2HV76K/3HV76K SIMPLE SWITCHER 2A/ 3A Step-Down Voltage Regulator

April 2009-revised June 2011

GENERAL DESCRIPTION

The 2HV76K/3HV76K 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 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 2HV76K/3HV76K 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 2HV76K/3HV76K 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.

FEATURES

- 3.3V, 5V, 12V, 15V and adjustable output versions
- Adjustable version output voltage range, 1.23V to 57V ± 4% max over line and load conditions
- Guaranteed 3A output current
- Wide input voltage range, 60V
- 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)

PIN ASSIGNMENT

TO-220, TO-263 :	SOP-8L
(for lload ≤ 3 A)	(for lload ≤ 2 A)
1-Vin	1- Vin
2-OUTPUT	2- OUTPUT
3-GND	3-FB
4-FB	4-ON/OFF
5-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.

TYPICAL APPLICATION (Fixed Output Voltage Versions)

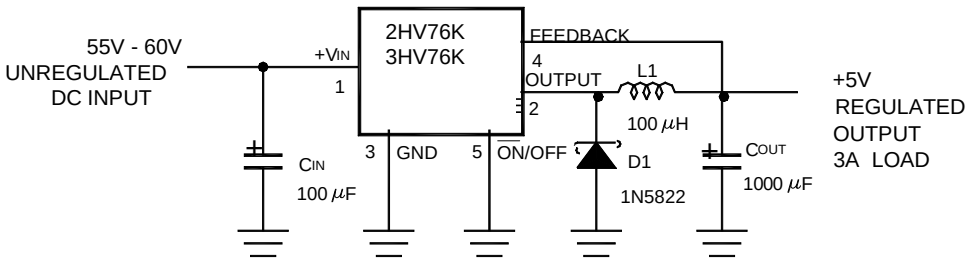
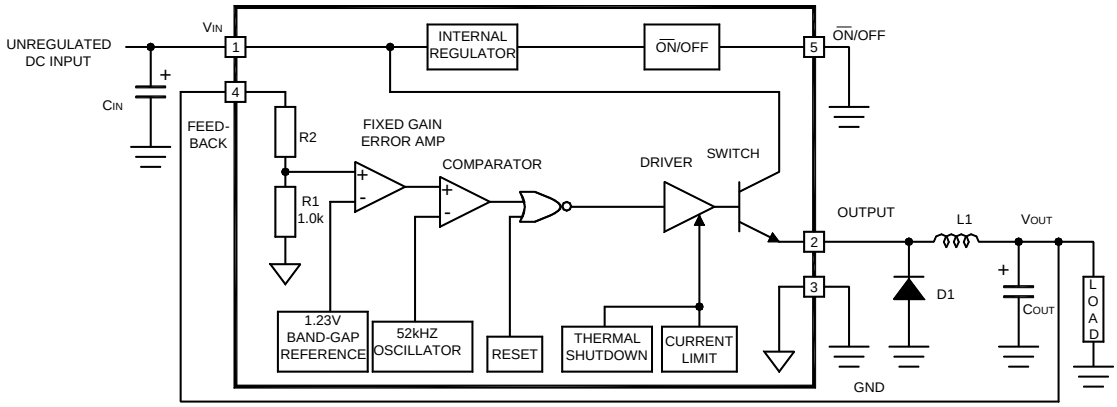


FIGURE 1.

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				
	3.3	**5.0**	**12**	**15**	**ADJ**
-40°C ≤ T_A≤ 125°C	2HV76K-3.3 3HV76K-3.3	2HV76K-5.0 3HV76K-5.0	2HV76K-12 3HV76K-12	2HV76K-15 3HV76K-15	2HV76K-ADJ 3HV76K-ADJ

Absolute Maximum Ratings (Note 1)

Minimum ESD Rating	2kV
(C= 100pF, R = 1.5 kΩ)	
Lead Temperature (Soldering, 10 Seconds)	260°C

Maximum Supply Voltage

2HV76K /3HV76K	63V
$\overline{ON}$/OFF Pin Input Voltage	$-0.3V \le V \le +V_{IN}$
Output Voltage to Ground (Steady State)	-0.75V
Power Dissipation	Internally Limited
Storage Temperature Range	-65°C to +150°C
Maximum Junction Temperature	150°C

Operating Ratings

Temperature Range

2HV76K / 3HV76K	$-40°C \le T_J \le +125°C$

Supply Voltage

2HV76K / 3HV76K	60V

2HV76K-3.3 /3HV76K-3.3

Electrical Characteristics

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	Typ	Limit (Note 2)	Units (Limits)
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 3HV76K	$6V \le V_{IN} \le 60V$, $0.5A \le I_{LOAD} \le 3A$ Circuit of *Figure 2*	3.3	3.168/**3.135** 3.450/**3.482**	V V(Min) V(Max)
V_{OUT}	Output Voltage 2HV76K	$5.5V \le V_{IN} \le 60V$, $0.5A \le I_{LOAD} \le 2A$ 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 (3HV76K) I_{LOAD} =2A (2HV76K)	75		%

2HV76K-5.0/3HV76K-5.0
Electrical Characteristics

Specifications with standard type face are for T_J = 25°C, and those with *Figure 2* **boldface type** apply over full Operating Temperature Range.

Symbol	Parameter	Conditions	Typ	Limit (Note 2)	Units (Limits)
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 3HV76K	$0.5A \le I_{LOAD} \le 3A$, $8V \le V_{IN} \le 60V$	5.0	4.800/**4.750** 5.225/**5.275**	V V(Min) V(Max)

		Circuit of *Figure 2*			
V_{OUT}	Output Voltage 2HV76K	$0.5A \le I_{LOAD} \le 2A$, $7.5V \le V_{IN} \le 60V$ 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 (3HV76K) I_{LOAD} =2A (2HV76K)	77		%

2HV76K-12 / 3HV76K-12

Electrical Characteristics

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	Typ	Limit (Note 2)	Units (Limits)
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 3HV76K	$0.5A \le I_{LOAD} \le 3A$, $15V \le V_{IN} \le 60V$ Circuit of *Figure 2*	12	11.52/**11.40** 12.54/**12.66**	V V(Min) V(Max)
V_{OUT}	Output Voltage 2HV76K	$0.5A \le I_{LOAD} \le 2A$, $14.5V \le V_{IN} \le 60V$ 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 (3HV76K) I_{LOAD} =2A (2HV76K)	88		%

2HV76K-15 / 3HV76K-15

Electrical Characteristics

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	Typ	Limit (Note 2)	Units (Limits)
SYSTEM PARAMETERS (Note 3) **Test Circuit** *Figure 2*					
V_{OUT}	Output Voltage	V_{IN} =25V, I_{LOAD} =0.5A Circuit of *Figure 2*	15	14.70 15.30	V V(Min) V(Max)
V_{OUT}	Output Voltage 3HV76K	$0.5A \le I_{LOAD} \le 3A$, $18V \le V_{IN} \le 60V$ Circuit of *Figure 2*	15	14.40/**14.25** 15.68/**15.83**	V V(Min) V(Max)
V_{OUT}	Output Voltage 2HV76K	$0.5A \le I_{LOAD} \le 2A$, $17.5V \le V_{IN} \le 60V$ 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 (3HV76K) I_{LOAD} =2A (2HV76K)	88		%

2HV76K-ADJ /3HV76K-ADJ

Electrical Characteristics

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	Typ	Limit (Note 2)	Units (Limits)
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 3HV76K	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)
V_{OUT}	Feedback Voltage 2HV76K	0.5A ≤ I_{LOAD} ≤ 2A , 7.5V ≤ 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 (3HV76K), I_{LOAD} =2A (2HV76K) 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		2HV76K/3HV76K		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 3HV76K	I_{OUT} =3A (Note 4)		1.4	1.55/1**.70**	V V(Max)
V_{SAT}	Saturation Voltage 2HV76K	I_{OUT} =2A (Note 4)		1.2	1.35/1**.45**	V V(Max)
DC	Max Duty Cycle (ON)	(Note 5)		98	93	% %(Min)
I_{CL}	Current Limit	3HV76K		5.8	4.2/**3.5** 6.9/**7.5**	A A(Min) A(Max)
I_{CL}	Current Limit	2HV76K		3.4	2.5/2.3 4.6/4.9	A
I_L	Output Leakage Current	(Notes 6, 7): Output = 0V Output = -0.75V Output = -0.75V		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	ON/OFF Pin = 5V (OFF)	Vin= 60V	50	200	μA μA(Max)

All Output Voltage Versions

Electrical Characteristics (Continued)

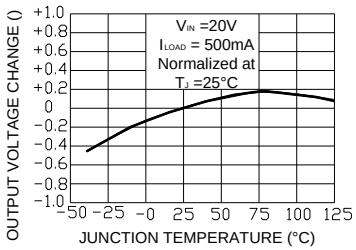
Specifications with standard type face are for T_J = 25°C, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, V_{IN} =12V for the 3.3V, 5V, and Adjustable version, V_{IN} =25V for the 12V version, and V_{IN} =30V for the 15V version, I_{LOAD} =500mA.

Symbol	Parameter	Conditions	2HV76K/3HV76K		Units (Limits)
			Typ	Limit (Note 2)	
$\overline{ON}$/OFF CONTROL					
V_{IH}	$\overline{ON}$/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}	$\overline{ON}$/OFF Pin Input Current	$\overline{ON}$/OFF Pin = 5V (OFF)	12	30	μA μA(Max)
I_{IL}		$\overline{ON}$/OFF Pin = 0V (ON)	0	10	μA μA(Max)

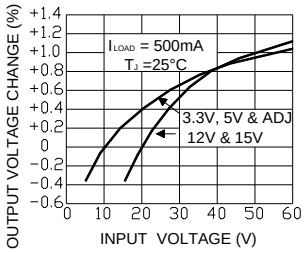
Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but do not guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical 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 2HV76K/3HV76K 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} =60V.
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*)

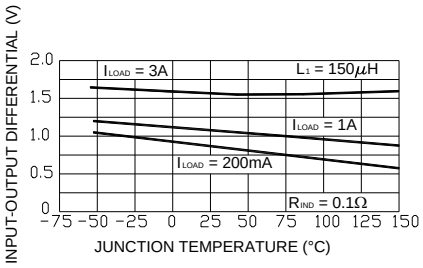
Normalized Output Voltage



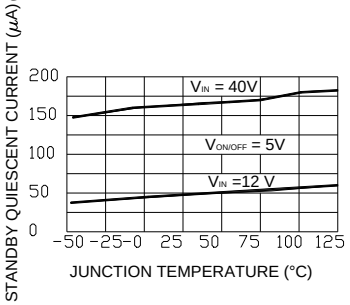
Line Regulation



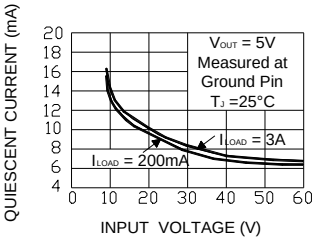
Dropout Voltage



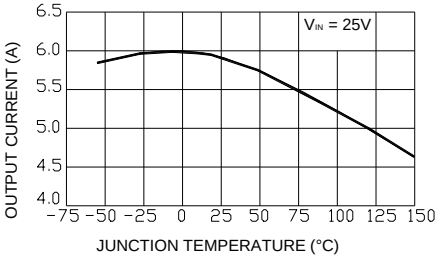
Standby Quiescent Current



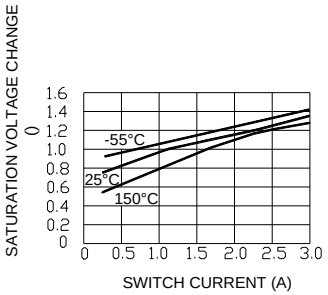
Quiescent Current



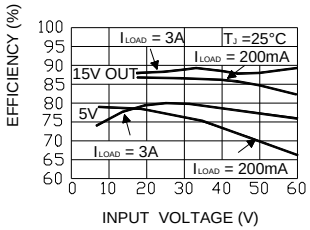
Current Limit



Switch Saturation Voltage

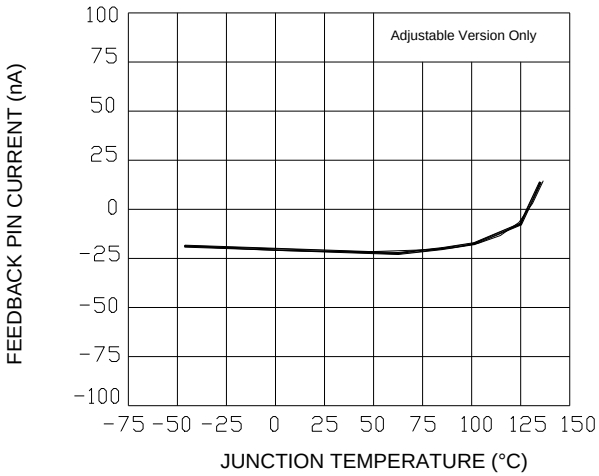


Efficiency



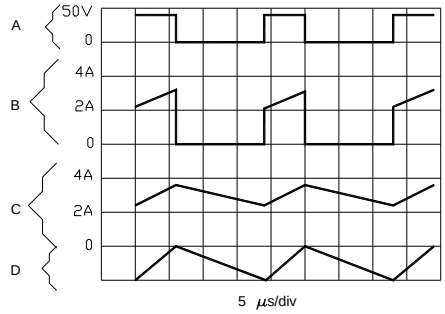
Typical Performance Characteristics (Circuit of *Figure 2*) (Continued)

Feedback Pin Current

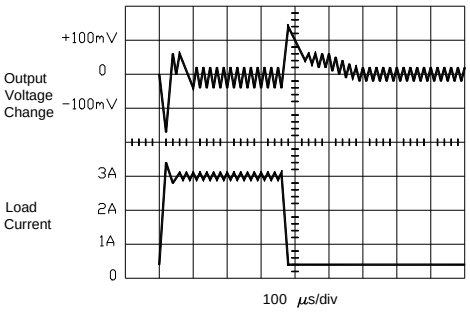


Typical Performance Characteristics (Circuit of *Figure 2*) (Continued)

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

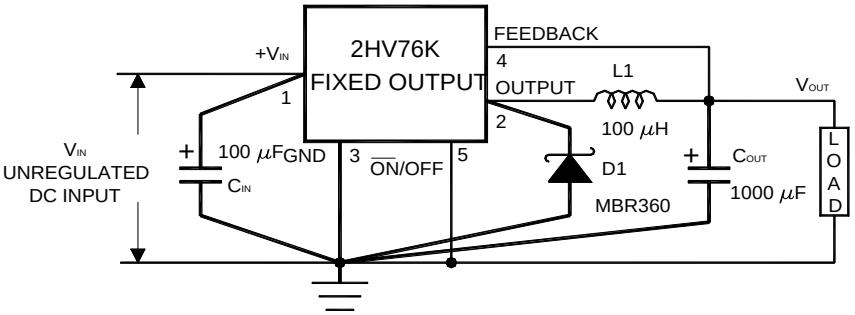
Horizontal Time Base: 5μs/div

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.

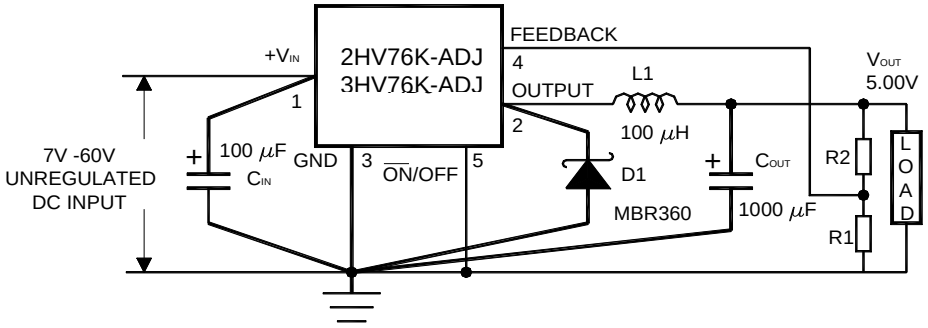
Single-point grounding (as indicated) or ground plane construction should be used for best results. When using the Adjustable version, physically locate the programming resistors near the regulator, to keep the sensitive feedback wiring short.

Fixed Output Voltage Versions



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



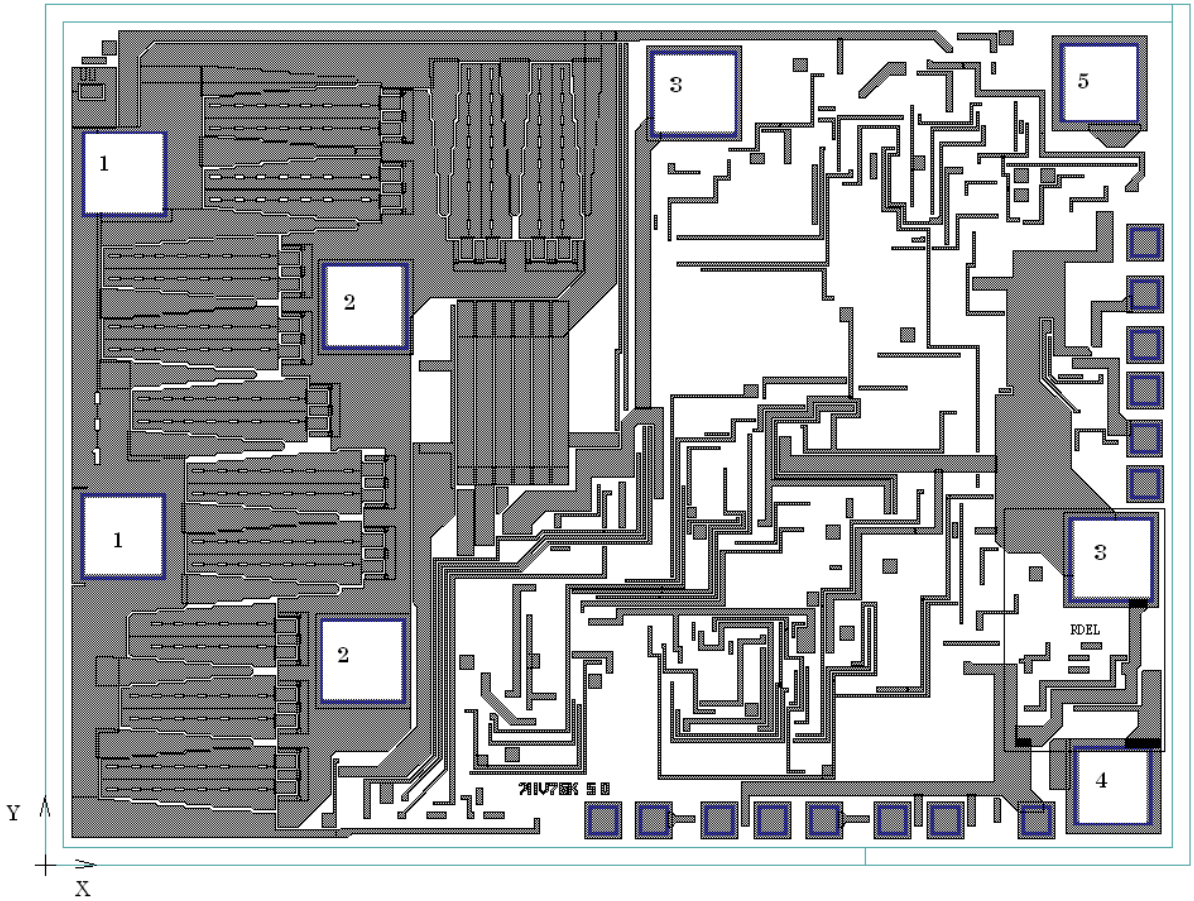
$$V_{OUT} = V_{REF}(1 + \frac{R_2}{R_1})$$

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

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

FIGURE 2.

PAD LOCATION



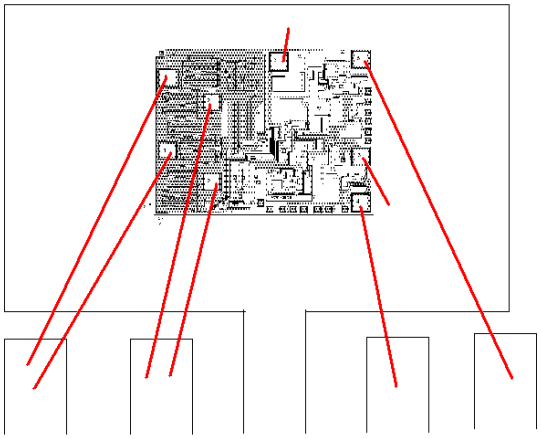
2HV76K/3HV76K

Chip Size: 2.54 x 1.91 mm^2

PAD LOCATION COORDINATES

Pad N	Coordinates (um)		PAD size (um*um)
	X	Y	
1	172	730	190*190
1	175	1533	190*190
2	705	453	190*190
2	710	1240	190*190
3	1439	1711	190*190
3	2365	677	190*190
4	2369	175	175*175
5	2338	1735	175*175

BONDING DIAGRAM

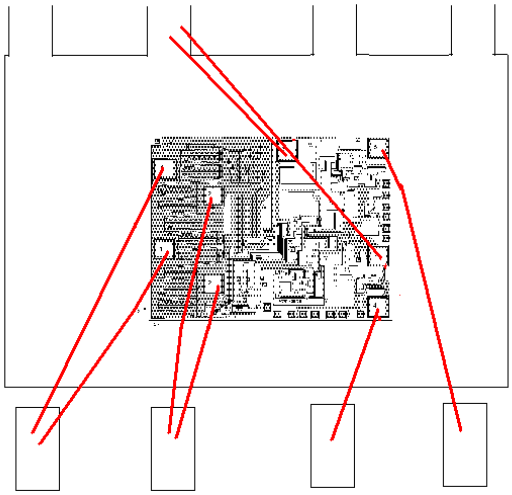


2HV76K/3HV76K

Chip Size: 2.54 x 1.91 mm^2

Package: TO-220: TO-263

The wire diameters 75um



2HV76K/3HV76K (for $I_{LOAD} \leq 2A$)

Package: SO-8

The wire diameters 50um

The appearance complies with the requirements of the company standards.