



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 $\pm 4\%$ tolerance on output voltage within specified input voltages and output load conditions, and $\pm 10\%$ on the oscillator frequency. External shutdown is included, featuring 50 μ A (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 $\pm 4\%$ 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 $I_{load} \leq 3\text{ A}$)	(for $I_{load} \leq 2\text{ A}$)
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)

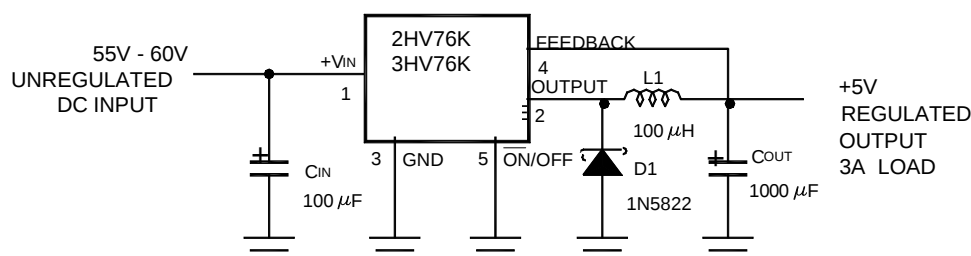
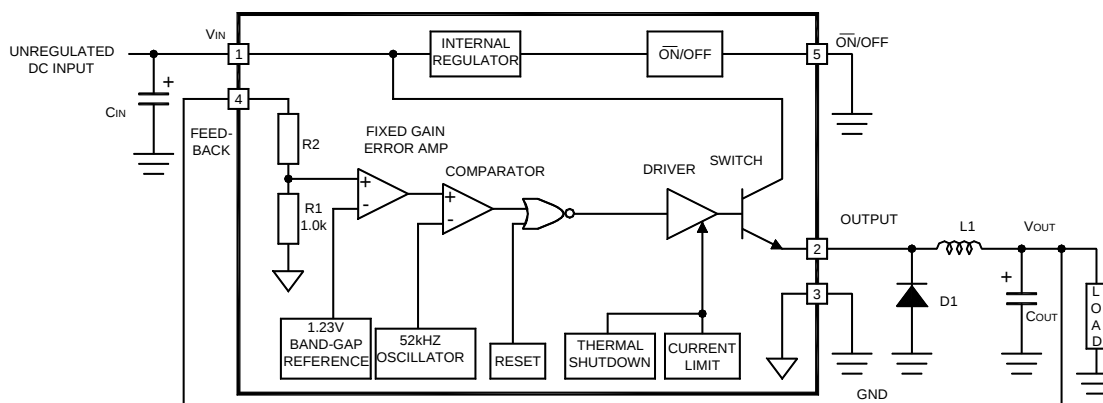


FIGURE 1.



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	2HV76K-5.0	2HV76K-12	2HV76K-15	2HV76K-ADJ
	3HV76K-3.3	3HV76K-5.0	3HV76K-12	3HV76K-15	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

Operating Ratings

2HV76K /3HV76K

63V

Temperature Range

ON/OFF Pin Input Voltage

 $-0.3V \leq V \leq +V_{IN}$

2HV76K / 3HV76K

 $-40^{\circ}C \leq T_J \leq +125^{\circ}C$

Output Voltage to Ground

-0.75V

Supply Voltage

60V

(Steady State)

Power Dissipation

Internally Limited

Storage Temperature Range

 $-65^{\circ}C$ to $+150^{\circ}C$

Maximum Junction Temperature

150°C

2HV76K-3.3 /3HV76K-3.3**Electrical Characteristics**

Specifications with standard type face are for $T_J = 25^{\circ}C$, 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	$6V \leq V_{IN} \leq 60V$, $0.5A \leq I_{LOAD} \leq 3A$ Circuit of Figure 2	3.3	3.168/ 3.135 3.450/ 3.482	V V(Min) V(Max)
V_{OUT}	Output Voltage 2HV76K	$5.5V \leq V_{IN} \leq 60V$, $0.5A \leq I_{LOAD} \leq 2A$ 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 $T_J = 25^{\circ}C$, 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	$0.5A \leq I_{LOAD} \leq 3A$, $8V \leq V_{IN} \leq 60V$	5.0	4.800/ 4.750 5.225/ 5.275	V V(Min) V(Max)



		Circuit of Figure 2			
V_{OUT}	Output Voltage 2HV76K	$0.5A \leq I_{LOAD} \leq 2A$, $7.5V \leq V_{IN} \leq 60V$ 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 $T_J = 25^\circ C$, 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	$0.5A \leq I_{LOAD} \leq 3A$, $15V \leq V_{IN} \leq 60V$ Circuit of Figure 2	12	11.52/ 11.40 12.54/ 12.66	V V(Min) V(Max)
V_{OUT}	Output Voltage 2HV76K	$0.5A \leq I_{LOAD} \leq 2A$, $14.5V \leq V_{IN} \leq 60V$ 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 $T_J = 25^\circ C$, 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	$0.5A \leq I_{LOAD} \leq 3A$, $18V \leq V_{IN} \leq 60V$ Circuit of Figure 2	15	14.40/ 14.25 15.68/ 15.83	V V(Min) V(Max)
V_{OUT}	Output Voltage 2HV76K	$0.5A \leq I_{LOAD} \leq 2A$, $17.5V \leq V_{IN} \leq 60V$ 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 $T_J = 25^\circ\text{C}$, 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	$V_{IN} = 12\text{V}$, $I_{LOAD} = 0.5\text{A}$, $V_{OUT} = 5\text{V}$ Circuit of Figure 2	1.230	1.217 1.243	V V(Min) V(Max)
V_{OUT}	Feedback Voltage 3HV76K	$0.5\text{A} \leq I_{LOAD} \leq 3\text{A}$, $8\text{V} \leq V_{IN} \leq 60\text{V}$ $V_{OUT} = 5\text{V}$ Circuit of Figure 2	1.230	1.193/1.180 1.273/1.286	V V(Min) V(Max)
V_{OUT}	Feedback Voltage 2HV76K	$0.5\text{A} \leq I_{LOAD} \leq 2\text{A}$, $7.5\text{V} \leq V_{IN} \leq 60\text{V}$ $V_{OUT} = 5\text{V}$ Circuit of Figure 2	1.230	1.193/1.180 1.273/1.286	V V(Min) V(Max)
η	Efficiency	$V_{IN} = 12\text{V}$, $I_{LOAD} = 3\text{A}$ (3HV76K), $I_{LOAD} = 2\text{A}$ (2HV76K) $V_{OUT} = 5\text{V}$	77		%



All Output Voltage Versions

Electrical Characteristics

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

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 $T_J = 25^\circ\text{C}$, and those with **boldface type** apply over full Operating Temperature Range. Unless otherwise specified, $V_{IN} = 12\text{V}$ for the 3.3V, 5V, and Adjustable version, $V_{IN} = 25\text{V}$ for the 12V version, and $V_{IN} = 30\text{V}$ for the 15V version, $I_{LOAD} = 500\text{mA}$.

Symbol	Parameter	Conditions	2HV76K/3HV76K		Units (Limits)
			Typ	Limit (Note 2)	
ON/OFF CONTROL					
V _{IH}	ON/OFF Pin	V _{OUT} = 0V	1.4	2.2/2.4	V(Min)
V _{IL}	Logic Input Level	V _{OUT} = Nominal Output Voltage	1.2	1.0/0.8	V(Max)
I _{IH}	ON/OFF Pin Input Current	ON/OFF Pin = 5V (OFF)	12	30	μA μA(Max)
I _{IL}		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.

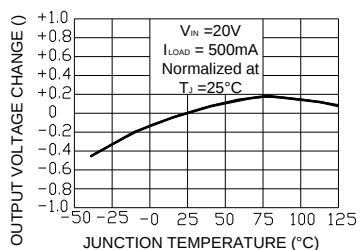
Note 7: $V_{IN} = 60\text{V}$.

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%.

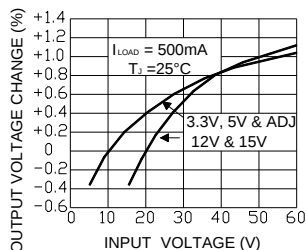


Typical Performance Characteristics (Circuit of Figure 2)

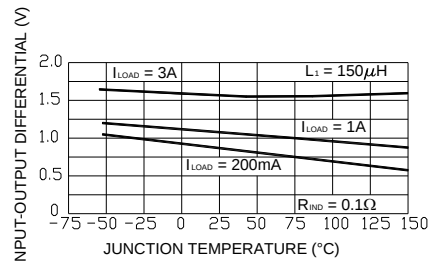
Normalized Output Voltage



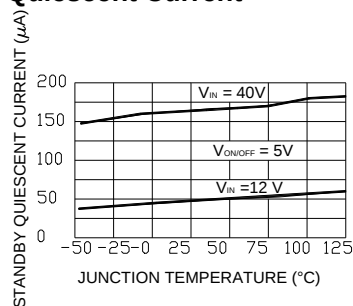
Line Regulation



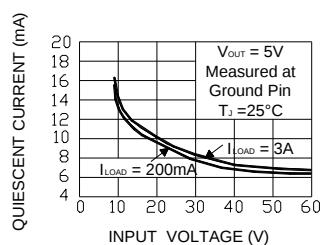
Dropout Voltage



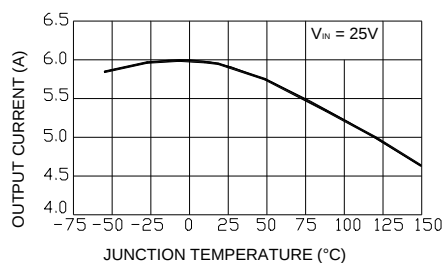
Standby Quiescent Current



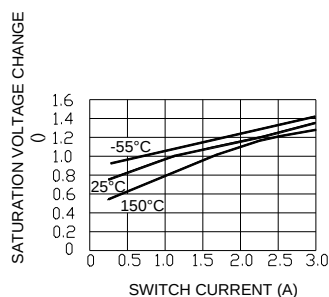
Quiescent Current



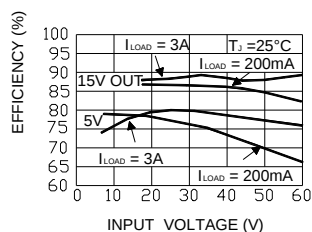
Current Limit



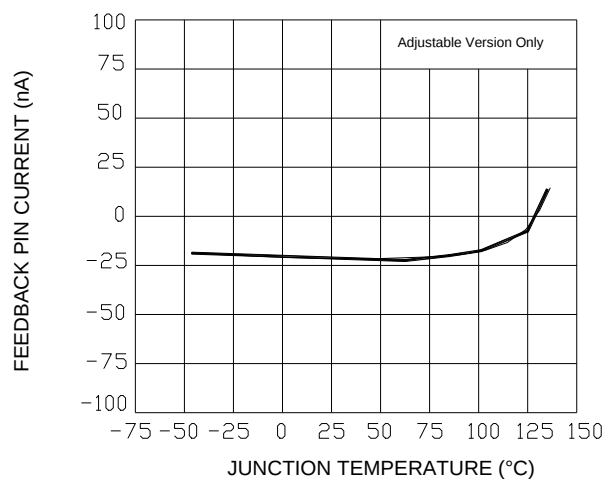
Switch Saturation Voltage

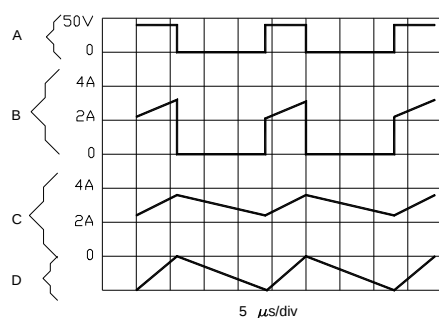
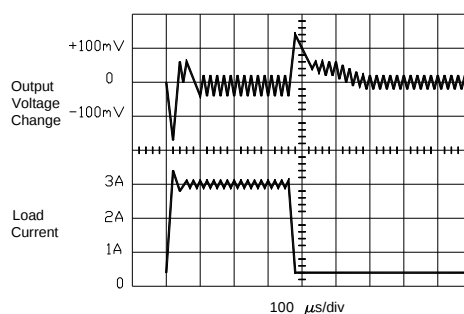


Efficiency




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

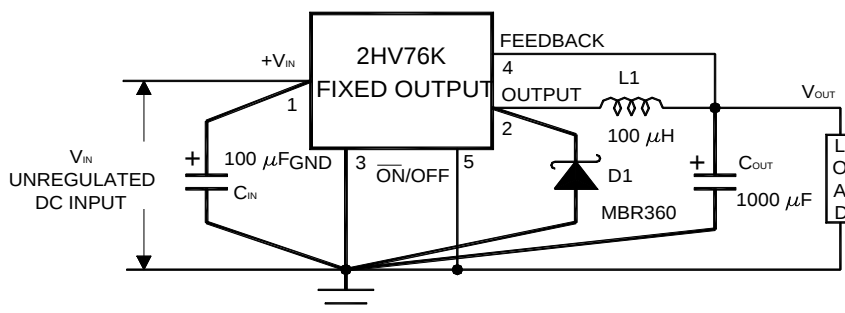


Test Circuit and Layout Guidelines

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.

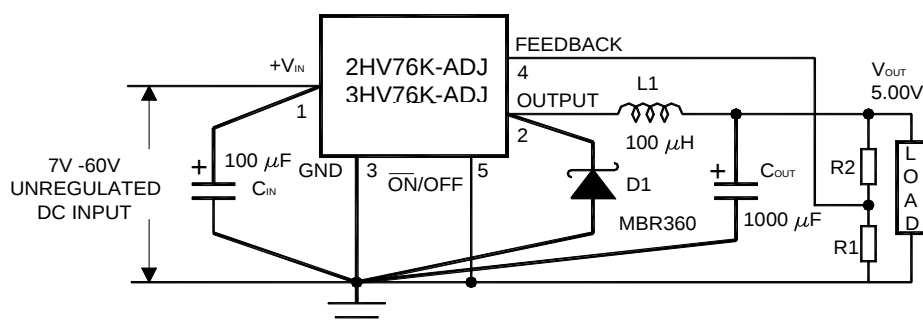
Single-point grounding (as indicated) or ground plane construction should be used for best results. When using the Adjustable version, physically locate the programming resistors near the regulator, to keep the sensitive feedback wiring short.

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

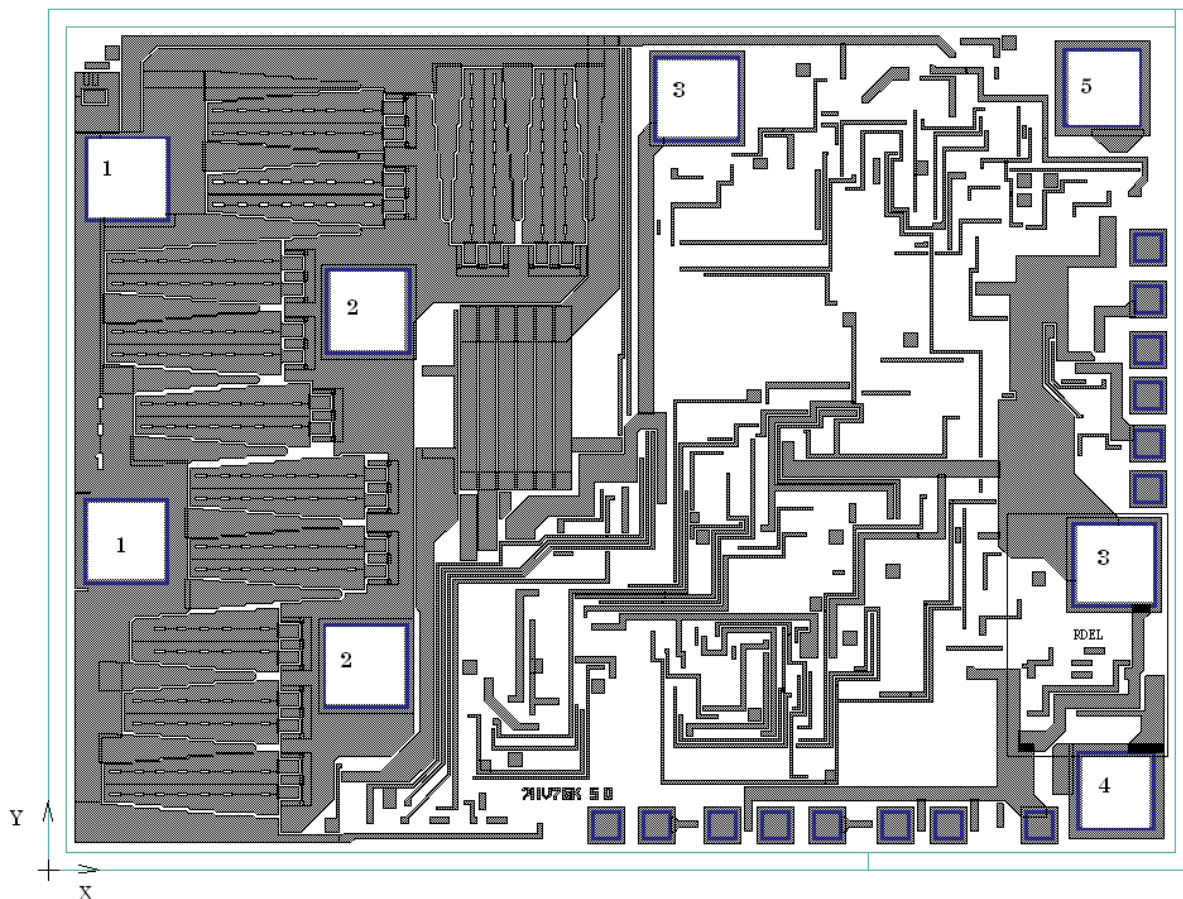


$$V_{OUT} = V_{REF} \left(1 + \frac{R_2}{R_1} \right)$$

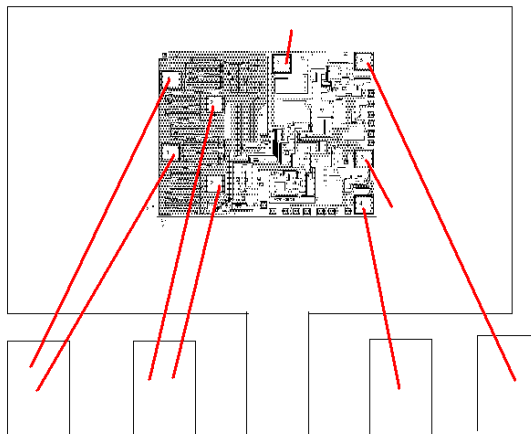
$$R_2 = R_1 \left(\frac{V_{OUT}}{V_{REF}} - 1 \right)$$

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

FIGURE 2.

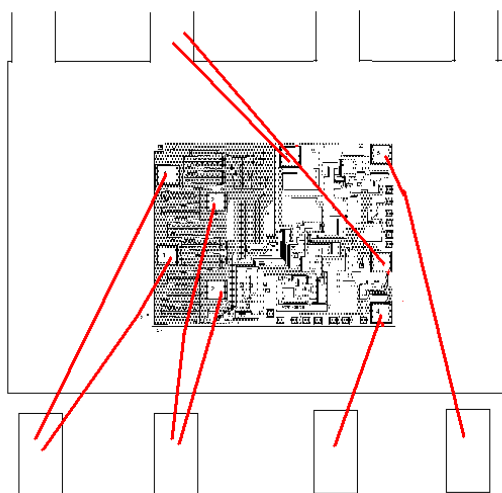
PAD LOCATION**2HV76K/3HV76K**Chip Size: 2.54 x 1.91 mm²**PAD LOCATION COORDINATES**

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 mm²

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.