# N57M5114

# 32-tap Digital Potentiometer (POT)

### Description

The N57M5114 is a single digital POT designed as an electronic replacement for mechanical potentiometers and trim pots. Ideal for automated adjustments on high volume production lines, they are also well suited for applications where equipment requiring periodic adjustment is either difficult to access or located in a hazardous or remote environment.

The N57M5114 contains a 32-tap series resistor array connected between two terminals $R_H$ and $R_L$. An up/down counter and decoder that are controlled by three input pins, determines which tap is connected to the wiper, $R_W$. The wiper setting, stored in nonvolatile memory, is not lost when the device is powered down and is automatically reinstated when power is returned. The wiper can be adjusted to test new system values without affecting the stored setting. Wiper-control of the N57M5114 is accomplished with three input control pins, $\overline{CS}$, U/$\overline{D}$, and $\overline{INC}$. The $\overline{INC}$ input increments the wiper in the direction which is determined by the logic state of the U/$\overline{D}$ input. The $\overline{CS}$ input is used to select the device and also store the wiper position prior to power down.

The digital POT can be used as a three-terminal resistive divider or as a two-terminal variable resistor. Digital POTs bring variability and programmability to a wide variety of applications including control, parameter adjustments, and signal processing.

### Features

- 32-position Linear Taper Potentiometer
- Non-volatile EEPROM Wiper Storage
- Low Standby Current
- Single Supply Operation: 2.5 V − 6.0 V
- Increment Up/Down Serial Interface
- Resistance Values: 10 kΩ, 50 kΩ and 100 kΩ
- Available in SOIC, TSSOP, MSOP and Space Saving $2 \times 3$ mm TDFN Packages
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant

### Applications

- Automated Product Calibration
- Remote Control Adjustments
- Offset, Gain and Zero Control
- Tamper-proof Calibrations
- Contrast, Brightness and Volume Controls
- Motor Controls and Feedback Systems
- Programmable Analog Functions

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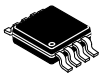
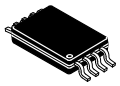
**SOIC−8**
**V SUFFIX**
**CASE 751BD**



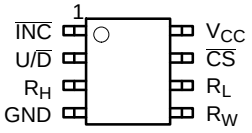
**MSOP−8**
**Z SUFFIX**
**CASE 846AD**



**TSSOP−8**
**Y SUFFIX**
**CASE 948AL**

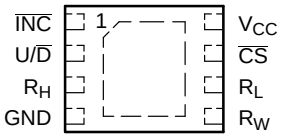
**TDFN−8**
**VP2 SUFFIX**
**CASE 511AK**

### PIN CONFIGURATIONS




SOIC (V), MSOP (Z)

TSSOP (Y)




TDFN (VP2)

(Top Views)

### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

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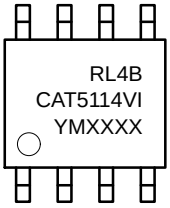
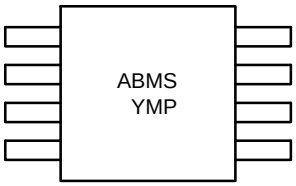
## DEVICE MARKING INFORMATION

**SOIC**




R = Resistance
2 = 10 kΩ
4 = 50 kΩ
5 = 100 kΩ
L = Assembly Location
4 = Lead Finish − NiPdAu
I = Industrial Temp Range
Y = Production Year (Last Digit)
M = Production Month (1−9, O, N, D)
XXXX = Last Four Digits of Assembly Lot Number

**MSOP**




ABMS = 10 kΩ
ABMT = 50 kΩ
ABTH = 100 kΩ
Y = Production Year (Last Digit)
M = Production Month (1−9, O, N, D)
P = Product Revision

**TSSOP**

A4 = Device Code
R = Resistance
2 = 10 kΩ
4 = 50 kΩ
5 = 100 kΩ
L = Assembly Location
4 = Lead Finish − NiPdAu
Y = Production Year (last digit)
M = Production Month (1−9, O, N, D)
XXX = Last Three Digits of Assembly Lot Number

**TDFN**

EF = 10 kΩ
HF = 50 kΩ
GW = 100 kΩ
XXX = Last Three Digits of Assembly Lot Number
Y = Production Year (Last Digit)
M = Production Month (1−9, O, N, D)

## Functional Diagram

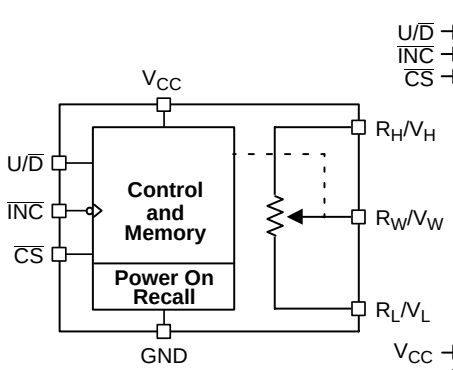



**Figure 1. General**

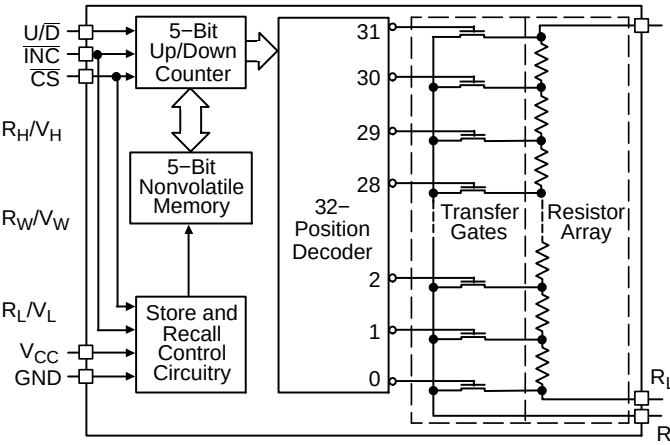



**Figure 2. Detailed**

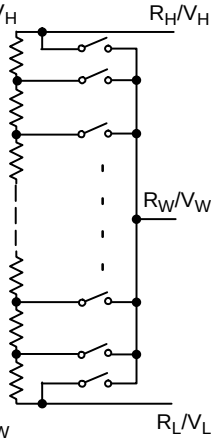



**Figure 3. Electronic Potentiometer Implementation**

**Table 1. PIN DESCRIPTIONS**

| Name | Function |
|---|---|
| $\overline{INC}$ | Increment Control |
| U/$\overline{D}$ | Up/Down Control |
| $R_H$ | Potentiometer High Terminal |
| GND | Ground |
| $R_W$ | Wiper Terminal |
| $R_L$ | Potentiometer Low Terminal |
| $\overline{CS}$ | Chip Select |
| $V_{CC}$ | Supply Voltage |

## Pin Function

**$\overline{INC}$:** Increment Control Input

The $\overline{INC}$ input moves the wiper in the up or down direction determined by the condition of the U/$\overline{D}$ input.

**U/$\overline{D}$:** Up/Down Control Input

The U/$\overline{D}$ input controls the direction of the wiper movement. When in a high state and $\overline{CS}$ is low, any high-to-low transition on $\overline{INC}$ will cause the wiper to move one increment toward the $R_H$ terminal. When in a low state and $\overline{CS}$ is low, any high-to-low transition on $\overline{INC}$ will cause the wiper to move one increment towards the $R_L$ terminal.

**$R_H$:** High End Potentiometer Terminal

$R_H$ is the high end terminal of the potentiometer. It is not required that this terminal be connected to a potential greater than the $R_L$ terminal. Voltage applied to the $R_H$ terminal cannot exceed the supply voltage, $V_{CC}$ or go below ground, GND.

**$R_W$:** Wiper Potentiometer Terminal

$R_W$ is the wiper terminal of the potentiometer. Its position on the resistor array is controlled by the control inputs, $\overline{INC}$, U/$\overline{D}$ and $\overline{CS}$. Voltage applied to the $R_W$ terminal cannot exceed the supply voltage, $V_{CC}$ or go below ground, GND.

**$R_L$:** Low End Potentiometer Terminal

$R_L$ is the low end terminal of the potentiometer. It is not required that this terminal be connected to a potential less than the $R_H$ terminal. Voltage applied to the $R_L$ terminal cannot exceed the supply voltage, $V_{CC}$ or go below ground, GND. $R_L$ and $R_H$ are electrically interchangeable.

**$\overline{CS}$:** Chip Select

The chip select input is used to activate the control input of the N57M5114 and is active low. When in a high state, activity on the $\overline{INC}$ and U/$\overline{D}$ inputs will not affect or change the position of the wiper.

## Device Operation

The N57M5114 operates like a digitally controlled potentiometer with $R_H$ and $R_L$ equivalent to the high and low terminals and $R_W$ equivalent to the mechanical potentiometer's wiper. There are 32 available tap positions including the resistor end points, $R_H$ and $R_L$. There are 31 resistor elements connected in series between the $R_H$ and $R_L$ terminals. The wiper terminal is connected to one of the 32 taps and controlled by three inputs, $\overline{INC}$, U/$\overline{D}$ and $\overline{CS}$. These inputs control a seven-bit up/down counter whose output is decoded to select the wiper position. The selected wiper position can be stored in nonvolatile memory using the $\overline{INC}$ and $\overline{CS}$ inputs.

With $\overline{CS}$ set LOW the N57M5114 is selected and will respond to the U/$\overline{D}$ and $\overline{INC}$ inputs. HIGH to LOW transitions on $\overline{INC}$ will increment or decrement the wiper (depending on the state of the U/$\overline{D}$ input and seven−bit counter). The wiper, when at either fixed terminal, acts like its mechanical equivalent and does not move beyond the last position. The value of the counter is stored in nonvolatile memory whenever $\overline{CS}$ transitions HIGH while the $\overline{INC}$ input is also HIGH. When the N57M5114 is powered-down, the last stored wiper counter position is maintained in the nonvolatile memory. When power is restored, the contents of the memory are recalled and the counter is set to the value stored.

With $\overline{INC}$ set low, the N57M5114 may be de-selected and powered down without storing the current wiper position in nonvolatile memory. This allows the system to always power up to a preset value stored in nonvolatile memory.

**Table 2. OPERATION MODES**

| $\overline{INC}$ | $\overline{CS}$ | U/$\overline{D}$ | Operation |
|---|---|---|---|
| High to Low | Low | High | Wiper toward H |
| High to Low | Low | Low | Wiper toward L |
| High | Low to High | X | Store Wiper Position |
| Low | Low to High | X | No Store, Return to Standby |
| X | High | X | Standby |

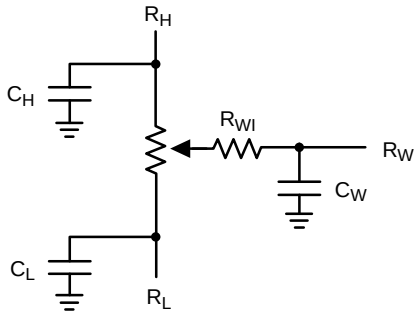



**Figure 4. Potentiometer Equivalent Circuit**

**Table 3. ABSOLUTE MAXIMUM RATINGS**

| Parameters | Ratings | Units |
|---|---|---|
| Supply Voltage<br>$V_{CC}$ to GND | −0.5 to +7 | V |
| Inputs<br>$\overline{CS}$ to GND | −0.5 to $V_{CC}$ +0.5 | V |
| $\overline{INC}$ to GND | −0.5 to $V_{CC}$ +0.5 | V |
| U/$\overline{D}$ to GND | −0.5 to $V_{CC}$ +0.5 | V |
| H to GND | −0.5 to $V_{CC}$ +0.5 | V |
| L to GND | −0.5 to $V_{CC}$ +0.5 | V |
| W to GND | −0.5 to $V_{CC}$ +0.5 | V |
| Operating Ambient Temperature<br>Industrial ('I' suffix) | −40 to +85 | °C |
| Junction Temperature | +150 | °C |
| Storage Temperature | −65 to 150 | °C |
| Lead Soldering (10 s max) | +300 | °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.

**Table 4. RELIABILITY CHARACTERISTICS**

| Symbol | Parameter | Test Method | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $V_{ZAP}$ (Note 1) | ESD Susceptibility | MIL−STD−883, Test Method 3015 | 2000 | | | V |
| $I_{LTH}$ (Notes 1, 2) | Latch-up | JEDEC Standard 17 | 100 | | | mA |
| $T_{DR}$ | Data Retention | MIL−STD−883, Test Method 1008 | 100 | | | Years |
| $N_{END}$ | Endurance | MIL−STD−883, Test Method 1033 | 1,000,000 | | | Stores |

1. This parameter is tested initially and after a design or process change that affects the parameter.
2. Latch-up protection is provided for stresses up to 100 mA on address and data pins from −1 V to $V_{CC}$ + 1 V.

**Table 5. DC ELECTRICAL CHARACTERISTICS** ($V_{CC}$ = +2.5 V to +6 V unless otherwise specified)

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **POWER SUPPLY** | | | | | | |
| $V_{CC}$ | Operating Voltage Range | | 2.5 | – | 6.0 | V |
| $I_{CC1}$ | Supply Current (Increment) | $V_{CC}$ = 6 V, f = 1 MHz, $I_W$ = 0 | – | – | 100 | μA |
| | | $V_{CC}$ = 6 V, f = 250 kHz, $I_W$ = 0 | – | – | 50 | μA |
| $I_{CC2}$ | Supply Current (Write) | Programming, $V_{CC}$ = 6 V | – | – | 1000 | μA |
| | | $V_{CC}$ = 3 V | – | – | 500 | μA |
| $I_{SB1}$ (Note 4) | Supply Current (Standby) | $\overline{CS}$ = $V_{CC}$ − 0.3 V<br>U/$\overline{D}$, $\overline{INC}$ = $V_{CC}$ − 0.3 V or GND | – | − | 1 | μA |
| **LOGIC INPUTS** | | | | | | |
| $I_{IH}$ | Input Leakage Current | $V_{IN}$ = $V_{CC}$ | – | – | 10 | μA |
| $I_{IL}$ | Input Leakage Current | $V_{IN}$ = 0 V | – | – | −10 | μA |
| $V_{IH2}$ | CMOS High Level Input Voltage | 2.5 V ≤ $V_{CC}$ ≤ 6 V | $V_{CC}$ x 0.7 | – | $V_{CC}$ + 0.3 | V |
| $V_{IL2}$ | CMOS Low Level Input Voltage | | −0.3 | – | $V_{CC}$ x 0.2 | V |
| **POTENTIOMETER CHARACTERISTICS** | | | | | | |
| $R_{POT}$ | Potentiometer Resistance | −10 Device | | 10 | | kΩ |
| | | −50 Device | | 50 | | |
| | | −00 Device | | 100 | | |
| | Pot. Resistance Tolerance | | | | ±20 | % |
| $V_{RH}$ | Voltage on $R_H$ pin | | 0 | | $V_{CC}$ | V |
| $V_{RL}$ | Voltage on $R_L$ pin | | 0 | | $V_{CC}$ | V |
| | Resolution | | | 3.2 | | % |
| INL | Integral Linearity Error | | | | 0.5 | LSB |
| DNL | Differential Linearity Error | | | | 0.25 | LSB |
| $R_{WI}$ | Wiper Resistance | $V_{CC}$ = 5 V, $I_W$ = 1 mA | | 70 | 200 | Ω |
| | | $V_{CC}$ = 2.5 V, $I_W$ = 1 mA | | 150 | 400 | Ω |
| $I_W$ | Wiper Current | | −4.4 | | 4.4 | mA |
| $TC_{RPOT}$ | TC of Pot Resistance | | | 300 | | ppm/°C |
| $TC_{RATIO}$ | Ratiometric TC | | | | 20 | ppm/°C |
| $V_N$ | Noise | 100 kHz / 1 kHz | | 8/24 | | nV/√Hz |
| $C_H/C_L/C_W$ | Potentiometer Capacitances | | | 8/8/25 | | pF |
| fc | Frequency Response | Passive Attenuator, 10 kΩ | | 1.7 | | MHz |

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.

3. This parameter is tested initially and after a design or process change that affects the parameter.
4. Latch−up protection is provided for stresses up to 100 mA on address and data pins from −1 V to $V_{CC}$ + 1 V.
5. $I_W$ = source or sink.
6. These parameters are periodically sampled and are not 100% tested.

**Table 6. AC TEST CONDITIONS**

| | |
|---|---|
| $V_{CC}$ Range | 2.5 V ≤ $V_{CC}$ ≤ 6 V |
| Input Pulse Levels | 0.2 x $V_{CC}$ to 0.7 x $V_{CC}$ |
| Input Rise and Fall Times | 10 ns |
| Input Reference Levels | 0.5 x $V_{CC}$ |

**Table 7. AC OPERATING CHARACTERISTICS** ($V_{CC}$ = +2.5 V to +6.0 V, $V_H$ = $V_{CC}$, $V_L$ = 0 V, unless otherwise specified)

| Symbol | Parameter | Min | Typ (Note 7) | Max | Units |
|---|---|---|---|---|---|
| $t_{CI}$ | $\overline{CS}$ to $\overline{INC}$ Setup | 100 | – | – | ns |
| $t_{DI}$ | U/$\overline{D}$ to $\overline{INC}$ Setup | 50 | – | – | ns |
| $t_{ID}$ | U/$\overline{D}$ to $\overline{INC}$ Hold | 100 | – | – | ns |
| $t_{IL}$ | $\overline{INC}$ LOW Period | 250 | – | – | ns |
| $t_{IH}$ | $\overline{INC}$ HIGH Period | 250 | – | – | ns |
| $t_{IC}$ | $\overline{INC}$ Inactive to $\overline{CS}$ Inactive | 1 | – | – | µs |
| $t_{CPH}$ | $\overline{CS}$ Deselect Time (NO STORE) | 100 | – | – | ns |
| $t_{CPH}$ | $\overline{CS}$ Deselect Time (STORE) | 10 | – | – | ms |
| $t_{IW}$ | $\overline{INC}$ to $V_{OUT}$ Change | – | 1 | 5 | µs |
| $t_{CYC}$ | $\overline{INC}$ Cycle Time | 1 | – | – | µs |
| $t_R$, $t_F$ (Note 8) | $\overline{INC}$ Input Rise and Fall Time | – | – | 500 | µs |
| $t_{PU}$ (Note 8) | Power-up to Wiper Stable | – | – | 1 | ms |
| $t_{WR}$ | Store Cycle | – | 5 | 10 | ms |

7. Typical values are for $T_A$ = 25°C and nominal supply voltage.
8. This parameter is periodically sampled and not 100% tested.
9. MI in the A.C. Timing diagram refers to the minimum incremental change in the W output due to a change in the wiper position.

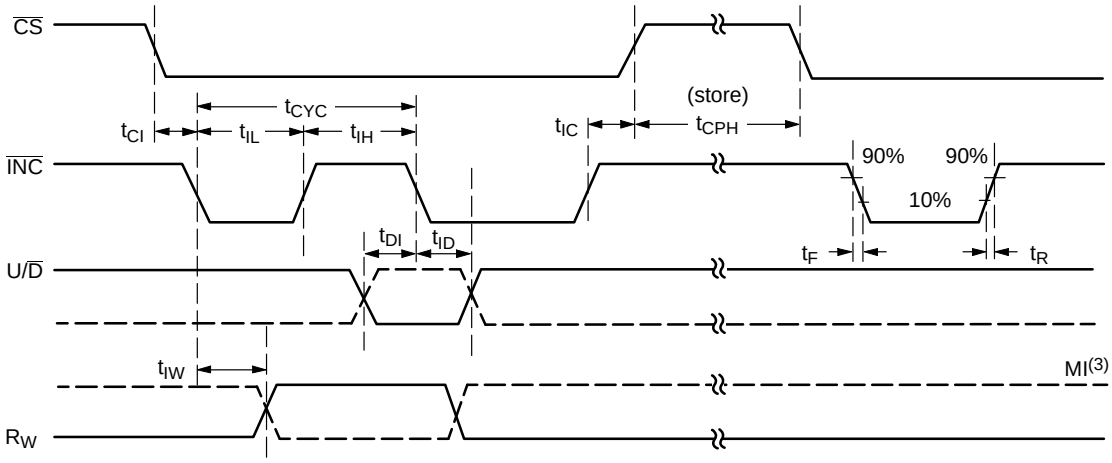



**Figure 5. A.C. Timing**

## APPLICATIONS INFORMATION

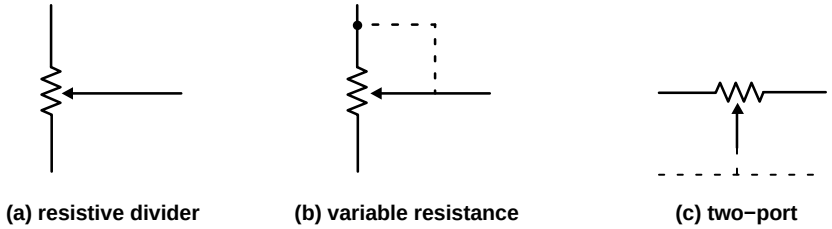



**Figure 6. Potentiometer Configuration**

### Applications

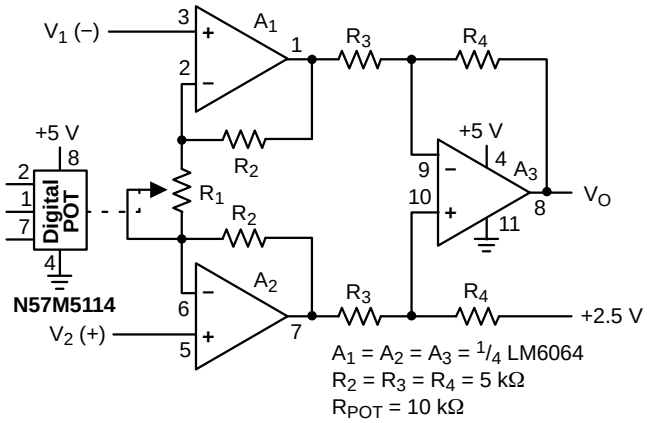



**Figure 7. Programmable Instrumentation Amplifier**

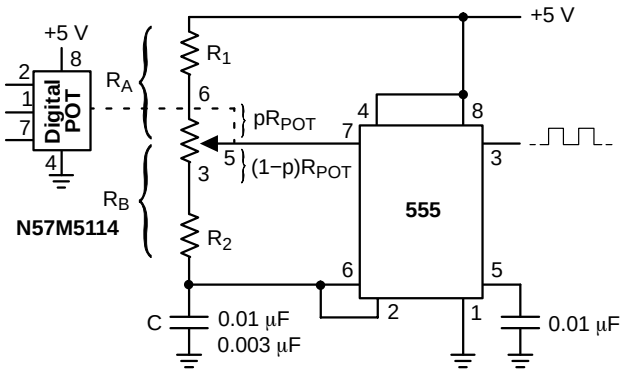



**Figure 8. Programmable Sq. Wave Oscillator (555)**

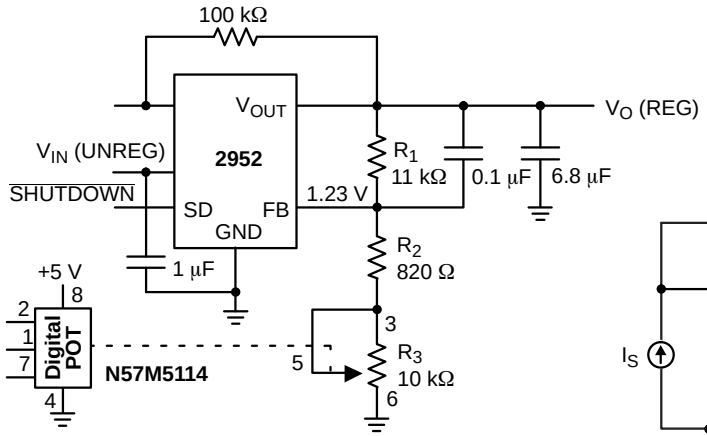



**Figure 9. Programmable Voltage Regulator**

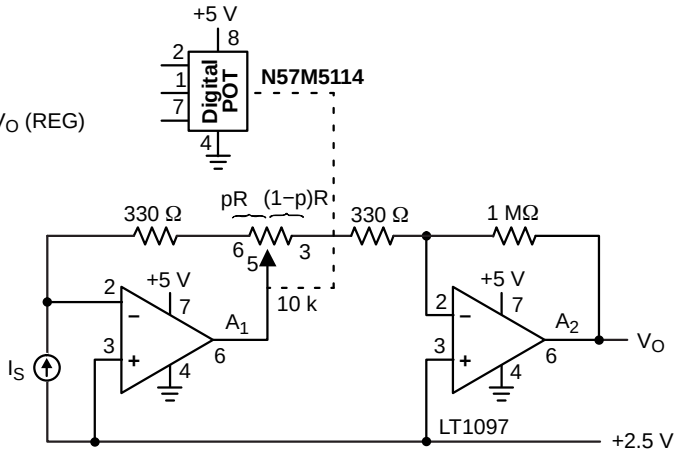



**Figure 10. Programmable I to V Convertor**

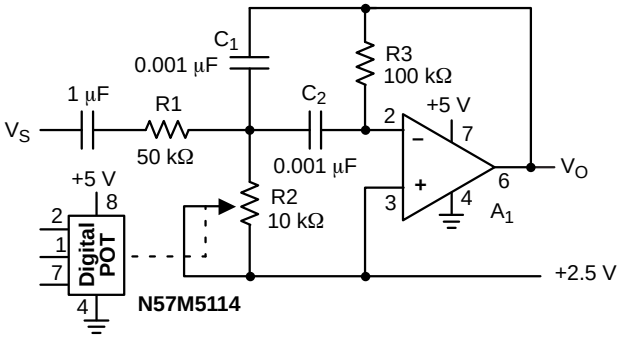



**Figure 11. Programmable Bandpass Filter**

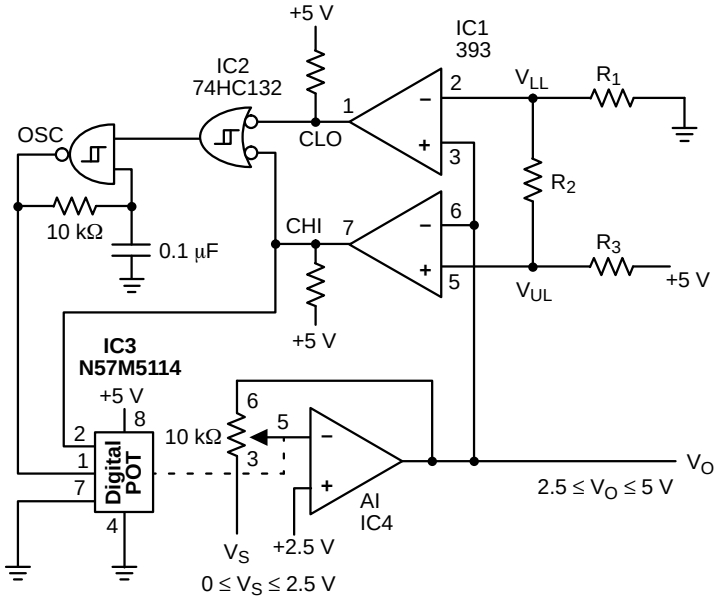



**Figure 12. Automatic Gain Control**

**Table 8. ORDERING INFORMATION**

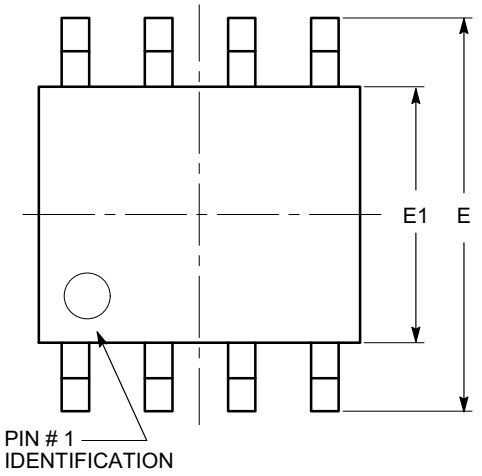
| Orderable Part Numbers | Resistance Values (kΩ) | Package−Pin | Lead Finish | Shipping† |
|---|---|---|---|---|
| N57M5114WD10TG | 10 | SOIC−8 | NiPdAu | 100 Units / Rail |
| N57M5114WD50TG | 50 | | | |
| N57M5114WD00TG | 100 | | | |
| N57M5114VP2D10TG | 10 | TDFN−8<br>2 x 3 mm | NiPdAu | 3000 / Tape & Reel |
| N57M5114VP2D50TG | 50 | | | |
| N57M5114VP2D00TG | 100 | | | |
| N57M5114YD10TG | 10 | TSSOP−8 | NiPdAu | 3000 / Tape & Reel |
| N57M5114YD50TG | 50 | | | |
| N57M5114YD00TG | 100 | | | |
| N57M5114ZD10TG | 10 | MSOP−8 | NiPdAu | 96 Units / Rail |
| N57M5114ZD50TG | 50 | | | |
| N57M5114ZD00TG | 100 | | | |

†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.

10. All packages are RoHS-compliant (Pb-Free, Halogen-Free).
11. The standard lead finish is NiPdAu.
12. For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.

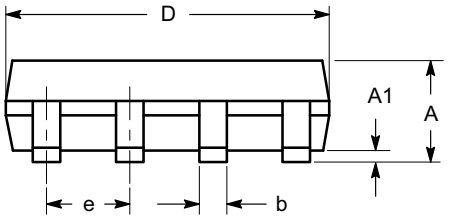
## PACKAGE DIMENSIONS

**SOIC 8, 150 mils**
CASE 751BD
ISSUE O

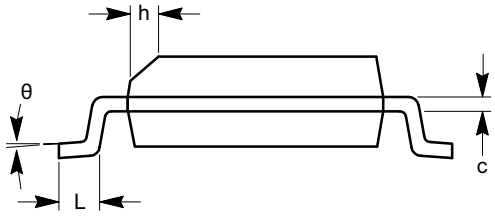



**TOP VIEW**

| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | 1.35 | | 1.75 |
| A1 | 0.10 | | 0.25 |
| b | 0.33 | | 0.51 |
| c | 0.19 | | 0.25 |
| D | 4.80 | | 5.00 |
| E | 5.80 | | 6.20 |
| E1 | 3.80 | | 4.00 |
| e | 1.27 BSC | | |
| h | 0.25 | | 0.50 |
| L | 0.40 | | 1.27 |
| θ | 0° | | 8° |




**SIDE VIEW**

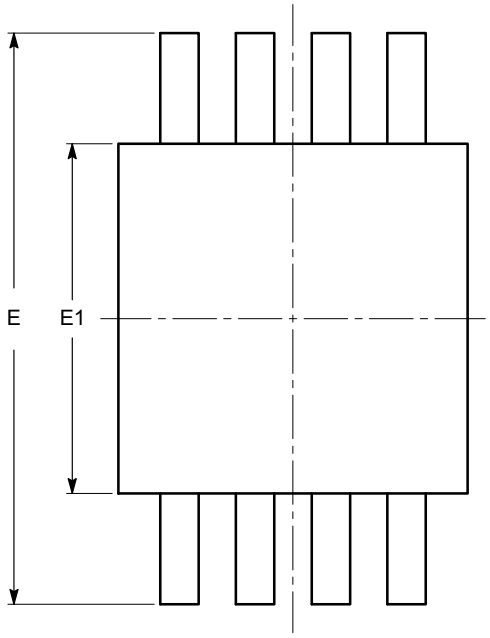



**END VIEW**

**Notes:**
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MS-012.

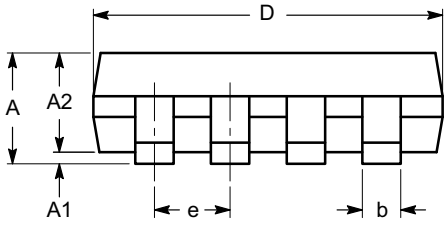
## PACKAGE DIMENSIONS

**MSOP 8, 3x3**
CASE 846AD
ISSUE O

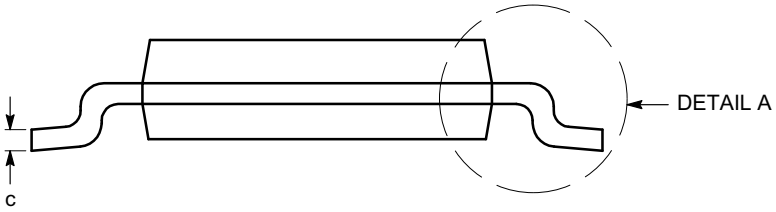



**TOP VIEW**

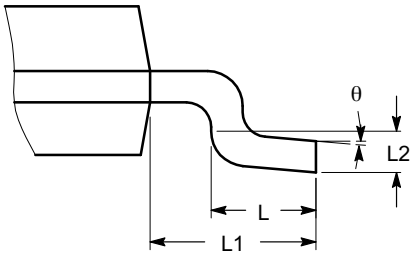
| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | | | 1.10 |
| A1 | 0.05 | 0.10 | 0.15 |
| A2 | 0.75 | 0.85 | 0.95 |
| b | 0.22 | | 0.38 |
| c | 0.13 | | 0.23 |
| D | 2.90 | 3.00 | 3.10 |
| E | 4.80 | 4.90 | 5.00 |
| E1 | 2.90 | 3.00 | 3.10 |
| e | 0.65 BSC | | |
| L | 0.40 | 0.60 | 0.80 |
| L1 | 0.95 REF | | |
| L2 | 0.25 BSC | | |
| θ | 0° | | 6° |




**SIDE VIEW**




**END VIEW**

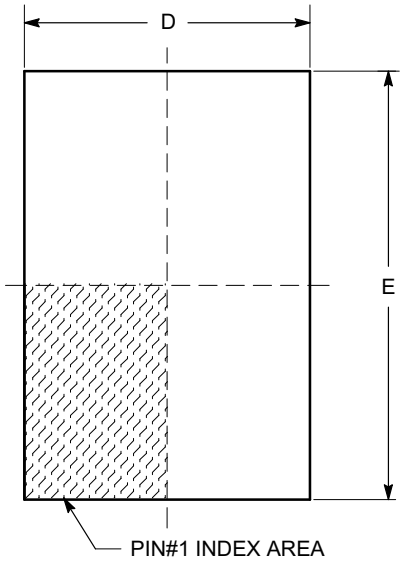



**DETAIL A**

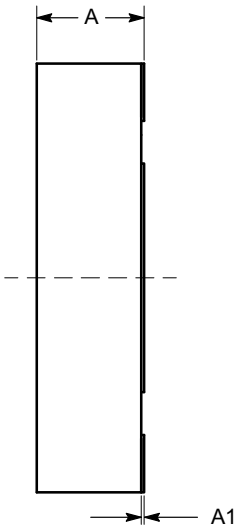
**Notes:**
(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-187.

## PACKAGE DIMENSIONS

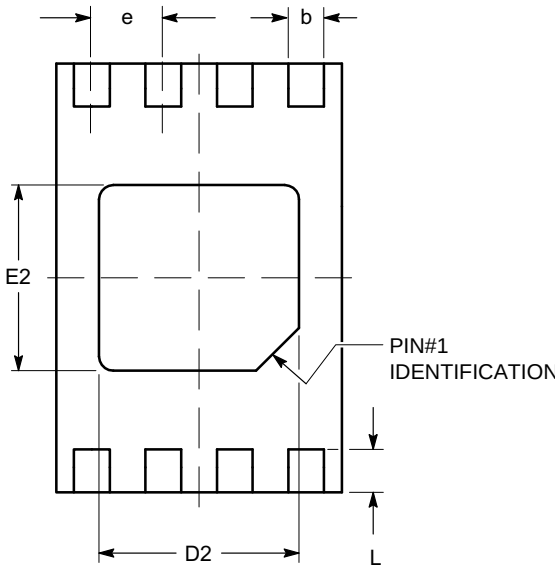
**TDFN8, 2x3**
CASE 511AK
ISSUE A




**TOP VIEW**

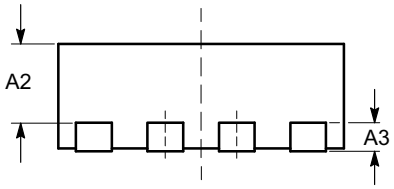



**SIDE VIEW**




**BOTTOM VIEW**

| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.00 | 0.02 | 0.05 |
| A2 | 0.45 | 0.55 | 0.65 |
| A3 | | 0.20 REF | |
| b | 0.20 | 0.25 | 0.30 |
| D | 1.90 | 2.00 | 2.10 |
| D2 | 1.30 | 1.40 | 1.50 |
| E | 2.90 | 3.00 | 3.10 |
| E2 | 1.20 | 1.30 | 1.40 |
| e | | 0.50 TYP | |
| L | 0.20 | 0.30 | 0.40 |



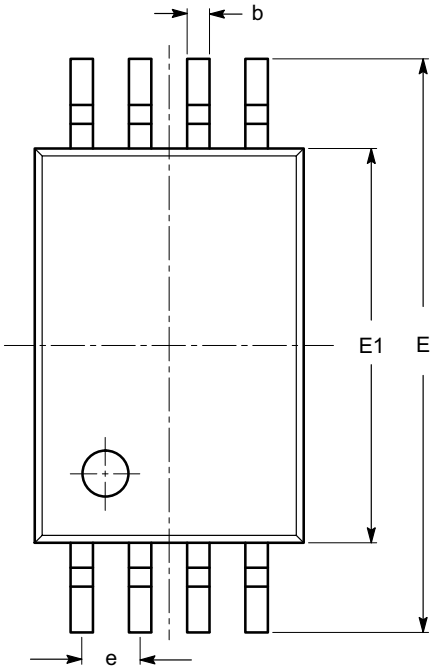

**FRONT VIEW**

**Notes:**
(1) All dimensions are in millimeters.
(2) Complies with JEDEC MO-229.

# N57M5114

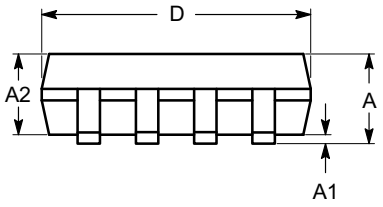
## PACKAGE DIMENSIONS

**TSSOP8, 4.4x3**
CASE 948AL
ISSUE O

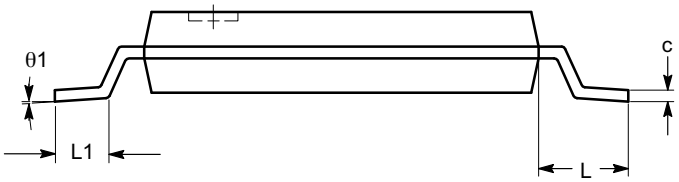



**TOP VIEW**

| SYMBOL | MIN | NOM | MAX |
|---|---|---|---|
| A | | | 1.20 |
| A1 | 0.05 | | 0.15 |
| A2 | 0.80 | 0.90 | 1.05 |
| b | 0.19 | | 0.30 |
| c | 0.09 | | 0.20 |
| D | 2.90 | 3.00 | 3.10 |
| E | 6.30 | 6.40 | 6.50 |
| E1 | 4.30 | 4.40 | 4.50 |
| e | 0.65 BSC | | |
| L | 1.00 REF | | |
| L1 | 0.50 | 0.60 | 0.75 |
| θ | 0° | | 8° |




**SIDE VIEW**




**END VIEW**

**Notes:**

(1) All dimensions are in millimeters. Angles in degrees.
(2) Complies with JEDEC MO-153.

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