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Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

MIC2915X/30X/50X/75X

High-Current Low Dropout Regulators

Features

- High Current Capability:
  - MIC29150/29151/29152/29153: 1.5A
  - MIC29300/29301/29302/29303: 3A
  - MIC29500/29501/29502/29503: 5A
  - MIC29751/29752: 7.5A
- Low Dropout Voltage
- Low Ground Current
- Accurate 1% Guaranteed Tolerance
- Extremely Fast Transient Response
- Reverse-Battery and “Load Dump” Protection
- Zero-Current Shutdown Mode (5-Pin Versions)
- Error Flag Signals Output Out-of-Regulation (5-Pin Versions)
- Also Characterized for Smaller Loads with Industry-Leading Performance Specifications
- Fixed-Voltage and Adjustable Versions

Applications

- Battery-Powered Equipment
- High-Efficiency Green Computer Systems
- Automotive Electronics
- High-Efficiency Linear Power Supplies
- High-Efficiency Post-Regulator for Switching Supply

General Description

The MIC2915x/2930x/2950x/2975x are high current, high accuracy, low dropout voltage regulators. Using Microchip’s proprietary Super βeta PNP process with a PNP pass element, these regulators feature 350 mV to 425 mV (full load) typical dropout voltages and very low ground current. Designed for high current loads, these devices also find applications in lower current, extremely low dropout-critical systems, where their tiny dropout voltage and ground current values are important attributes.

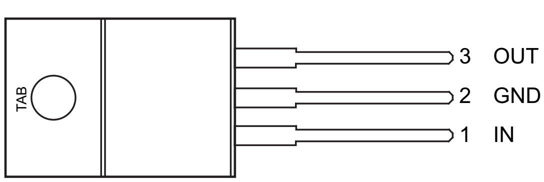
The MIC2915x/2930x/2950x/2975x are fully protected against overcurrent faults, reversed input polarity, reversed lead insertion, overtemperature operation, and positive and negative transient voltage spikes. Five pin fixed-voltage versions feature logic level ON/OFF control and an error flag that signals whenever the output falls out of regulation. Flagged states include low input voltage (dropout), output current limit, overtemperature shutdown, and extremely high voltage spikes on the input.

On the MIC29xx1 and MIC29xx2, the ENABLE pin may be tied to V_{IN} if it is not required for ON/OFF control. The MIC2915x/2930x/2950x are available in 3-pin and 5-pin TO-220 and surface mount TO-263 (D^2Pak) packages. The MIC2975x 7.5A regulators are available in a 5-pin TO-247 package. The 1.5A, adjustable output MIC29152 is available in a 5-pin power D-Pak (TO-252) package.

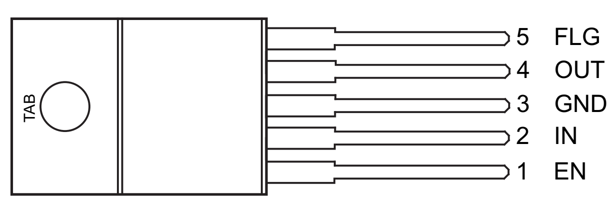
For applications with input voltage 6V or below, see MIC37xxx LDOs.

Package Types

MIC29150/300/500
3-Lead TO-220 (T)
(Top View)

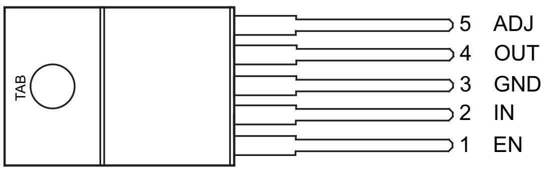


MIC29151/301/501/751
5-Lead TO-220 Fixed Voltage (T)
(Top View)

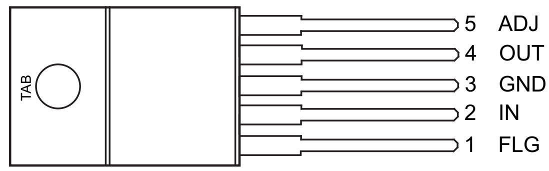


Package Types (Continued)

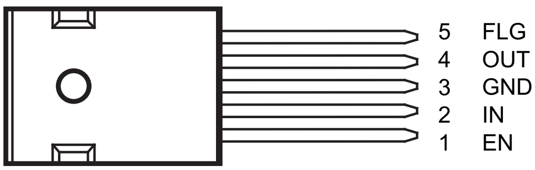
MIC29152/302/502
5-Lead TO-220 Adjustable Voltage (T)
(Top View)



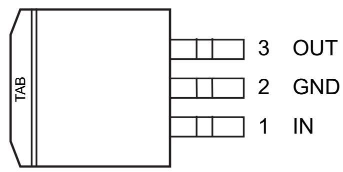
MIC29153/303/503
5-Lead TO-220 Adjustable with Flag (T)
(Top View)



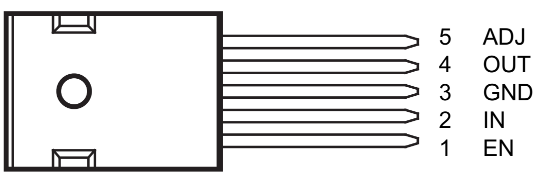
MIC29751
5-Lead TO-247 Fixed Voltage (WT)
(Top View)



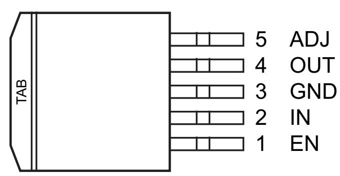
MIC29150/300
3-Lead TO-263 (D^2Pak) (UT)
(Top View)



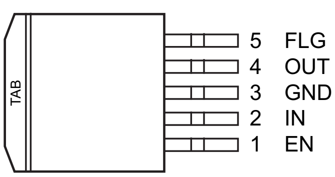
MIC29752
5-Lead TO-247 Adjustable Voltage (WT)
(Top View)



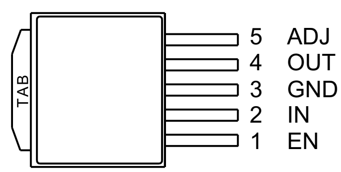
MIC29302/502
5-Lead TO-263 (D^2Pak) Adj. Voltage (U)
(Top View)



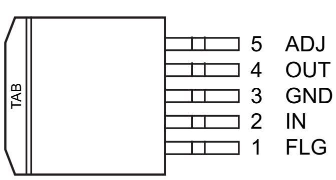
MIC29151/301/501
5-Lead TO-263 (D^2Pak) Fixed Voltage (U)
(Top View)



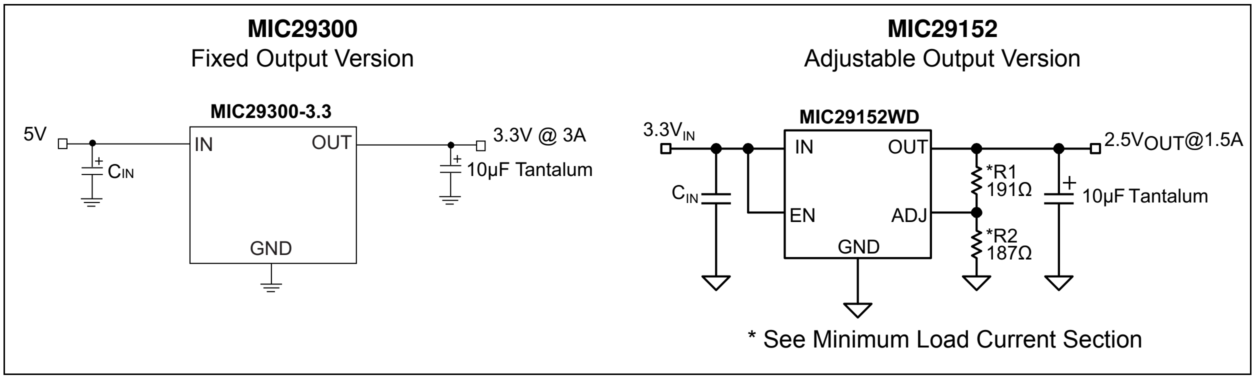
MIC29152
5-Lead TO-252 (D-Pak) Adjustable Voltage (D)
(Top View)



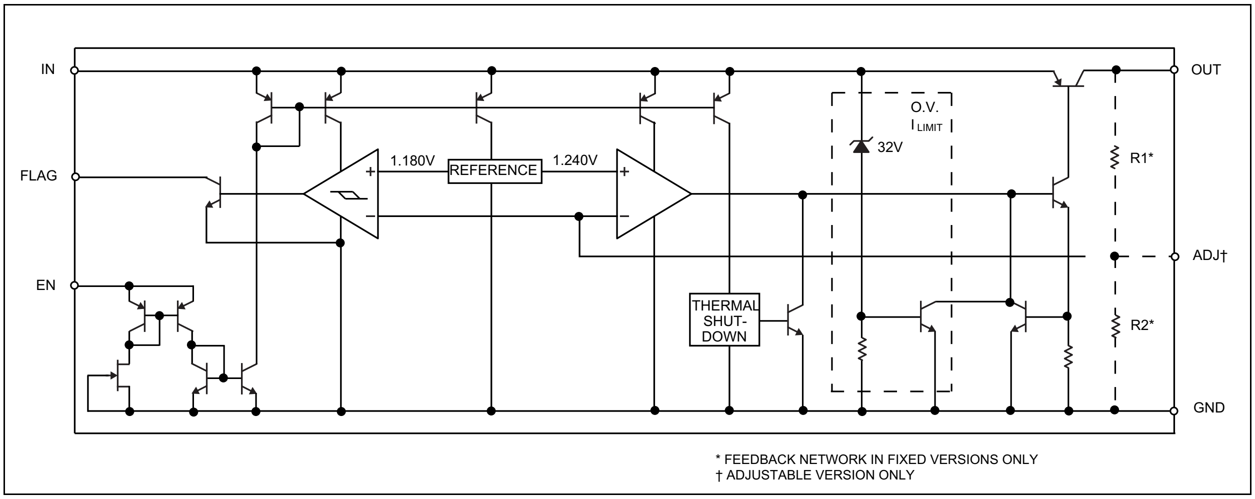
MIC29153/303/503
5-Lead TO-263 (D^2Pak) Adj. with Flag (U)
(Top View)



Typical Application Circuits



Functional Diagram



1.0 ELECTRICAL CHARACTERISTICS

Absolute Maximum Ratings † (Note 1)

Input Supply Voltage (V_{IN}) (Note 1) .... –20V to +60V
Enable Input Voltage (V_{EN}) .... –0.3V to V_{IN}
Power Dissipation .... Internally Limited
ESD Rating .... Note 2

Operating Ratings‡

Maximum Operating Input Voltage .... +26V

† 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: Maximum positive supply voltage of 60V must be of limited duration (<100 ms) and duty cycle (≤1%). The maximum continuous supply voltage is 26V. Exceeding the absolute maximum rating may damage the device.

2: Devices are ESD sensitive. Handling precautions recommended.

TABLE 1-1: ELECTRICAL CHARACTERISTICS (Note 1, Note 2)

Electrical Characteristics: $V_{IN} = V_{OUT}$ + 1V; I_{OUT} = 10 mA; T_J = +25°C. **Bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
Output Voltage	V_{OUT}	–1	—	1	%	I_{OUT} = 10 mA
		–2	—	2		10 mA ≤ I_{OUT} ≤ I_{FL}, (V_{OUT} + 1V) ≤ V_{IN} ≤26V (Note 3)
Line Regulation		—	0.06	0.5	%	I_{OUT} = 10 mA, (V_{OUT} + 1V) ≤ V_{IN} ≤ 26V
Load Regulation		—	0.2	1	%	$V_{IN} = V_{OUT}$ + 1V, 10 mA ≤ I_{OUT} ≤ 1.5A (Note 3, Note 4)
$\Delta V_O/\Delta T$		—	**20**	**100**	ppm/°C	Output Voltage (Note 4) Temperature Coefficient
Dropout Voltage ΔV_{OUT} = –1% (Note 5)		—	80	**200**	mV	MIC2915x I_{OUT} = 100 mA
		—	220	—		MIC2915x I_{OUT} = 750 mA
		—	350	**600**		MIC2915x I_{OUT} = 1.5A
		—	80	**175**		MIC2930x I_{OUT} = 100 mA
		—	250	—		MIC2930x I_{OUT} = 1.5A
		—	370	**600**		MIC2930x I_{OUT} = 3A
		—	125	**250**		MIC2950x I_{OUT} = 250 mA
		—	250	—		MIC2950x I_{OUT} = 2.5A
		—	370	**600**		MIC2950x I_{OUT} = 5A
		—	80	**200**		MIC2975x I_{OUT} = 250 mA
		—	270	—		MIC2975x I_{OUT} = 4A
		—	425	750		MIC2975x I_{OUT} = 7.5A
Ground Current (Note 6)	I_{GND}	—	8	**20**	mA	MIC2915x I_{OUT} = 750 mA, $V_{IN} = V_{OUT}$ + 1V
		—	22	—		MIC2915x I_{OUT} = 1.5A
		—	10	**35**		MIC2930x I_{OUT} = 1.5A, $V_{IN} = V_{OUT}$ + 1V
		—	37	—		MIC2930x I_{OUT} = 3A
		—	15	**50**		MIC2950x I_{OUT} = 2.5A, $V_{IN} = V_{OUT}$ + 1V
		—	70	—		MIC2950x I_{OUT} = 5A
		—	35	**75**		MIC2975x I_{OUT} = 4A, $V_{IN} = V_{OUT}$ + 1V
			120	—		MIC2975x I_{OUT} = 7.5A
Ground Pin Current at Dropout	I_{GRNDDO}	—	0.9	—	mA	MIC2915x, V_{IN} = 0.5V less than specified V_{OUT} × I_{OUT} = 10 mA
		—	1.7	—		MIC2930x, V_{IN} = 0.5V less than specified V_{OUT} × I_{OUT} = 10 mA
		—	2.1	—		MIC2950x, V_{IN} = 0.5V less than specified V_{OUT} × I_{OUT} = 10 mA
		—	3.1	—		MIC2975x, V_{IN} = 0.5V less than specified V_{OUT} × I_{OUT} = 10 mA
Current Limit	I_{LIM}	—	2.1	**3.5**	A	MIC2915x, V_{OUT} = 0V, (Note 7)
		—	4.5	**5.0**		MIC2930x, V_{OUT} = 0V, (Note 7)
		—	7.5	**10.0**		MIC2950x, V_{OUT} = 0V, (Note 7)
		—	9.5	**15.0**		MIC2975x, V_{OUT} = 0V, (Note 7)

TABLE 1-1: ELECTRICAL CHARACTERISTICS (Note 1, Note 2) (CONTINUED)

Electrical Characteristics: V_{IN} = V_{OUT} + 1V; I_{OUT} = 10 mA; T_J = +25°C. **Bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
e_n, Output Noise Voltage (10 Hz to 100 kHz) I_L = 100 mA		—	400	—	µV_{RMS}	C_L = 10 µF
		—	260	—		C_L = 33 µF
Ground Current in Shutdown		—	2	10	µA	MIC29150/1/2/3 only
		—	—	**30**		V_{EN} = 0.4V
Reference - MIC29xx2/MIC29xx3						
Reference Voltage		1.228	1.240	1.252	V	—
		1.215	—	**1.265**	V_{MAX}	
Reference Voltage		**1.203**	—	**1.277**	V	Note 8
Adjust Pin Bias Current		—	40	80	nA	—
		—	—	**120**		
Reference Voltage Temperature Coefficient		—	20	—	ppm/°C	Note 9
Adjust Pin Bias Current Temperature Coefficient		—	0.1	—	nA/°C	—
Flag Output (Error Comparator) - MIC29xx1/29xx3						
Output Leakage Current		—	0.01	1.00	µA	V_{OH} = 26V
		—	—	**2.00**		
Output Low Voltage	V_{OL}	—	220	300	mV	Device set for 5V, V_{IN} = 4.5V I_{OL} = 250 µA
		—	—	**400**		
Upper Threshold Voltage		40	60	—	mV	Device set for 5V, (Note 10)
		25	—	—		
Lower Threshold Voltage		—	75	95	mV	Device set for 5V, (Note 10)
		—	—	**140**		
Hysteresis		—	15	—	mV	Device set for 5V, (Note 10)

TABLE 1-1: ELECTRICAL CHARACTERISTICS (Note 1, Note 2) (CONTINUED)

Electrical Characteristics: $V_{IN} = V_{OUT} + 1V$; $I_{OUT} = 10$ mA; $T_J = +25°C$. **Bold** values indicate –40°C ≤ T_J ≤ +125°C, unless noted.

Parameter	Symbol	Min.	Typ.	Max.	Units	Conditions
ENABLE Input - MIC29xx1/MIC29xx2						
Input Logic Voltage Low (OFF)		—	—	0.8	V	—
Input Logic Voltage High (ON)		2.4	—	—	V	—
Enable Pin Input Current		—	100	600	µA	$V_{EN} = 26V$
		—	—	**750**		
		0.7	—	2		$V_{EN} = 0.8V$
		—	—	**4**		
Regulator Output Current in Shutdown		—	10	**500**	µA	$V_{EN} \le 0.8V$ and $V_{IN} \le 26V$, $V_{OUT} = 0$.

Note 1: Specification for packaged product only.

2: When used in dual supply systems where the regulator load is returned to a negative supply, the output voltage must be diode clamped to ground.

3: Full load current (I_{FL}) is defined as 1.5A for the MIC2915x, 3A for the MIC2930x, 5A for the MIC2950x, and 7.5A for the MIC2975x families.

4: Output voltage temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

5: Dropout voltage is defined as the input-to-output differential when the output voltage drops to 99% of its normal value with V_{OUT} + 1V applied to V_{IN}.

6: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current plus the ground pin current.

7: $V_{IN} = V_{OUT}$ (nominal) + 1V. For example, use V_{IN} = 4.3V for a 3.3V regulator or use 6V for a 5V regulator. Employ pulse-testing procedures to pin current.

8: $V_{REF} \le V_{OUT} \le (V_{IN} - 1V)$, $2.3V \le V_{IN} \le 26V$, $10\ mA < I_L \le I_{FL}$, $T_J \le T_{JMAX}$.

9: 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} = 20V (a 4W pulse) for T = 10 ms.

10: Comparator thresholds are expressed in terms of a voltage differential at the adjust terminal below the nominal reference voltage measured at 6V input. To express these thresholds in terms of output voltage change, multiply by the error amplifier gain = V_{OUT}/V_{REF} = (R1 + R2)/R2. For example, at a programmed output voltage of 5V, the error output is guaranteed to go low when the output drops by 95 mV x 5V/1.240V = 384 mV. Thresholds remain constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.7% guaranteed.

TEMPERATURE SPECIFICATIONS (Note 1)

Parameters	Sym.	Min.	Typ.	Max.	Units	Conditions
Temperature Ranges						
Storage Temperature Range	T_S	–65	—	+150	°C	—
Operating Junction Temperature	T_J	–40	—	+125	°C	—
Lead Temperature	—	—	—	+260	°C	Soldering, 5 sec.
Package Thermal Resistance						
Thermal Resistance TO-220	θ_{JC}	—	2	—	°C/W	—
Thermal Resistance TO-263	θ_{JC}	—	2	—	°C/W	—
Thermal Resistance TO-247	θ_{JC}	—	1.5	—	°C/W	—
Thermal Resistance TO-252	θ_{JC}	—	3	—	°C/W	—
Thermal Resistance TO-252	θ_{JA}	—	56	—	°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.

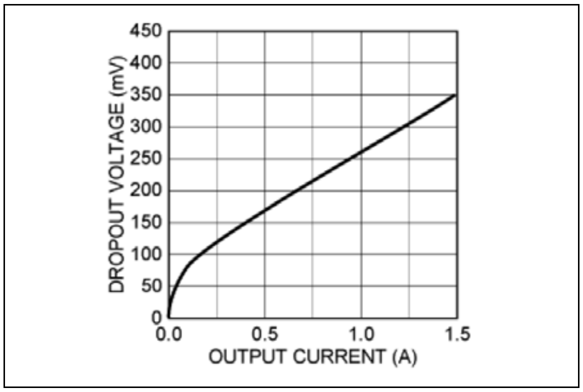


FIGURE 2-1: *MIC2915x Dropout Voltage vs. Output Current.*

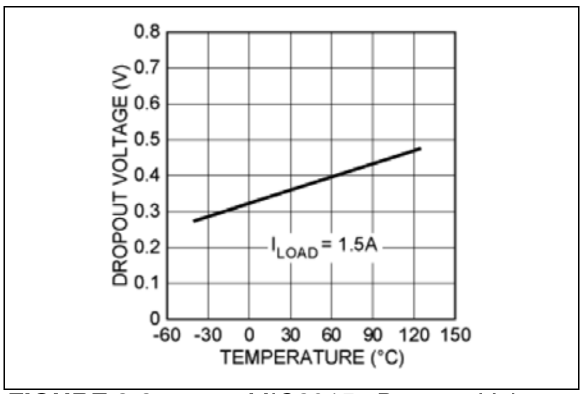


FIGURE 2-2: *MIC2915x Dropout Voltage vs. Temperature.*

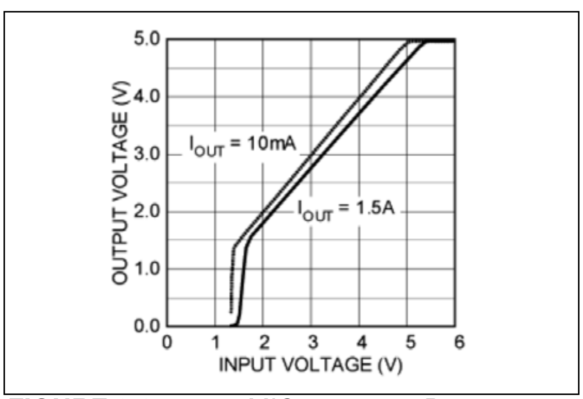


FIGURE 2-3: *MIC29150-5.0 Dropout Characteristics.*

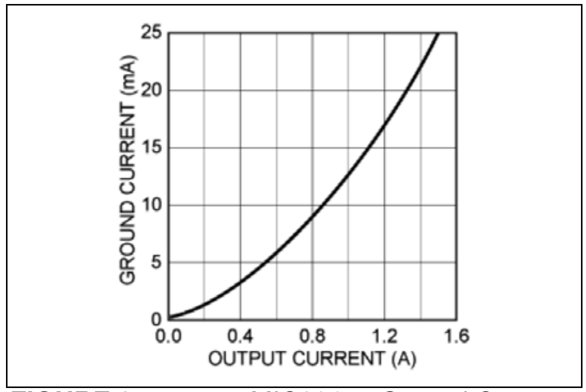


FIGURE 2-4: *MIC2915x Ground Current vs. Output Current.*

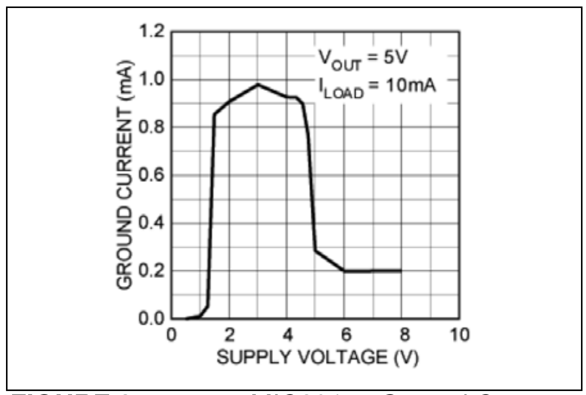


FIGURE 2-5: *MIC2915x Ground Current vs. Supply Voltage.*

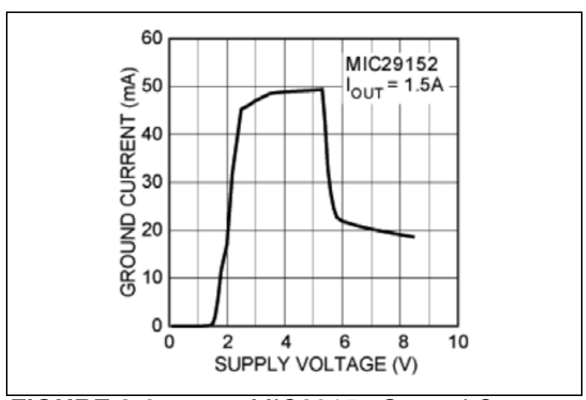


FIGURE 2-6: *MIC2915x Ground Current vs. Supply Voltage.*

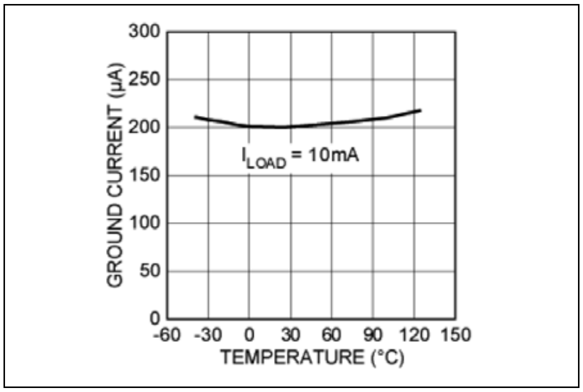


FIGURE 2-7: *MIC2915x Ground Current vs. Temperature.*

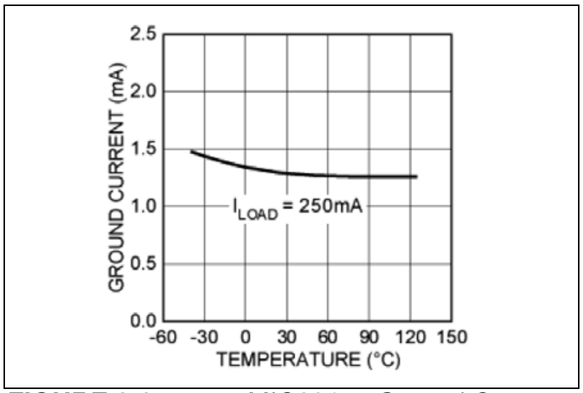


FIGURE 2-8: *MIC2915x Ground Current vs. Temperature.*

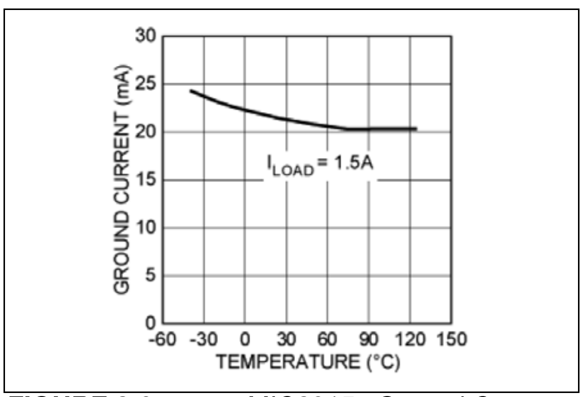


FIGURE 2-9: *MIC2915x Ground Current vs. Temperature.*

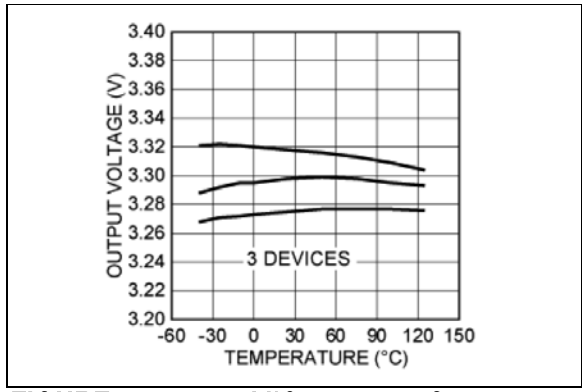


FIGURE 2-10: *MIC29150-3.3 Output Voltage vs. Temperature.*

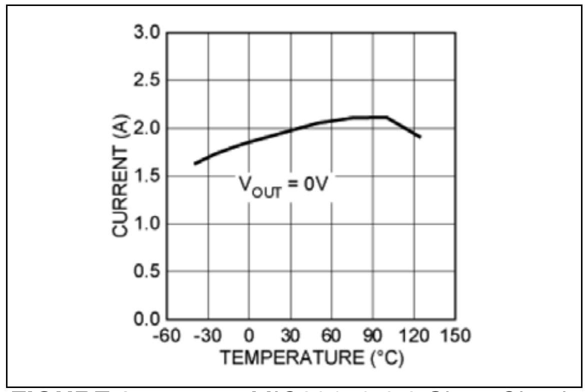


FIGURE 2-11: *MIC29150-3.3 Short-Circuit Current vs. Temperature.*

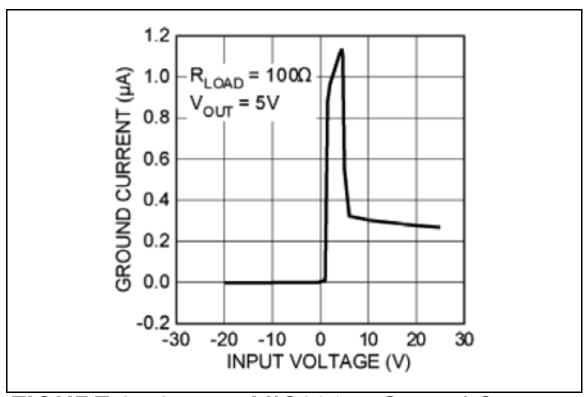


FIGURE 2-12: *MIC2915x Ground Current vs. Input Voltage.*

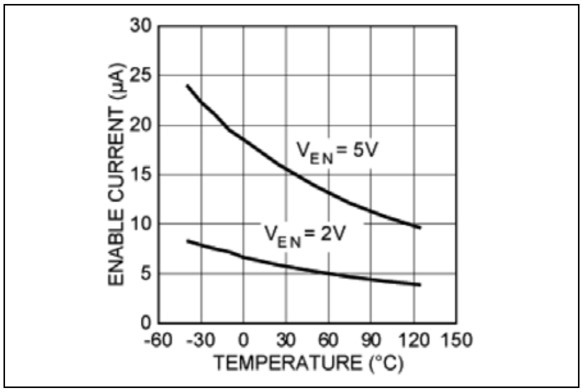


FIGURE 2-13: *MIC29151-xx/2 Enable Current vs. Temperature.*

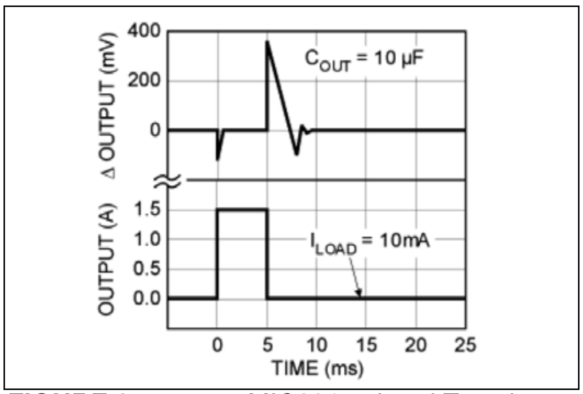


FIGURE 2-14: *MIC2915x Load Transient.*

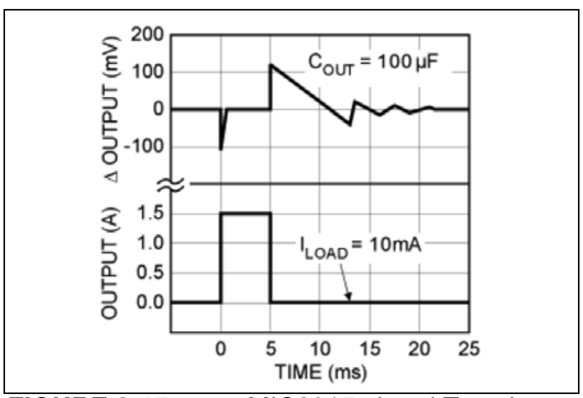


FIGURE 2-15: *MIC2915x Load Transient.*

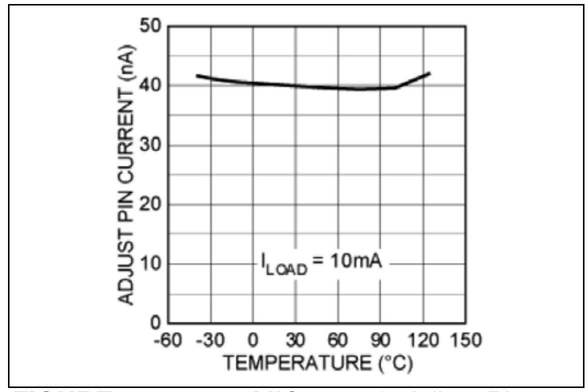


FIGURE 2-16: *MIC29152/3 Adjust Pin Current vs. Temperature.*

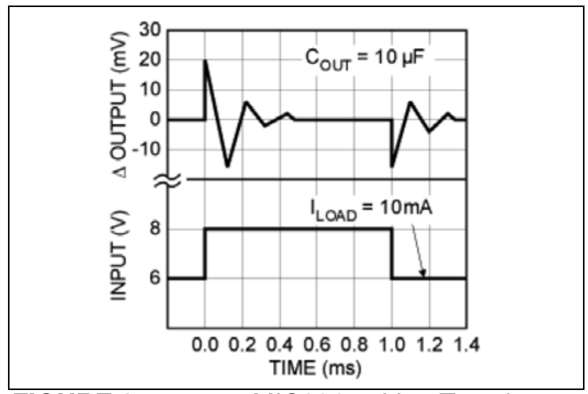


FIGURE 2-17: *MIC2915x Line Transient.*

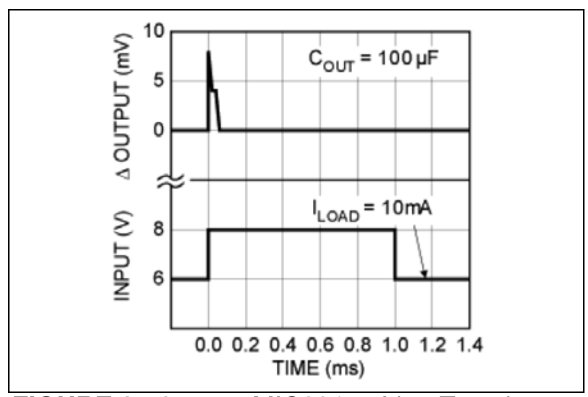


FIGURE 2-18: *MIC2915x Line Transient.*

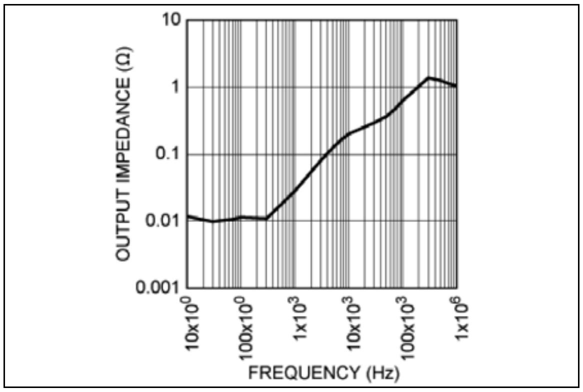


FIGURE 2-19: MIC2915x Output Impedance vs. Frequency.

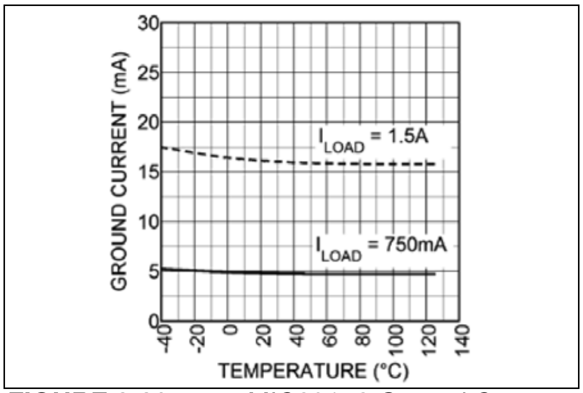


FIGURE 2-20: MIC29152 Ground Current vs. Temperature.

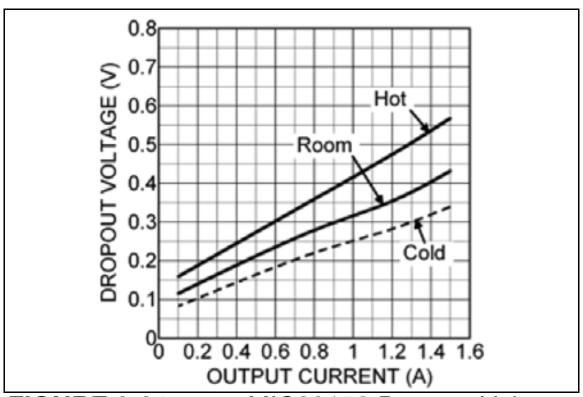


FIGURE 2-21: MIC29152 Dropout Voltage vs. Output Current.

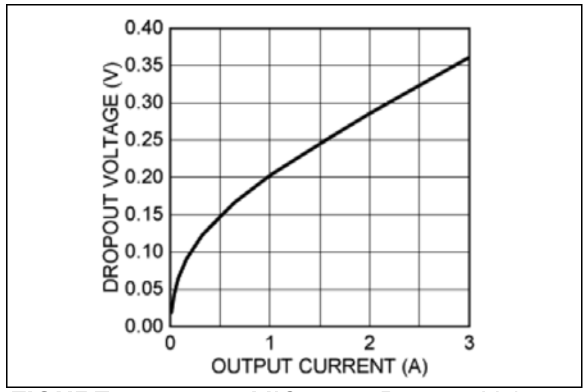


FIGURE 2-22: MIC2930x Dropout Voltage vs. Output Current.

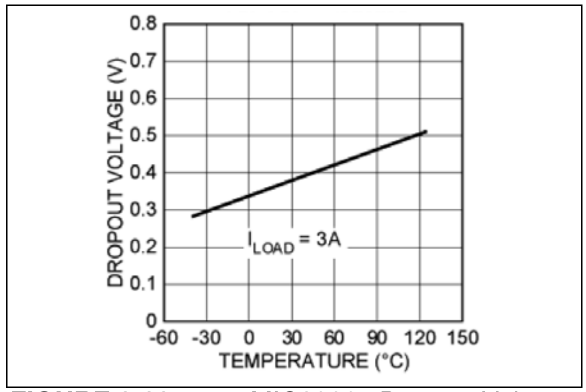


FIGURE 2-23: MIC2930x Dropout Voltage vs. Temperature.

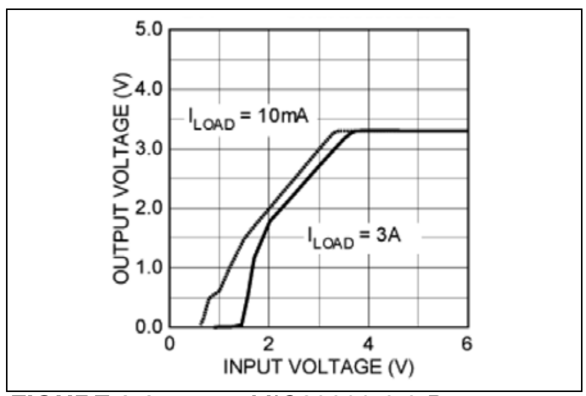


FIGURE 2-24: MIC29300-3.3 Dropout Characteristics.

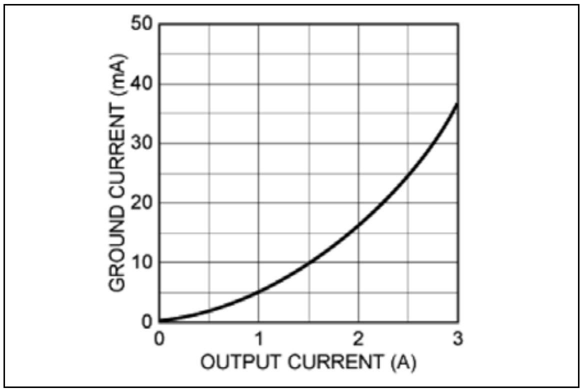


FIGURE 2-25: *MIC2930x Ground Current vs. Output Current.*

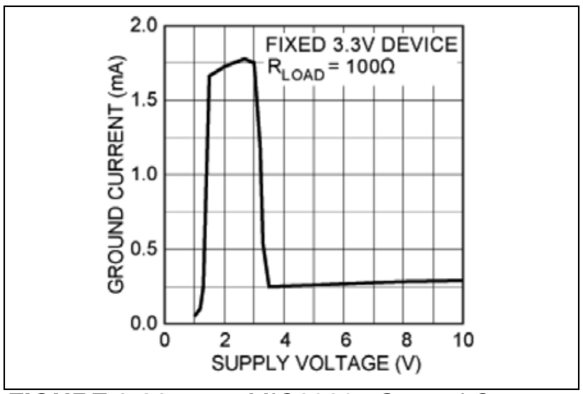


FIGURE 2-26: *MIC2930x Ground Current vs. Supply Voltage.*

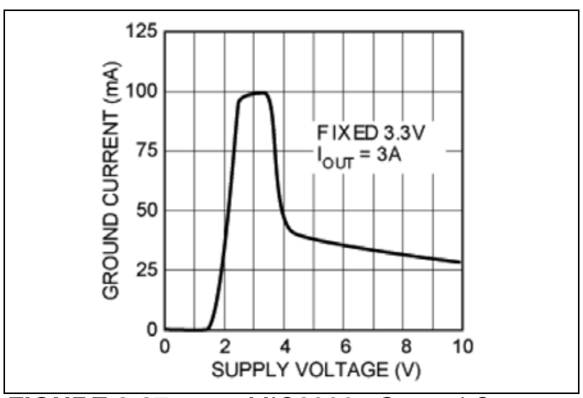


FIGURE 2-27: *MIC2930x Ground Current vs. Supply Voltage.*

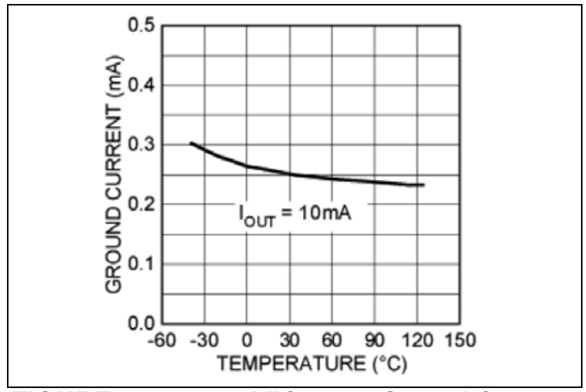


FIGURE 2-28: *MIC2930x Ground Current vs. Temperature.*

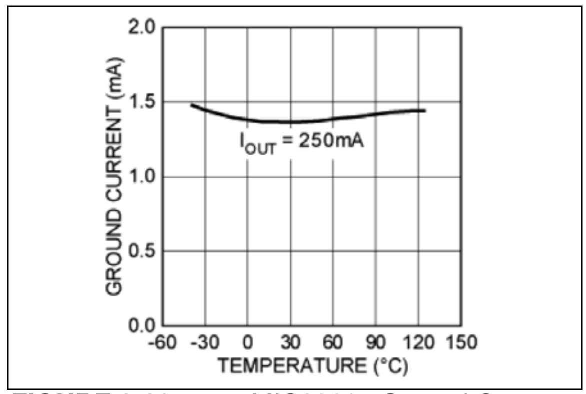


FIGURE 2-29: *MIC2930x Ground Current vs. Temperature.*

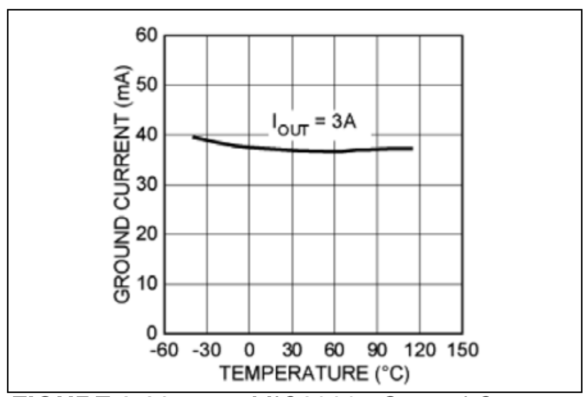


FIGURE 2-30: *MIC2930x Ground Current vs. Temperature.*

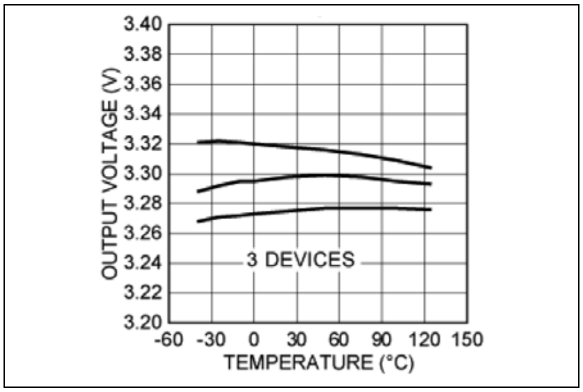


FIGURE 2-31: *MIC29300-3.3 Output Voltage vs. Temperature.*

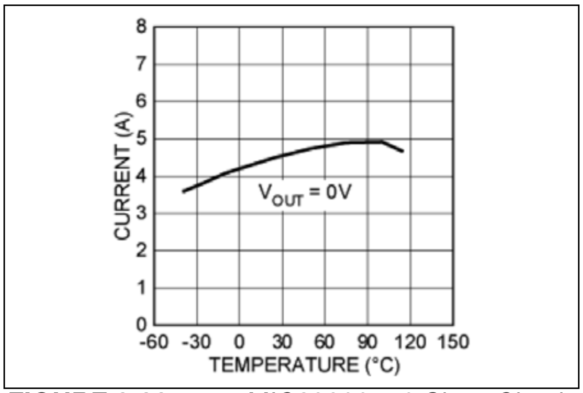


FIGURE 2-32: *MIC29300-5.0 Short-Circuit Current vs. Temperature.*

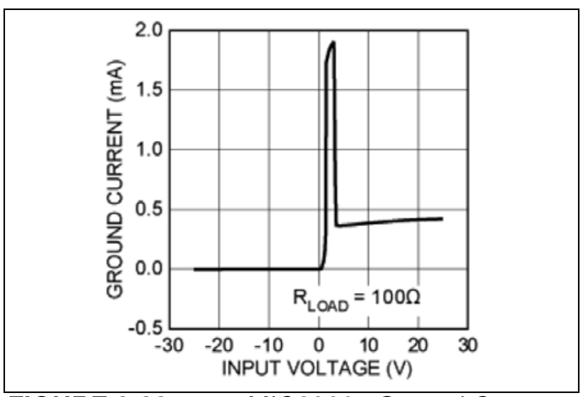


FIGURE 2-33: *MIC2930x Ground Current vs. Input Voltage.*

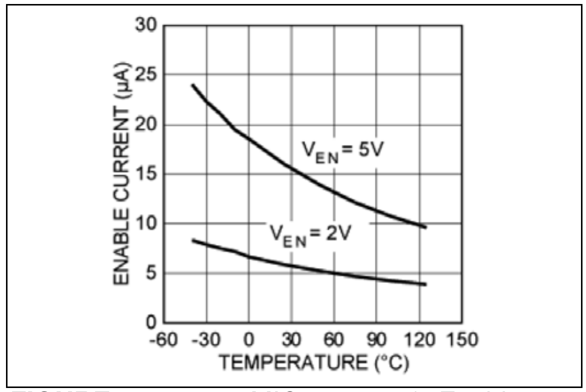


FIGURE 2-34: *MIC29301-xx/2 Enable Current vs. Temperature.*

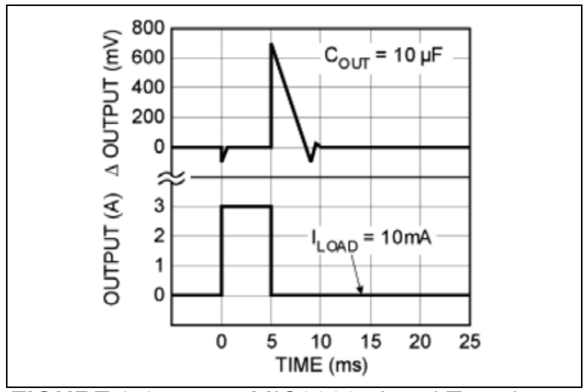


FIGURE 2-35: *MIC2930x Load Transient.*

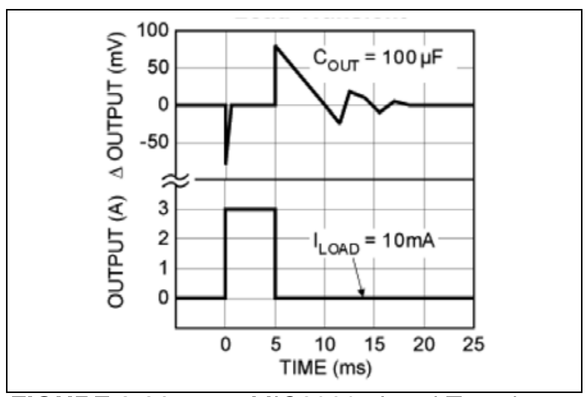


FIGURE 2-36: *MIC2930x Load Transient.*

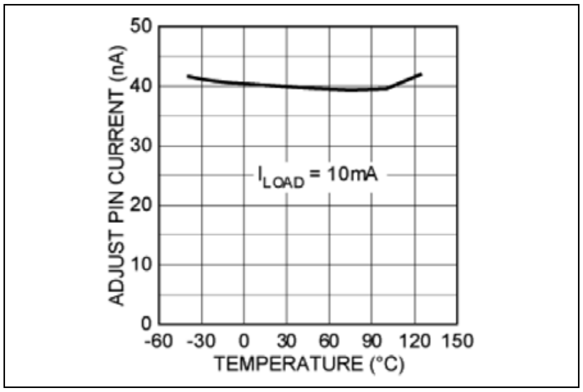


FIGURE 2-37: *MIC29302/3 Adjust Pin Current vs. Temperature.*

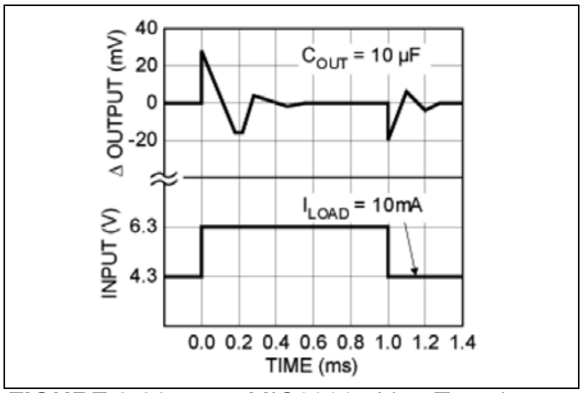


FIGURE 2-38: *MIC2930x Line Transient.*

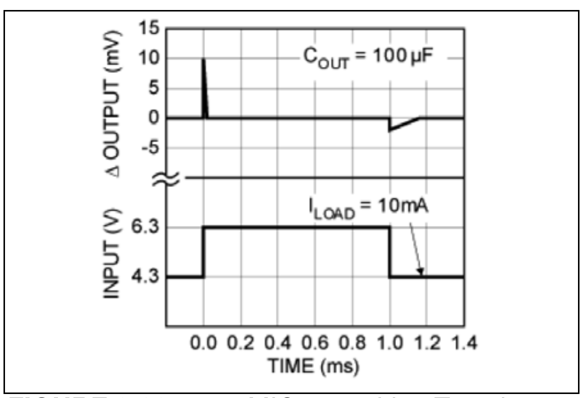


FIGURE 2-39: *MIC2930x Line Transient.*

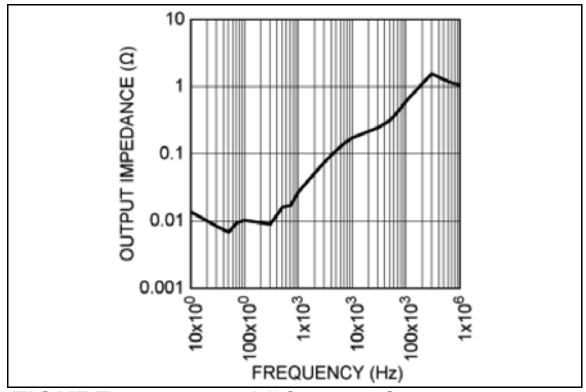


FIGURE 2-40: *MIC2930x Output Impedance vs. Frequency.*

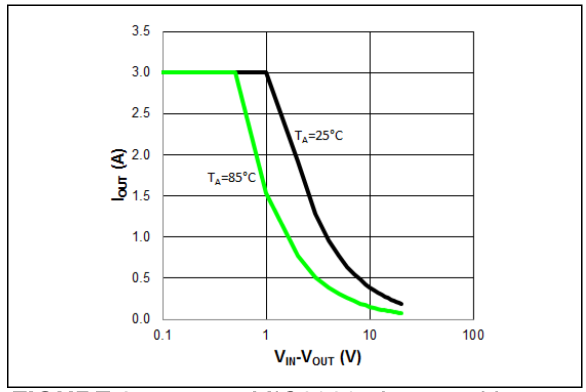


FIGURE 2-41: *MIC2930x I_{OUT} vs. V_{IN} – V_{OUT} SOA (TO-263).*

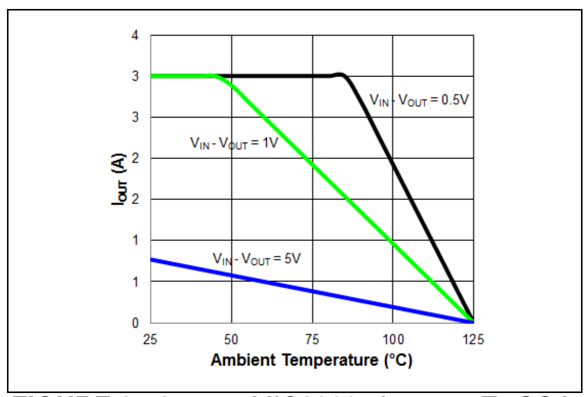


FIGURE 2-42: *MIC2930x I_{OUT} vs. T_A SOA (TO-263).*

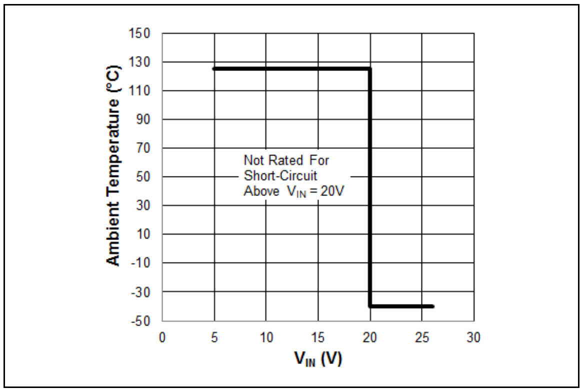


FIGURE 2-43: *MIC2930x Short-Circuit SOA vs. Temperature (TO-263).*

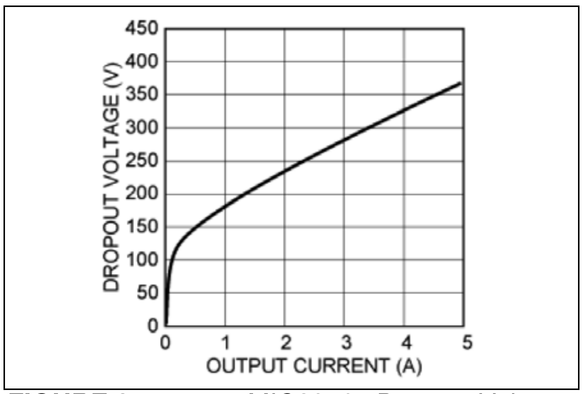


FIGURE 2-44: *MIC2950x Dropout Voltage vs. Output Current.*

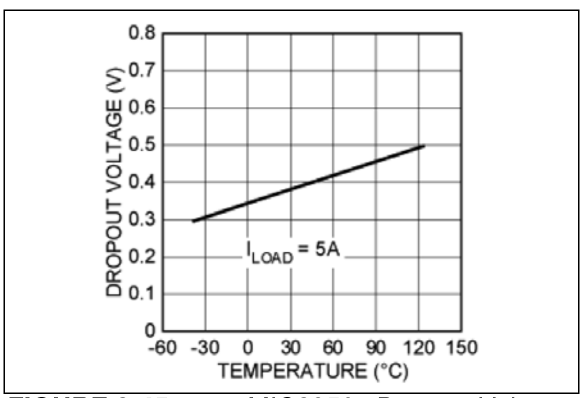


FIGURE 2-45: *MIC2950x Dropout Voltage vs. Temperature.*

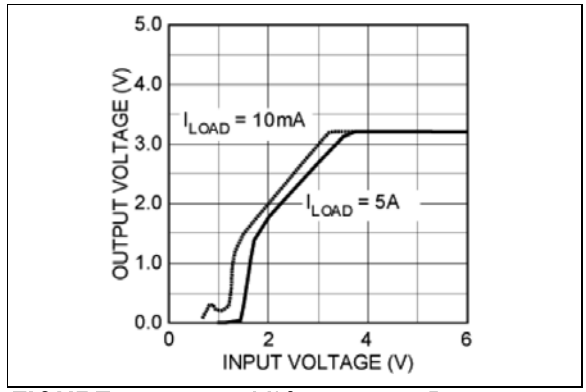


FIGURE 2-46: *MIC29500-3.3 Dropout Characteristics.*

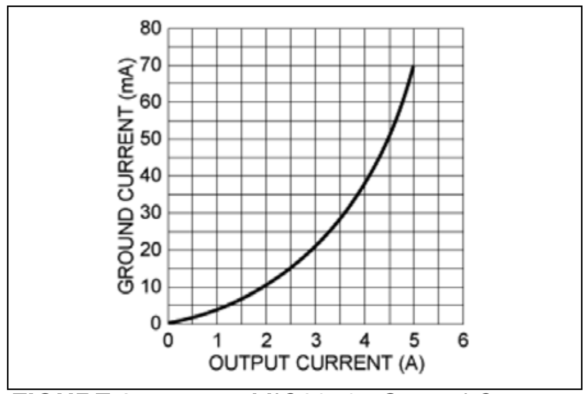


FIGURE 2-47: *MIC2950x Ground Current vs. Output Current.*

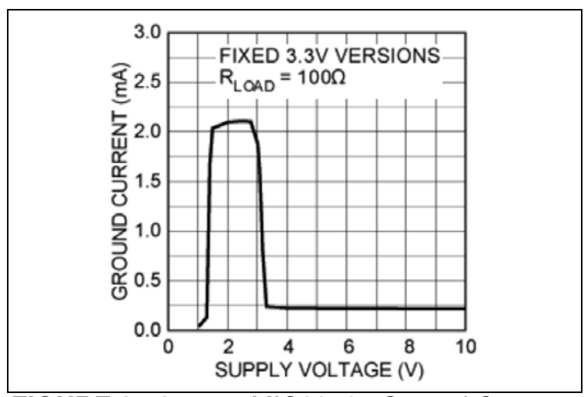


FIGURE 2-48: *MIC2950x Ground Current vs. Supply Voltage.*

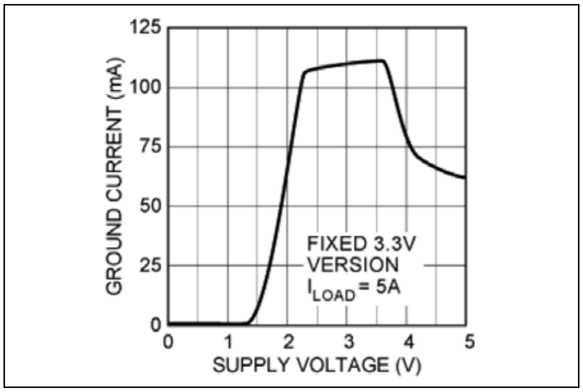


FIGURE 2-49: *MIC2950x Ground Current vs. Supply Voltage.*

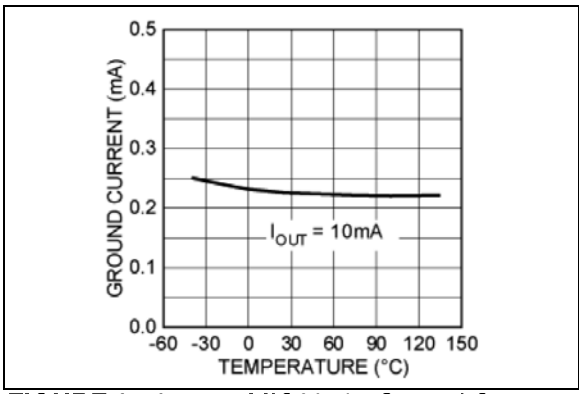


FIGURE 2-50: *MIC2950x Ground Current vs. Temperature.*

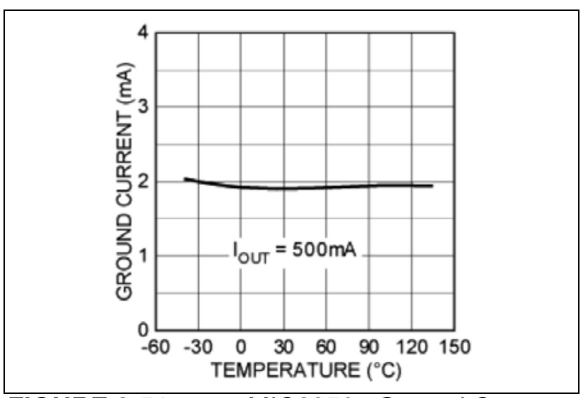


FIGURE 2-51: *MIC2950x Ground Current vs. Temperature.*

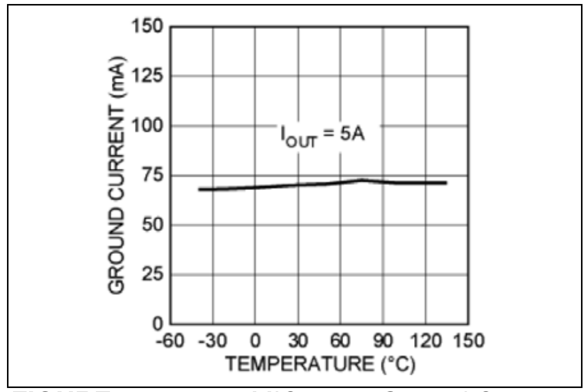


FIGURE 2-52: *MIC2950x Ground Current vs. Temperature.*

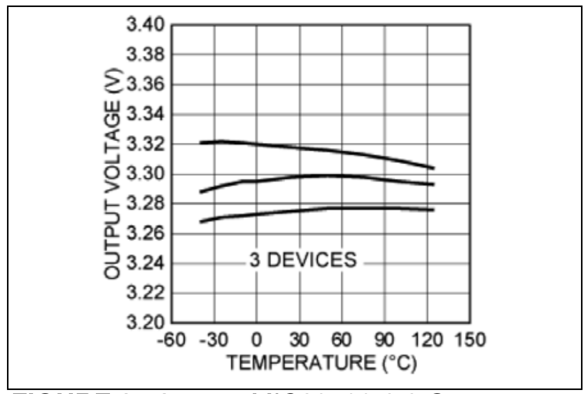


FIGURE 2-53: *MIC29500-3.3 Output Voltage vs. Temperature.*

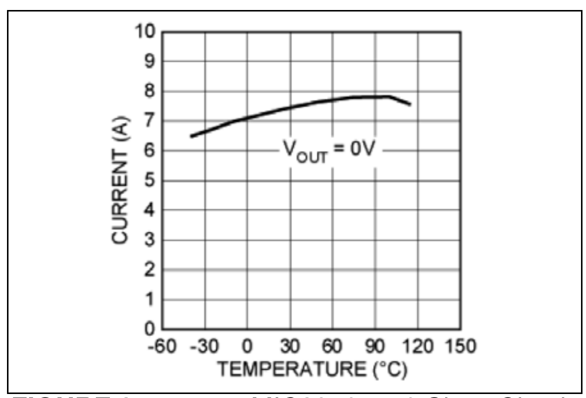


FIGURE 2-54: *MIC2950x-5.0 Short-Circuit Current vs. Temperature.*

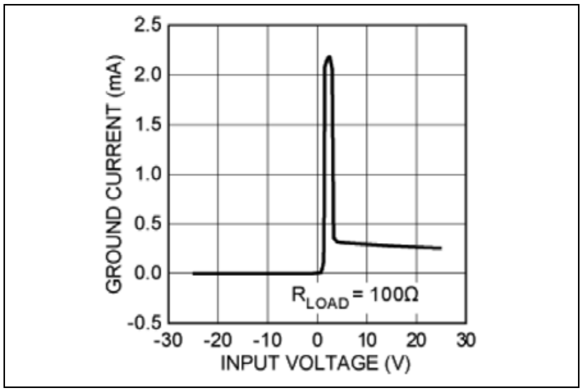


FIGURE 2-55: MIC2950x Ground Current vs. Input Voltage.

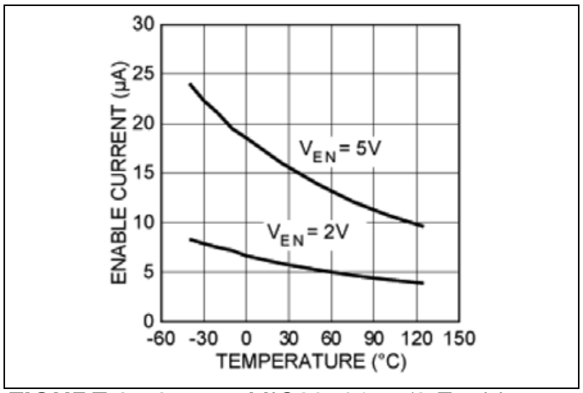


FIGURE 2-56: MIC29501-xx/2 Enable Current vs. Temperature.

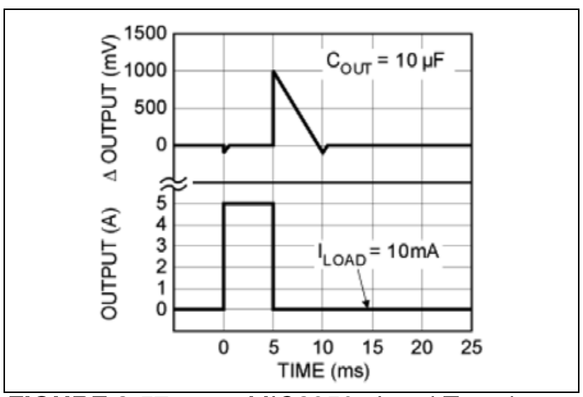


FIGURE 2-57: MIC2950x Load Transient.

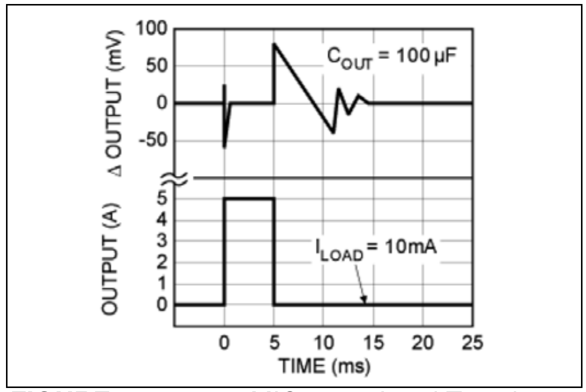


FIGURE 2-58: MIC2950x Load Transient.

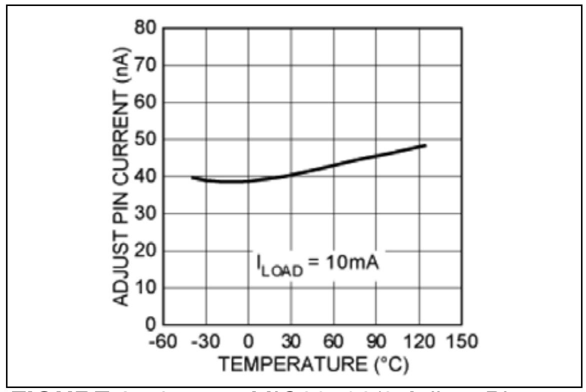


FIGURE 2-59: MIC29502/3 Adjust Pin Current vs. Temperature.

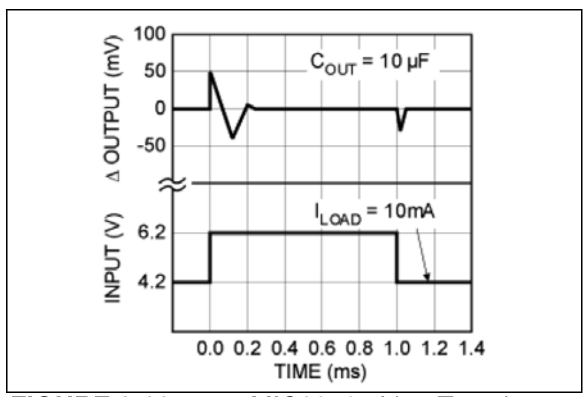


FIGURE 2-60: MIC2950x Line Transient.

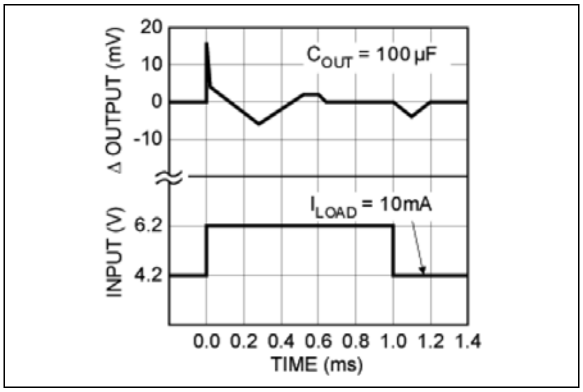


FIGURE 2-61: *MIC2950x Line Transient.*

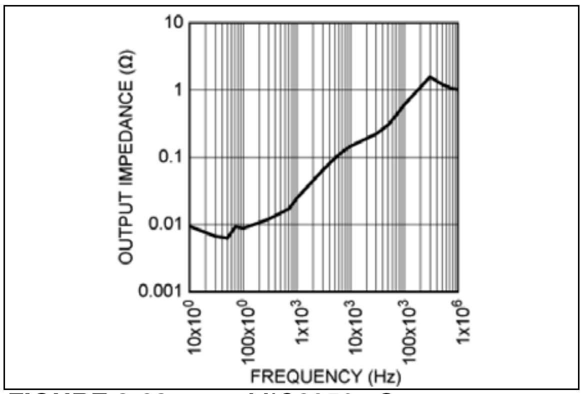


FIGURE 2-62: *MIC2950x Output Impedance vs. Frequency.*

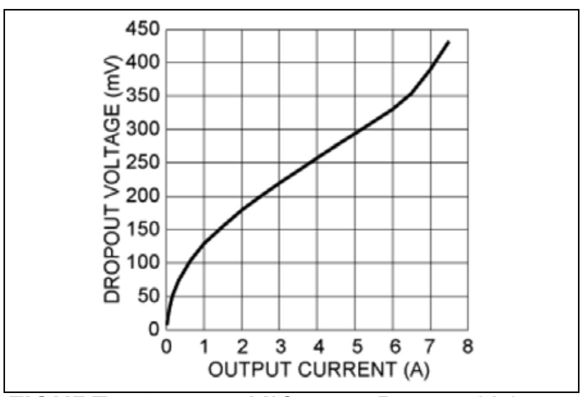


FIGURE 2-63: *MIC2975x Dropout Voltage vs. Output Current.*

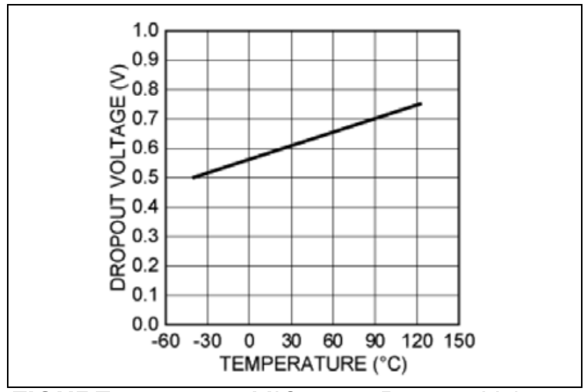


FIGURE 2-64: *MIC2975x Dropout Voltage vs. Temperature.*

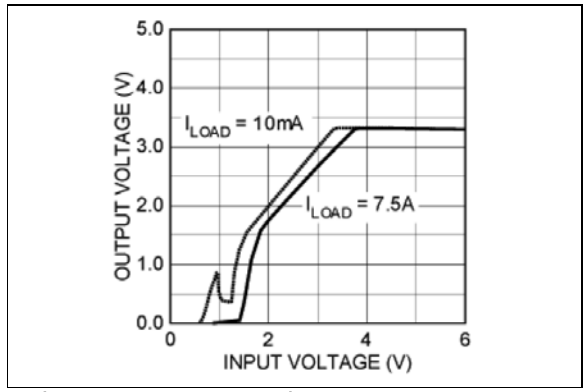


FIGURE 2-65: *MIC29751-3.3 Dropout Characteristics.*

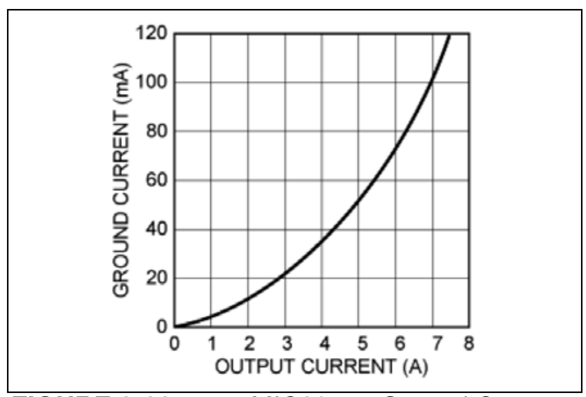


FIGURE 2-66: *MIC2975x Ground Current vs. Output Current.*

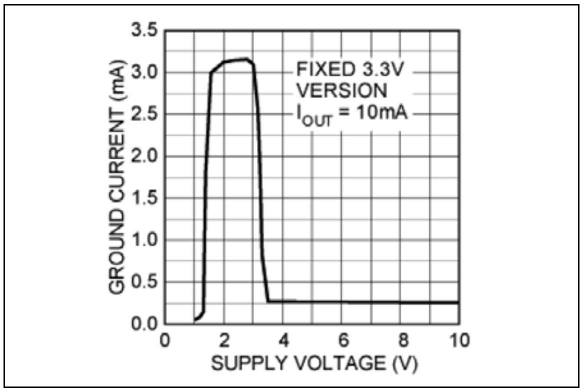


FIGURE 2-67: *MIC2975x Ground Current vs. Supply Voltage.*

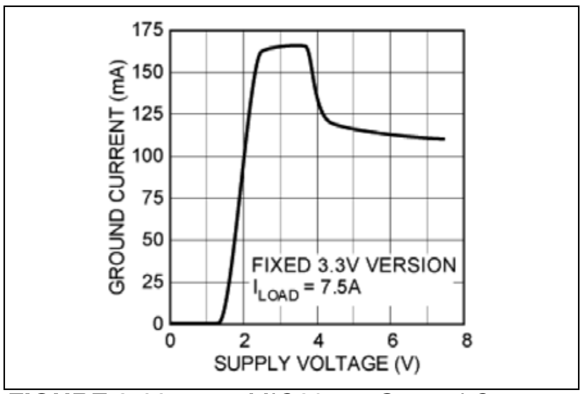


FIGURE 2-68: *MIC2975x Ground Current vs. Supply Voltage.*

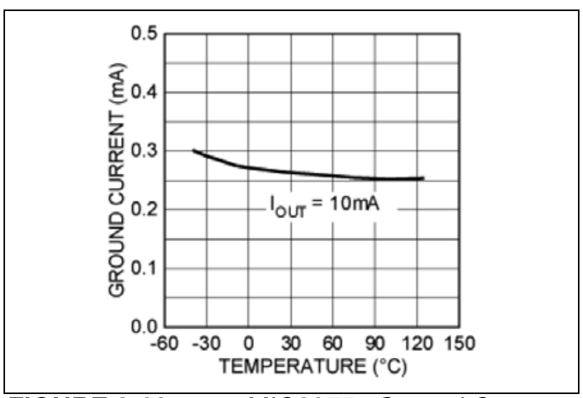


FIGURE 2-69: *MIC2975x Ground Current vs. Temperature.*

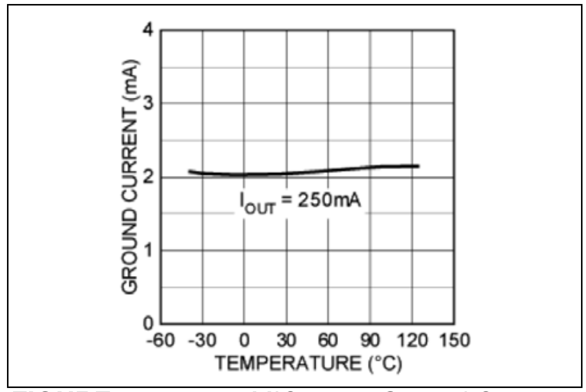


FIGURE 2-70: *MIC2975x Ground Current vs. Temperature.*

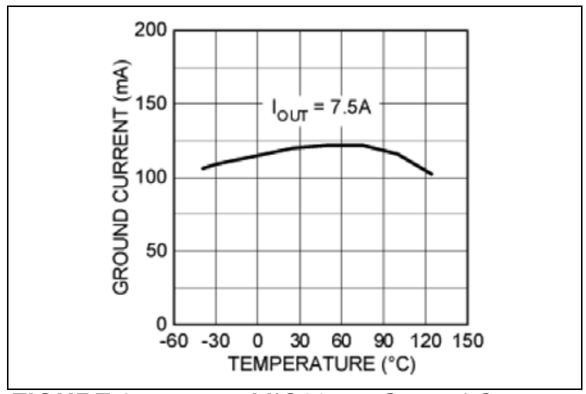


FIGURE 2-71: *MIC2975x Ground Current vs. Temperature.*

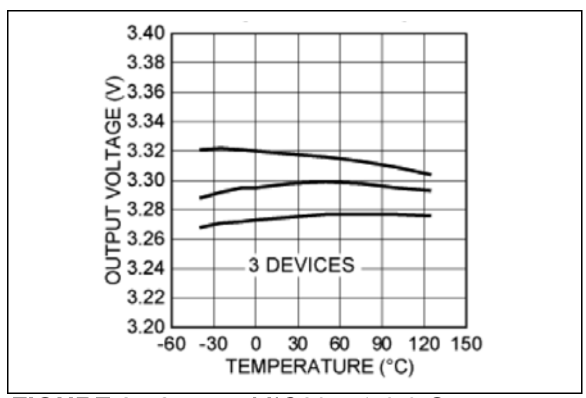


FIGURE 2-72: *MIC29751-3.3 Output Voltage vs. Temperature.*

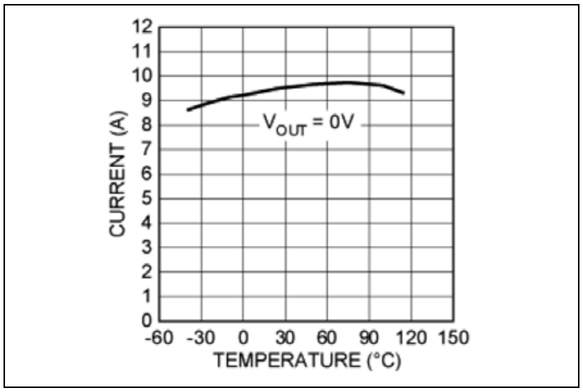


FIGURE 2-73: *MIC29751-5.0 Short-Circuit Current vs. Temperature.*

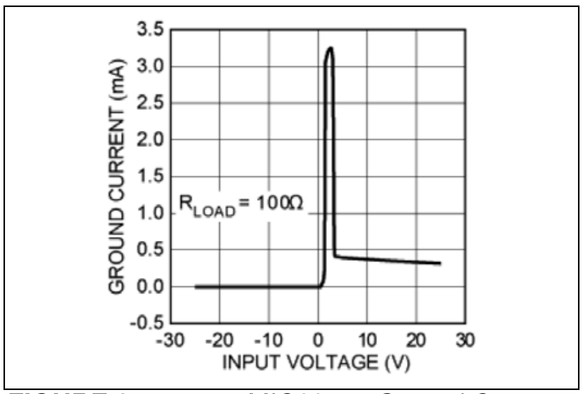


FIGURE 2-74: *MIC2975x Ground Current vs. Input Voltage.*

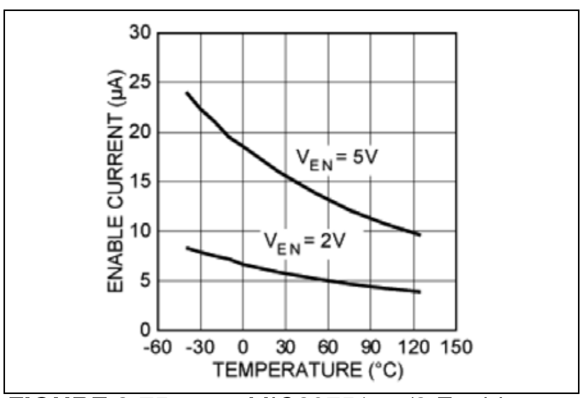


FIGURE 2-75: *MIC29751-xx/2 Enable Current vs. Temperature.*

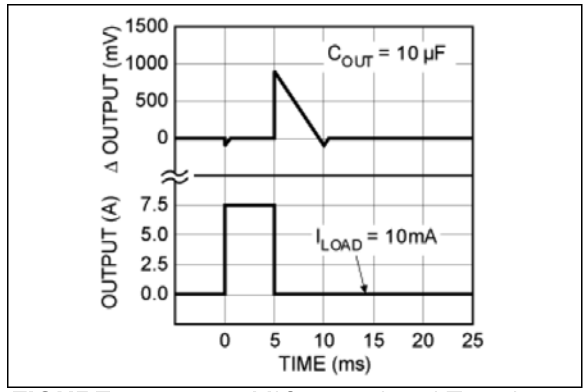


FIGURE 2-76: *MIC2975x Load Transient.*

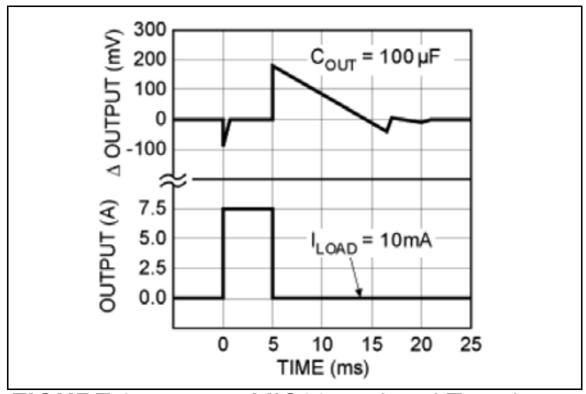


FIGURE 2-77: *MIC2975x Load Transient.*

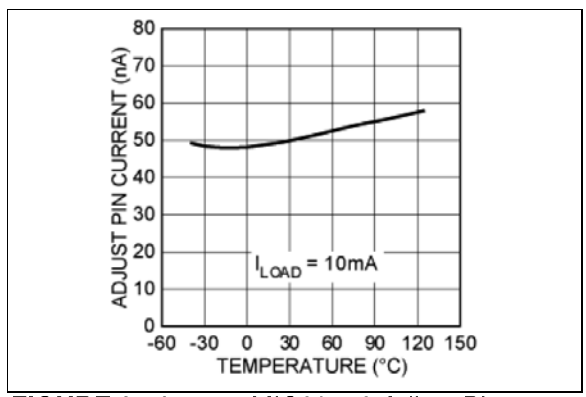


FIGURE 2-78: *MIC29752 Adjust Pin Current vs. Temperature.*

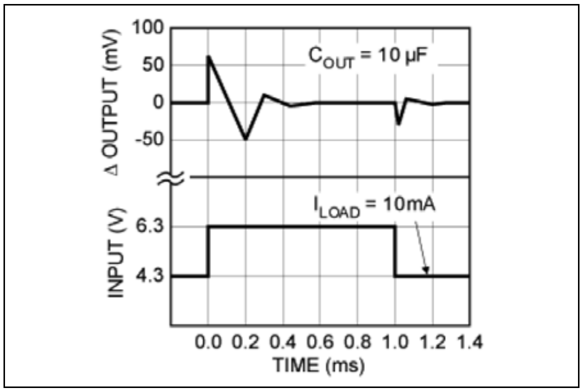


FIGURE 2-79: *MIC2975x Line Transient.*

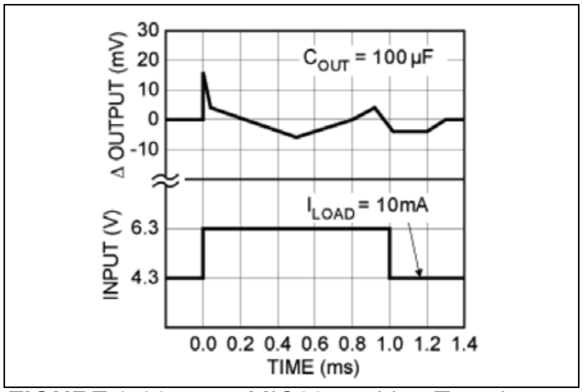


FIGURE 2-80: *MIC2975x Line Transient.*

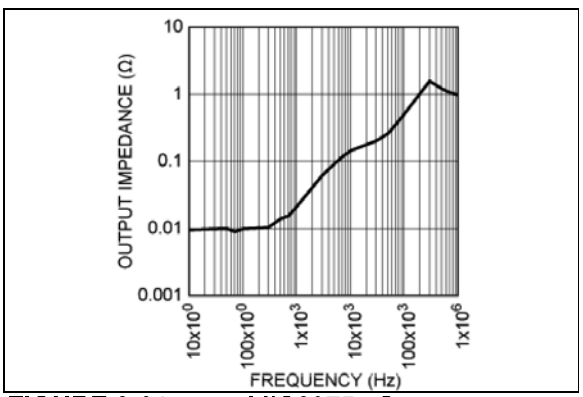


FIGURE 2-81: *MIC2975x Output Impedance vs. Frequency.*

3.0 PIN DESCRIPTIONS

The descriptions of the pins are listed in Table 3-1 and Table 3-2.

TABLE 3-1: PIN FUNCTION TABLE

Pin Number TO-220 TO-263	Pin Name	Description
1	INPUT	Supplies the current to the output power device.
2	GND	TAB is also connected internally to the IC’s ground on D-PAK.
3	OUTPUT	The regulator output voltage.

TABLE 3-2: PIN FUNCTION TABLE

Pin Number Fixed TO-220 TO-247 TO-263	Pin Number Adjustable TO-220 TO-247 TO-252 TO-263	Pin Number Adj. w/ Flag TO-220 TO-247 TO-263	Pin Name	Description
1	1	—	ENABLE	CMOS compatible control input. Logic-high = enable, logic-low = shutdown.
2	2	2	INPUT	Supplies the current to the output power device.
3, TAB	3, TAB	3, TAB	GND	TAB is also connected internally to the IC’s ground on D-PAK.
4	4	4	OUTPUT	The regulator output voltage.
—	5	5	ADJUST	Adjustable regulator feedback input that connects to the resistor voltage divider that is placed from OUTPUT to GND in order to set the output voltage.
5	—	1	FLAG	Active-low error flag output signal that indicates an output fault condition.

4.0 APPLICATION INFORMATION

The MIC2915x, MIC2930x, MIC2950x, and MIC2975x are high-performance low-dropout voltage regulators suitable for all moderate to high-current voltage regulator applications. Their 350 mV to 425 mV typical dropout voltage at full load make them especially valuable in battery powered systems and as high efficiency noise filters in post-regulator applications. Unlike older NPN-pass transistor designs, where the minimum dropout voltage is limited by the base-emitter voltage drop and collector-emitter saturation voltage, dropout performance of the PNP output of these devices is limited merely by the low VCE saturation voltage.

A trade-off for the low-dropout voltage is a varying base driver requirement. But Microchip's Super ßeta PNP process reduces this drive requirement to merely 1% of the load current.

The MIC2915x/2930x/2950x/2975x family of regulators are fully protected from damage due to fault conditions. Current limiting is provided. This limiting is linear; output current under overload conditions is constant. Thermal shutdown disables the device when the die temperature exceeds the +125°C maximum safe operating temperature. Line transient protection allows device and load survival even when the input voltage spikes between –20V and +60V. When the input voltage exceeds approximately 32V, the overvoltage sensor disables the regulator. The output structure of these regulators allows voltages in excess of the desired output voltage to be applied without reverse current flow. MIC29xx1 and MIC29xx2 versions offer a logic-level ON/OFF control. When disabled, the devices draw nearly zero current.

An additional feature of this regulator family is a common pinout. A design's current requirement may change up or down, but use the same board layout because all of these regulators have identical pinouts.

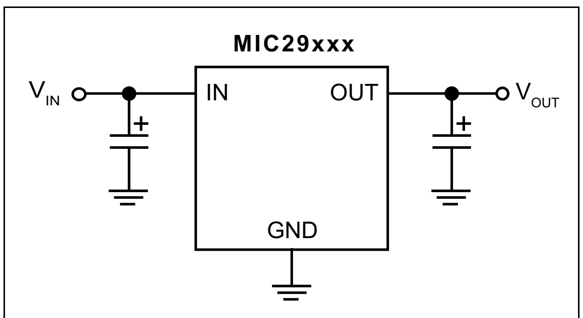


FIGURE 4-1: *Linear Regulators Require Only Two Capacitors for Operation.*

4.1 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}

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

EQUATION 4-1:

$$P_D = I_{OUT}(1.01(V_{IN} - V_{OUT}))$$

The ground current is approximated by 1% of I_{OUT}. Then the heat sink thermal resistance is determined with Equation 4-2.

EQUATION 4-2:

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

Where:

T_{JMAX}	≤ 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 Super ßeta PNP regulators allow very significant reductions in regulator power dissipation and the associated heat sink without compromising performance. When this technique is employed, a capacitor of at least 0.1 µF is needed directly between the input and regulator ground.

Please refer to Application Note 9 and Application Hint 17 for further details and examples on thermal design and heat sink specification.

With no heat sink in the application, calculate the junction temperature to determine the maximum power dissipation that will be allowed before exceeding the maximum junction temperature of the MIC29152. The maximum power allowed can be calculated using the thermal resistance (θ_{JA}) of the D-Pak adhering to the following criteria for the PCB design: 2 oz. copper and 100 mm^2 copper area for the MIC29152.

For example, given an expected maximum ambient temperature (T_A) of +75°C with V_{IN} = 3.3V, V_{OUT} = 2.5V, and I_{OUT} = 1.5A, first calculate the expected P_D using Equation 4-3:

EQUATION 4-3:

$$P_D = (3.3V - 2.5V) \times 1.5A - (3.3V \times 0.016A) = 1.1472W$$

Next, calculate the junction temperature for the expected power dissipation.

EQUATION 4-4:

$$\begin{aligned} T_J &= (\theta_{JA} \times P_D) + T_A \\ &= (56^oC/W \times 1.1472W) + 75^oC = 139.24^oC \end{aligned}$$

Now determine the maximum power dissipation allowed that would not exceed the IC's maximum junction temperature (+125°C) without the use of a heat sink.

EQUATION 4-5:

$$\begin{aligned} P_{D(MAX)} &= (T_{J(MAX)} - T_A) \div \theta_{JA} \\ &= (125^oC - 75^oC) \div 56^oC/W = 0.893W \end{aligned}$$

4.2 Capacitor Requirements

For stability and minimum output noise, a capacitor on the regulator output is necessary. The value of this capacitor is dependent upon the output current; lower currents allow smaller capacitors. The MIC2915x/2930x/2950x/2975x regulators are stable with the following minimum capacitor values at full load, as noted in Table 4-1.

TABLE 4-1: MINIMUM CAPACITOR VALUES AT FULL LOAD

Device	Full-Load Capacitor
MIC2915x	10 µF
MIC2930x	10 µF
MIC2950x	10 µF
MIC2975x	22 µF

This capacitor need not be an expensive low ESR type: aluminum electrolytics are adequate. In fact, extremely low ESR capacitors may contribute to instability. Tantalum capacitors are recommended for systems where fast load transient response is important.

Where the regulator is powered from a source with high AC impedance, a 0.1 µF capacitor connected between Input and GND is recommended. This capacitor should have good characteristics to above 250 kHz.

4.3 Minimum Load Current

The MIC2915x–2975x regulators are specified between finite loads. If the output current is too small, leakage currents dominate and the output voltage rises. The following minimum load current swamps any expected leakage current across the operating temperature range, as shown in Table 4-2.

TABLE 4-2: MINIMUM LOAD CURRENTS

Device	Minimum Load
MIC2915x	5 mA
MIC2930x	7 mA
MIC2950x	10 mA
MIC2975x	10 mA

4.4 Adjustable Regulator Design

The adjustable regulator versions, MIC29xx2 and MIC29xx3, allow programming the output voltage anywhere between 1.25V and the 25V. Two resistors are used. The resistor values are calculated by Equation 4-6.

EQUATION 4-6:

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

In the equation above, V_{OUT} is the desired output voltage. Figure 4-2 shows 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 sub-section).