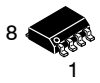
Constant Voltage / Constant Current Secondary-Side Controller

NCS1002



SOIC−8
D SUFFIX
CASE 751

Description

The NCS1002 is a highly integrated solution for Switching Mode Power Supply (SMPS) applications requiring a dual control loop to perform Constant Voltage (CV) and Constant Current (CC) regulation. The NCS1002 integrates a 2.5 V voltage reference and two precision op amps. The voltage reference, along with Op Amp 1, is the core of the voltage control-loop. Op Amp 2 is an independent, uncommitted amplifier specifically designed for the current control. Key external components needed to complete the two control loops are: (a) A resistor divider that senses the output of the power supply (battery charger) and fixes the voltage regulation set point at the specified value. (b) A sense resistor that feeds the current sensing circuit with a voltage proportional to the DC output current. This resistor determines the current regulation set point and must be adequately rated in terms of power dissipation. The NCS1002 comes in a small 8−pin SOIC package and is ideal for space-shrunk applications such as battery chargers.

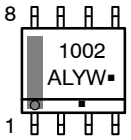
Features

- Low Input Offset Voltage: 0.5 mV, Typ
- Input Common-Mode Range includes Ground
- Low Quiescent Current: 300 μA per Op Amp at V_{CC} = 5 V
- Large Output Voltage Swing
- Wide Power Supply Range: 3 V to 32 V
- High ESD Protection: 2 kV
- These are Pb−Free Devices

Typical Applications

- Battery Chargers
- Switch Mode Power Supplies

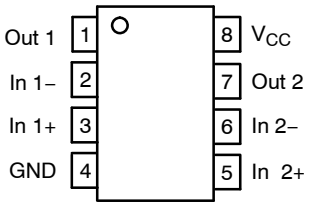
MARKING DIAGRAM



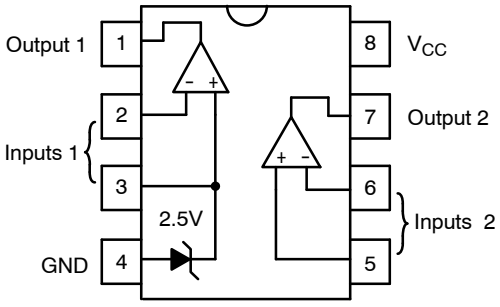
A	= Assembly Location
L	= Wafer Lot
Y	= Year
W	= Work Week
▪	= Pb−Free Package

(Note: Microdot may be in either location)

PIN CONNECTIONS



(Top View)



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit
V_{CC}	Supply Voltage (V_{CC} to GND)	36	V
V_{id}	Differential Input Voltage	36	V
V_i	Input Voltage	−0.3 to +36	V
V_{ESD}	ESD Protection Voltage at Pin Human Body Model	2000	V
T_J	Maximum Junction Temperature	150	°C
T_A	Specification Temperature Range (T_{min} to T_{max})	−40 to +105	°C
T_{oper}	Operating Free−Air Temperature Range	−55 to +125	°C
T_{stg}	Storage Temperature Range	−55 to +150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

THERMAL CHARACTERISTICS

Symbol	Parameter		Rating	Unit
$R_{\theta JA}$	Thermal Resistance	Junction−to−Ambient	175	°C/W

ELECTRICAL CHARACTERISTICS

Symbol	Characteristics	Conditions	Min	Typ	Max	Unit
I_{CC}	Total Supply Current, excluding current in the Voltage Reference V_{CC} = 5 V, no load; −40 ≤ T_A ≤ +105°C			0.3	0.4	mA
I_{CC}	Total Supply Current, excluding Current in the Voltage Reference V_{CC} = 30 V, no load; −40 ≤ T_A ≤ +105°C				0.75	mA

OP AMP 1 (OP AMP WITH NONINVERTING INPUT CONNECTED TO THE INTERNAL V_{ref})
(V_{CC} = 5 V, T_A = 25°C unless otherwise noted)

V_{IO}	Input Offset Voltage	T_A = 25°C			2.0	mV
		−40 ≤ T_A ≤ +105°C			3.0	mV
DV_{IO}	Input Offset Voltage Drift (−40 ≤ T_A ≤ +105°C)			7.0		μV/°C
I_{IB}	Input Bias Current (Inverting Input Only) T_A = 25°C			20		nA
AVD	Large Signal Voltage Gain (V_{CC} = 15 V, R_L = 2 kΩ, V_{ICM} = 0 V)			100		V/mV
PSRR	Power Supply Rejection (V_{CC} = 5.0 V to 30 V, V_{OUT} = 2 V)		80	100		dB
I_{SOURCE}	Output Source Current (V_{CC} = 15 V, V_{OUT} = 2.0 V, V_{id} = 1 V)		20	40		mA
I_O	Short Circuit to GND (V_{CC} = 15 V)			40	60	mA
I_{SINK}	Output Current Sink (V_{id} = −1 V)	V_{CC} = +15 V, V_{OUT} = 0.2 V (Note 1)	1	10		mA
		V_{CC} = +15 V, V_{OUT} = 2 V	10	20		mA
V_{OH}	Output Voltage Swing, High (V_{CC} = 30 V)	R_L = 2 kΩ, T_A = 25°C	26	27		V
		−40 ≤ T_A ≤ +105°C	26			
		R_L = 10 kΩ, T_A = 25°C	27	28		
		−40 ≤ T_A ≤ +105°C	27			
V_{OL}	Output Voltage Swing, Low	R_L = 10 kΩ, T_A = 25°C		5.0	50	mV
		−40 ≤ T_A ≤ +105°C			50	
SR	Slew Rate (AV = +1, V_i = 0.5 V to 2 V, V_{CC} = 15 V, R_L = 2 kΩ, C_L = 100 pF)		0.2	0.4		V/μs
GBP	Gain Bandwidth Product (V_{CC} = 30 V, AV = +1, (Note 1) R_L = 2 kΩ, C_L = 100 pF, f = 100 kHz, V_{IN} = 10 mV_{PP})		0.5	0.9		MHz
THD	Total Harmonic Distortion (f = 1 kHz, AV = 10, R_L = 2 kΩ, V_{CC} = 30 V, V_{OUT} = 2 V_{PP})			0.08		%

OP AMP 2 (INDEPENDENT OP AMP) (V_{CC} = 5.0 V, T_A = 25°C unless otherwise noted)

V_{IO}	Input Offset Voltage	T_A = 25°C		0.5	2.0	mV
		−40 ≤ T_A ≤ +105°C			3.0	
DV_{IO}	Input Offset Voltage Drift (−40 ≤ T_A ≤ +105°C)			7.0		μV/°C
I_{IO}	Input Offset Current	T_A = 25°C		2.0	75	nA
		−40 ≤ T_A ≤ +105°C			150	
I_B	Input Bias Current	T_A = 25°C		20	150	nA
		−40 ≤ T_A ≤ +105°C			200	

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. Guaranteed by design and/or characterization.
2. The input common−mode voltage of either input signal should not be allowed to go negative by more than 0.3 V. The upper end of the common−mode range is V_{CC} − 1.5 V. Both inputs can go to V_{CC} + 0.3 V without damage.
3. The Dynamic Impedance is defined as I ZKA I = ΔV_{KA} / ΔI_K.
4. Guaranteed by design and/or characterization.

ELECTRICAL CHARACTERISTICS (continued)

Symbol	Characteristics	Conditions	Min	Typ	Max	Unit
OP AMP 2 (INDEPENDENT OP AMP) (continued) (V_{CC} = 5.0 V, T_A = 25°C unless otherwise noted)						
AVD	Large Signal Voltage Gain (V_{CC} = 15 V, R_L = 2 kΩ, V_{OUT} = 1.4 V to 11.4 V)	T_A = 25°C	50	100		V/mV
		−40 ≤ T_A ≤ +105°C	25			
PSRR	Power Supply Rejection (V_{CC} = 5 V to 30 V)		65	100		dB
V_{ICM}	Input Common Mode Voltage Range (Note 2) (V_{CC} = +30 V)	T_A = 25°C	0		V_{CC} − 1.5	V
		−40 ≤ T_A ≤ +105°C	0		V_{CC} − 2.0	
CMRR	Common Mode Rejection Ratio (Note 4)	0 to V_{CC} − 1.7 V, T_A = 25°C	70	85		dB
		0 to V_{CC} − 2.2 V −40 ≤ T_A ≤ +105°C	60			
I_{SOURCE}	Output Current Source (V_{CC} = 15 V, V_{OUT} = 2 V, V_{ID} = +1 V)		20	40		mA
I_O	Short−Circuit to GND (V_{CC} = 15 V)			40	60	mA
I_{SINK}	Output Current Sink (V_{ID} = −1 V)	V_{CC} = +15 V, V_{OUT} = 0.2 V	1	10		mA
		V_{CC} = +15 V, V_{OUT} = 2 V	10	20		mA
V_{OH}	Output Voltage Swing, High (V_{CC} = 30 V)	R_L = 2 kΩ, T_A = 25°C	26	27		V
		−40 ≤ T_A ≤ +105°C	26			
		R_L = 10 kΩ, T_A = 25°C	27	28		
		−40 ≤ T_A ≤ +105°C	27			
V_{OL}	Output Voltage Swing, Low	R_L = 10 kΩ, T_A = 25°C		5.0	50	mV
		−40 ≤ T_A ≤ +105°C			50	
SR	Slew Rate (AV = +1, V_i = 0.5 V to 3 V, V_{CC} = 15 V, R_L = 2 kΩ, C_L = 100 pF)		0.2	0.4		V/μs
GBP	Gain Bandwidth Product (V_{CC} = 30 V, AV = +1, R_L = 2 kΩ, C_L = 100 pF, f = 100 kHz, V_{IN} = 10 mV_{PP}) (Note 4)		0.5	0.9		MHz
THD	Total Harmonic Distortion (f = 1 kHz, AV = 10, R_L = 2 kΩ, V_{CC} = 30 V, V_{OUT} = 2 V_{PP})			0.08		%
e_{noise}	Equivalent Input Noise Voltage (f = 1 kHz, R_S = 100 Ω, V_{CC} = 30 V)			50		nV/√Hz
VOLTAGE REFERENCE (continued) (V_{CC} = 5.0 V, T_A = 25°C unless otherwise noted)						
I_K	Cathode Current		0.075		100	mA
V_{ref}	Reference Voltage (I_K = 1 mA)	T_A = 25°C	2.49	2.5	2.51	V
		−40 ≤ T_A ≤ +105°C	2.48	2.5	2.52	
ΔV_{ref}	Reference Deviation over Temperature (V_{KA} = V_{ref}, I_K = 10 mA, −40 ≤ T_A ≤ +105°C) (Note 4)			7.0	30	mV
I_{min}	Minimum Cathode Current for Regulation (2.4875 V_f ≤ V_{KA} ≤ 2.5125 V_f)			40	75	μA
I ZKA I	Dynamic Impedance (Note 3) (V_{KA} = V_{ref}, I_K = 1 mA to 100 mA, f < 1 kHz)			0.2	0.5	Ω

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

1. Guaranteed by design and/or characterization.
2. The input common−mode voltage of either input signal should not be allowed to go negative by more than 0.3 V. The upper end of the common−mode range is V_{CC} − 1.5 V. Both inputs can go to V_{CC} + 0.3 V without damage.
3. The Dynamic Impedance is defined as I ZKA I = ΔV_{KA} / ΔI_K.
4. Guaranteed by design and/or characterization.

TYPICAL CHARACTERISTICS

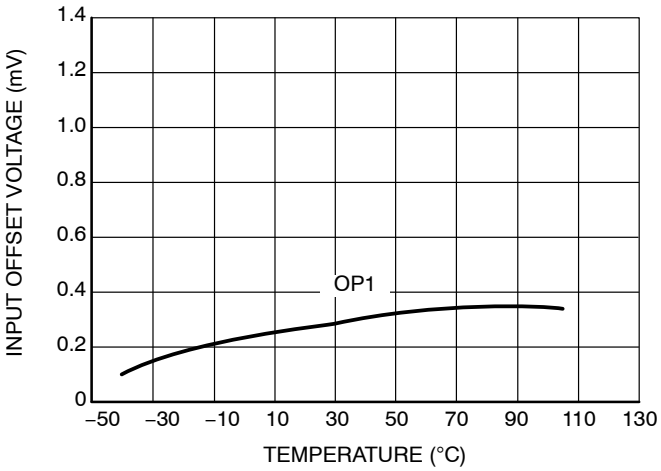


Figure 1. Input Offset Voltage vs. Temperature

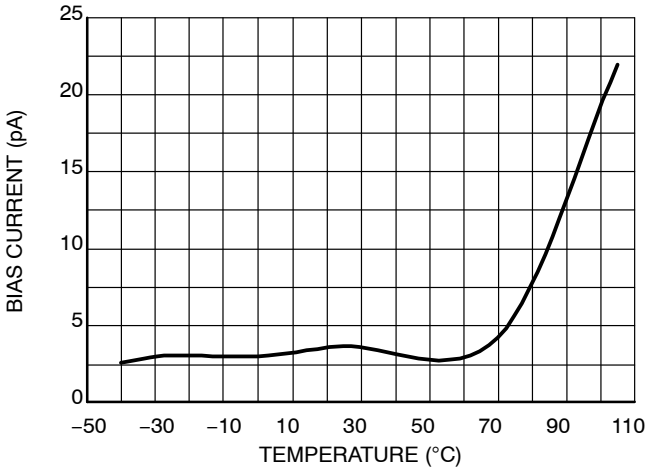


Figure 2. IB vs. Temperature

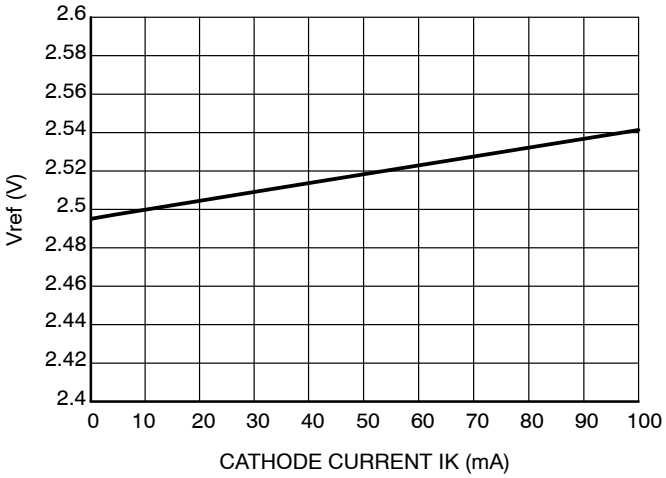


Figure 3. Vref as a Function of IK

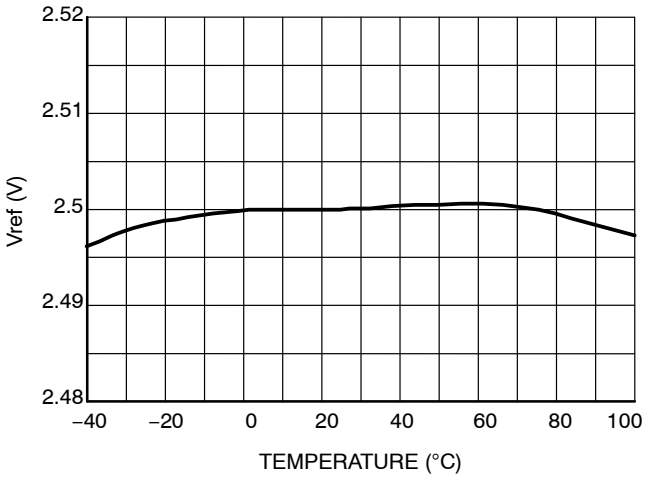


Figure 4. Vref Over Temperature

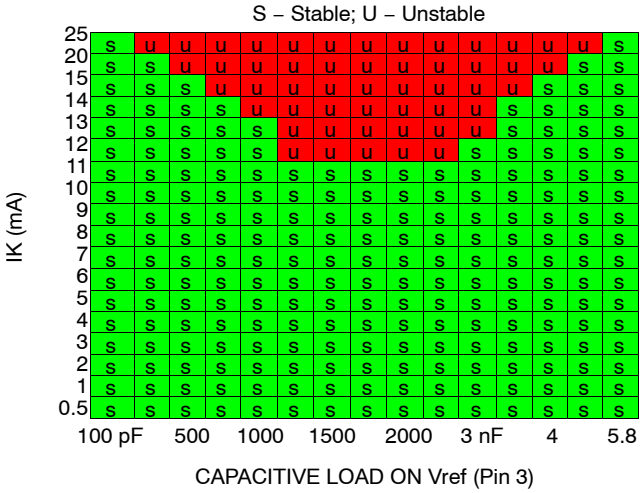


Figure 5. Region of Reference Stability vs. Capacitive Load (Pin 3)

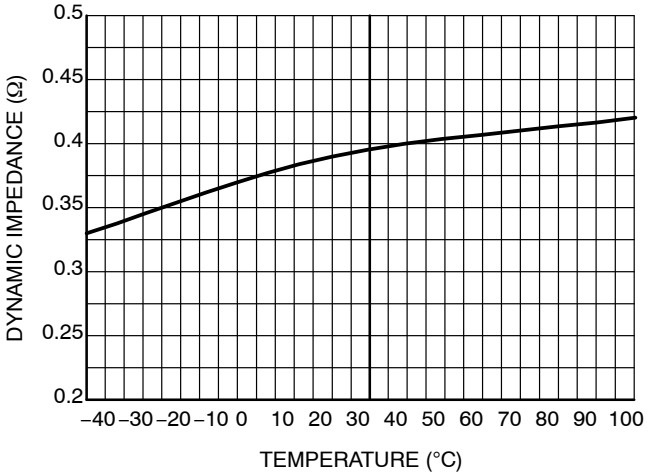


Figure 6. Ref Dynamic Impedance vs. Temperature

TYPICAL CHARACTERISTICS

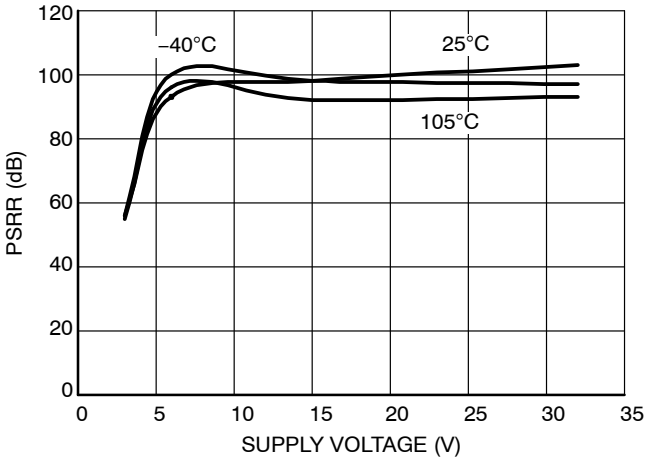


Figure 7. NCS1002 PSRR vs. Supply Voltage

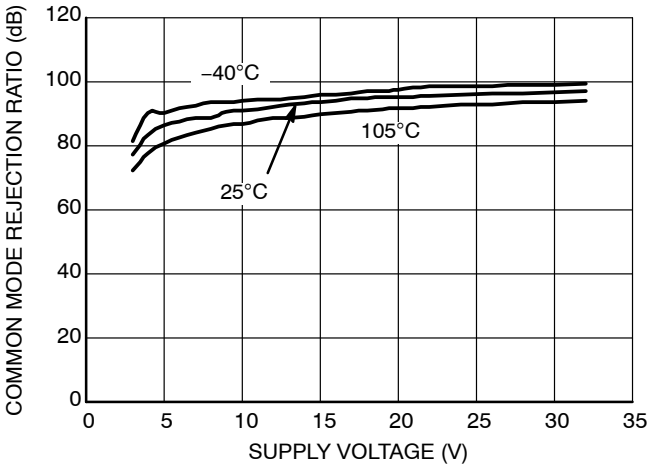


Figure 8. NCS1002 CMRR vs. Supply Voltage

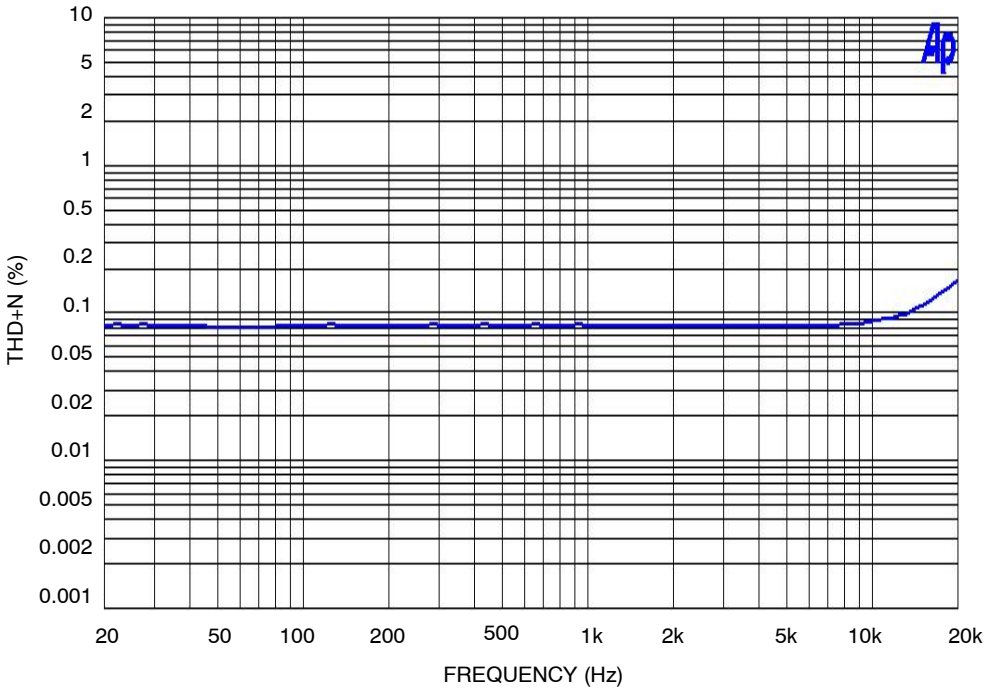


Figure 9. THD+N

ORDERING INFORMATION

Device	Package	Shipping†
NCS1002DR2G	SOIC−8 (Pb−Free)	2,500 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

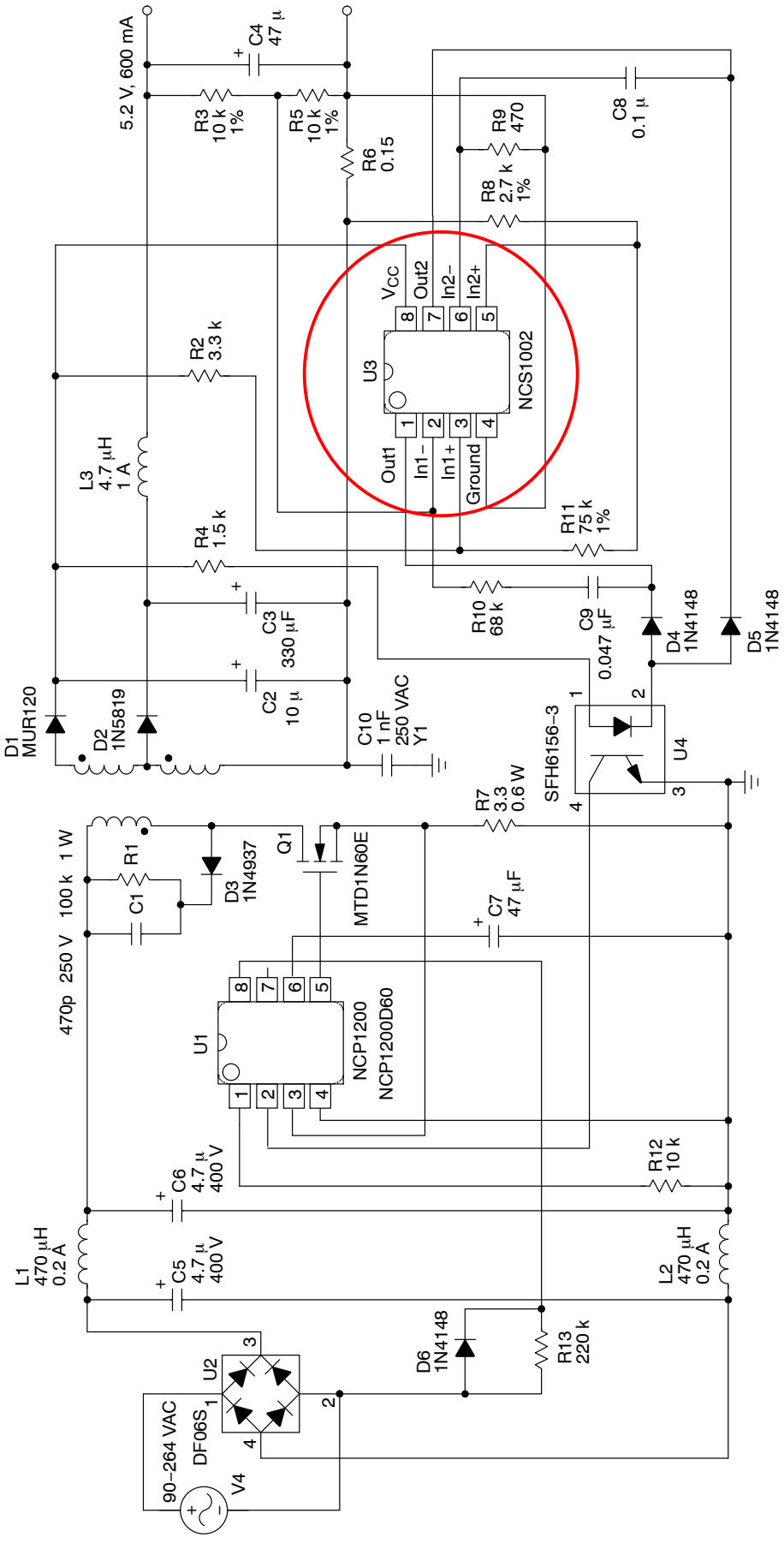
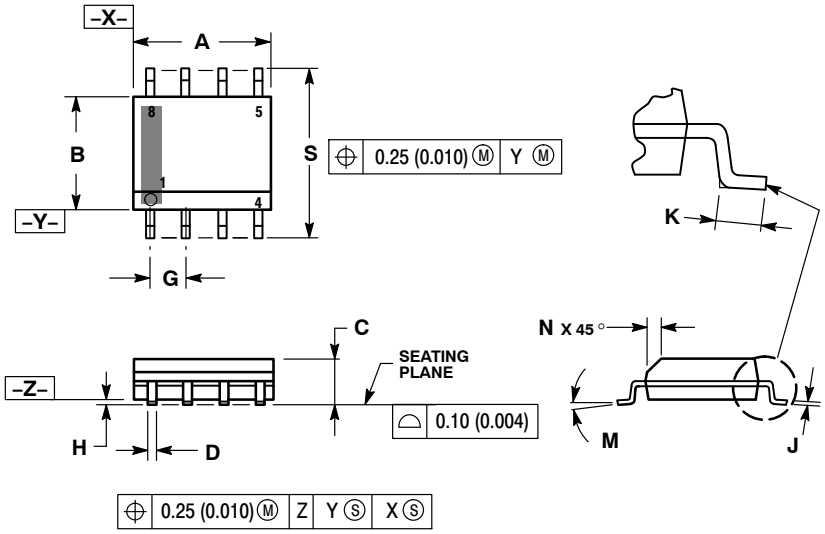


Figure 1. AC Adapter Application

SCALE 1:1

SOIC−8 NB
CASE 751−07
ISSUE AK

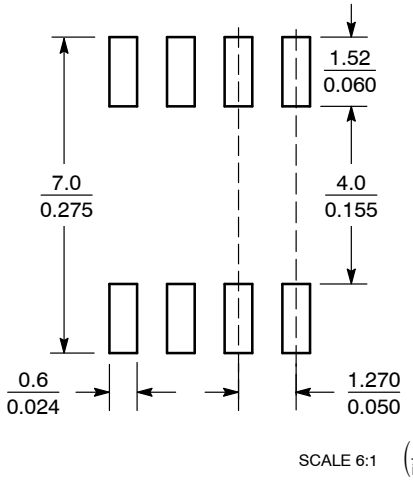
DATE 16 FEB 2011



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0°	8°	0°	8°
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

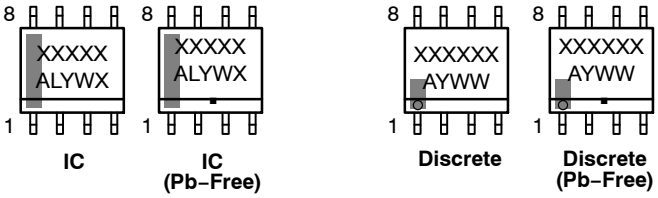
SOLDERING FOOTPRINT*



SCALE 6:1 (mm / inches)

*For additional information on our Pb−Free strategy and soldering details, please download the **onsemi** Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

GENERIC MARKING DIAGRAM*



XXXXX = Specific Device Code
A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package

XXXXXX = Specific Device Code
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb−Free Package

*This information is generic. Please refer to device data sheet for actual part marking. Pb−Free indicator, "G" or microdot "▪", may or may not be present. Some products may not follow the Generic Marking.

STYLES ON PAGE 2

DOCUMENT NUMBER:	**98ASB42564B**	Electronic versions are uncontrolled except when accessed directly from the Document Repository. Printed versions are uncontrolled except when stamped "CONTROLLED COPY" in red.	
DESCRIPTION:	**SOIC−8 NB**		**PAGE 1 OF 2**

SOIC−8 NB
CASE 751−07
ISSUE AK

DATE 16 FEB 2011

STYLE 1:
PIN 1. EMITTER
2. COLLECTOR
3. COLLECTOR
4. EMITTER
5. EMITTER
6. BASE
7. BASE
8. EMITTER

STYLE 2:
PIN 1. COLLECTOR, DIE, #1
2. COLLECTOR, #1
3. COLLECTOR, #2
4. COLLECTOR, #2
5. BASE, #2
6. EMITTER, #2
7. BASE, #1
8. EMITTER, #1

STYLE 3:
PIN 1. DRAIN, DIE #1
2. DRAIN, #1
3. DRAIN, #2
4. DRAIN, #2
5. GATE, #2
6. SOURCE, #2
7. GATE, #1
8. SOURCE, #1

STYLE 4:
PIN 1. ANODE
2. ANODE
3. ANODE
4. ANODE
5. ANODE
6. ANODE
7. ANODE
8. COMMON CATHODE

STYLE 5:
PIN 1. DRAIN
2. DRAIN
3. DRAIN
4. DRAIN
5. GATE
6. GATE
7. SOURCE
8. SOURCE

STYLE 6:
PIN 1. SOURCE
2. DRAIN
3. DRAIN
4. SOURCE
5. SOURCE
6. GATE
7. GATE
8. SOURCE

STYLE 7:
PIN 1. INPUT
2. EXTERNAL BYPASS
3. THIRD STAGE SOURCE
4. GROUND
5. DRAIN
6. GATE 3
7. SECOND STAGE Vd
8. FIRST STAGE Vd

STYLE 8:
PIN 1. COLLECTOR, DIE #1
2. BASE, #1
3. BASE, #2
4. COLLECTOR, #2
5. COLLECTOR, #2
6. EMITTER, #2
7. EMITTER, #1
8. COLLECTOR, #1

STYLE 9:
PIN 1. EMITTER, COMMON
2. COLLECTOR, DIE #1
3. COLLECTOR, DIE #2
4. EMITTER, COMMON
5. EMITTER, COMMON
6. BASE, DIE #2
7. BASE, DIE #1
8. EMITTER, COMMON

STYLE 10:
PIN 1. GROUND
2. BIAS 1
3. OUTPUT
4. GROUND
5. GROUND
6. BIAS 2
7. INPUT
8. GROUND

STYLE 11:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. DRAIN 2
7. DRAIN 1
8. DRAIN 1

STYLE 12:
PIN 1. SOURCE
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 13:
PIN 1. N.C.
2. SOURCE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 14:
PIN 1. N−SOURCE
2. N−GATE
3. P−SOURCE
4. P−GATE
5. P−DRAIN
6. P−DRAIN
7. N−DRAIN
8. N−DRAIN

STYLE 15:
PIN 1. ANODE 1
2. ANODE 1
3. ANODE 1
4. ANODE 1
5. CATHODE, COMMON
6. CATHODE, COMMON
7. CATHODE, COMMON
8. CATHODE, COMMON

STYLE 16:
PIN 1. EMITTER, DIE #1
2. BASE, DIE #1
3. EMITTER, DIE #2
4. BASE, DIE #2
5. COLLECTOR, DIE #2
6. COLLECTOR, DIE #2
7. COLLECTOR, DIE #1
8. COLLECTOR, DIE #1

STYLE 17:
PIN 1. VCC
2. V2OUT
3. V1OUT
4. TXE
5. RXE
6. VEE
7. GND
8. ACC

STYLE 18:
PIN 1. ANODE
2. ANODE
3. SOURCE
4. GATE
5. DRAIN
6. DRAIN
7. CATHODE
8. CATHODE

STYLE 19:
PIN 1. SOURCE 1
2. GATE 1
3. SOURCE 2
4. GATE 2
5. DRAIN 2
6. MIRROR 2
7. DRAIN 1
8. MIRROR 1

STYLE 20:
PIN 1. SOURCE (N)
2. GATE (N)
3. SOURCE (P)
4. GATE (P)
5. DRAIN
6. DRAIN
7. DRAIN
8. DRAIN

STYLE 21:
PIN 1. CATHODE 1
2. CATHODE 2
3. CATHODE 3
4. CATHODE 4
5. CATHODE 5
6. COMMON ANODE
7. COMMON ANODE
8. CATHODE 6

STYLE 22:
PIN 1. I/O LINE 1
2. COMMON CATHODE/VCC
3. COMMON CATHODE/VCC
4. I/O LINE 3
5. COMMON ANODE/GND
6. I/O LINE 4
7. I/O LINE 5
8. COMMON ANODE/GND

STYLE 23:
PIN 1. LINE 1 IN
2. COMMON ANODE/GND
3. COMMON ANODE/GND
4. LINE 2 IN
5. LINE 2 OUT
6. COMMON ANODE/GND
7. COMMON ANODE/GND
8. LINE 1 OUT

STYLE 24:
PIN 1. BASE
2. EMITTER
3. COLLECTOR/ANODE
4. COLLECTOR/ANODE
5. CATHODE
6. CATHODE
7. COLLECTOR/ANODE
8. COLLECTOR/ANODE

STYLE 25:
PIN 1. VIN
2. N/C
3. REXT
4. GND
5. IOUT
6. IOUT
7. IOUT
8. IOUT

STYLE 26:
PIN 1. GND
2. dv/dt
3. ENABLE
4. ILIMIT
5. SOURCE
6. SOURCE
7. SOURCE
8. VCC

STYLE 27:
PIN 1. ILIMIT
2. OVLO
3. UVLO
4. INPUT+
5. SOURCE
6. SOURCE
7. SOURCE
8. DRAIN

STYLE 28:
PIN 1. SW_TO_GND
2. DASIC_OFF
3. DASIC_SW_DET
4. GND
5. V_MON
6. VBULK
7. VBULK
8. VIN

STYLE 29:
PIN 1. BASE, DIE #1
2. EMITTER, #1
3. BASE, #2
4. EMITTER, #2
5. COLLECTOR, #2
6. COLLECTOR, #2
7. COLLECTOR, #1
8. COLLECTOR, #1

STYLE 30:
PIN 1. DRAIN 1
2. DRAIN 1
3. GATE 2
4. SOURCE 2
5. SOURCE 1/DRAIN 2
6. SOURCE 1/DRAIN 2
7. SOURCE 1/DRAIN 2
8. GATE 1

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