



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 $\pm 4\%$ tolerance on output voltage under specified input voltage and output load conditions, and $\pm 15\%$ on the oscillator frequency. External shutdown is included, featuring typically 50 μ A 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.

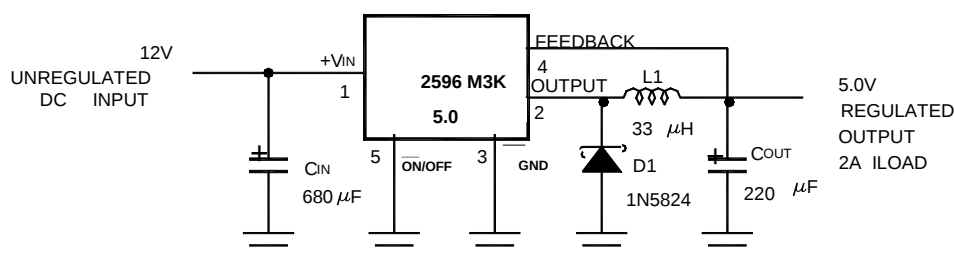
FEATURES

- 3.3V, 5V, 12V, 15V, and adjustable output versions
- Adjustable version output voltage range, 1.23V to 37V $\pm 3\%$ 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

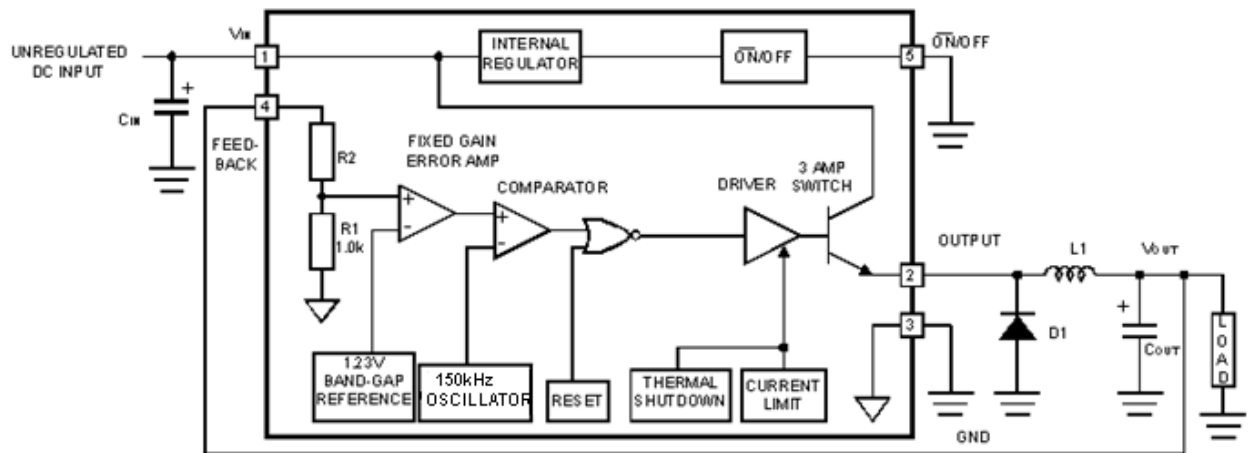
1. V_{in}
2. OUT
3. GND
4. FB
5. ON/OFF

SOP-8L (for 2596M3K)

(for $I_{load} \leq 1.5A$)

1. V_{in}
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
ON/OFF Pin Input Voltage	$-0.3V \leq V \leq +V_{IN}$
FB Pin Voltage	$-0.3V \leq V \leq +V_{IN}$
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	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$
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 $T_J = -40...+125^{\circ}\text{C}$.

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



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

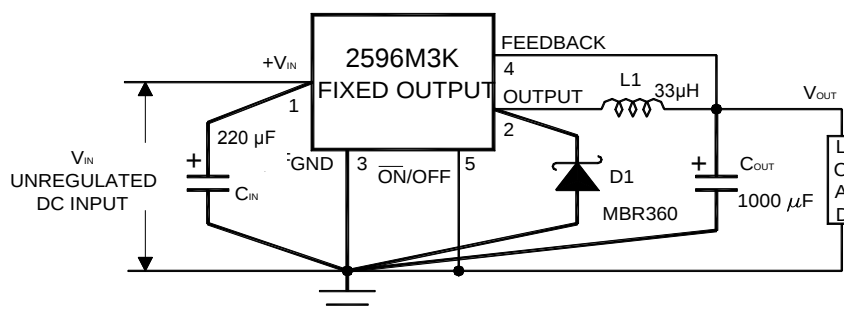
I _{fb}	Feedback Bias Current	$V_{OUT} = 5V$ (Adjustable Version Only)	*		50	100 500	nA
FO	Oscillator Frequency	(Note 6)	*	130 120	150	170 180	kHz
V _{SAT}	Saturation Voltage 2596M3K	$I_{OUT} = 2A$ (Note 2)	*		1.2	1.4 1.6	V
	2596M4K	$I_{OUT} = 3A$ (Note 2)	*		1.4	1.6 1.8	V
DC	Max Duty Cycle (ON)	(Note 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	V _{OUT} =0V	*	2.2 2.4	1.4		V
V _{IL}		V _{OUT} =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 protection feature lowers the average power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.



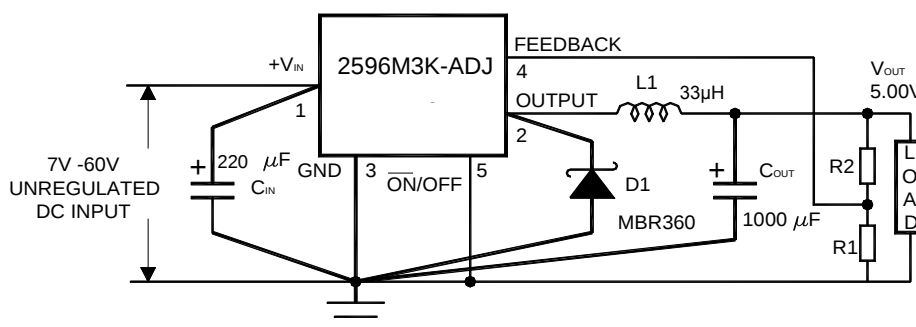
Test Circuit and Layout Guidelines

Fixed Output Voltage Versions



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

Adjustable Output Voltage Version



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

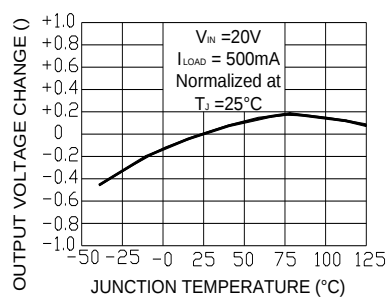
$$R_2 = R_1 \left(\frac{V_{OUT}}{V_{REF}} - 1 \right)$$

where $V_{REF} = 1.23V$, R_1 between 1k and 5k

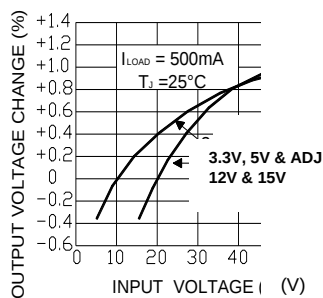
FIGURE 1.

Typical Performance Characteristics (Circuit of Figure 1)

Normalized Output Voltage

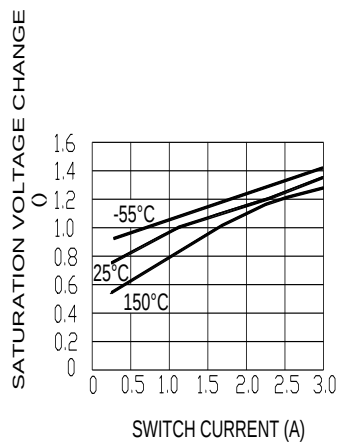


Line Regulation

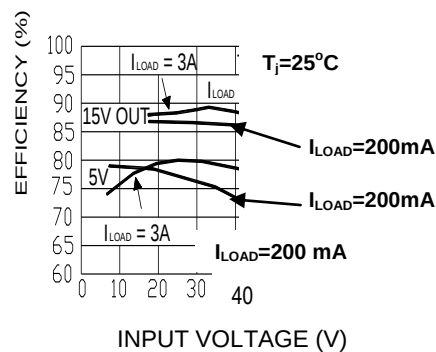




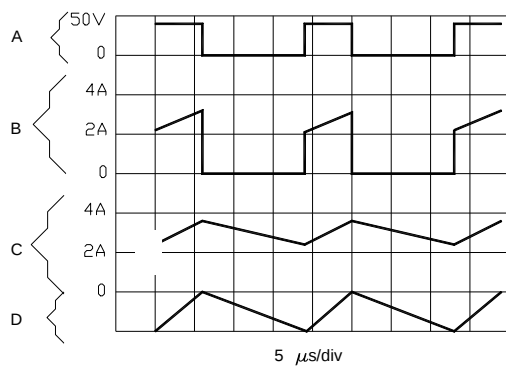
Switch Saturation Voltage



Efficiency



Switching Waveforms



$V_{\text{OUT}} = 15\text{V}$

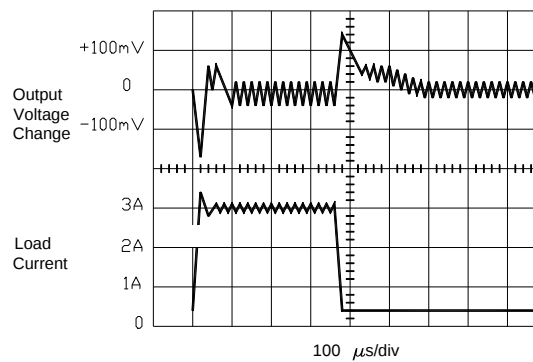
A: Output Pin Voltage, 50V/div

B: Output Pin Current 2A/div

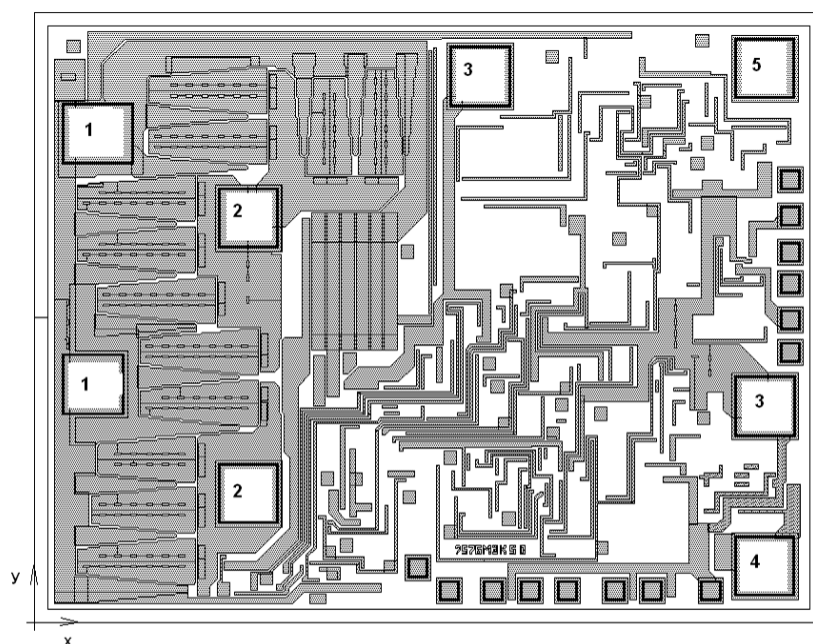
C: Inductor Current 2A/div

D: Output Ripple Voltage 50mV/div

Load Transient



PAD LOCATION



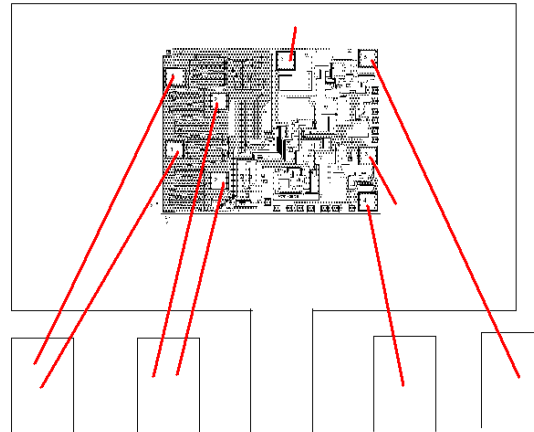
2596M3K/M4K-XX

Chip Size: 2.47 x 1.91 mm²

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

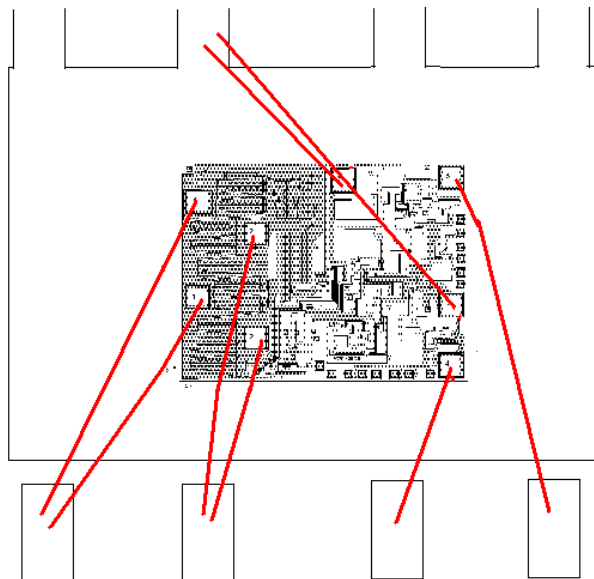
**2596M3K/M4K-XX**

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