MICROCHIP

MIC49300

3A Low Voltage LDO Regulator with Dual Input Voltages

Features

- Input Voltage Range:
  - V_{IN}: 1.4V to 6.5V
  - V_{BIAS}: 3.0V to 6.5V
- Stable with 1 µF Ceramic Capacitor
- ±1% Initial Tolerance
- Maximum Dropout Voltage ($V_{IN} – V_{OUT}$) of 500 mV over Temperature
- Adjustable Output Voltage Down to 0.9V
- Ultra-Fast Transient Response (Up to 10 MHz Bandwidth)
- Excellent Line and Load Regulation Specifications
- Logic Controlled Shutdown Option
- Thermal Shutdown and Current Limit Protection
- Power S-Pak Package
- Junction Temperature Range of –40°C to +125°C

Applications

- Graphics Processors
- PC Add-In Cards
- Microprocessor Core Voltage Supply
- Low Voltage Digital ICs
- High Efficiency Linear Power Supplies
- SMPS Post Regulators

General Description

The MIC49300 is a high-bandwidth, low-dropout, 3.0A voltage regulator ideal for powering core voltages of low-power microprocessors. The MIC49300 implements a dual supply configuration that allows for very low output impedance and very fast transient response.

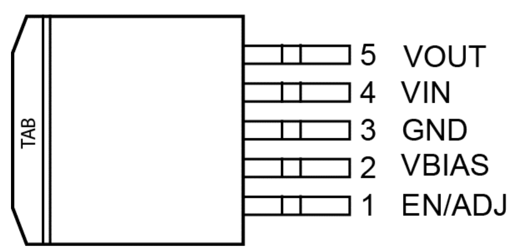
The MIC49300 requires a bias input supply and a main input supply, allowing for ultra-low input voltages on the main supply rail. The input supply operates from 1.4V to 6.5V and the bias supply requires between 3V and 6.5V for proper operation. The MIC49300 offers fixed output voltages from 0.9V to 1.8V and adjustable output voltages down to 0.9V.

The MIC49300 requires a minimum of output capacitance for stability, working optimally with small ceramic capacitors.

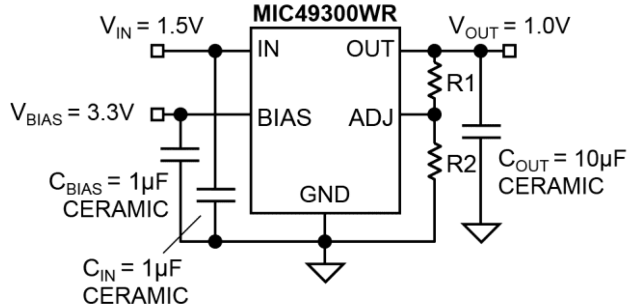
The MIC49300 is available in a 5-lead S-Pak. It operates over a junction temperature range of –40°C to +125°C.

Package Type

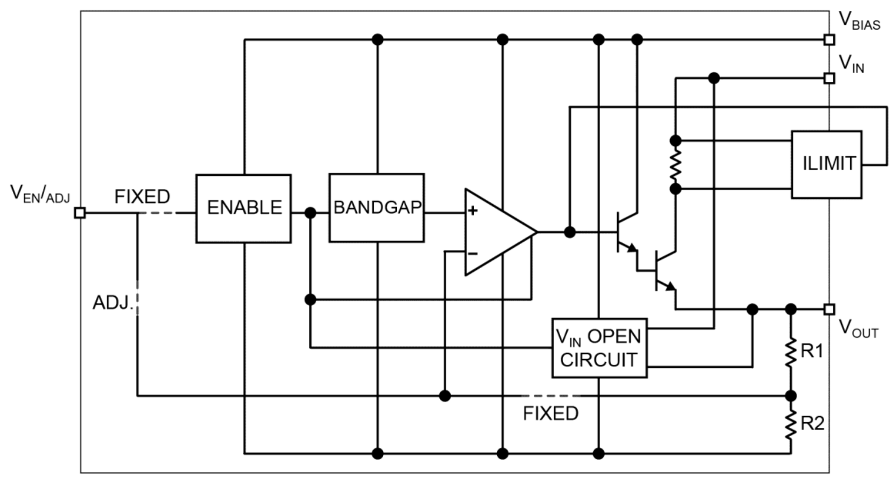
MIC49300
5-Lead S-Pak (R)
(Top View)



Typical Application Circuit



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{IN}) .... +8V
Bias Supply Voltage (V_{BIAS}) .... +8V
Enable Input Voltage (V_{EN}) .... +8V
Power Dissipation .... Internally Limited
ESD Rating (Note 1) .... 2 kV

Operating Ratings ‡

Supply Voltage (V_{IN}) .... +1.4V to +6.5V
Bias Supply Voltage (V_{BIAS}) .... +3V to +6.5V
Enable Input Voltage (V_{EN}) .... 0V to V_{BIAS}

† Notice: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operational sections of this specification is not intended. Exposure to maximum rating conditions for extended periods may affect device reliability.

‡ Notice: The device is not guaranteed to function outside its operating ratings.

Note 1: Device is ESD sensitive. Handling precautions are recommended. Human body model, 1.5 kΩ in series with 100 pF.

ELECTRICAL CHARACTERISTICS

T_A = +25°C with V_{BIAS} = V_{OUT} + 2.1V; V_{IN} = V_{OUT} + 1V; **bold** values valid for –40°C ≤ T_J ≤ +125°C, unless noted. Note 1

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage Accuracy	V_{OUT}	–1	—	1	%	At 25°C, fixed voltage options over temperature range
		–2	—	**2**		
Line Regulation	$\Delta V_{OUT}/(V_{OUT} \times \Delta V_{IN})$	**–0.1**	0.01	**0.1**	%/V	V_{IN} = 2.0V to 6.5V
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.2	**0.5**	%	I_L = 0 mA to 3A
Dropout Voltage	$V_{IN} – V_{OUT}$	—	125	**200**	mV	I_L = 1.5A
		—	280	**400**		I_L = 3A
Dropout Voltage (Note 2)	$V_{BIAS} – V_{OUT}$	—	1.5	**2.1**	V	I_L = 3A
Ground Pin Current (Note 3)	I_{GND}	—	25	—	mA	I_L = 0 mA
		—	25	**50**		I_L = 3A
Ground Pin Current in Shutdown	I_{GND_SHDN}	—	0.07	**5**	µA	V_{EN} ≤ 0.6V, (I_{BIAS} + I_{CC}), Note 3
Current through VBIAS	I_{BIAS}	—	20	**35**	mA	I_L = 0 mA
		—	50	**150**		I_L = 3A
Current Limit	I_{LIM}	—	6.5	**9**	A	V_{OUT} = 0V

ELECTRICAL CHARACTERISTICS (CONTINUED)

T_A = +25°C with $V_{BIAS} = V_{OUT}$ + 2.1V; $V_{IN} = V_{OUT}$ + 1V; **bold** values valid for –40°C ≤ T_J ≤ +125°C, unless noted. Note 1

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Enable Input (Note 4)						
Enable Input Threshold	V_{IH}	**1.6**	—	—	V	Regulator enable
	V_{IL}	—	—	**0.6**		Regulator shutdown
Enable Input Current	I_{IN}	—	0.1	1.0	µA	—
Reference						
Reference Voltage	V_{REF}	0.891	0.9	0.909	V	Adjustable option only
		0.882	—	**0.918**		

Note 1: Specification for packaged product only.

2: For V_{OUT} ≤ 1V, V_{BIAS} dropout specification does not apply due to a minimum 3V V_{BIAS} input.

3: $I_{GND} = I_{BIAS} + (I_{IN} – I_{OUT})$. At high loads, input current on V_{IN} will be less than the output current, due to drive current being supplied by V_{BIAS}.

4: Fixed output voltage versions only.

TEMPERATURE SPECIFICATIONS

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Junction Temperature Range	T_J	–40	—	+125	°C	—
Package Thermal Resistances						
Thermal Resistance, S-Pak 5-Ld	θ_{JC}	—	2	—	°C/W	—

2.0 TYPICAL PERFORMANCE CURVES

Note: The graphs and tables provided following this note are a statistical summary based on a limited number of samples and are provided for informational purposes only. The performance characteristics listed herein are not tested or guaranteed. In some graphs or tables, the data presented may be outside the specified operating range (e.g., outside specified power supply range) and therefore outside the warranted range.

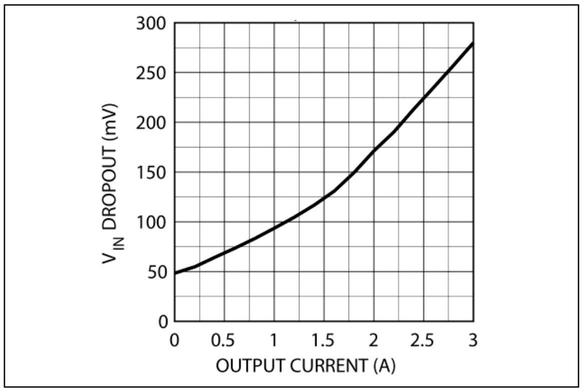


FIGURE 2-1: *V_{IN} Dropout vs. Output Current.*

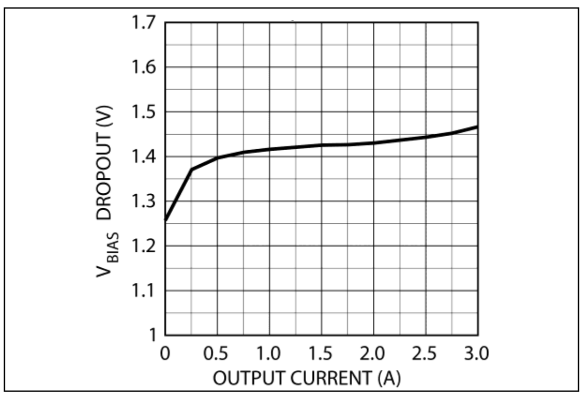


FIGURE 2-2: *V_{BIAS} Dropout vs. Output Current.*

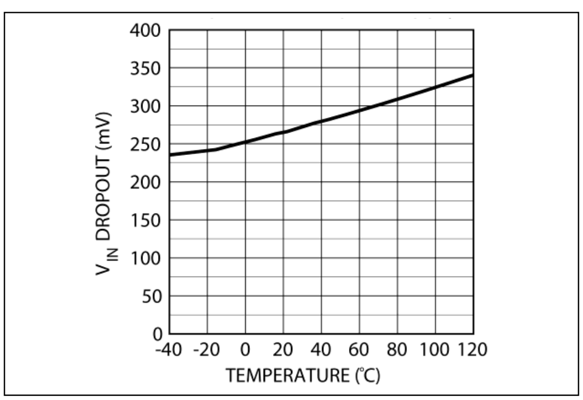


FIGURE 2-3: *Dropout vs. Temperature (Input Supply).*

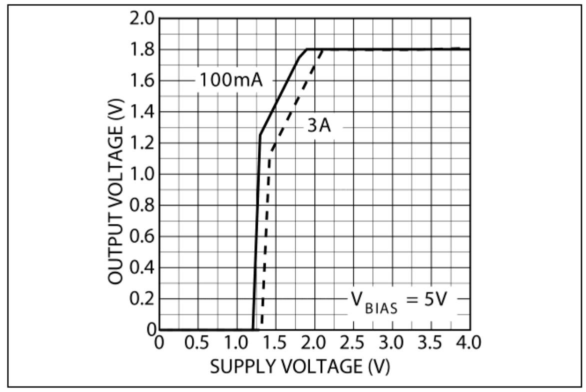


FIGURE 2-4: *Dropout Characteristics.*

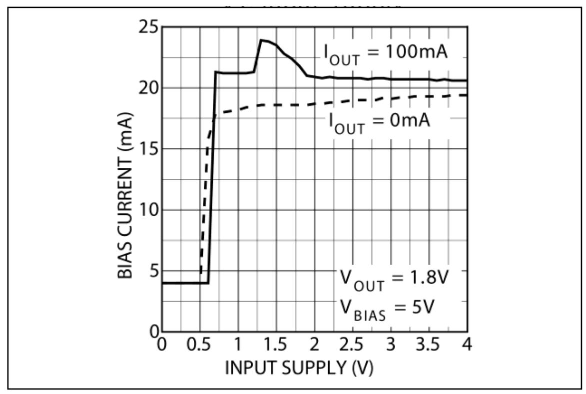


FIGURE 2-5: *Bias Current vs. Input Supply.*

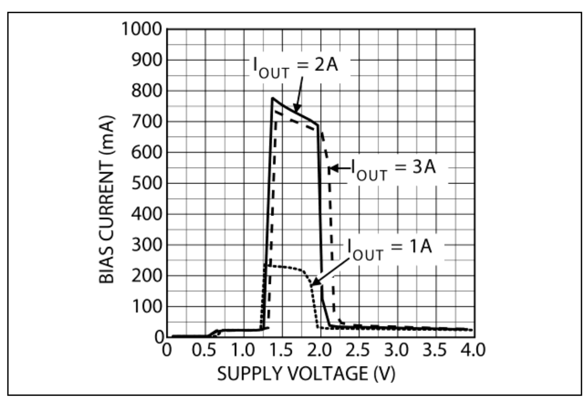


FIGURE 2-6: *Bias Current vs. Supply Voltage.*

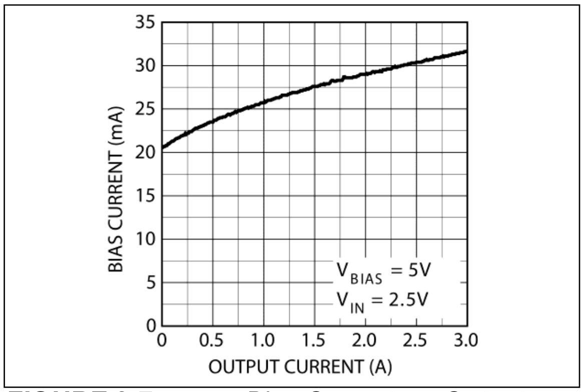


FIGURE 2-7: *Bias Current vs. Output Current.*

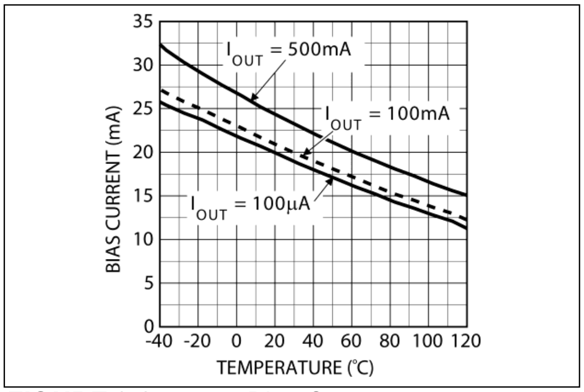


FIGURE 2-8: *Bias Current vs. Temperature.*

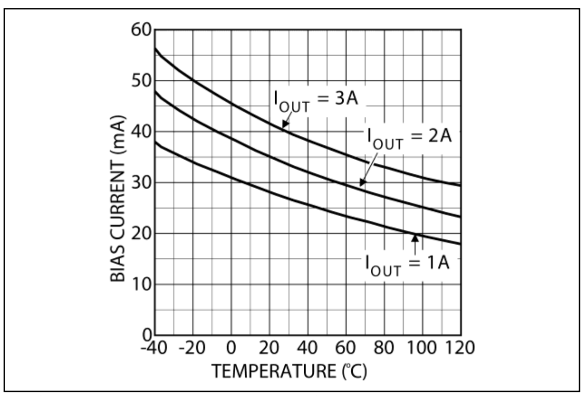


FIGURE 2-9: *Bias Current vs. Temperature.*

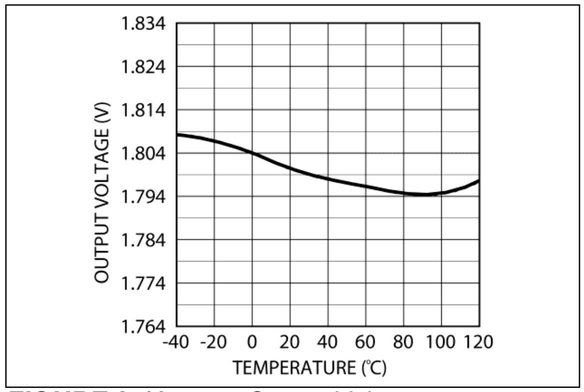


FIGURE 2-10: *Output Voltage vs. Temperature.*

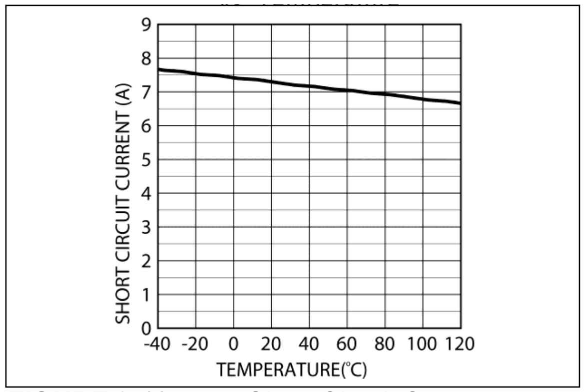


FIGURE 2-11: *Short-Circuit Current vs. Temperature.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number	Pin Name	Description
1	EN	Enable (input): CMOS-compatible input. Logic high = enable, logic low = shutdown.
	ADJ	Adjustable regulator feedback input. Connect to resistor voltage divider.
2	VBIAS	Input bias voltage for powering all circuitry on the regulator with the exception of the output power device.
3	GND	Ground (TAB is connected to ground on S-Pak).
4	VIN	Input voltage that supplies current to the output power device.
5	VOUT	Regulator output.

4.0 APPLICATION INFORMATION

The MIC49300 is an ultra-high performance, low dropout linear regulator designed for high current applications that require fast transient response. The MIC49300 utilizes two input supplies, significantly reducing dropout voltage, perfect for low-voltage, DC-to-DC conversion. The MIC49300 requires a minimum of external components and obtains a bandwidth of up to 10 MHz. As a µCap regulator, the output is tolerant of virtually any type of capacitor including ceramic and tantalum.

The MIC49300 regulator is fully protected from damage due to fault conditions, offering linear current limiting and thermal shutdown.

4.1 Bias Supply Voltage

VBIAS, which requires relatively light current, provides power to the control portion of the MIC49300. VBIAS requires approximately 33 mA for a 1.5A load current. Dropout conditions require higher currents. Most of the biasing current is used to supply the base current to the pass transistor. This allows the pass element to be driven into saturation, reducing the dropout to 300 mV at a 1.5A load current. Bypassing on the bias pin is recommended to improve performance of the regulator during line and load transients. Small ceramic capacitors from VBIAS to ground help reduce high frequency noise from being injected into the control circuitry from the bias rail and are good design practice. Good bypass techniques typically include one larger capacitor such as a 1 µF ceramic and smaller valued capacitors such as 0.01 µF or 0.001 µF in parallel with that larger capacitor to decouple the bias supply. The V_{BIAS} input voltage must be 1.6V above the output voltage with a minimum V_{BIAS} input voltage of 3V.

4.2 Input Supply Voltage

VIN provides the high current to the collector of the pass transistor. The minimum input voltage is 1.4V, allowing conversion from low voltage supplies.

4.3 Output Capacitor

The MIC49300 requires a minimum of output capacitance to maintain stability. However, proper capacitor selection is important to ensure desired transient response. The MIC49300 is specifically designed to be stable with virtually any capacitance value and ESR. A 1 µF ceramic chip capacitor should satisfy most applications. Output capacitance can be increased without bound. See the Typical Performance Curves for examples of load transient response.

X7R dielectric ceramic capacitors are recommended because of their temperature performance. X7R-type capacitors change capacitance by 15% over their operating temperature range and are the most stable type of ceramic capacitors. Z5U and Y5V dielectric capacitors change value by as much as 50% and 60%, respectively, over their operating temperature ranges. To use a ceramic chip capacitor with Y5V dielectric, the value must be much higher than an X7R ceramic or a tantalum capacitor to ensure the same capacitance value over the operating temperature range. Tantalum capacitors have a very stable dielectric (10% over their operating temperature range) and can also be used with this device.

4.4 Input Capacitance

An input capacitor of 1 µF or greater is recommended when the device is more than 4 inches away from the bulk supply capacitance, or when the supply is a battery. Small, surface-mount, ceramic chip capacitors can be used for the bypassing. The capacitor should be placed within 1 inch of the device for optimal performance. Larger values will help to improve ripple rejection by bypassing the input to the regulator, further improving the integrity of the output voltage.

4.5 Thermal Design

Linear regulators are simple to use. The most complicated design parameters to consider are thermal characteristics. Thermal design requires the following application-specific parameters:

- Maximum ambient temperature (T_A)
- Output Current (I_{OUT})
- Output Voltage (V_{OUT})
- Input Voltage (V_{IN})
- Ground Current (I_{GND})

First, calculate the power dissipation of the regulator from these numbers and the device parameters from this data sheet.

EQUATION 4-1:

$$P_D = V_{IN} \times I_{IN} + V_{BIAS} \times I_{BIAS} - V_{OUT} \times I_{OUT}$$

The input current will be less than the output current at high output currents as the load increases. The bias current is a sum of base drive and ground current. Ground current is constant over load current. Then the heat sink thermal resistance is determined with this formula:

EQUATION 4-2:

$$\theta_{SA} = \frac{T_{J(MAX)} + T_A}{P_D - (\theta_{JC} + \theta_{CS})}$$

The heat sink may be significantly reduced in applications where the maximum input voltage is known and large compared with the dropout voltage. Use a series input resistor to drop excessive voltage and distribute the heat between this resistor and the regulator. The low dropout properties of the MIC49300 allow significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 1 µF is needed directly between the input and regulator ground. Refer to Application Note 9 for further details and examples on thermal design and heat sink specification.

4.6 Minimum Load Current

The MIC49300, unlike most other high current regulators, does not require a minimum load to maintain output voltage regulation.

4.7 Power Sequencing

There is no power sequencing requirement for VIN and VBIAS, giving more flexibility to the user.

4.8 Adjustable Regulator Design

The MIC49300 adjustable version allows programming the output voltage anywhere between 0.9Vand 5V. Two resistors are used. The resistor value between VOUT and the adjust pin should not exceed 1 kΩ. Larger values can cause instability. The resistor values are calculated by:

EQUATION 4-3:

$$R1 = R2 \times \left(\frac{V_{OUT}}{0.9} - 1\right)$$

Where:

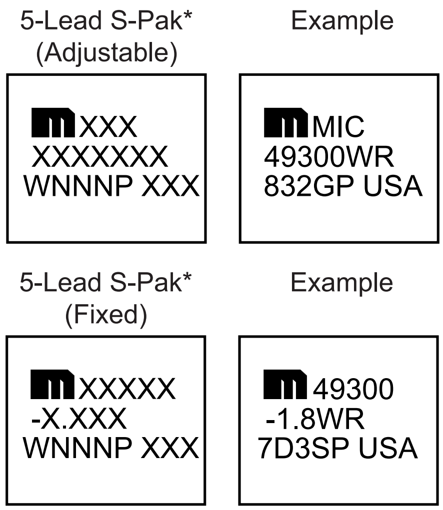
V_{OUT} is the desired output voltage.

4.9 Enable

The fixed output voltage versions of the MIC49300 feature an active high enable input (EN) that allows on-off control of the regulator. Current drain reduces to “zero” when the device is shut down, with only microamperes of leakage current. The EN input has TTL/CMOS compatible thresholds for simple logic interfacing. EN may be directly tied to VIN and pulled up to the maximum supply voltage.

5.0 PACKAGING INFORMATION

5.1 Package Marking Information



Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package is Pb-free. The Pb-free JEDEC designator ((e3)) can be found on the outer packaging for this package.
	●, ▲, ▼	Pin one index is identified by a dot, delta up, or delta down (triangle mark).

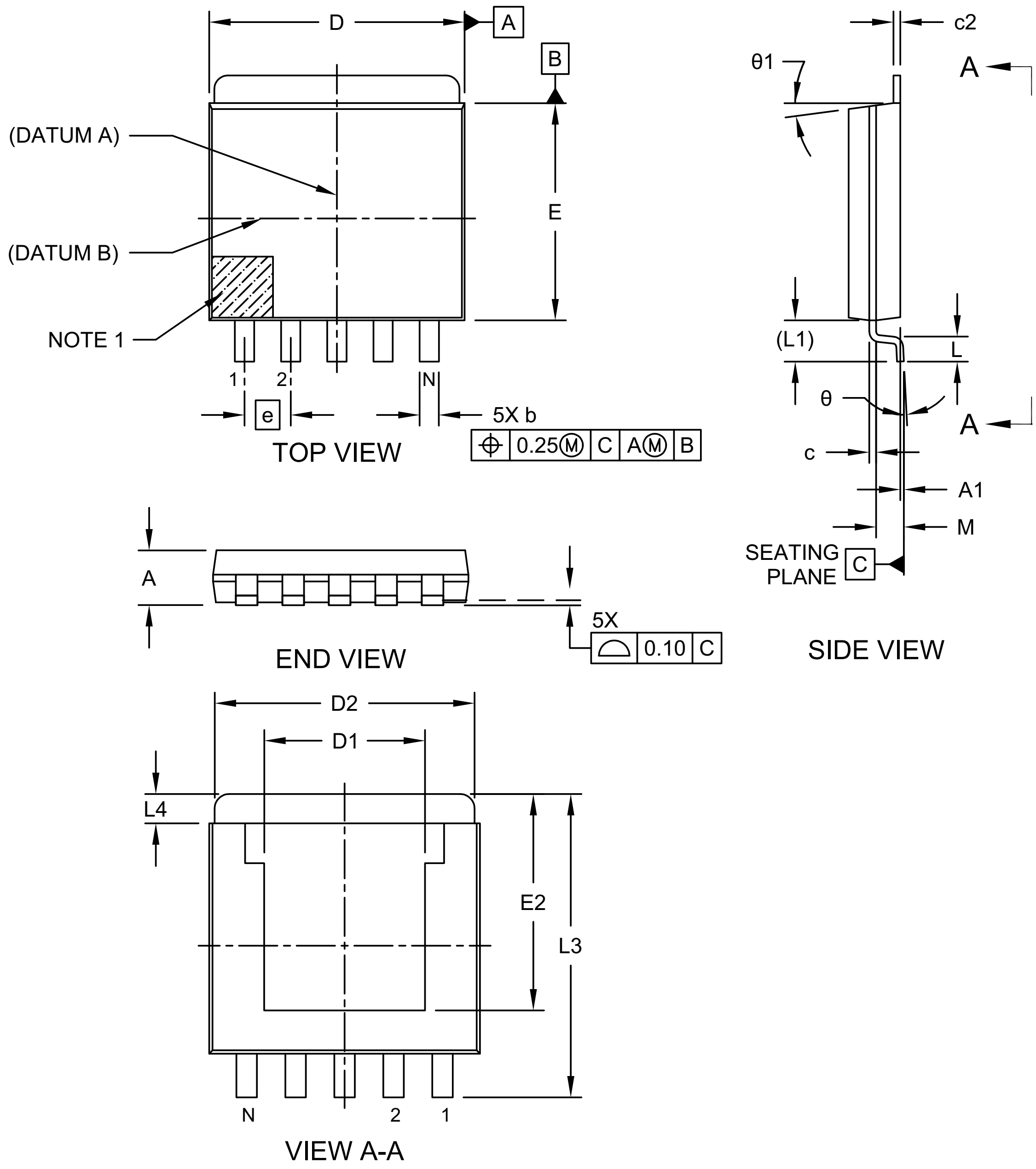
Note: In the event the full Microchip part number cannot be marked on one line, it will be carried over to the next line, thus limiting the number of available characters for customer-specific information. Package may or may not include the corporate logo.

Underbar (_) and/or Overbar (‾) symbol may not be to scale.

Note: If the full seven-character YYWWNNN code cannot fit on the package, the following truncated codes are used based on the available marking space:
6 Characters = YWWNNN; 5 Characters = WWNNN; 4 Characters = WNNN; 3 Characters = NNN;
2 Characters = NN; 1 Character = N

5-Lead Plastic Surface Flange-Mount Package (8BA) - [SPAK]
Micrel Legacy Package S-PAK-05L

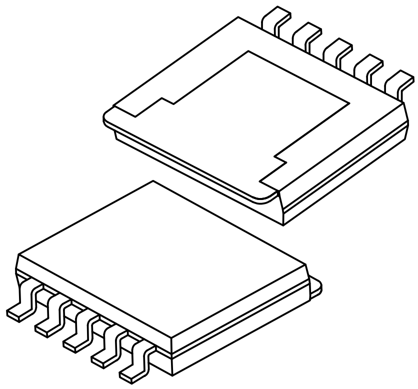
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1142 Rev A Sheet 1 of 2

5-Lead Plastic Surface Flange-Mount Package (8BA) - [SPAK]
Micrel Legacy Package S-PAK-05L

Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Units			Millimeters	
Dimension Limits		MIN	NOM	MAX
Number of Terminals	N		5	
Terminal Pitch	e		1.70 BSC	
Overall Height	A	1.78	1.91	2.03
Standoff	A1	0.03	0.08	0.13
Overall Width	D	9.27	9.40	9.52
Tab Width	D2	8.89	9.02	9.14
Exposed Pad Width	D1	5.45	5.58	5.71
Molded Package Length	E	7.87	8.00	8.13
Exposed Pad Length	E2	7.39	7.52	7.65
Terminal Width	b	0.63	0.71	0.79
Terminal Thickness	c	0.23	0.25	0.38
Tab Thickness	c2	0.23	0.25	0.38
Lead Length	L	0.79	0.92	1.04
Footprint	L1		1.53 REF	
Overall Length	L3	10.41	10.54	10.67
Tab Length	L4	0.76	1.02	1.27
Seating Plane to Leadframe	M	0.89	1.02	1.14
Footprint Angle	θ	0°	-	6°
Mold Draft Angle	θ1	0°	-	15°

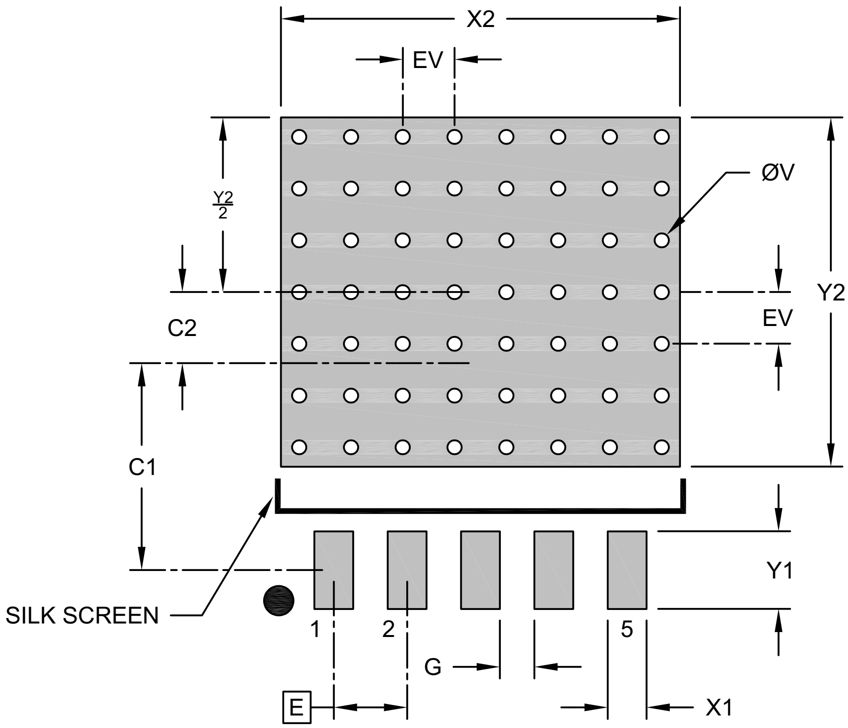
Notes:

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
   REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-1142 Rev A Sheet 2 of 2

5-Lead Plastic Surface Flange-Mount Package (8BA) - [SPAK]
Micrel Legacy Package S-PAK-05L

Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



RECOMMENDED LAND PATTERN

	Units	MILLIMETERS		
	Dimension Limits	MIN	NOM	MAX
Contact Pitch	E		1.70 BSC	
Center Pad Width	X2			9.25
Center Pad Length	Y2			8.10
Contact Pad to Footprint Center	C1		4.80	
Footprint Center to Center Pad	C2		1.65	
Contact Pad Width (X5)	X1			0.90
Contact Pad Length (X5)	Y1			1.80
Contact Pad to Contact Pad (X4)	G	0.80		
Thermal Via Diameter	V		0.33	
Thermal Via Pitch	EV		1.20	

Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-3142 Rev A

NOTES:

APPENDIX A: REVISION HISTORY

Revision A (February 2024)

- Converted Micrel document MIC49300 to Microchip data sheet DS20006874A.
- Minor text changes throughout.

NOTES:

PRODUCT IDENTIFICATION SYSTEM

To order or obtain information, e.g., on pricing or delivery, contact your local Microchip representative or sales office.

Part Number	-X.X	X	XX	-XX
Device	Output Voltage	Temperature Range	Package	Media Type

Device:	MIC49300:		3A Low Voltage LDO Regulator with Dual Input Voltages
Output Voltage:	<blank>	=	Adjustable
	0.9	=	0.9V
	1.2	=	1.2V
	1.5	=	1.5V
	1.8	=	1.8V
Temperature Range:	W	=	–40°C to +125°C
Package:	R	=	5-Lead S-Pak
Media Type:	<blank>	=	48/Tube
	TR	=	750/Reel

Examples:

a) MIC49300WR:	MIC49300, Adjustable Output Voltage, –40°C to +125°C Temp. Range, 5-Lead S-Pak, 48/Tube
b) MIC49300-0.9WR-TR:	MIC49300, 0.9V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead S-Pak, 750/Reel
c) MIC49300-1.2WR:	MIC49300, 1.2V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead S-Pak, 48/Tube
d) MIC49300-1.5WR-TR:	MIC49300, 1.5V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead S-Pak, 750/Reel
e) MIC49300-1.8WR:	MIC49300, 1.8V Output Voltage, –40°C to +125°C Temp. Range, 5-Lead S-Pak, 48/Tube

Note: Tape and Reel identifier only appears in the catalog part number description. This identifier is used for ordering purposes and is not printed on the device package. Check with your Microchip Sales Office for package availability with the Tape and Reel option.

NOTES:

Note the following details of the code protection feature on Microchip products:

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ISBN: 978-1-6683-4054-7

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09/14/21