MAXIM

External Four-Input Feedback Integrator for Power Supplies

MAX1804

General Description

The MAX1804 feedback integrator is designed to improve voltage regulation in power-supply systems. The device corrects line- and load-regulation problems, and can be used to compensate for voltage drops in power-management distribution lines.

The regulation set point is determined by an external reference voltage applied at the ADJ pin. The difference between that reference and MAX1804 feedback is integrated, and a correction current is applied to the voltage regulator's feedback.

The MAX1804's four inputs allow voltage monitoring in several local and remote locations to correct for distribution losses caused by long traces, connectors, and switches. This eliminates the wasteful practice of permanently adjusting the regulator's output voltage high enough to correct for worst-case voltage drops. This is especially helpful in systems where the load current varies widely and portions of the load are often shut down or disconnected (for example, in notebook computers).

If a load switch is opened and the output voltage sensed at one input falls, the MAX1804 automatically disables that input and adjusts the regulator's output voltage to the lowest of remaining active inputs. If all inputs are disabled, the OUT pin is in a high-impedance state and makes no output voltage correction.

When $\overline{SHDN}$ is low, the MAX1804 draws less than 1µA and its inputs and output are high impedance. The MAX1804 is available in a 10-pin µMAX package, about half the size of an 8-pin SOIC.

Features

♦ **High Precision (±1% max Error)**
♦ **Low Power (25µA Supply Current)**
♦ **Automatic Input Disable**
♦ **Shutdown (1µA max Supply Current)**
♦ **Inputs and Outputs High Impedance in Shutdown or When V+ = 0**
♦ **+2.7V to +5.5V Supply Range**
♦ **2.8V to 5.5V Regulation Adjust Range**
♦ **Parallelable for More than Four Inputs**
♦ **10-Pin µMAX Package**

Ordering Information

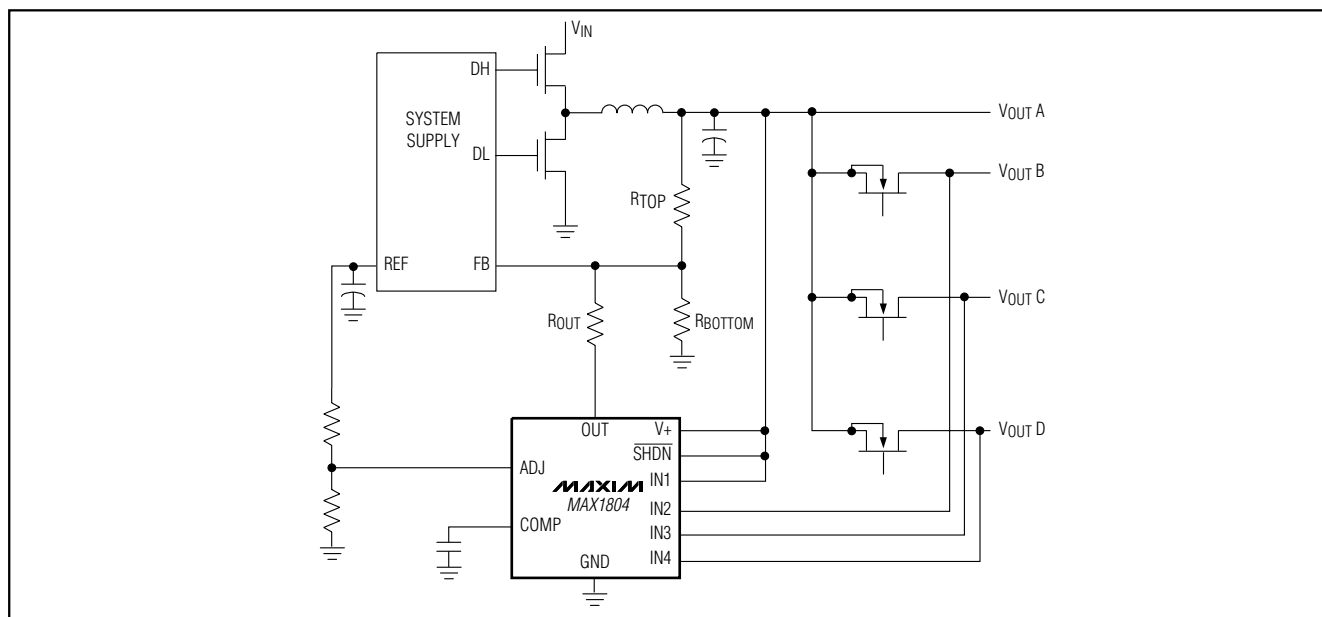| PART	TEMP. RANGE	PIN-PACKAGE
MAX1804EUB	-40°C to +85°C	10 µMAX

Pin Configuration appears at end of data sheet.

Applications

Remote Feedback Regulators

High-Accuracy Regulators

Desktop/Notebook Computers

Servers and Workstations

Subnotebooks and PDAs

Typical Operating Circuit

MAXIM _____ *Maxim Integrated Products* **1**

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External Four-Input Feedback Integrator for Power Supplies

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ABSOLUTE MAXIMUM RATINGS

V+, IN1, IN2, IN3, IN4, OUT, ADJ, $\overline{SHDN}$ to GND......-0.3V, +6V
COMP to GND ....-0.3V, V+ +0.3V
Continuous Power Dissipation (T_A = +70°C)
   10-Pin µMAX (derate 8.3mW/°C above +70°C) 667mW

Operating Temperature Extended Range ....-40°C to +85°C
Junction Temperature ....…………………………+150°C
Storage Temperature Range……...……………-65°C to +165°C
Lead Temperature (soldering, 10s) ....+300°C

Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(T_A = 0°C to +85°C, V_{V+} = 3.3V, V_{ADJ} = 1.2V, V_{OUT} = 2V, C_{V+} = 0.1µF, C_{COMP} = 470pF. Typical values are at T_A = +25°C, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range (V+)		2.7		5.5	V
Shutdown Supply Current (V+)	$\overline{SHDN}$ = GND		0.01	1	µA
Quiescent Supply Current (V+)	$\overline{SHDN}$ = V+		25	35	µA
UVLO Threshold, Rising			2.5	2.6	V
UVLO Threshold, Falling		2.3	2.4		V
INTEGRATOR INPUTS IN1–IN4					
IN_ Voltage Range		0		5.5	V
IN_ Offset	V_{V+} = 2.7V to 5.5V	-15		15	mV
IN_ Scale Factor	V_{ADJ} = 0.7V to 1.4V	3.988	4.000	4.016	V/V
IN_ Transconductance	$V_{IN\_}$ = 4.75V to 4.85V, V_{COMP} = 1.3V	12	30	48	µS
IN_ Bias Current	$V_{IN\_}$ = 4.8V		1.5	2.7	µA
IN_ Shutdown Current	$\overline{SHDN}$ = GND			0.2	µA
IN_ Leakage Current	V_{V+} = 0, $V_{\overline{SHDN}}$ = 0			0.2	µA
IN_ Disable Threshold	V_{ADJ} = 0.7V to 1.4V, V_{ADJ} x 4, falling edge	87	90	93	%
IN_ Disable Threshold Hysteresis	V_{ADJ} = 0.7V to 1.4V, rising edge		50		mV
ADJ INPUT					
ADJ Voltage Range		0.7		1.4	V
ADJ Bias Current		-20		20	nA
ADJ Shutdown Current	$\overline{SHDN}$ = GND			0.2	µA
ADJ Leakage Current	V_{V+} = 0, $V_{\overline{SHDN}}$ = 0			0.2	µA
COMP OUTPUT					
COMP Source Current	V_{COMP} = 1.3V, $V_{IN\_}$ = 4.6V	1.6	2.0	2.4	µA
COMP Sink Current	V_{COMP} = 1.3V, $V_{IN\_}$ = 5.0V	1.6	2.0	2.4	µA
COMP Output Voltage Low	Sink 1µA, $V_{IN\_}$ = 5.0V			0.2	V
COMP Output Voltage High	Source 1µA, $V_{IN\_}$ = 4.6V	2.4			V
OUT OUTPUT					
OUT Output Voltage Low	I_{OUT} = 10µA, $V_{IN\_}$ = 4.6V			0.2	V
OUT Output Leakage Current	$V_{\overline{SHDN}}$ = 0			0.1	µA
	V_{V+} = 0			0.1	
	$V_{IN\_}$ = 5.0V			0.1	
OUT Transconductance	V_{COMP} = 1V to 2V	4	10	22	µS

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ELECTRICAL CHARACTERISTICS (continued)

(T_A = 0°C to +85°C, V_{V+} = 3.3V, V_{ADJ} = 1.2V, V_{OUT} = 2V, C_{V+} = 0.1µF, C_{COMP} = 470pF. Typical values are at T_A = 25°C, unless otherwise noted.)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$\overline{\text{SHDN}}$ INPUT					
Logic Input Voltage High	V_{V+} = 2.7V to 5.5V	2.0			V
Logic Input Voltage Low	V_{V+} = 2.7V to 5.5V			0.6	V
Logic Input Current		-1		1	µA

ELECTRICAL CHARACTERISTICS

(T_A = -40°C to +85°C, V_{V+} = 3.3V, V_{ADJ} = 1.2V, V_{OUT} = 2V, C_{V+} = 0.1µF, C_{COMP} = 470pF.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range (V+)		2.7		5.5	V
Shutdown Supply Current (V+)	$\overline{\text{SHDN}}$ = GND			1	µA
Quiescent Supply Current (V+)	$\overline{\text{SHDN}}$ = V+			35	µA
UVLO Threshold, Rising				2.6	V
UVLO Threshold, Falling		2.3			V
INTEGRATOR INPUTS IN1–IN4					
IN_ Voltage Range		0		5.5	V
IN_ Offset	V_{V+} = 2.7V to 5.5V	-20		20	mV
IN_ Scale Factor	V_{ADJ} = 0.7V to 1.4V	3.98		4.02	V/V
IN_ Transconductance	$V_{IN\_}$ = 4.75V to 4.85V, V_{COMP} = 1.3V	12		60	µS
IN_ Bias Current	$V_{IN\_}$ = 4.8V			2.7	µA
IN_ Shutdown Current	$\overline{\text{SHDN}}$ = GND			0.2	µA
IN_ Leakage Current	V_{V+} = 0, $V_{\overline{\text{SHDN}}}$ = 0			0.2	µA
IN_ Disable Threshold	V_{ADJ} = 0.7V to 1.4V, V_{ADJ} x 4, falling edge	87		93	%
ADJ INPUT					
ADJ Voltage Range		0.7		1.4	V
ADJ Bias Current		-30		30	nA
ADJ Shutdown Current	$\overline{\text{SHDN}}$ = GND			0.2	µA
ADJ Leakage Current	V_{V+} = 0, $V_{\overline{\text{SHDN}}}$ = 0			0.2	µA
COMP OUTPUT					
COMP Source Current	V_{COMP} = 1.3V, $V_{IN\_}$ = 4.6V	1.6		2.4	µA
COMP Sink Current	V_{COMP} = 1.3V, $V_{IN\_}$ = 5.0V	1.6		2.4	µA
COMP Output Voltage Low	Sink 1µA, $V_{IN\_}$ = 5.0V			0.2	V
COMP Output Voltage High	Source 1µA, $V_{IN\_}$ = 0.6V	2.4			V
OUT Output Voltage Low	I_{OUT} = 10µA, $V_{IN\_}$ = 4.6V			0.2	V
OUT Output Leakage Current	$V_{\overline{\text{SHDN}}}$ = 0			0.1	µA
	V_{V+} = 0			0.1	
	V_{IN} = 5.0V			0.1	
OUT Transconductance	V_{COMP} = 1V to 2V	3		23	µS

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ELECTRICAL CHARACTERISTICS (continued)

(**T$_A$ = -40°C to +85°C**, V$_{V+}$ = 3.3V, V$_{ADJ}$ = 1.2V, V$_{OUT}$ = 2V, C$_{V+}$ = 0.1µF, C$_{COMP}$ = 470pF.) (Note 1)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
SHDN INPUT					
Logic Input Voltage High	V$_{V+}$ = 2.7V to 5.5V	2.0			V
Logic Input Voltage Low	V$_{V+}$ = 2.7V to 5.5V			0.6	V
Logic Input Current		-1		1	µA

Note 1: Specifications to -40°C are guaranteed by design and not production tested.
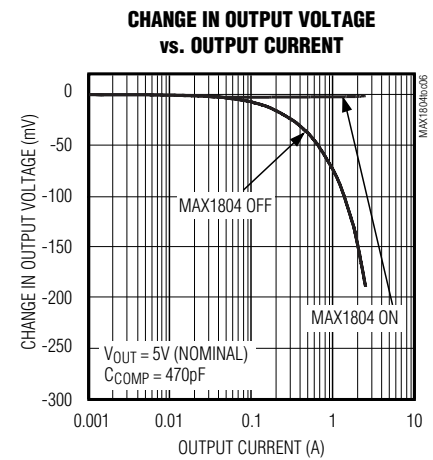
_____*Typical Operating Characteristics*

(V$_{V+}$ = V$_{\overline{SHDN}}$ = 3.3V, V$_{ADJ}$ = 1.2V, V$_{OUT}$ = 2V, C$_{COMP}$ = 470pF, T$_A$ = +25°C, unless otherwise noted.)

QUIESCENT CURRENT vs. TEMPERATURE

IN_REGULATION SET-POINT ERROR vs. TEMPERATURE

NOTE: Circuit of Figure 1.

IN_ (TO COMP) TRANSCONDUCTANCE vs. TEMPERATURE

OUT CURRENT vs. COMP VOLTAGE

IN_SCALE FACTOR vs. ADJ VOLTAGE

NOTE: Circuit of Figure 1.

CHANGE IN OUTPUT VOLTAGE vs. OUTPUT CURRENT
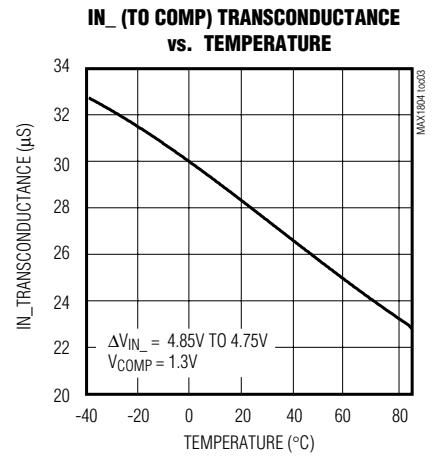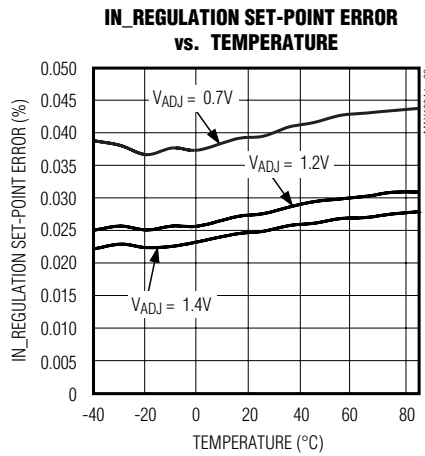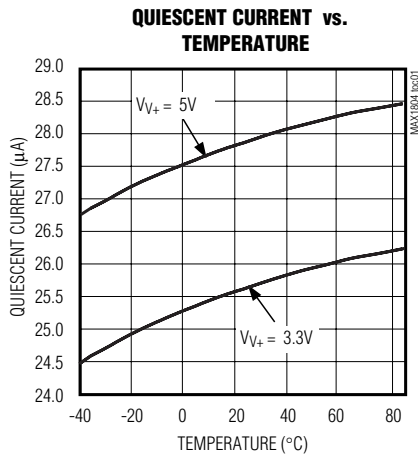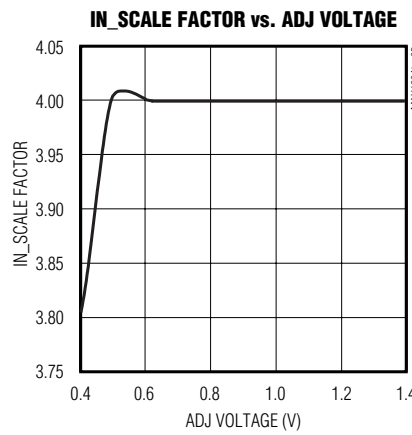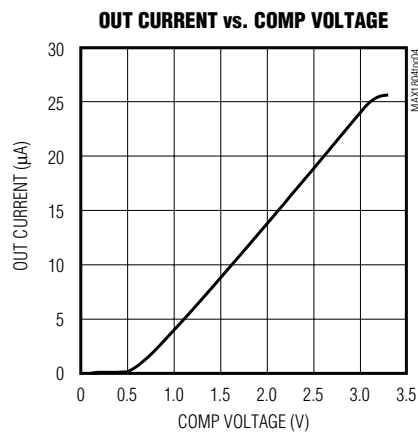
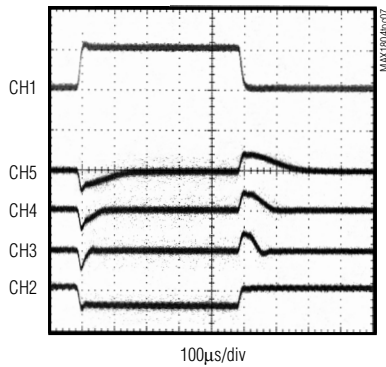**NOTE**: Application Circuit of Figure 2.

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_____Typical Operating Characteristics (continued)

(V_{V+} = $V_{\overline{SHDN}}$ = 3.3V, V_{ADJ} = 1.2V, V_{OUT} = 2V, C_{COMP} = 470pF, T_A = +25°C, unless otherwise noted.)

**LOAD TRANSIENT RESPONSE
(APPLICATION CIRCUIT OF FIGURE2)**

100µs/div

CH1 = I_{LOAD}; 1.00A/div
CH5 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 1000pF)
CH4 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 470pF)
CH3 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 220pF)
CH2 = V_{IN1}; 500mV/div; AC-COUPLED (MAX1804 DISABLED)
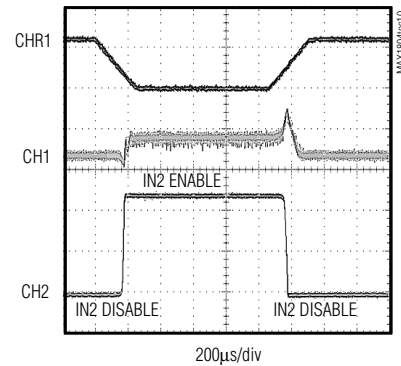V_{IN} (MAX1653) = 8V

LOAD TRANSIENT RESPONSE

400µs/div
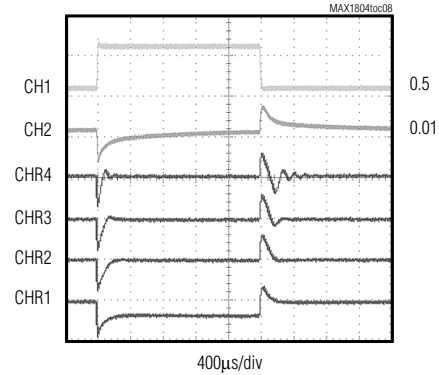
CH1 = I_{LOAD}; 500mA/div
CH2 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 0.047µF)
CHR4 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 1000pF)
CHR3 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 2200pF)
CHR2 = V_{IN1}; 500mV/div; AC-COUPLED (C_{COMP} = 4700pF)
CHR1 = V_{IN1}; 500mV/div; AC-COUPLED (MAX1804 DISABLED)
V_{IN} (MAX603) = 8V
NOTE: Circuit of Figure 3.

STARTUP/SHUTDOWN WAVEFORM

200µs/div
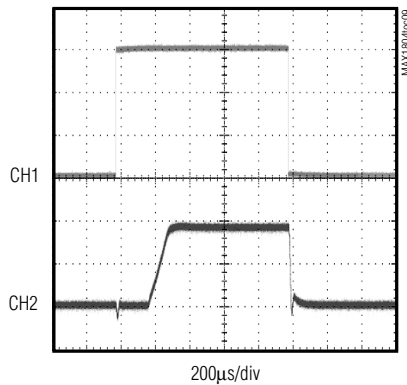
CH1 = $\overline{SHDN}$, 2V/div
CH2 = V_{IN2}; 200mV/div; DC OFFSET = 4.7V
I_{LOAD} = 0.5A
V_{IN} (MAX1653) = 8V
NOTE: Circuit of Figure 2.

AUTOMATIC INPUT DISABLE WAVEFORM

200µs/div

CHR1 = $V_{G(PFET)}$; 5V/div
CH1 = V_{IN1}; 200mV/div; DC OFFSET = 4.8V
CH2 = V_{IN2}; 2V/div
V_{IN} (MAX1653) = 8V
NOTE: Circuit of Figure 2.

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External Four-Input Feedback Integrator for Power Supplies

NAME	PIN	FUNCTION
IN1	1	Sense Input 1. Connect to one of up to four inputs to be monitored. If IN_ is the lowest active input, IN_ will be regulated at 4 x V_{ADJ}. If IN_ is less than 90% of the regulation set point (4 x V_{ADJ}), it is automatically disabled.
IN2	2	Sense Input 2
IN3	3	Sense Input 3
IN4	4	Sense Input 4
ADJ	5	Regulation Adjustment Input. The voltage at this input adjusts the regulation set point of IN1–IN4.There is a 4x scale factor between V_{ADJ} and the regulation set point.
GND	6	Ground
COMP	7	Integrator Capacitor Connection. Connect a capacitor (>100pF) to GND to set the integrator time constant. See *Integrator Gain-Bandwidth Product and Regulator Stability* section.
OUT	8	Open-Drain Output. Can sink at least 10µA if any of the inputs remain below the regulation set point. Connect OUT to the feedback point of the regulator-divider resistors. If OUT is connected through a resistor, its value relative to the regulator's feedback-divider values sets the maximum positive adjustment range. See *Setting the Maximum Regulator Output Adjustment Increase* section.
$\overline{SHDN}$	9	Shutdown Control Input. When $\overline{SHDN}$ is low, the device is off and the supply current is reduced to about 10nA. All inputs are in high-impedance state. When $\overline{SHDN}$ is high, the device is on.
V+	10	Power-Supply Input. Bypass with 0.1µF capacitor to GND.

_____Detailed Description

The MAX1804 is a precision external feedback integrator used for tight point-of-load regulation in power-management systems. The dynamic regulation of the output is still controlled by the power-supply regulator. The MAX1804 is used only to fine tune the output voltage, removing load- and line-regulation errors and voltage drops across switches and connectors that occur in the power-supply distribution line.

The MAX1804 includes four remote-sense inputs and an output that connects to a voltage regulator's feedback divider. It can be used with any regulator or controller with a high-impedance feedback input. Its OUT pin sinks current to increase the regulator's set point so that the four IN_ inputs are at or above MAX1804's regulation set point, which is four times the voltage applied to the ADJ pin. The MAX1804 monitors the input signals and compares the lowest to the voltage set point. The error between the input signal and the set point is integrated. The MAX1804 output stage generates a current based on the integrator output to adjust the regulator's output voltage to meet the set point.
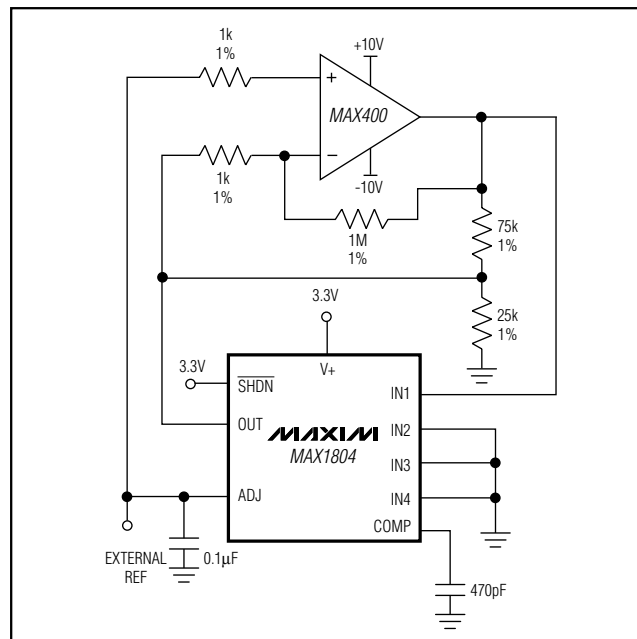

Figure 1. Test Circuit for MAX1804 IN_ Regulation Set Point

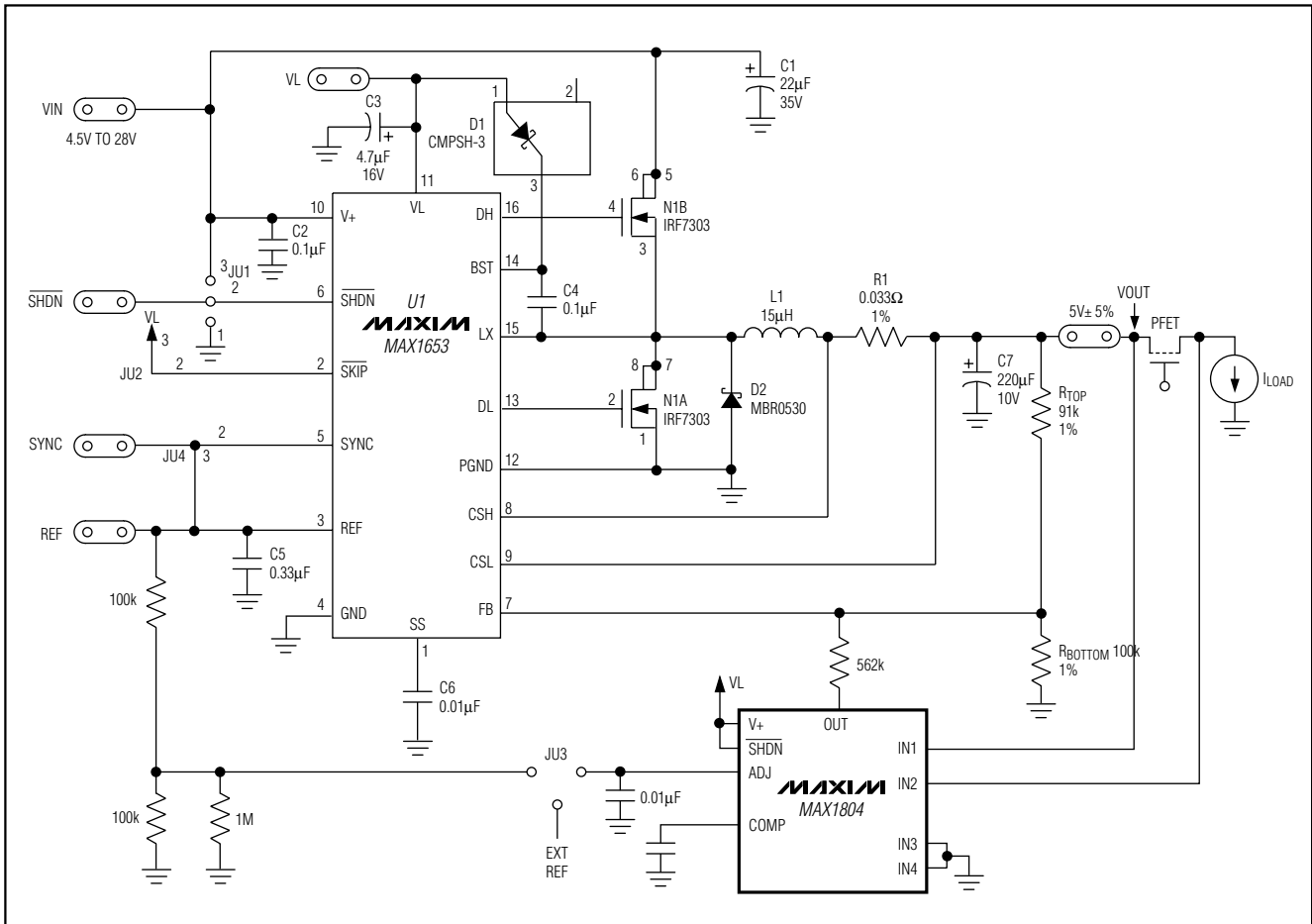# External Four-Input Feedback Integrator for Power Supplies

Figure 2. Application Circuit with Step-Down Regulator

The MAX1804 only sinks current at OUT (Figure 4). The maximum sink current and maximum regulator voltage increase are limited by the minimum guaranteed OUT current of 10µA. The maximum regulator output voltage increase can be further limited by including a resistor between OUT and the feedback point of the regulator.

If any of the IN_ inputs fall to 90% of the regulation set point, they are automatically disabled and OUT continues to regulate according to the lowest remaining active input. See *Automatic Input Disable*.

Adjusting the Regulation Set Point

The MAX1804 monitors the voltage at the IN1–IN4 sense inputs and regulates the lowest active input to four times the reference voltage at ADJ. The IN1–IN4 regulation set point is calculated as:

$$V_{IN\_} = 4 \times V_{ADJ}$$

The total error in the MAX1804 regulation set point is:

total percentage error = [(IN_scale factor x V_{ADJ} + IN_offset) / (4 x V_{ADJ})] x 100%

The maximum IN_ voltage is 5.5V. Use the MAX1804 for higher output voltages by using an external divider to divide down the desired output voltage at the IN1–IN4 pins. Since the IN_ input bias current is fairly high (1.5µA typ), choose the resistive divider accordingly.

Automatic Input Disable

The MAX1804 has an input buffer stage that monitors the sense inputs (IN1–IN4) and connects the lowest to its internal integrator (Figure 4). Each input is compared to 90% of the set point. If the input falls below this value, the input buffer is disabled and the output voltage is adjusted according to the lowest of the remaining active inputs (see Automatic Input Disable in *Typical Operating Characteristics*). If all four sense
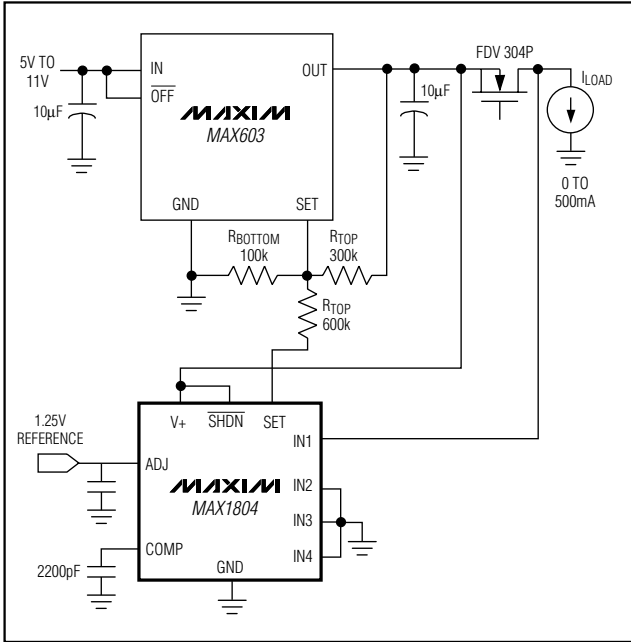
MAX1804

Figure 3. MAX1804 Used with Linear Regulator

inputs are disabled, OUT is high impedance. Connect any unused input to GND.

Setting the Maximum Regulator Output Voltage Increase

The ratio between the maximum guaranteed OUT current of 10µA and the current in the regulator's feedback resistive divider determines the maximum increase. The maximum increase in the regulator output voltage depends on the regulator's upper feedback resistor (R_{TOP}) and the sink current into OUT:

$$\Delta V_{OUT}(MAX) = I_{OUT}(MAX) \times R_{TOP}$$

The maximum adjust current $I_{OUT}(MAX)$ can be further limited with a resistor (R_{OUT}) between OUT and the feedback point of the regulator (see *Typical Operating Circuit*):

$$I_{OUT}(MAX) = V_{FB} / R_{OUT}$$

where V_{FB} is the voltage at the regulator's feedback point.

Therefore:

$$\Delta V_{OUT}(MAX) = V_{FB} \times R_{TOP} / R_{OUT}$$

and:

$$R_{OUT} = V_{FB} \times R_{TOP} / \Delta V_{OUT}(MAX)$$

Place the regulator's feedback resistors and R_{OUT} close to the regulator's feedback pin to reduce noise pickup at the regulator's feedback point, which can cause unstable switching in the regulator (Figure 5).

Shutdown Mode

$\overline{SHDN}$ is a logic input that, when held low, places the MAX1804 in its low-power shutdown mode, reducing the supply current to 10nA (typ). The IN1–IN4, OUT, and ADJ are high impedance when the MAX1804 is in shutdown or when V+ is removed. Connect $\overline{SHDN}$ to V+ for normal operation.

Undervoltage Lockout

The MAX1804 has an undervoltage lockout (UVLO) feature that deactivates the device when the supply voltage at V+ goes below 2.4V; IN1–IN4, OUT, and ADJ go to high impedance and do not affect the regulator operation. Hysteresis holds the device in lockout until the supply voltage at V+ rises above 2.6V.

Integrator Gain-Bandwidth Product and Regulator Stability

The MAX1804 gain-bandwidth (GBW) product is set by the external capacitor on COMP:

$$GBW = [4 \times (IN\_ \text{ transconductance})] / (2\pi \times C_{COMP})$$

The bandwidth is typically 40kHz with a 470pF capacitor on COMP.

For system stability, the integrator GBW product is typically set below the regulator circuit's crossover frequency, if known. Switching regulators typically have crossover frequencies well below their switching frequencies. Setting the MAX1804's GBW product too high can cause regulator loop instability, typically evidenced by ringing after transients. Setting the GBW product unnecessarily low will slow the MAX1804's loop response to transients, although the regulator's loop transient response will remain unaffected (see Load Transient Response in *Typical Operating Characteristics*).

Often the regulator's crossover frequency varies with load and is not easily found. If the regulator's crossover frequency is unknown, the MAX1804's gain-bandwidth product can be chosen empirically. Start with a fairly low capacitor value (470pF is a good starting point) and increase the value until the circuit is stable with all loads. Then increase the value further to ensure design margin. If transient response is unimportant, choose a large COMP capacitor value (such as 2200pF), thereby maximizing stability.
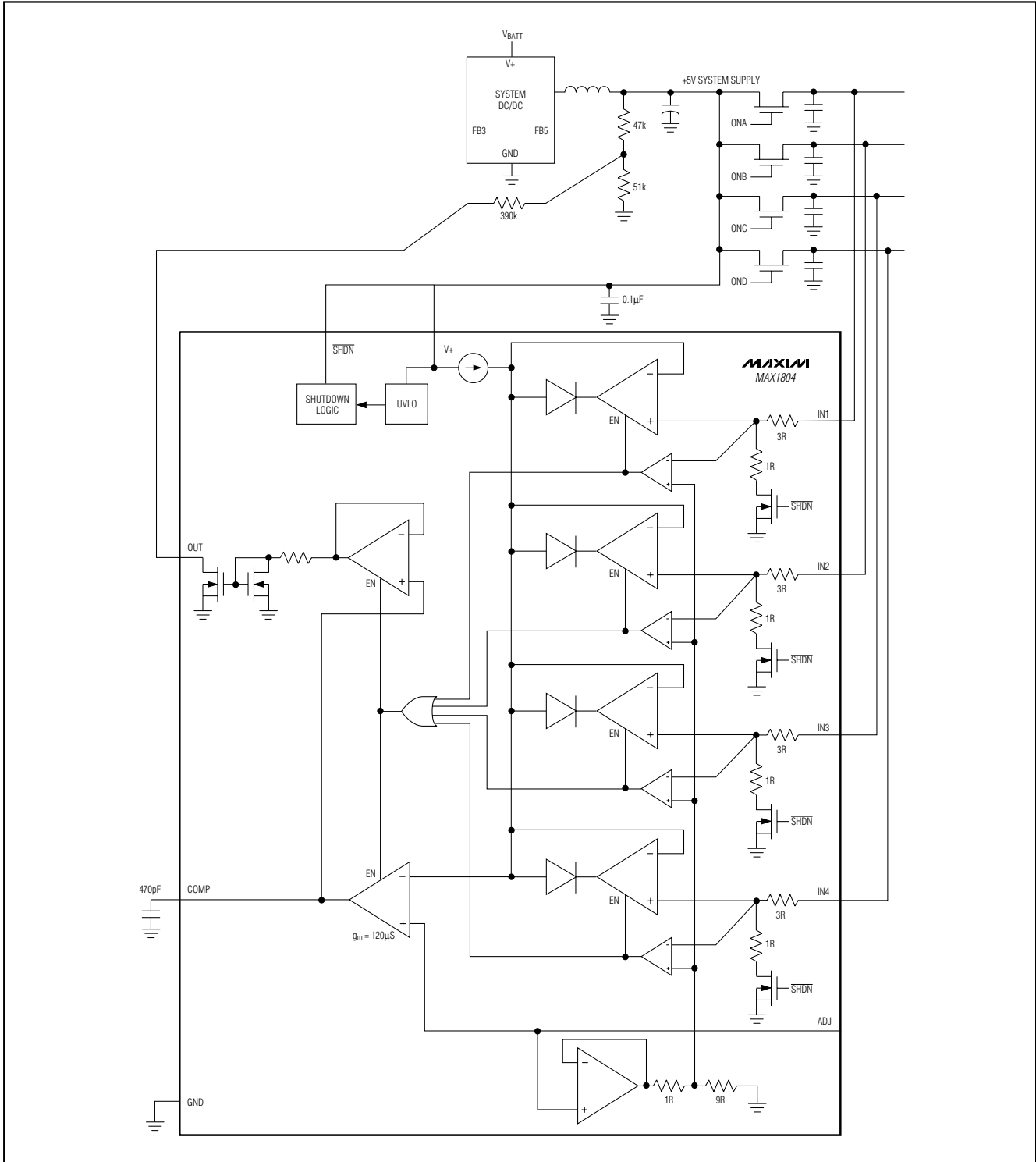
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Figure 4. MAX1804 Functional Block Diagram

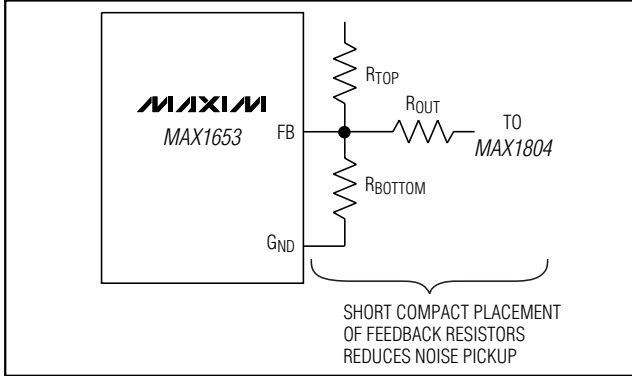# External Four-Input Feedback Integrator for Power Supplies

Figure 5. Proper Layout of Feedback Resistors for Regulator

Applications Information

Layout Information

Proper layout is essential due to high current levels and switching waveforms that generate noise. Place the regulator's feedback resistors and R_{OUT} (from the regulator feedback point to OUT of MAX1804) close to the regulator's feedback point to prevent noise pickup (Figure 5). Minimize leakage of the COMP capacitor and traces around COMP because they cause IN_ set-point errors according to the IN_ transconductance. A leakage of I_{COMP} at COMP will result in an error given by:

$$IN\_ \text{ error voltage} = I_{COMP} / (IN\_ \text{ transconductance})$$

For a typical value of IN_ transconductance of 30µS, a leakage of 0.1µA will result in an IN_ error voltage of 3mV in the set point.

Design Example (Step-Down Converter Application)

Figure 2 is an example of an application circuit using the MAX1804 for point-of-load regulation when using a step-down controller (MAX1653). Use the following design procedure to optimize the basic schematic. Begin the design by establishing the following:

- Input voltage to the MAX1653 controller (7V to 20V)
- Typical output voltage and accuracy of MAX1653 (5V ±5%)

This gives a target of:

$$V_{OUT, min} = 5V - 5\% = 4.75V$$

To minimize power dissipation, set regulator output $V_{OUT, R} = 4.8V$ with MAX1653 feedback resistors.

Choose feedback resistors (R_{TOP} and R_{BOTTOM}) for about 25µA current in the resistive divider for noise immunity.

Therefore:

$$(R_{TOP} + R_{BOTTOM}) = 4.8V / 25µA = 192k\Omega$$

For the MAX1653, the voltage at its feedback point $V_{FB} = 2.5V$.

Choose $R_{TOP} = 91k\Omega$ and therefore, $R_{BOTTOM} = 100k\Omega$.

If the desired adjustment range is +400mV, max OUT current (MAX1804) is given by:

$$I_{OUT}(MAX) = 0.4V / 91k\Omega = 4.4µA$$

$$R_{OUT} = V_{FB} / I_{OUT}(MAX) = 2.5V / 4.4µA = 562k\Omega$$

To guarantee that the output will not go below the target of 4.75V, including all error sources, set the MAX1804 nominal regulation point to 4.85V.

Since:

$$IN\_ \text{scale factor} = 4 \times V_{ADJ}, V_{ADJ} = 1.2125V$$

Divide the reference voltage down and bypass as required if using the MAX1653 reference voltage as shown in Figure 2. Assuming 0.1% resistor accuracy and using the MAX1653 reference, the error budget can be calculated as:

Reference Accuracy	-1.6%
ADJ Divider Accuracy	-0.2%
Scale Factor Error	-0.4%
IN_ Offset Voltage (-15mV)	-0.3%
Total	-2.5%

This gives a worst-case output voltage of 4.73V, which is below the target of 4.75V. The most-significant error source is the MAX1653 reference. Therefore, use a better reference, if available, in the system or increase the V_{ADJ} to increase the worst-case output voltage to 4.75V.

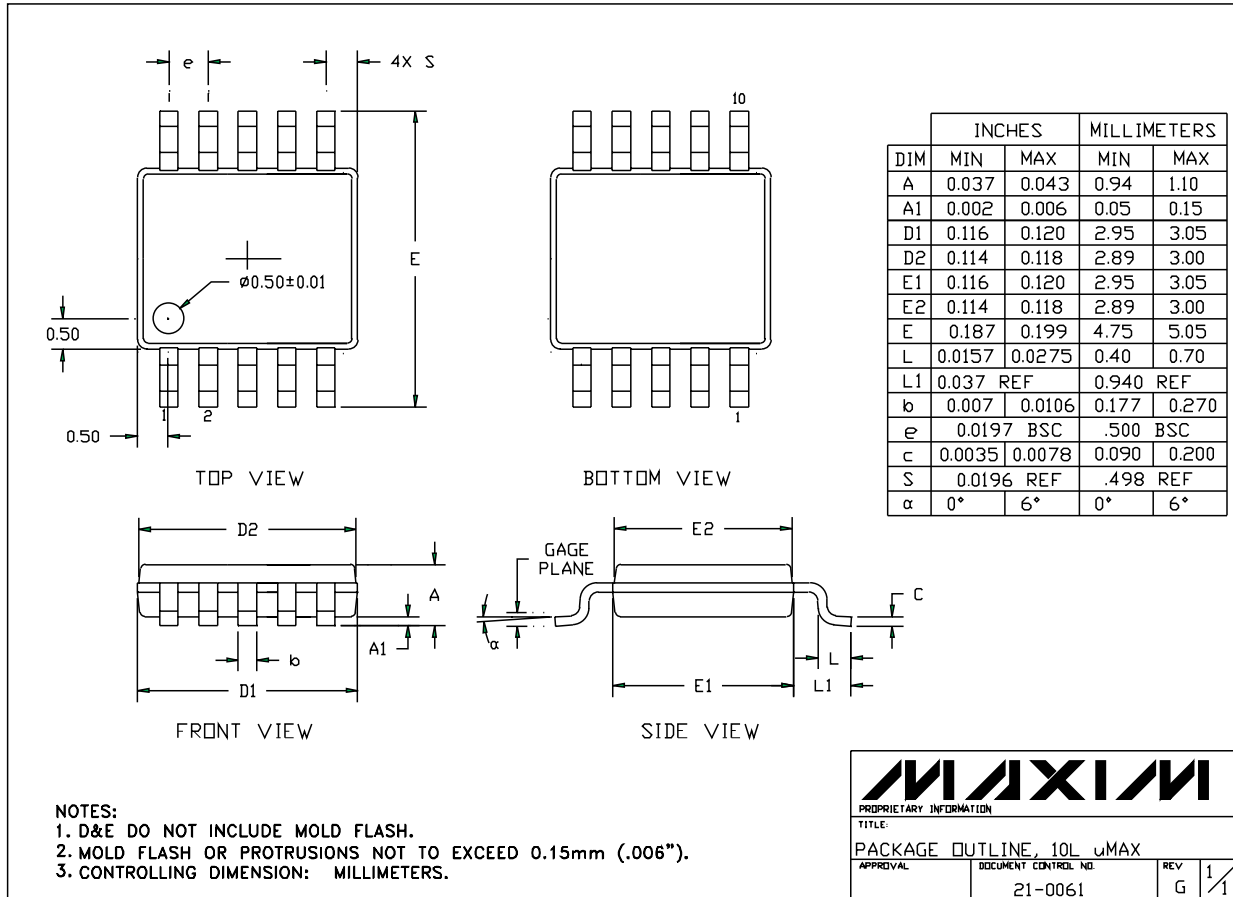The MAX1653 works well with the MAX1804's GBW product set at 40kHz, so use a 470pF capacitor on COMP.

Chip Information

TRANSISTOR COUNT: 636

MAXIM

External Four-Input Feedback Integrator for Power Supplies

_____Package Information

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.037	0.043	0.94	1.10
A1	0.002	0.006	0.05	0.15
D1	0.116	0.120	2.95	3.05
D2	0.114	0.118	2.89	3.00
E1	0.116	0.120	2.95	3.05
E2	0.114	0.118	2.89	3.00
E	0.187	0.199	4.75	5.05
L	0.0157	0.0275	0.40	0.70
L1	0.037 REF		0.940 REF	
b	0.007	0.0106	0.177	0.270
e	0.0197 BSC		.500 BSC	
c	0.0035	0.0078	0.090	0.200
S	0.0196 REF		.498 REF	
α	0°	6°	0°	6°

NOTES:
1. D&E DO NOT INCLUDE MOLD FLASH.
2. MOLD FLASH OR PROTRUSIONS NOT TO EXCEED 0.15mm (.006").
3. CONTROLLING DIMENSION: MILLIMETERS.

TITLE:
PACKAGE OUTLINE, 10L uMAX
APPROVAL | DOCUMENT CONTROL NO. 21-0061 | REV G | 1/1

Note: *MAX1804 does not feature exposed pads*