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

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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.

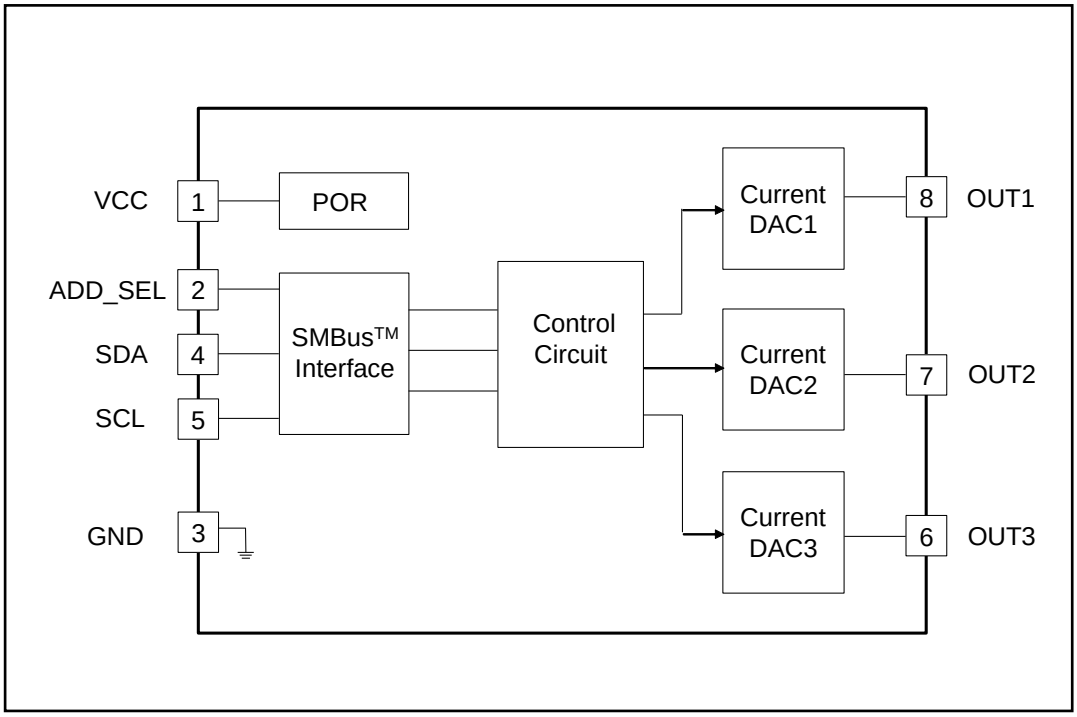
2. FEATURES

- 3-Channel Current DAC
- Programmable 128 Steps Sinking and Sourcing Current
- Full Scale Current 0 to ±1270uA
- 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°C to 125°C Temperature Range
- SOT23-8 Green Package (Lead Free and Halogen Free)

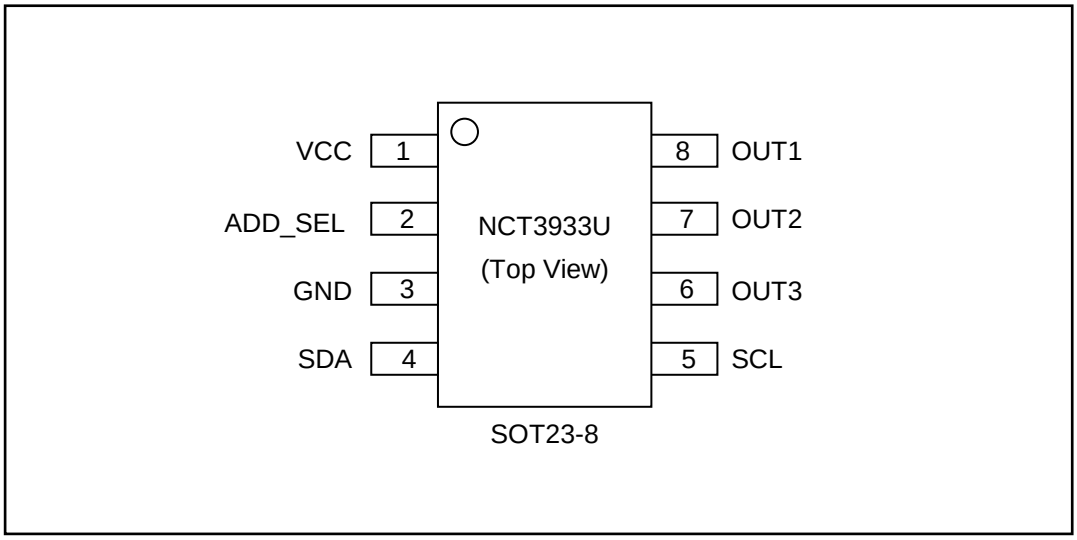
3. APPLICATIONS

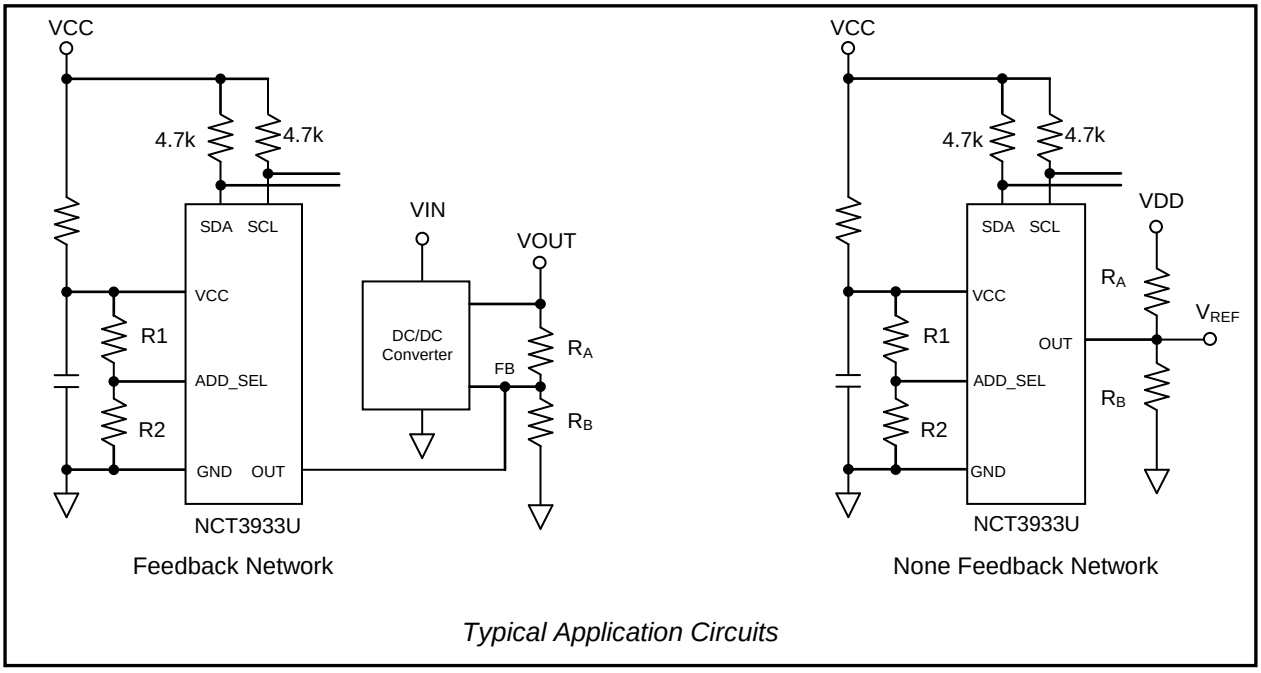
- Power Supply Adjustment for M/B and Graphic Card
- Power Supply Margining
- Adjustable Current Sink or Source
- LCD Brightness and Contrast Adjustment

4. BLOCK DIAGRAM



5. PIN CONFIGURATION AND TYPICAL APPLICATION CIRCUIT





Typical Application Circuits

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_{12ts}	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_{12ts}	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}=-500uA (sinking) and R_A=1kΩ, the output voltage will be increased as:

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

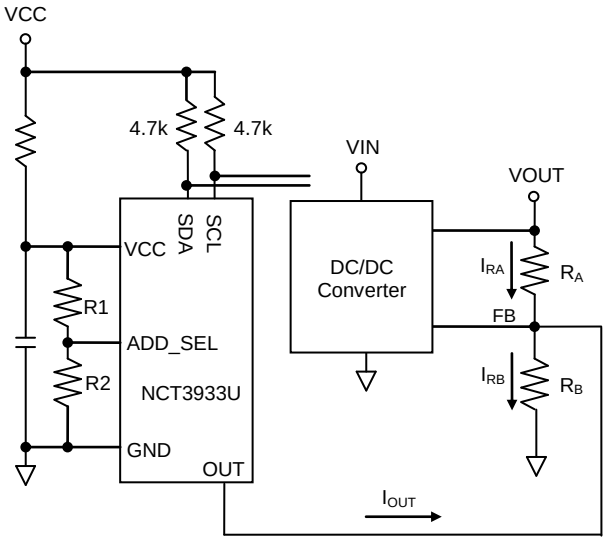


Fig. 7-1

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}=10uA (sourcing) and R_A= R_B=1kΩ, the output voltage will be increased as:

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

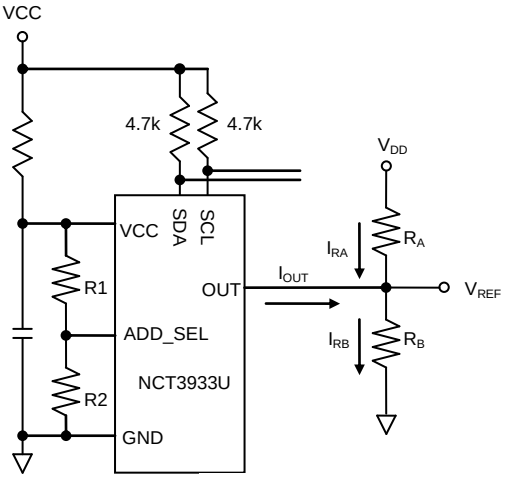


Fig. 7-2

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

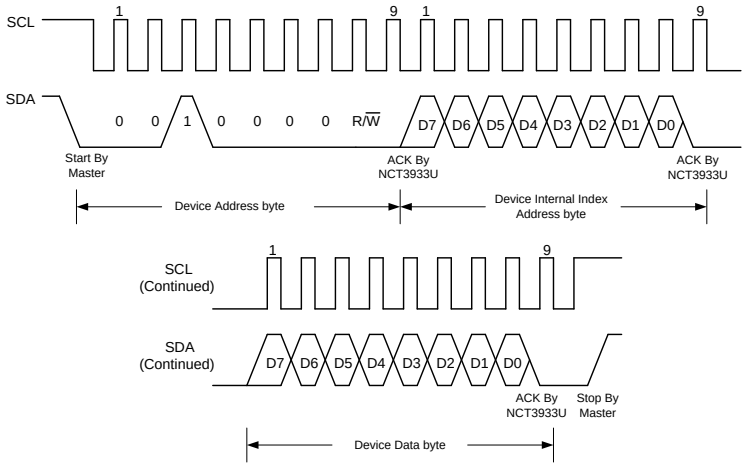
Table1. Recommended Slave Address Setting

7.10 Access Interface

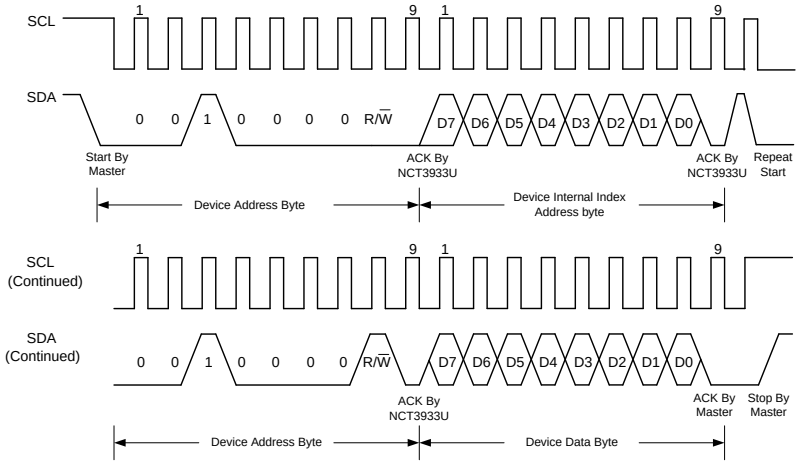
The NCT3933U provides SMBus™ serial interface to read/write internal registers, and the SMBus™ address for read and write, for example, is 00100001b and 00100000b, respectively.

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

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

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°C	0.4	W
Package Thermal Resistance, SOT23-8, θ_{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°C. Unless otherwise specified.)

PARAMETER	SYM.	MIN.	TYP.	MAX.	UNIT	CONDITIONS
Supply Input Voltage						
Supply Input Voltage	V_{CC}	3		5.5	V	
POR Threshold	V_{CC_POR}		2.6		V	
Supply Input Current	I_{CC}	0.5		1.5	mA	All I_{OUT} = 0A, VCC = 5V SCL = SDA = 0V or 5V
Supply Input Current in Power Saving Mode	I_{CC_PSM}	0.3		0.6	mA	All I_{OUT} = 0A, VCC = 5V SCL = SDA = 0V or 5V, CR05 bit6=1
Input High Leakage	I_{IH}			+1	μA	VIN = VCC
Input Low Leakage	I_{IL}	-1			μA	VIN = 0V

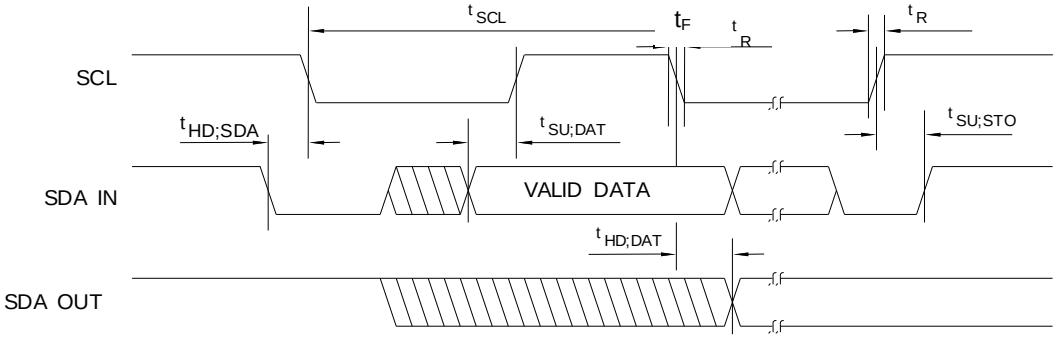
SMBUS Interface						
Input High Voltage	V_{IH}	2.1		V_{PULLUP}	V	
Input Low Voltage	V_{IL}			0.8	V	
Output Low Voltage	V_{OL}			0.4	V	$I_{OL} = I_{PULLUP}$
Nominal Pullup Voltage	V_{PULLUP}	2.7		5.5	V	
Current Sinking	I_{PULLUP}	12			mA	V_{OL} = 0.4V
Current DAC Output						
Output Leakage Current at Zero Current Setting	I_{ZERO}	-1		+1	uA	V_{OUT}(1) = 0~5V
Outptut Current Acuracy		-5		+5	%	I_{OUT} = 110uA ~ 2540uA, V_{OUT}(1) = 0.8V
		-5		+5	uA	I_{OUT} = 0uA ~ 100uA, V_{OUT}(1) = 0.8V
Outptut Current Variation due to Output Voltage Change(2)		-1.2		+1.2	%/V	I_{OUT} sinking, V_{OUT}(1) = 0.5V~VCC
		-1		+1		I_{OUT} sourcing, V_{OUT}(1) = 0V~VCC-1V
Output Current Variation due to Power Supply Change(3)		-1		+1	%/V	I_{OUT} sinking, V_{OUT}(1)=0.5V, VCC=3V~5.5V
		-1		+1		I_{OUT} sourcing, V_{OUT}(1)=0.5V, VCC=3V~5.5V
Step Speed Accuracy			80		%	
Watchdog Timer Delay Accuracy			80		%	
Address Selection						
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) VOUT is defined as voltage on OUT pins.

Note(2) Outptut Current Variation due to Output Voltage Change is defined as (ΔIOUT / IOUT) / ΔVOUT. IOUT is set at full scale value.

Note(3) Output Current Variation due to Power Supply Changeis defined as (ΔIOUT / IOUT) / ΔVCC. VOUT is measured at 0.5V and IOUT is set at full scale value.

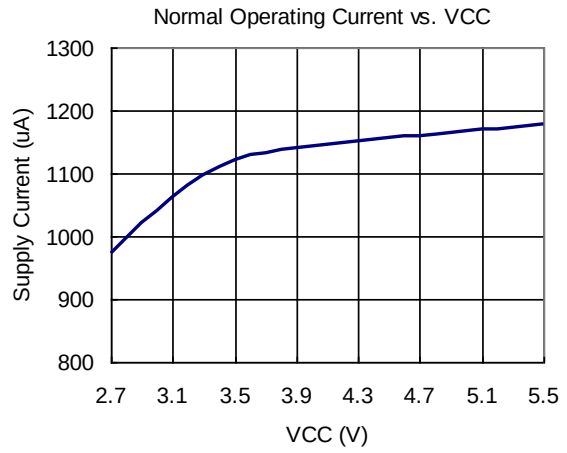
9.5. AC Characteristics

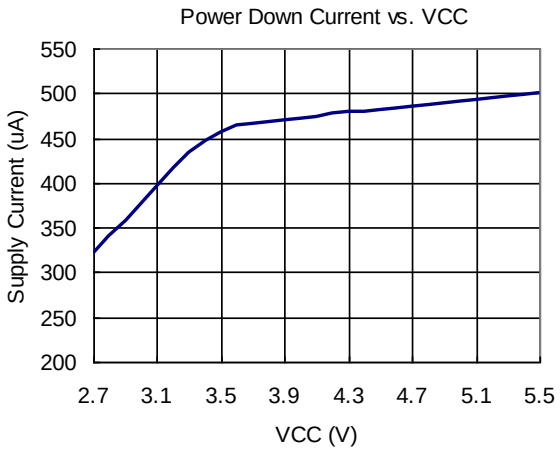


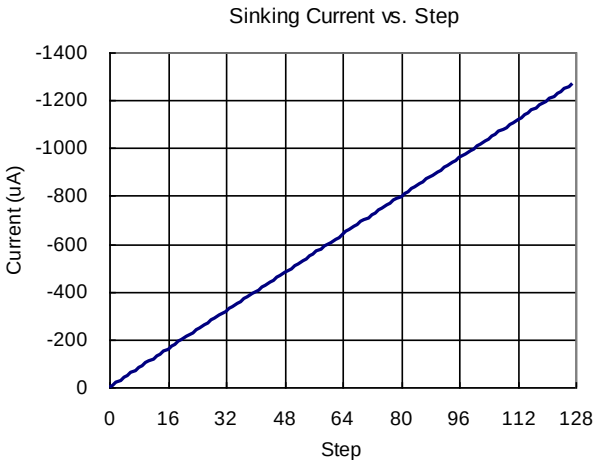
Serial Bus Timing Diagram

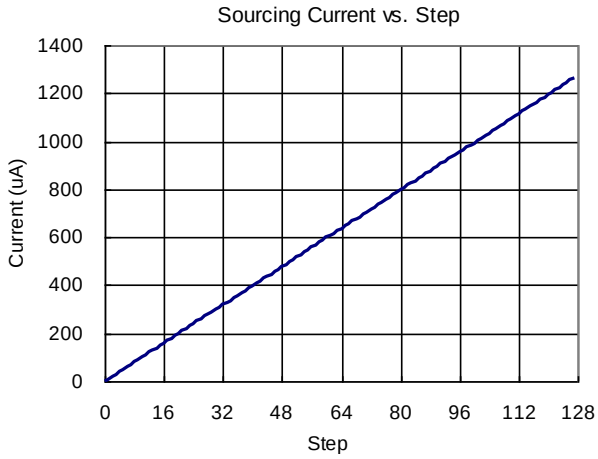
PARAMETER	SYMBOL	MIN.	MAX.	UNIT
SCL clock period	t_{SCL}	10	100	KHz
Start condition hold time	$t_{HD;SDA}$	4.0		uS
Stop condition setup-up time	$t_{SU;STO}$	4.0		uS
DATA to SCL setup time	$t_{SU;DAT}$	250		nS
DATA to SCL hold time	$t_{HD;DAT}$	300		nS
SCL and SDA rise time	t_R		1.0	uS
SCL and SDA fall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

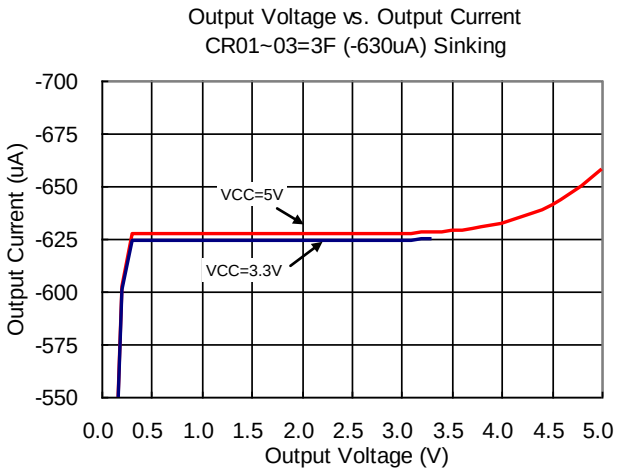
10. TYPICAL OPERATION CHARACTERISTICS

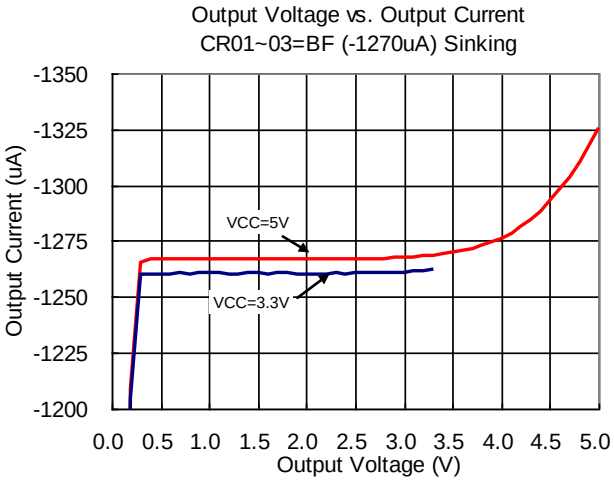




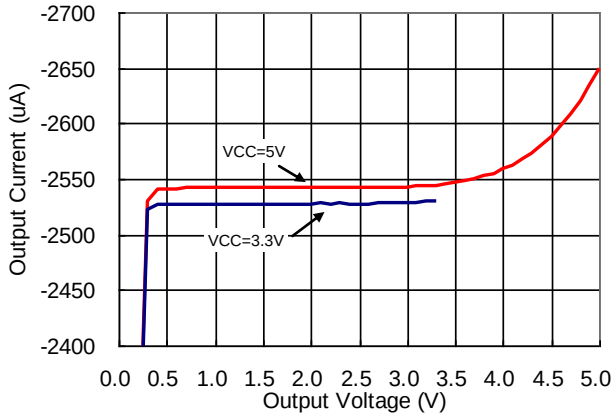




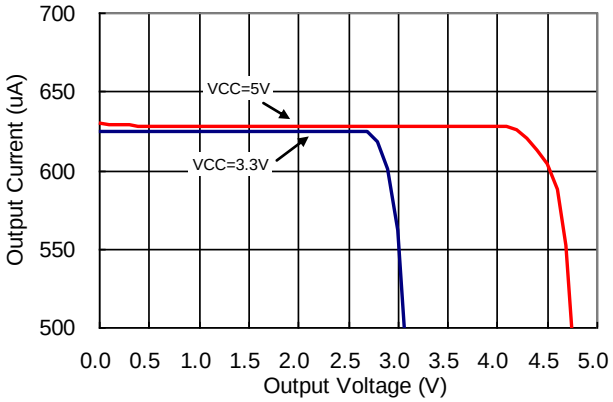




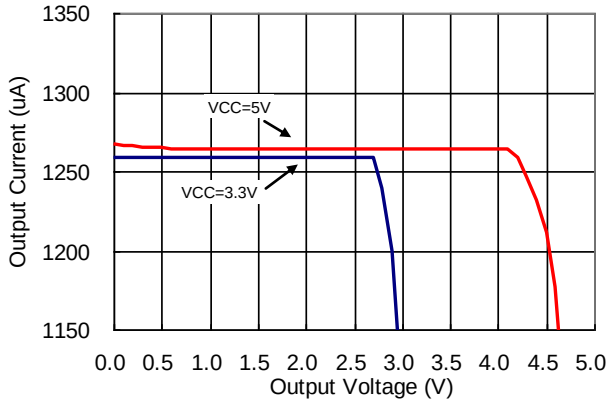
Output Voltage vs. Output Current
CR01~03=FF CR05=15 (-2540uA) Sinking



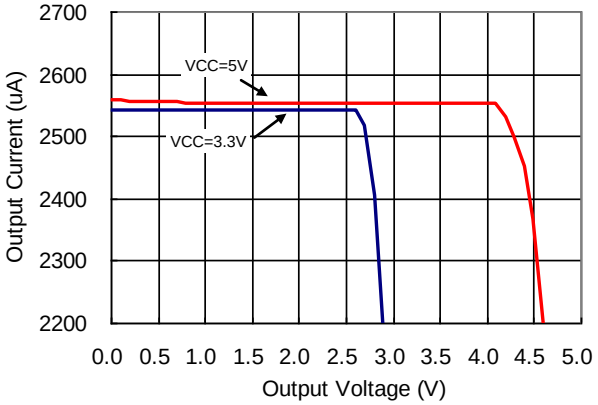
Output Voltage vs. Output Current
CR01~03=BF (630uA) Sourcing



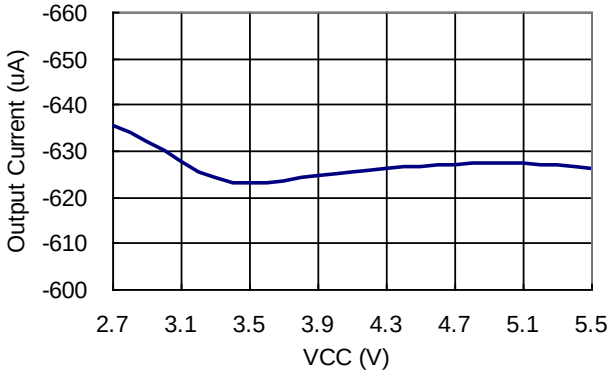
Output Voltage vs. Output Current
CR01~03=FF (1270uA) Sourcing



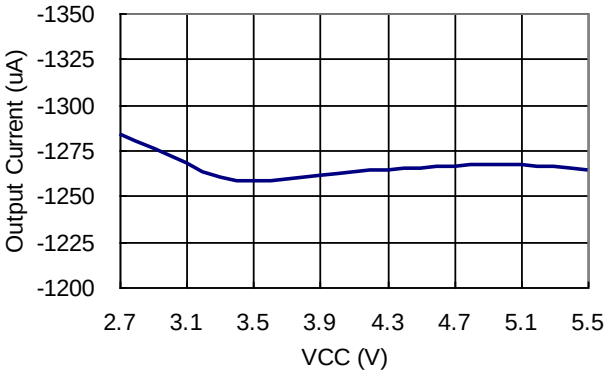
Output Voltage vs. Output Current
CR01~03=FF, CR05=15 (2540uA) Sourcing



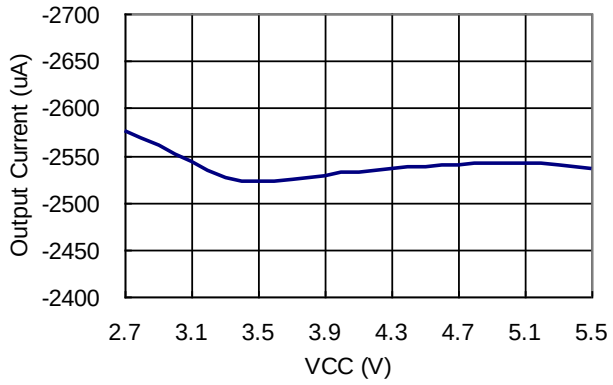
Output Current vs. VCC
CR01~03=3F (-630uA) Sinking



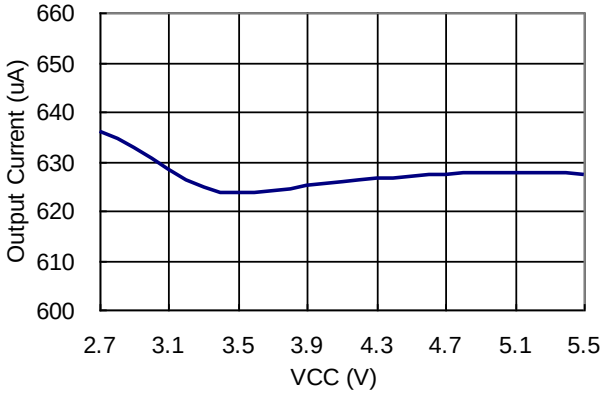
Output Current vs. VCC
CR01~03=7F (-1270uA) Sinking



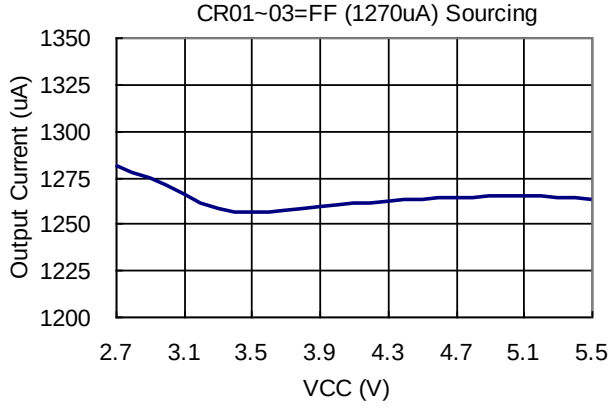
Output Current vs. VCC
CR01~03=7F, CR05=15 (-2540uA) Sinking



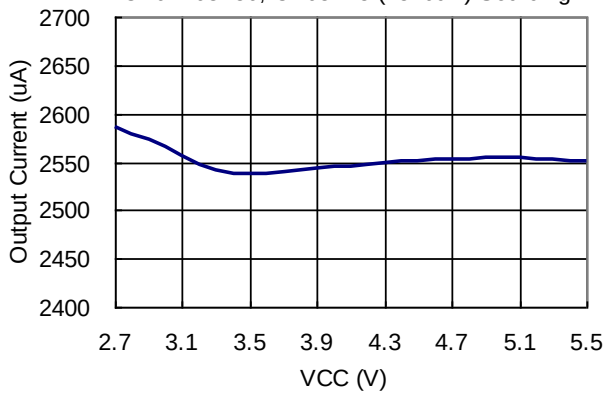
Output Current vs. VCC
CR01~03=BF (630uA) Sourcing



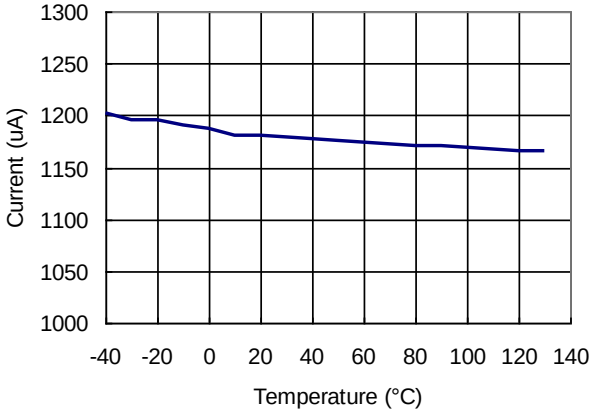
Output Current vs. VCC
CR01~03=FF (1270uA) Sourcing



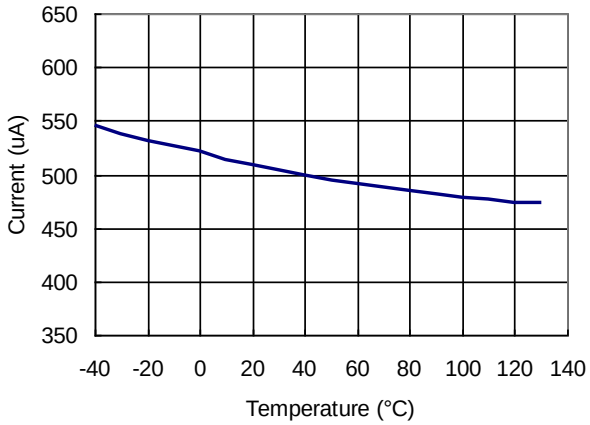
Output Current vs. VCC
CR01~03=50, CR05=15 (2540uA) Sourcing

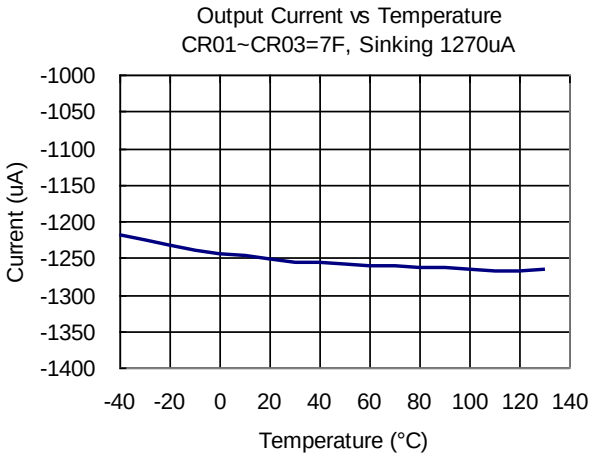


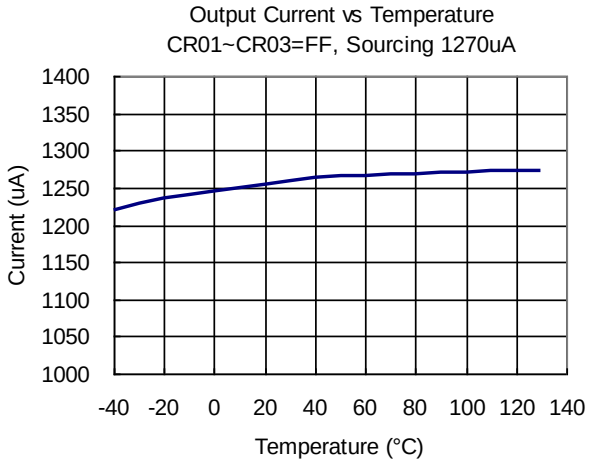
Operating Current vs. Temperature

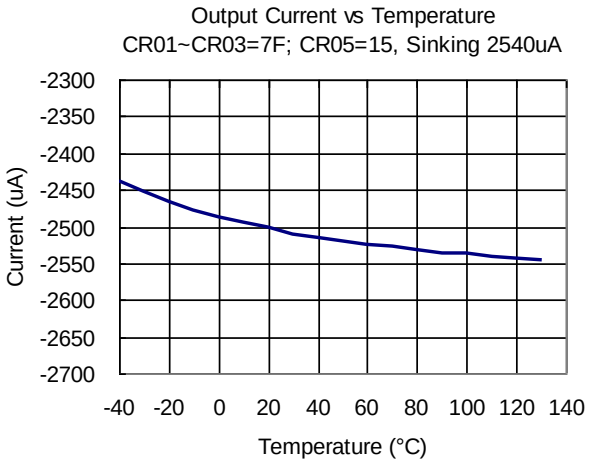


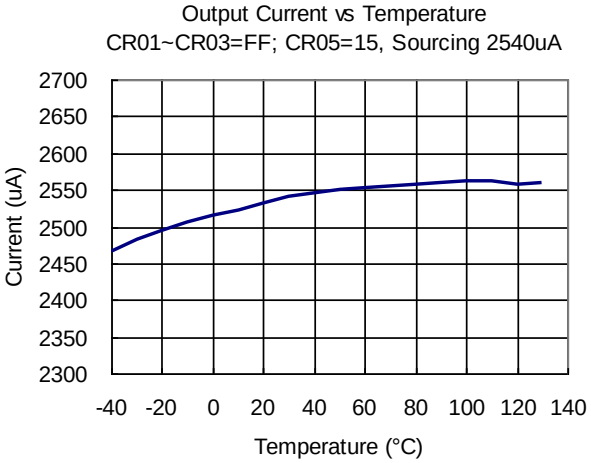
Power Down Current vs. Temperature



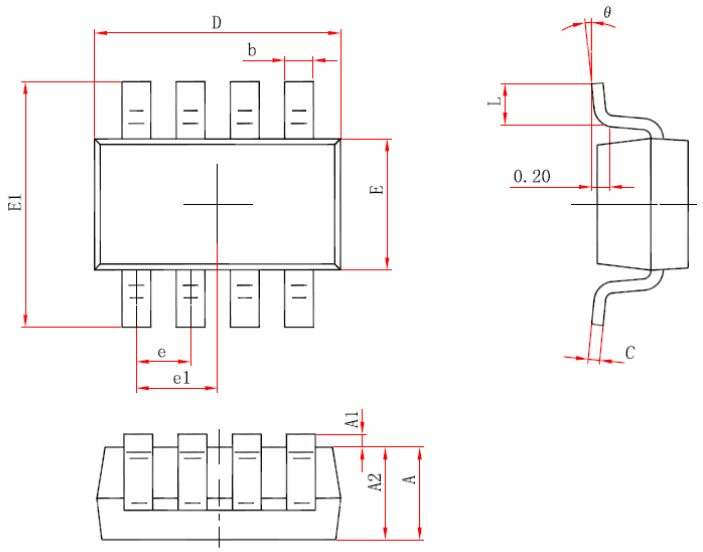

Output Current vs Temperature
CR01~CR03=7F, Sinking 1270uA
Current (uA)
-1000
-1050
-1100
-1150
-1200
-1250
-1300
-1350
-1400
-40 -20 0 20 40 60 80 100 120 140
Temperature (°C)


Output Current vs Temperature
CR01~CR03=FF, Sourcing 1270uA
Current (uA)
1400
1350
1300
1250
1200
1150
1100
1050
1000
-40 -20 0 20 40 60 80 100 120 140
Temperature (°C)


Output Current vs Temperature
CR01~CR03=7F; CR05=15, Sinking 2540uA
Current (uA)
-2300
-2350
-2400
-2450
-2500
-2550
-2600
-2650
-2700
-40 -20 0 20 40 60 80 100 120 140
Temperature (°C)

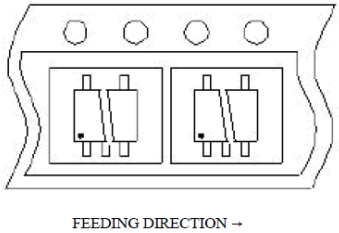

Output Current vs Temperature
CR01~CR03=FF; CR05=15, Sourcing 2540uA
Current (uA)
2700
2650
2600
2550
2500
2450
2400
2350
2300
-40 -20 0 20 40 60 80 100 120 140
Temperature (°C)

11. PACKAGE DIMENSION



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	**Max**	**Min**	**Max**
A	1.050	1.250	0.041	0.049
A1	0.000	0.100	0.000	0.004
A2	1.050	1.150	0.041	0.045
b	0.300	0.500	0.012	0.020
c	0.100	0.200	0.004	0.008
D	2.820	3.020	0.111	0.119
E	1.500	1.700	0.059	0.067
E1	2.650	2.950	0.104	0.116
e	0.65 (BSC)		0.026(BSC)	
e1	0.975 (BSC)		0.038(BSC)	
L	0.300	0.600	0.012	0.024
θ	0°	8°	0°	8°

➢ TAPING SPECIFICATION

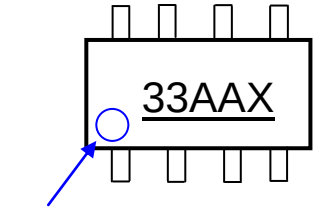


SOT23 -8 Package

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 MAYKING SPECIFICATION



Pin 1 index

1st Line: 33AAX

- 33 : NCT3933U
- AA: Date code (Week)
- 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
A1	2012/06/26	19	Correct taping specification

Important Notice

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