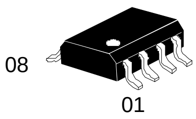
HIGH-VOLTAGE MOSFET КEY BUILT-IN LED – DRIVER

(functional analogue of HV9967 f. Suprtex inc.)

Microcircuits IL3367D, IZ3367 is a high-voltage LED – driver with built-in MOSFET кey.
It is intended for application in a modern energy-saving lighting systems and advertising-informational devices.



Index D
SO-package

IL3367D - plastic SO8-package

Figure 1 – Integrated circuit designation

Main characteristics:

- Control of LED medium current with accuracy of 3%;
- LED current mean value is set by external resistor;
- input voltage on pin SW 8 V ≤ U_{IN} ≤ 60 V;
- fixed duration of off-state, set by external resistor;
- option of LED light brightness adjustment by low-frequency PWM-signal;
- short circuit protection by output
- operating temperaturesrange from minus 40 to plus 85 °C;
- built-in MOSFET-transistor with operating voltage 60 V and the resistance of open channel 0,8 Ohm (standard value);
- option of cascade connection with a high-voltage MOSFET-transistor, operating in depletion mode.

Application scope:

- DC/DC or AC/DC LED driver ;
- LED lighting for LCD-displays;
- Multi-purpose direct DC supply
- LED panels and boards;
- architectural and decorative LED light
- charging devices.

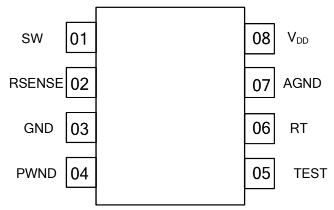


Figure 2 – Designation of pins in package of IL3367D imicorcircuit

Table 1 – Microcircuit pins assignment in package and chip contact pads

Pin number	Contact pad number	Symbol	Pin description
01	16, 17, 18	SW	MOSFET key Output, high-voltage voltage regulator input
02	19, 20, 21	RSENSE	Check current input
03	22, 23, 24	GND	Digital part common pin
04	25	PWMD	MOSFET кey PWM switching-on of
05	01	TEST	Test pin
06	02	RT	RC- generator resistor connection input
07	11	AGND	Analogue pin common pin
08	15	V_{DD}	Adjustable internally supply voltage pin
-	03 -10, 12 - 14	-	N\A

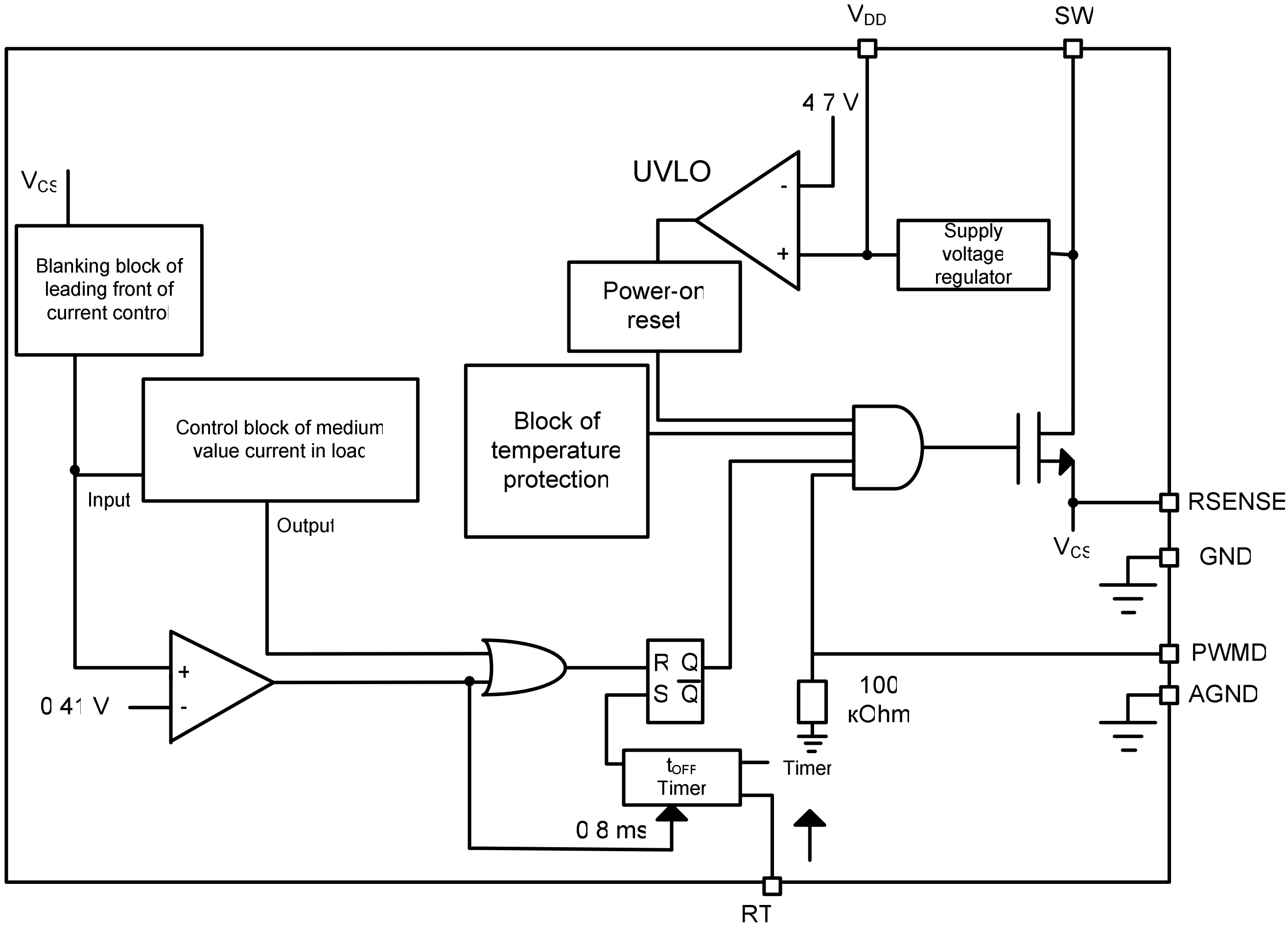


Figure 3 – Microcircuit block diagram

Table 2 – Absolute maximum ratings

Symbol	Parameter	Norm		Unit
		min	max	
U_{IN}	Input supply voltage on SW pin	8	60	V
U_{DD}	Supply voltage on V_{DD} pin	0	5,25	V
U_I	Voltage on PWMD, RSENSE, RT, pins	0	U_{DD}	V
Tj	Maximum chip temperature	-	125	°C

Table 3 – Recommended operating ratings

Symbol	Parameter	Norm		Unit
		min	max	
U_{IN}	Input supply voltage on SW pin	-0,5	65	V
U_{DD}	Supply voltage on V_{DD} pin	-0,3	6,0	V
U_I	Voltage on PWMD, RSENSE, RT, pins	-0,3	U_{DD}+0,3	V
I_{RT}	Current on RT pin	-	2	mA
Tj	Maximum chip temperature	-	150	°C

Table 4 – Electrical parameters of integrated circuit

Symbol	Parameter	Measurement conditions	Norm		Ambient temperature, °C	Unit
			min	max		
U_{DDR}	Internally as adjustable supply voltage	U_{IN} = 8; 12; 60 V R_{OSC} = 100 кOhm	4,70	5,20	25 ± 10	V
$UVLO_{RISE}$	Threshold voltage at supply voltage ramp	U_{DD} rises	4,10	4,70	-40 85	V
$UVLO_{FALL}$	Threshold voltage at supply voltage fall	U_{DD} falls	3,5	-	-40 85	V
$U_{EN(hi)}$	High level input voltage on PWMD pin	$U_{DD} = U_{DDR}$ U_{IN} = 12 V U_{PWMD} rises	-	2,00	-40 85	V
$U_{EN(lo)}$	Low level input voltage on PWMD pin	$U_{DD} = U_{DDR}$ U_{IN} = 12 V U_{PWMD} falls	0,80	-	-40 85	V
R_{EN}	Attenuating resistance on PWMD pin	U_{PWMD} = 5 V	50	150	25 ± 10	кOhm
$U_{CS(TH)}$	Threshold voltage of loading current mean value control block	U_{IN} = 12 V $U_{DD} = U_{PWMD}$= 5 V	243,0	257,0	25 ± 10	mV
			236,5	262,0	-40 85	
$U_{CS(SHORT)}$	Threshold voltage of absolute current mean value control block	U_{IN} = 12 V $U_{DD} = U_{DDR}$ $U_{PWMD} = U_{DDR}$	355	440	-40 85	mV
I_{INsd}	Off-state consumption current	U_{IN} = 60 V U_{PWMD}= 0 V	-	1,0	25 ± 10	mA
t_{BLANK}	Blanking time of check current lead front	U_{IN} = 12 V $U_{DD} = U_{DDR}$ $U_{PWMD}= U_{DDR}$	140	290	-40 85	ns
$t_{ON(MIN)}$	Driver switch-on minimum time	U_{IN} = 12 V $U_{DD} = U_{DDR}$ U_{RSENSE} = 300 mV	-	950	-40 85	ns

Table 4 (cont.)

Symbol	Parameter	Measurement conditions	Norm		Ambient temperature, °C	Unit of measurement
			min	max		
t_{DELAY}	Delay time of switching of SW output at signal change on RSENSE input	U_{IN} = 12 V U_{DD} = U_{DDR} U_{RSENSE} = 500 mV	-	150	25 ± 10	ns
t_{HICCUP}	Driver switching off time in absolute maximum current mode	U_{IN} = 12 V U_{DD} = U_{DDR}	500	1100	25 ± 10	us
$t_{ON(SHORT)}$	Driver switching on minimum time in absolute maximum current mode	U_{IN} = 12 V U_{DD} = U_{DDR} U_{RSENSE}= 500 mV	-	400	25 ± 10	ns
t_{OFF}	Driver switch off time duration	U_{IN} = 12 V U_{DD} = U_{DDR} U_{RSENSE}=300 mV R_{OSC} = 400 кOhm	28,0	48,0	-40 85	us
		U_{IN} = 12 V U_{DD} = U_{DDR} U_{RSENSE} = 300 mV R_{OSC} = 100 кOhm	7,0	12,0	-40 85	us
t_{OFF1}		U_{IN} = 12 V U_{DD} = U_{DDR} U_{RSENSE}=300 mV R_{OSC} = 10 кOhm	0,7	1,2	-40 85	us
I_C	Driver output current in open state	U_{DD} = 4,75 V U_{SW} =2 V	750	-	25 ± 10	mA

Short description of integrated circuit

IL3367D, IZ3367 is LED driver microcircuit , providing accurate regulation by medium current and functioning in the mode with fixed off –state duration.

In contrast to integrated circuit with peak current control the microcircuit hasn't « peak current – medium current» difference induced error . Thus accuracy and effectiveness LED current adjustment is significantly increased at change of supply voltage or load without necessity to apply compensating chains.

Driver IL3367D, IZ3367 feeding may be realized from DC main 8 – 60 V.

Mean value of output current may be programmed by selecting different value of current-measuring resistor on internal (stabilized with accuracy ±3 %) reference voltage equal to (250 ± 7) mV. The regulation of the light emitting diodes brightness is provided by change of signal porosity on input of PWM-regulator.

Information on application

Adjustment by upconverter peak current is the most economically efficient and simple way of djusting output current. However, such adjustment causes problems with current accuracy and stabilization due to error occurrence, generated by the difference «a peak current – medium current», that occurs as a result of current pulsation in output inductor and signal propagation delay in current-reading comparator.

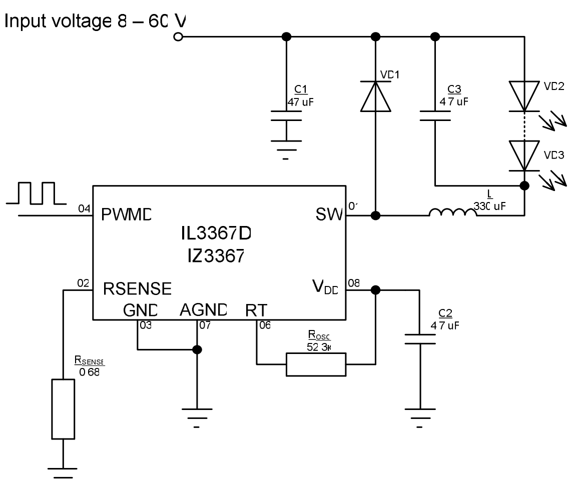
It is impossible to measure inductor current continuous signal against 'ground" in voltage adding converter because power transistor is open within only very short spaces of time.

Although it is easy to detect peak current on circuit transistor adjustment by average inductor current is normally connected to current signals with respect to voltage U_{IN}.

In IL3367D, IZ3367 corresponding control circuit is used providing quick and very accurate adjustment by average current in inductor by current of transistor read-in only. No current adjustment compensating chain is required. Current pulsations in inductor chain does not make noticeable impact on this control circuit and therefore LED current doesn't depend on change of inductance values, commutation frequency and output voltage.

The functioning in current switch-off state fixed duration in inductance coil is used for stabilization and efficiency increase in LED current adjustment in wide range of input voltages.

Standard application circuit of IL3367D, IZ3367 microcircuits is shown in Figure 4.



VD1 – diode

VD2, VD3 – the light emitting diodes

In the diagram there are shown numbers of microcircuit IL3367D pins, for IZ3367 integrated circuit see Table 1.

Figure 4 – Standard microcircuit application circuit

The description of operation of the LED-driver

IL3367D, IZ3367 microcircuits allow very accurate control of LED current in LED drivers. Microcircuit has a built-in MOSFET-transistor with operating voltage of 60 V and open channel resistance of 0,8 Ohm (typical value). It is possible sequential connection to the source of external MOSFET-transistor in case of high input voltage (more than 60 V). When MOSFET-transistor is opened, the LED-driver starts to accumulate internal energy on inductance coil or initial transformer winding, then the energy by different ways, depending on type of buck converter, enters directly light emitting diodes. The energy accumulated in a magnetic element enters output chain during off time of MOSFET-transistor, setting current in LED chains.

At input supply voltage supply when voltage on V_{DD} pin reaches threshold value of internal supply voltage of low-voltage part of the circuit UVLO, built-in MOSFET-transistor passes into on-state. Source and drain of MOSFET-transistor connected to SW and RSENSE pins accordingly. The value of output current is checked by read-in of voltage drop on current-sensing resistor connected to RSENSE pin. When given voltage reaches threshold value of comparator actuation, buil-in MOSFET-transistor keeps activated during time equal to on-time till comparator actuation. Thus, it is provided the adjustment by medium value of current. The threshold value of comparator actuation is set in the circuit internally and makes 250 mV. Medium current through LEDs is determined under the formula

$$I_{LED}=0,25 / R_{SENSE}. \qquad (1)$$

Then built in MOSFET-transistor passes into off-state on a constant period of time equal to t_{OFF}. Off-time of inbuilt MOSFET-transistor t_{OFF} is defined by the formula

$$t_{OFF} = R_{OSC} \bullet 100\ pF, \qquad (2)$$

where 10 кOhm < R_{OSC} < 400 кOhm.

When selecting nominal value inductance taking into account tolerance spread of current of sawtooth configuration 30~40% is recommended to use following formula

$$L = V_{LED}(max) \bullet t_{OFF} / (0,4 \bullet I_{LED}), \qquad (3)$$

where $V_{LED}(max)$ – voltage drop on the light emitting diodes,

I_{LED} – medium current through the light emitting diodes,

t_{OFF} – off-time of inbuilt MOSFET-transistor.

The porosity of PWM-modulation is limited to 80%, as otherwise it is possible to reduce medium current through LED at exceeding of voltage on the light emitting diodes more than 80 % from input voltage on V_{IN}.

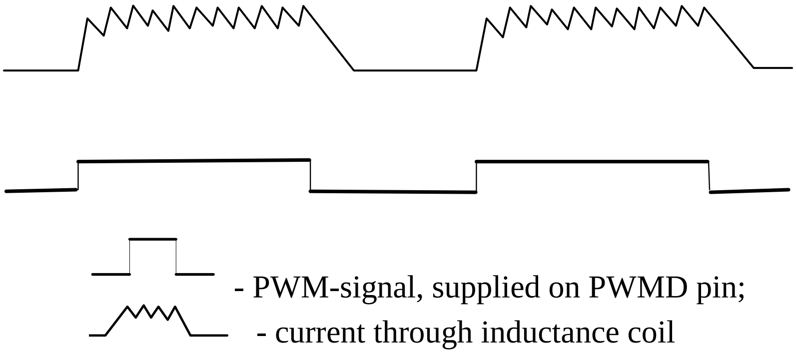
At excess of voltage on RSENSE pin 0,41 V actuates the protectioncircuit from short circuit that increases off-time of driver till t_{HICCUP} = 800 us and decreases on-time till $t_{ON(MIN)}$ = 400 ns.

IL3367D, IZ3367 microcircuits have built-in overheat protection circuit. When chip temperature will exceed 125 °C, microcircuit is switched off till the temperature falls to on 20 °C.

LED light brightness adjustment

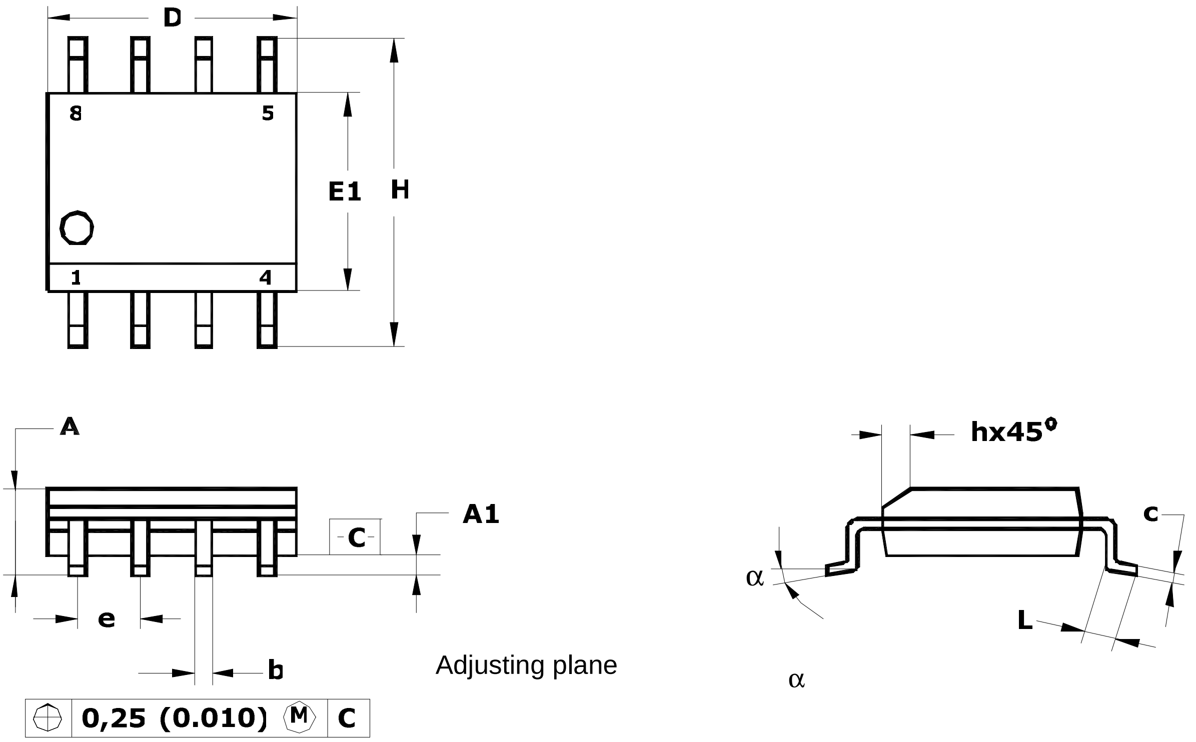
Adjustment of LED light brightness is realized by current switching ON/OFF at it's a constant value (so called PWM-attenuation). The method is based on change of LED light brightness change through change of duty factor of output current pulses.

PWM-attenuation is realized through supply of external PWM-signal on PWMD pin. PWM-signal can be generated by microcontroller or by impulse oscillator with pulses duty factor proportionally to the LED brightness degree. This signal allows or prohibits LED current modulation depending on pulse form. In this mode current value through LED can be in one of two positions: zero or nominal current value, set by read-in resistor R_{SENSE}, connected to the source of built-in MOSFET-transistor (RSENSE pin). Using this method it is impossible to obtain the LED light brightness exceeding that is limited by internally set threshold of comparator actuation. Using PWM-attenuation in operation of IL3367D, IZ3367 integrated circuits, LED light brightness is regulated from 0 to 100 %. The accuracy of the method of PWM-attenuation is limited by only minimum duration of impulse, entering the gate of the external MOSFET-transistor, that composes fractions of percent from duty factor of impulses of PWM-signal. Conventional image of IL3367D, IZ3367microcircuits reaction to supply of external PWM-signal on PWMD pin is shown on Figure 5.



- PWM-signal, supplied on PWMD pin;
- current through inductance coil

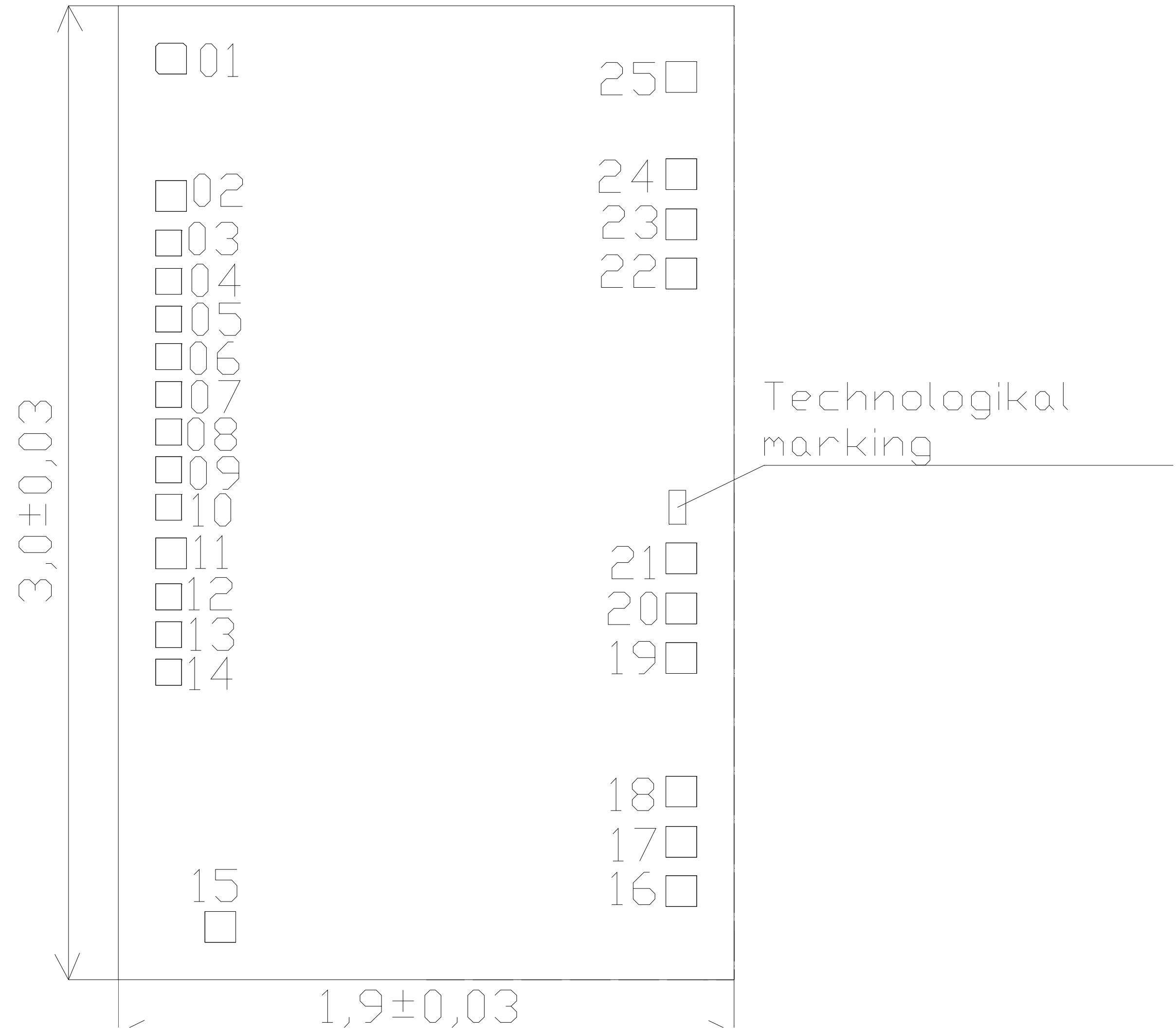
Figure 5 – Conventional image of IL3367D, IZ3367 microcircuits reaction on supply of external PWM-signal on PWMD pin



Note – Dimensions D, E1 not include value of flash that mustn’t exceed 0,25 (0.010) on side.

	D	E1	H	b	e	α	A	A1	c	L	h
Millimeters											
min	4,80	3,80	5,80	0,33		0°	1,35	0,10	0,19	0,41	0,25
max	5,00	4,00	6,20	0,51	1,27	8°	1,75	0,25	0,25	1,27	0,50
Inches											
min	0,1890	0,1497	0,2284	0,013		0°	0,0532	0,0040	0,0075	0,016	0,0099
max	0,1968	0,1574	0,2440	0,020	0,100	8°	0,0688	0,0090	0,0098	0,050	0,0196

Figure 6 – Package MS-012AA overall dimensions



Chip thickness 0,35 ± 0,02 mm.

Technological marking on chip: 3367-2. Coordinates of technological marking, um: left bottom corner x = 1,430, y = 1,715.

Chip carried out on substrate of electrically related with GND and AGND pins

Figure 7 –Contact pads layout diagram

Table 5 – Coordinates and dimensions of a contact pads

Contact pad number	Coordinates of a contact pads (left bottom corner), um		Contact pads size, um
	X	Y	
01	0,125	0,115	95 x 95
02	0,538	0,115	95 x 95
03	0,691	0,115	80 x 80
04	0,809	0,115	80 x 80
05	0,925	0,115	80 x 80
06	1,041	0,115	80 x 80
07	1,157	0,115	80 x 80
08	1,273	0,115	80 x 80
09	1,389	0,115	80 x 80
10	1,505	0,115	80 x 80
11	1,639	0,115	95 x 95
12	1,781	0,115	80 x 80
13	1,897	0,115	80 x 80
14	2,013	0,115	80 x 80
15	2,790	0,267	95 x 95
16	2,635	1,690	95 x 95
17	2,482	1,690	95 x 95
18	2,328	1,690	95 x 95
19	1,960	1,690	95 x 95
20	1,805	1,690	95 x 95
21	1,650	1,690	95 x 95
22	0,826	1,690	95 x 95
23	0,671	1,690	95 x 95
24	0,416	1,690	95 x 95
25	0,172	1,690	95 x 95
Note – Coordinates and dimensions of a contact pads are given by «Passivation» layer			