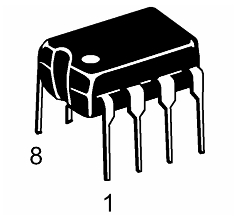
IL6083, IL6083-01

PULSE WIDTH MODULATION MICROCIRCUIT OF POWER MOS TRANSISTOR

Description of Main Functions:

Microcircuit is the integrated circuit of the pulse width modulation controller for control of the power N-channel MOS transistor, used a switch. Controller is ideal for application brightness control of the lamps, used in the car dashboard panel. Microcircuit is developed for the gate control of the power MOS transistor.

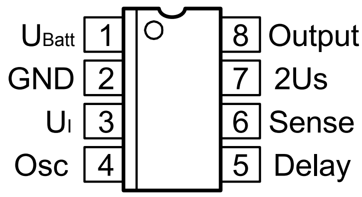


DIP-8 package of type
MS-001BA
T_A=from -40°C to +110°C

Functional Features:

Performs pulse width modulation with the frequency of up to 2 kHz.
Protection from short circuit, increased voltage in the load and incorrect supply voltage polarity U_{Batt}.
Ensures continuity of the working cycle from 18 to 100% - IL6083N (from 10 to 100% - IL6083N-01).
Internal limitation of the voltage pulse rise rate in the lamp.
Protection from ground bus rupture.

Identification of Pins in the Package



Features:

Microcircuit is supplied from the car borne supply mains
Minimum number of the external time setting components.
Operating voltage range of the microcircuit supply from 9 V to 16,5 V.

Table of Limit Modes

Description of Parameter, Identification	Not less	Not more	Unit of Measurement
Supply voltage U_{Batt}		32,5	V
Storage temperature T_{stg}	-55	+125	°C
Chip maximum temperature Tj(max)		+150	°C
Temperature resistance chip - environment $R_{th\ j\text{-}a}$, =120 °C/Wt			

Table of Limit-Permissible Modes

Description of Parameter, Identification	Not less	Not more	Unit of Measurement
Supply voltage U_{Batt}	9,0	16,5	V
Operating temperature range of environment T_A	-40	+110	^{o}C

Table of electric modes:

Rated normal values for the electric parameters are indicated for the ambient temperature of -40 C T_A 110 C, supply voltage of 9V U_{Batt} 16,5V. The values of the electric parameters are listed relative to pin 2 (common pin of the microcircuit) (see Figure 1).

Description of Parameter, Unit of Measurement	Letter Identification	Mode of Measurements	Norm		Remarks
			min	max	
Supply (Pin 1)					
Consumption Current, mA	Is			7.9	
Hsupply voltage, V	U_{Batt}	Determination of overvoltage, first stage		25	
Stabilized voltage of microcircuit, V	Us_1	Is=10 mA	24.5	27.0	
Battery reduced voltage level, V	U_{BattL}	Enabling	4.8	6.0	
		Disabling	4.4	5.6	
Overvoltage Detection from Battery Supply Source					
First stage of overvoltage, V	U_{Batt1}	Enabling	18.3	21.7	
		Disabling	16.7	20.3	
Second stage of overvoltage, V	U_{Batt2}	Enabling	25.5	32.5	
		Disabling	19.5	26.5	
Stabilized voltage, V	Us_2	Is=30mA	18.5	21.5	
Protection from Short Circuit (Pin 6)					
Current limitation voltage of short circuit, mV	U_{T1}	$U_{T1} = U_S - U_6$	85	120	
Short circuit voltage, mV	U_{T2}	$U_{T2} = U_S - U_6$	75	105	
	$U_{T1} - U_{T2}$		3	30	
Current Detection of Short Circuit (Pin 5), U_{Batt} = 12.0 V					
Disabling threshold voltage, V	U_{T5}	$U_{T5} = U_S - U_5$	10.2	10.6	
Capacitance current, mA	I_5	$I_5 = I_{ch} - I_{dis}$	5	15	

INTEGRAL

Description of Parameter, Unit of Measurement		Letter Identification	Mode of Measurements	Norm min	Norm max	Remarks
Voltage doubler (Pin 7)						
Voltage, V		U_7	100% operating cycle	$2U_S$		
Oscillator frequency, kHz		f_7		280	520	
Voltage internal limitation, V		U_{7_1}	I_7=5мА	26.0	30.0	
				U_{S+14}	U_{S+16}	
Front steepness, V/msec		$dU_8/dt_{макс}$			130	
Output signal front steepness ratio to input front steepness.		$_4$	$dU_8/dt=\ _4\ dU_4/dt$	53	72	
Circuit output (Pin 8)						
Output voltage, V		U_8	Low level	0.35	0.95	
			U_{Batt} = 16.5V Tamb = 110 C, R4=150Om		1,5	1
Output current, mA		I_8	U_8 – low level	1.0		
			U_8 – high level, $I_7 > \|I_8\|$	-1.0		
Operating cycle, %		t_{pmin}/T	U_{Batt} = 13.5V, C_2=68nF	15	21	IL6083N
					10	IL6083N-01
		$t_{pмax}/T$	U_{Batt} 12.4V, C_2=68nF	100		
		t_p/T	U_{Batt} = 16.5V, C_2=68nF	65	81	
Internal Oscillator (Pin 4)						
Oscillator frequency, Hz		f_1		10	2000	
Threshold cycle	Upper	$_1$	U_8 – high level	0.68	0.72	2
		$_2$	U_8 – low level	0.65	0.69	2
	Lower	$_3$		0.26	0.3	2
Oscillator current, mcA		I_{OSC}	U_{Batt}=12.0 V	34	54	
Oscillator frequency, Hz		f_2	C4 disconnected, C_2=68nF, ope-rating cycle – 50%	56	90	

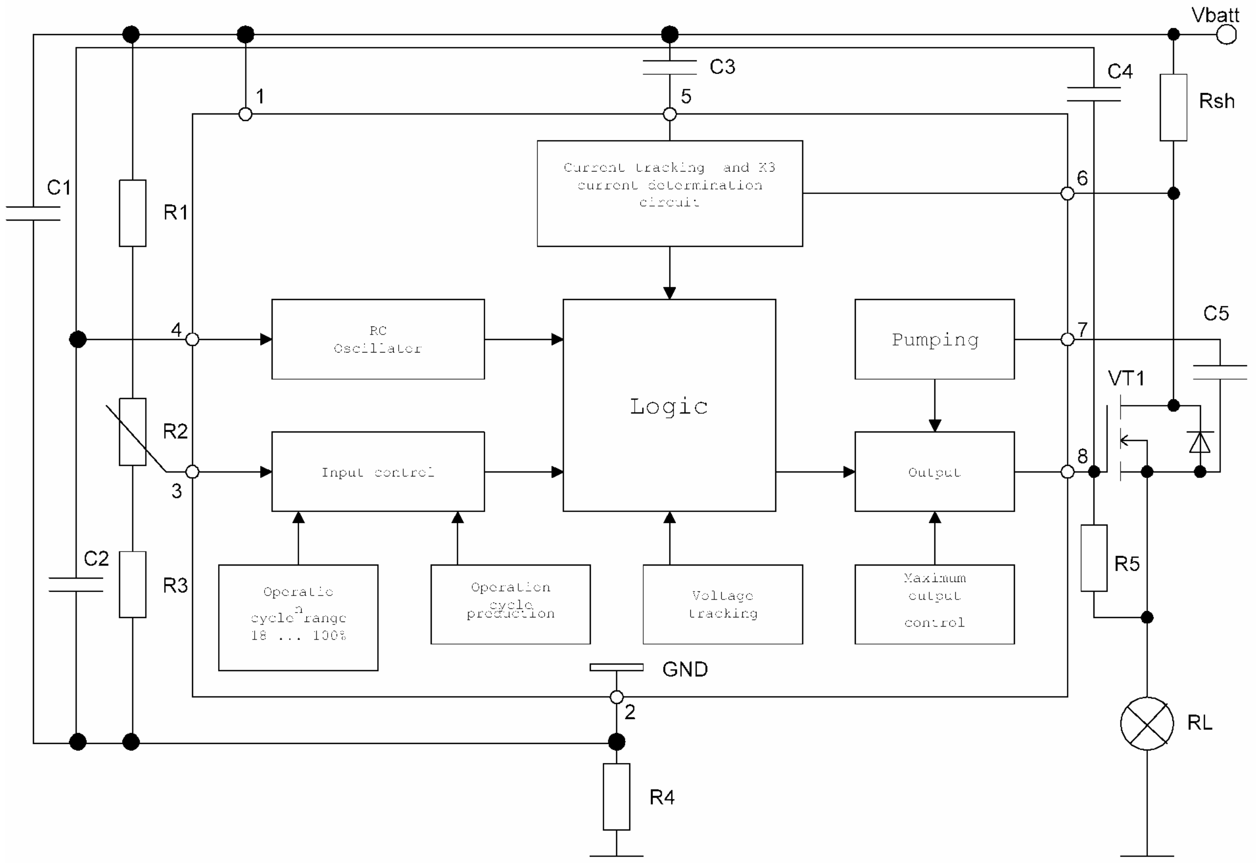
Notes:
1. Measurements are to be performed relative to ground of the supply source (U_{Batt}).
2. $_1=U_{T100}/U_S$, $_2=U_{T<100}/U_S$, $_3=U_{TL}/U_S$

U_{T100} – upper voltage of the switching threshold (100% operating cycle)

$U_{T<100}$ – switching threshold voltage (operating cycle < 100%)

U_{TL} – switching threshold lower voltage

Type Circuit of Microcircuit Enabling



C1=47mcF;
C2=68nF;
C3=100nF;
C4=1.8nF;
C5=47nF;

R1, R3 – rated values;
R2=47kOhm;
R4=150Ohm;
R5=1MOhm;
Rsh – shunting resistor
RL – load.

Figure 1 – Type circuit of enabling microcircuit IL6083N

Pin Designation Table

Pin Number	Purpose of Pin
1	Supply voltage pin (**U_{Batt}**)
2	Common pin (**GND**)
3	Control pin (**U_I**)
4	Internal oscillator pin (**Osc**)
5	Pin of short circuit current detrmination (**Delay**)
6	Pin for protection from short circuit current (**Sense)**
7	Voltage doubler pin (**2Us**)
8	Control pin of external transistor gate (**Output**)

Functional Description

IC IL6083N is designed for direct control of power MOS transistor and is suitable for control of lamps brightness for backlighting the indicator panel of the car borne systems status. IC is connected directly to the transport vehicle mains (U_{Batt}) via the resistor of 150 Ohm
(R4 in Figure 1), jointly with the decoupling filtering capacitor of 47 mcF (C1 in Figure 1). The device has the internal oscillator, whose frequency depends upon capacitance of the external capacitor C2.

Principle of operation of the pulse width modulation controller IC depends upon porocity alteration of the positive voltage output pulses, arriving at the gate of the external power MOS transistor in dependence upon voltage at the control input «U_I» (pin 3) (connection is done by means of the potentiometer).

Fill-up coefficient of the output signal is determined as ratio of the functioning pulse duration to period and is within the range from 18 to 100% for IL6083N and from 10 to 100% for IL6083N-01.

If voltage increase occurs U_{Batt} > 20 V (typ.), the external transistor is diabled and enabled again at U_{Batt} < 18,5 V (hysteresis).

If U_{Batt} > 28,5 V (typ.), controller limits voltage, reducing it from Us = 26 V to 20 V. In case of the high voltage occurance in the supply circuit, the gate of the external MOS transistor remains under the microcircuit ground potential, thus performing voltage separation between the transistor and the lamps (i. e. protects load). Meanwhile, protection from short circuit does not function. At U_{Batt} approximately < 23 V, the overvoltage detection circuit of step 2 is diabled. Thus, during the overvoltage detection of step 2 the lamp voltage Ulamp is computed by the formula:

Ulamp = U_{Batt} - Us - Ugs
Us – microcircuit stabilized voltage during overvoltage detection of stage 2.
Ugs – voltage drain-gate at MOS transistor.

In case, when voltage (approximately) U_{Batt} < 5V, the external MOS transistor is disabled, and the detection circuit of short circuit is disabled. Hysteresis guarantees, that the external MOS transistor will be enabled again at (approximately) U_{Batt} > 5,4 V.

In order to protect the MOS transistor in case of the ground bus rupture it is recommended to enable, to ensure the proper disabling, 1 MOhm resistor between gate and supply.

Pulse wodth is controlled by means of the external potentiometer (47 kOhm), connected to pin 3. Characteristic (turning angle / porosity) is linear. Fill-up coefficient of the output pulse at pin 8 may also vary from 18 to 100 % for IL6083N and from 10 to 100% for IL6083N-01. Further limitation of porosity is possible by means of the resistors R1 and R3 (see Fig. 1).

In order to reduce the dissipated power at the external MOS transistor and extend the service life of the lamps for backlighting the panel of indicators, the microcircuit automatically reducing the maximum operating cycle at pin 8, if the stabilized voltage exceeds Us = 13 V. Pin 3 is protected from short circuit relative to U_{Batt} and ground (U_{Batt} < 16,5 V).

Microcircuit internal RC oscillator determines the output voltage frequency at pin 8. It is determined by the external capacitor C2. It is charged by means of direct current I, from the first current source, until it attains the upper switching threshold voltage. Then the second current source will be enabled, which will branch the double current I * 2 from the charging current. Thus, capacitor C2 is discharged by means of the current I, until it reaches the lower threshold switching voltage. The second source will be cut off and the process repeats.

Example for Computation of Oscillator Frequency:

Switching thresholds

U_{T100} – upper switching threshold (100% operating cycle)

U_{T100} = Us * $_1$ = (U_{Batt} – Is * R4) * $_1$.

$U_{T<100}$ – upper switching threshold (< 100% operating cycle)

$U_{T<100}$ = Us * $_2$ = (U_{Batt} – Is * R4) * $_2$.

U_{TL} – lower switching threshold

U_{TL} = Us * $_3$ = (U_{Batt} – Is * R4) * $_3$.

Taking into consideration, that $_1$, $_2$, and $_3$ are the invariable constant values, and U_{Batt} = 12V,

Is = 4 mA, R4 = 150 Ohm:

$_1$ = 0,7 $_2$ = 0,67 and $_3$ = 0,28.

U_{T100} = (12 V – 4 mA * 150 Ohm) * 0,7 8 V.

$U_{T<100}$ = 1,4 V * 0,67 = 7,6 V.

U_{TL} = 1,4 V * 0,28 = 3,2 V.

There are 3 differentiated oscillator frequencies:

f1 for the operating cycle – 100%, without reduction of the characteristic slope by means of the capacitor C4 (see Figure 1)

$$f1 = \frac{Iosc}{2(U_{T100} - U_{TL}) * C2}$$, as C2 = 68 nF, Iosc = 45 mcA

f1 = 75 Hz.

2) f2 for the operating cycle less than 100%, without reduction of the characteristic slope by means of the capacitor C4.

As the operating cycle is less than 100%, the frequency oscillator f2 is equal to:

$$f2 = \frac{Iosc}{2(U_{T<100} - U_{TL}) * C2}$$, as C2 = 68 nF, Iosc = 45 mcA

f2 = 69 Гц.

3) f3 for the operating cycle less than 100%, with reduction of the characteristic slope by means of the capacitor C4.

$$f3 = \frac{Iosc}{2(U_{T<100} - U_{TL}) * C2 + 2U_{Batt} * C4}$$, as C2 = 68 nF, Iosc = 45 mcA, C4 = 1,8 nF

f3 = 70 Hz.

Selecting the various values C2 and C4, it is possible to obtain a number of the oscillator frequencies, f, from 10 to 2000 Hz.

Voltage increase at the lamp is proportionate to the oscillator voltage increase during the switching time in compliance with the equation:

dU_8/dt = $_4$*dU_4/dt = 2 $_4$*f*($_2$- $_3$)*(U_{Batt} – Is*R4),

where f = 75 Hz, $U_{TX} = U_{T<100}$ and $_4$ = 63
we get:
dU_8/dt = 2*63*75Hz (0,67-0,28)*(12V-4mA*150 Ohm) = 42 V/msec.

By means of the external capacitance C4 the slope can go down:
dU_8/dt = Iosc/(C4+C2/ $_4$)
where Iosc = 45 mcA, C4 = 1,8 nF, C2 = 68 nF and $_4$ = 63
then dU_8/dt = 45 mcA/(1,8 nF + 68 nF/63) = 15,6 V/msec.

In order to reduce the oscillations it is recommended to include the resistor with the resistance of 100 Ohm into the capacitance circuit C4.

Lamp current is controlled by means of the external shunting resistor. If the lamp current exceeds the detection threshold of the short circuit current (U_{T2} 90 mB), operating cycle 100% and capacitor C3 is charges by the source current Ich – Idis. External MOS transistor will be cut off after exceeding the attained threshold (U_{T5}). MOS transistor will be switched on only after the single supply voltage reset. Current source, Idis, ensures discharge of the capacitance C3 by the parasitic current.

Delay time, t_d, is determined from the equation:

$$t_d = C5 * U_{T5} / (Ich - Idis)$$

as C5 = 100 nF and U_{T5} = 10,4 V, Ich = 13 mcA, Idis = 3 mcA,
we get:
t_d = 100 nF * 10,4 V / (13 mcA – 3 mcA)
t_d = 104 msec.

For protection of the extenal MOS transistor and load from the short circuit the microcircuit has the internal circuits to monitor the load current value and determination of the short circuit current, which limit the load current in the mode КЗ.

Voltage drop at the external shunting resistor Rsh is determined and measured by the short circuit determination circuit. Current is limited for the voltage drop from U_{T1} 100 mV, where $U_{T1}=Us-U_6$. As for the differences of voltages $U_{T1} – U_{T2}$ 10 mV, it ensures, that current is limited only when the short circuit determination circuit functions.

With the initial voltage supply enabling the microcircuit output is in the off condition during the half a period of the oscillator. During this time the capacitor C3 is charged by the voltage supply, thus ensuring the current limitation and protection from the short circuit in case of activating the microcircuit for the first time.

Output, pin 8, is intended for control of the power MOS transistor. The gradually accumulated charge is generated by the built-in oscillator (f_7 400 kHz) and the voltage doubler circuit. This ensures the voltage application at the gate with the operating cycle 100%.