STEP UP PULSE VOLTAGE CONVERTER, LOAD CURRENT 1,0 A

(functional analogue LT1308B f. Linear Technology)

Microcircuit IZ1308B is a step up pulse voltage converter

with load current up to 1,0 A. Microcircuits IZ1308B is intended for application in power supplies used in all types of equipment.

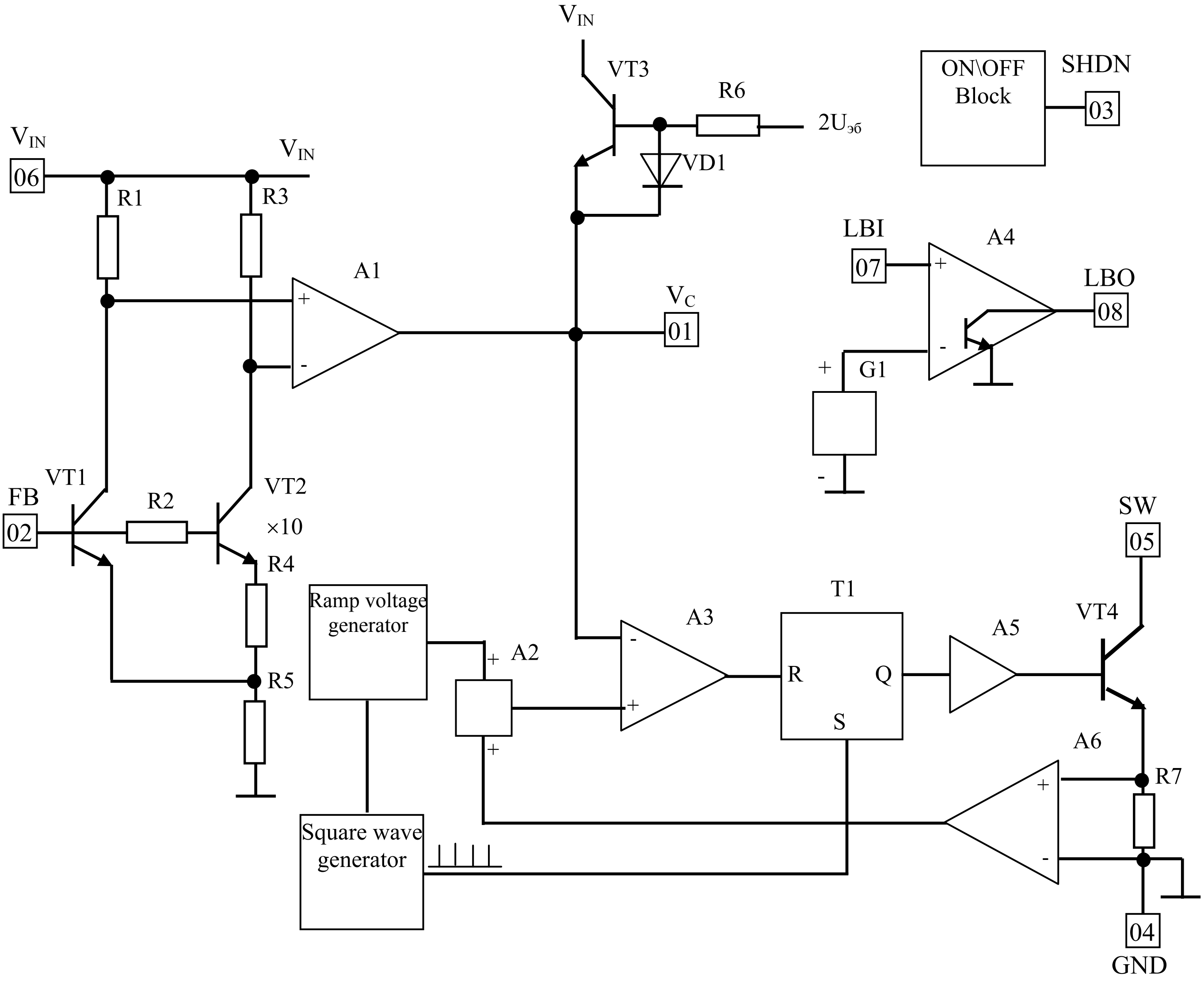
The IC is available both as unsawn –scribed wafers and separate chips.

FEATURES :

-Input voltage range from 1,0 to 10,0 V;
-Output voltage – controlled voltage from 1,22 to 34,00 V;
- Fixed frequency– 600 kHz;
- Maximum quiescent current in shutdown - max 1,0 uA;
- Low battery indicator (200 mV ± 2 %);
- Load current up to 1.0 A (it depends on co-relation between input and output voltages;
- Operating temperature - from minus 40 to plus 85 °C;
- Allowable value of static current potential 2000 V

Table 1 – Description of pins and contact pads

# Contact pad of chip	Symbol	Function
01-06	GND	Common pin
07-12	SW	Output
13, 14	V_{IN}	Input
20	LBI	Low battery indicator input
21	LBO	Low battery indicator output
30	V_C	Compensation pin
31	FB	Feedback pin
32	SHDN	ON\OFF pin
Note: Contact pads 15-19, 22-29, 33-37 are not to be wired (test pads)		



A1 – Error signal amplifier
A2 – Adder (Integrator)
A3 – PWM comparator
A4 – Low battery indicator
A5 – Driver
A6 – Protection of output overcurrent
G1 – Constant voltage supply 200 mV
R1 – R7 – Resistors
T1 – RS – Trigger
VD1 – Diode
VT1 – VT4 – Transistors

Figure 1 – Electrical Block Diagram

Table2 – Absolute maximum ratings

Symbol of parameter	Parameter	Norm		Units
		min	max	
U_{input}	Input voltage	0	10	V
$U_{ON/OFF}$	Voltage at ON\OFF SHDN pin	0	10	V
U_{LBO}	Voltage at LBO pin	0	10	V
$U_{output\ 1}$	Voltage at SW pin	-0,4	36	V
$U_{feedback1}$	Voltage at feedback pin FB	–	U_{input}+1	V
U_c	Voltage at compensation pin Vc	–	2,0	V
U_{LBI1}	Voltage at pin LBI	-0,1	1,0	V
$P_{dissip.}$	Power dissipation[1]	–	1,8	W

Note – Simultaneous impact produced by a few absolute maximum ratings are not permitted.

---

[1] At ambient temperature T_{amb} = 25 °C.

Power dissipated by a microcircuit in a conventional package $P_{dissip.}$ W, at ambient temperature T_{amb} from plus 25 up to plus 85 °C shall be defined by a formulae

$$P_{dis} = (125 – T_{amb}) / R_{H\ chip\text{-}amb.}\ , \qquad (1)$$

where125 – chip temperature, °C;

T_{amb} – ambient temperature, °C;

$R_{T\ chip\text{-}amb}$ – heat resistance chip-ambient, °C/W

Table 3 – Recommended operating conditions

Symbol of parameter	Parameter	Norm		Units
		min	max	
U_{input}	Input voltage	1	10	B
$U_{ON/OFF}$	Voltage at ON\OFF pin SHDN	0	10	B
U_{LBO}	Voltage at LBO output	0	10	B
U_{LBI1}	Voltage at LBI input	-0,1	1,0	B
P_{pac}	Power dissipation[1]	–	1,5	Вт

[1] At ambient temperature T_{amb} = 25 °C.

Power dissipated by the microcircuit P_{dis} W, at ambient temperature T_{amb} from 25 to plus 85 °C is to be found by formulae (1)

Table 4 – IZ1308B Electrical Characteristics

Symbol of parameter	Parameter, unit	Measurement coditions	Norm		Ambient temperature, °C	Unit
			Min	Max		
$U_{feedback}$	Feedback voltage	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp}$	1,19	1,25	-40; 85	V
$I_{\text{пот}}$	Consumption current	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp}$	–	4,0	-40; 85	mA
$I_{\text{пот. жд}}$	Consumption current in stand-by mode	U_{inp} = 1,2 V; $U_{ON/OFF}$ = 0 V	–	1,0	-40; 85	uA
I_{oc}	Offset current by feedback pin	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp}$	–	100	-40; 85	nA
K_U	Instability by voltage	1,2 V ≤ U_{inp} ≤ 2,0 V; $U_{ON/OFF} = U_{inp}$	–	0,4	-40; 85	%/V
		2,0 V ≤ U_{Inp} ≤ 10 В; $U_{ON/OFF} = U_{inp}$	–	0,2		
F_{gen}	Generation frequency	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{Inp}$	500	700	-40; 85	кГц
$K_{duty\ cycle.\ max}$	Maximum duty cycle	U_{in} = 1,2 V; $U_{ON\backslash OFF} = U_{inp}$	82	–	-40; 85	%
$I_{output\ max}$	Output overcurrent protection threshold	U_{inp}= 1,2 V; $U_{ON/OFF} = U_{input}$	2,0	–	25 ± 10	A
I^1_{inp}	High level input current by ON\OFF pin	U_{inp} = 1,2 V; $U_{OM/OFF}$ = 1,1 V	–	5,0	-40; 85	uA
		$U_{inp.}$ = 1,2 V; $U_{ON/OFF}$ = 6,0 V	–	40		
I^0_{inp}	Low level input current by ON\OFF pin	U_{inp}= 1,2 V; $U_{ON/OFF}$ = 0 V	–	0,1	25 ± 10	uA
U_{LBI}	Threshold voltage at LBI pin	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp.}$	196	204	25 ± 10	mV
			194	206	-40; 85	
U_{LBO_L}	Low level voltage at LBO pin	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp}$; I_{LBO} = 50 uA	–	0,25	-40; 85	V
$I_{leak\ LBO}$	Leak current by pin LBO	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp.}$; U_{LBI} = 250 mV; U_{LBO} = 5,0 V	–	0,1	-40; 85	uA
I_{LBI}	Offset current by LBI pin	U_{inp} = 1,2 V; $U_{ON/OFF} = U_{inp}$; U_{LBI} = 150 mV	–	|-100|	25 ± 10	nA

Table 4 (cont.)

Symbol of parameter	Parameter,unit	Measurement conditions	Norm		Amb. temperature, °C	Unit
			Min.	max		
$I_{ут.\ вых}$	Leak current by output	U_{in} = 1,2 V; $U_{ON/OFF} = U_{in}$; $U_{output1}$ = 5,0 V	–	10	-40; 85	uA
Note: Microcircuit measurement and operation mode makes sure p-n junction temperature shall not exceed ` 125 °C						

FUNCTIONAL DESCRIPTION

Microcircuit consists of the blocks as below:
-reference voltage supply (1,22 V),
- generator of ramp voltage and generator of square wave frequency 600 kHz,
- amplifier of error signal ,
- WPM comparator,
- RS-trigger, ON\OFF block
- protection block of output overcurrent,
- output transistor to provide load current at least 1,0 A,
- low battery indicator.

At calculation it should taken into account that input voltage should be always less than output voltage.

It is impossible to assure current value 1,0 A at any and all combinations of input and output voltage.

In order to calculate voltage converter characteristics the source data as below should be available:

1) Rated output voltage : U_{output};
2) If available, reference functions of microcircuit based converter's efficiency (η) on load current (if no specific function is observed for calculation purposes η=80% is to be used.

1. Calculation of the maximum output load current at preset output voltage and range of input voltages.

Initially duty cycle for minimum voltage out of the selected range of input voltages is defined. For calculation minimum voltage out of the range of the input voltages shall be used as it results in maximum current value passing through the switch (power output transistor).

Duty cycle $K_{duty\ cycle}$, %, is defined by the formulae

$$\text{Kduty cycle} = 1 - \frac{U_{\text{input(min)}} \bullet \eta}{\text{Uoutput}}, \qquad (2)$$

where $U_{input\ (min)}$ – minimum voltage out of the selected range of input voltages ,V
U_{output} – selected output voltage, V;
η – efficiency of converter, %.

Value of ripple current passing through electromagnetic coil ΔI_L, A, is calculated by formulae

$$\Delta I_L = \frac{U_{\text{input (min)}} \bullet \text{K duty cycle}}{f_{\text{gen(min).}} \bullet L}, \qquad (3)$$

where $U_{input\ (min)}$ – minimum input voltage , V;
$K_{duty\ cycle}$ – duty cycle calculated by formulae , (2), %;
$F_{gen(min)}$ – minimum generation frequency, kHz;
L – selected inductance (See item3 to make your choice), uH

Maximum output load current $I_{output(max)}$, A shall be defined by formulae,

$$I_{output\,(max)} = \left(I_{output\,max} - \frac{\Delta I_L}{2} \right) \bullet (1 - K_{duty\,cycle}), \qquad (4)$$

где $I_{output.max(min)}$ – minimum value of parameter “Output overcurrent protection threshold” A;
ΔI_L– value of current ripples through electromagnetic coil calculated by formulae (3), A;
$K_{duty\,cycle}$ – duty cycle calculated by formulae (2), %.

If the rated value obtained $I_{output\,(max)}$ is a bit below the required maximum output current $I_{output(max)}$, then the rated value of inductivity may be increased. Because in this case current ripples passing through electromagnetic coil grow less and maximum output current increases. Should the rated value $I_{output(max)}$ appears to be higher that the needed maximum output current $I_{output\,(max)}$, then the maximum current passing through the switch $I_{switch(max)}$, A, may be defined by the formulae

$$I_{switch(max)} = \frac{\Delta I_L}{2} + \frac{I_{output(max)}}{1 - K_{duty\,cycle}}, \qquad (5)$$

where ΔI_L – values of current ripples through the electromagnetic coil found by formulae (3);
$I_{output(max)}$ – required maximum , A;
$K_{duty\,cycle}$ – duty cycle calculated by formulae, (2), %.

$I_{switch(max)}$ appears to be peak current current which should be sustained by external inductance, Schottky diode and switch incorporated into microcircuit (power output transistor).

2. Calculation of minimum input voltage $U_{input(min)}$, V, at preset output voltage and output load current.

Minimum voltage $U_{Input(min)}$, V, is calculated by formulae:

$$U_{Input(min)} = \frac{I_{outputxutp\,x)} \bullet Uoutput}{I_{output.max(min)}} \bullet \frac{1}{\eta}, \qquad (6)$$

Where $I_{out(max)}$ – selected output load current, A;
U_{output} – selected output voltage, V;
$I_{output.max\,(min)}$ – minimum value of output overcurrent protection threshold, A
η – efficiency of converter %.

3. Selection of electromagnetic coil

The desirable inductance coil should be in line with the requirements as below:

1) To be able to accommodate current 2,0 A in steady-state mode and over 3,0 A in non-steady state mode (transient process, start-up current)

2) Resistance to inductor direct current (DCR) should be maximum 0,05 Ohm.

The most desirable values of inductance tend to vary within the range of 2,0 to 20,0 uH (for most of applications 10,0 uH). The higher inductance is the higher maximum output current due to step-down of current ripples through electromagnetic coil.

The lower inductance value is the tinier overall dimensions of the device appear. The rated current of electromagnetic coil should any time exceed the current maximum value shown in formulae (5) because the said current is increasing as long as the inductance is growing less (due to increase of current ripples). To calculate the most preferable inductance value L, uH the formulae as below may be used:

$$L = \frac{U_{input} \bullet (U_{output} - U_{input})}{\Delta I_L \bullet f_{gen(min)} \bullet U_{output}}, \qquad (7)$$

where

U_{input} – selected value of input voltage V;
U_{output} – selected output voltage, V;
$F_{gen(min)}$ – minimum value of parameter “generation frequency” ,kHz;
ΔI_L – the anticipated value of current ripples through electromagnetic coil, see below A .

The value of current ripples through electromagnetic coil cannot be calculated by formulae(3) as the inductance value is unknown . The most preferable value for current ripples is thought to fall within the range from 20 to 40 % of output current.

$$\Delta I_L = (0{,}2 \div 0{,}4) \bullet I_{output(max)} \bullet \frac{U_{output}}{U_{input}}, \qquad (8)$$

where $I_{output(max)}$ – selected maximum output current.

4 Selection of rectifying diode

For decrease in losses Schottky diodes need be in use. The rated direct current of diode should be equal to maximum output current.

$$I_F = I_{output(max)}, \qquad (9)$$

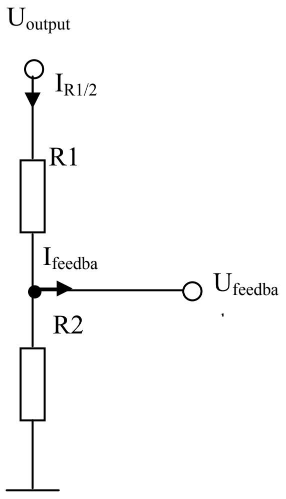
Where I_F – mean value of direct current in diode , A;
$I_{output(max)}$ – selected maximum , A.

Peak current of Schottky diode is much higher than mean rated current .

The diode should accommodate the power dissipation P_{DISS}, W, calculated by formulae

$$P_{DISS} = I_F \bullet U_F, \qquad (10)$$

Where I_F – mean value of direct diode current , A;
U_F – direct voltage of diode, V.



R1, R2 - resistors

Figure 2 – Resistance divider

5. Setting of output voltage

The current passing through a resistance divider $I_{R2/3,}$ A, should be at least 100 times higher than offset current I_{oc}, A, by feedback pin:

$$I_{R2/3} \geq 100 \bullet I_{oc}, \qquad (11)$$

where $I_{R1/2}$ – current passing through resistance divider, A;
I_{oc} – offset current by feedback pin, A.

In this case the error less than 1% is being added to the measured value.

The only fault displayed by smaller values of resistors in divider is increase in power losses in resistance divider, the accuracy however is slightly better.

The resistor values of resistance divider are calculated as below:

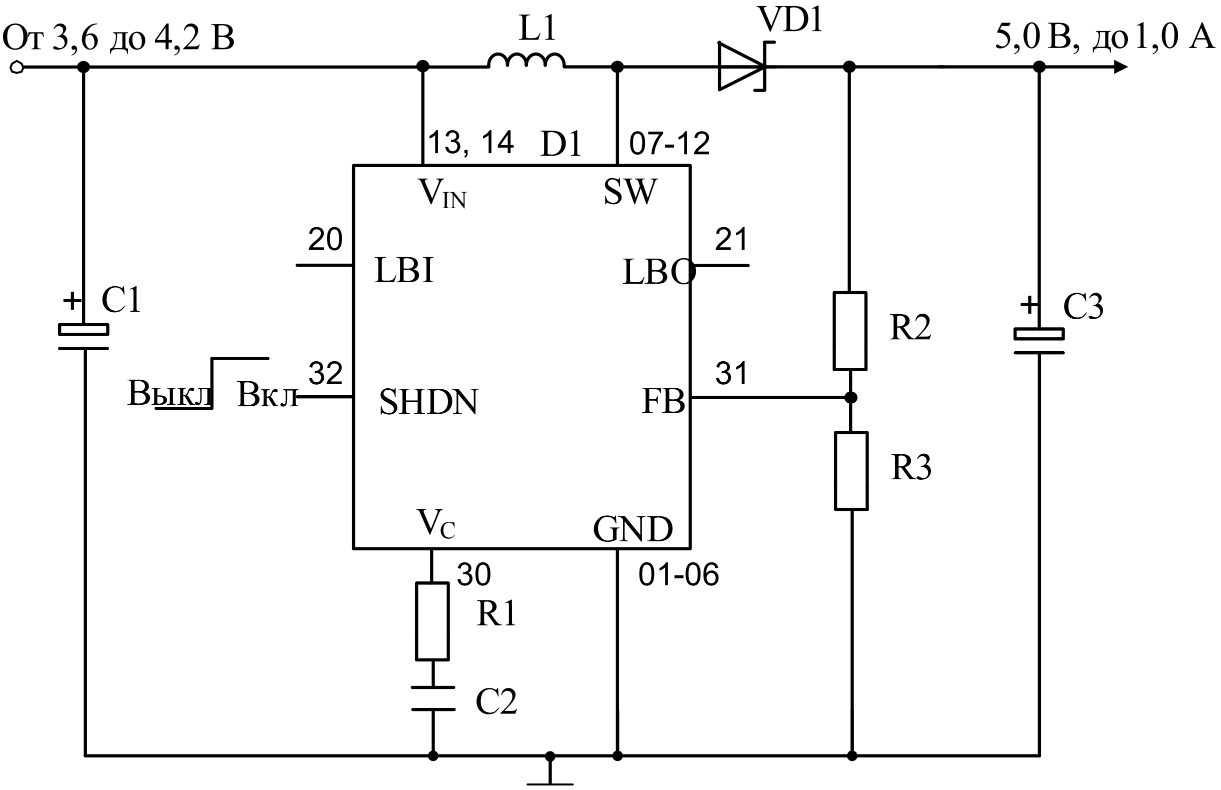
$$R3 \leq \frac{Ufeedback}{I_{R2/3}}, \qquad (12)$$

$$R2 = R3 \bullet \left(\frac{U_{output}}{U_{feedback}} - 1) \right), \qquad (13)$$

где U_{output} selected output voltage – V;
$U_{feedback}$ – voltage of feedback, V.

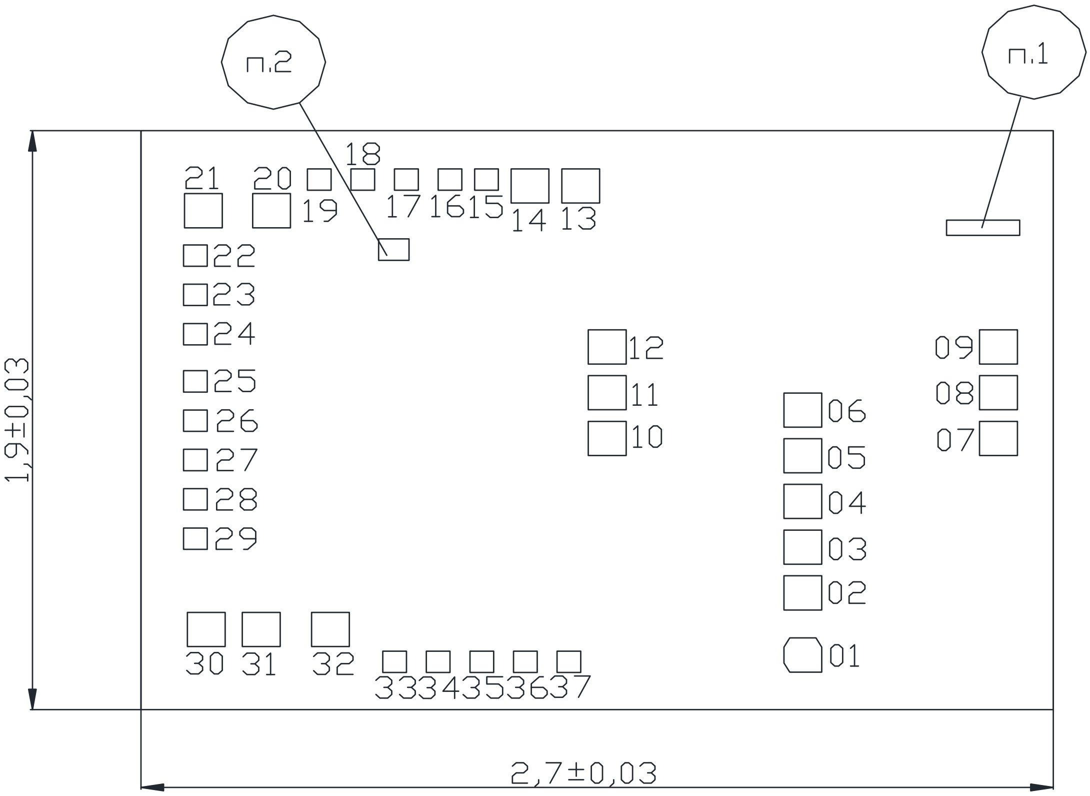
6. Selection of RC- sequence at compensation pin

To smoothen the signal at compensation pin and to lessen the ripples at output it is allowed to increase the rated value of capacitor in RC- sequence at compensation pin.



C1 – tantalum capacitor 47 uF, 10 V
C2 – ceramic capacitor 1,0 nF
C3 – tantalum capacitor 220 uF, 6,0 V
D1 – microcircuit
L1 – electromagnetic coil 10 uH, maximum current at least 3,0 A
R1 – resistor 100 kOhm ± 5,0 %
R2 – resistor 309 kOhm ± 0,1 %
R3 – resistor 100 kOhm ± 0,1 %
VD1 – Schottky diode 15 V, high -speed, maximum current 1,5 A

Figure 3 – Typical application circuit



Technological marking on chip:
1. 1308B” with coordinates, mm: left bottom corner x = 2,404; y = 1,556.
2. “20” with coordinates, mm: left bottom corner x = 0,703; y = 1,4745.

Chip thickness 0,35 ± 0,02 mm.

Figure 4 – Chip outline drawing

Coordinates of contact pads are shown in Table 5.

Table 5

Contact pad	Coordinates (left bottom corner), mm		Contact pad size ,mm
	X	У	
01	1,903	0,123	0,112 x 0,112
02	1,903	0,327	0,112 x 0,112
03	1,903	0,477	0,112 x 0,112
04	1,903	0,627	0,112 x 0,112
05	1,903	0,777	0,112 x 0,112
06	1,903	0,927	0,112 x 0,112
07	2,482	0,834	0,112 x 0,112
08	2,482	0,984	0,112 x 0,112
09	2,482	1,134	0,112 x 0,112
10	1,324	0,834	0,112 x 0,112
11	1,324	0,984	0,112 x 0,112
12	1,324	1,134	0,112 x 0,112
13	1,2455	1,662	0,112 x 0,112
14	1,0955	1,662	0,112 x 0,112
15	0,9875	1,704	0,070 x 0,070
16	0,8795	1,704	0,070 x 0,070
17	0,7505	1,704	0,070 x 0,070
18	0,6215	1,704	0,070 x 0,070
19	0,4925	1,704	0,070 x 0,070
20	0,3305	1,581	0,112 x 0,112
21	0,1285	1,581	0,112 x 0,112
22	0,126	1,455	0,070 x 0,070
23	0,126	1,326	0,070 x 0,070
24	0,126	1,197	0,070 x 0,070
25	0,126	1,042	0,070 x 0,070
26	0,126	0,913	0,070 x 0,070
27	0,126	0,784	0,070 x 0,070
28	0,126	0,655	0,070 x 0,070
29	0,126	0,526	0,070 x 0,070
30	0,137	0,207	0,112 x 0,112
31	0,300	0,207	0,112 x 0,112
32	0,5045	0,207	0,112 x 0,112
33	0,7155	0,122	0,070 x 0,070
34	0,8445	0,122	0,070 x 0,070
35	0,9735	0,122	0,070 x 0,070
36	1,1025	0,122	0,070 x 0,070
37	1,2315	0,122	0,070 x 0,070

Notes

1 Coordinates and sizes of contact pads are shown by PASSIVATION LAYER .

2 Contact pad #1 is marked by laps at its three sides .