2596M3K/M4K-XX **SIMPLE SWITCHER Power Converter 150 kHz 2A/3A Step-Down Voltage Regulator**

January 2008 - revised June 2014

GENERAL DESCRIPTION

The 2596M3K/M4K series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving 3A (2596M4K) and 2A (2596M3K) load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3V, 5V, 12V, 15V and an adjustable output versions.

Requiring a minimum number of external components, these regulators are simple to use and include internal frequency compensation, and a fixed-frequency oscillator.

The 2596M3K/M4K series operates at a switching frequency of 150 kHz thus allowing smaller sized filter components than what would be needed with lower frequency switching regulators.

Available in a standard 5-lead TO-220 package, a 5- lead TO-263, TO-252 surface mount packages. The 2596M3K also available in a SOP-8L package.

Some features include a guaranteed ± 4% tolerance on output voltage under specified input voltage and output load conditions, and ±15% on the oscillator frequency. External shutdown is included, featuring typically 50μA standby current. The output switch includes cycle-by-cycle current limiting, as well as thermal shutdown for full protection under fault conditions. The oscillator frequency reduces 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.

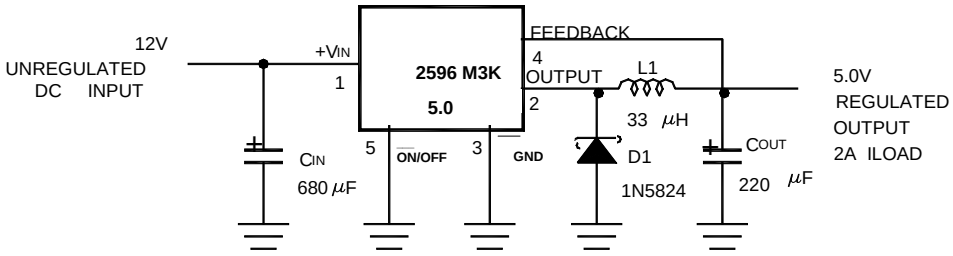
FEATURES

- 3.3V, 5V, 12V, 15V, and adjustable output versions
- Adjustable version output voltage range, 1.23V to 37V ± 3% max over line and load conditions
- Guaranteed 3A (2596M4K) and 2A (2596M3K) output current
- Wide input voltage range
- Requires only 4 external components
- 150 kHz fixed frequency oscillator
- TTL shutdown capability, low power standby mode
- Uses readily available standard inductors
- Thermal shutdown and current limit protection

APPLICATIONS

- Simple high-efficiency step-down (buck) regulator
- On-card switching regulators
- Positive to negative converter

TYPICAL APPLICATION (Fixed Output Voltage Versions)



Pin Assignments:

TO-220, TO-263, TO-252

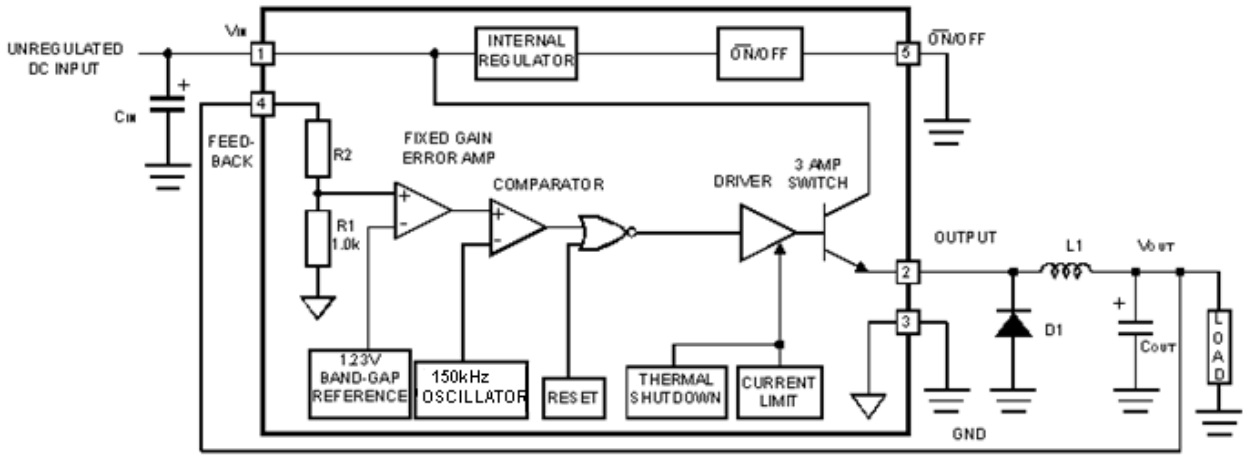
1. Vin
2. OUT
3. GND
4. FB
5. ON/OFF

SOP-8L (for 2596M3K)
(for Iload ≤ 1.5A)

1. Vin
2. OUTPUT
3. FB
4. ON/OFF

5,6,7,8 GND

For the best thermal performance, generous amounts of printed circuit board copper should be used in the board layout.



3.3V, R2 =1.7K
5V, R2 = 3.1K
12V, R2 = 8.84K
15V, R2 =11.3K
For ADJ Version
R1 = Open, R2 =0Ω

Absolute Maximum Ratings

Parameter	Value
Maximum Supply Voltage	45V
$\overline{ON}$/OFF Pin Input Voltage	$-0.3V \le V \le +V_{IN}$
FB Pin Voltage	$-0.3V \le V \le +V_{IN}$
Output Voltage to Ground	-0.8V
Power Dissipation	Internally Limited
Storage Temperature Range	-65°C to +150°C
Maximum Junction Temperature	150°C
Minimum ESD Rating (C= 100pF, R = 1.5 kΩ)	2kV

Operating Ratings

Temperature Range	$-40°C \le T_J \le +125°C$
Max Supply Voltage	40V
Iload (2596M3K)	2A
Iload (2596M4K)	3A

2596M3K-XX, 2596M4K-XX

Electrical Characteristics (Note 1)

Unless otherwise specified, V_{in}= 12v for the 3.3v, 5v and Adjustable versions, V_{in}=25v for 12v, 15v versions.
The ***** denotes the specifications which apply over full operating temperature range T_J = -40…+125°C.

Symbol	Parameter	Conditions					Units
				Min	Typ	Max	
SYSTEM PARAMETERS Test Circuit *Figure 1*							
V_{OUT}	Output Voltage 2596M3K-3.3	$5.1V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 2A$	*	3.168 3.135	3.3	3.432 3.465	V
	2596M4K-3.3	$5.5V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	*	3.168 3.135	3.3	3.432 3.465	V

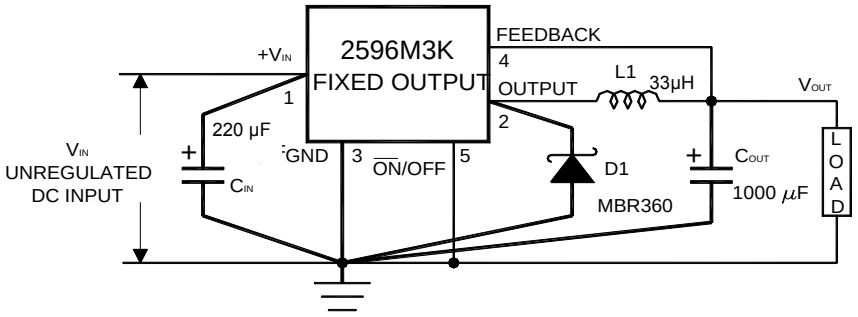
	2596M3K-5.0	$7V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 2A$	*	4.800 4.750	5.0	5.200 5.250	V
	2596M4K-5.0	$8V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	*	4.800 4.750	5.0	5.200 5.250	V
	2596M3K-12	$15V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 2A$	*	11.52 11.40	12	12.48 12.60	V
	2596M4K-12	$15V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	*	11.52 11.40	12	12.48 12.60	V
	2596M3K-15	$18V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 2A$	*	14.40 14.25	15	15.60 15.75	V
	2596M4K-15	$18V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$	*	14.40 14.25	15	15.60 15.75	V
	2596M3K-ADJ	$7V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 2A$ V_{OUT} programmed for 5v	*	1.193 1.180	1.230	1.267 1.280	V
	2596M4K-ADJ	$8V \le V_{IN} \le 40V$, $0.2A \le I_{LOAD} \le 3A$ V_{OUT} programmed for 5v	*	1.193 1.180	1.230	1.267 1.280	V
η	Efficiency 2596M3K-3.3	V_{IN} =12V, I_{LOAD} =2A			75		%
	2596M4K-3.3	V_{IN} =12V, I_{LOAD} =3A			75		%
	2596M3K-5.0	V_{IN} =12V, I_{LOAD} =2A			77		%
	2596M4K-5.0	V_{IN} =12V, I_{LOAD} =3A			77		%
	2596M3K-12	V_{IN} =15V, I_{LOAD} =2A			88		%
	2596M4K-12	V_{IN} =15V, I_{LOAD} =3A			88		%
	2596M3K-15	V_{IN} =18V, I_{LOAD} =2A			88		%
	2596M4K-15	V_{IN} =18V, I_{LOAD} =3A			88		%
	2596M3K- ADJ	V_{IN} =12V, I_{LOAD} =2A Vout programmed for 5v			77		%
	2596M4K- ADJ	V_{IN} =12V, I_{LOAD} =3A Vout programmed for 5v			77		%

All Output Voltage Versions Unless otherwise specified, V_{IN} =12V for the 3.3V, 5V and Adjustable versions, V_{IN} =25V for 12,15V versions.							
Ifb	Feedback Bias Current	V_{OUT} =5V (Adjustable Version Only)	*		50	100 500	nA
FO	Oscillator Frequency	(Note 6)	*	130 120	150	170 180	kHz
V_{SAT}	Saturation Voltage 2596M3K	I_{OUT} =2A (Note 2)	*		1.2	1.4 1.6	V
	2596M4K	I_{OUT} =3A (Note 2)	*		1.4	1.6 1.8	V
DC	Max Duty Cycle (ON)	(Note 3)		93	98		%
I_{CL}	Current Limit 2596M3K	Peak Current (Notes 2, 6)	*	2.5 2.3	3.2	4.6 5.2	A
	2596M4K			4.0 3.5	5.7	6.9 7.5	A
I_{OL}	Output Leakage Current	(Notes 4, 5): Output = 0V Output = -0.8V			0.4 10	2 30	mA
I_Q	Quiescent Current	(Note 4)			5	10	mA
I_{STBY}	Standby Quiescent Current	ON/OFF Pin = 5V (OFF)			60	200	uA
	ON/OFF CONTROL						
V_{IH}	ON/OFF Pin Logic Input Level	VOUT=0V	*	2.2 2.4	1.4		V
V_{IL}		VOUT=Nominal Output Voltage	*		1.2	1.0 0.8	V
I_{IH}	ON/OFF Pin Input Current	ON/OFF Pin = 5V (OFF)			12	30	uA
I_{IL}		ON/OFF Pin = 0V (ON)			0	10	uA

Note 1: External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance.
Note 2: Output pin sourcing current. No diode, inductor or capacitor connected to output.
Note 3: Feedback pin removed from output and connected to 0V.
Note 4: Feedback pin removed from output and connected to +12V for the Adjustable, 3.3V, and 5V, versions, and +25V for the 12V and 15V versions, to force the output transistor OFF.
Note 5: V_{IN} =40V.
Note 6: 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 protections feature lowers the average power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.

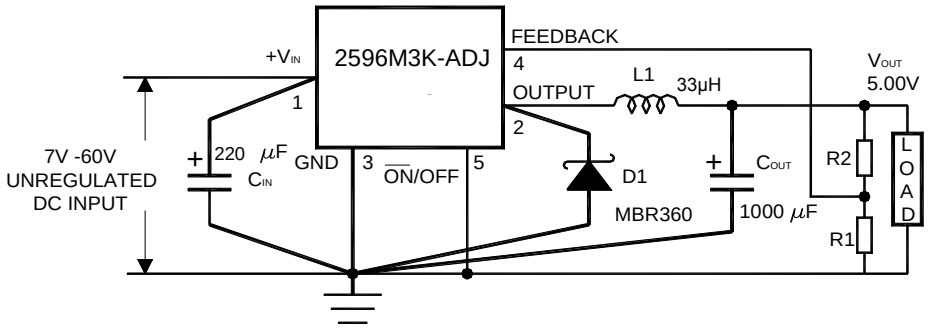
Test Circuit and Layout Guidelines

Fixed Output Voltage Versions



C_{IN} — 220uF, 75V, Aluminum Electrolytic
C_{OUT} —1000µF, 25V, Aluminum Electrolytic
D1 — Schottky, MBR360
L_1 — 33uH, Pulse Eng. PE-92108
R_1 — 2k, 0.1%
R_2 — 6.12k, 0.1%

Adjustable Output Voltage Version



$$V_{OUT} = V_{REF}(1 + \frac{R_2}{R_1})$$

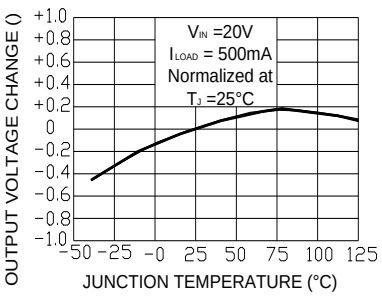
$$R_2 = R_1(\frac{V_{OUT}}{V_{REF}} - 1)$$

where V_{REF} = 1.23V, R1 between 1k and 5k

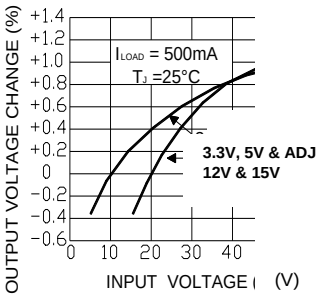
FIGURE 1.

Typical Performance Characteristics (Circuit of *Figure 1*)

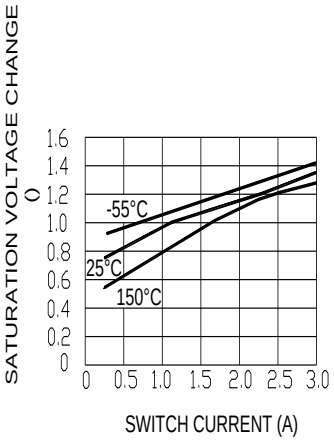
Normalized Output Voltage



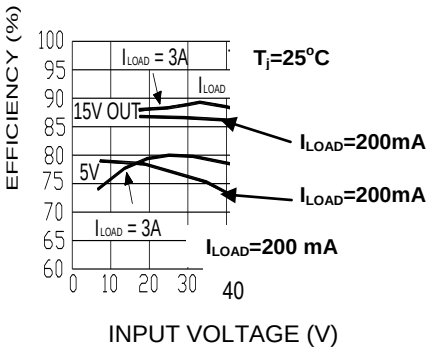
Line Regulation



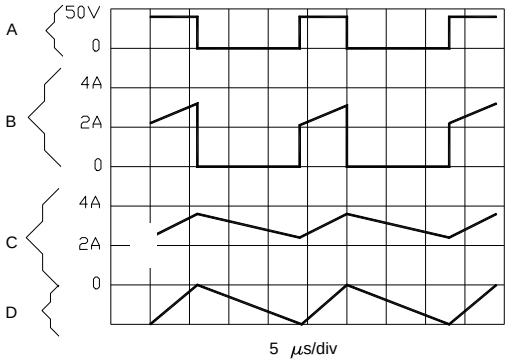
Switch Saturation Voltage



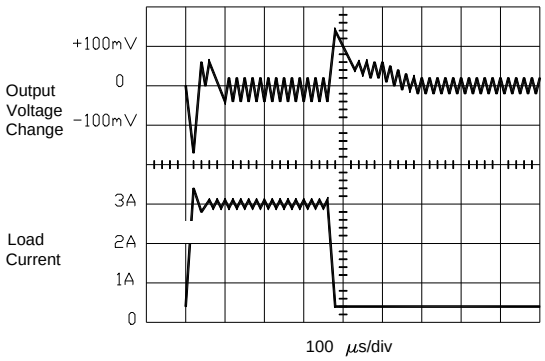
Efficiency



Switching Waveforms

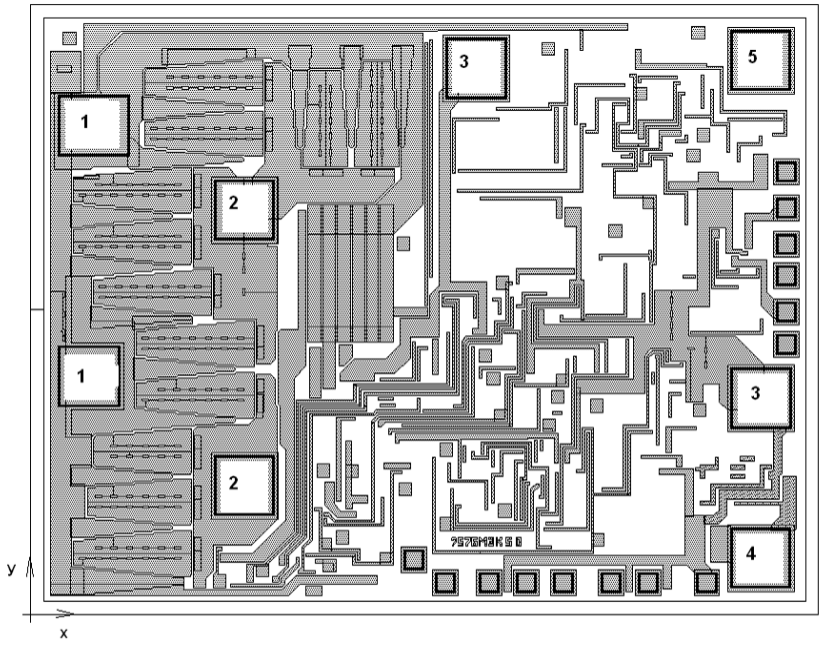


Load Transient



V_{OUT} =15V
A: Output Pin Voltage, 50V/div
B: Output Pin Current 2A/div
C: Inductor Current 2A/div
D: Output Ripple Voltage 50mv/div

PAD LOCATION

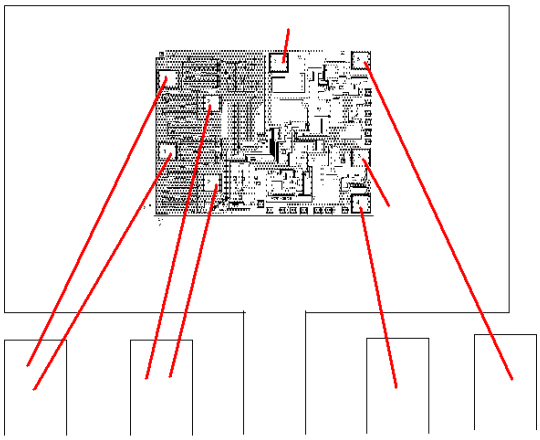


2596M3K/M4K-XX
Chip Size: 2.47 x 1.91 mm^2

PAD LOCATION COORDINATES

Pad N	Coordinates (μm)		Pad size (μm × μm)
	X	Y	
1	196	1533	223x190
1	183	746	196x190
2	668	1267	190x190
2	668	405	190x190
3	1397	1711	190x190
3	2290	677	190x190
4	2290	177	190x190
5	2290	1735	190x190

BONDING DIAGRAM

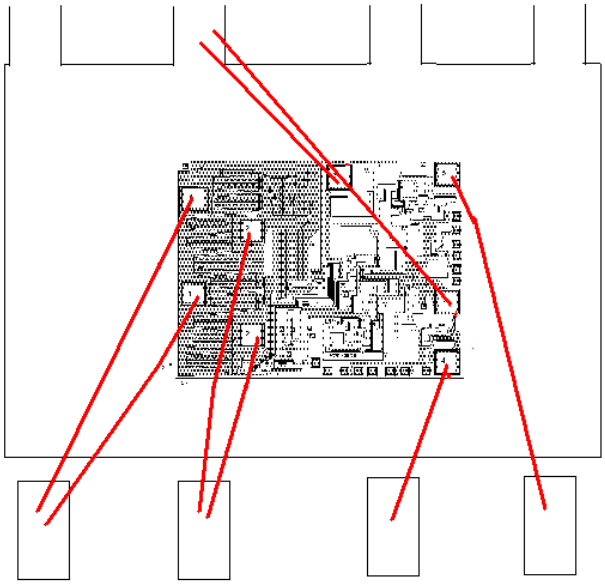


2596M3K/M4K-XX

Chip Size = 2.47*1.91mm

Package: TO-220; TO-263 TO-252;

The wire diameters 75um for 2596M4K
The wire diameters 50um for 2596M3K



2596M3K-XX **(only)**

Package: SO-8
The wire diameters 50um