Replacement of
LM2576 Series

Simple Switcher (3A Step-Down Voltage Regulator)

MIK2576 Series

May 2001 - revised July 2002

Description

The MIK2576 series of regulators are monolithic integrated circuits that provide all the active functions for a step-down (buck) switching regulator, capable of driving 3A 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 MIK2576 series offers a high-efficiency replacement for popular three-terminal linear regulators. It substantially reduces the size of the heat sink, and in some cases no heat sink is required. A standard series of inductors optimized for use with the MIK2576 are available from several different manufacturers. This feature greatly simplifies the design of switch-mode power supplies. Other features include a guaranteed ± 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.
Note: The MIK2576HV is not produced yet.

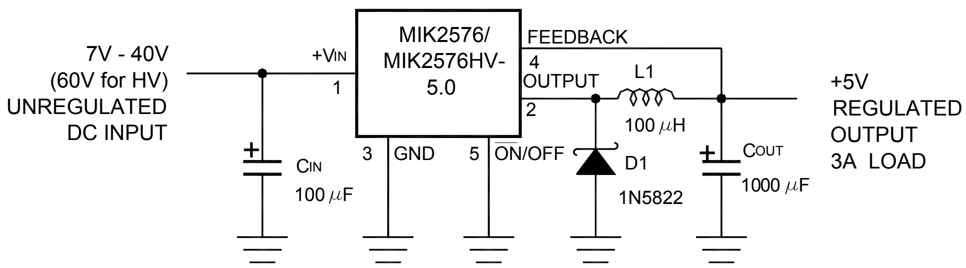
Features

- 3.3V, 5V, 12V, 15V, and adjustable output versions
- Adjustable version output voltage range
- 1.23V to 37V (57V for HV version) ± 4% max over line and load conditions
- Guaranteed 3A output current
- Wide input voltage range, 40V up to 60V for HV version
- Requires only 4 external components
- 52 kHz fixed frequency oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Uses readily available standard inductors
- Thermal shutdown and current limit protection

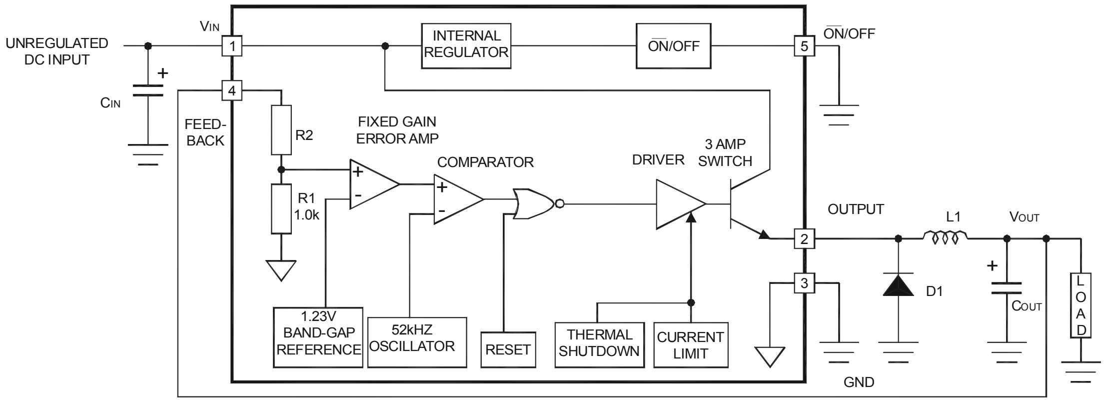
Applications

- Simple high-efficiency step-down (buck) regulator
- Efficient pre-regulator for linear regulators
- On-card switching regulators
- Positive to negative converter (Buck-Boost)

Typical application Figure 1.(Fixed Output Voltage Versions)



Block Diagram



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

Ordering information

Temperature Range	Output Voltage, V					Package Type
	3.3	5.0	12	15	ADJ	
-40°C ≤ T_A ≤ 125°C	MIK2576HVS-3.3	MIK2576HVS-5.0	MIK2576HVS-12	MIK2576HVS-15	MIK2576HVS-ADJ	TO-263
	MIK2576S-3.3	MIK2576S-5.0	MIK2576S-12	MIK2576S-15	MIK2576S-ADJ	
	MIK2576HVT-3.3	MIK2576HVT-5.0	MIK2576HVT-12	MIK2576HVT-15	MIK2576HVT-ADJ	TO-220
	MIK2576T-3.3	MIK2576T-5.0	MIK2576T-12	MIK2576T-15	MIK2576T-ADJ	

Absolute Maximum Ratings (Note 1)

Parameter	Maximum	Units
Maximum Supply Voltage MIK2576 MIK2576HV	 45 63	V
ON/OFF Pin Input Voltage	$-0.3V \le V \le +V_{IN}$	
Output Voltage to Ground (Steady State)	-1	V
Power Dissipation	Internally Limited	W
Storage Temperature Range	-65 to +150	°C
Maximum Junction Temperature	150	°C
Minimum ESD Rating (C= 100pF, R = 1.5 kΩ)	2	kV
Lead Temperature (Soldering, 10 Seconds)	260	°C

Operating Ratings

Parameter	Value	Units
Temperature Range MIK2576/ MIK2576HV	$-40 \le T_J \le +125$	°C
Supply Voltage MIK2576 MIK2576HV	 40 60	V

Electrical Characteristics MIK2576-3.3, MIK2576HV-3.3

Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range.

Symbol	Parameter	Conditions	MIK2576-3.3 MIK2576HV-3.3		Units (Limits)
			Typ	**Limit** (Note 2)	
SYSTEM PARAMETERS (Note 3) **Test Circuit** *Figure 2*					
V_{OUT}	Output Voltage	V_{IN} =12V, I_{LOAD} =0.5A Circuit of *Figure 2*	3.3	 3.234 3.366	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576	$6V \le V_{IN} \le 40V$, $0.5A \le I_{LOAD} \le 3A$ Circuit of *Figure 2*	3.3	 3.168/**3.135** 3.432/**3.465**	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576HV	$6V \le V_{IN} \le 60V$, $0.5A \le I_{LOAD} \le 3A$ Circuit of *Figure 2*	3.3	 3.168/**3.135** 3.450/**3.482**	V V(Min) V(Max)
η	Efficiency	V_{IN} =12V, I_{LOAD} =3A	75		%

Electrical Characteristics MIK2576-5.0, MIK2576HV-5.0

Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range.

Symbol	Parameter	Conditions	MIK2576-5.0 MIK2576HV-5.0		Units (Limits)
			Typ	**Limit** (Note 2)	
SYSTEM PARAMETERS (Note 3) **Test Circuit** *Figure 2*					
V_{OUT}	Output Voltage	V_{IN} =12V, I_{LOAD} =0.5A Circuit of *Figure 2*	5.0	 4.900 5.100	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576	$0.5A \le I_{LOAD} \le 3A$, $8V \le V_{IN} \le 40V$ Circuit of *Figure 2*	5.0	 4.800/**4.750** 5.200/**5.250**	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576HV	$0.5A \le I_{LOAD} \le 3A$, $8V \le V_{IN} \le 60V$ Circuit of *Figure 2*	5.0	 4.800/**4.750** 5.225/**5.275**	V V(Min) V(Max)
η	Efficiency	V_{IN} =12V, I_{LOAD} =3A	77		%

Electrical Characteristics MIK2576-12, MIK2576HV-12

Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range.

Symbol	Parameter	Conditions	MIK2576-12 MIK2576HV-12		Units (Limits)
			Typ	**Limit**(Note 2)	
SYSTEM PARAMETERS (Note 3) **Test Circuit** *Figure 2*					
V_{OUT}	Output Voltage	V_{IN} =25V, I_{LOAD} =0.5A Circuit of *Figure 2*	12	 11.76 12.24	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576	0.5A ≤ I_{LOAD} ≤ 3A, 15V ≤ V_{IN} ≤ 40V Circuit of *Figure 2*	12	 11.52/**11.40** 12.48/**12.60**	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576HV	0.5A ≤ I_{LOAD} ≤ 3A, 15V ≤ V_{IN} ≤ 60V Circuit of *Figure 2*	12	 11.52/**11.40** 12.54/**12.66**	V V(Min) V(Max)
η	Efficiency	V_{IN} =15V, I_{LOAD} =3A	88		%

Electrical Characteristics MIK2576-15, MIK2576HV-15

Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range.

Symbol	Parameter	Conditions	MIK2576-15 MIK2576HV-15		Units (Limits)
			Typ	**Limit** (Note 2)	
SYSTEM PARAMETERS (Note 3) **Test Circuit** *Figure 2*					
V_{OUT}	Output Voltage	V_{IN} =25, I_{LOAD} =0.5A Circuit of *Figure 2*	15	 14.70 15.30	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576	0.5A ≤ I_{LOAD} ≤ 3A, 18≤ V_{IN} ≤ 40V Circuit of *Figure 2*	15	 14.40/**14.25** 15.60/**15.75**	V V(Min) V(Max)
V_{OUT}	Output Voltage MIK2576HV	0.5A ≤ I_{LOAD} ≤ 3A, 18 ≤ V_{IN} ≤ 60V Circuit of *Figure 2*	15	 14.40/**14.25** 15.68/**15.83**	V V(Min) V(Max)
η	Efficiency	V_{IN} =18V, I_{LOAD} =3A	88		%

Electrical Characteristics MIK2576-ADJ, MIK2576HV-ADJ

Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range.

Symbol	Parameter	Conditions	MIK2576-ADJ MIK2576HV-ADJ		Units (Limits)
			Typ	**Limit**(Note 2)	
SYSTEM PARAMETERS (Note 3) **Test Circuit** *Figure 2*					
V_{OUT}	Feedback Voltage	V_{IN} =12V, I_{LOAD} =0.5A, V_{OUT} =5V Circuit of *Figure 2*	1.230	 1.217 1.243	V V(Min) V(Max)
V_{OUT}	Feedback Voltage MIK2576	0.5A ≤ I_{LOAD} ≤ 3A , 8V ≤ V_{IN} ≤ 40V V_{OUT} =5V Circuit of *Figure 2*	1.230	 1.193/1.**180** 1.267/1.**280**	V V(Min) V(Max)
V_{OUT}	Feedback Voltage MIK2576HV	0.5A ≤ I_{LOAD} ≤ 3A, 8V ≤ V_{IN} ≤ 60V, V_{OUT} =5V Circuit of *Figure 2*	1.230	 1.193/1.**180** 1.273/1.**286**	V V(Min) V(Max)
η	Efficiency	V_{IN} =12V, I_{LOAD} =3A, V_{OUT} =5V	77		%

All Output Voltage Versions Electrical Characteristics

Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, V_{IN} =12V for the 3.3V, 5V, and Adjustable version, V_{IN} =25V for the 12V version, and V_{IN} =30V for the 15V version, , I_{LOAD} =500mA.

Symbol	Parameter	Conditions	MIK2576-XX MIK2576HV-XX		Units (Limits)
			Typ	**Limit** (Note 2)	
DEVICE PARAMETERS					
I_b	Feedback Bias Current	V_{OUT} =5V (Adjustable Version Only)	50	100/**500**	nA
f_O	Oscillator Frequency	(Note 8)	52	 47/**42** 58/**63**	kHz kHz(Min) kHz(Max)
V_{SAT}	Saturation Voltage	I_{OUT} =3A (Note 4)	1.4	 1.8/**2.0**	V V(Max)
DC	Max Duty Cycle (ON)	(Note 5)	98	 93	% %(Min)
I_{CL}	Current Limit	(Notes 4, 8)	5.8	 4.2/**3.5** 6.9/**7.5**	A A(Min) A(Max)
I_L	Output Leakage Current	(Notes 6, 7): Output = 0V Output = -1V Output = -1V	 7.5	2 30	mA(Max) mA mA(Max)
I_Q	Quiescent Current	(Note 6)	5	 10	mA mA(Max)
I_{STBY}	Standby Quiescent Current	$\overline{\text{ON}}$/OFF Pin = 5V (OFF)	50	 200	μA μA(Max)
$\overline{\text{ON}}$/OFF CONTROL					
V_{IH}	$\overline{\text{ON}}$/OFF Pin Logic Input Level	V_{OUT} = 0V	1.4	2.2/**2.4**	V(Min)
V_{IL}		V_{OUT} = Nominal Output Voltage	1.2	1.0/**0.8**	V(Max)
I_{IH}	$\overline{\text{ON}}$/OFF Pin Input Current	$\overline{\text{ON}}$/OFF Pin = 5V (OFF)	12	 30	μA μA(Max)
I_{IL}		$\overline{\text{ON}}$/OFF Pin = 0V (ON)	0	 10	μA μA(Max)

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Note 2: All limits guaranteed at room temperature (standard type face) and at temperature extremes (**bold type face**).

Note 3: External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the MIK2576/MIK2576HV is used as shown in the *Figure 2* test circuit, system performance will be as shown in system parameters section of Electrical Characteristics.

Note 4: Output pin sourcing current. No diode, inductor or capacitor connected to output.

Note 5: Feedback pin removed from output and connected to 0V.

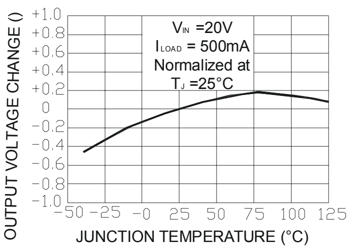
Note 6: Feedback pin removed from output and connected to +12V for the Adjustable, 3.3V, and 5V, versions, and +25V for the 12V and 15V versions, to force the output transistor OFF.

Note 7: V_{IN} =40V (60V for high voltage version).

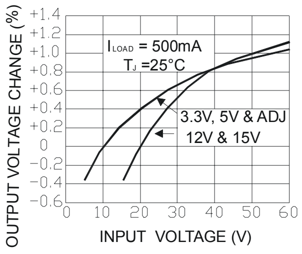
Note 8: The oscillator frequency reduces to approximately 11 kHz in the event of an output short or an overload which causes the regulated output voltage to drop approximately 40% from the nominal output voltage. This self protections feature lowers the average power dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.

Typical Performance Characteristics (Circuit of *Figure 2*)

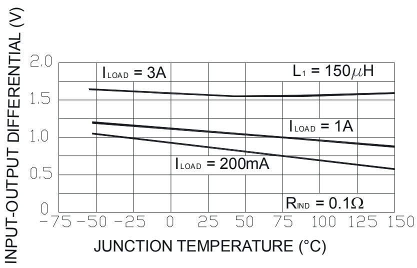
Normalized Output Voltage



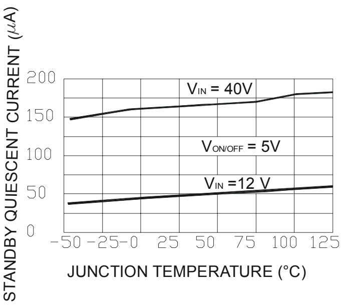
Line Regulation



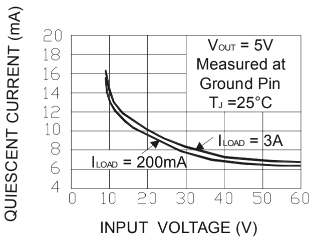
Dropout Voltage



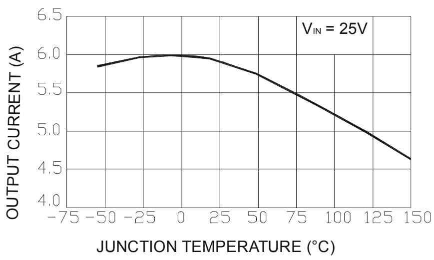
Standby Quiescent Current



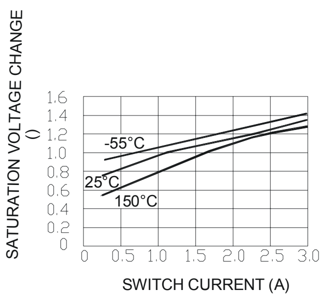
Quiescent Current



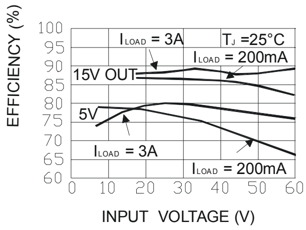
Current Limit



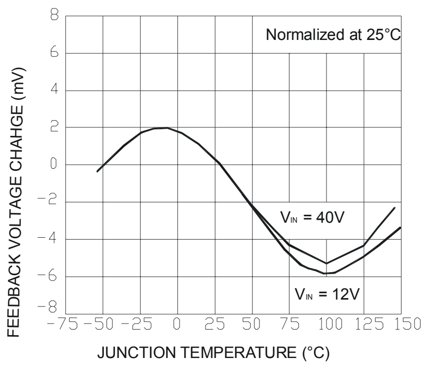
Switch Saturation Voltage



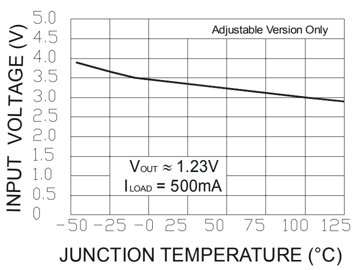
Efficiency



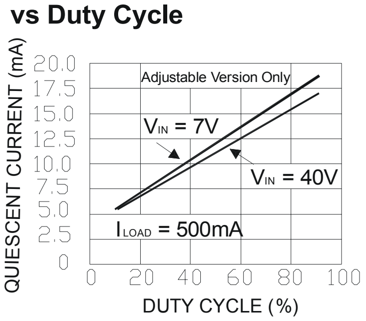
Oscilator Frequency



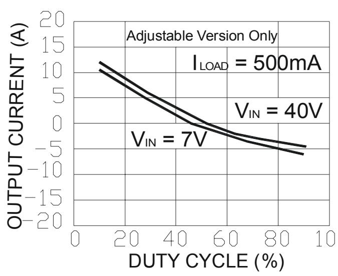
Minimum Operating Voltage



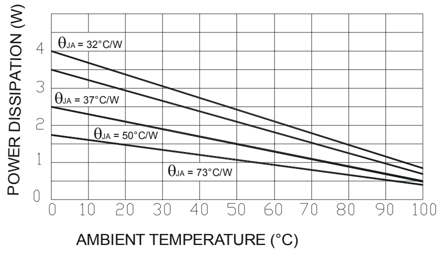
Quiescent Current vs Duty Cycle



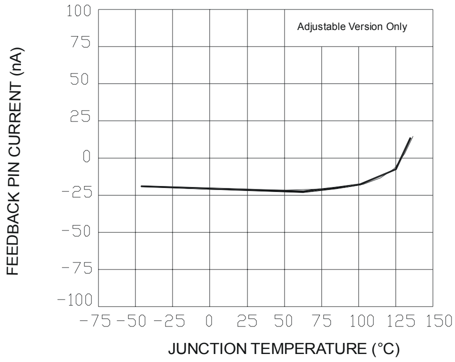
Feedback Voltage vs Duty Cycle



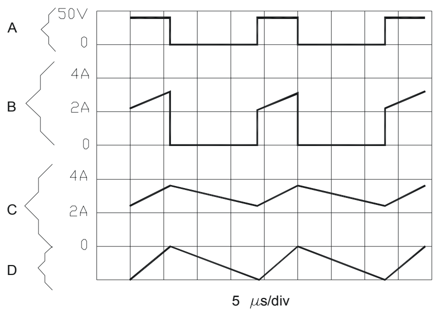
Maximum Power Dissipation (TO-263)



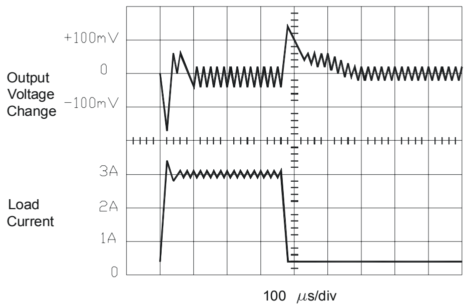
Feedback Pin Current



Switching Waveforms



Load Transient Response



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,

AC-Coupled

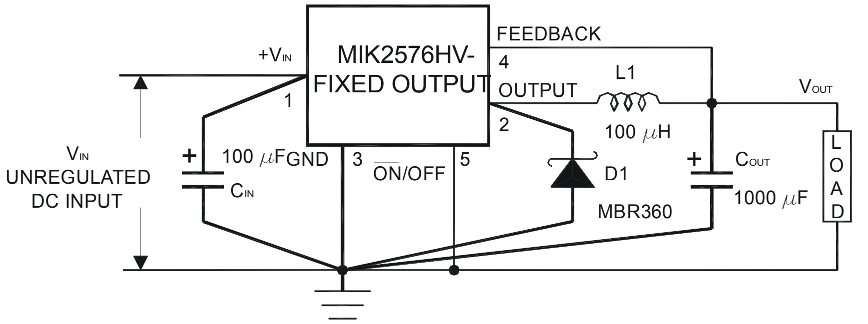
Horizontal Time Base: 5µs/div

Test Circuit and Layout Guidelines

As in any switching regulator, layout is very important. Rapidly switching currents associated with wiring inductance generate voltage transients which can cause problems. For minimal inductance and ground loops, the length of the leads indicated by heavy lines should be kept as short as possible.

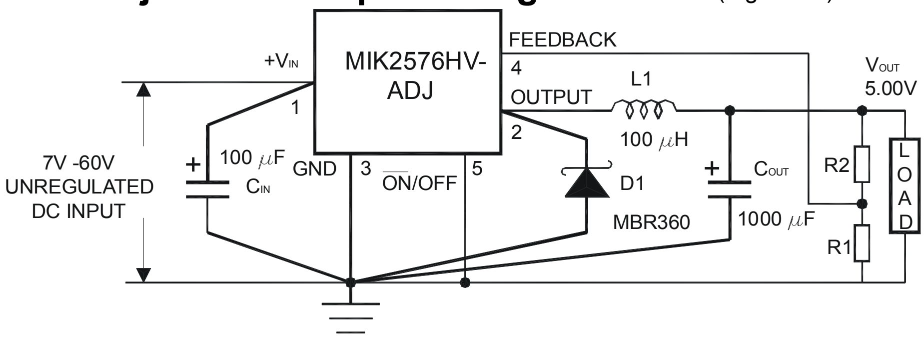
Single-point grounding (as indicated) or ground plane construction should be used for best results. When using the Adjustable version, physically locate the programming resistors near the regulator, to keep the sensitive feedback wiring short.

Fixed Output Voltage Versions (Figure 2a)



C_{IN} — 100µF, 75V, Aluminum Electrolytic
C_{OUT} —1000µF, 25V, Aluminum Electrolytic
D1 — Schottky, MBR360
L_1 — 100µH, Pulse Eng. PE-92108
R_1 — 2k, 0.1%
R_2 — 6.12k, 0.1%

Adjustable Output Voltage Version (Figure 2b)

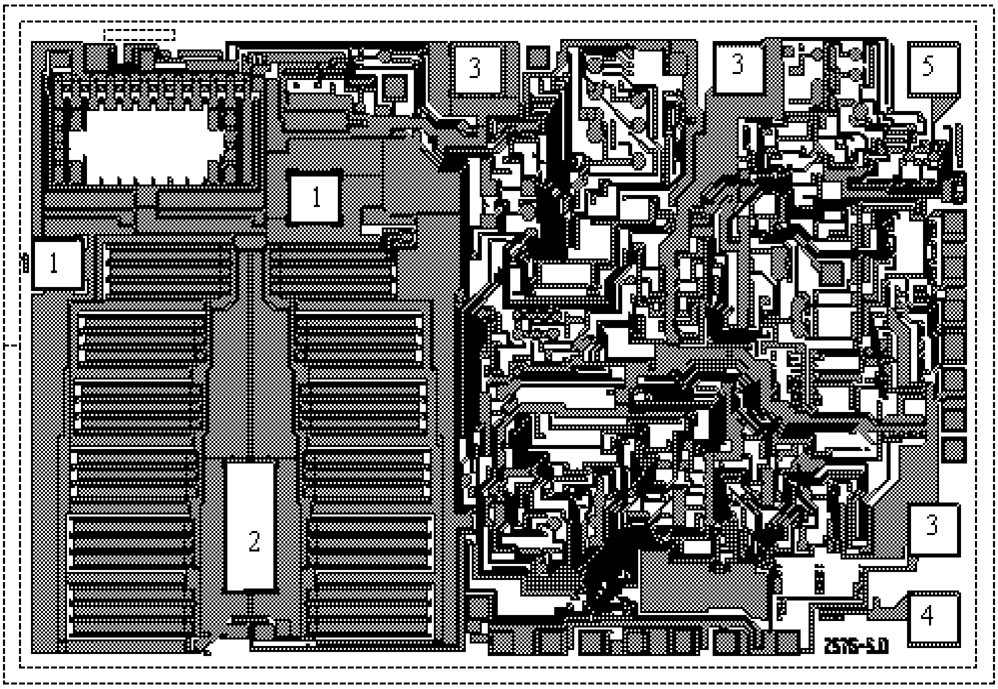


$$V_{OUT} = V_{REF}(1 + \frac{R_2}{R_1})$$

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

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

Pad location MIK2576



Chip Size 3.95x2.65mm

Pad Location Coordinates (the center of pads)

N	Pad size (µm)	Coordinates (µm)	
		X	Y
1	190x190	220.5	1640
1	190x190	1244	1900
2	190x500	985.5	619.5
3	190x190	1893.5	2399
3	190x190	2935	2403
3	190x190	3716.5	603.5
4	190x190	3716.5	254
5	190x190	3716.5	2399