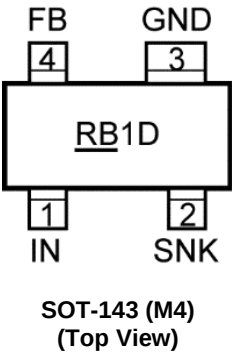


Ordering Information

Part Number ⁽¹⁾	Marking	Voltage (V)	Tolerance	Configuration	Temperature Range	Package
MIC4043YM4	<u>RB</u> 1D	1.245	1%	Open Collector	−40°C to +85°C	SOT-143

Note:
1. Underbar () symbol may not be to scale.

Pin Configuration



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⁾

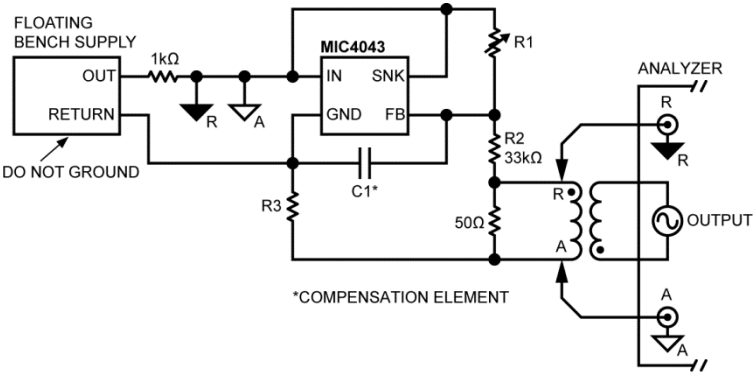
$T_A = +25^\circ\text{C}$, **bold** values indicate $-40^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$, unless noted.

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

Notes:

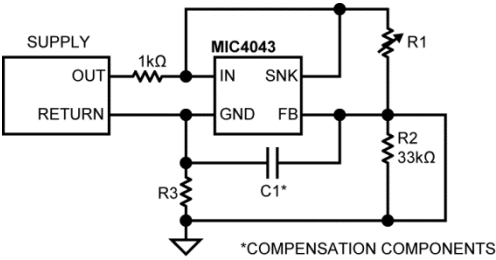
- Exceeding the absolute maximum ratings may damage the device.
- The device is not guaranteed to function outside its operating ratings.
- Devices are ESD sensitive. Handling precautions are recommended. Human body model, 1.5kΩ in series with 100pF. Machine model, 200pF.
- Reference voltage is not referenced 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

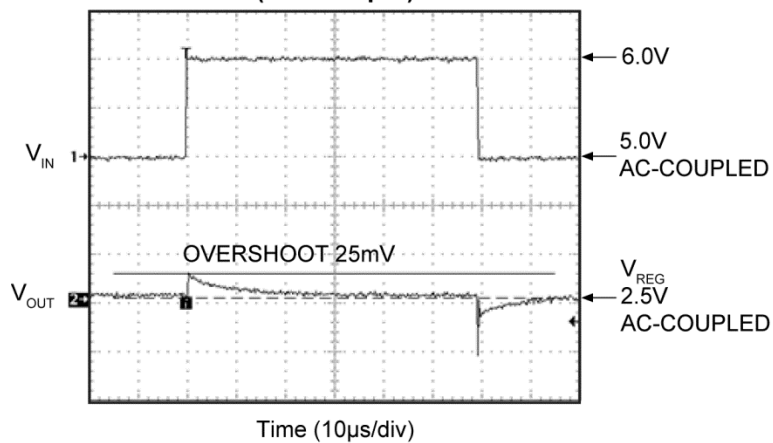
Test Circuit 1: Compensation (Bode Plot) Circuit



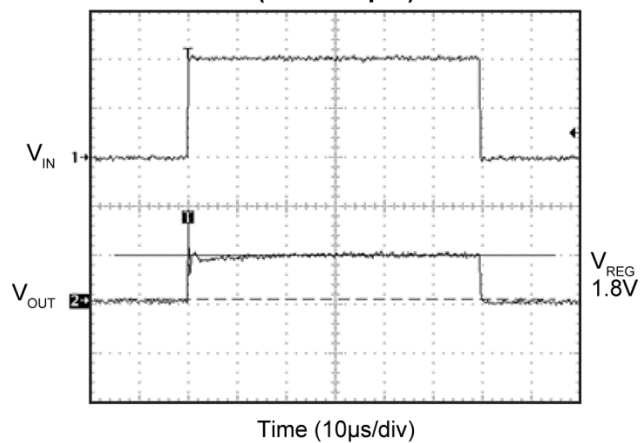
Test Circuit 2: Transient Response Circuit

Functional Characteristics

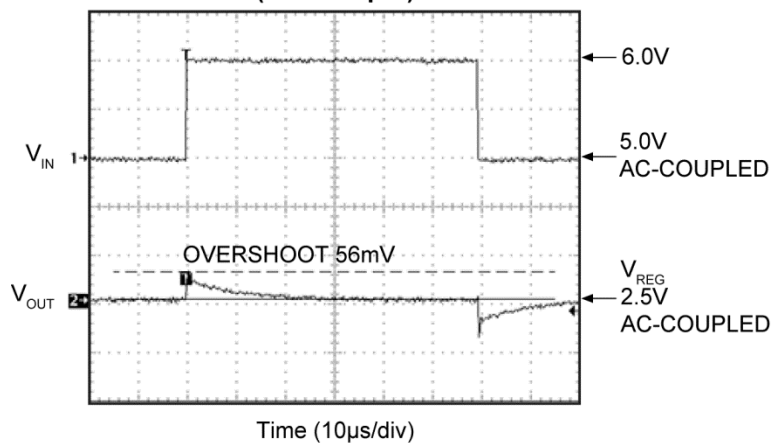
**Transient Response
(1.8V Output)**



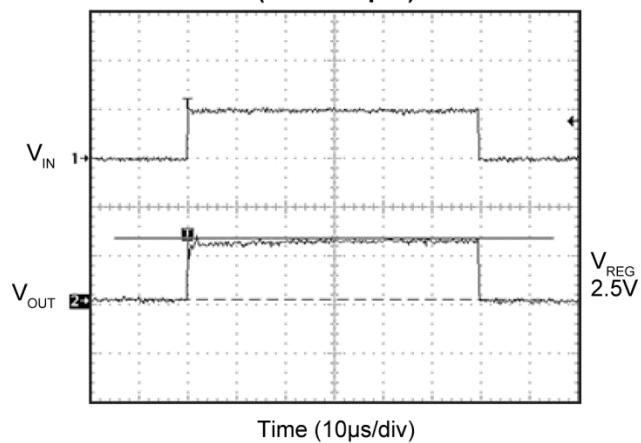
**Turn-On Transient Response
(1.8V Output)**



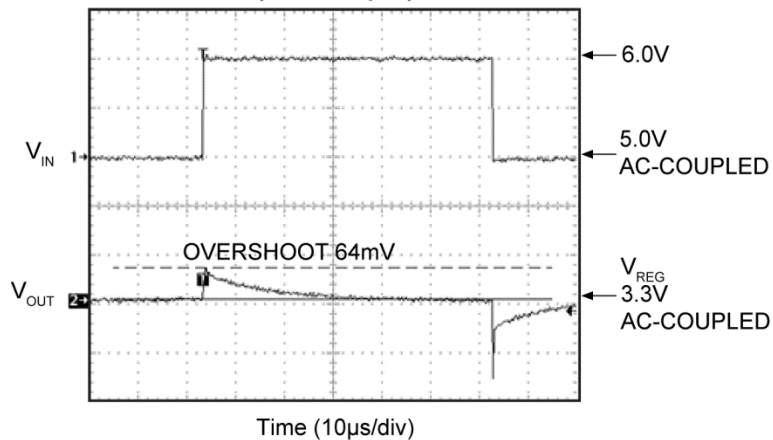
**Transient Response
(1.8V Output)**



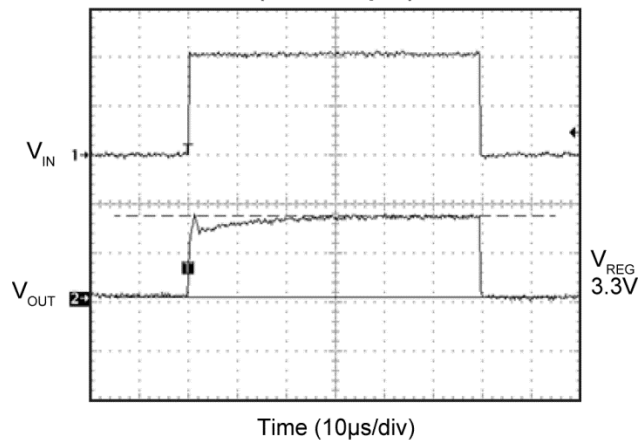
**Turn-On Transient Response
(1.8V Output)**



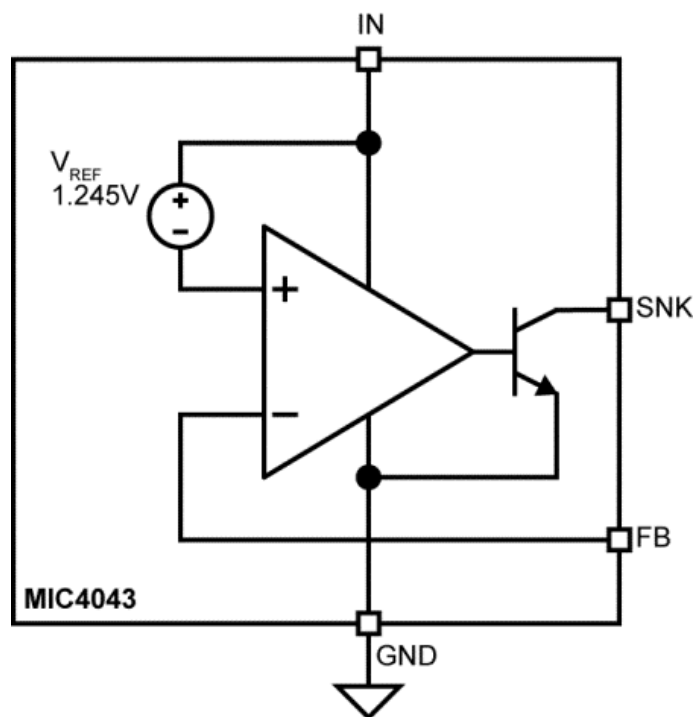
**Transient Response
(1.8V Output)**



**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.

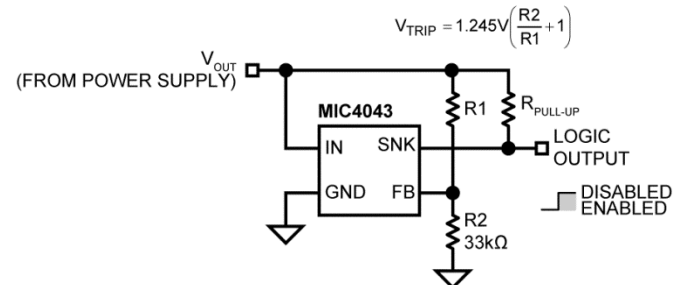


Figure 1. Voltage Detector

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 ($V_{SAT(MIN)} = 200\text{mV}$).

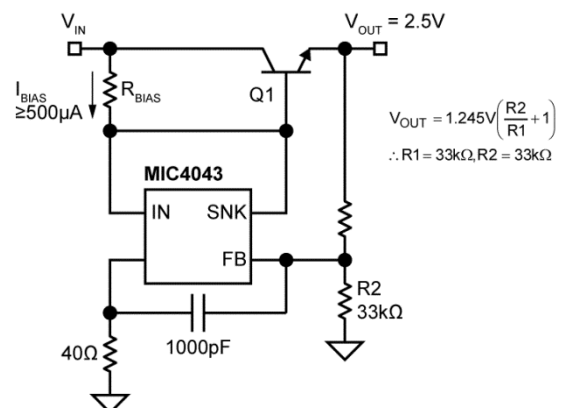


Figure 2. High-Current Regulator

[illegible]

AMP TO STEP SIZE

CLEAR TRIP

0.000dB 10.000dB MAG (A/R) 0.344dB
0.0deg 45.000deg MARKER 7 779.911Hz
PHASE (A/R) 86.891deg

STEP
SIZE

CLEAR
TRIP

AMPTD
10.000mV

100 1K 10K 100K 1M

START 100.000Hz STOP 1 000 000.000Hz

Revision 2.0

Off-Line 2.5V/2A Power Supply

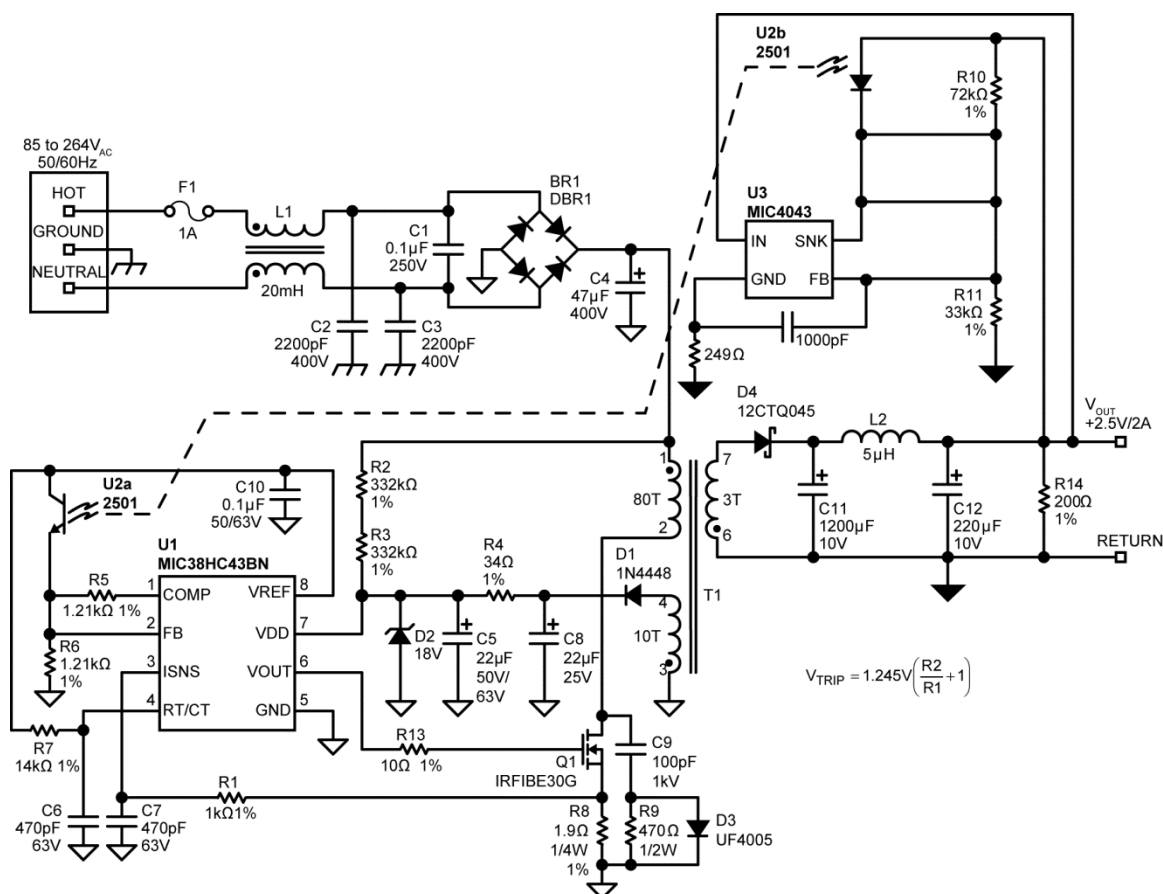


Figure 6. Off-Line 2.5V/2A Power Supply

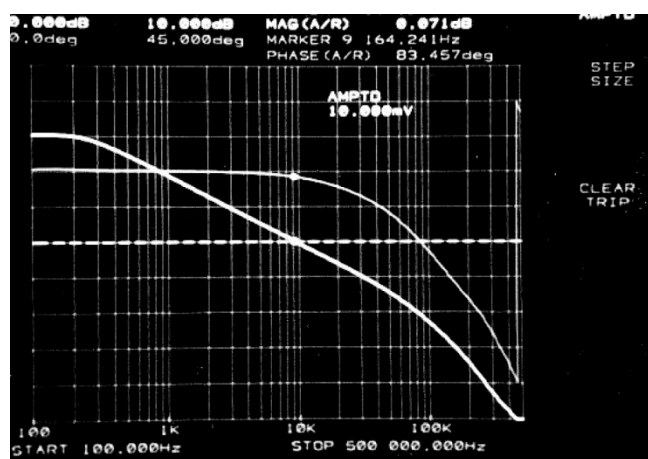


Figure 7. 2.5V/1A Output Bode Plot
(0 Margin = 83°)

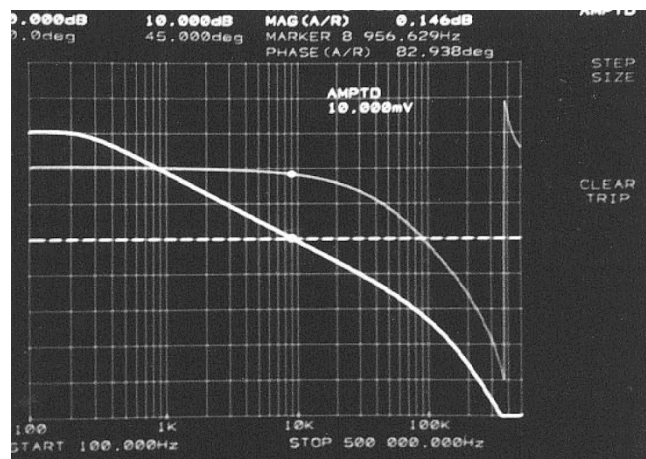


Figure 8. 2.5V/2A Output Bode Plot
(0 Margin = 83°)

85 to 264V_{AC}
50/60Hz

HOT
GROUND
NEUTRAL

F1
1A

L1
20mH

C1
0.1μF
250V

C2
2200pF
400V

C3
2200pF
400V

BR1
DBR1

C4
47μF
400V

U2a
2501

U1
MIC38HC43BN

R5
1.21kΩ
1%

R6
1.21kΩ
1%

R7
14kΩ
1%

C6
470pF
63V

C7
470pF
63V

R1
1kΩ
1%

U2b
2501

U3
MIC4043

R10
72kΩ
1%

R11
33kΩ
1%

249Ω

1000pF

D4
12CTQ045

L2
5μH

C11
1200μF
10V

C12
220μF
10V

R14
200Ω
1%

V_{OUT}
+3.3V/2A

RETURN

T1

D1
1N4448

C8
22μF
25V

Q1
IRF1BE30G

C9
100pF
1kV

R8
1.9Ω
1/4W
1%

R9
470Ω
1/2W

D3
UF4005

R2
332kΩ
1%

R3
332kΩ
1%

R4
34Ω
1%

D2
18V

C5
0.1μF
50/63V

V_{TRIP} = 1.245V($\frac{R2}{R1} + 1$)

0.000deg 10.000deg MAG (A/R) 0.00000
 0.0deg 45.000deg MARKER 10 282.303Hz
 PHASE (A/R) 82.156deg

STEP
 SIZE

CLEAR
 TRIP

100 1K 10K 100K

START 100.000Hz STOP 500 000.000Hz

AMPTD
 10.000dB

0.000dB
0.0deg

10.000dB
45.000deg

MAGNITUDE
MAG (A/R) 0.109dB
MARKER 11 082.018Hz
PHASE (A/R) 80.207deg

AMPTO
10.000mV

STEP
SIZE

CLEAR
TRIP

100 1K 10K 100K

START 100.000Hz STOP 500 000.000Hz

Downloaded from Arrow.com.

Off-Line 5V/2A Power Supply

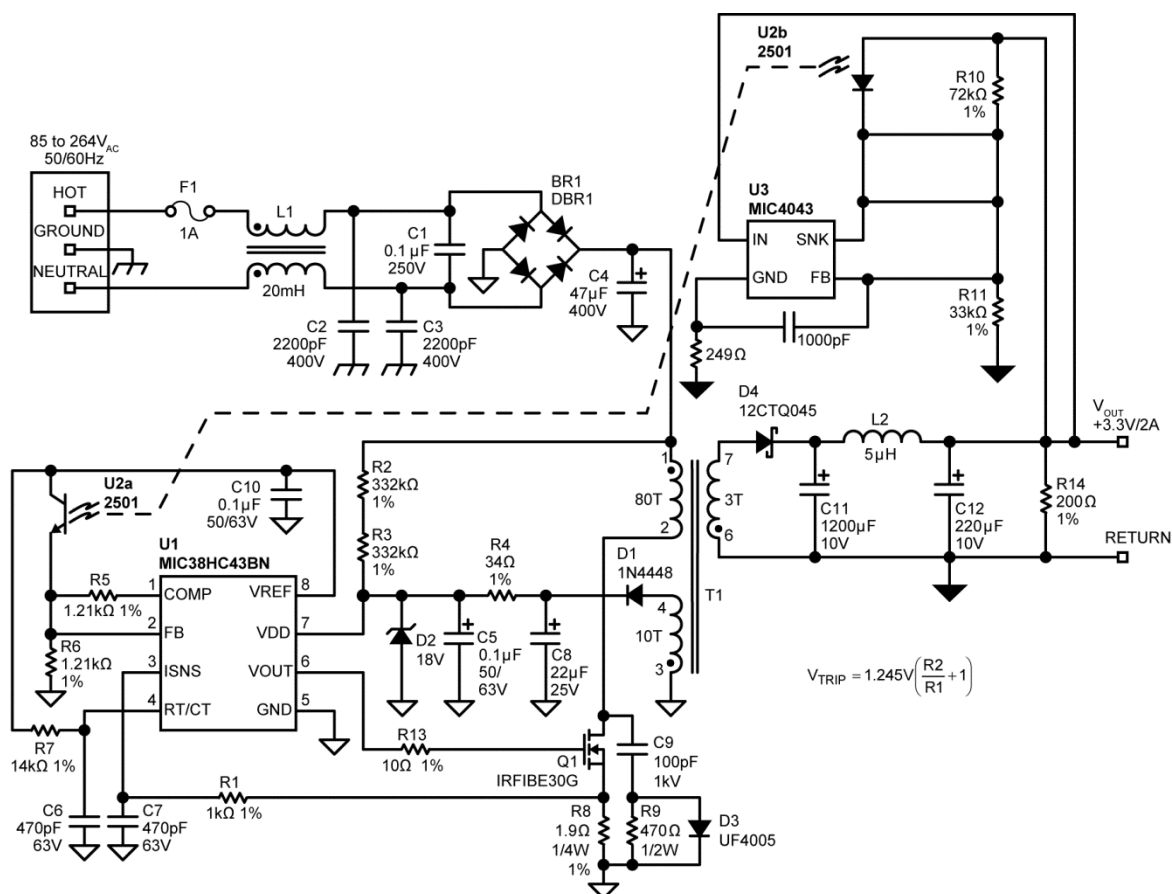
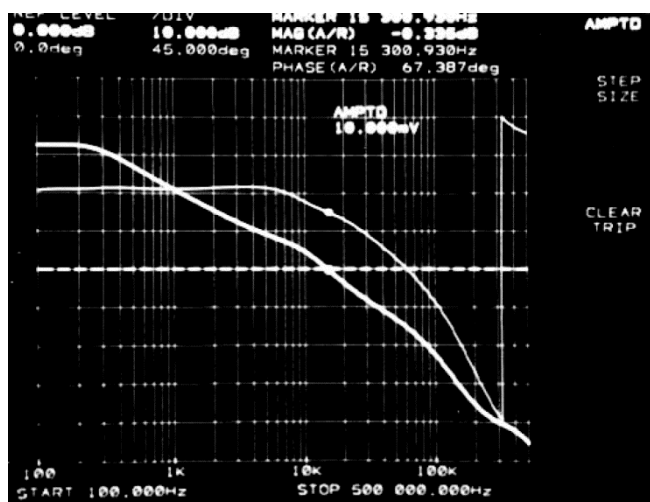
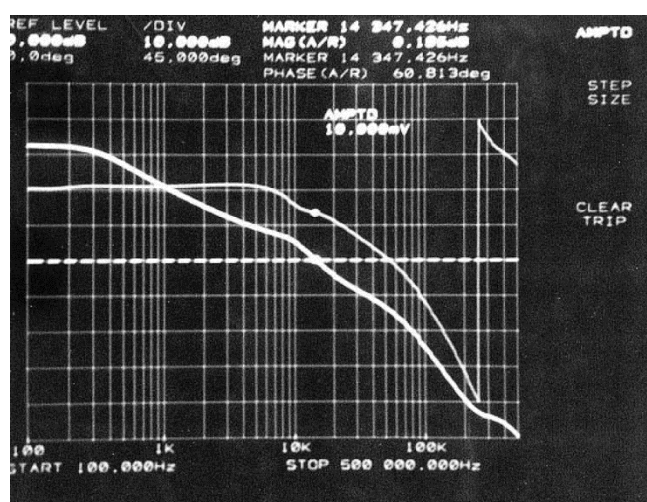
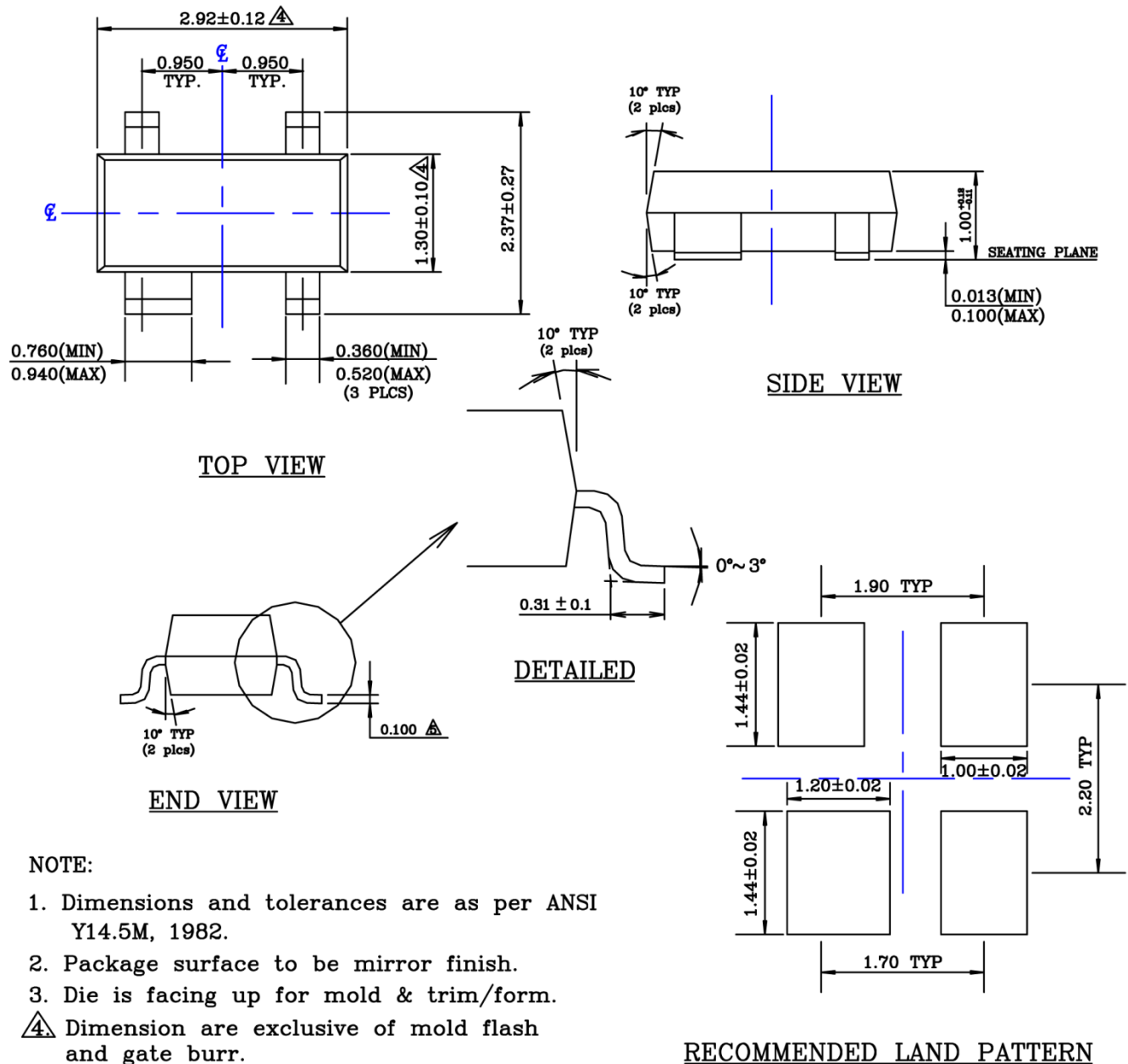


Figure 12. Off-Line 5V/2A Power Supply

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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