DATA SHEET
12 AUGUST 2003

No. 00015
REV 1-03

REPLACEMENT
of **LM2576**

MIK2576 series

3.0A STEP-DOWN SWITCHING REGULATOR

GENERAL 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.

APPLICATIONS

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

FEATURES

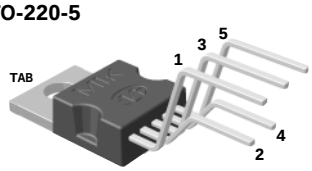
- 3.3V, 5V, 12V, 15V, and adjustable output versions
- Adjustable version output voltage range, 1.23V to 37V ± 4% max over line and load conditions
- Guaranteed 3A output current
- Wide input voltage range, 40V
- Requires only 4 external components
- 52 kHz fixed frequency oscillator
- TTL shutdown capability,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

PIN CONNECTION AND DESCRIPTION

PIN	SYMBOL	DESCRIPTION (REFER TO FIGURE 1)
1	V_{IN}	This pin is the positive input supply for the MIK2576 step-down switching regulator. In order to minimize voltage transients and to supply the switching currents needed by the regulator, a suitable input bypass capacitor must be present (C_{IN} in Figure 1).
2	V_{OUT}	This is the emitter of the internal switch. The saturation voltage V_{SAT} of this output switch is typically 1.5V. 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	Circuit ground pin. To maintain output voltage stability, the power ground connections must be low-impedance (see page 7, Figure 2). Both the TAB and pin 3 are ground and either connection may be used, as they are both part of the same copper lead frame.
4	Feedback	This pin senses regulated output voltage to complete the feedback loop. The signal is divided by the internal resistor divider network R2, R1 and applied to the non-inverting input of the internal error amplifier. In the Adjustable version of the MIK2576 switching regulator this pin is the direct input of the error amplifier and the resistor network R2, R1 is connected externally to allow programming of the output voltage.
5	$\overline{ON}$/OFF	For normal operation, this pin should be grounded or driven with a low-level TTL voltage (typically below 1.6V). To put the regulator into standby mode, drive this pin with a high-level TTL or CMOS signal. This pin can be safely pulled up to $+V_{IN}$ without a resistor in series with it. This pin should not be left open.

MIK2576**T**, MIK2576**T**-xx

TO-220-5



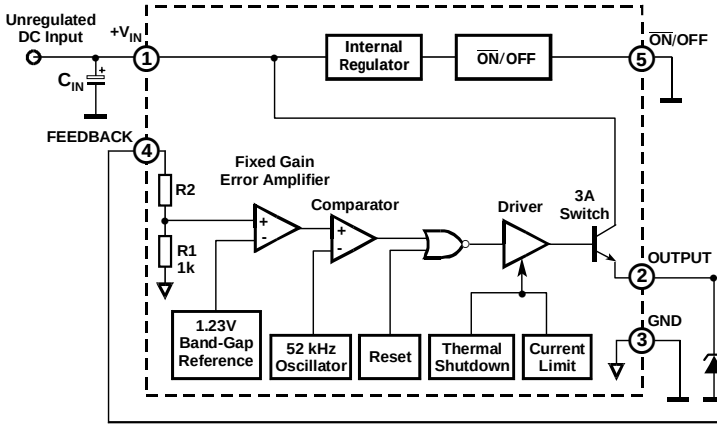
TAB — ADJ/GND
1 — V_{IN}
2 — V_{OUT}
3 — ADJ/GND
4 — FEEDBACK
5 — ON/OFF

MIK2576**S**, MIK2576**S**-xx

TO-263-5

TAB — ADJ/GND
1 — V_{IN}
2 — V_{OUT}
3 — ADJ/GND
4 — FEEDBACK
5 — ON/OFF

BLOCK DIAGRAM AND TYPICAL APPLICATION



OUTPUT VOLTAGE VERSION	R2 (kΩ)
3.3	1.70
5.0	3.10
12.0	8.84
15.0	11.30
FOR ADJUSTABLE VERSION R1= open, R2= 0 Ω	

Figure 1

ABSOLUTE MAXIMUM RATINGS

PARAMETER	MAXIMUM	UNIT
Maximum Supply Voltage	45	V
$\overline{ON}$/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

NOTE:
Stresses above 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 above those indicated in the operation sections of the specifications is not implied.

Exposure to Absolute Maximum Rating conditions for extended periods may affect device reliability.

OPERATING RATINGS

PARAMETER	VALUE	UNIT
Temperature Range	$-40 \le T_J \le +125$	°C
Supply Voltage	40	V

ELECTRICAL CHARACTERISTICS (TEST CIRCUIT OF FIGURE 2, PAGE 7), NOTE 1

MIK2576-**3.3**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage	V_{IN} = 12V, I_{LOAD} = 0.5A, T_J = 25°C	3.234	3.3	3.366	V
V_{OUT}	Output Voltage	6.0V ≤ V_{IN} ≤ 40V, 0.5A ≤ I_{LOAD} ≤ 3.0A				V
		T_J = 25°C	3.168	3.3	3.432	
		T_J = -40 to 125°C	3.135	—	3.465	
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 3.0A	—	75	—	%

MIK2576-**5.0**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage	V_{IN} = 12V, I_{LOAD} = 0.5A, T_J = 25°C	4.90	5.0	5.10	V
V_{OUT}	Output Voltage	8.0V ≤ V_{IN} ≤ 40V, 0.5A ≤ I_{LOAD} ≤ 3.0A				V
		T_J = 25°C	4.80	5.0	5.20	
		T_J = -40 to 125°C	4.75	—	5.25	
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 3.0A	—	77	—	%

MIK2576-**12**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage	V_{IN} = 25V, I_{LOAD} = 0.5A, T_J = 25°C	11.76	12	12.24	V
V_{OUT}	Output Voltage	15V ≤ V_{IN} ≤ 40V, 0.5A ≤ I_{LOAD} ≤ 3.0A				V
		T_J = 25°C	11.52	12	12.48	
		T_J = -40 to 125°C	11.40	—	12.60	
η	Efficiency	V_{IN} = 15V, I_{LOAD} = 3.0A	—	88	—	%

MIK2576-**15**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Output Voltage	V_{IN} = 25V, I_{LOAD} = 0.5A, T_J = 25°C	14.70	15	15.30	V
V_{OUT}	Output Voltage	18V ≤ V_{IN} ≤ 40V, 0.5A ≤ I_{LOAD} ≤ 3.0A				V
		T_J = 25°C	14.40	15	15.60	
		T_J = -40 to 125°C	14.25	—	15.75	
η	Efficiency	V_{IN} = 18V, I_{LOAD} = 3.0A	—	88	—	%

MIK2576 **adjustable**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
V_{OUT}	Feedback Voltage	V_{IN} = 12V, I_{LOAD} = 0.5A, V_{OUT} = 5.0V, T_J = 25°C	1.217	1.23	1.243	V
V_{OUT}	Feedback Voltage	6.0V ≤ V_{IN} ≤ 40V, 0.5A ≤ I_{LOAD} ≤ 3.0A				V
		T_J = 25°C	1.193	1.23	1.267	
		T_J = -40 to 125°C	1.180	—	1.280	
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 3.0A, V_{OUT} = 5.0V	—	77	—	%

Note 1: External components such as the catch diode, inductor, input and output capacitors can affect switching regulator system performance. When the MIK2576 is used as shown in the Figure 15 test circuit, system performance will be as shown in system parameters section.

ELECTRICAL CHARACTERISTICS (TEST CIRCUIT OF FIGURE 2, PAGE 7 , CONTINUED)

(Unless otherwise specified, V_{IN} = 12V for the 3.3V, 5.0V, and Adjustable version, V_{IN} = 25V for the 12V version, and V_{IN} = 30V for the 15V version. I_{LOAD} = 500 mA. For typical values T_J = 25°C, for min/max values T_J is the operating junction temperature range that applies [Note 2], unless otherwise noted.)

ALL OUTPUT VOLTAGE VERSIONS

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
DEVICE PARAMETERS						
I_B	Feedback Bias Current	V_{OUT} =5V (Adjustable Version Only) T_J = 25ºC T_J = -40ºC to +125ºC	— —	50 —	100 500	nA
F_{OSC}	Oscillator Frequency	T_J = 25ºC (Note 3) T_J = 0ºC to +125ºC T_J = -40ºC to +125ºC	— 47 42	52 — —	— 58 63	kHz
V_{SAT}	Saturation Voltage	I_{OUT} =3A (Note 4) T_J = 25ºC T_J = -40ºC to +125ºC	— —	1.4 —	1.8 2.0	V
DC	Max Duty Cycle (ON)	(Note 5)	93	98	—	%
I_{CL}	Current Limit	(Notes 3, 4) T_J = 25ºC T_J = -40ºC to +125ºC	4.2 3.5	5.8 —	6.9 7.5	A
I_L	Output Leakage Current	T_J = 25ºC (Notes 6, 7), Output = 0V Output = -1V	— —	0.8 7.5	2.0 30	mA
I_Q	Quiescent Current	(Note 6) T_J = 25ºC	—	5.0	10.0	mA
I_{STBY}	Standby Quiescent Current	$\overline{ON}$/OFF Pin = 5V (OFF) T_J = 25ºC	—	50	200	μA
$\overline{ON}$/OFF CONTROL						
V_{IH}	$\overline{ON}$/OFF Pin Logic Input Level	V_{OUT} = 0V T_J = 25ºC T_J = -40ºC to +125ºC	2.2 2.4	1.4 —	— —	V
V_{IL}		V_{OUT} = Nominal Output Voltage T_J = 25ºC T_J = -40ºC to +125ºC	— —	1.2 —	1.0 0.8	V
I_{IH}	$\overline{ON}$/OFF Pin Input Current	$\overline{ON}$/OFF Pin = 5V (OFF), T_J = 25ºC	—	12	30	μA
I_{IL}		$\overline{ON}$/OFF Pin = 0V (ON), T_J = 25ºC	—	0	10	

Note 2 Tested junction temperature range for the MIK2576: T_{LOW} = -40°C T_{HIGH} = +125°C

Note 3 The oscillator frequency reduces to approximately 18 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 dissipation of the IC by lowering the minimum duty cycle from 5% down to approximately 2%.

Note 4 Output (Pin 2) sourcing current. No diode, inductor or capacitor connected to output pin.

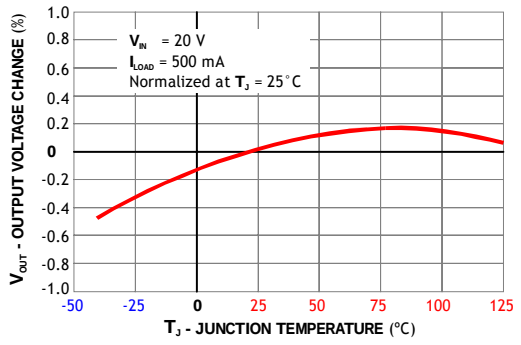
Note 5 Feedback (Pin 4) removed from output and connected to 0 V.

Note 6 Feedback (Pin 4) removed from output and connected to +12V for the Adjustable, 3.3V, and 5.0V versions, and +25V for the 12V and 15V versions, to force the output transistor «OFF».

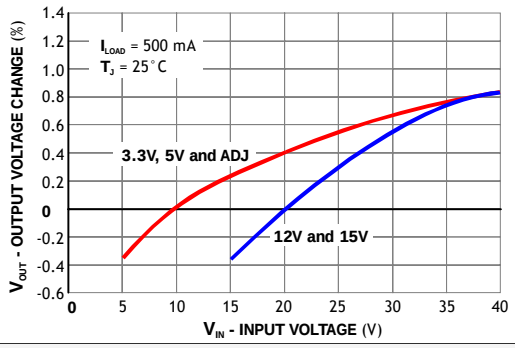
Note 7 V_{IN} = 40 V.

TYPICAL CHARACTERISTICS

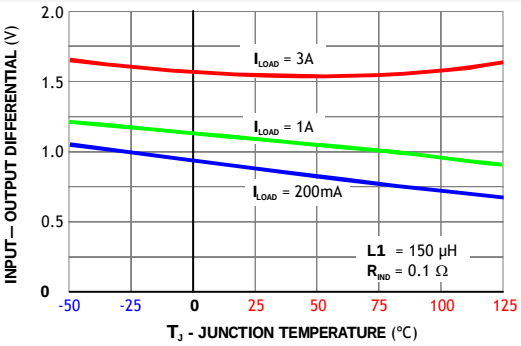
NORMALIZED OUTPUT VOLTAGE



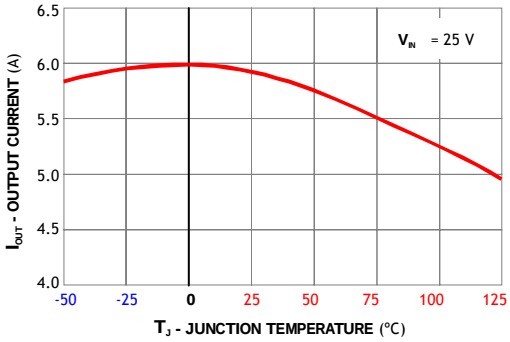
LINE REGULATION



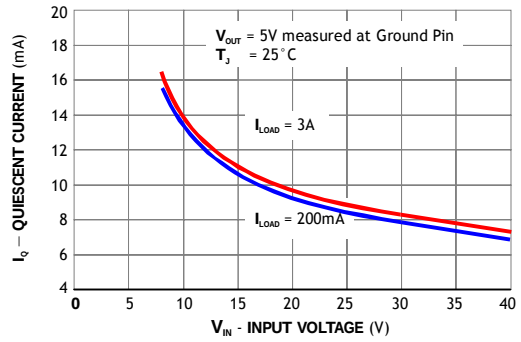
DROPOUT VOLTAGE



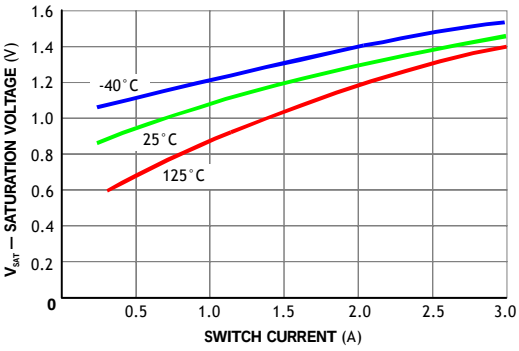
CURRENT LIMIT



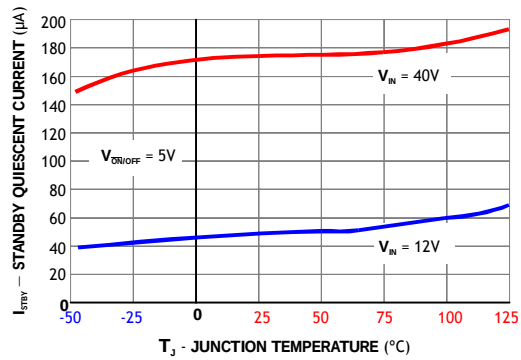
QUIESCENT CURRENT



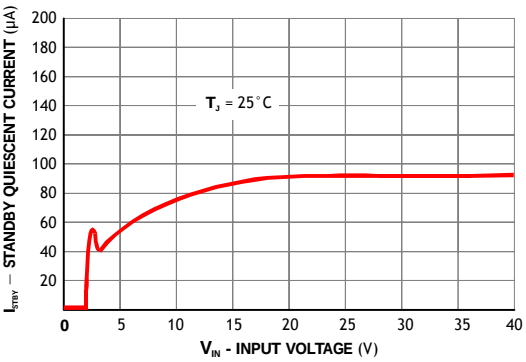
SWITCH SATURATION VOLTAGE



STANDBY QUIESCENT CURRENT (1)

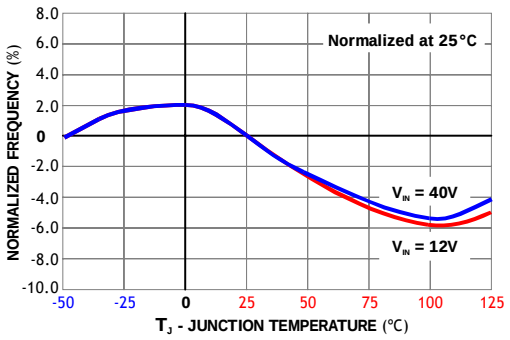


STANDBY QUIESCENT CURRENT (2)

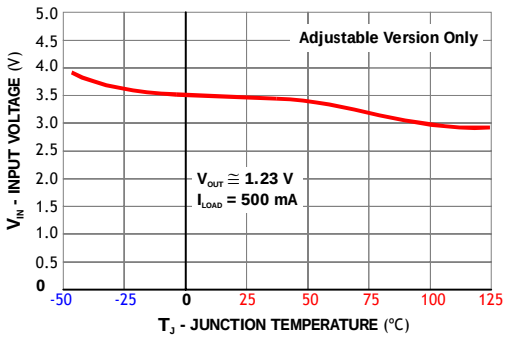


TYPICAL CHARACTERISTICS (CONTINUED)

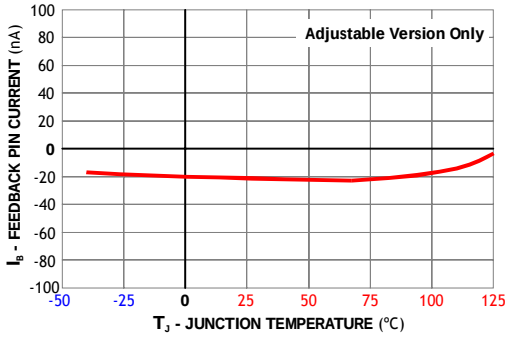
OSCILLATOR FREQUENCY



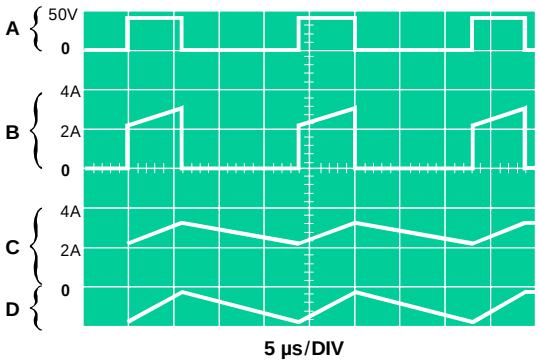
MINIMUM OPERATING VOLTAGE



FEEDBACK PIN CURRENT



SWITCHING WAVEFORMS

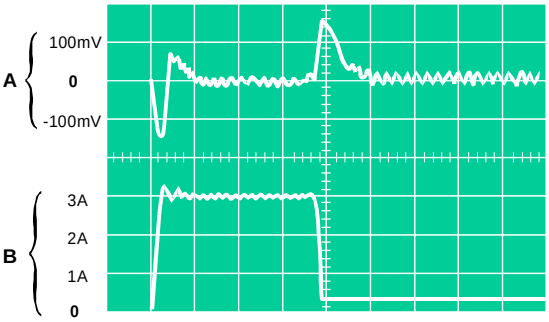


5 µs/DIV

A: Output Pin Voltage, 10V/DIV
B: Inductor Current, 2.0A/DIV
C: Inductor Current, 2.0A/DIV, AC-Coupled
D: Output Ripple Voltage, 50 mV/dDIV, AC-Coupled

V_{OUT} = 15 V
Horizontal Time Base: 5.0 ms/DIV

LOAD TRANSIENT RESPONSE



100 µs/DIV

A: Output Voltage Change
B: Load Current

TYPICAL TEST CIRCUIT

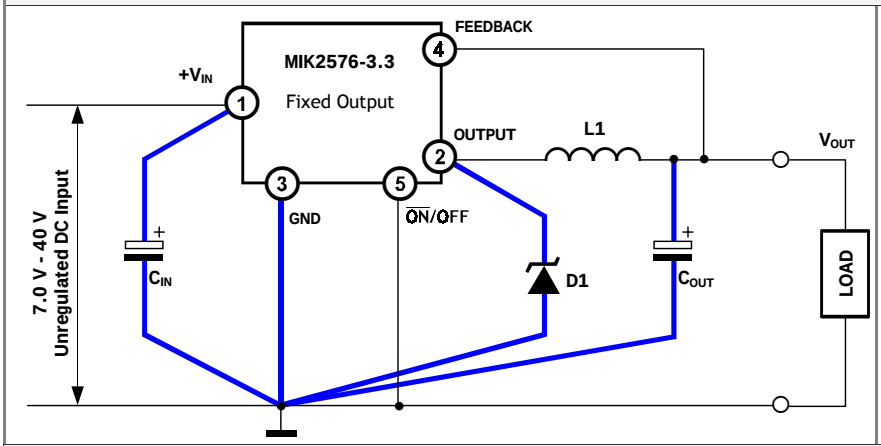
As in any switching regulator, the layout of the printed circuit board (PCB) is very important. Rapidly switching currents associated with wiring inductance, stray capacitance and parasitic inductance of the printed circuit board traces can generate voltage transients which can generate electromagnetic interferences (EMI) and affect the desired operation. As indicated in the Figure 2, 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.

On the other hand, the PCB area connected to the Pin 2 (emitter of the internal switch) of the MIK2576 should be kept to a minimum in order to minimize coupling to sensitive circuitry.

Another sensitive part of the circuit is the feedback. It is important to keep the sensitive feedback wiring short. To assure this, physically locate the programming resistors near to the regulator, when using the adjustable version of the MIK2576 regulator.

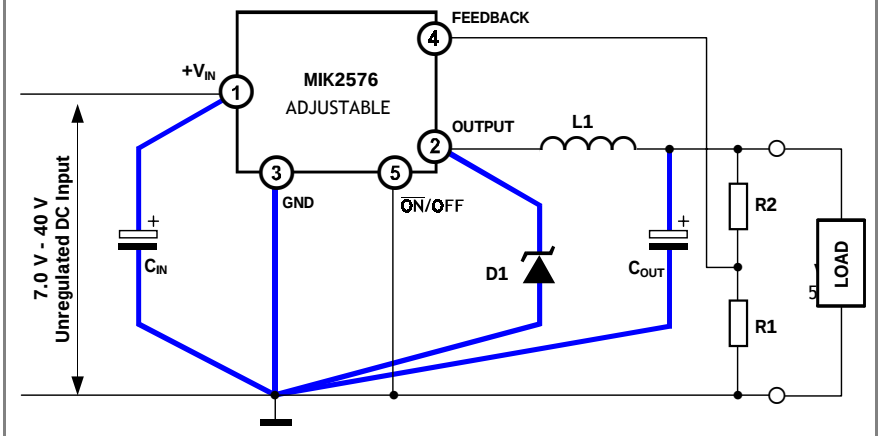
FIXED OUTPUT VOLTAGE VERSIONS



CIN – 100 µF, 75V, Aluminium Electrolytic
COUT – 1000 µF, 25 V, Aluminium Electrolytic
D1 – Schottky, MBR360

L1 – 100 µH, Pulse Eng. PE-92108

ADJUSTABLE OUTPUT VOLTAGE VERSIONS



CIN – 100 µF, 75V, Aluminium Electrolytic
COUT – 1000 µF, 25 V, Aluminium Electrolytic
D1 – Schottky, MBR360

L1 – 100 µH, Pulse Eng. PE-92108
R1 – 2.0 k, 0.1%

R2 – 6.12 k, 0.1%

$$V_{OUT} = V_{REF}\left(1 + \frac{R2}{R1}\right)$$

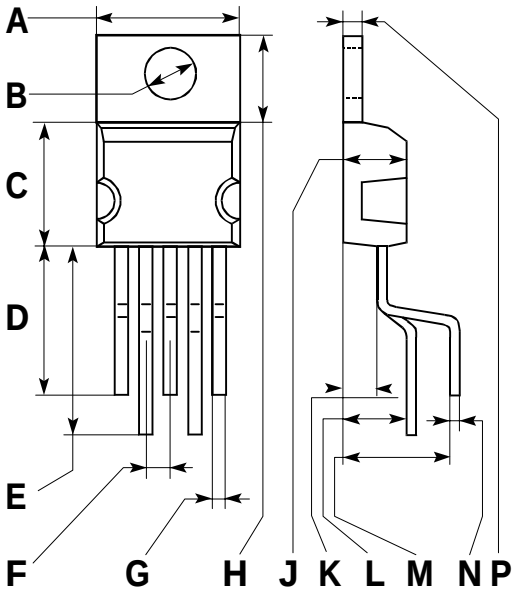
$$R2 = R1\left(\frac{V_{OUT}}{V_{REF}} - 1\right)$$

where V_{REF} = 1.23V, **R1** between 1.0k and 5.0k

Figure 2

PHYSICAL DIMENSIONS AND MARKING DIAGRAMS

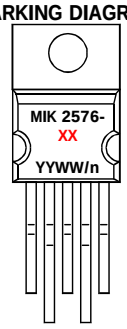
TO-220-5 PACKAGE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	10.01	10.31	0.394	0.406
B	3.79	3.89	0.149	0.153
C	8.90	9.30	0.350	0.366
D	8.95	9.25	0.352	0.364
E	9.75	10.05	0.384	0.395
F	1.70 TYP		0.220 TYP	
G	0.71	0.91	0.028	0.036
H	6.15	6.45	0.240	0.250
J	4.47	4.67	0.176	0.184
K	2.52	2.82	0.099	0.111
L	4.25	4.55	0.167	0.179
M	8.25	8.55	0.325	0.337
N	0.31	0.53	0.012	0.021
P	1.17	1.37	0.046	0.054

TO-220-5

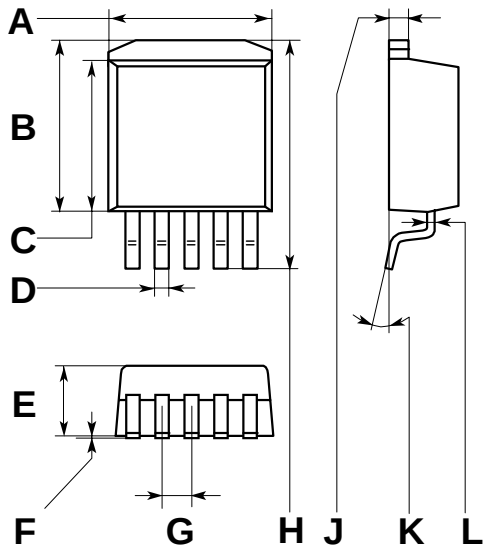
MARKING DIAGRAM



XX – output voltage (see table below)
YY – Year
WW – Work Week
n – assembly location

XX	OUTPUT VOLTAGE
33	3.3 V
5	5.0 V
12	12.0 V
15	15.0 V
Blank	Adjustable

TO-263-5 PACKAGE



DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.88	10.18	0.389	0.401
B	9.76	10.36	0.384	0.408
C	8.20	8.60	0.323	0.339
D	0.71	0.91	0.028	0.036
E	4.47	4.67	0.176	0.184
F	0.00	0.15	0.000	0.006
G	1.70 TYP		0.067 TYP	
H	15.14	15.54	0.596	0.612
J	1.17	1.37	0.046	0.054
K	0°	7°	0°	7°
L	0.31	0.53	0.012	0.021

TO-263-5

MARKING DIAGRAM

XX – output voltage (see table below)
Y – Year
WW – Work Week
n – assembly location

XX	OUTPUT VOLTAGE
33	3.3 V
5	5.0 V
12	12.0 V
15	15.0 V
Blank	Adjustable

ORDERING INFORMATION (THE FORM OF PACKING IS STIPULATED IN THE CONTRACT)

ORDERING NUMBER	OUTPUT VOLTAGE (V)	TEMPERATURE RANGE *	PACKAGE	SHIPPING
MIK 2576 **T**	Adjustable	T_J = 0°C ÷ 70°C	TO-220-5	50 units/Rail __ 800 units/Reel
MIK 2576- 3.3 **T**	3.3		TO-220-5	50 units/Rail __ 800 units/Reel
MIK 2576- 5.0 **T**	5.0		TO-220-5	50 units/Rail __ 800 units/Reel
MIK 2576-12.0 **T**	12.0		TO-220-5	50 units/Rail __ 800 units/Reel
MIK 2576-15.0 **T**	15.0		TO-220-5	50 units/Rail __ 800 units/Reel
MIK 2576 **S**	Adjustable		TO-263-5	50 units/Rail __ 800 units/Reel
MIK 2576- 3.3 **S**	3.3		TO-263-5	50 units/Rail __ 800 units/Reel
MIK 2576- 5.0 **S**	5.0		TO-263-5	50 units/Rail __ 800 units/Reel
MIK 2576-12.0 **S**	12.0		TO-263-5	50 units/Rail __ 800 units/Reel
MIK 2576-15.0 **S**	15.0		TO-263-5	50 units/Rail __ 800 units/Reel

***** Junction temperatures

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