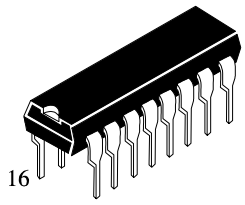
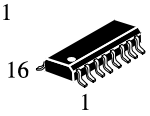
AMPLIFIER IC FOR SENSORS WITH DIFFERENT CONDUCTANCE

Functional Description

Designed IC is an integrated circuit (IC) of the amplifier for sensors with different conductance. IL1815 – is an IC of adaptive amplifier increasing analog signal from the sensor and transmitting a strobe of pulses from IC output into electrical circuit of motor engine control device. The amplifier ensures one short output pulse leading edge of which coincides with negative half-wave, crossing zero of input analog signal produced by alternating magnetic field of inductive sensor coil.



N SUFFIX
PLASTIC



D SUFFIX
SOIC

T_A = –40 ÷ +125°C

Functions

IC is purposed for application in automotive electronics in injection controller block as well as in engine control system for:

- crankshaft position (condition) control;
- Switching when crossing zero;
- engine rotation speed control;
- tachometer (rotation speed measurement);
- engine check (testing).

IC IL1815 is analog to microcircuit of the third integration scale and comprises 131 elements. The circuit is implemented in 14-pin DIP-package of MS-001AA (IL1815N) type and in 14-pin SO-package of MS-012AB (IL1815D) type.

Connection of loading of 1 kOhm to IC output (to pin 10) is tolerable.

Features

- Adaptive hysteresis
- One-polar power supply mode
- Influence of «ground» on input
- Precise choice of the initial ignition moment
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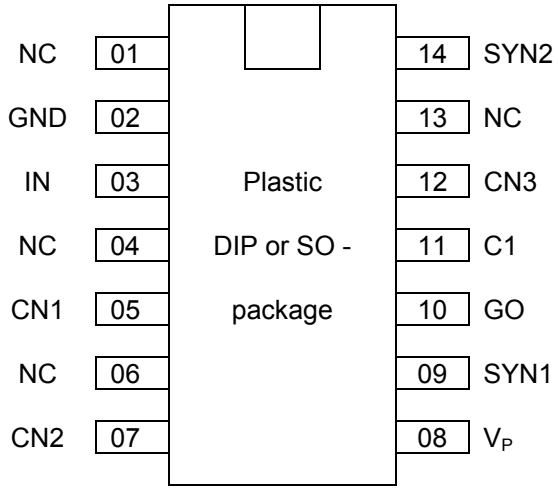
- Operation in the supply voltage range of 2,5 V up to 12 V
- control of input (pin 3) by signal coming into external resistor with amplitude from 75 mV up to 120V.
- Compatibility with CMOS - logic

INTEGRAL

Pin symbols.



Pin description table.

Table of pin description in IC IL1815N (for 14-pin DIP package of MS-001AA type) and IC IL1815D (for 14-pin SO package of MS-012AB type)

Number	Symbol	Description
01	NC	Not connected
02	GND	Common output
03	IN	Signal input
04	NC	Not connected
05	CN1	Input of sensitivity threshold control
06	NC	Not connected
07	CN2	Output of capacitance peak detector
08	Vp	Supply output from voltage source
09	SYN1	Synchronization input
10	GO	Gate output
11	CI	Choice input
12	CN3	Reference voltage output
13	NC	Not connected
14	SYN2	Output of RC – synchronization

Table of maximum ratings

Symbol	Parameter	min	max	Unit
V_P	Supply voltage	2,0	12,0	V
P_{tot}	Maximum dissipated power [1)]	-	1250,0	mW
T_{stg}	Storage temperature	-65	150	°C
T_c	Maximum chip temperature[2)]	-	125	°C
I_I	Input current	-	±30	mA

Note:
Short-term temperature rise of chip up to 150°C is tolerable.

Maximum absolute ratings

Symbol	Parameter	min	max	Unit
V_P	Supply voltage	2,5	12,0	V
T_c	Maximum chip temperature	-	125	°C

Table of electrical parameters (for T_a(ambient)=25°C; supply voltage V_p=10 V and in compliance with connection circuit given in Fig. 1 without L1)

Symbol	Parameter	Test conditions	Target		Unit
			min	max	
I_P	Consumption current	f_I=500 Hz, output 09=2 V, output 11=0,8 V	-	6,0	mA
W	Width of reference pulse on output 12	f_I=from 1 Hz to 2 kHz, R1=150 kOhm, C1=0,001 mkF	70,0	130,0	mks
I_{IB}	Bias current of logic input	V_I=2 V (on outputs 09 and 11)	-	5,0	mkA
Z_I	Input impedance	[1)] V_I=5 B (rms)	12,0	28,0	kOhm
V_{CROSS}	Threshold of crossing zero	V_I =100 mV (on output 03)	-	25,0	mV
V_{TL}	Threshold of logic input	On outputs 09 and 11	0,8	2,0	V
V_{OH}	High output voltage	R_4=1 kOhm (output 10)	7,5	-	V
V_{OL}	Low output voltage	I_{SINK}=0,1 mA (output 10)	-	0,4	V
V_{TA}	Input switching threshold	Mode 1: output 05 is open, $V_I \leq$135 mV	30,0	60,0	mV
		Mode 1: output 05 is open, $V_I \geq$230 mV	40,0	90,0	[2)] % from U_{03} + P_K
		Mode 2: output 05 is shorted to V_P	200,0	450,0	mV
		Mode 3: output 05 is shorted to «ground»	-25,0	25,0	mV
I_{LS}	Output leakage current on output 12	V_{12}=11 V	-	10	mkA
V_{SV}	Saturation voltage on output 12	I_{12}=2 mA	-	0,4	V

Note:

1) Measured with external input resistor of 18 kOhm. The circuit comprises series connected resistor of 1 kOhm with diode, connected to «ground» which attenuate input signal;

2) numerical value of the rate on the controlled variable V_{TA}, is defined by percentage of U_{03} signal sum incoming on output 03 and P_K voltage level on output 07 of peak detector.

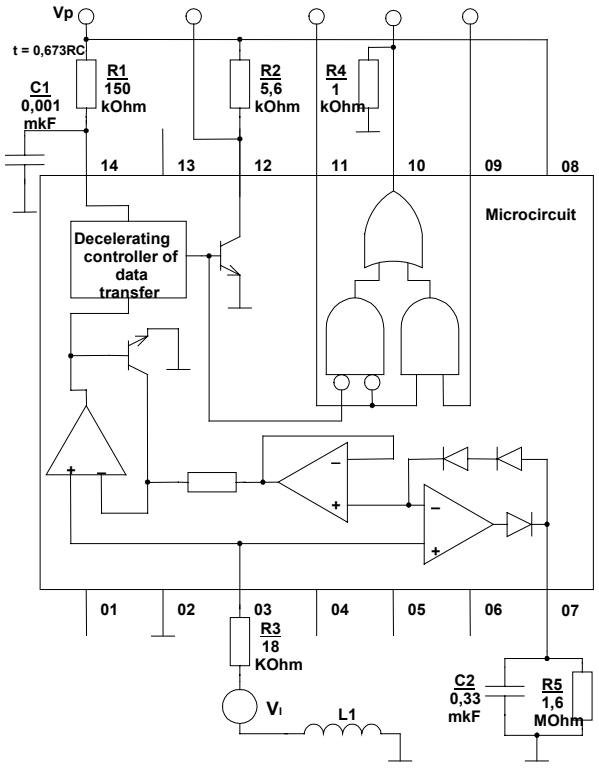
Electrical parameters (for T_a(ambient)=25°C; supply voltage V_p=10 V and in accordance with connection circuit shown in figure 1 without L1)

Symbol	Parameter	Test conditions	Target	Unit
			Typical value	
I_{IS}	Bias current of signal input (on output 03)	V_I=0 V direct component (output 03)	200,0	nA

Table 1 – Truth table

Signal input pin 03	RC-synchronization pin 14	Choice input output 11	Synchronization input pin 09	Gate output pin 10
± pulses	RC	L	X	Pulses = RC
X	X	H	H	H
X	X	H	L	L
± pulses	L	L	L	Crossing zero level

External loading connection circuit and preferred application circuit



Functionality description

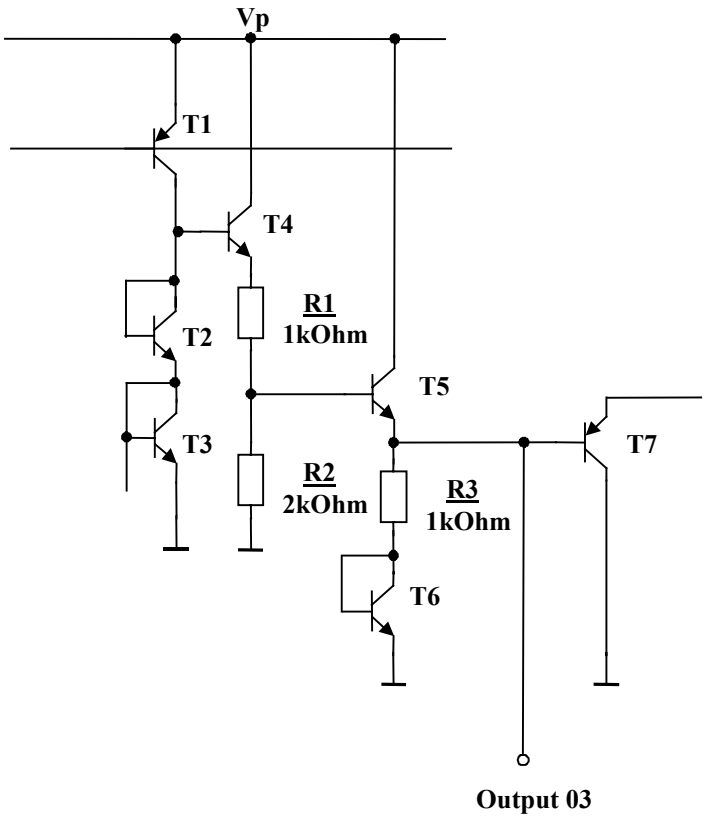
Under normal operation (function) conditions the signal synchronized by reference voltage source (from pin 12) having passed the controller of data transmission delay (see fig.1) and transformed by external electrical circuit returns into the IC. Then, logic input (pin 11) enables to choose whether synchronization signal (from clock synchronization input –

pin 09) or processed input signal (from pin 03), having passed the controller of data transmission delay, for transmission to output stage of IC logic block.

The amplifier is started by incoming positive threshold voltage that is generated during effect of voltage peak on output 07. This peak appears when input signal comes into output 03 of the circuit and its maximum value varies in time with input signal amplitude. Thus, input hysteresis changes with amplitude of input signal. That allows electrical circuit to perceive the signal where high-frequency noise is grater than amplitude of input signal of lower frequency. Minimum amplitude of input signal V_I = 75 mV.

Latching circuit of input voltage.
Voltage of input signal on output 03 is internally fixed.

Напряжение входного сигнала на выводе 03 внутренне зафиксировано. Remaining limit of input signal on this output is ensured by external resistor R3 (see fig.1), which is to be chosen to provide maximum current (amplitude value) ±3 mA in normal operation conditions.



Input voltage latching circuit.

Positive inputs of amplifiers (from output 03) are fixed in electrical circuit (see fig.2) by connected in series resistor R3 and diode T4 connected to «ground». Therefore for changes of input signal exceeding 500 mV relative to «ground» level, input current will be «dropped» on «ground» through output 02 of the device. On the other hand, active limits of the above mentioned **latch** tie output 3 usually to 350 mV below «ground» level for negative input signals (see R1, R2, T2, T3 in fig.2). Thus, for transmitting input signal more

than 350 mV below «ground» level, current of input output 03 (right up to 3 mA) will be sourced from supply output V_P. If output V_P is not shunted insufficiently from incoming pulsation voltage, normal operation of the device on output V_P will be disturbed. Similarly, minor changes of «ground» potential appear on output 02 of the device, in consequence of which, poor quality of equipment earth related to «ground» of input signal may cause unreliable device operation. Thus, to ensure combined input voltage and frequency range of IC operation it's necessary to think over an adequate device ground connection and avoid pulsations of supply voltage V_P.

Limitation of input current.

As mentioned above, current limit for signal input (output 03) is ensured by the user by means of external resistor R3 (fig.1). For applications where signal of input voltage is not symmetric regarding «ground» the worst case of voltage peak may be calculated by the following formula:

$$R3_{MIN} = (V_{IN} \text{ peak}) / 3 \text{ mA} \qquad \textbf{(1)}$$

In applied example shown in figure 1 (when R3=18 KOhm), recommended maximum input signal voltage is ±54 V (amplitude value).

Operation of sensor actuation (detection device) when crossing zero.

LM1815 is purposed for operation as sensor of crossing zero starting unit internal counting when input signal negative half-wave (trailing edge) crosses zero. As against other sensors of crossing zero, LM1815 can't be started until input signal crosses switching threshold on positive part of waveform, only afterwards electrical circuit is connected again. The following crossings of zero are disregarded unless switching threshold is exceeded again. This switching threshold changes depending on connection of output 05. There can be three different operation modes.

Mode 1, output 05 is not connected (open).

In this mode when amplitude of input signal more than typical value ±75 mV and less than ± 135mV - typical value of switching threshold makes 45 mV. Under these conditions input signal has to cross first 45 mV of switching threshold in positive direction in order to «equip» the sensor of crossing zero, and then cross zero in negative direction to start it.

If signal amplitude is less than 30 mV (minimum in the range of electrical characteristics), short pulse does not guarantee IC starting (switching).

Input signals with amplitude more than ±230 mV ensure switching threshold of 80% (typical value) of input voltage peak. Capacitor of peak detector in the device on output 07 stores (memorizes) the value regarding positive input peaks determining switching threshold. Input signals have to exceed this switching threshold in positive direction in order to «equip» sensor of crossing zero which operates on negative wavefront (edge) of input signal.

Pulses of peak detector change quickly according to increase in amplitude of input signal and attenuate owing to the property of externally connected to output 07 resistor, decreasing input signal. In case when amplitude of input signal decreases quicker than voltage stored on the capacitor of peak detector, output signal may decrease until the voltage on capacitor becomes very minor, equal to the «ground» level.

Note that after input voltage is fixed, waveform observed on output 03 is not identical to the one observed on variable reactive sensor. Just as voltage stored on output 07 is not identical to pulse (variable) voltage appears on output 03.

Mode 2, output 05 is connected to V_P.

Under this mode minimum amplitude of input signal is ±200 mV. IC is started on negative wave (edge) of input signal crossing zero, after switching threshold on positive wave (edge) of input signal is exceeded.

Mode 3, output 05 - grounded.

With grounded output 05, input switching threshold is set from 0 V (typical rate) up to ±25 mV (maximum). Positive wave (front) of input signal crossing zero «equip» the zero detector and the next coming negative wave (edge) - start the IC. This is the main IC application mode.

Single-ended operation synchronization.

Pulse synchronization is preset by resistor and capacitor connected to output 14. Preferred maximum resistor value - 150 kOhm. Capacitance may be changed if needed (according to application requirements), until capacitor variable is not showing any leakage which will result adversely in RC - constant variable.

Width of input pulse is determined by formula:

$$W = 0.673 \times R \times C \qquad \textbf{(2)}$$

Since normally generated is a string of pulses of a determined width, preferred maximum input signal frequency is:

$$F_I \text{ (maximum)} = 1 / (1.346 \times R \times C) \qquad \textbf{(3)}$$

In an applied example shown in figure 1 (R=150 kOhm, C=0.001 mkF), preferred maximum input frequency will usually be 5 kHz. Under influence of input frequency higher than preferred F_I (maximum) value, operation of electrical circuit may be unreliable. For the applications which do not require generation of pulses into electrical circuit (i.e. in static operation mode), output 14 may be directly connected to the «ground».

Logic inputs and outputs.

In some systems it's necessary to generate pulses, for example, under conditions of engine shutdown (when motor car is stopped), when variable reactive sensor has no output signal. External input pulses from output 09 strobed (pulses controlled) from choice input (output 11), go to output 10 when there is a high level («H») on output 11. Output 12 - a direct output of data (generated pulses), is not subject to influence of logic on output 11.

Input/output pins 09, 11, 10 and 12 are compatible with CMOS logic. Besides, pins 09, 11 and 12 are compatible with TTL logic. Output 10 is not meant for controlling TTL loading (see fig.3). Output 12 - an open collector of NPN-transistor.

Pins 01, 04, 06 and 13 do not have internal connections and may be «grounded».

Diagram of IC output.