MICROCHIP

MIC39300/01/02

3A, Low Voltage Low Dropout Regulator

Features

- 3.0A Minimum Guaranteed Output Current
- 550 mV Maximum Dropout Voltage over Temperature
- Ideal for 3.0V to 2.5V Conversion
- Ideal for 2.5V to 1.8V Conversion
- 1% Initial Accuracy
- Low Ground Current
- Current Limiting and Thermal Shutdown
- Reversed-Battery Protection
- Reversed-Leakage Protection
- Fast Transient Response
- TO-263 (D^2Pak) and TO-220 Packaging
- TTL/CMOS Compatible Enable Pin (MIC39301/2 Only)
- Error Flag Output (MIC39301 Only)
- Adjustable Output (MIC39302 Only)

Applications

- LDO Linear Regulator for PC Add-In Cards
- High-Efficiency Linear Power Supplies
- SMPS Post Regulator
- Multimedia and PC Processor Supplies
- Low Voltage Microcontrollers
- StrongARM Processor Supply

General Description

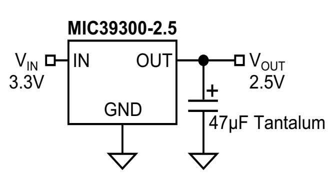
The MIC39300, MIC39301, and MIC39302 are 3.0A low-dropout linear voltage regulators that provide a low voltage, high-current output with a minimum of external components. Utilizing Microchip's proprietary Super βeta PNP pass element, the MIC39300/1/2 offers extremely low dropout (typically 385 mV at 3.0A) and low ground current (typically 45 mA at 3.0A).

The MIC39300/1/2 are ideal for PC add-in cards that need to convert from standard 3.3V to 2.5V or 2.5V to 1.8V. A guaranteed maximum dropout voltage of 550 mV over all operating conditions allows the MIC39300/1/2 to provide 2.5V from a supply as low as 3V, and 1.8V from a supply as low as 2.5V. The MIC39300/1/2 also have fast transient response for heavy switching applications. The device requires only 47 µF of output capacitance to maintain stability and achieve fast transient response.

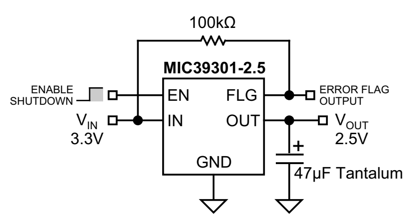
The MIC39300/1/2 are fully protected with overcurrent limiting, thermal shutdown, reversed-battery protection, reversed-leakage protection, and reversed-lead insertion. The MIC39301 offers a TTL-logic compatible enable pin and an error flag that indicates undervoltage and overcurrent conditions. Offered in fixed voltages, the MIC39300/1 come in the TO-220 and TO-263 (D^2Pak) packages and are an ideal upgrade to older, NPN-based linear voltage regulators. The MIC39302 adjustable option allows programming the output voltage anywhere between 1.24V and 15.5V and is offered in a 5-Pin TO-263 (D^2Pak) package.

Typical Application Circuits

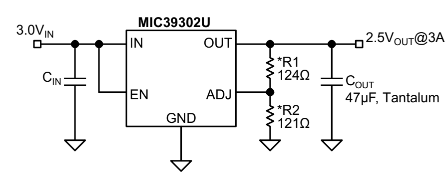
MIC39300



MIC39301



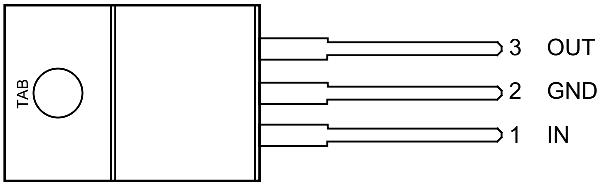
MIC39302 Adjustable Output Application



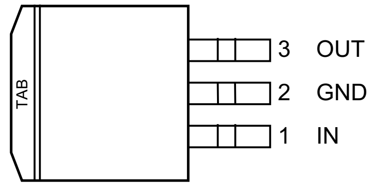
See the Minimum Load Current section.

Package Types

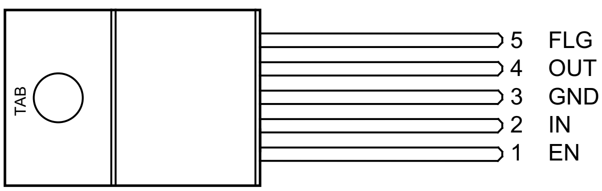
MIC39300-x.xWT
TO-220-3 (T)



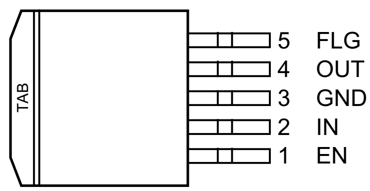
MIC39300-x.xWU
TO-263-3 (U)



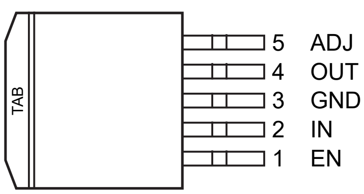
MIC39301-x.xWT
TO-220-5 (T)



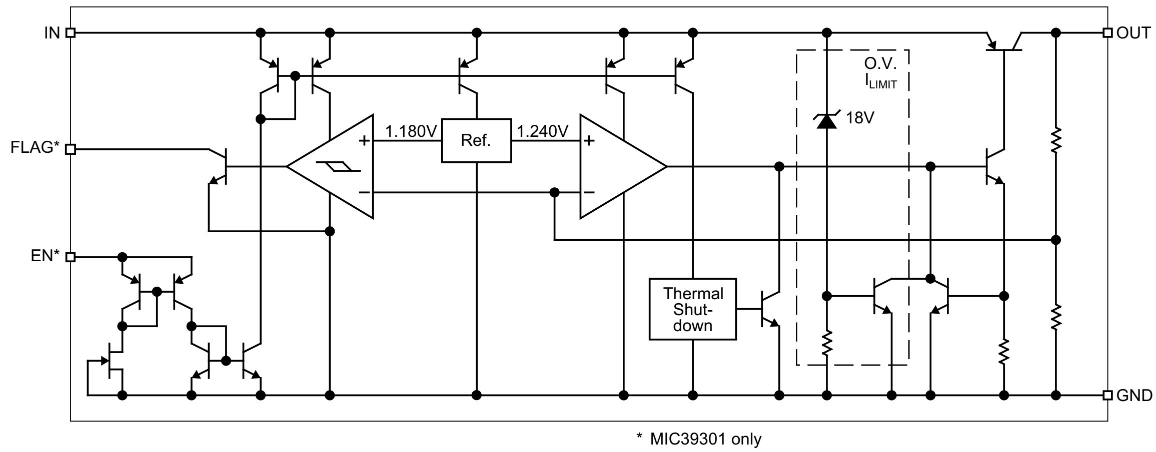
MIC39301-x.xWU
TO-263-5 (D^2Pak) (U)



MIC39302WU
TO-263-5 (D^2Pak) (U)



Functional Block Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings †

Supply Voltage (V_{IN})......-20V to +20V
Enable Voltage (V_{EN})......+20V
ESD Rating (Note 1)......ESD Sensitive

Operating Ratings ‡

Supply Voltage (V_{IN})......+2.5V to +16V
Enable Voltage (V_{EN})......+16V
Maximum Power Dissipation ($P_{D(max)}$)......(Note 2)

† 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. Specifications are for packaged product only.

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

Note 1: Devices are ESD sensitive. Handling precautions are recommended.

2: $P_{D(max)} = (T_{J(max)} – T_A) \div \theta_{JA}$, where θ_{JA} depends upon the printed circuit layout. See the Application Information section.

ELECTRICAL CHARACTERISTICS

Electrical Characteristics: T_J = 25°C, **Bold** values indicate -40°C ≤ T_J ≤ +125°C; unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage	V_{OUT}	-1	—	1	%	I_{OUT} =10 mA
		-2		**2**	%	10 mA ≤ I_{OUT} ≤ 3A,V_{OUT} + 1V ≤ V_{IN} ≤ 8V
Line Regulation	$\Delta V_{OUT}/\Delta V_{IN}$	—	0.06	0.5	%	I_{OUT} = 10 mA,V_{OUT} + 1V ≤ V_{IN} ≤ 8V
Load Regulation	$\Delta V_{OUT}/V_{OUT}$	—	0.2	1	%	V_{IN} = V_{OUT} + 1V,10 mA ≤ I_{OUT} ≤ 3A
Output Voltage Temperature Coefficient (Note 1)	$\Delta V_{OUT}/\Delta T$	—	**20**	**100**	ppm/°C	—
Dropout Voltage (Note 2), (Note 4)	V_{DO}	—	65	**200**	mV	I_{OUT} = 100 mA, ΔV_{OUT} = -1%
		—	185	—	mV	I_{OUT} = 750 mA, ΔV_{OUT} = -1%
		—	250	—	mV	I_{OUT} = 1.5A, ΔV_{OUT} = -1%
		—	385	**550**	mV	I_{OUT} = 3A, ΔV_{OUT} = -1%
Ground Current (Note 3)	I_{GND}	—	10	**20**	mA	I_{OUT} = 750 mA, V_{IN} = V_{OUT} + 1V
		—	17	—	mA	I_{OUT} = 1.5A, V_{IN} = V_{OUT} + 1V
		—	45	—	mA	I_{OUT} = 3A, V_{IN} = V_{OUT} + 1V
Dropout Ground Pin Current	$I_{GND(do)}$	—	6	—	mA	V_{IN} ≤ V_{OUT}(nominal) -0.5V, I_{OUT} = 10 mA
Current Limit	$I_{OUT(lim)}$	—	4.5	—	A	V_{OUT} = 0V, V_{IN} = V_{OUT} + 1V
Enable Input (MIC39301)						
Enable Input Voltage	V_{EN}	—	—	**0.8**	V	Logic low (OFF)
		2.5	—	—	V	Logic high (ON)
Enable Input Current	I_{IN}	—	15	**75**	µA	V_{EN} = 2.5V
		—	—	90	µA	V_{EN} = 16V
		—	—	**4**	µA	V_{EN} = 0.8V

Electrical Characteristics: T_J = 25°C, **Bold** values indicate -40°C ≤ T_J ≤ +125°C; unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Shutdown Output Current (Note 5)	$I_{OUT(shdn)}$	—	10	**20**	μA	—
Flag Output (MIC39301)						
Output Leakage Current	$I_{FLG(leak)}$	—	0.01	1	μA	V_{IN} = 16V
		—	—	**2**		
Output Low Voltage (Note 4)	$V_{FLG(do)}$	—	220	300	mV	V_{IN} = 2.50V, I_{OL} = 250 μA
		—	—	**400**		—
Low Threshold	V_{FLG}	93	—	**—**	%	% of V_{OUT}
High Threshold		—	—	99.2	%	% of V_{OUT}
Hysteresis		—	1	**—**	%	—
Reference (Adjust Pin) - MIC39302 Only						
Reference Voltage	V_{ADJ}	1.228	1.240	1.252	V	—
		1.215	—	**1.265**		
Reference Voltage Temp. Coefficient (Note 6)	V_{TC}	—	20	—	ppm/°C	—
Adjust Pin Bias Current	I_{ADJ}	—	40	80	nA	—
		—	—	**120**		
Adjust Pin Bias Current Temp. Coefficient	I_{TC}	—	0.1	—	nA/°C	—

1: Output voltage temperature coefficient is ΔV_{OUT}(worst case) ÷ ($T_{J(max)} – T_{J(min)}$) where $T_{J(max)}$ is +125°C and $T_{J(min)}$ is -40°C.

2: $V_{DO} = V_{IN} – V_{OUT}$ when V_{OUT} decreases to 99% of its nominal output voltage with $V_{IN} = V_{OUT}$ + 1V. For output voltages below 2.5V, dropout voltage is the input-to-output voltage differential with the minimum input voltage being 2.5V. Minimum input operating voltage is 2.5V.

3: $I_{IN} = I_{GND} + I_{OUT}$.

4: For a 1.8V device, V_{IN} = 2.5V.

5: V_{EN} ≤ 0.8V, V_{IN} ≤ 8V, and V_{OUT} = 0V.

6: Thermal regulation is defined as the change in output voltage at a time t after a change in power dissipation is applied, excluding load or line regulation effects. Specifications are for a 200 mA load pulse at V_{IN} = 8V for t = 10 ms.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Lead Temperature	—	—	—	260	°C	Soldering, 5 sec.
Junction Operating Temperature Range	T_J	-40	—	+125	°C	—
Storage Temperature Range	T_S	-65	—	+150	°C	—
Package Thermal Resistances						
Thermal Resistance TO-263	θ_{JC}	—	2	—	°C/W	—
Thermal Resistance TO-220	θ_{JC}	—	2	—	°C/W	—

Note 1: The maximum allowable power dissipation is a function of ambient temperature, the maximum allowable junction temperature and the thermal resistance from junction to air (i.e., T_A, T_J, θ_{JA}). Exceeding the maximum allowable power dissipation will cause the device operating junction temperature to exceed the maximum +125°C rating. Sustained junction temperatures above +125°C can impact the device reliability.

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.

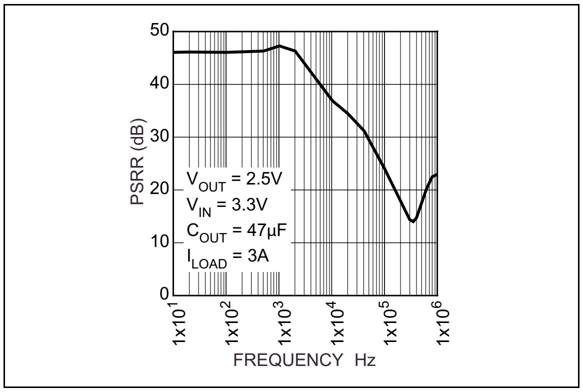


FIGURE 2-1: *Power Supply Ripple Rejection vs. Frequency.*

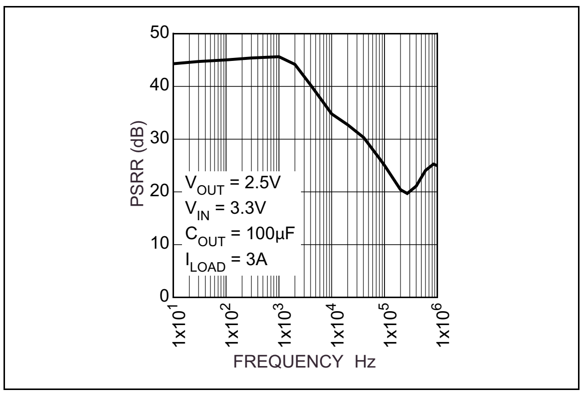


FIGURE 2-2: *Power Supply Ripple Rejection vs. Frequency.*

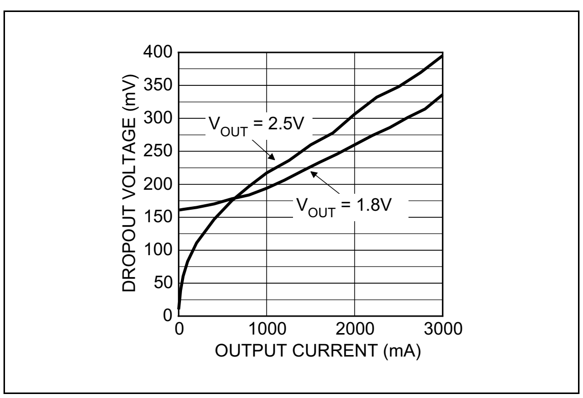


FIGURE 2-3: *Dropout Voltage vs. Output Current.*

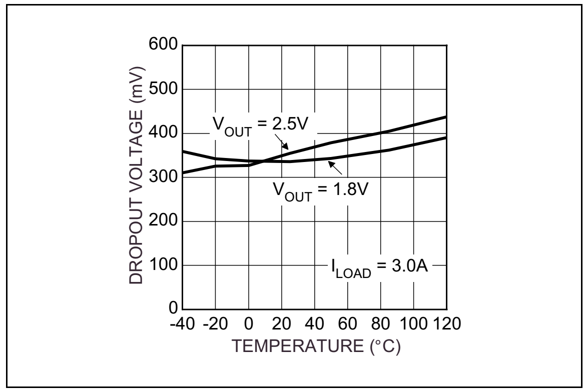


FIGURE 2-4: *Dropout Voltage vs. Temperature.*

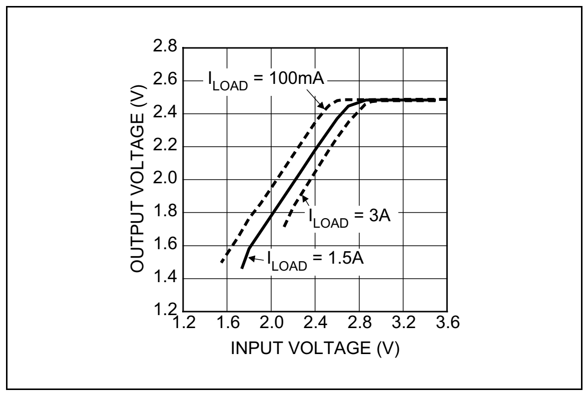


FIGURE 2-5: *Dropout Characteristics.*

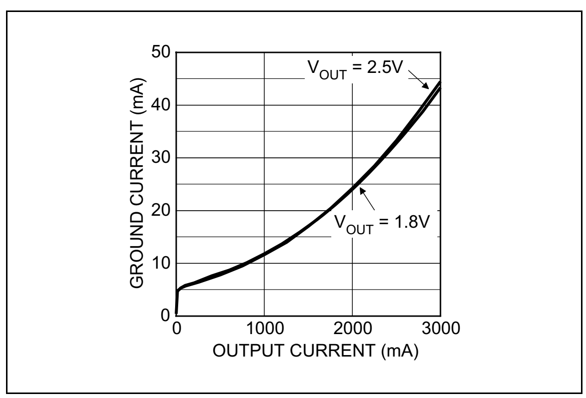


FIGURE 2-6: *Ground Current vs. Output Current.*

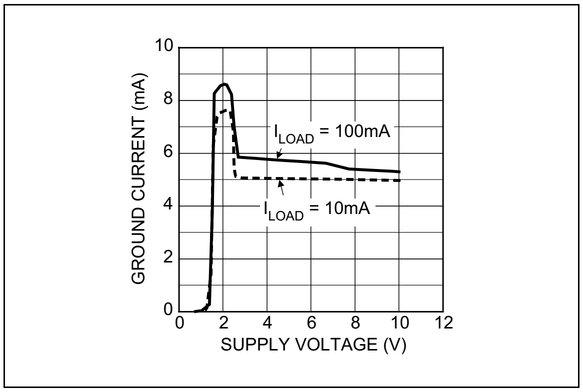


FIGURE 2-7: *Ground Current vs. Supply Voltage.*

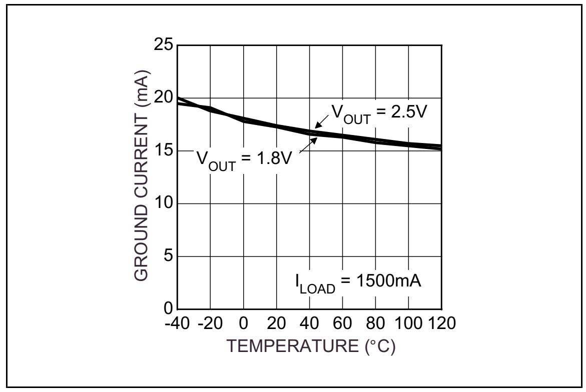


FIGURE 2-10: *Ground Current vs. Temperature.*

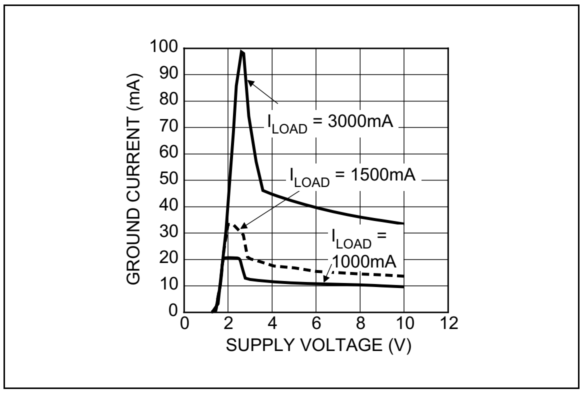


FIGURE 2-8: *Ground Current vs. Supply Voltage.*

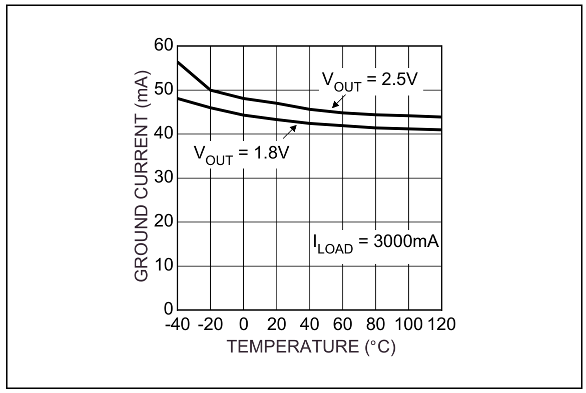


FIGURE 2-11: *Ground Current vs. Temperature.*

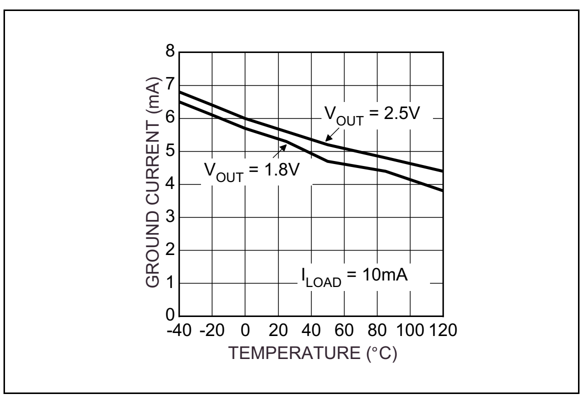


FIGURE 2-9: *Ground Current vs. Temperature.*

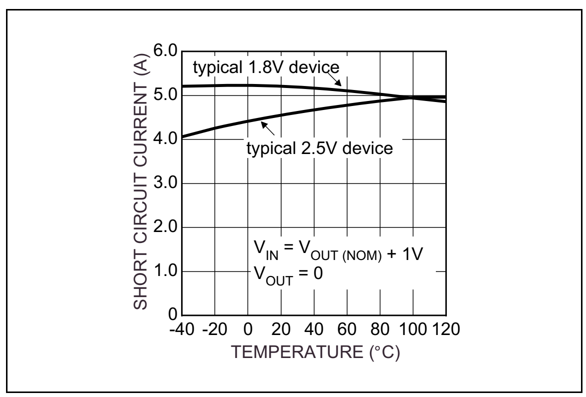


FIGURE 2-12: *Short Circuit Current vs. Temperature.*

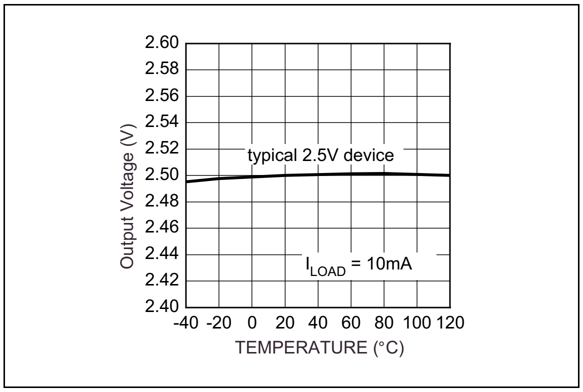


FIGURE 2-13: *Output Voltage vs. Temperature.*

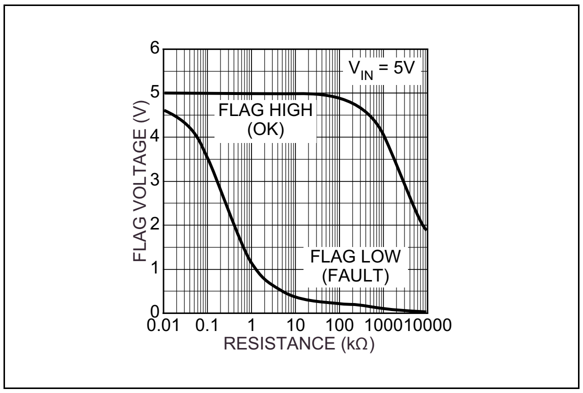


FIGURE 2-14: *Error Flag Pull-Up Resistor.*

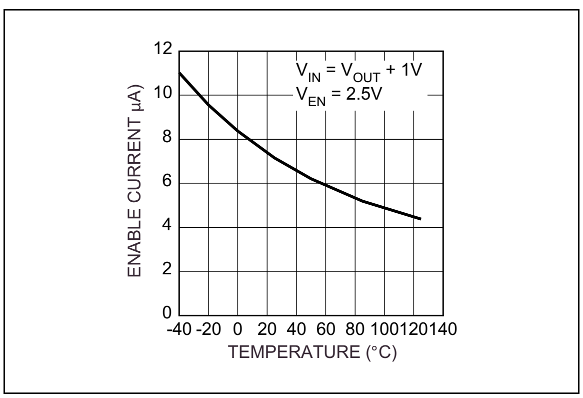


FIGURE 2-15: *Enable Current vs. Temperature.*

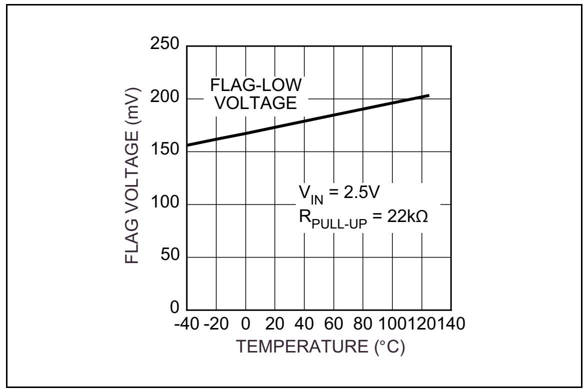


FIGURE 2-16: *Flag-Low Voltage vs. Temperature.*

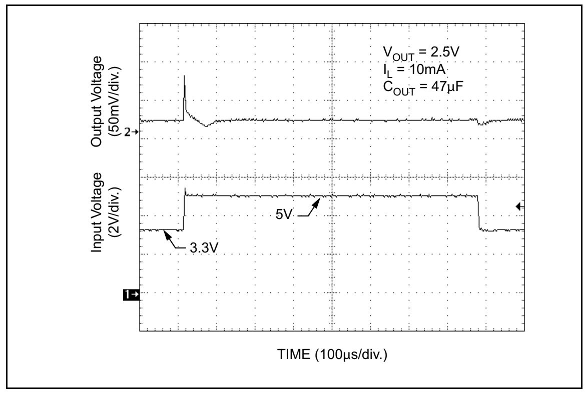


FIGURE 2-17: *Line Transient Response.*

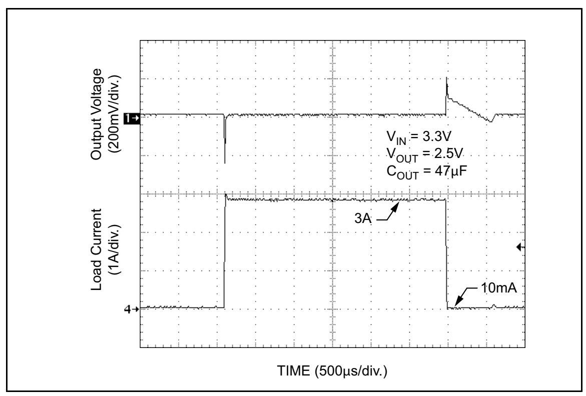


FIGURE 2-18: *Load Transient Response.*

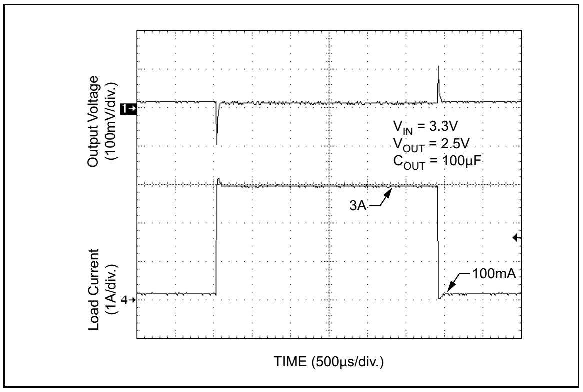


FIGURE 2-19: *Load Transient Response.*

3.0 PIN DESCRIPTIONS

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

TABLE 3-1: PIN FUNCTION TABLE

Pin Number MIC39300	Pin Number MIC39301	Pin Number MIC39302	Pin Name	Description
—	1	1	EN	Enable (Input): TTL/CMOS compatible input. Logic-high = enable; logic-low or open = shutdown.
1	2	2	IN	Unregulated Input: +16V maximum supply.
2, TAB	3, TAB	3, TAB	GND	Ground: Ground pin and TAB are internally connected.
3	4	4	OUT	Regulator Output.
—	5	—	FLG	Error Flag (Output): Open-collector indicates an output fault condition. Active low.
—	—	5	ADJ	Adjustable Regulator Feedback Input: Connect to the resistor voltage divider that is placed from OUT to GND in order to set the output voltage.

4.0 APPLICATION INFORMATION

The MIC39300/1/2 are high-performance, low-dropout voltage regulators suitable for moderate to high-current voltage regulator applications. Its 550 mV dropout voltage at full load makes it especially valuable in battery-powered systems and as a high-efficiency noise filter in post-regulator applications. Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-to-emitter voltage drop and collector-to-emitter saturation voltage, dropout performance of the PNP output of these devices is limited only by the low V_{CE} saturation voltage.

A trade-off for the low dropout voltage is a varying base drive requirement. Microchip's Super βeta PNP process reduces this drive requirement to only 2% to 5% of the load current.

The MIC39300/1/2 regulators are fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear; output current during overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the maximum safe operating temperature. Transient protection allows device (and load) survival even when the input voltage spikes above and below nominal. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow.

4.1 Thermal Design

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

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

Calculate the power dissipation of the regulator from these numbers and the device parameters from this data sheet, where the ground current is taken from the data sheet.

EQUATION 4-1:

$$P_D = (V_{IN} - V_{OUT})I_{OUT} + V_{IN} \times I_{GND}$$

The heat sink thermal resistance is determined by:

EQUATION 4-2:

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

Where:

$T_{J(MAX)} \leq$	125°C
θ_{CS}	Between 0°C/W and 2°C/W

The heat sink may be significantly reduced in applications where the minimum input voltage is known and is 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 Microchip's Super βeta PNP regulators 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 1.0 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.

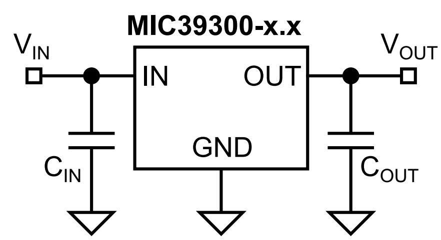


FIGURE 4-1: *Capacitor Requirements.*

4.2 Output Capacitor

The MIC39300/1/2 requires an output capacitor to maintain stability and improve transient response. Proper capacitor selection is important to ensure proper operation. The MIC39300/1/2 output capacitor selection is dependent upon the ESR (equivalent series resistance) of the output capacitor to maintain stability. When the output capacitor is 47 μF or greater, the output capacitor should have less than 1Ω of ESR. This will improve transient response as well as promote stability. Ultra low ESR capacitors, such as ceramic chip capacitors may promote instability. These very low ESR levels may cause an oscillation and/or underdamped transient response. A low-ESR solid tantalum capacitor works extremely well and provides good transient response and stability over temperature. Aluminum electrolytics can also be used, as long as the ESR of the capacitor is < 1Ω.

The value of the output capacitor can be increased without limit. Higher capacitance values help to improve transient response and ripple rejection and reduce output noise.

4.3 Input Capacitor

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

4.4 Transient Response and 3.3V to 2.5V and 2.5V to 1.8V Conversions

The MIC39300/1/2 has excellent transient response to variations in input voltage and load current. The device has been designed to respond quickly to load current variations and input voltage variations. Large output capacitors are not required to obtain this performance. A standard 47 µF output capacitor, preferably tantalum, is all that is required. Larger values help to improve performance even further.

By virtue of its low dropout voltage, this device does not saturate into dropout as readily as similar NPN-based designs. When converting from 3.3V to 2.5V or 2.5V to 1.8V, the NPN-based regulators are already operating in dropout, with typical dropout requirements of 1.2V or greater. To convert down to 2.5V without operating in dropout, NPN-based regulators require an input voltage of 3.7V at the very least. The MIC39300/1 regulator will provide excellent performance with an input as low as 3.0V or 2.5V. This gives the PNP-based regulators a distinct advantage over older, NPN-based linear regulators.

4.5 Minimum Load Current

The MIC39300/1/2 regulators are specified between finite loads. If the output current is too small, leakage currents dominate and the output voltage rises. A 10 mA minimum load current is necessary for proper regulation.

4.6 Error Flag

The MIC39301 version features an error flag circuit that monitors the output voltage and signals an error condition when the voltage drops 5% below the nominal output voltage. The error flag is an open-collector output that can sink 10 mA during a fault condition.

Low output voltage can be caused by a number of problems, including an overcurrent fault (device in current limit) or low input voltage. The flag is inoperative during overtemperature shutdown.

When the error flag is not used, it is best to leave it open. A pull-up resistor from FLG to either V_{IN} or V_{OUT} is required for proper operation.

4.7 Enable Input

The MIC39301/2 feature an enable input for on/off control of the device. The enable input's shutdown state draws “zero” current (only microamperes of leakage). The enable input is TTL/CMOS compatible for simple logic interface, but can be connected to up to 20V. When enabled, it draws approximately 15 µA.

4.8 Adjustable Regulator Design

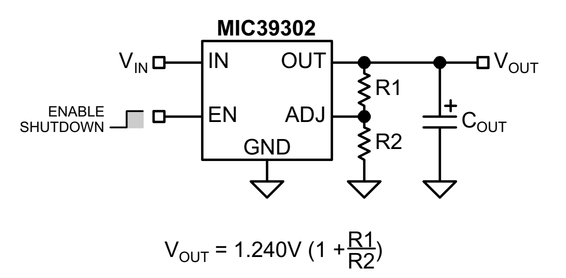


FIGURE 4-2: *Adjustable Regulator with Resistors.*

The MIC39302 allows programming the output voltage anywhere between 1.24V and 15.5V. Two resistors are used. The resistor values are calculated by:

EQUATION 4-3:

$$R1 = R2\left(\frac{V_{OUT}}{1.240} - 1\right)$$

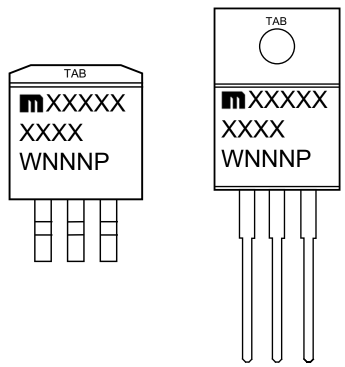
Where V_{OUT} is the desired output voltage. Figure 4-2 shows the component definition. Applications with widely varying load currents may scale the resistors to draw the minimum load current required for proper operation (see the Minimum Load Current section).

5.0 PACKAGING INFORMATION

5.1 Package Marking Information

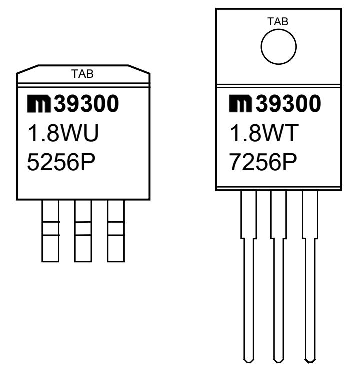
MIC39300

3-Lead TO-263* 3-Lead TO-220*



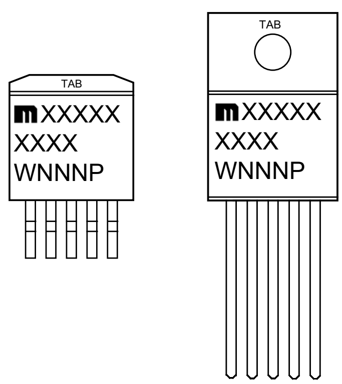
MIC39300

Example Example



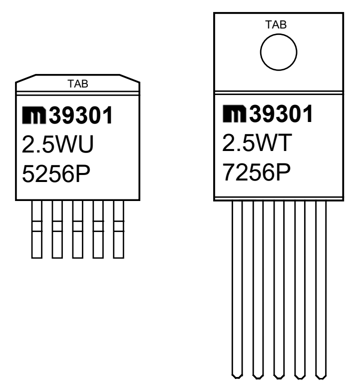
MIC39301

5-Lead TO-263* 5-Lead TO-220*



MIC39301

Example Example



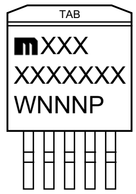
Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week '01')
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package 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.

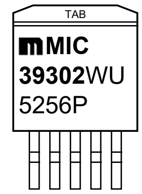
MIC39302

5-Lead TO-263*



MIC39302

Example



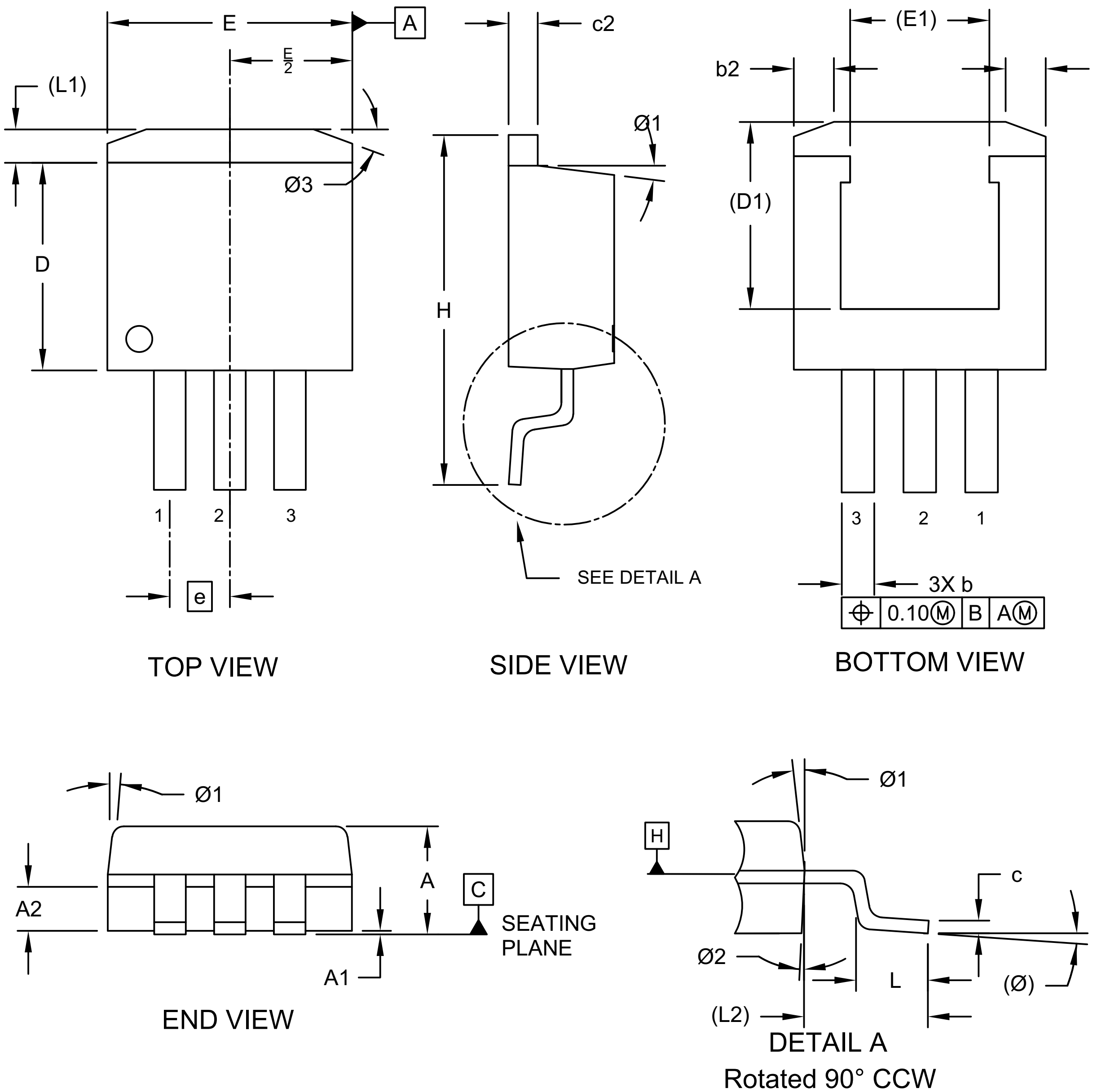
Legend:	XX...X	Product code or customer-specific information
	Y	Year code (last digit of calendar year)
	YY	Year code (last 2 digits of calendar year)
	WW	Week code (week of January 1 is week ‘01’)
	NNN	Alphanumeric traceability code
	(e3)	Pb-free JEDEC® designator for Matte Tin (Sn)
	*	This package 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.

3-Lead Transistor Outline (9GA) - [TO-263]

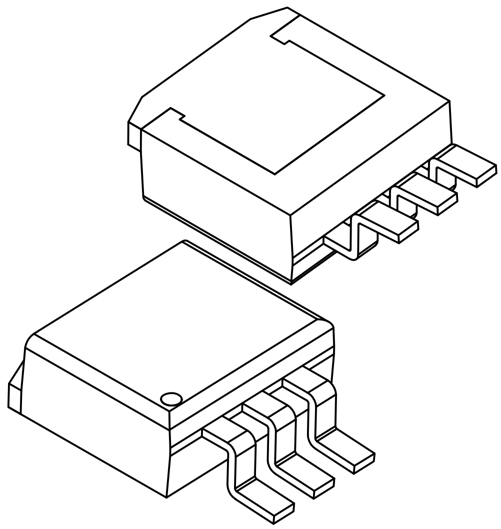
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-1169 Rev B Sheet 1 of 2

3-Lead Transistor Outline (9GA) - [TO-263]

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



		MILLIMETERS		
Dimension Limits		Min	Nom	Max
Number of Leads	N	3		
Pitch	e	2.54 BSC		
Overall Height	A	4.32	–	4.60
Seating Plane Height	A1	–	–	0.30
Lead Width	b	1.19	–	1.34
Thermal Pad Cut Back	b2	1.39	–	1.90
Lead Thickness	c	0.30	–	0.58
Thermal Pad Thickness	c2	1.14	–	1.39
Molded Body Length	D	8.38	–	9.16
Thermal Pad Length	D1	7.69 REF		
Total Width	E	10.05	–	10.66
Thermal Pad Width	E1	6.50 REF		
Overall Length	H	14.60	–	15.87
Foot Length	L	2.28	–	2.79
Tab Length	L1	1.14	–	1.67
Lead Length	L2	5.05 REF		
Foot Angle	θ	0°	–	8°
Mold Draft Angle	θ1	3°	–	10°
Mold Draft Angle	θ2	1°	–	7°
Thermal Tab Angle	θ3	18°	–	22°

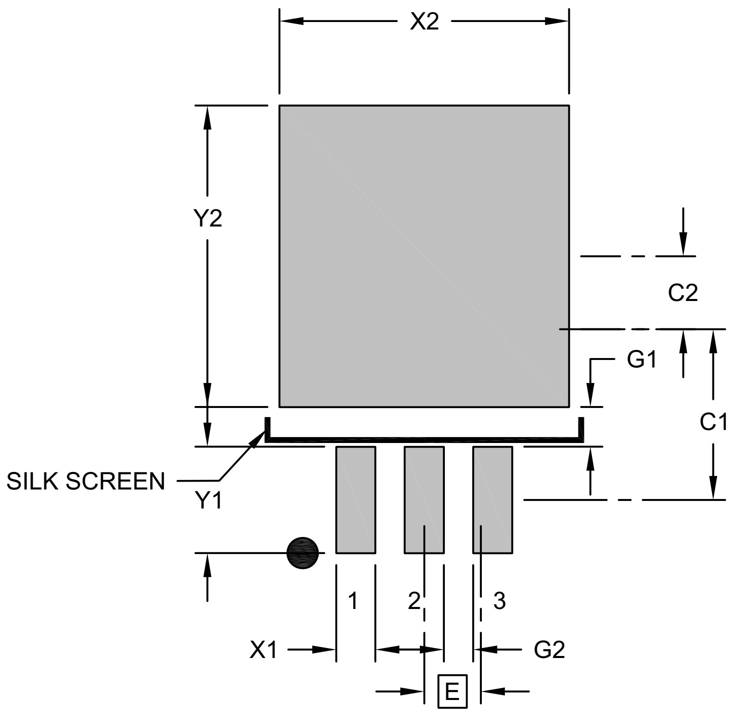
Notes:

1. 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 C04-1169 Rev B Sheet 2 of 2

3-Lead Transistor Outline (9GA) - [TO-263]

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	2.54 BSC		
Center Pad Width	X2			10.75
Center Pad Length	Y2			11.20
Contact Pad Spacing	C1		6.35	
Contact Pad Spacing	C2		2.70	
Contact Pad Width (X3)	X1			1.45
Contact Pad Length (X3)	Y1			3.90
Contact Pad to Center Pad (X3)	G1	1.47		
Contact Pad to Contact Pad (X2)	G2	1.09		

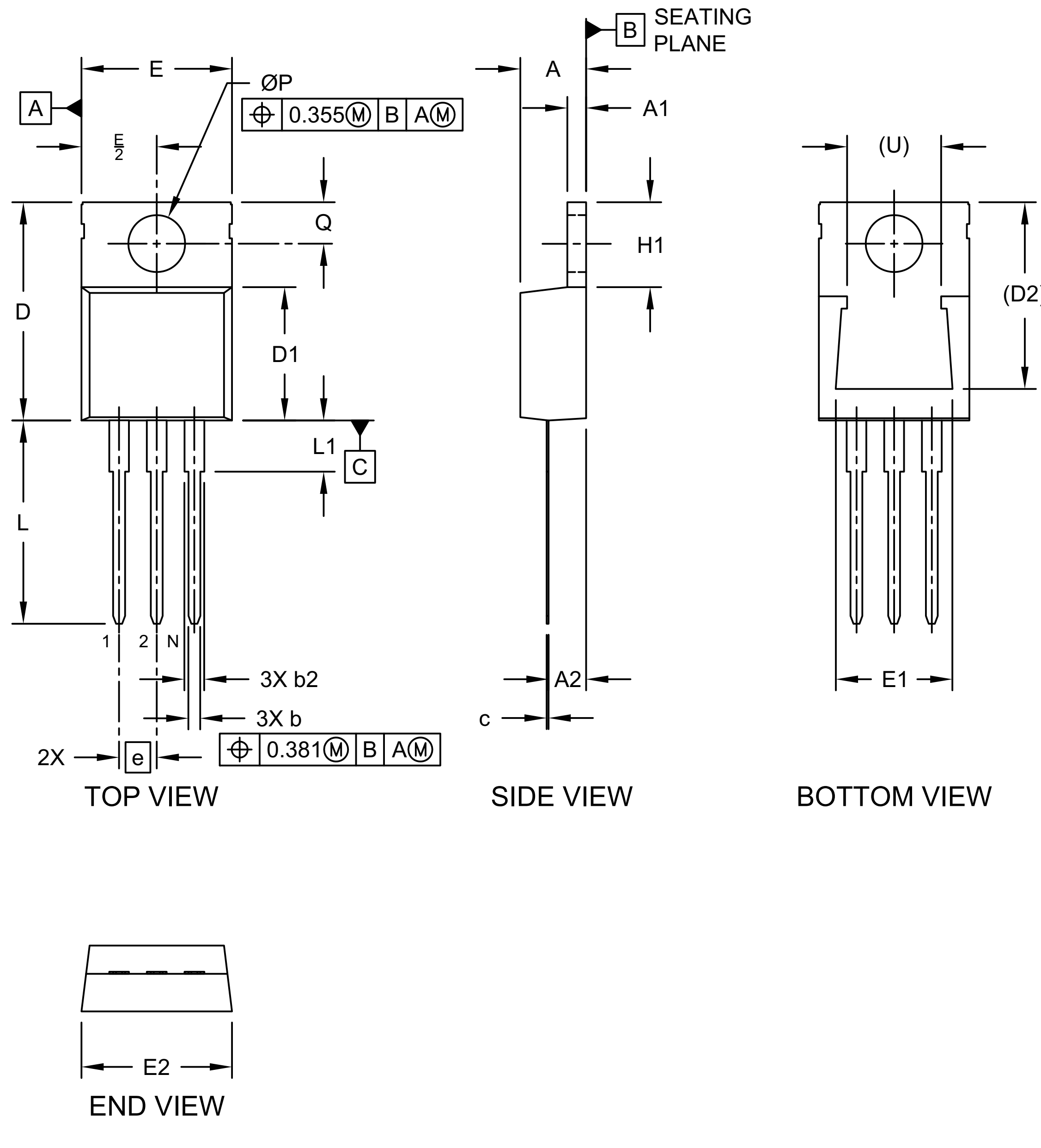
Notes:

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 C04-3169 Rev B

3-Lead Transistor Outline Package (AB) - [TO-220]

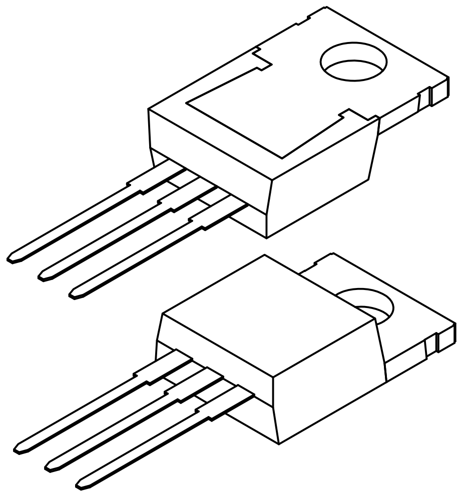
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-034-AB Rev C Sheet 1 of 2

3-Lead Transistor Outline Package (AB) - [TO-220]

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		3	
Terminal Pitch	e		2.54 BSC	
Overall Height	A	4.064	4.445	4.826
Tab Thickness	A1	1.143	1.270	1.397
Base to Lead	A2	2.032	2.540	3.048
Terminal Width	b	0.635	0.826	1.016
Shoulder Width	b2	1.143	1.334	1.524
Terminal Thickness	c	0.305	0.432	0.559
Overall Length	D	13.730	14.730	15.730
Molded Package Length	D1	8.850	9.000	9.150
Exposed Pad Length	D2		12.6 REF	
Overall Width	E	9.652	10.160	10.668
Exposed Pad Width	U		6.35 REF	
Exposed Pad Width	E1	6.858	7.874	8.890
Body Width	E2	9.779	10.224	10.668
Tab Length	H1	5.842	6.350	6.858
Terminal Length	L	12.700	13.716	14.732
Terminal Shoulder Length	L1	3.050	3.455	3.860
Mounting Hole Diameter	P	3.708	3.835	3.962
Mounting Hole Center	Q	2.540	2.794	3.048

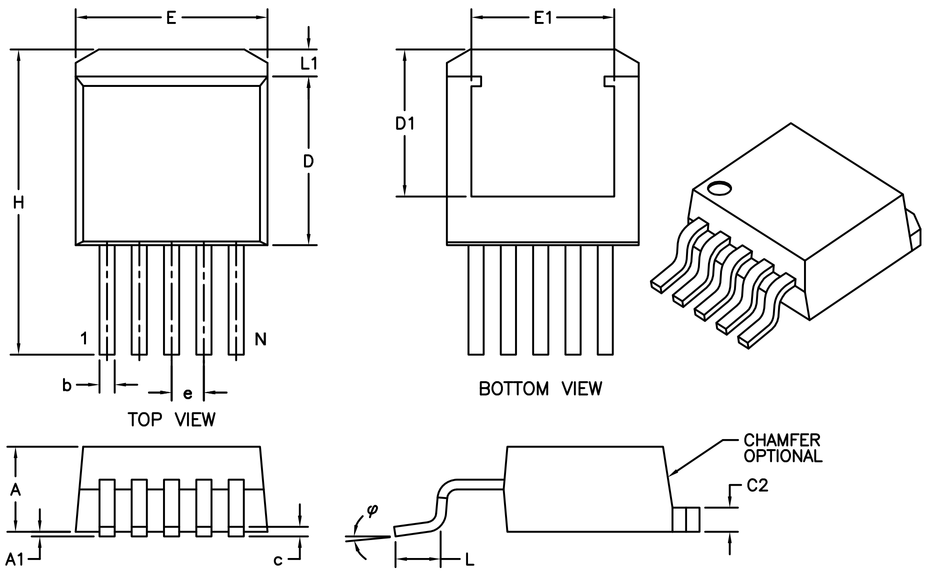
Notes:

1. 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 C04-034-AB Rev C Sheet 2 of 2

5-Lead Plastic (ET) [DDPAK]

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



	Units	INCHES		
	Dimension Limits	MIN	NOM	MAX
Number of Pins	N	5		
Pitch	e	.067 BSC		
Overall Height	A	.160	-	.190
Standoff §	A1	.000	-	.010
Overall Width	E	.380	-	.420
Exposed Pad Width	E1	.245	-	-
Molded Package Length	D	.330	-	.380
Overall Length	H	.549	-	.625
Exposed Pad Length	D1	.270	-	-
Lead Thickness	c	.014	-	.029
Pad Thickness	C2	.045	-	.065
Lead Width	b	.020	-	.039
Foot Length	L	.068	-	.110
Pad Length	L1	-	-	.067
Foot Angle	φ	0°	-	8°

Notes:

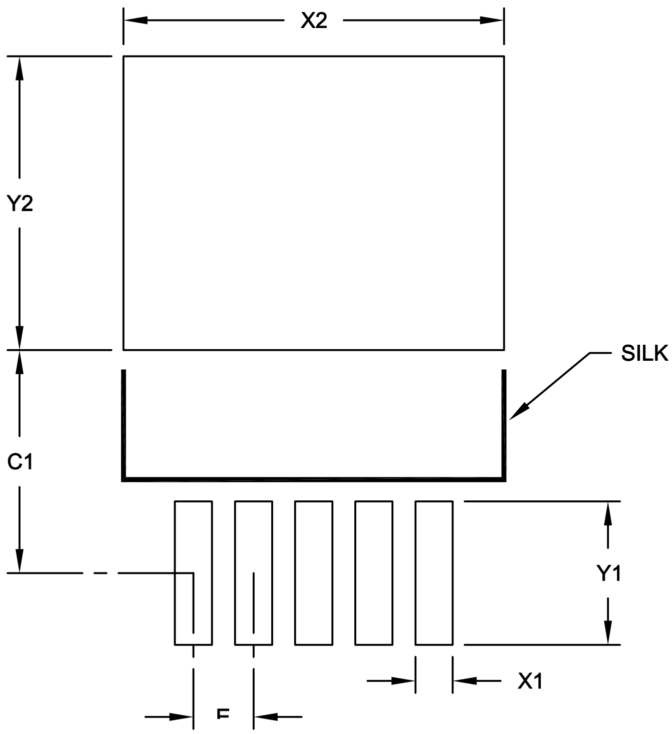
1. § Significant Characteristic
2. Dimensions D and E do not include mold flash or protrusions. Mold flash or protrusions shall not exceed .005" per side.
3. Dimensioning and tolerancing per ASME Y14.5M

BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-012B

5-Lead Plastic (ET) [DDPAK]

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	.067 BSC		
Optional Center Pad Width	X2			.423
Optional Center Pad Length	Y2			.327
Contact Pad Spacing	C1		.248	
Contact Pad Width (X28)	X1			.041
Contact Pad Length (X28)	Y1			.159

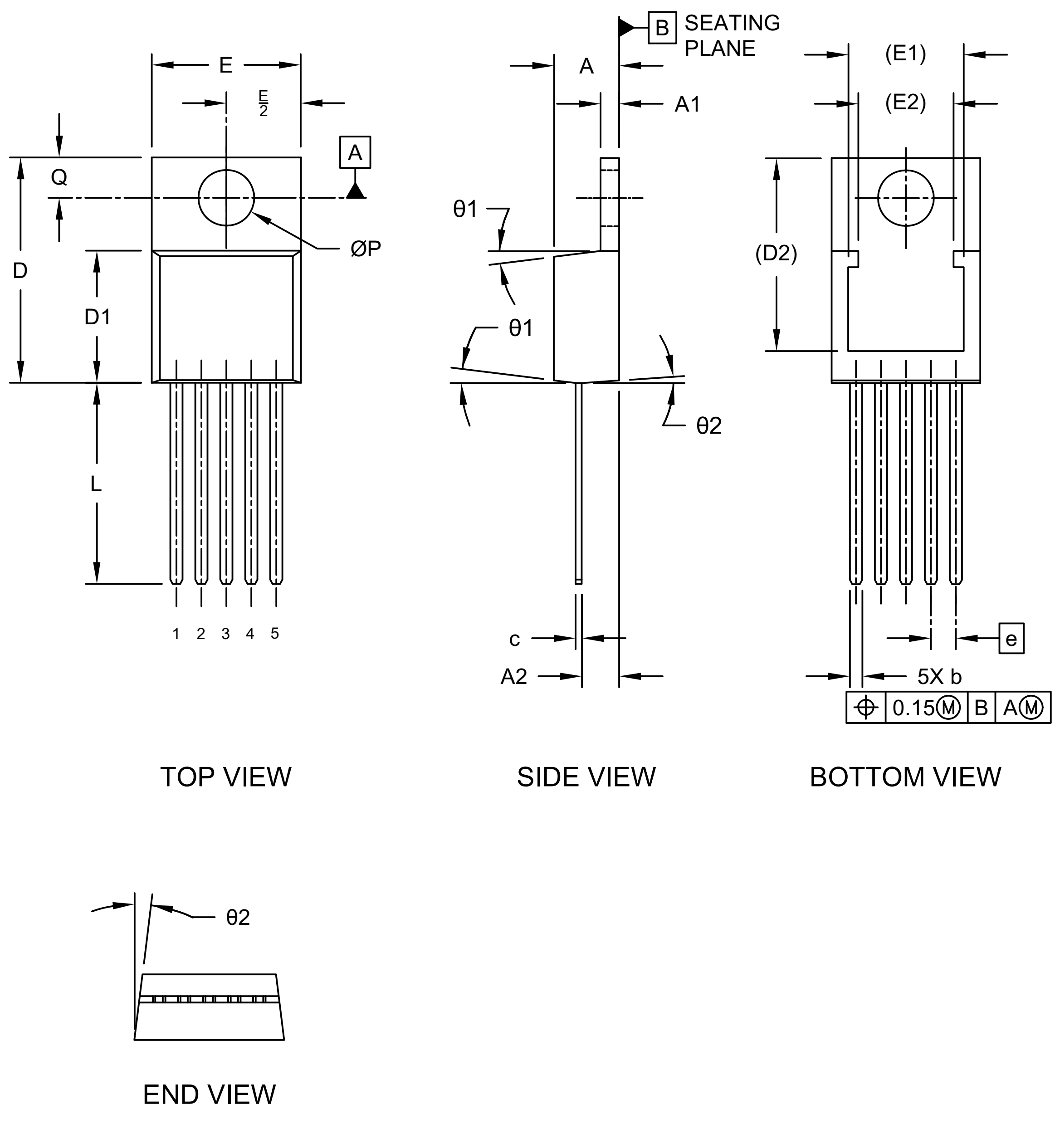
Notes:

1. Dimensioning and tolerancing per ASME Y14.5M
   BSC: Basic Dimension. Theoretically exact value shown without tolerances.

Microchip Technology Drawing No. C04-2012A

5-Lead Transistor Outline Type LB03 (B8X) - [TO-220]
Micrel Legacy Package TO220-LB03-5LD-PL-1

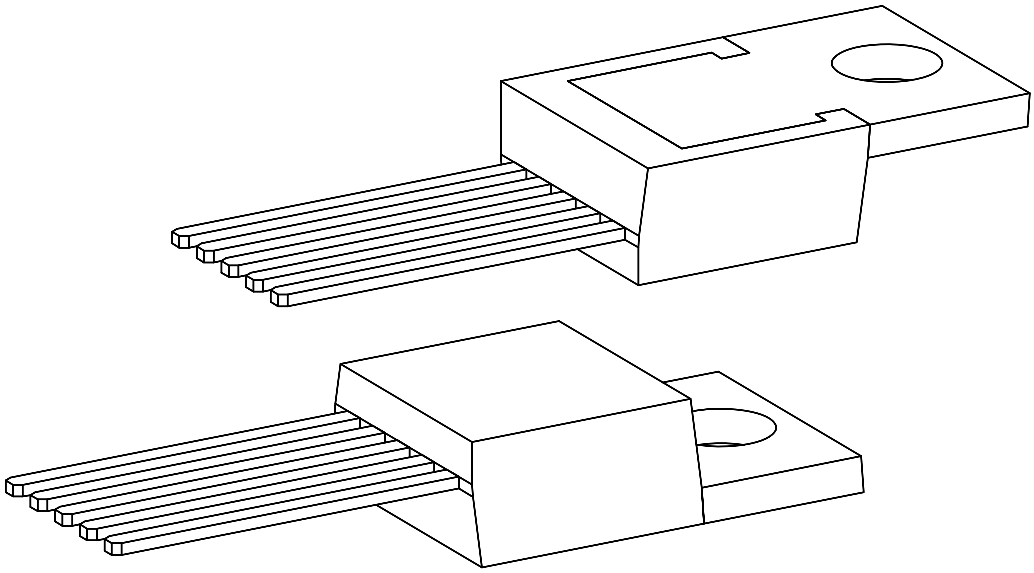
Note:	For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging



Microchip Technology Drawing C04-036-B8X Rev E Sheet 1 of 2

5-Lead Transistor Outline Type LB03 (B8X) - [TO-220]
Micrel Legacy Package TO220-LB03-5LD-PL-1

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



		INCHES		
Dimension Limits		Min	Nom	Max
Number of Leads	N	5		
Pitch	e	.067 BSC		
Overall Height	A	.160	.175	.190
Tab Height	A1	.045	.050	.055
Seating Plane to Lead	A2	.080	.098	.115
Lead Width	b	.025	.033	.040
Lead Thickness	c	.012	.016	.020
Lead Length	L	.500	.540	.580
Total Body Length Including Tab	D	.542	.580	.619
Molded Body Length	D1	.348	.354	.360
Total Width	E	.380	.400	.420
Pad Width	E1	0.256 REF		
Pad Length	D2	0.486 REF		
Hole Diameter	ØP	.146	.151	.156
Hole Center to Tab Edge	Q	.103	.108	.113
Molded Body Draft Angle	θ1	3	7	10
Molded Body Draft Angle	θ2	1	4	7

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 C04-036-B8X Rev E Sheet 2 of 2

APPENDIX A: REVISION HISTORY

Revision C (February 2024)

- Removed bold from maximum value of Output Leakage Current (Page 5).
- Updated the names of Figure 2-1, Figure 2-2 and Figure 2-12.
- Updated package name in Package Types.
- Updated Section 5.0, Packaging Information and Product Identification System.

Revision B (January 2022)

- Updated values and conditions for Enable Input Current in the Electrical Characteristics table.

Revision A (May 2018)

- Converted Micrel document MIC39300/01/02 to Microchip data sheet DS20006017A.
- 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 NO.	-X.X	X	X	-XX
Device	Output Voltage	Junction Temperature Range	Package	Media Type[1]

Device:	MIC393xx:	3A Low-Voltage µCap LDO Regulator
	MIC39300:	Fixed V_{OUT}
	MIC39301:	Fixed V_{OUT} with Enable + Output Error Flag + Shutdown
	MIC39302:	Adjustable Wide V_{IN} LDO
Output Voltage:	x.x =	Fixed (MIC39300/39301)
	1.8 =	1.8V
	2.5 =	2.5V
	blank=	Adjustable (MIC39302)
Junction Temperature Range:	W =	-40°C to +125°C, RoHs Compliant*
Package:	T =	3-Lead TO-220 (MIC39300)
	T =	5-Lead TO-220 (MIC39301)
	U =	3-Lead TO-263 (MIC39300)
	U =	5-Lead TO-263/D^2PAK/DDPAK (MIC39301/39302)
Media Type[1]:	blank=	50/Tube
	TR =	750/Reel (TO-263, 3L and 5L)

* RoHS compliant with “high-melting solder” exemption.

Examples:

a) MIC39300-1.8WT: 3A, 1% Low-Voltage LDO Regulator, 1.8V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 3-Lead TO-220 Package, 50/Tube

b) MIC39300-2.5WT: 3A, 1% Low-Voltage LDO Regulator, 2.5V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 3-Lead TO-220 Package, 50/Tube

c) MIC39300-2.5WU: 3A, 1% Low-Voltage LDO Regulator, 2.5V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 3-Lead TO-263 Package, 50/Tube

d) MIC39300-2.5WU-TR: 3A, 1% Low-Voltage LDO Regulator, 2.5V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 3-Lead TO-263 Package, 750/Reel

e) MIC39301-1.8WT: 3A, 1% Low-Voltage LDO Regulator with Enable, Output Error Flag + Shutdown, 1.8V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 5-Lead TO-220 Package, 50/Tube

f) MIC39301-1.8WU: 3A, 1% Low-Voltage LDO Regulator with Enable, Output Error Flag + Shutdown, 1.8V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 5-Lead DDPAK Package, 50/Tube

g) MIC39301-1.8WU-TR: 3A, 1% Low-Voltage LDO Regulator with Enable, Output Error Flag + Shutdown, 1.8V Fixed Output Voltage, -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 5-Lead DDPAK Package, 750/Reel

h) MIC39302WU: 3A, 1% Adjustable Wide VIN LDO , Adjustable Output Voltage (1.24V to 15.5V), -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 5-Lead DDPAK Package, 50/Tube

i) MIC39302WU-TR 3A, 1% Adjustable Wide VIN LDO , Adjustable Output Voltage (1.24V to 15.5V), -40°C to +125°C Junction Temperature Range, RoHS Compliant*, 5-Lead DDPAK Package, 750/Reel

Note 1: 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:

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Fax: 33-1-69-30-90-79

Germany - Garching
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Germany - Haan
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