Inv № 559

2C76M1K ***SIMPLE SWITCHER*** **2A Step-Down Voltage Regulator & Operational Amplifier**

Preliminary July 2010 –revised February 2011

GENERAL DESCRIPTION

Many chargers use the PWM *Simple Switcher* in conjunction with operational amplifiers. This allows one to introduce an additional adjustment for the Overcurrent Protection (OCP). In this case the OCP values can be changed with the help of external resistors. When the OCP case occurs, the SW is OFF, and V_{OUT} decreases.

The 2C76M1K includes both devices – the PWM *Simple Switcher* and an OpAmp, thereby reducing the size and cost for charger applications.

The 2C76M1K provides all the active functions for a step-down (buck) switching regulator and is capable of driving 2A load with an excellent line and load regulation. It includes internal frequency compensation components and a fixed-frequency oscillator. Among other features are a guaranteed ±1.5% tolerance on an output voltage within the specified input voltages and output load conditions, and ±10% tolerance - on the oscillator frequency. The external shutdown is included, featuring 120μA standby current (typical).

The 2C76M1K has an OVP function. If a voltage of the OVP pin overshoots 1.25V, the OVP takes place and the circuit is turned OFF with I_{STB}~120μA (typical). When the voltage of the OVP pin falls down less 0.7V, the circuit is turned ON.

The output switch includes cycle-by-cycle current limiting and thermal shutdown elements for a full protection under fault conditions.

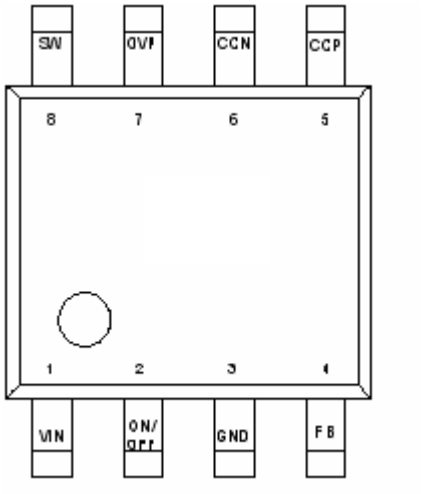
The high gain, internally frequency-compensated operational amplifiers were designed specifically to operate from a single power supply over a wide range of voltages.

These devices are available in fixed 5-volt and adjustable output voltage versions.

FEATURES

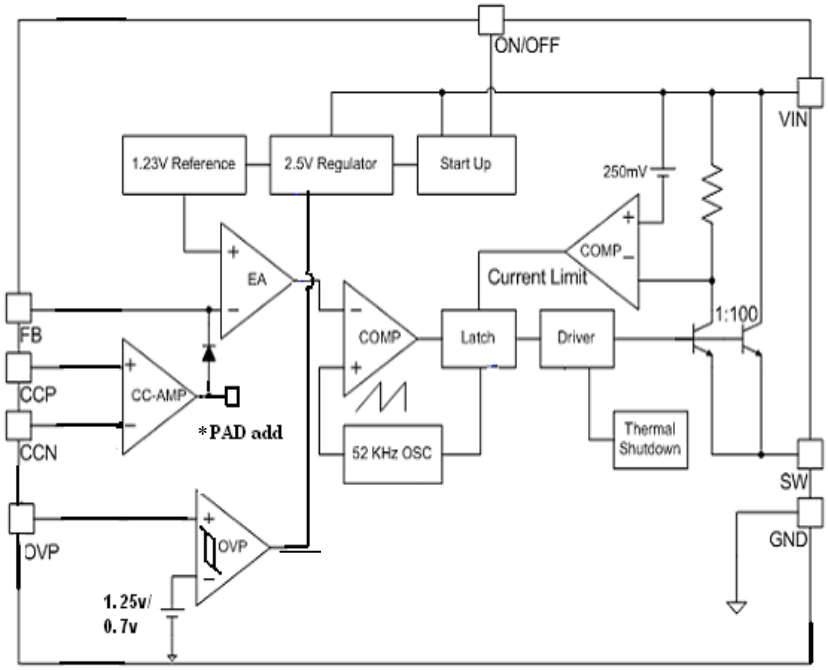
- Output voltage range of 1.23V to 37V±1.5% over the line and load conditions
- Guaranteed 2A output current
- Wide input voltage range up to 40V
- 52kHz fixed frequency oscillator
- TTL shutdown capability, low power standby mode
- High efficiency
- Thermal shutdown and current limit protection
- Low input offset voltage and offset current of the OpAmp
- Internal frequency compensation of the OpAmp

PACKAGE INFORMATION



1 - VIN
2 - ON/OFF
3 - GND
4 - FB
5 - CCP
6 - CCN
7 - OVP
8 - SW

BLOCK DIAGRAM



Note1. *There is a reserved **PAD add** at the output of internal Op Amplifier. It allows one to connect **PAD add** to the FB pin (shorting the diode) during the packaging. In this case the device can be used as a LED driver. A typical circuit application can be seen in the Fig.4. ADDITIONAL APPLICATION.

Fig.1

TYPICAL APPLICATION

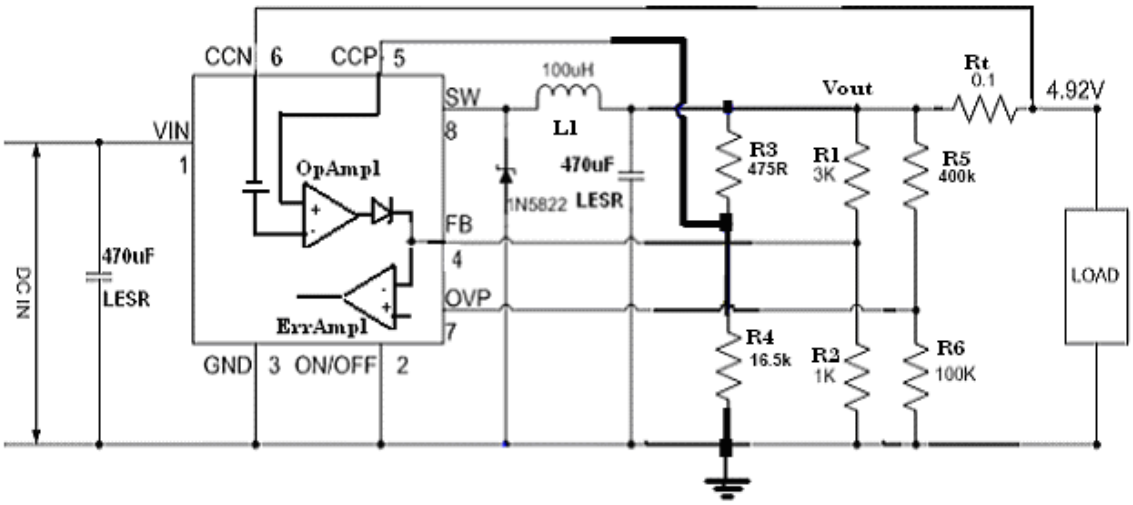


Fig.2

V_{OUT} = 1.23V × (R1+R2)/R2

OCP threshold: I_{th} = [V_{OUT}/(R3+R4)×R3+12mV]/Rt

When the OCP gets activated, the SW is OFF and V_{OUT} decreases. When V_{OUT} fall down less ~0.01V, the SW switches over to the cycle-by-cycle current limiting depending on V_{IO} of the internal Operational Amplifier.
(Note: the conventional switching regulators work all time at the cycle-by-cycle current limiting mode when I_{LOAD}>CL). See Figure below.

TIMING DIAGRAM FOR THE TYPICAL APLICATION

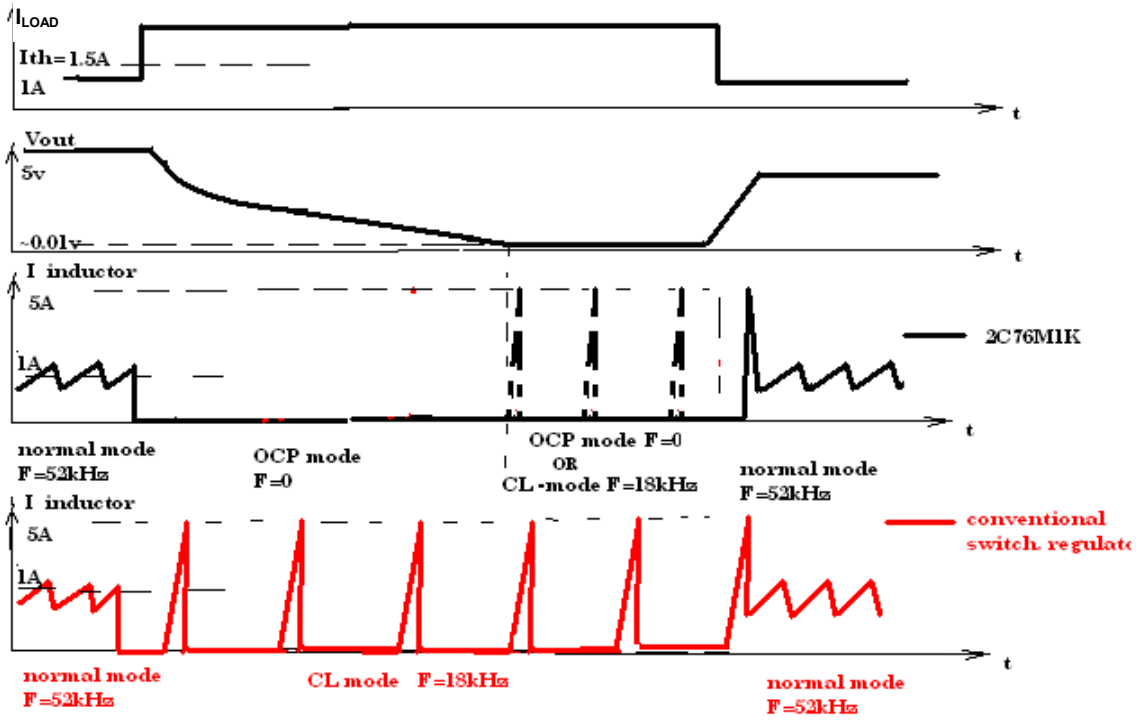
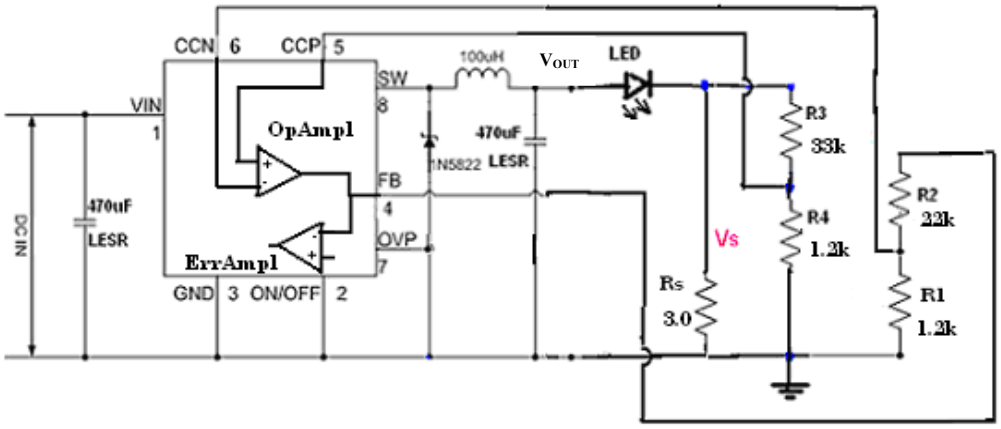


Fig.3

ADDITIONAL APPLICATION



V_{FB} ~ 1.23V
$V_{CCP} = V_{FB} \times R1/(R1+R2)$
$V_{CCN} = V_{CCP}$
$Vs = V_{CCN}/R4(R3+R4)$

Fig.4

ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE
Maximum supply voltage	V_{IN}	45V
FB pin voltage	V_{FB}	-0.3V ≤ V ≤ V_{IN}
ON/OFF pin voltage	$V_{ON/OFF}$	-0.3V ≤ V ≤ V_{IN}
SW pin voltage	V_{OUT}	-0.8V ≤ V ≤ V_{IN}+0.3V
Maximum junction temperature	$T_{J\,max}$	150°C
Maximum ESD rating (C = 100pF, R = 1.5k)	ESD	2kV
Power dissipation	P_D	Internally-limited
Input differential voltage range	V_{IDR}	45V
Input common mode voltage range	V_{ICR}	-0.3V to 45V
Load-dump protection (the device maintains short-term pulse V_{IN} up to 60V). At V_{IN}=60V with the pulse width <100μs the voltage of the V_{OUT} node (see Fig.2. **TYPICAL APPLICATION**) is V_{OUT}≤6.5V.	$V_{IN\ pulse}$	60V

OPERATING RATINGS

Supply voltage	5.5V to 40V
Temperature range	-40ºC ≤ T_J ≤ +125ºC

ELECTRICAL CHARACTERISTICS

(at V_{IN}=12V, unless specified otherwise)

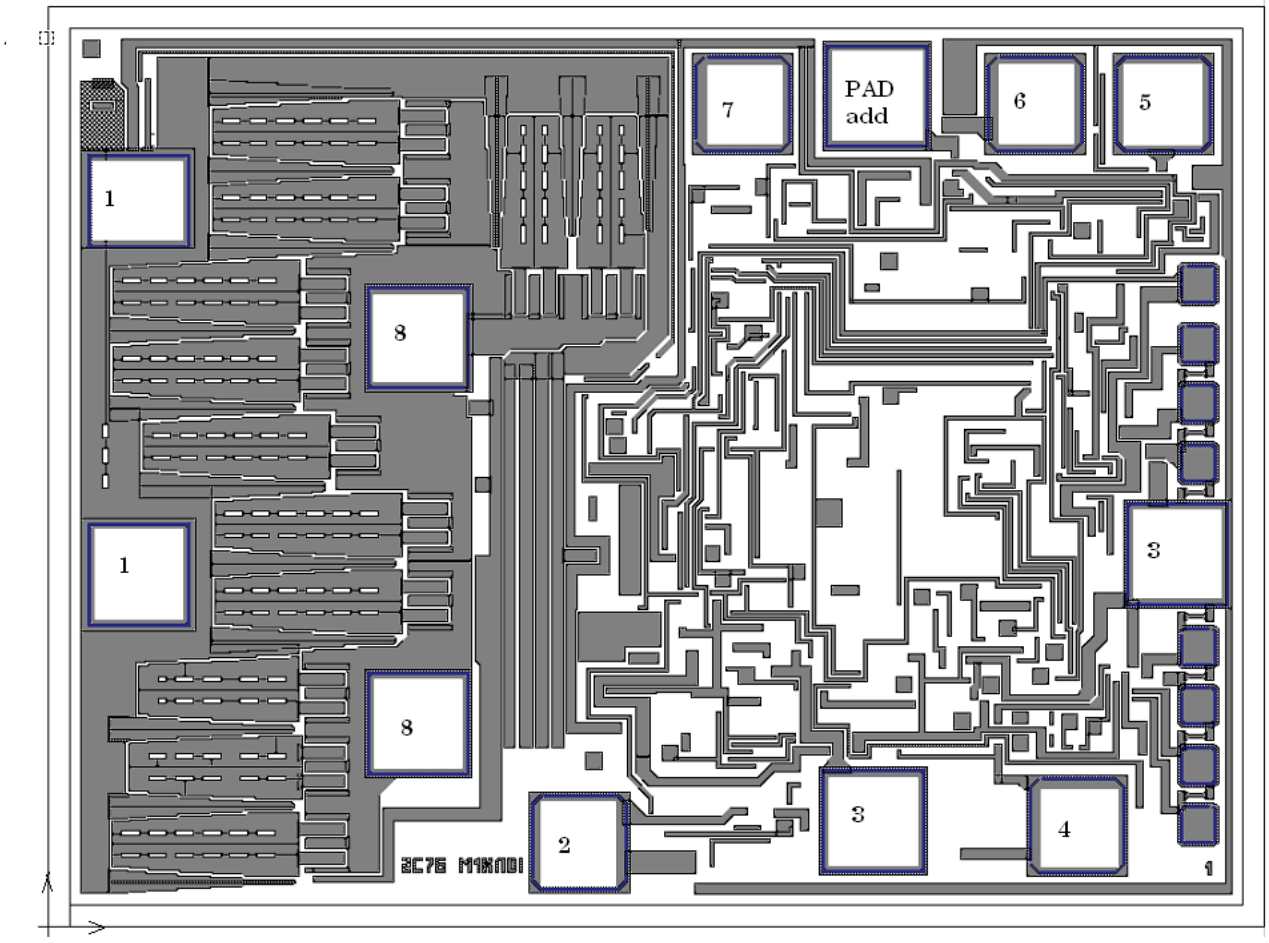
SYMBOL	PARAMETER	CONDITION	NOTE	MIN	TYP	MAX	UNITS
System Parameters							
V_{OUT}	V_{OUT}: 2C76M1K-adj	7V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 2A, V_{OUT} programmed for 5V		1211	1230	1249	mV
			*	1200		1260	
	V_{OUT}: 2C76M1K-5.0	7V ≤ V_{IN} ≤ 40V, 0.2A ≤ I_{LOAD} ≤ 2A		4.90	5.00	5.10	V
			*	4.85		5.15	
η	Efficiency	V_{IN} = 12V, I_{LOAD} = 2A, V_{OUT} = 5V			77		%
LineReg	Line regulation	V_{IN} = 8V to 40V, I_{LOAD} = 0.2A			0.3	0.5	%
LoadReg	Load regulation	I_{LOAD} = 0.2A to 2A, V_{IN} = 12V			0.5	1.0	%
Device Parameters							
PWM regulator							
I_{FB}	Feedback bias current	V_{OUT} = 5V, V_{FB} = 1.3V, V_{CCN}-V_{CCP} = 0.1V			50	100	nA
			*			500	
F_O	Oscillator frequency			47	52	58	kHz
			*	42		63	
F_{SCP}	Oscillator frequency of short-circuit protect	When V_{OUT} < 40% from the nominal			18		kHz
$DC_{(max)}$	Max duty cycle	VFB = 0V force driver ON			100		%
$DC_{(min)}$	Min duty cycle	VFB = 12V force driver OFF			0		%
CL	Current limit	Peak current. No outside circuit. VFB = 0V		2.5	3.2	4.5	A
			*	2.3		4.9	
V_{SAT}	Saturation voltage	I_{OUT} = 2A. No outside circuit. VFB = 0V			1.10	1.20	V
			*			1.35	
I_L	Output leakage current	V_{OUT}=0V. No outside circuit. VFB=12V, Vin=40V		-300	-40		μA
I_{L1}	Output leakage current	V_{OUT} = -1V. No outside circuit. VFB = 12V, V_{IN} = 40V		-30	-3		mA
Vth_ON/ OFF	ON/OFF input threshold voltage		*	0.6	1.3	2.0	V
I_H	ON/OFF input current	$V_{ON/OFF}$ =2.5V		-5	0.1	5	μA
I_L	ON/OFF input current	$V_{ON/OFF}$ = 0.5V		-1.0	-0.1		μA

OVP_H	High voltage threshold, OVP pin	When the OVP pin voltage is >OVP_H, the circuit is OFF. When the OVP pin voltage is <OVP_L, the circuit is ON.		1.15	1.22	1.31	V
			*	1.11		1.35	
OVP_L	Low voltage threshold, OVP pin				0.74		V
T_{SD}	Thermal shutdown temperature		*		170		°C
Operational amplifier, CC-AMP							
V_{IO}	Input offset voltage	V_{IN} = 5.5V to 40V, V_{FB} = 1.5V			3	11	mV
			*		10	15	
αV_{IO}	Average temperature coefficient of input offset current		*		10		µV/°C
I_{IO}	Input offset current	V_{CM} = 0V			8	100	nA
			*			300	
αI_{IO}	Average temperature coefficient of input offset current		*		30		pA/°C
I_{IB}	Input bias current	V_{CM} = 0V			-30	-500	nA
			*			-800	
V_{ICR}	Common-mode input voltage range	V_{IN} = 5.5V to 40V			0.05V to V_{IN}-1.5V		V
			*		0.05V to V_{IN}-2V		V
CMRR	Common-mode rejection ratio	V_{IC} = 0.05V to V_{IN}-1.5V		60	80		dB
PSRR	Power supply rejection ratio			60	90		dB
V_{OUT_H}	High-level output voltage	R_L ≥ 20kΩ, V_{IN} = 40V, R_L between FB and GND		36	36.9		V
			*	35			
V_{OUT_L}	Low-level output voltage	R_L ≥ 10kΩ, R_L between FB and GND			0	20	mV
			*			30	
Isc	Short-circuit output current to GND	V_{FB} = 0, V_{ID} = +1V		-60	-40	-20	mA
Common Parameters							
I_Q	Quiescent current	FB pin is removed from the output and connected to +12V to force the output transistor OFF. No-load OpAmp			5.5	11	mA
I_{STB}	Standby quiescent current	ON/OFF pin=5V (OFF). No-load OpAmp			120	330	µA

Note: *denotes the full operating temperature range of T_J = -40 to + 125°C.

2C76M1K

PAD LOCATION



Chip size = 2.25 mm x 1.70 mm

PAD	PAD COORDINATES (Center)		SIZE
	X (µm)	Y (µm)	
1	167	1340	190 x 190
1	167	650	190 x 190
2	984	154	178 x 178
3	1526	195	190 x 190
3	2090	687	190 x 190
4	1903	185	178 x 178
5	2063	1520	178 x 178
6	1826	1520	178 x 178
7	1284	1519	178 x 178
8	684	1087	190 x 190
8	684	375	190 x 190
PAD add	1534	1535	190 x 190

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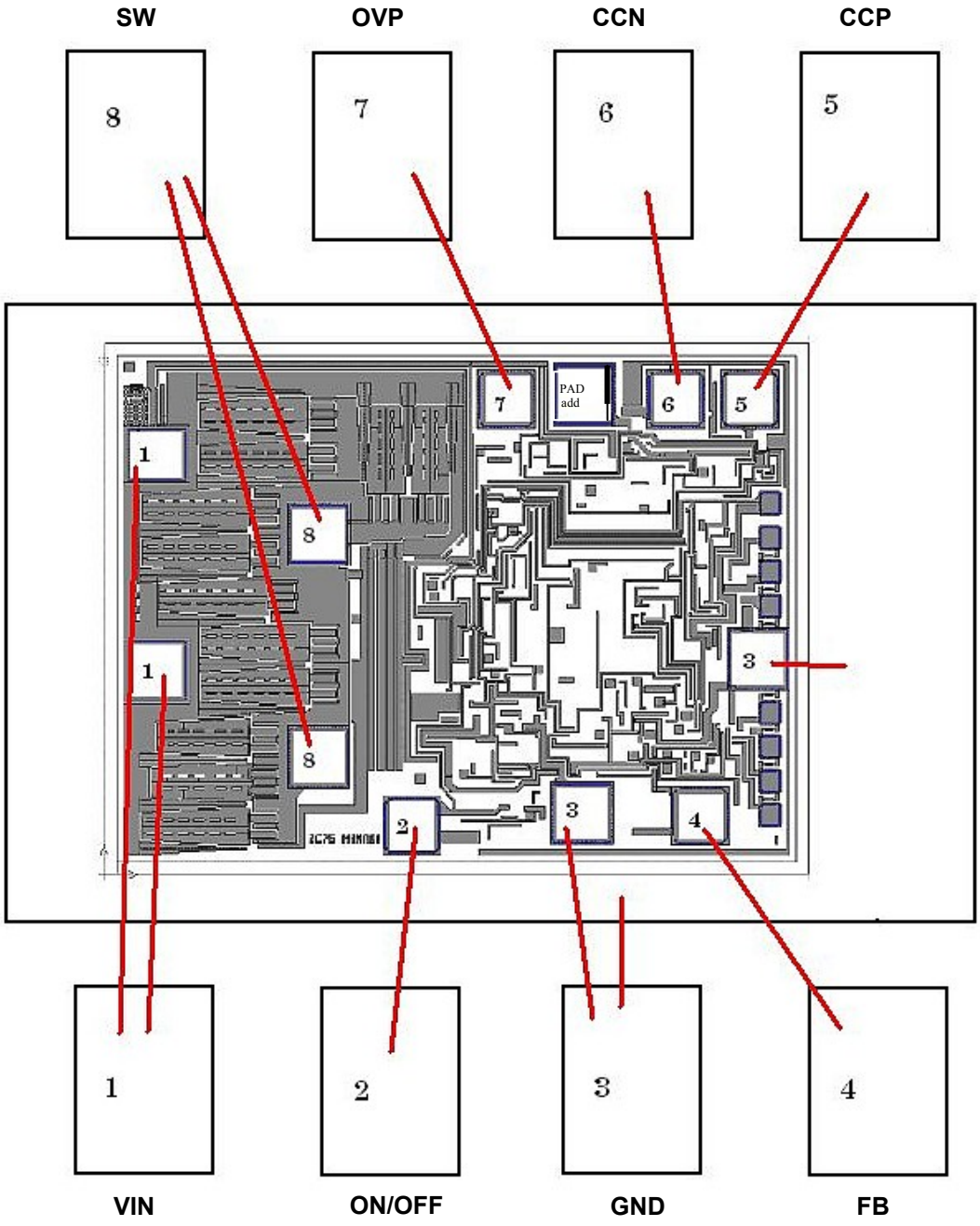
BONDING DIAGRAM



Package: SO-8
Wire diameter: 50µm