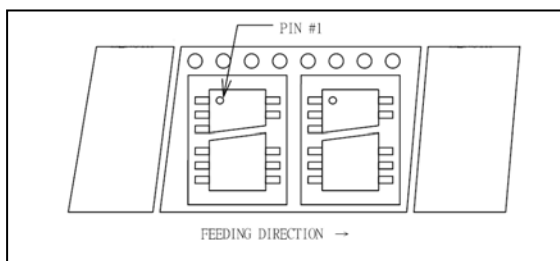




## 11. PACKAGE DIMENSION



### ➤ TAPING SPECIFICATION

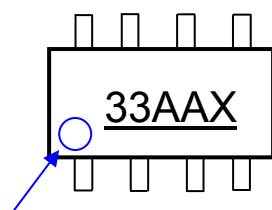


**8 Pin SOT23 Package**

## 12. ORDERING INFORMATION

Part Number	Package Type	Supplied as	Production Flow
NCT3933U	SOT23-8 (Green Package)	T Shape: 3,000 units/T&R	-20°C to +125°C

## 13. TOP MARKING SPECIFICATION



Pin 1 index

1<sup>st</sup> Line: 33AAX

- 33 : NCT3933U
- AA: Date code
- X: the IC version (A means A; B means B & C means C...etc.)

**14. REVISION HISTORY**

VERSION	DATE	PAGE	DESCRIPTION
A0	2010/10/18	All	First release

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