32-tap Digital Potentiometer (POT)

Description

The CAT5114 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 CAT5114 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 CAT5114 is accomplished with three input control pins, $\overline{\text{CS}}$, U/\overline{D}, and \overline{\text{INC}}. The \overline{\text{INC}} input increments the wiper in the direction which is determined by the logic state of the U/\overline{D} input. The \overline{\text{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: $10 \text{ k}\Omega$, $50 \text{ k}\Omega$ and $100 \text{ k}\Omega$
- Available in PDIP, SOIC, TSSOP, MSOP and Space Saving 2 x 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
 MSOP-8

 V SUFFIX
 Z SUFFIX

 CASE 751BD
 CASE 846AD



PDIP-8 L SUFFIX CASE 646AA

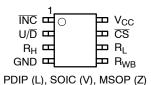


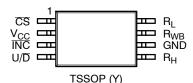
TSSOP-8
Y SUFFIX
CASE 948AL

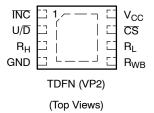


TDFN-8 VP2 SUFFIX CASE 511AK

PIN CONFIGURATIONS







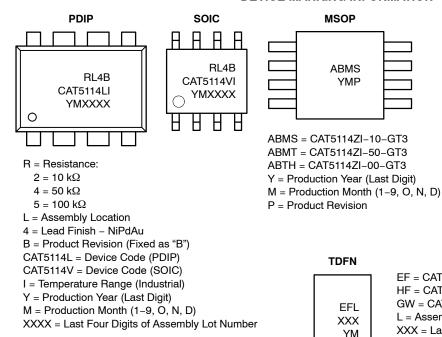
ORDERING INFORMATION

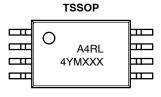
See detailed ordering and shipping information in the package dimensions section on page 9 of this data sheet.

DEVICE MARKING INFORMATION MSOP

ABMS

YMP





A4 = Device Code

R = Resistance:

 $2 = 10 \text{ k}\Omega$

 $4 = 50 \text{ k}\Omega$

 $5 = 100 \text{ k}\Omega$

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

EFL XXX ΥM EF = CAT5114VP2I10GT3 HF = CAT5114VP2I50GT3 GW = CAT5114VP2I00GT3

L = Assembly Location

XXX = Last Three Digits of Assembly Lot Number

Y = Production Year (Last Digit)

M = Production Month (1-9, O, N, D)

Functional Diagram

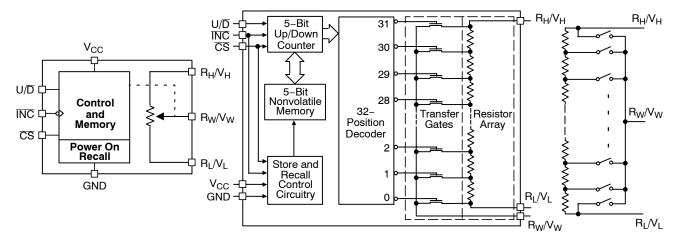


Figure 1. General

Figure 2. Detailed

Figure 3. Electronic Potentiometer Implementation

Table 1. PIN DESCRIPTIONS

Name	Function	
INC	Increment Control	
U/D	Up/Down Control	
R _H	Potentiometer High Terminal	
GND	Ground	
R _W	Wiper Terminal	
R _L	Potentiometer Low Terminal	
CS	Chip Select	
V _{CC}	Supply Voltage	

Pin Function

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/**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.

RH: High End Potentiometer Terminal

 $R_{\rm H}$ is the high end terminal of the potentiometer. It is not required that this terminal be connected to a potential greater than the $R_{\rm L}$ terminal. Voltage applied to the $R_{\rm H}$ terminal cannot exceed the supply voltage, $V_{\rm CC}$ 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.

RL: 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.

CS: Chip Select

The chip select input is used to activate the control input of the CAT5114 and is active low. When in a high state, activity on the $\overline{\rm INC}$ and ${\rm U/\overline{D}}$ inputs will not affect or change the position of the wiper.

Device Operation

The CAT5114 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 $\overline{\text{CS}}$ set LOW the CAT5114 is selected and will respond to the U/ $\overline{\text{D}}$ and $\overline{\text{INC}}$ inputs. HIGH to LOW transitions on $\overline{\text{INC}}$ will increment or decrement the wiper (depending on the state of the U/ $\overline{\text{D}}$ 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 $\overline{\text{CS}}$ transitions HIGH while the $\overline{\text{INC}}$ input is also HIGH. When the CAT5114 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 INC set low, the CAT5114 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

INC	CS	U/D	Operation
High to Low	Low	High	Wiper toward H
High to Low	Low	Low	Wiper toward L
High	Low to High	Х	Store Wiper Position
Low	Low to High	Х	No Store, Return to Standby
Х	High	Х	Standby

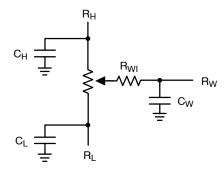


Figure 4. Potentiometer Equivalent Circuit

Table 3. ABSOLUTE MAXIMUM RATINGS

Parameters	Ratings	Units
Supply Voltage V _{CC} to GND	-0.5 to +7	V
Inputs CS to GND	-0.5 to V _{CC} +0.5	V
INC to GND	-0.5 to V _{CC} +0.5	V
U/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 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 Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

Table 4. RELIABILITY CHARACTERISTICS

Symbol	Parameter	Test Method	Min	Тур	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 1003	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	Тур	Max	Units
POWER SUPPL	Y		•			
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	μΑ
		V _{CC} = 6 V, f = 250 kHz, I _W = 0	_	-	50	μΑ
I _{CC2}	Supply Current (Write)	Programming, V _{CC} = 6 V	-	-	1000	μΑ
		V _{CC} = 3 V	_	-	500	μΑ
I _{SB1} (Note 4)	Supply Current (Standby)	$\overline{CS} = V_{CC} - 0.3 \text{ V}$ U/ \overline{D} , $\overline{INC} = V_{CC} - 0.3 \text{ V}$ or GND	_	-	1	μΑ
LOGIC INPUTS						
I _{IH}	Input Leakage Current	V _{IN} = V _{CC}	-	-	10	μΑ
I _{IL}	Input Leakage Current	V _{IN} = 0 V	_	-	-10	μΑ
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
POTENTIOMET	ER 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	I _W ≤ 2 μA		0.5	1	LSB
DNL	Differential Linearity Error	I _W ≤ 2 μA		0.25	0.5	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

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

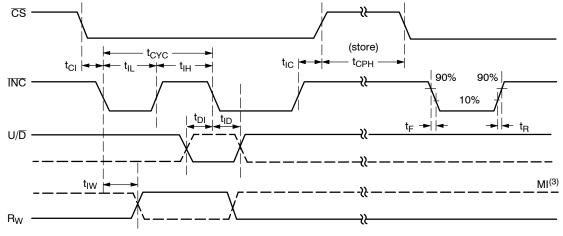
Table 6. AC TEST CONDITIONS

V _{CC} Range	$2.5 \text{ V} \le \text{V}_{CC} \le 6 \text{ V}$
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)

		1	T (A)\		
Symbol	Parameter	Min	Typ (Note 7)	Max	Units
t _{Cl}	CS to INC Setup	100	_	-	ns
t _{DI}	U/D to INC Setup	50	-	-	ns
t _{ID}	U/D to INC Hold	100	-	-	ns
t _{IL}	INC LOW Period	250	-	-	ns
t _{IH}	INC HIGH Period	250	-	-	ns
t _{IC}	INC Inactive to CS Inactive	1	-	=	μs
t _{CPH}	CS Deselect Time (NO STORE)	100	-	=	ns
t _{CPH}	CS Deselect Time (STORE)	10	-	=	ms
t _{IW}	ĪNC to V _{OUT} Change	-	1	5	μs
tcyc	INC Cycle Time	1	-	-	μs
t _R , t _F (Note 8)	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.



APPLICATIONS INFORMATION

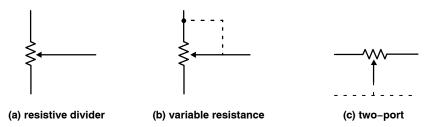


Figure 6. Potentiometer Configuration

Applications

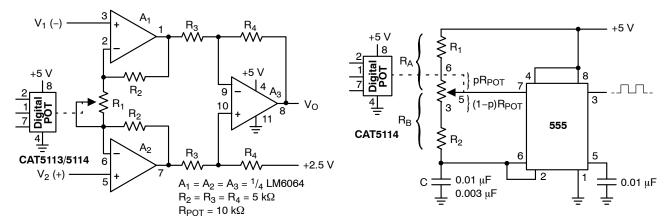


Figure 7. Programmable Instrumentation
Amplifier

Figure 8. Programmable Sq. Wave Oscillator (555)

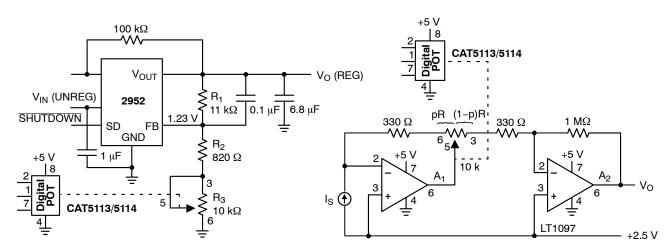


Figure 9. Programmable Voltage Regulator

Figure 10. Programmable I to V Convertor

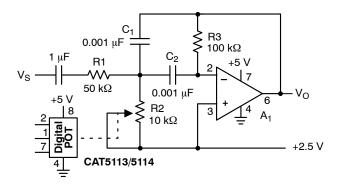


Figure 11. Programmable Bandpass Filter

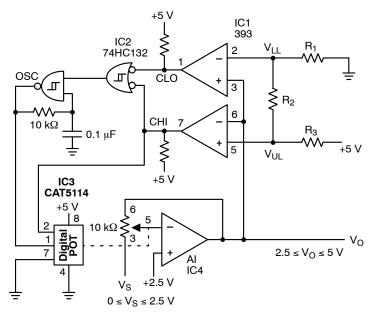


Figure 12. Automatic Gain Control

Table 8. ORDERING INFORMATION

Orderable Part Numbers	Resistance Values (kΩ)	Package-Pin	Lead Finish	Shipping [†]
CAT5114LI-10-G	10			
CAT5114LI-50-G	50	PDIP-8	NiPdAu	50 Units / Rail
CAT5114LI-00-G	100			
CAT5114VI-10-GT3	10			
CAT5114VI-50-GT3	50	SOIC-8	NiPdAu	100 Units / Rail
CAT5114VI-00-GT3	100			
CAT5114VP2I10GT3 (Notes 10, 11)	10			
CAT5114VP2I50GT3 (Notes 10, 11)	50	TDFN-8 2 x 3 mm	NiPdAu	3000 / Tape & Reel
CAT5114VP2I00GT3 (Notes 10, 11)	100			
CAT5114YI-10-GT3	10			
CAT5114YI-50-GT3	50	TSSOP-8	NiPdAu	3000 / Tape & Reel
CAT5114YI-00-GT3	100			
CAT5114ZI-10-GT3	10			
CAT5114ZI-50-GT3	50	MSOP-8	NiPdAu	96 Units / Rail
CAT5114ZI-00-GT3	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. Contact factory for package availability.

11. Part number is not exactly the same as the "Example of Ordering Information" shown above. For the indicated part numbers there are NO hyphens in the orderable part numbers.

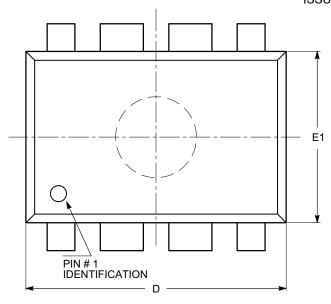
12. All packages are RoHS-compliant (Pb-Free, Halogen-Free).

^{13.} The standard lead finish is NiPdAu.

^{14.} For additional package and temperature options, please contact your nearest ON Semiconductor Sales office.

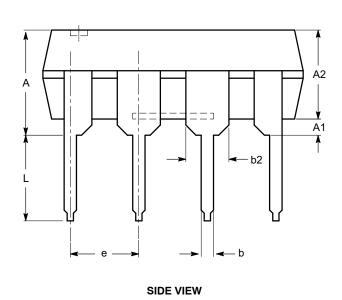
PACKAGE DIMENSIONS

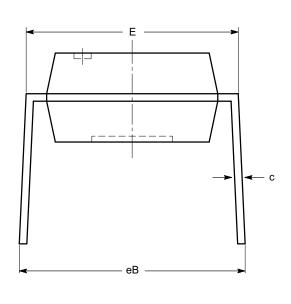
PDIP-8, 300 mils CASE 646AA ISSUE A



SYMBOL	MIN	NOM	MAX	
Α			5.33	
A1	0.38			
A2	2.92	3.30	4.95	
b	0.36	0.46	0.56	
b2	1.14	1.52	1.78	
С	0.20	0.25	0.36	
D	9.02	9.27	10.16	
Е	7.62	7.87	8.25	
E1	6.10	6.35	7.11	
е	2.54 BSC			
eB	7.87		10.92	
L	2.92	3.30	3.80	

TOP VIEW



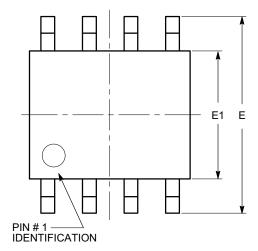


END VIEW

- (1) All dimensions are in millimeters.
- (2) Complies with JEDEC MS-001.

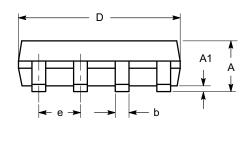
PACKAGE DIMENSIONS

SOIC 8, 150 mils CASE 751BD ISSUE O

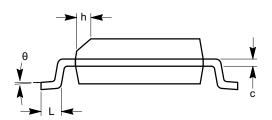


SYMBOL	MIN	NOM	MAX
Α	1.35		1.75
A1	0.10		0.25
b	0.33		0.51
С	0.19		0.25
D	4.80		5.00
Е	5.80		6.20
E1	3.80		4.00
е		1.27 BSC	
h	0.25		0.50
L	0.40		1.27
θ	0°		8°

TOP VIEW



SIDE VIEW

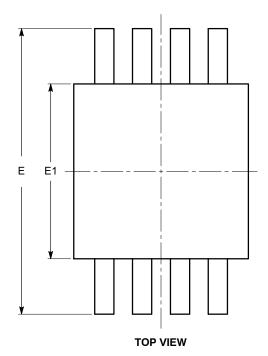


END VIEW

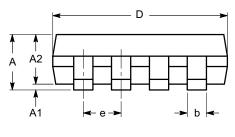
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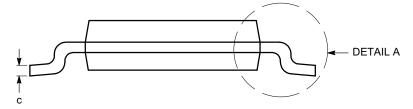
PACKAGE DIMENSIONS

MSOP 8, 3x3 CASE 846AD ISSUE O



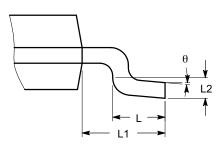
SYMBOL	MIN	NOM	MAX
Α			1.10
A1	0.05	0.10	0.15
A2	0.75	0.85	0.95
b	0.22		0.38
С	0.13		0.23
D	2.90	3.00	3.10
E	4.80	4.90	5.00
E1	2.90	3.00	3.10
е		0.65 BSC	
L	0.40	0.60	0.80
L1	0.95 REF		
L2	0.25 BSC		
θ	0°		6°





SIDE VIEW

END VIEW

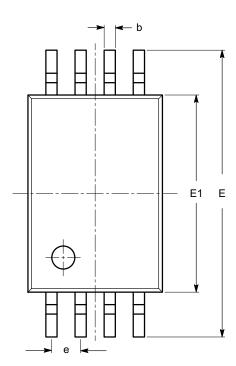


- (1) All dimensions are in millimeters. Angles in degrees.(2) Complies with JEDEC MO-187.

DETAIL A

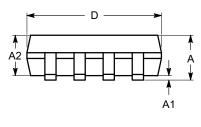
PACKAGE DIMENSIONS

TSSOP8, 4.4x3 CASE 948AL ISSUE O

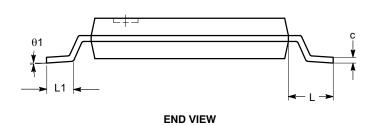


SYMBOL	MIN	NOM	MAX	
Α			1.20	
A1	0.05		0.15	
A2	0.80	0.90	1.05	
b	0.19		0.30	
С	0.09		0.20	
D	2.90	3.00	3.10	
E	6.30	6.40	6.50	
E1	4.30	4.40	4.50	
е	0.65 BSC			
L	1.00 REF			
L1	0.50	0.60	0.75	
θ	0°		8°	

TOP VIEW



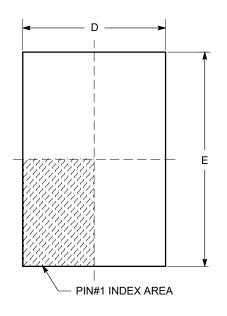
SIDE VIEW

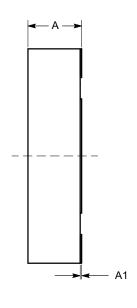


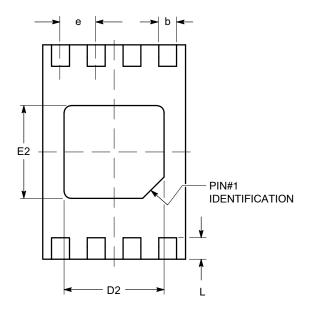
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PACKAGE DIMENSIONS

TDFN8, 2x3 CASE 511AK ISSUE A





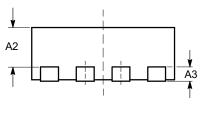


TOP VIEW

SIDE VIEW

BOTTOM VIEW

SYMBOL	MIN	NOM	MAX
Α	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2	0.45	0.55	0.65
АЗ	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
е	0.50 TYP		
L	0.20	0.30	0.40



FRONT VIEW

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

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