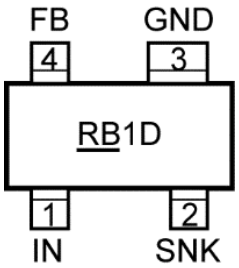
Ordering Information

Part Number[1]	Marking	Voltage (V)	Tolerance	Configuration	Temperature Range	Package
MIC4043YM4	RB1D	1.245	1%	Open Collector	–40°C to +85°C	SOT-143

Note:

1. Underbar (_) symbol may not be to scale.

Pin Configuration



SOT-143 (M4)
(Top View)

Pin Description

Pin Number	Pin Name	Pin Function
1	IN	Input: Supply voltage input.
2	SNK	Sink (Output): NPN open collector output.
3	GND	Ground
4	FB	Feedback (Input): Feedback input from external voltage-divider network.

Absolute Maximum Ratings[2]

Input Voltage (V_{IN}) ..... +15V
Output Voltage (V_{SNK}) ..... +15V
Storage Temperature (T_S) ..... –65°C to +150°C
ESD Rating[4]
Human Body Model 2kV
Machine Model 200V

Operating Ratings[3]

Input Voltage (V_{IN}) ..... +10V
Output Voltage (V_{SNK}) ..... +10V
Maximum Output Current (I_{SNK}) 15mA
Temperature Range (T_A) ..... –40°C to +85°C

Electrical Characteristics[5]

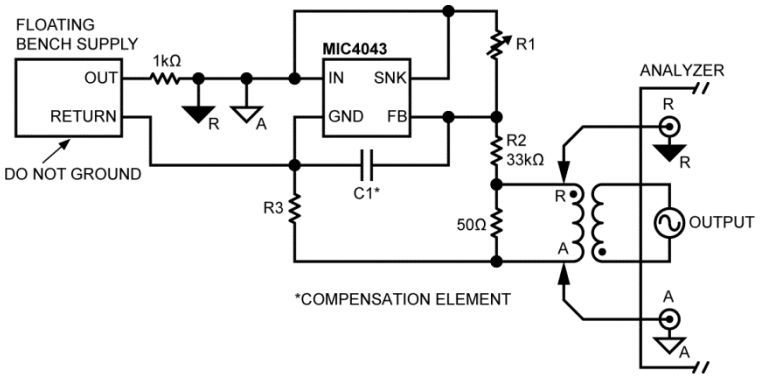
T_A = +25°C, **bold** values indicate –40°C ≤ T_A ≤ +85°C, unless noted.

Parameter	Condition	Min.	Typ.	Max.	Units
Reference Voltage[5]			1.245		V
Reference Voltage Tolerance				±1	%
				±2	
Supply Current	I_{SNK} = 0mA		35	65	µA
				70	
Transconductance (ΔI_{SNK} / ΔV_{IN})	1mA < I_{SNK} < 15mA	3.5	150		S
		2			
Output Transistor Saturation Voltage	I_{SNK} = 15mA		160	250	mV
				400	
Output Leakage	V_{SNK} = 5V, output transistor off			0.5	µA
				1	

Notes:

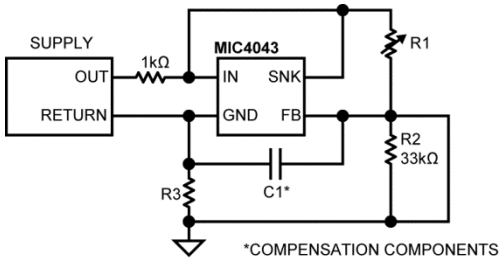
2. Exceeding the absolute maximum ratings may damage the device.
3. The device is not guaranteed to function outside its operating ratings.
4. Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5kΩ in series with 100pF. Machine model, 200pF.
5. Reference voltage is not referenced to ground. The reference is between the IN and FB pins.

Test Circuit



V_{OUT}	R1	R2	R3	C1
1.8V	72kΩ	33kΩ	20kΩ	0.001µF
2.5V	33kΩ	33kΩ	40kΩ	0.001µF
3.3V	20kΩ	33kΩ	150kΩ	0.001µF

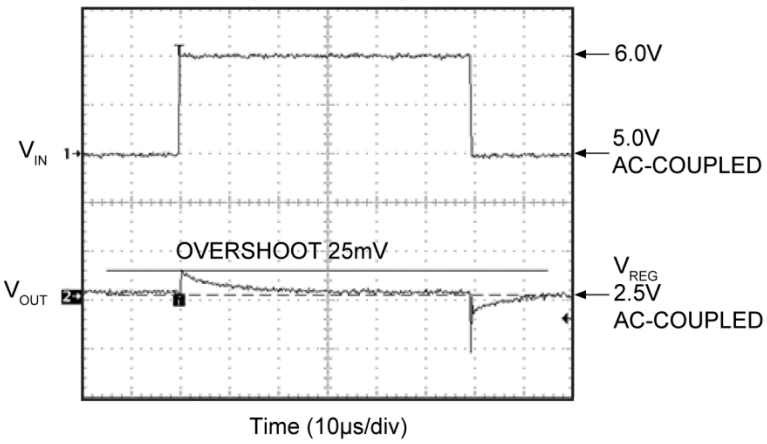
Test Circuit 1: Compensation (Bode Plot) Circuit



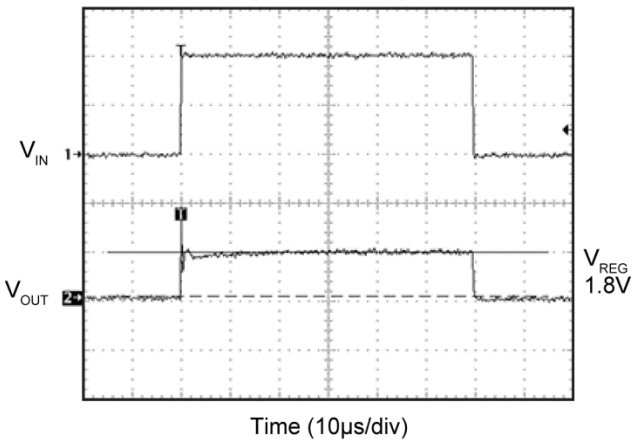
Test Circuit 2: Transient Response Circuit

Functional Characteristics

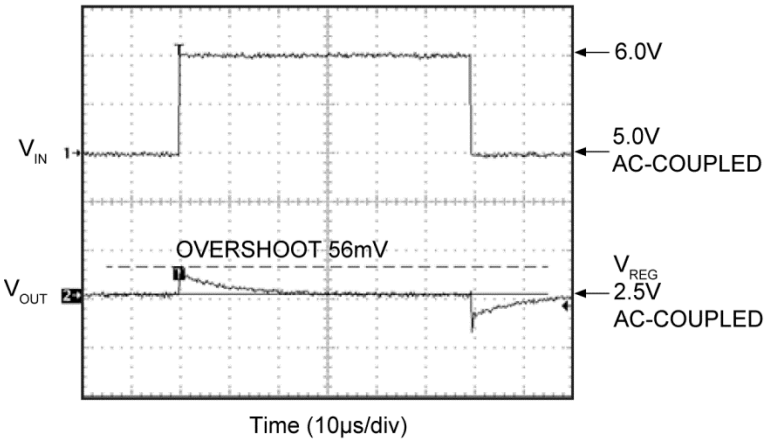
Transient Response (1.8V Output)



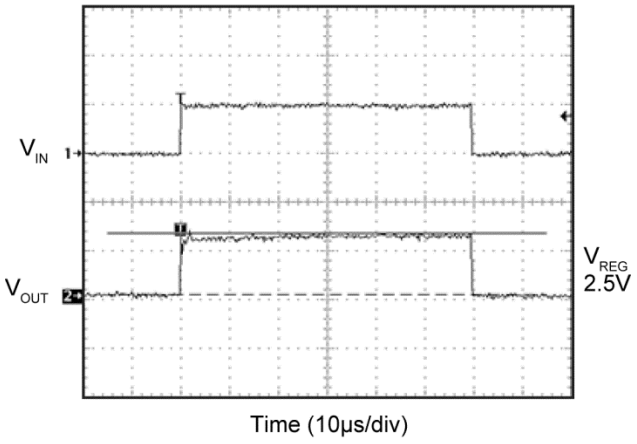
Turn-On Transient Response (1.8V Output)



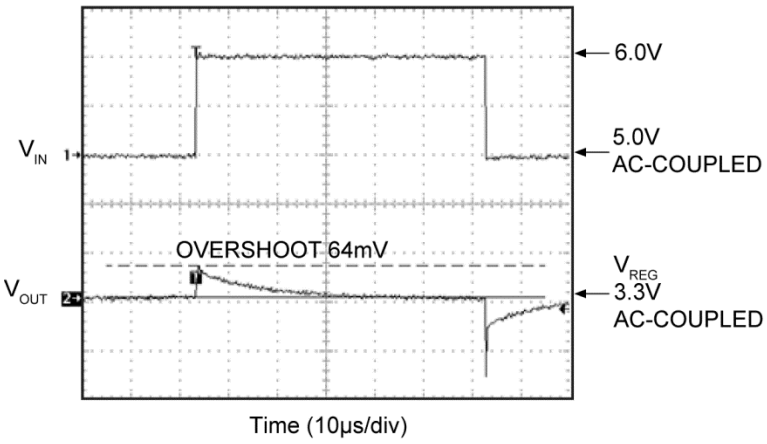
Transient Response (1.8V Output)



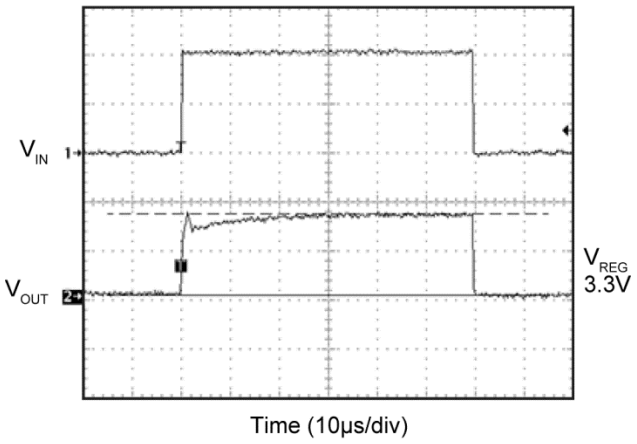
Turn-On Transient Response (1.8V Output)



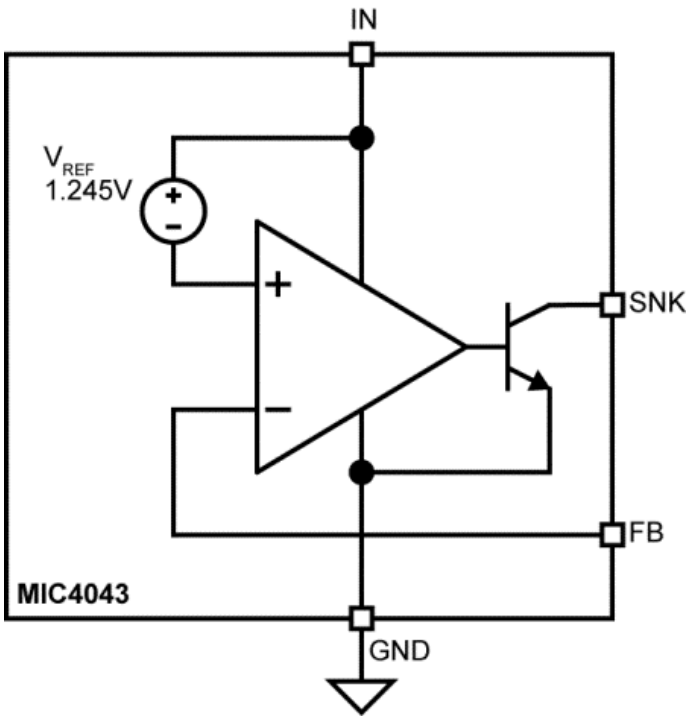
Transient Response (1.8V Output)



Turn-On Transient Response (1.8V Output)



Functional Diagram



Functional Description

The MIC4043 combines a G_M amplifier, precision 1.245V reference, and a pass transistor in a single package.

The operation of the MIC4043 is similar to conventional shunt regulators such as the industry standard ’431. In a closed loop system, the MIC4043 maintains the desired feedback voltage at the FB pin by sinking current onto the SNK pin proportional to the error voltage at the FB pin. The ratio of sink current to error voltage is the transconductance of the device.

Reference

The MIC4043 uses a high-side reference. External voltage dividers providing feedback to the MIC4043 will be inverted when compared to those used with ’431-equivalent devices.

Behavior

The external feedback voltage is compared to the internal high-side 1.245V reference.

If the feedback voltage, V_{FB}, is less than $V_{IN} – V_{REF}$, the amplifier provides no drive to the sink transistor. If the feedback voltages are greater than $V_{IN} – V_{REF}$, the amplifier drives the pass transistor which sinks current to ground.

Application Information

Replacement of '431-Type Devices

Since the MIC4043 uses a high-side reference, external voltage dividers providing the feedback voltage will be inverted when compared to those used with '431-equivalent devices.

The industry-standard '431 is also typically used in series with an opto-isolator LED. This configuration has a voltage drop of at least 2.5V for the '431 plus 1.4V for the LED (3.9V). More recent lower-voltage shunt regulators require at least 1.25V of headroom in addition to the 1.4V for the opto-isolator, for a total of 2.65V.

The MIC4043 removes the need to place the shunt reference in parallel with the opto-isolator. The MIC4043 combines a 1.245V reference in conjunction with an error amplifier that drives an NPN output transistor. The NPN transistor is connected in series with the opto-isolator and regulates the drive current in the opto-isolator. Unlike conventional shunt regulators, the MIC4043 does not have to connect the shunt reference in series with the opto-isolator, so the voltage drop is just the saturation voltage for one transistor, typically 160mV at full load.

Compensation

The non-inverting side of the error amplifier is connected to the high-side reference; the reference is connected to the IN pin. The inverting side of the error amplifier is brought out to the FB pin. For some applications, no compensation is needed, but for most, some resistor capacitor network is necessary between the FB pin and GND pin. The value of the feedback capacitance is application specific, but for most applications 100pF to 3000pF is all that is needed. Changing the feedback capacitor changes the loop response; that is, phase and gain margin. An empirical way to check overall system loop response, if a network analyzer is not available, is to step load the output of the systems from 10% to 100% of nominal load. The resultant small signal response at the output of the systems will provide an idea of which direction to go based on the overshoot and settling time of V_{OUT}.

Voltage Detector

Figure 1 shows a simple voltage threshold detector with a logic output.

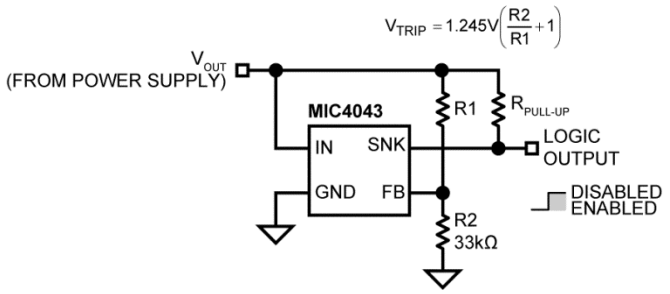


Figure 1. Voltage Detector

High-Current Regulator

For the high-current regulator shown in Figure 2, headroom is equal to the saturation voltage of Q1 plus the saturation voltage of the MIC4043 ($V_{SAT(MIN)}$ = 200mV).

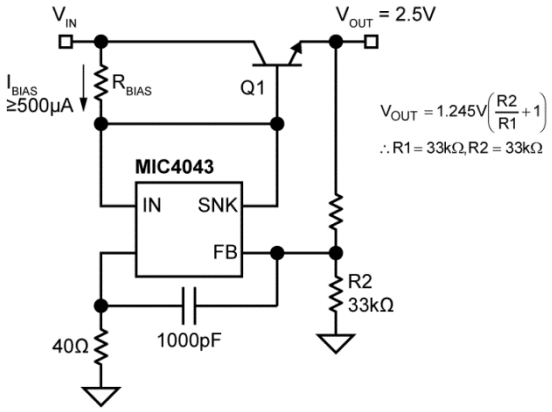


Figure 2. High-Current Regulator

Off-Line 1.8V/2A Power Supply

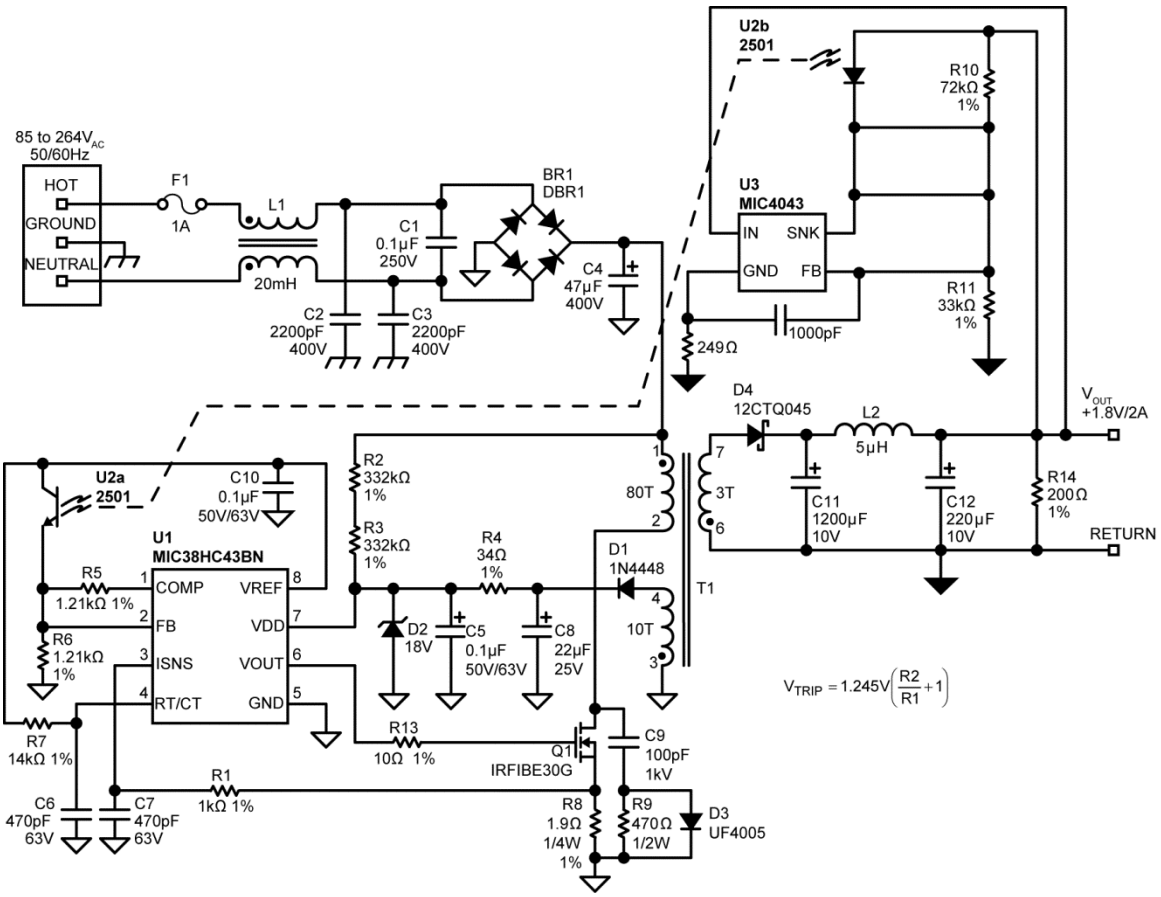


Figure 3. Off-Line 1V/2A Power Supply

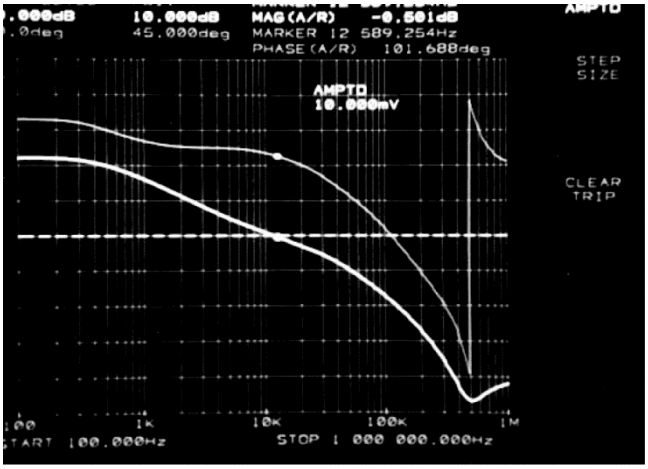


Figure 4. 1.8V/1A Output Bode Plot
(θ Margin = 102°)

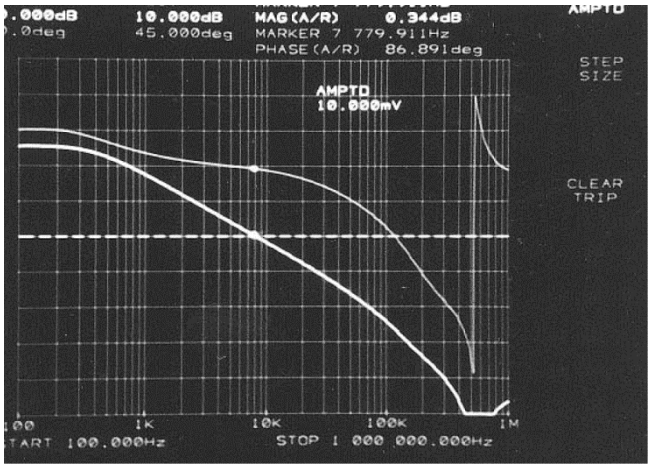


Figure 5. 1.8V/2A Output Bode Plot
(θ Margin = 87°)

Off-Line 2.5V/2A Power Supply

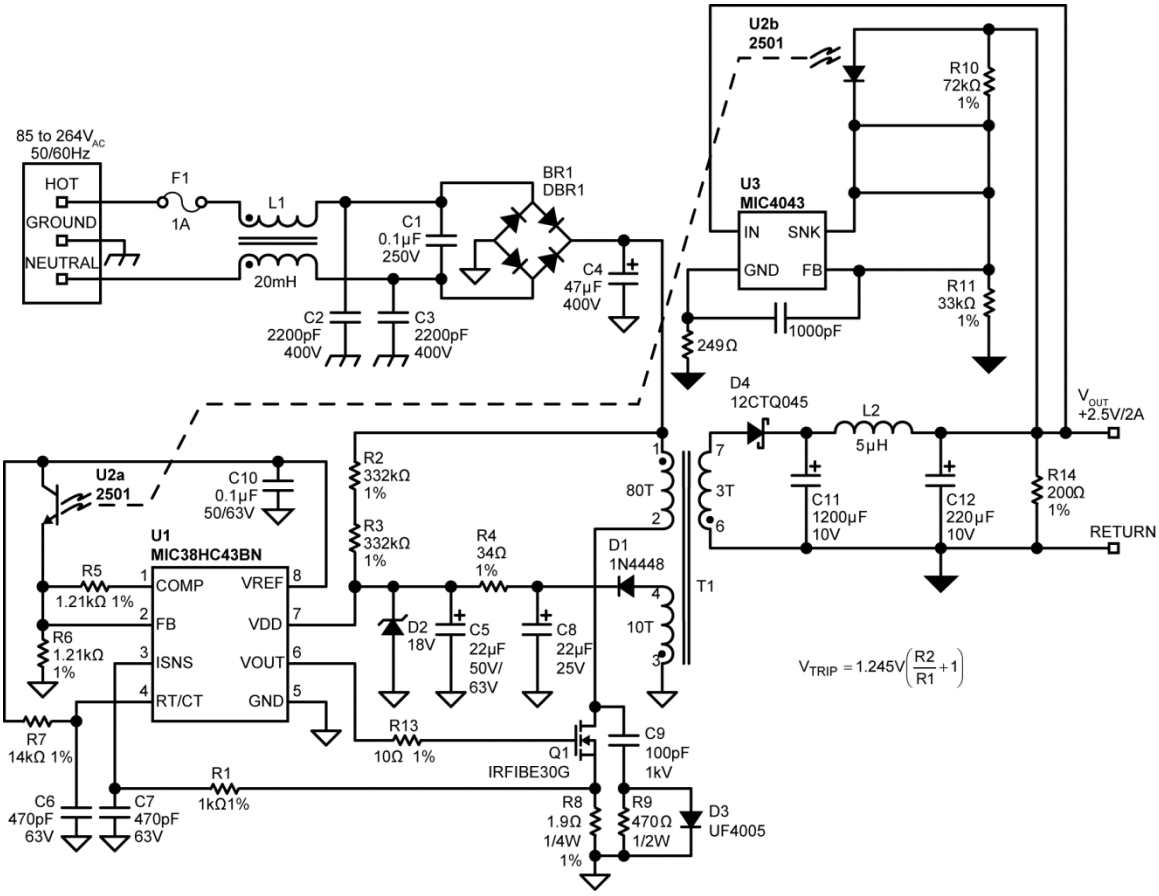


Figure 6. Off-Line 2.5V/2A Power Supply

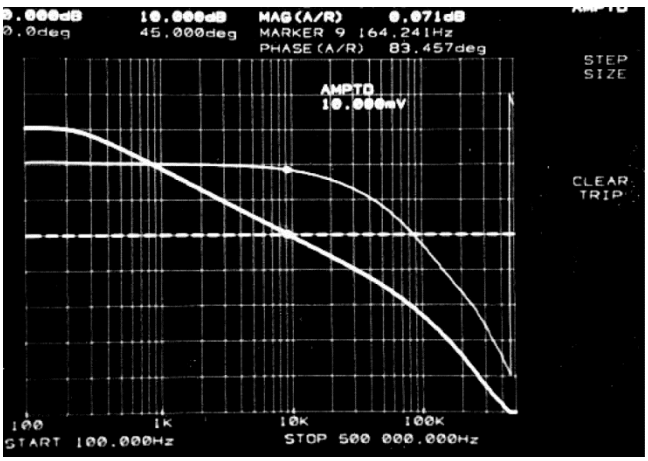


Figure 7. 2.5V/1A Output Bode Plot
(θ Margin = 83°)

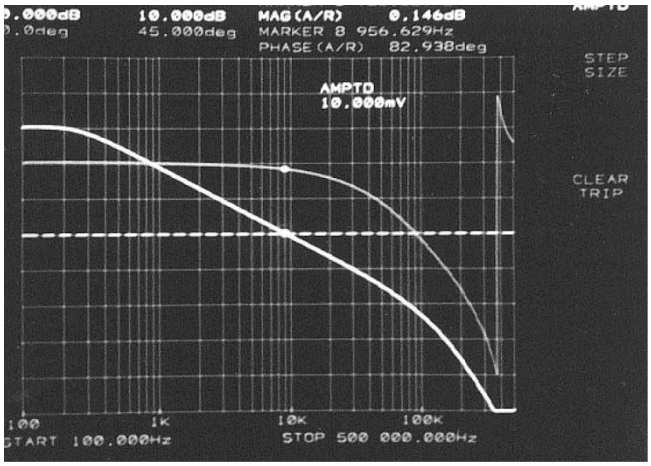


Figure 8. 2.5V/2A Output Bode Plot
(θ Margin = 83°)

Off-Line 3.3V/2A Power Supply

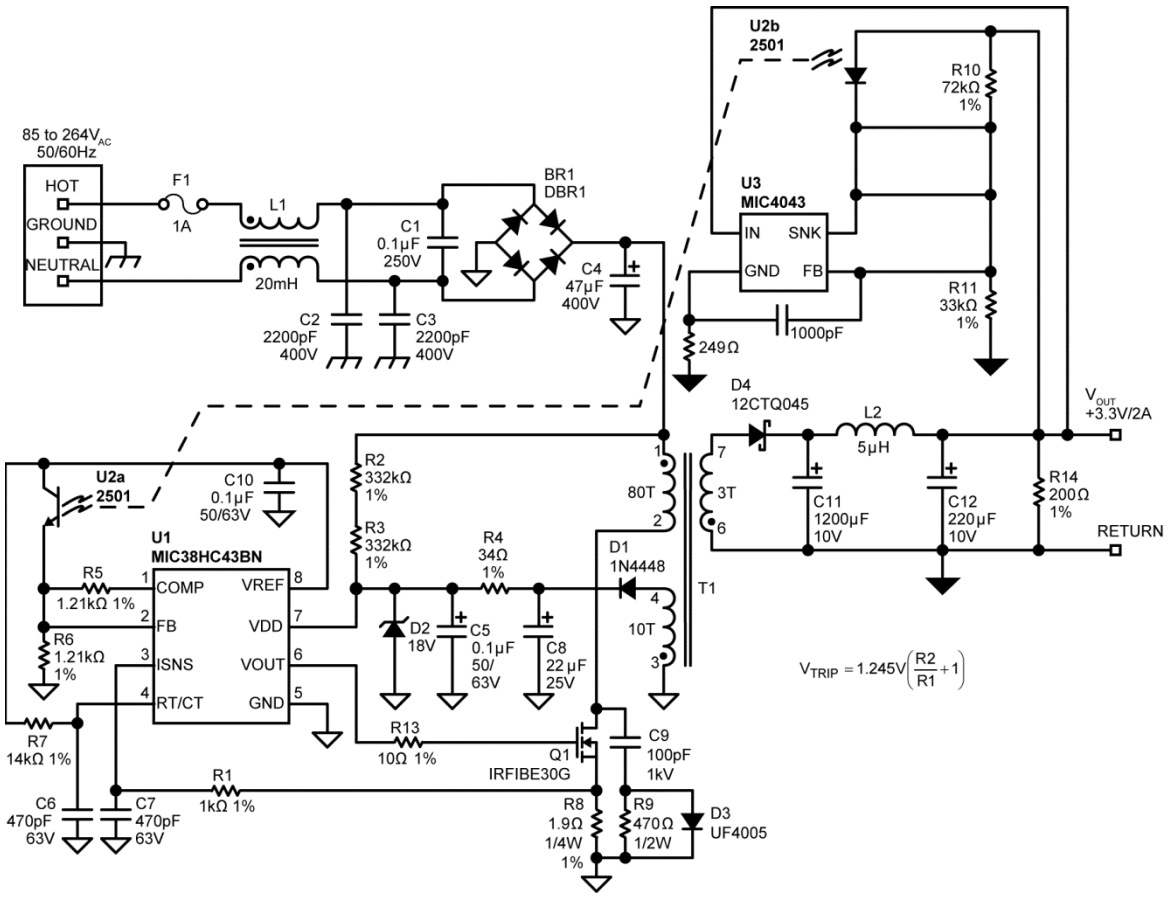


Figure 9. Off-Line 3.3V/2A Power Supply

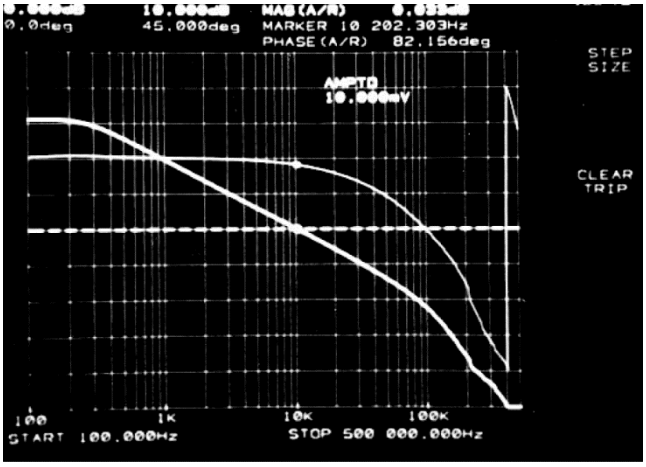


Figure 10. 3.3V/1A Output Bode Plot
(θ Margin = 82°)

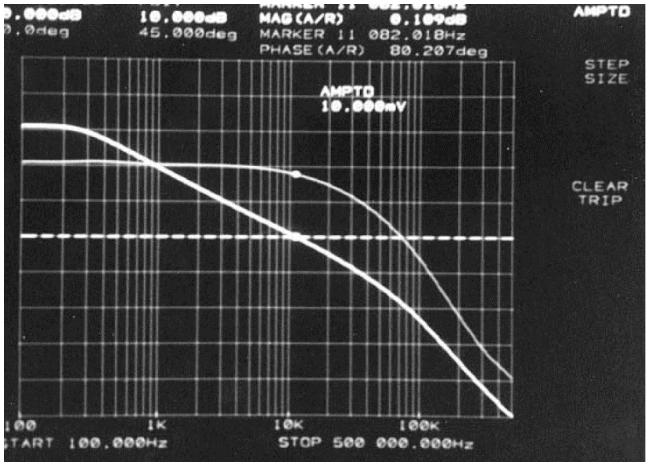


Figure 11. 3.3V/2A Output Bode Plot
(θ Margin = 80°)

Off-Line 5V/2A Power Supply

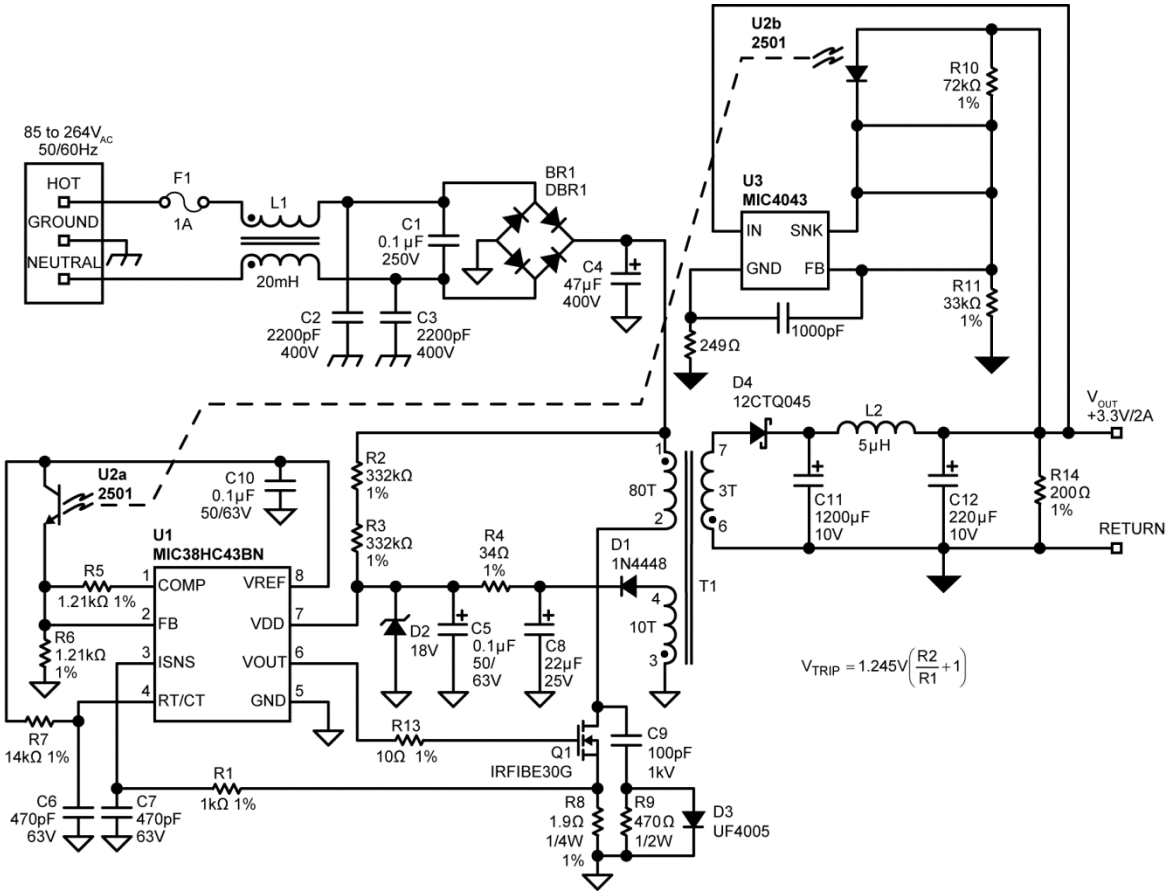


Figure 12. Off-Line 5V/2A Power Supply

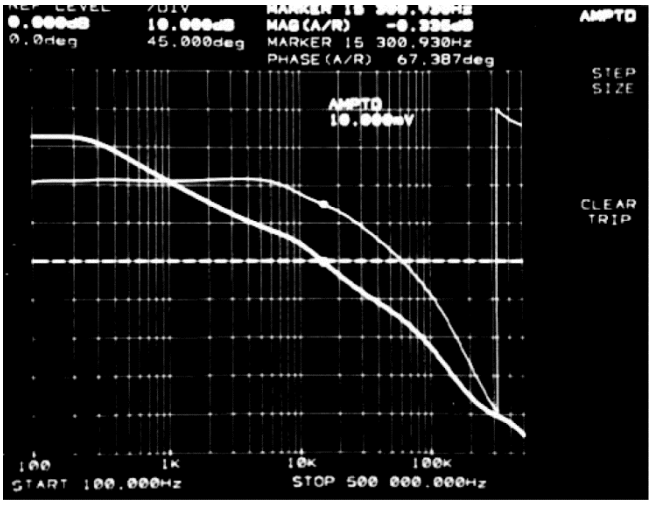


Figure 13. 5V/1A Output Bode Plot
(θ Margin = 67°)

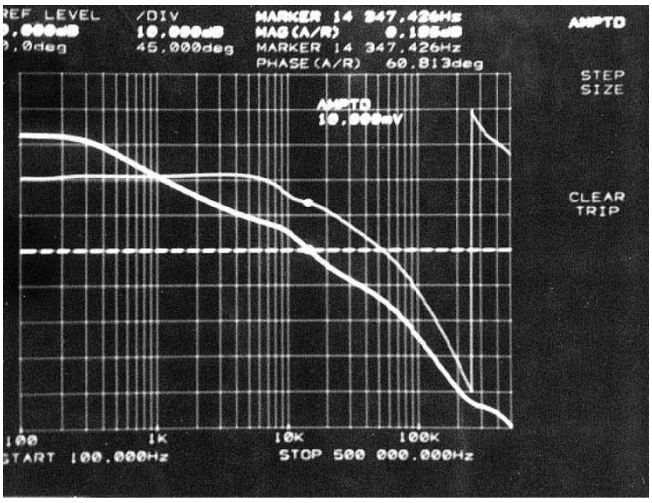
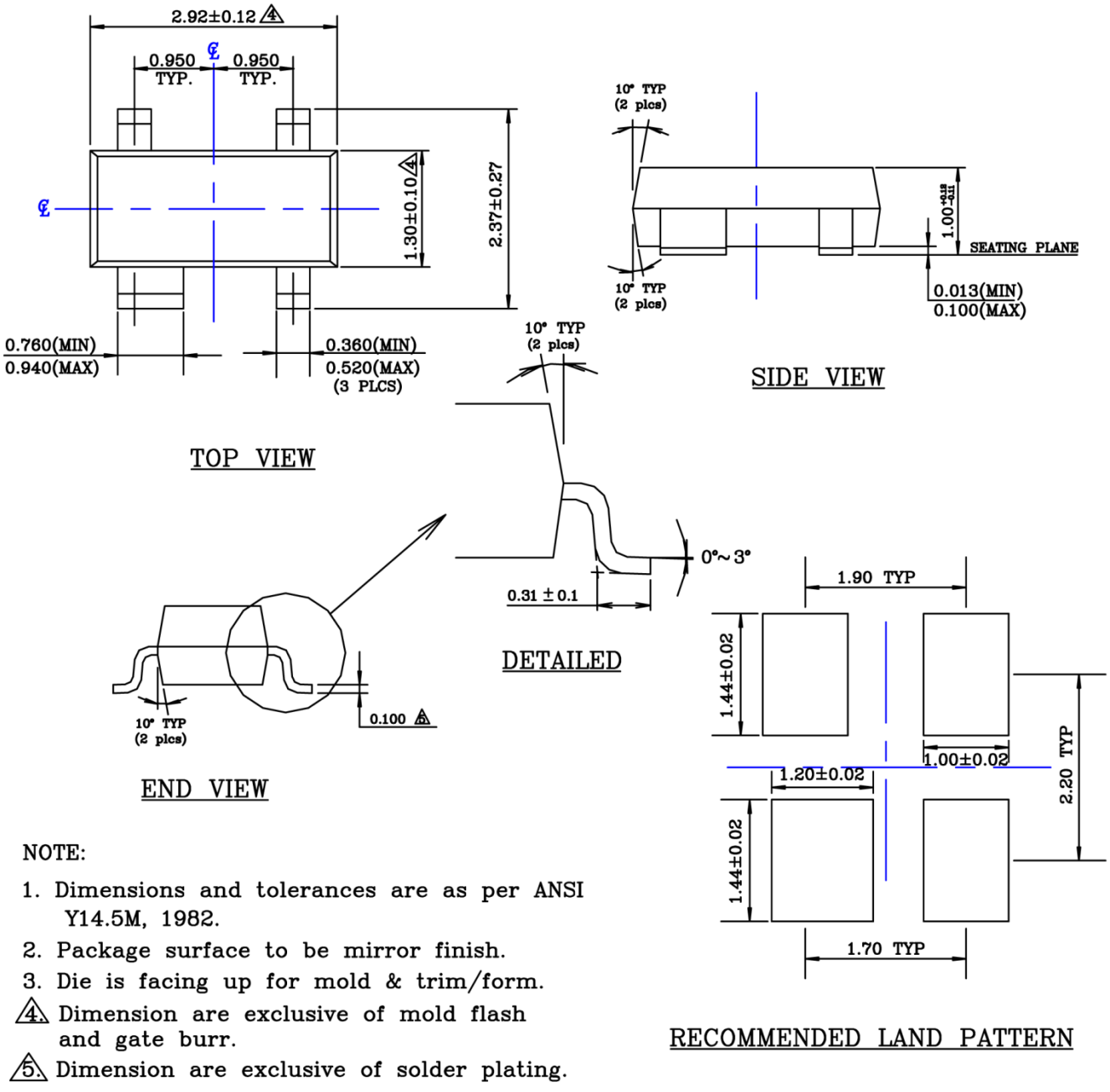


Figure 14. 5V/2A Output Bode Plot
(θ Margin = 61°)

Package Information and Recommended Landing Pattern[6]



NOTE:

1. Dimensions and tolerances are as per ANSI Y14.5M, 1982.
2. Package surface to be mirror finish.
3. Die is facing up for mold & trim/form.
4. Dimension are exclusive of mold flash and gate burr.
5. Dimension are exclusive of solder plating.

SOT-143 (M4)

Note:

6. Package information is correct as of the publication date. For updates and most current information, go to www.micrel.com.

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