BL0937 Application Note

Catelog

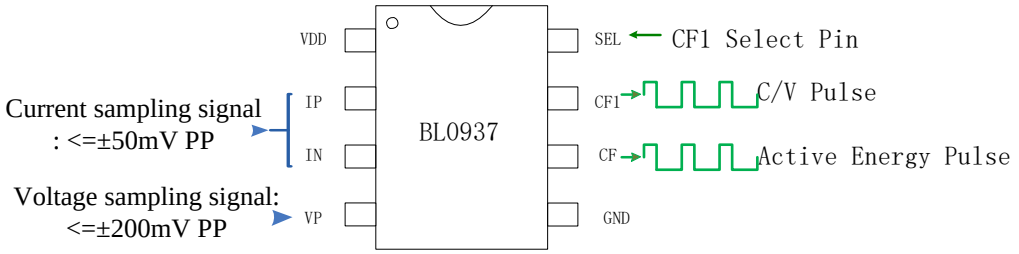
Overview

The BL0937 is a high accuracy electrical energy measurement IC intended for single-phase application. It measures line voltage and current and calculates active energy and instantaneous rms voltage and current. The devices are suitable for multifunction smart electricity meters, power distribution units for corporate data centers, and in-home energy monitors for consumers.

BL0937 Features

- High accuracy, less than ±0.5% error over a dynamic range of 2500: 1
- High stability of large signal, in the condition of signal 300mA, less than ± 0.2% error in the output frequency fluctuation (CF).
- High stability of small signal, in the condition of signal 50mA, less than ± 0.3% error in the output frequency fluctuation (CF).
- Current and voltage RMS, current measurement range (4mA ~ 30A) @ 1mohm
- On-Chip anti-creep protection
- On-Chip power supply detector
- On-Chip voltage reference of 1.218V(Typical)
- On-chip oscillator as clock source, 2MHz (Typical)
- Single 3.3V supply, low power consumption (6 mW Typical)
- SOP8

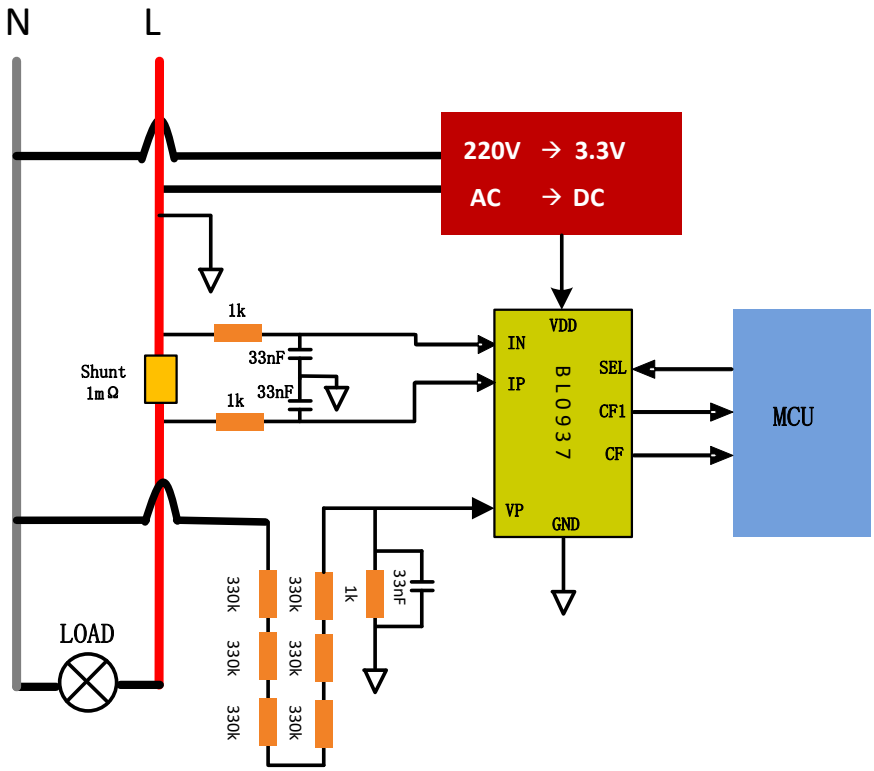
Pin Description:



Pin	Symbol	DESCRIPTIONS
1	VDD	Power Supply (+3.3V). Provides the supply voltage for BL0937 It should be maintained at 3.0V~3.6V when IC is working
2,3	IP, IN	Inputs for Current Channel. These inputs are fully differential voltage inputs with a maximum signal range of ±50 mV PP(35mV rms). Because of the internal ESD protection circuit, If the voltage exceeds ± 1.5V the IC will not be damaged badly.
4	VP	Positive Input for Voltage Channel. The Voltage Inputs is differential voltage inputs with a maximum signal range of ±200 mV PP(141mV rms). Because of the internal ESD protection circuit, If the voltage exceeds ± 1.5V the IC will not be damaged badly.
5	GND	Ground Reference.
6	CF	High frequency pulse output for active power, the pulse width is fixed to 38uS (Typical), the frequency is proportional to the active power value. Over-current indication pin; If over-current occurs, the pin output 6.78KHz pulse.
7	CF1	SEL=0, the output pulse is current RMS, the pulse width is fixed to 38uS (Typical), The frequency is proportional to the current RMS value; SEL=1, the output pulse is voltage RMS, pulse width is fixed to 38uS (Typical), The frequency is proportional to the voltage RMS value;
8	SEL	RMS pulse output select.

Typical Application Circuit:

Design parameters: Line voltage=220V(nominal), Imax=16A, Shunt Size=1mΩ



The shunt size(1mΩ) is selected to maximize the use of the dynamic range on current channel. However, there are some import considerations when selecting a shunt for an energy metering application. First, minimize the power dissipation in the shunt. the maximum rated current can be 35A,therefore the maximum power dissipated in the shunt is $(35A)^2 \times 1m\Omega=1.225W$. Secondly, the higher power dissipation may make it difficult to manage the thermal issues. High temperatures may cause significant error at heavy loads. So, the maximum rated current@ (1mΩ shunt) should be limited to 16A.

The line voltage attenuation is carried out by a simple resistor divider. In this design the line voltage is attenuated down to $(220V \times 1K\Omega)/(330K\Omega \times 6+1K\Omega)=111mV$ rms.

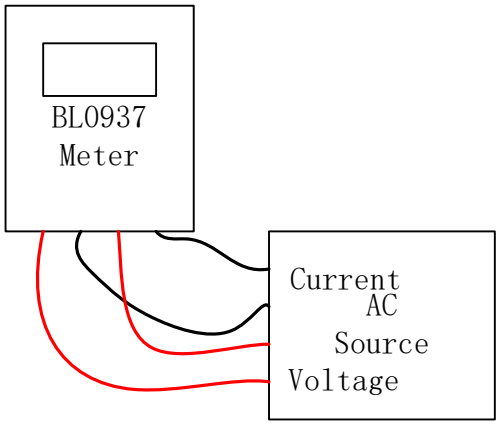
The interface between BL0937 and MCU is very simple. only 3 GPIO of the MCU need connected to CF, CF1 and SEL PINS. By measuring the pulse period of CF and CF1, MCU calculates the active power, RMS voltage and current, and then counts the active energy.

Calibrating the BL0937

To obtain accurate readings that do not reflect meter-to meter variations in external components or the internal voltage reference and the internal Clock. The BL0937 requires calibration. It is a simple process that can be performed quickly.

Accurate source is used a perform the calibration. The accurate source must be able to provide a controllable voltage and current input with higher accuracy than that required

in the resulting meter. The following figure shows a typical setup using an accurate source.



It is recommended to use the single-point calibration method. the accurate source provide the rated voltage U0(V), current I0(A) and active power P0(W) to the BL0937 meter. The corresponding pulse frequency U_Freq0(Hz), I_Freq0(Hz) and P_Freq0(Hz) measured by MCU can be converted to the corresponding conversion coefficient:

$$\text{Voltage coefficient Ku} = \frac{\text{U0}}{\text{U\_freq0}}$$

$$\text{Current coefficient Ki} = \frac{\text{I0}}{\text{I\_Freq0}}$$

$$\text{Active Power coefficient Kp} = \frac{\text{P0}}{\text{P\_Freq0}}$$

These coefficients are stored in the MCU system. In normal mode, the output pulse frequency of BL0937 changes with the change of LOAD. MCU measures the pulse frequency of BL0937 and calculate the corresponding voltage, current, power by using the coefficients.

About Active energy measurement:

According to the active power coefficient Kp, the active energy can be obtained by counting the CF pulse.

(1 kWh: the active power is 1000W, lasting for 1 hour, and the power consumption is 1 KWH)

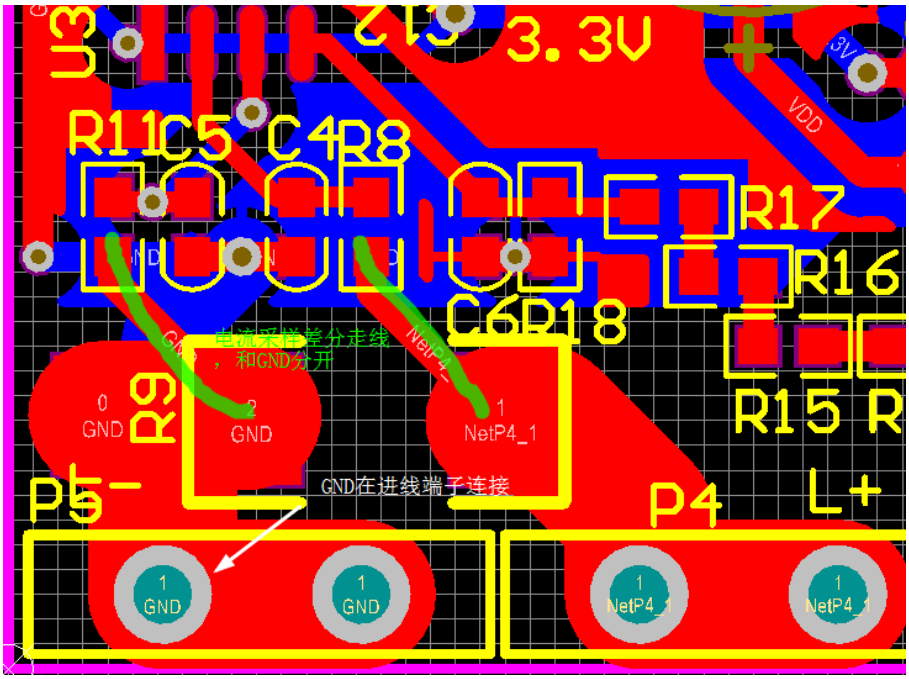
$$\text{the Active Energy /CF} = \frac{\text{P0}}{\text{Freq0}*3600000} = \frac{Kp}{3600000}\ \text{kWh}$$

PCB Layout Considerations

1) The resistors and capacitors of the current sampling should be close to the IP,IN Pin of the BL0937 to prevent crosstalk from the other signal on the PCB; (current sampling signal maybe 5uV ~ 16mV)

2) The load current is flowing through the shunt resistor, the heavy load current maybe exceed 16A. so, keep the current wire as wide as possible.

3) If SMT shunt resistor is used for current sampling, In order to reduce the crosstalk to the current differential sampling signal, the ground wire of the sampling resistor is separated from the power supply ground. The ADC of BL0937 is differentia sampling channel. The PCB wire of current sampling IP and IN should be balanced as far as possible, and the wire should be kept parallel and as short as possible.



L+, L-, R8, C4, C5 and R11 in the figure above are wired;

4) The BL0937's power supply ground is connected to L- terminal by copper; To improve the anti-jamming capability.

5) The decoupling capacitor C12 of the power supply of BL0937 is as close as possible to the chip VDD pin.

References: BL0937_datasheet