LTA6321, LTA6358, LTA6324

36V, 1.1MHz Micro-power, RRO Operational Amplifiers

General Description

The LTA6321, LTA6358 and LTA6324 are a family of micro-power, 36 V wide supply voltage, rail-to-rail output operational amplifiers capable of operating on supplies ranging from +4 V to +36 V. LTA6321/LTA6358/LTA6324 offer outstanding dc precision and ac performance, including low offset (±2 mV typically), low offset drift (±5 µV/℃ typically), 1.1 MHz bandwidth, Unique features such as differential input-voltage range to the negative supply rail, short-circuit current (±35 mA), high capacitive load drive of up to 1 nF, and high slew rate (0.8 V/µs) make the LTA6321/LTA6358/LTA6324 high-performance operational amplifiers for high-voltage industrial applications.

The robust design of the LTA6321/LTA6358/LTA6324 family provides ease-of-use to the circuit designer: integrated RF/EMI rejection filter, no phase reversal in overdrive conditions, and high electro-static discharge (ESD) protection. The LTA6321/LTA6358/LTA6324 are optimized for operation at voltages from +4V (±2V) to +36 V (±18 V) over the extended temperature range of -40 ℃ to +125℃.

Features and Benefits

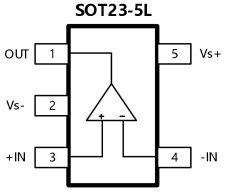
- Wide Supply: ±2 V to ±18 V, 4V to 36 V
- Low Offset Voltage: ±2 mV typically
- Low Offset Voltage Drift: ±5 µV/℃
- High Common-Mode Rejection: 110 dB
- Gain Bandwidth: 1.1 MHz
- Slew Rate: 0.8 V/µs
- Low Noise: 42 nV/√Hz at 1 kHz
- Low Quiescent Current: 260 µA per amplifier
- Rail-to-Rail Output

Applications

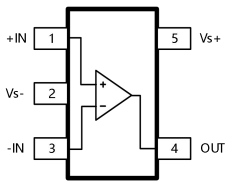
- Tracking Amplifier in Power Modules
- Power Delivery: UPS, Server, and Merchant Network Power
- High-Side and Low-Side Current Sensing
- Transducer Amplifiers
- Battery-Powered Instruments
- Test and Measurement Equipment
- Multiplexed Data-Acquisition Systems
- Programmable Logic Controllers

Pin Configuration (Top View)

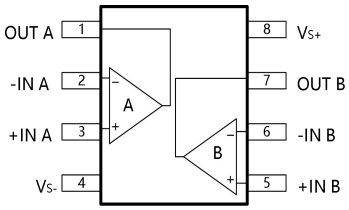
LTA6321
SOT23-5L



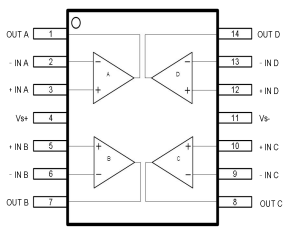
LTA6321U
SOT23-5L



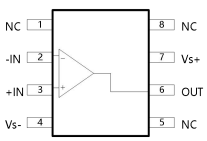
LTA6358
SOIC-8L/MSOP-8L



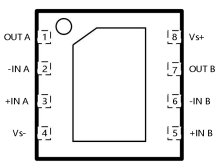
LTA6324
SOIC-14L / TSSOP-14L



LTA6321
SOIC-8L / MSOP-8L



LTA6358
DFN3×3-8L



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Table of Content

General Description 1
Features and Benefits 1
Application 1
Pin Configuration (Top View) 1
Table of Content 2
Pin Description 3
Ordering Information 3
Limiting Value 3
ESD Ratings 3
Electrical Characteristics 4
Typical Performance Characteristics 6
Tape and Reel Information 8
Package Outlines 9
Important Notice 15

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Pin Description

Symbol	Description
–IN	Inverting input of the amplifier. The voltage range is from V_{S-} to V_{S+} – 1.5V.
+IN	Non-inverting input of the amplifier. This pin has the same voltage range as –IN.
V_{S+}	Positive power supply. The voltage is from 4V to 36V. Split supplies are possible as long as the voltage between V_{S+} and V_{S-} is from 4V to 36V.
V_{S-}	Negative power supply. It is normally tied to ground. It can also be tied to a voltage other than ground as long as the voltage between V_{S+} and V_{S-} is from 4V to 36V.
OUT	Amplifier output.
NC	No connection

Ordering Information

Type Number	Package Name	Package Quantity	Eco Class	Marking Code
LTA6321XT5/R6	SOT23-5L	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	F21
LTA6321UXT5/R6	SOT23-5L	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	F21U
LTA6321XS8/R8	SOIC-8L	Tape and Reel, 4 000	Green (RoHS & no Sb/Br)	F6321
LTA6321XV8/R6	MSOP-8L	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	F6321
LTA6358XS8/R8	SOIC-8L	Tape and Reel, 4 000	Green (RoHS & no Sb/Br)	F6358, AL_1M
LTA6358XV8/R6	MSOP-8L	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	F6358, AL_1M
LTA6358XF8/R6	DFN3x3-8L	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	F6358, AL_1M
LTA6324XS14/R5	SOIC-14L	Tape and Reel, 2 500	Green (RoHS & no Sb/Br)	F6324
LTA6324XT14/R6	TSSOP-14L	Tape and Reel, 3 000	Green (RoHS & no Sb/Br)	F6324

Limiting Value – In accordance with the Absolute Maximum Rating System (IEC 60134).

Parameter	Absolute Maximum Rating
Supply Voltage, V_{S+} to V_{S-}	40 V
Signal Input Terminals: Voltage, Current	V_{S-} to V_{S+} – 1.5 V, ±10 mA
Output Short-Circuit	Continuous
Storage Temperature Range, T_{stg}	–65 to +150 °C
Junction Temperature, T_J	150 °C
Lead Temperature Range (Soldering 10 sec)	260 °C

ESD Rating

Parameter	Item	Value	Unit
Electrostatic Discharge Voltage	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001	±2 000	V
	Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002	±2 000	

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Electrical Characteristics

V_S = 4 V to 36 V, T_A = +25 °C, V_{CM} = V_{OUT} = V_S/2, and R_L = 10 kΩ connected to V_S/2, unless otherwise noted. Boldface limits apply over the specified temperature range, T_A = -40 °C to +125 °C.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
OFFSET VOLTAGE						
V_{OS}	Input offset voltage			±2	±4	mV
V_{OS} TC	Offset voltage drift	T_A = -40 to +125 °C		±5		µV/°C
PSRR	Power supply rejection ratio	V_S = 4.5 to 36 V, V_{CM} = 0.1 V		115		dB
		T_A = -40 to +125 °C		105		
INPUT BIAS CURRENT						
I_B	Input bias current	T_A= +25°C		10		pA
		T_A = +85 °C		150		
		T_A = +125 °C		600		
I_{OS}	Input offset current			5		pA
NOISE						
V_n	Input voltage noise	f = 0.1 to 10 Hz		6		μV_{PP}
e_n	Input voltage noise density	f = 1 kHz		42		nV/√ Hz
I_n	Input current noise density	f = 1 kHz		5		fA/√ Hz
INPUT VOLTAGE						
V_{CM}	Common-mode voltage range		V_{S-}		V_{S+}-1.5	V
CMRR	Common-mode rejection ratio	V_S = 36 V, V_{CM} = 0 to 34.5 V		110		dB
		V_{CM} = 0.1 to 34 V, T_A = -40 to +125 °C		95		
		V_S = 5.0 V, V_{CM} = 0 to 3.5 V		90		
		V_{CM} = 0.1 to 3 V, T_A = -40 to +125 °C		85		
INPUT IMPEDANCE						
C_{IN}	Input capacitance	Differential		2.0		pF
		Common mode		3.5		
OPEN-LOOP GAIN						
A_{VOL}	Open-loop voltage gain	V_S = 36 V, V_O = 0.1 to 34.5 V		115		dB
		T_A = -40 to +125 °C		110		
		V_S = 5 V, V_O = 0.1 to 4.5 V		100		
		T_A = -40 to +125 °C		95		
FREQUENCY RESPONSE						
GBW	Gain bandwidth product			1.1		MHz
SR	Slew rate	V_S = 36 V, G = +1, 10 V step		0.8		V/µs
THD+N	Total harmonic distortion + noise	G = +1, f = 1 kHz, V_O = 3 V_{RMS}		0.0002		%
t_S	Settling time	To 0.1%, V_S = 36 V, G = +1, 5 V step		16		µs
		To 0.01%, V_S = 36 V, G = +1, 5 V step		22		
t_{OR}	Overload recovery time	V_{IN} × Gain > V_S		2		µs

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Electrical Characteristics (continued)

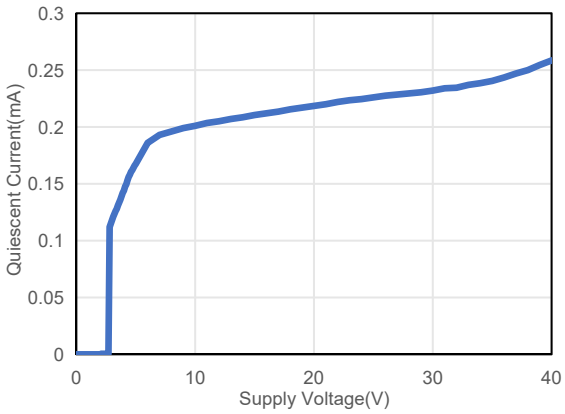
V_S = 4 V to 36 V, T_A = +25°C, V_{CM} = V_{OUT} = V_S/2, and R_L = 10 kΩ connected to V_S/2, unless otherwise noted. Boldface limits apply over the specified temperature range, T_A = -40 °C to +125 °C.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
OUTPUT						
V_{OH}	Output Swing from Positive Rail	V_S = ±18 V, R_L = 10 kΩ		215		mV
		V_S = ±18 V, R_L = 2 kΩ		1050		
V_{OL}	Output Swing from Negative Rail	V_S = ±18 V, R_L = 10 kΩ		150		mV
		V_S = ±18 V, R_L = 2 kΩ		650		
I_{SC}	Short-circuit current			±35		mA
POWER SUPPLY						
V_S	Operating supply voltage	T_A = -40 to +125 °C	4		36	V
I_Q	Quiescent current (per amplifier)	V_S = 5 V		180		µA
		V_S = 36 V		260		
THERMAL CHARACTERISTICS						
T_A	Operating temperature range		-40		+125	°C
θ_{JA}	Package Thermal Resistance	SOT23-5L		190		°C/W
		MSOP-8L		201		
		SOIC-8L		125		
		DFN3×3-8L		85		
		TSSOP-14L		112		
		SOIC-14L		115		

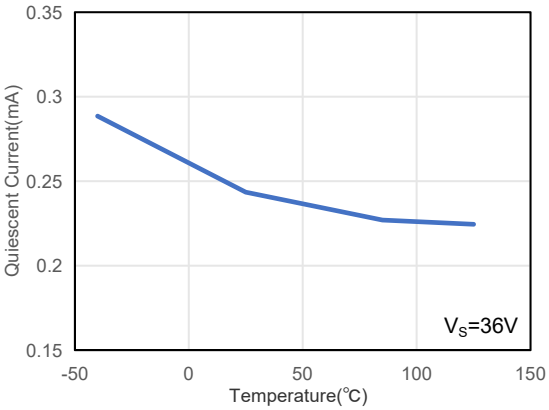
CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Typical Performance Characteristics

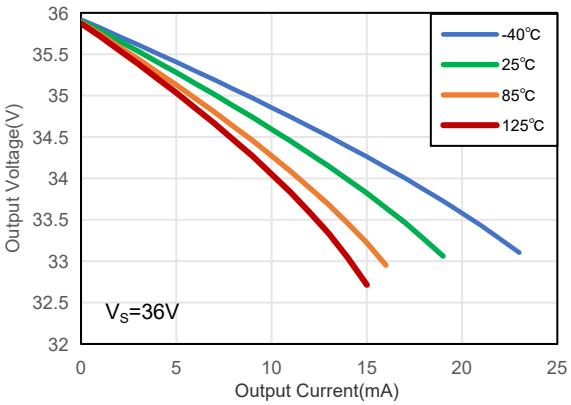
At T_A = +25 °C, V_{CM} = V_S/2, and R_L = 10 kΩ connected to V_S/2, unless otherwise noted.



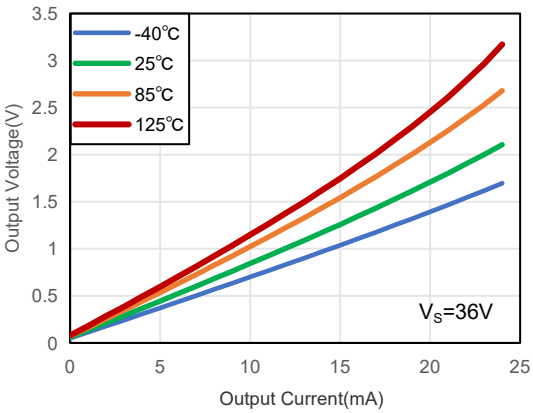
Quiescent Current as a function of Supply Voltage



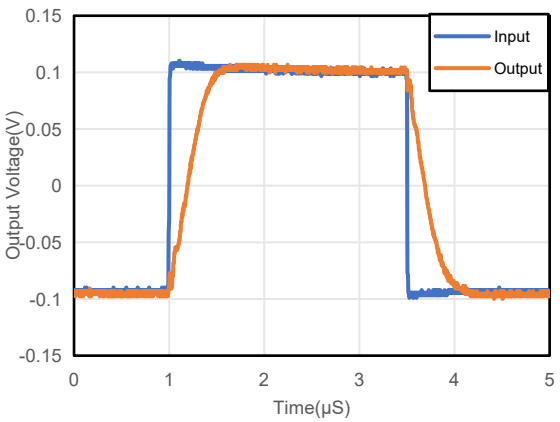
Quiescent Current as a function of Temperature



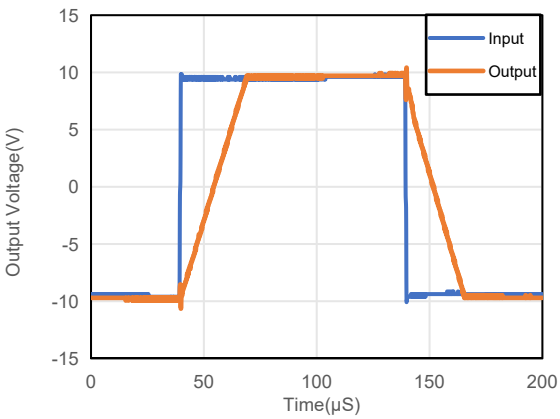
Output Voltage Swing as a function of Output Current (Sourcing, V_S = 36 V)



Output Voltage Swing as a function of Output Current (Sinking, V_S = 36 V)



Small-Signal Step Response

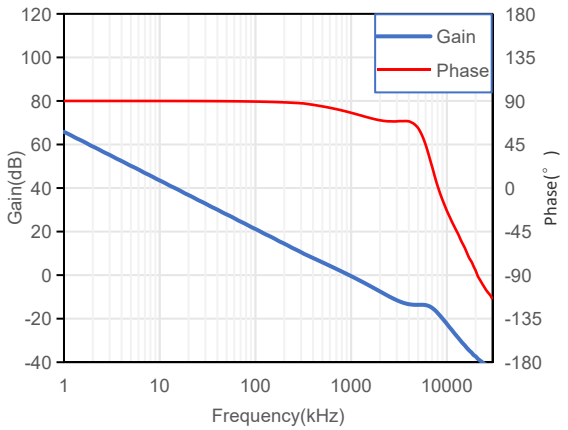


Large-Signal Step Response

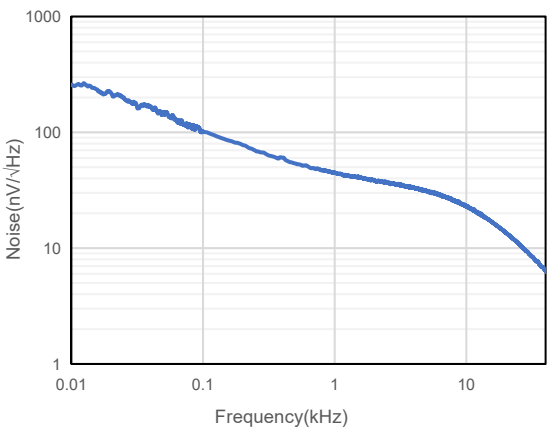
CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Typical Performance Characteristics (continued)

At T_A = +25 °C, V_{CM} = V_S/2, and R_L = 10 kΩ connected to V_S/2, unless otherwise noted.



Open-Loop Gain and Phase vs. Frequency

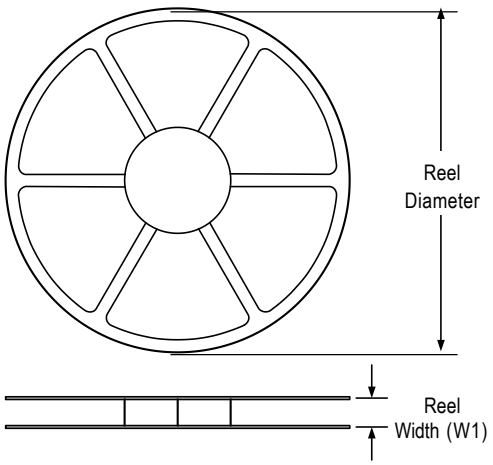


Voltage Noise Density vs. Frequency

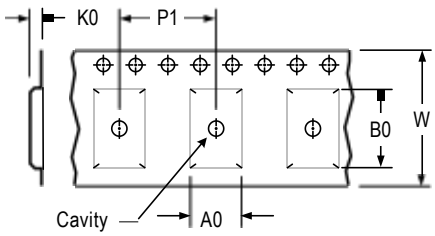
CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Tape and Reel Information

REEL DIMENSIONS

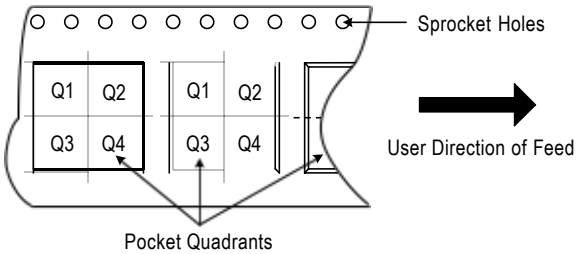


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIETATION IN TAPE



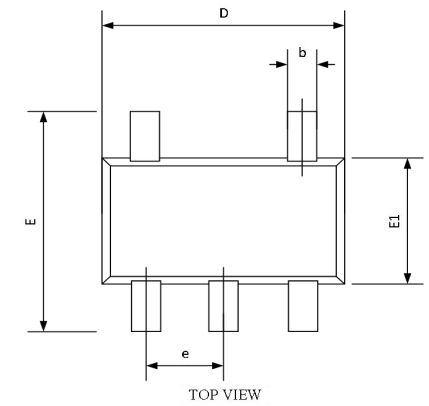
* All dimensions are nominal.

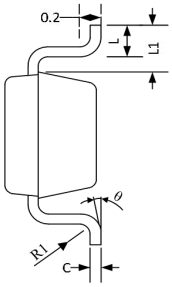
Device	Package Type	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin 1 Quadrant
LTA6321XT5/R6	SOT23	5	3 000	178	9.5	3.3	3.2	1.5	4.0	8.0	Q3
LTA6321UXT5/R6	SOT23	5	3 000	178	9.5	3.3	3.2	1.5	4.0	8.0	Q3
LTA6321XS8/R8	SOIC	8	4 000	330	12.5	6.6	5.3	2.0	8.0	12.0	Q1
LTA6321XV8/R6	MSOP	8	3 000	330	12.5	5.0	3.5	2.0	8.0	12.0	Q1
LTA6358XV8/R6	MSOP	8	3 000	330	12.5	5.0	3.5	2.0	8.0	12.0	Q1
LTA6358XS8/R8	SOIC	8	4 000	330	12.5	6.6	5.3	2.0	8.0	12.0	Q1
LTA6358XF8/R6	DFN3×3	8	3 000	330	12.5	3.3	3.3	1.1	8.0	12.0	Q1
LTA6324XS14/R5	SOIC	14	2 500	330	16.5	6.5	9.5	2.0	8.0	16.0	Q1
LTA6324XT14/R6	TSSOP	14	3 000	330	16.5	6.9	5.5	1.3	8.0	16.0	Q1

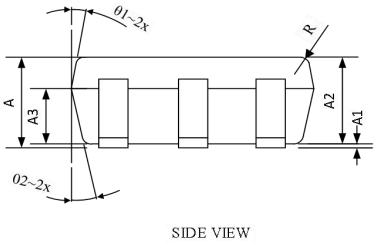
CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Package Outlines

DIMENSIONS, SOT23-5L

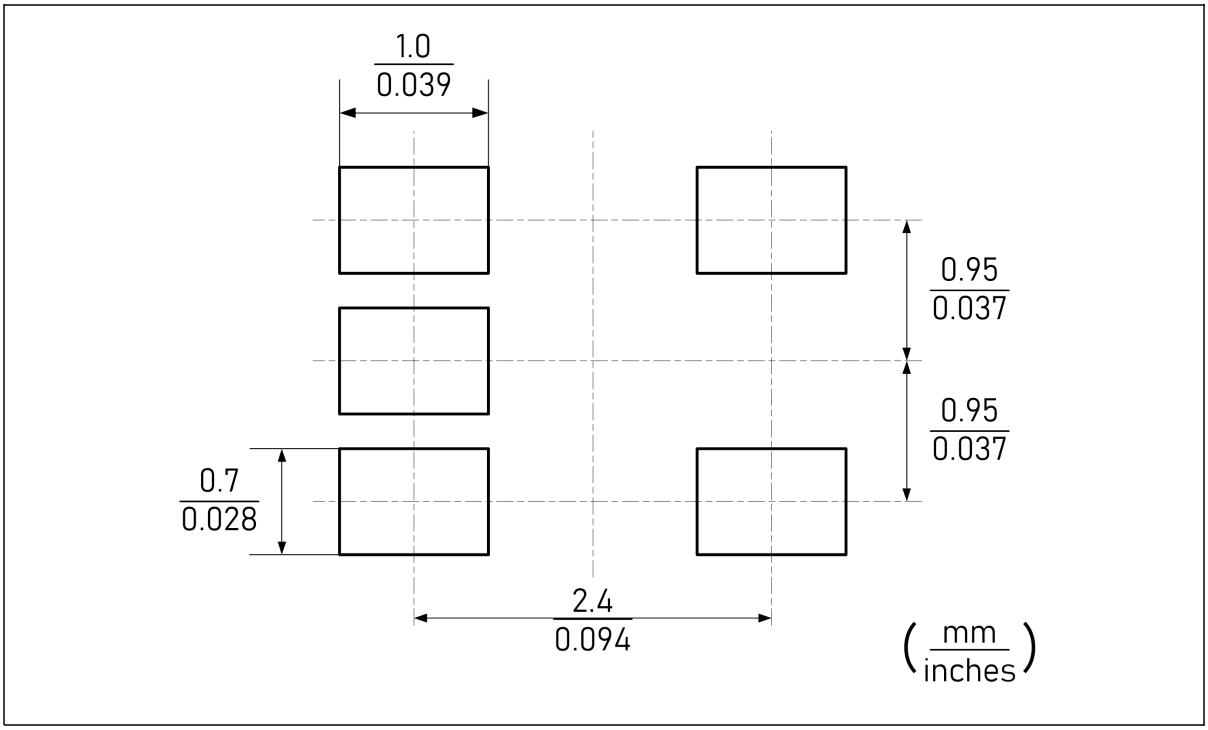






SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	1.06	1.15	1.25
A1	0.01	0.05	0.10
A2	1.00	1.10	1.20
A3	0.65	0.70	0.75
b	0.30	0.35	0.45
c	0.127 REF		
D	2.82	2.92	3.02
E	2.60	2.80	3.00
E1	1.50	1.60	1.70
e	0.95 BSC		
L	0.30	0.40	0.60
L1	0.55	0.60	0.65
R	0.10 REF		
R1	0.12 REF		
θ	0	-	8°
θ1	8°	10°	12°
θ2	10°	12°	14°

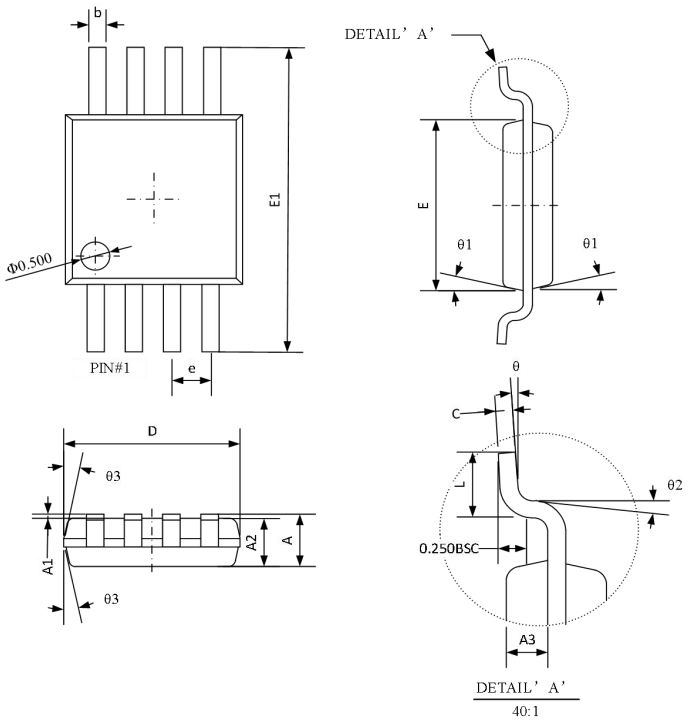
RECOMMENDED SOLDERING FOOTPRINT, SOT23-5L



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

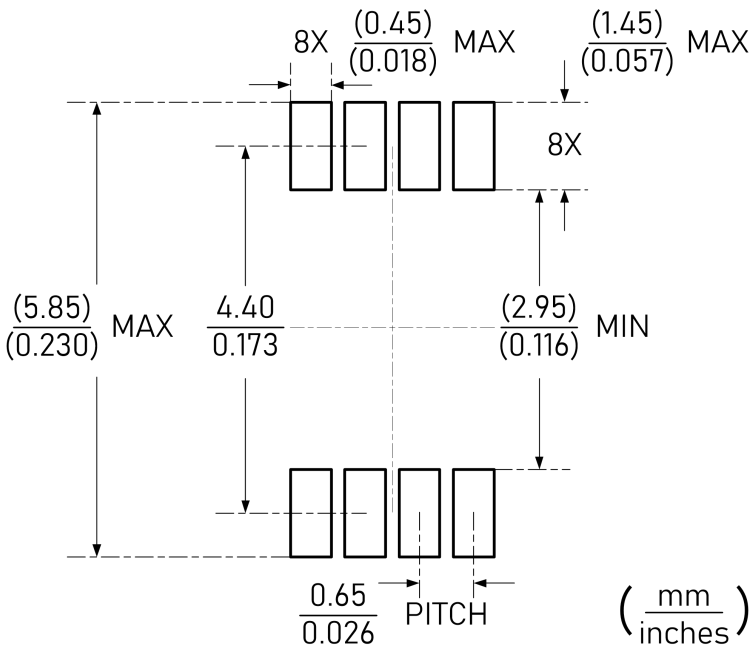
Package Outlines (continued)

DIMENSIONS, MSOP-8L



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.800	0.930	1.100
A1	0.020	0.080	0.150
A2	0.750	0.850	0.950
A3	0.249	0.349	0.449
c	0.090	0.152	0.230
E	2.900	3.000	3.100
E1	4.700	4.900	5.100
L	0.400	0.600	0.800
b	0.250	0.300	0.380
D	2.900	3.000	3.100
e	0.650 BSC		
θ	0°	3°	8°
θ1	12° REF		
θ2	4° REF		
θ3	12° REF		

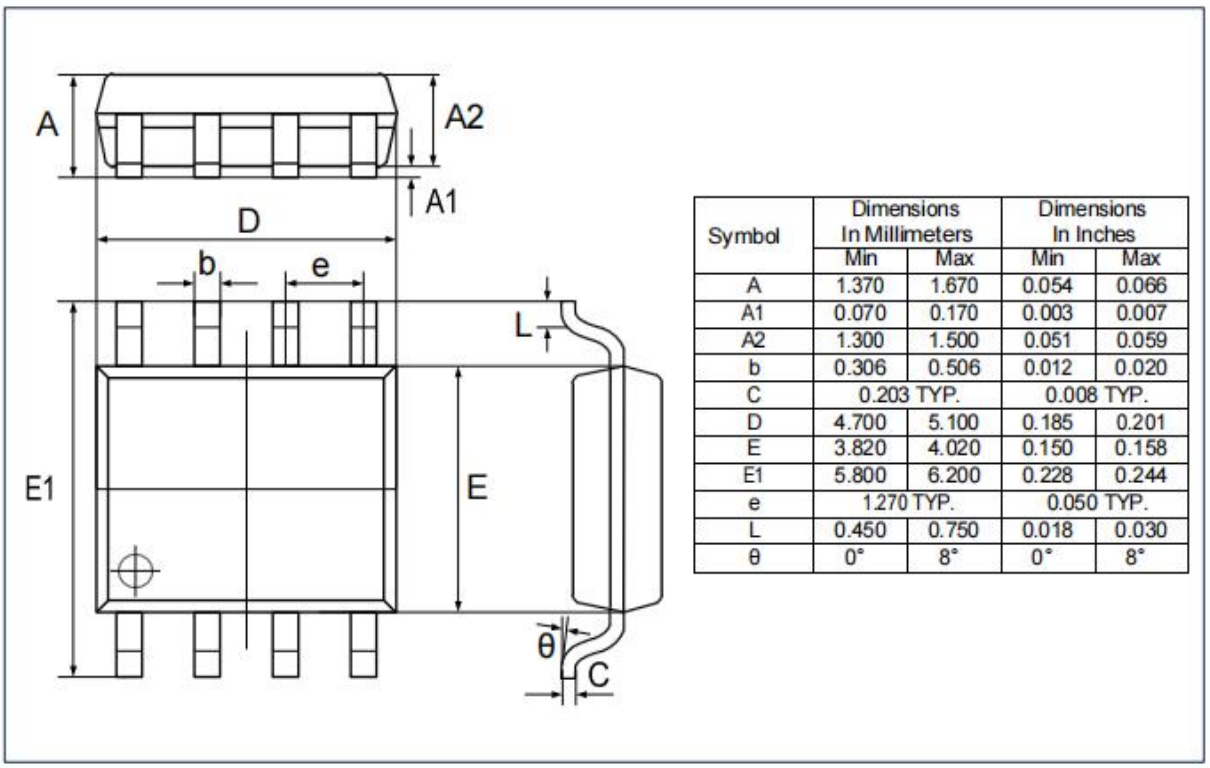
RECOMMENDED SOLDERING FOOTPRINT, MSOP-8L



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

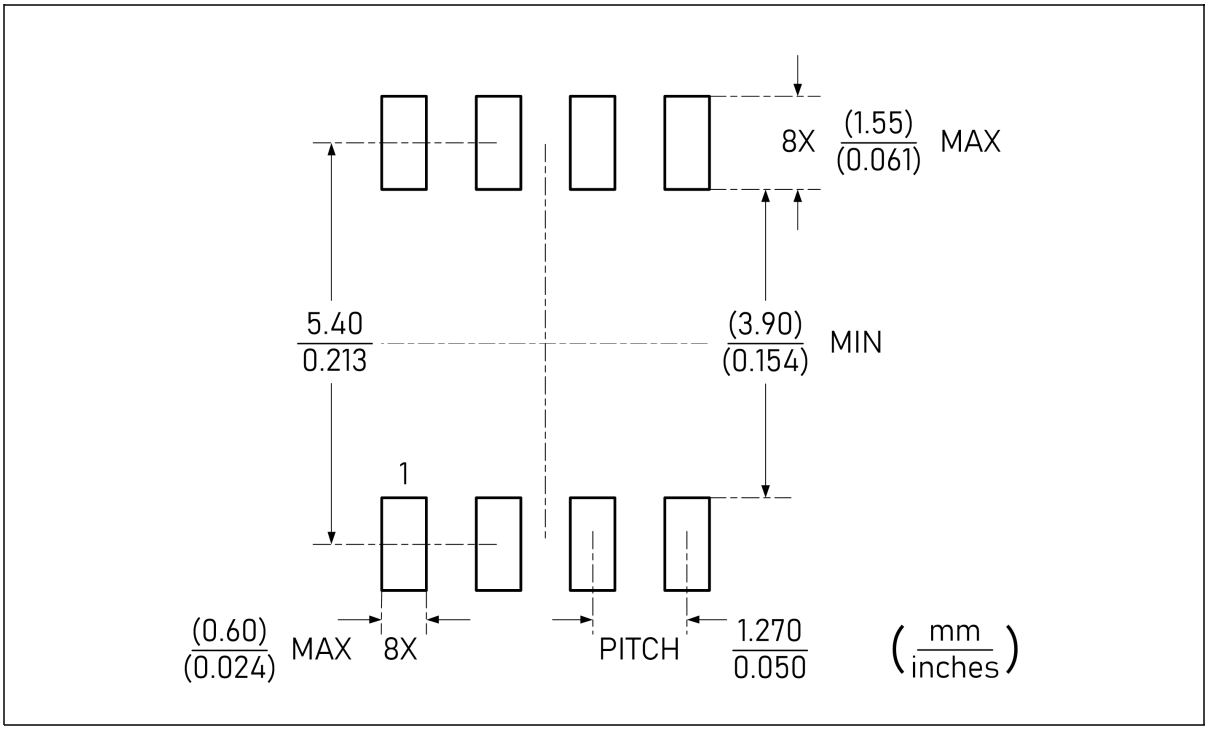
Package Outlines (continued)

DIMENSIONS. SOIC-8L



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	1.370	1.670	0.054	0.066
A1	0.070	0.170	0.003	0.007
A2	1.300	1.500	0.051	0.059
b	0.306	0.506	0.012	0.020
C	0.203 TYP.		0.008 TYP.	
D	4.700	5.100	0.185	0.201
E	3.820	4.020	0.150	0.158
E1	5.800	6.200	0.228	0.244
e	1.270 TYP.		0.050 TYP.	
L	0.450	0.750	0.018	0.030
θ	0°	8°	0°	8°

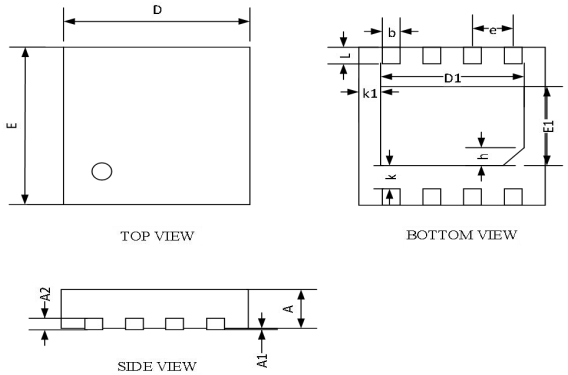
RECOMMENDED SOLDERING FOOTPRINT, SOIC-8L



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Package Outlines (continued)

DIMENSIONS, DFN3x3-8L

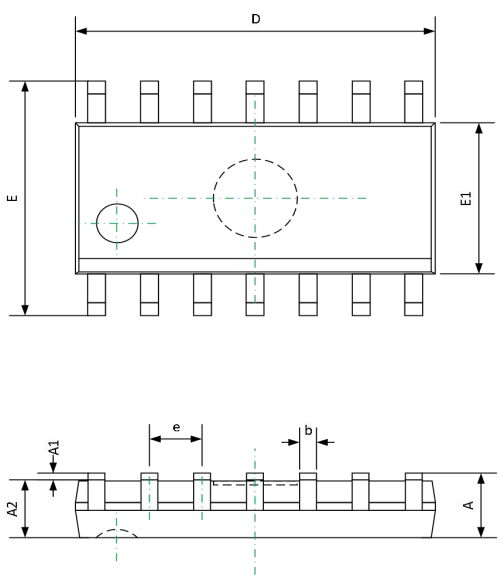


SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
b	0.25	0.28	0.31
A2		0.21 BSC	
D	2.90	3.00	3.10
E	2.90	3.00	3.10
E1	1.45	1.50	1.55
D1	2.25	2.30	2.35
e		0.65 REF	
L	0.25	0.30	0.35
h		0.49 REF	
k1	0.30	0.35	0.40
k	0.40	0.45	0.50

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

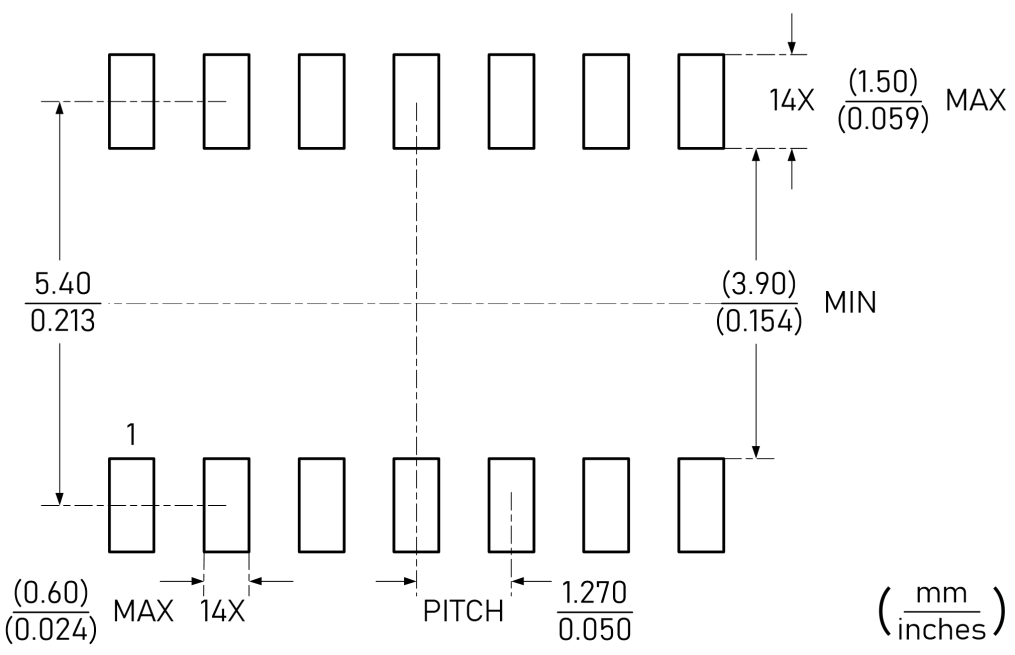
Package Outlines (continued)

DIMENSIONS, SOIC-14L



Symbol	Dimensions in Millimeters		Dimensions in inches	
	Min.	Max.	Min.	Max.
A	1.450	1.850	0.057	0.073
A1	0.100	0.300	0.004	0.012
A2	1.350	1.550	0.053	0.061
b	0.406TYP.		0.016TYP.	
C	0.203TYP.		0.008TYP.	
D	8.630	8.830	0.340	0.336
E	5.840	6.240	0.230	0.246
E1	3.850	4.050	0.152	0.159
e	1.270(TYP)		0.050(TYP)	
L	0.350	0.750	0.014	0.030
θ	2°	8°	2°	8°

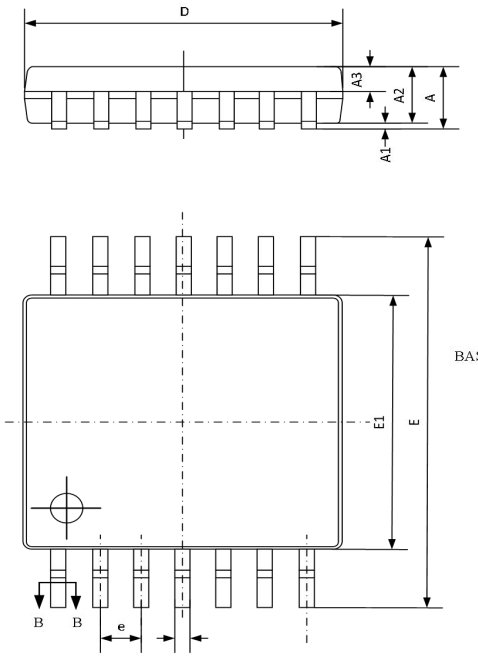
RECOMMENDED SOLDERING FOOTPRINT, SOIC-14L



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

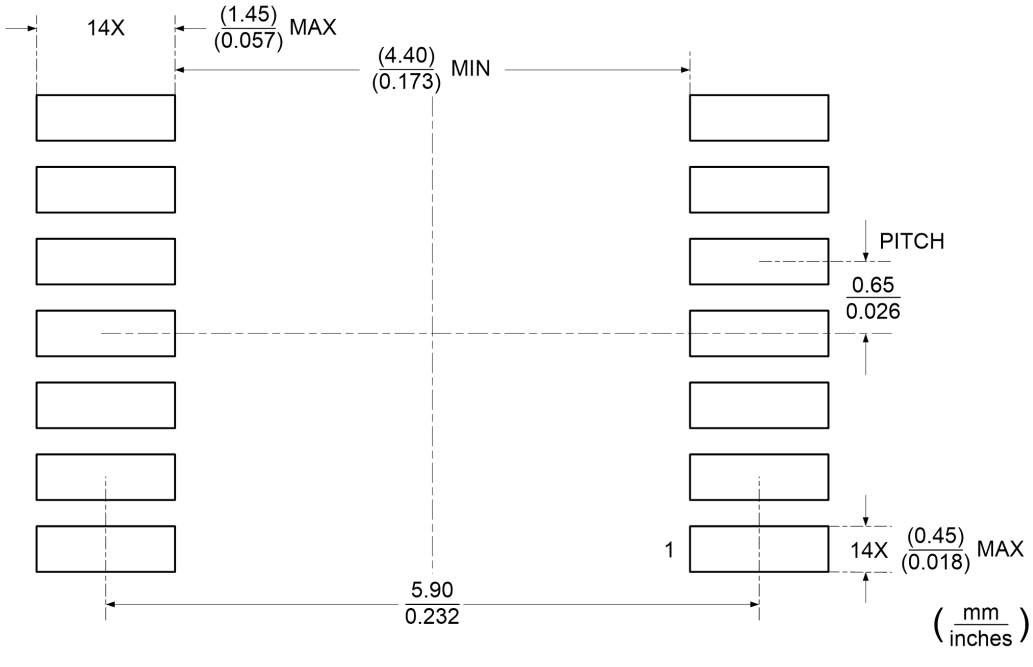
Package Outlines (continued)

DIMENSIONS, TSSOP-14L



SYMBOL	MILLIMETER		
	MIN	NOM	MAX
A	-	-	1.200
A1	0.050	-	0.150
A2	0.900	1.000	1.050
A3	0.390	0.440	0.490
b	0.200	-	0.280
b1	0.190	0.220	0.250
c	0.130	-	0.170
c1	0.120	0.130	0.140
D	4.860	5.000	5.100
E1	4.300	4.400	4.500
E	6.200	6.400	6.600
e	0.65 BSC		
L	0.450	0.600	0.750
L1	1.00 BSC		
θ	0	-	8°

RECOMMENDED SOLDERING FOOTPRINT, TSSOP-14L



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.

Important Notice

Linearin is a global fabless semiconductor company specializing in advanced high-performance high-quality analog/mixed-signal IC products and sensor solutions. The company is devoted to the innovation of high performance, analog-intensive sensor front-end products and modular sensor solutions, applied in multi-market of medical & wearable devices, smart home, sensing of IoT, intelligent industrial & smart factory (industrie 4.0), and automotives. Linearin's product families include widely-used standard catalog products, solution-based application specific standard products (ASSPs) and sensor modules that help customers achieve faster time-to-market products. Go to http://www.linearin.com for a complete list of Linearin product families.

For additional product information, or full datasheet, please contact with the Linearin's Sales Department or Representatives.

CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.
Linearin and designs are registered trademarks of Linearin Technology Corporation.
© Copyright Linearin Technology Corporation. All Rights Reserved.
All other trademarks mentioned are the property of their respective owners.