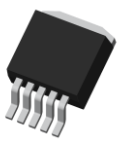
3A, 150kHz, Step-Down Switching Regulator LM2596A

FEATURES

- 3.3V, 5.0V, 12V, 15V, and Adjustable Output Versions
- Adjustable Version Output Voltage Range, 1.23V to 37V ±4% maximum over line and load conditions
- Guaranteed 3.0A Output Current
- Wide Input Voltage Range: Up to 40V
- Requires Only 4 External Components
- 150kHz Fixed Frequency Internal Oscillator
- TTL Shutdown Capability, Low Power Standby Mode
- High Efficiency
- Uses Readily Available Standard Inductors
- Thermal Shutdown and Current Limit Protection
- Moisture Sensitivity Level 3 for SMD type packages



TO-263-5

ORDERING INFORMATION

Device	Package
LM2596AR-x.x	TO-263-5L

x.x: Output Voltage

APPLICATIONS

- Simple High-Efficiency Step-Down (Buck) Regulator
- Efficient Pre-Regulator for Linear Regulators
- On-Card Switching Regulators
- Positive to Negative Converter (Buck-Boost)
- Negative Boost Converters
- Power Supply for Battery Chargers

DESCRIPTION

The LM2596A series of regulators are monolithic integrated circuits ideally suited for easy and convenient design of a step-down switching regulator (buck converter). All circuits of this series are capable of driving a 3.0A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5.0V, 12V, 15V, and an adjustable output version.

These regulators were designed to minimize the number of external components to simplify the power supply design. Standard series of inductors optimized for use with the LM2596A are offered by several different inductor manufacturers.

The LM2596A features include a ±4% tolerance on output voltage within specified input voltages and output load conditions, and ±10% on the oscillator frequency. External shutdown is included, featuring 50μA (typical) standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions.

ABSOLUTE MAXIMUM RATINGS (Note 1)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Maximum Supply Voltage	V_{IN}	-	45	V
$\overline{ON}$/OFF Pin Input Voltage	$V_{ON/OFF}$	−0.3	V_{IN}	V
FB pin voltage	V_{FB}	−0.8	-	V
Power Dissipation	P_D	-	Internally Limited	W
ESD Rating, HBM	-	2000	-	V
Maximum Junction Temperature	T_J	-	150	°C
Storage Temperature	T_{STG}	−65	150	°C

Note 1. 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 under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

RECOMMENDED OPERATING RATINGS (Note 2)

CHARACTERISTIC	SYMBOL	MIN	MAX	UNIT
Supply Voltage	V_{IN}	-	40	V
Operating Junction Temperature	T_J	−40	125	°C

Note 2. The device is not guaranteed to function outside its operating ratings.

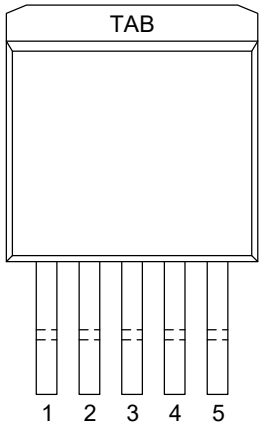
THERMAL INFORMATION

THERMAL METRIC	θ_{JA}	θ_{JC}	UNIT
Thermal Resistance, TO-263-5L	70	5	°C/W

ORDERING INFORMATION

VOUT	Package	Order No.	Description	Supplied As	Status
ADJ	TO-263-5L	LM2596AR-ADJ	Adjustable Output	Tape & Reel	Active
3.3V	TO-263-5L	LM2596AR-3.3	3.3V Fixed Output	Tape & Reel	Contact Us
5.0V	TO-263-5L	LM2596AR-5.0	5.0V Fixed Output	Tape & Reel	Active
12V	TO-263-5L	LM2596AR-12	12V Fixed Output	Tape & Reel	Contact Us
15V	TO-263-5L	LM2596AR-15	15V Fixed Output	Tape & Reel	Contact Us

PIN CONFIGURATION

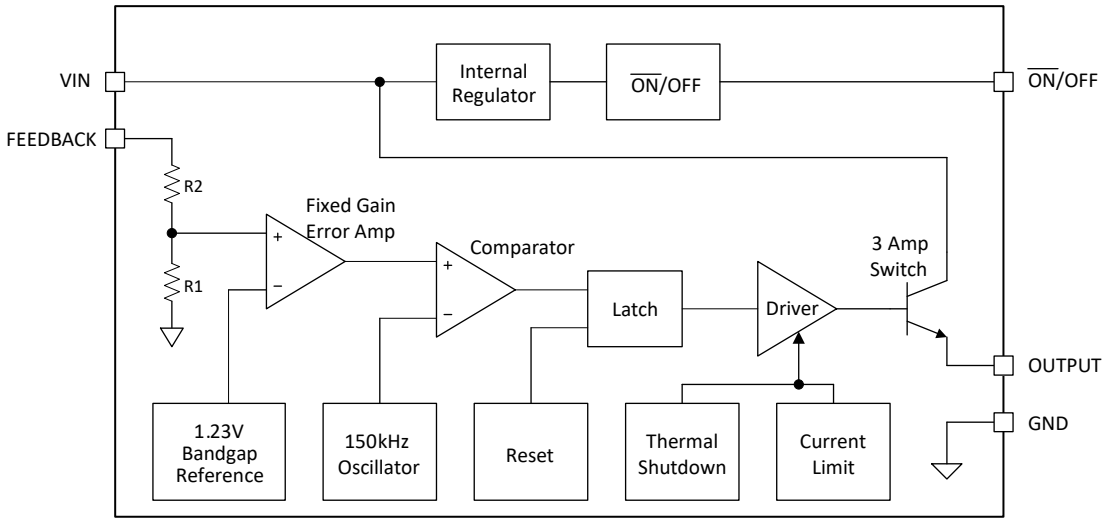


TO-263-5L

PIN DESCRIPTION

Pin No. TO-263-5L	Pin Name	Pin Function
1	VIN	Supply input pin to collector pin of power transistor. Connect to power supply and input bypass capacitors C_{IN}, Path from VIN pin to high frequency bypass C_{IN} and GND must be as short as possible to minimize voltage transients.
2	OUTPUT	Emitter pin of the power transistor. This is a switching node. Attached this pin to an inductor and the cathode of the external diode. It should be kept in mind that the PCB area connected to this pin should be kept to a minimum in order to minimize coupling to sensitive circuitry.
3	GND	Ground pin. Path to C_{IN} must be as short as possible.
4	FEEDBACK	Feedback sense input pin. Connect to the midpoint of feedback divider to set V_{OUT} for ADJ version or connect this pin directly to the output capacitor for a fixed output version.
5	$\overline{ON}$/OFF	Enable input to the voltage regulator. It allows the switching regulator circuit to be shutdown using logic level signals. Applying level high shuts the regulator off. If the voltage applied to this pin is level low, the regulator will be in the ON condition. Do not leave this pin float.
TAB	TAB	Connect to GND. Put a copper plane connected to this pin as a thermal relief for TO-263 package.

BLOCK DIAGRAM

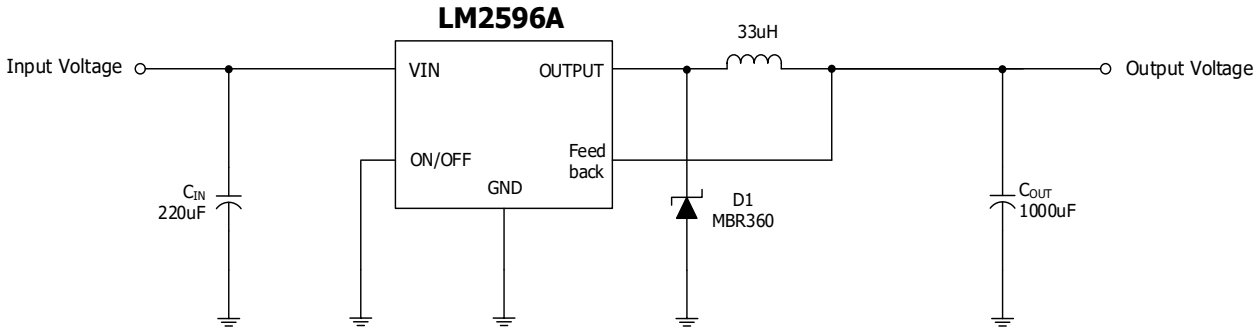


< Fixed Output Voltage Version >
3.3V, R1=1.0K / R2 = 1.7K
5.0V, R1=1.0K / R2 = 3.1K
12V, R1=1.0K / R2 = 8.84K
15V, R1=1.0K / R2 = 11.3K

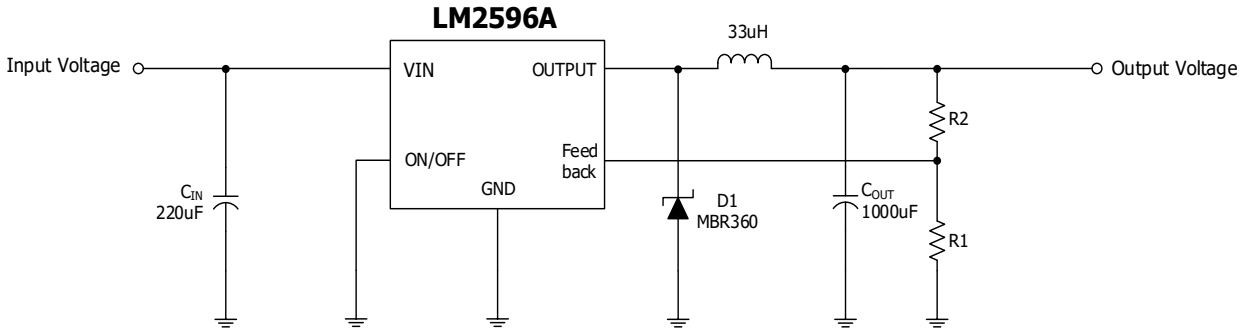
< Adjustable Output Voltage Version >
R1 = Open / R2 = 0

TYPICAL APPLICATION CIRCUIT

- Fixed Output Voltage Version



- Adjustable Output Voltage Version



* $V_{OUT} = V_{FB}(1 + R2 / R1)$, where VFB = 1.23V, R1 between 1KΩ and 5KΩ.

* External components such as the catch diode (D1), inductor (L1), input and output capacitors and PCB layout can affect switching regulator system performance.

ELECTRICAL CHARACTERISTICS

Specification with standard type face are for T_J = 25°C, and those with **boldface type** apply over full operating temperature range in the *Recommended Operating Ratings*.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
3.3V Output (Note 3)						
Output Voltage	V_{OUT}	V_{IN} = 12V, I_{LOAD} = 0.5A	3.234	3.3	3.366	V
Output Voltage	V_{OUT}	5.5V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 3.0A	3.168 **3.135**	3.3 -	3.432 **3.465**	V
Efficiency	η	V_{IN} = 12V, I_{LOAD} = 3.0A	-	75	-	%
5.0V Output (Note 3)						
Output Voltage	V_{OUT}	V_{IN} = 12V, I_{LOAD} = 0.5A	4.900	5.0	5.100	V
Output Voltage	V_{OUT}	8.0V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 3.0A	4.800 **4.750**	5.0 -	5.200 **5.250**	V
Efficiency	η	V_{IN} = 12V, I_{LOAD} = 3.0A	-	77	-	%
12V Output (Note 3)						
Output Voltage	V_{OUT}	V_{IN} = 25V, I_{LOAD} = 0.5A	11.76	12	12.24	V
Output Voltage	V_{OUT}	15V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 3.0A	11.52 **11.40**	12 -	12.48 **12.60**	V
Efficiency	η	V_{IN} = 15V, I_{LOAD} = 3.0A	-	88	-	%
15V Output (Note 3)						
Output Voltage	V_{OUT}	V_{IN} = 25V, I_{LOAD} = 0.5A	14.70	15	15.30	V
Output Voltage	V_{OUT}	18V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 3.0A	14.40 **14.25**	15 -	15.60 **15.75**	V
Efficiency	η	V_{IN} = 18V, I_{LOAD} = 3.0A	-	88	-	%
Adjustable Output (Note 3)						
Feedback Voltage	V_{FB}	V_{IN} = 12V, I_{LOAD} = 0.5A, V_{OUT} = 5.0V	1.217	1.23	1.243	V
Feedback Voltage	V_{FB}	8.0V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 3.0A, V_{OUT} = 5.0V	1.193 **1.180**	1.23 -	1.267 **1.280**	V
Efficiency	η	V_{IN} = 12V, I_{LOAD} = 3.0A, V_{OUT} = 5.0V	-	77	-	%

Note 3. External components such as catch diode, inductor, input and output capacitors can affect switching regulator system performance.

ELECTRICAL CHARACTERISTICS (continued)

Specification with standard type face are for T_J = 25°C, and those with **boldface type** apply over full operating temperature range in Recommended Operating Ratings. Unless otherwise specified, V_{IN} = 12V for the 3.3V, 5.0V, and Adjustable version, and V_{IN} = 25V for the 12V and 15V version. I_{LOAD} = 500mA. For typical values, T_J = 25°C, unless otherwise noted.

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNIT
All Output Voltage Versions						
Feedback Bias Current	I_B	V_{OUT} = 5.0V (Adjustable Version Only)	- -	50 -	100 **500**	nA
Oscillator Frequency (Note 4)	F_{OSC}		130 **120**	150 -	170 **180**	kHz
Saturation Voltage	V_{SAT}	I_{OUT} = 3.0A (Note 5)	- -	1.4 -	1.6 **1.8**	V
Max Duty Cycle (Note 6)	DC		93	98	-	%
Current Limit (Note 4,5)	I_{CL}	(Note 4, 5)	4.0 **3.5**	5.7 -	6.9 **7.5**	A
Output Leakage Current (Note 7, 8)	I_L	Output = 0V	-	0.4	2	mA
		Output = −0.8V (Note 7,8)	-	10	30	
Quiescent Current (Note 7)	I_Q		-	5	10	mA
Standby Quiescent Current	I_{STBY}	$\overline{ON}$/OFF pin = 5.0V (OFF)	-	60	200	μA
$\overline{ON}$/OFF Pin Input Level	V_{IH}	V_{OUT} = 0V	2.2 **2.4**	1.4 -	- -	V
	V_{IL}	V_{OUT} = Nominal Output Voltage	- -	1.2 -	1.0 **0.8**	V
$\overline{ON}$/OFF Pin Input Current	I_{IH}	$\overline{ON}$/OFF Pin = 5.0V (OFF)	-	12	30	μA
	I_{IL}	$\overline{ON}$/OFF Pin = 0V (ON)	-	0	10	μA

Note 4. The oscillator frequency reduces to approximately 36 kHz in the event of an output short or an overload which causes the regulated output voltage to drop approximately 40% from the nominal output voltage. This self-protection feature lowers the average power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.

Note 5. OUTPUT pin sourcing current. No diode, inductor or capacitor connected to OUTPUT.

Note 6. FEEDBACK pin removed from output and connected to 0V.

Note 7. FEEDBACK pin removed from output and connected to +12V for the 3.3V, 5.0V, and Adjustable versions, and 25V for the 12V and 15V versions, to force the output transistor OFF.

Note 8. V_{IN} = 40V.

TYPICAL OPERATING CHARACTERISTICS

T.B.D

APPLICATION CIRCUIT DESIGN PROCEDURE

TYPICAL CIRCUITS

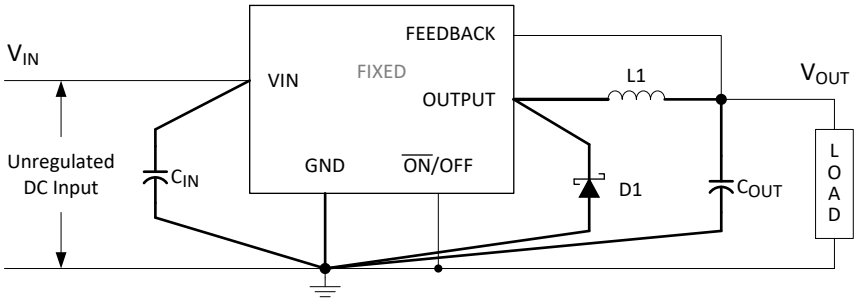


Figure 5. Fixed Output Voltage Version

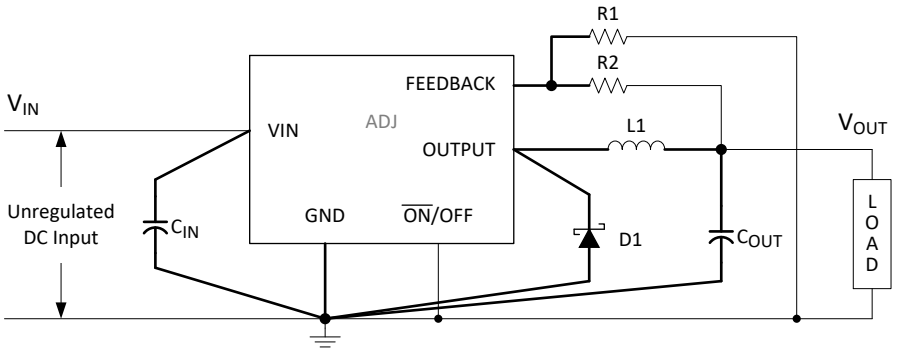


Figure 6. Adjustable Output Voltage Version

As indicated in the Figure 5 and Figure 6, to minimize inductance and ground loops, the length of the leads indicated by heavy lines should be kept as short as possible. For best results, single-point grounding (as indicated) or ground plane construction should be used.

REVISION NOTICE

The description in this datasheet is subject to change without any notice to describe its electrical characteristics properly.