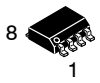
# Constant Voltage / Constant Current Secondary-Side Controller

# NCS1002A




**SOIC-8**
**D SUFFIX**
**CASE 751**

## Description

The NCS1002A is a performance upgrade from the NCS1002 focused on reducing power consumption in applications that require more efficient operation. It 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 NCS1002A 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 NCS1002A comes in a small 8-pin SOIC package and is ideal for space-shrunk applications such as battery chargers.

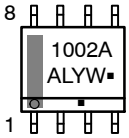
## Features

- Low Input Offset Voltage: 0.5 mV, Typ
- Input Common-Mode Range includes Ground
- Low Quiescent Current: 75 μA per Op Amp at $V_{CC}$ = 5 V
- Large Output Voltage Swing
- Wide Power Supply Range: 3 V to 36 V
- High ESD Protection: 2 kV
- This is a Pb-Free Device

## Typical Applications

- Battery Chargers
- Switch Mode Power Supplies

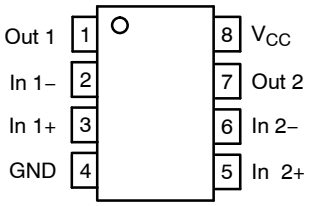
## MARKING DIAGRAM



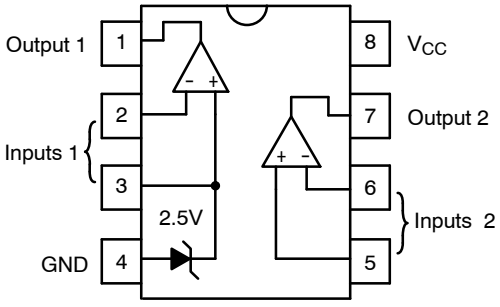

| | |
|---|---|
| A | = Assembly Location |
| L | = Wafer Lot |
| Y | = Year |
| W | = Work Week |
| ▪ | = Pb-Free Package |

(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 8 of this data sheet.

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## MAXIMUM RATINGS

| Symbol | Parameter | Rating | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply Voltage ($V_{CC}$ to GND) (Operating Range $V_{CC}$ = 3 V to 36 V) | 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 | −65 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 |



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## 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 | | – | 0.15 | 0.25 | mA |
| $I_{CC}$ | Total Supply Current, excluding Current in the Voltage Reference $V_{CC}$ = 30 V, no load; −40 ≤ $T_A$ ≤ +105 °C | | – | 0.2 | 0.3 | 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) | | – | 20 | 150 | 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 |
| 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 | |
| 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) | | 80 | 100 | – | dB |

1. Guaranteed by design and/or characterization.


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**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) | | | | | | |
| $V_{ICM}$ | 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 |
| 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** ($V_{CC}$ = 5.0 V, $T_A$ = 25 °C unless otherwise noted) | | | | | | |
| $I_K$ | Cathode Current | | 0.05 | | 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 | |
| $\Delta V_{ref}$ | 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 $V_f$) | | – | 10 | 50 | 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 |

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 = $\Delta V_{KA} / \Delta I_K$.
4. Guaranteed by design and/or characterization.



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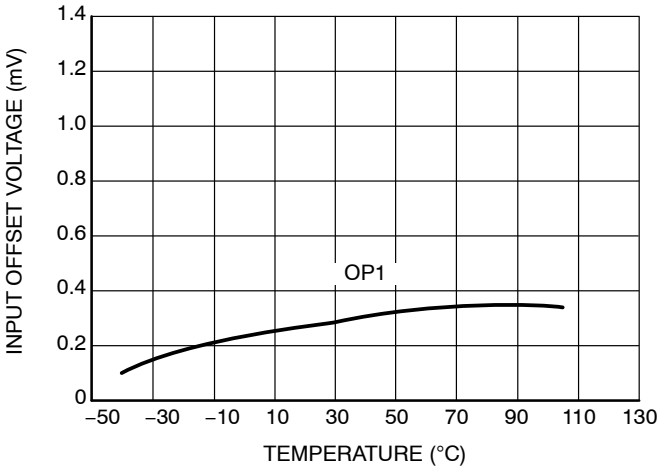


**Figure 1. Input Offset Voltage vs. Temperature**

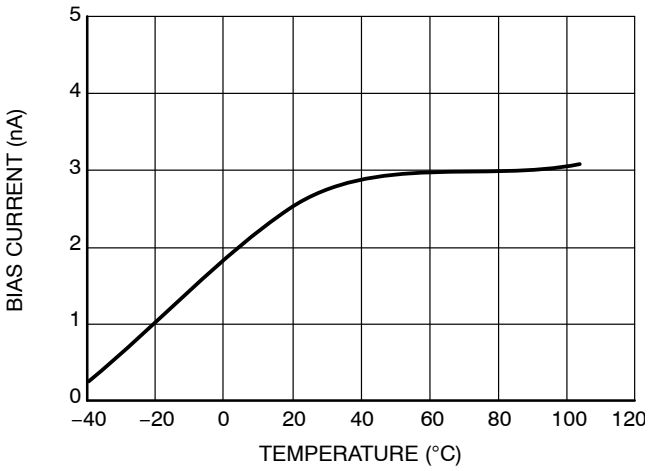


**Figure 2. IB vs. Temperature**

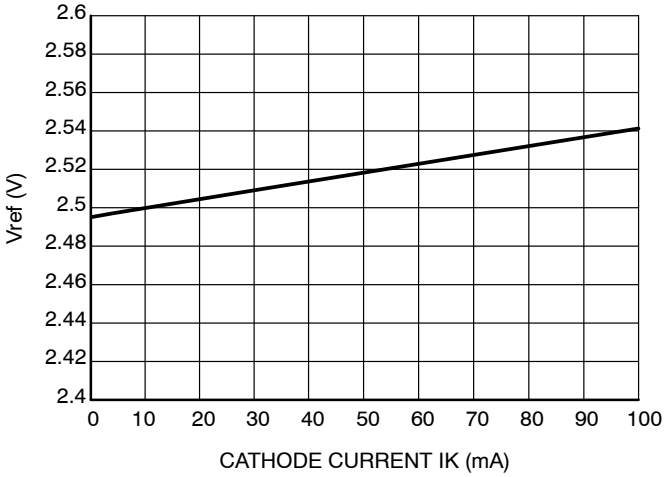


**Figure 3. Vref as a Function of IK**

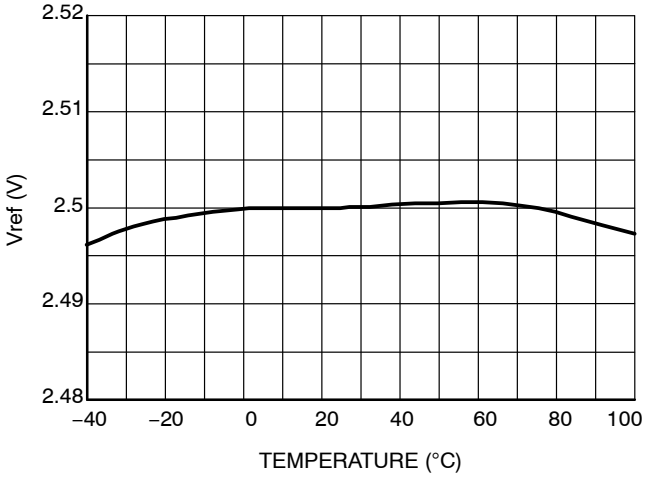


**Figure 4. Vref Over Temperature**

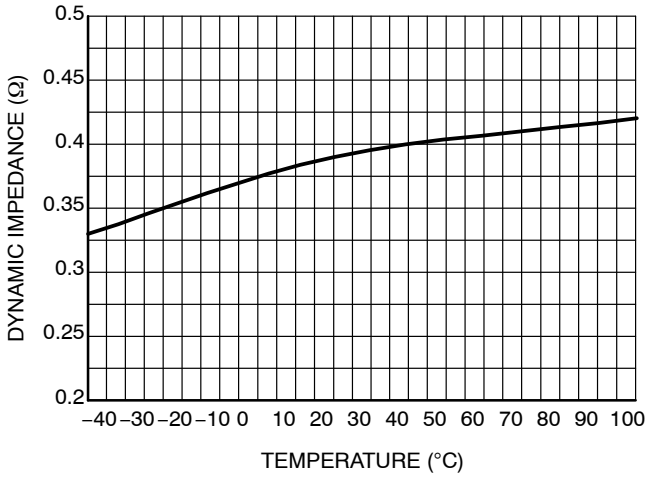


**Figure 5. Ref Dynamic Impedance vs. Temperature**



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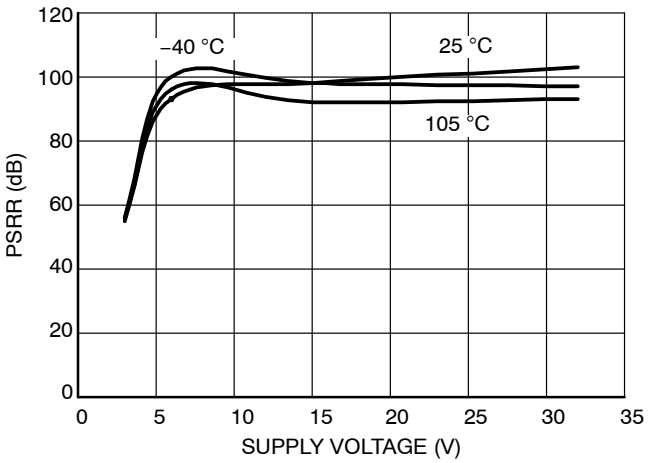


**Figure 6. NCS1002A PSRR vs. Supply Voltage**

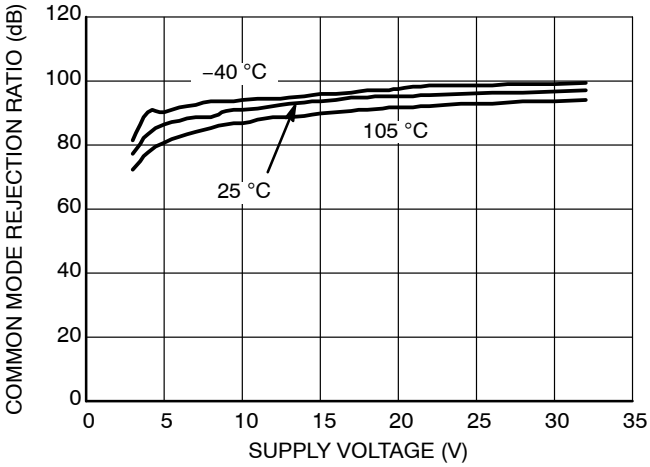


**Figure 7. NCS1002A CMRR vs. Supply Voltage**

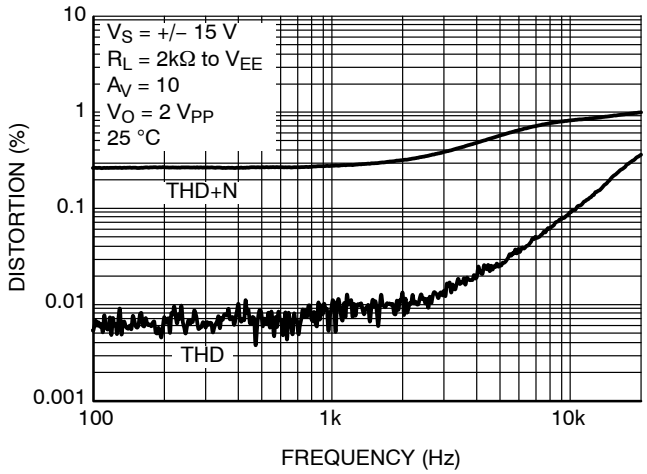


**Figure 8. Distortion vs. Frequency**

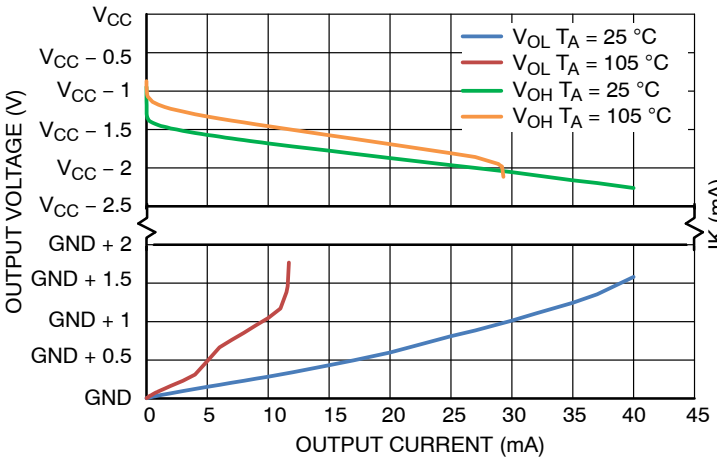


**Figure 9. Output Voltage Swing vs. Output Current**
**$V_{id}$ = 1 V, $V_{CM}$ = 0 V, $V_{CC}$ = 3 V to 36 V**

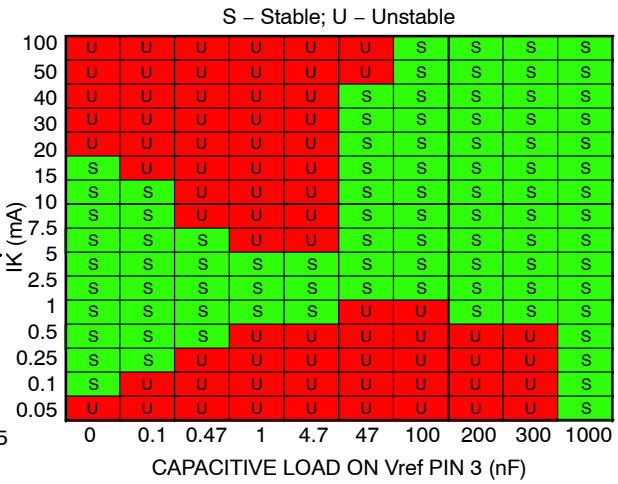


**Figure 10. Region of Reference Stability vs. Capacitive Load (Pin 3)**



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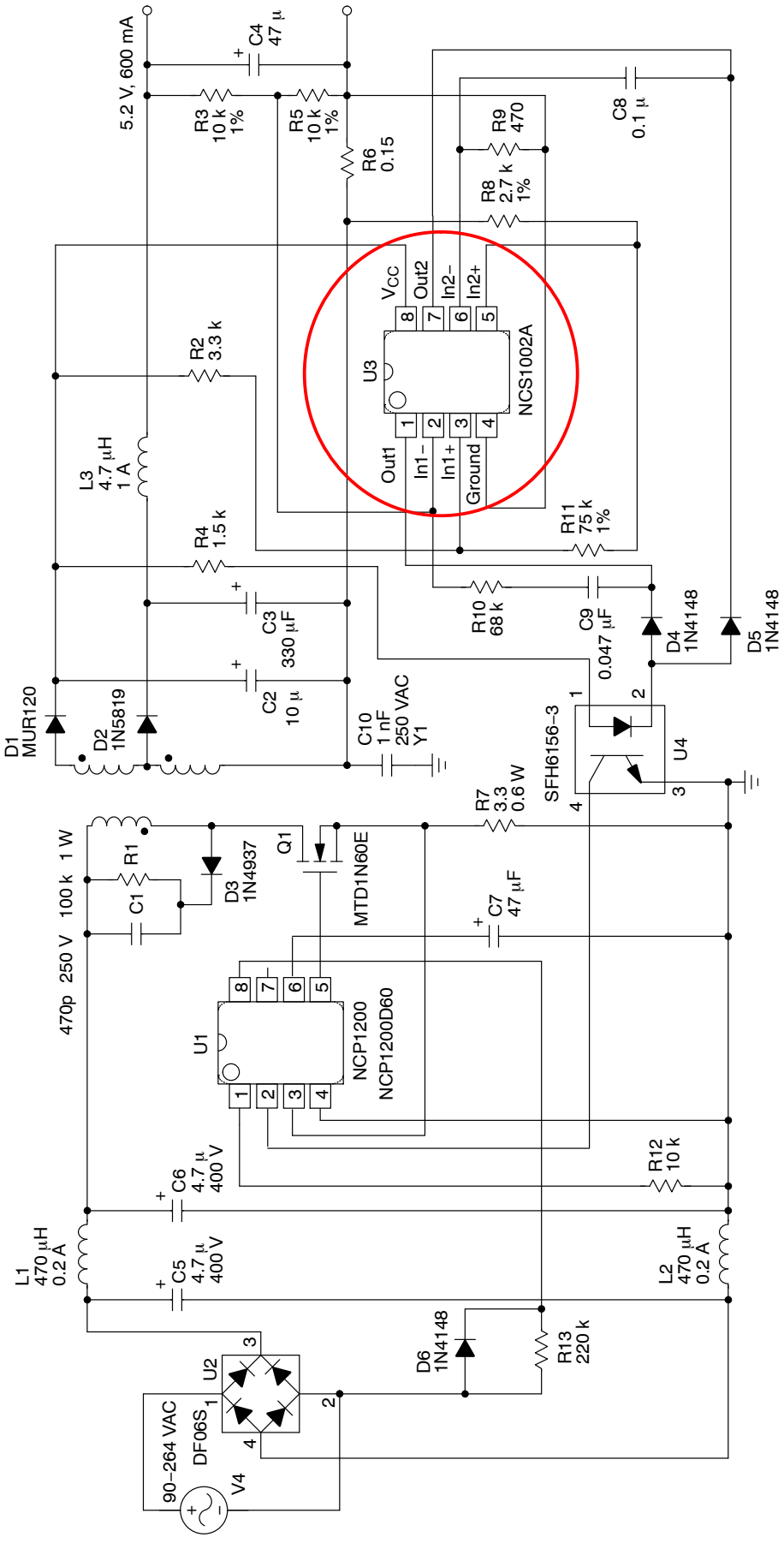


**Figure 1. AC Adapter Application**



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## ORDERING INFORMATION

| Device | Package | Shipping† |
|---|---|---|
| NCS1002ADR2G | SOIC-8<br>(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.



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## REVISION HISTORY

| Revision | Description of Changes | Date |
|---|---|---|
| 7 | Rebranded the Data Sheet to **onsemi** format. | 01/13/2026 |

This document has undergone updates prior to the inclusion of this revision history table. The changes tracked here only reflect updates made on the noted approval dates.



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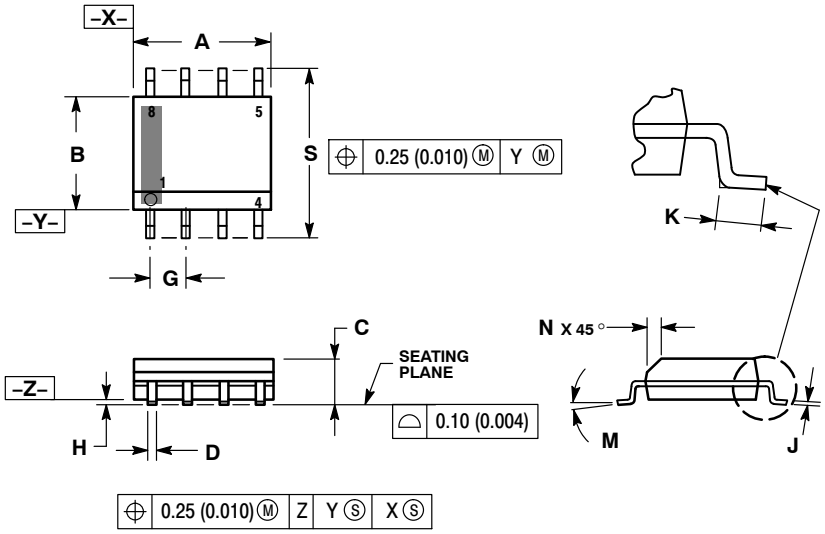
SCALE 1:1

**SOIC−8 NB**
CASE 751−07
ISSUE AK

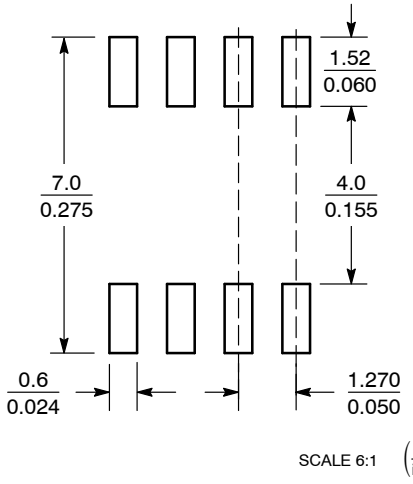
DATE 16 FEB 2011




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.

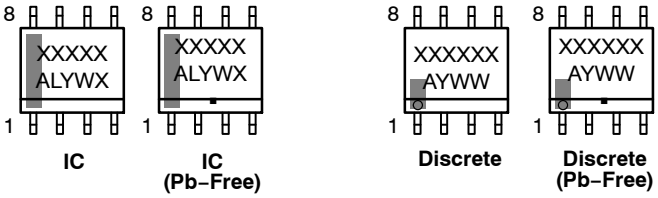
| | MILLIMETERS | | INCHES | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 4.80 | 5.00 | 0.189 | 0.197 |
| B | 3.80 | 4.00 | 0.150 | 0.157 |
| C | 1.35 | 1.75 | 0.053 | 0.069 |
| D | 0.33 | 0.51 | 0.013 | 0.020 |
| G | 1.27 BSC | | 0.050 BSC | |
| H | 0.10 | 0.25 | 0.004 | 0.010 |
| J | 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*




*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** |

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**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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