Features

- True RMS-to-DC Conversion
- Fast settling time for all input levels
- **Input level is specified up to 400mV$_{RMS}$**
- **Averaging capacitor is typically 22uF**
- **Negative output voltage**
- Computes RMS of AC and DC Signals
- Single or Dual Supply Operation
- Low Cost
- Power-Down Function
- **Low Power: 220 μA typically**
- **Wide power supply range : from ± 2.5V to ±6V**
- **8-pin SOP package**

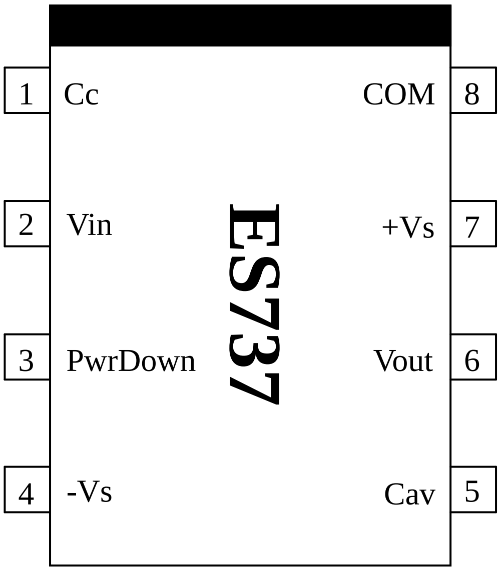
Description

The ES737 series are designed for the true RMS-to-DC conversion. ES737 accept low-level input signals from 0 to 400 mV $_{RMS}$ complex input waveforms. ES737 can be operated form either a single supply or dual supplies. The device draws less than 0.3 mA of quiescent supply current, furthermore, an enable pin is provided to turn-off the device, making it ideal for battery-powered applications.

Application

* Digital Multi-Meters
* Battery-Powered Instruments
* Panel Meter

Pin Assignment: ES737



SOP 8 Pin Package

Pin Description

Pin No	Symbol	Type	Description
1	Cc	I	Low-Z measurement input
2	Vin	I	High-Z measurement input.
3	PwrDown	I	Pull high (+Vs) to enable power-down function.
4	-Vs	P	Negative supply voltage.
5	Cav	I/O	Averaging capacitor
6	Vout	O	Measurement output.
7	+Vs	P	Positive supply voltage.
8	COM	P	Power ground

I: input, O: output, P: power

Absolute Maximum Ratings

Supply Voltage: Dual Supplies .... ±6V
Single Supply ....+12V
Input Voltage: .... ±6V
Power Dissipation (Package)
SOP…………………………………………………………………450mW
Operating Temperature Range ....……………………………......-20℃ to +70℃
Storage Temperature Range.....…………………...…………...........-55℃ to +150℃
Lead Temperature (Soldering, 10sec)....………………………………...............300℃

Electrical Characteristics-ES737

(T_A= +25℃, Vs = +3V, -Vs = -3V, unless otherwise noted.)

PARAMETER	CONDITIONS			MIN	TYP	MAX	UNITS
Transfer Equation					$V_{OUT} = \sqrt{avg.[(V_{IN})^2]}$		
Averaging Time Constant					6		ms/µF C_{AV}
CONVERSION ACCURACY							
Total Error, Internal Trim **(Notes 1)**	ES737					±0.5 ± 1.2	mV ±% of Reading
Total Error vs. Temperature (-20℃ to + 70℃)					±0.1 ±0.01		mV ±% of Reading/℃
Total Error vs. Supply					±0.1 ±0.01		mV ±% of Reading/V
Total Error vs. DC Reversal	VIN=±400mV					±2.5	±% of Reading
Total Error, External trim					0.1/0.2		mV ±% of Reading
Additional Error **(Note 2)**	Cav=10µF	Crest Factor = 1	400mV		Specified Accuracy		±% of Reading
		Crest Factor = 2	200mV		0.3		
			400mV		0.3		
		Crest Factor = 3	200mV		0.5		
			400mV		0.5		
		Crest Factor = 4	200mV		1.0		
			400mV		1.5		
FREQUENCY RESPONSE							
Bandwidth for 1% Additional Error (0.09dB)	10mV				6		kHz
	100mV				40		
	200mV				60		
	400mV				70		

Electrical Characteristics-ES737 (continued)

(T_A= +25℃, Vs = +3V, -Vs = -3V, unless otherwise noted.)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
INPUT CHARACTERISTICS						
Input Signal range	Continuous RMS, All Supplies			0 to 400		mV_{RMS}
	Peak Transient	±2.5V Supplies			1	V_{PK}
		±3V Supplies			1.5	
		±5V Supplies			2.8	
Input Resistance				100		MΩ
Input Offset Voltage **(Note3)**	ES737				±0.5	mV
OUTPUT CHARACTERISTICS						
Output Voltage Swing	+3V, -3V Supplies		1			V_{RMS}
	±5V Supplies		1	1.5		
Output Resistance			-	20	-	kΩ
Power SUPPLY						
Rated Performance				±3		V
Dual Supplies			±2.5		±6	V
Single Supply			+5		+10	V
Supply Current	±3V Supply. Vin connects to COM			220	-	μA
Supply Current (Power Down)	Pin3 connects to V+			25	40	μA

Note 1: Accuracy is specified for 0 to 400mV, 1kHz sine-wave input. Accuracy is degraded at higher RMS signal levels.

Note 2: Error vs. crest factor is specified as an additional error for $200mV_{RMS}$ and $400mV_{RMS}$ rectangular pulse input, pulse width = 200μs

Note 3: The input offset voltage can be reduced or canceled by an external 500kohm variable resistor shown in Figure 3.

Detailed Description

Figure 1 shows the simplified schematic of ES737. It consists of four major sub-circuits: absolute value circuit (rectifier), square/divider, current mirror and buffer amplifier. The actual computation performed by the ES737 follows the equation:

$$V_{RMS} = \text{Avg. } [V_{IN}2 ／ V_{RMS}]$$

The input voltage, V_{IN}, applied to the ES737 is converted to a uni-polar current I_1 (Figure 1) by the absolute-value/voltage. This current drives one input of the squarer/divider that produces a current I_4 , which has the transfer function:

$$I_4 = \frac{I_1^2}{I_3}$$

The current I_4 drives the internal current mirror through a low-pass filter formed by R1 and the external capacitor, C_{AV}. As long as the time constant of this filter is greater than the longest period of the input signal, I_4 is averaged. The current mirror returns a current, I_3, to the square/divider to complete the circuit. The current I_4 is then a function of the average of (I_1^2/ I_4), which is equal to I_{1RMS}.

The current mirror also produces a $2 \cdot I_4$ output current, I_{OUT}, that can be used directly or converted to a voltage using resistor R2 and the internal buffer to provide a low-impedance voltage output. The transfer function for the ES737 is:

$$V_{OUT} = 2 \cdot R2 \cdot I_{RMS} = V_{IN}$$

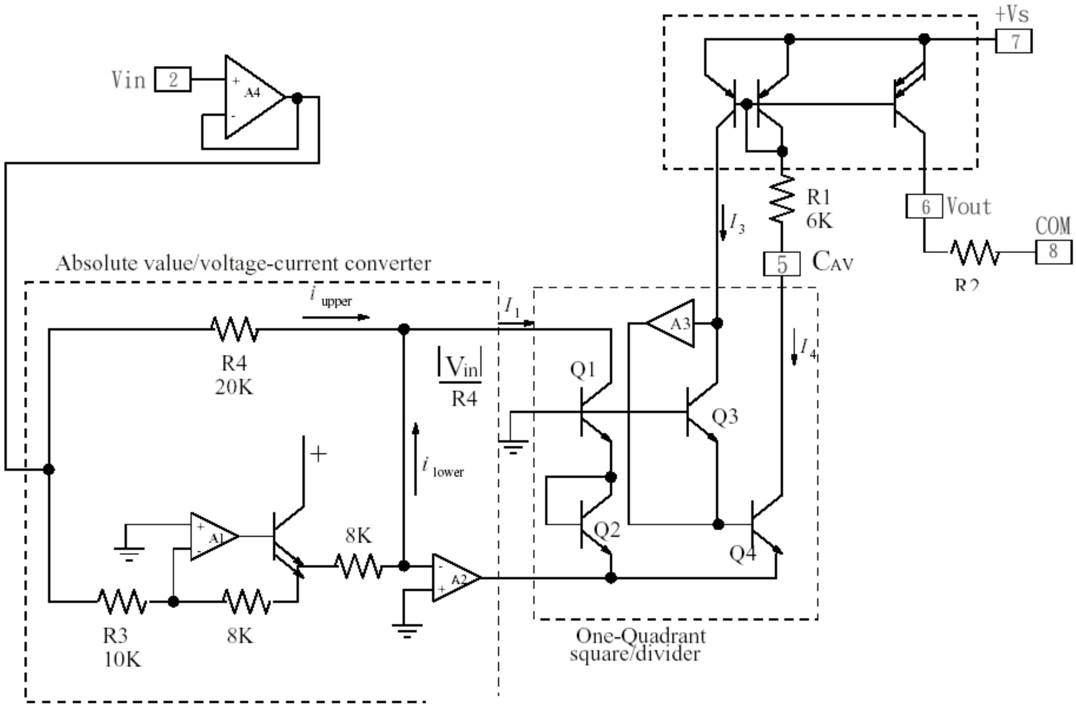


Figure 1. ES737 Simplified Schematics

Standard Connection for ES737 (Figure 2)

The standard RMS connection requires only two external components, Rin and C_{av}. Other components shown in figure 2 are optional. In this configuration, ES737 measure the RMS of the AC and DC levels present at the input, but shows an error for low-frequency inputs as a function of the C_{av} filter capacitor. Figure 4 gives practical values of C_{av} for various values of averaging error over frequency for the standard RMS connections (no post filtering). If the DC error can be rejected, a capacitor Ccp should be connected in series with the input, as would typically be the case in single-supply operation.

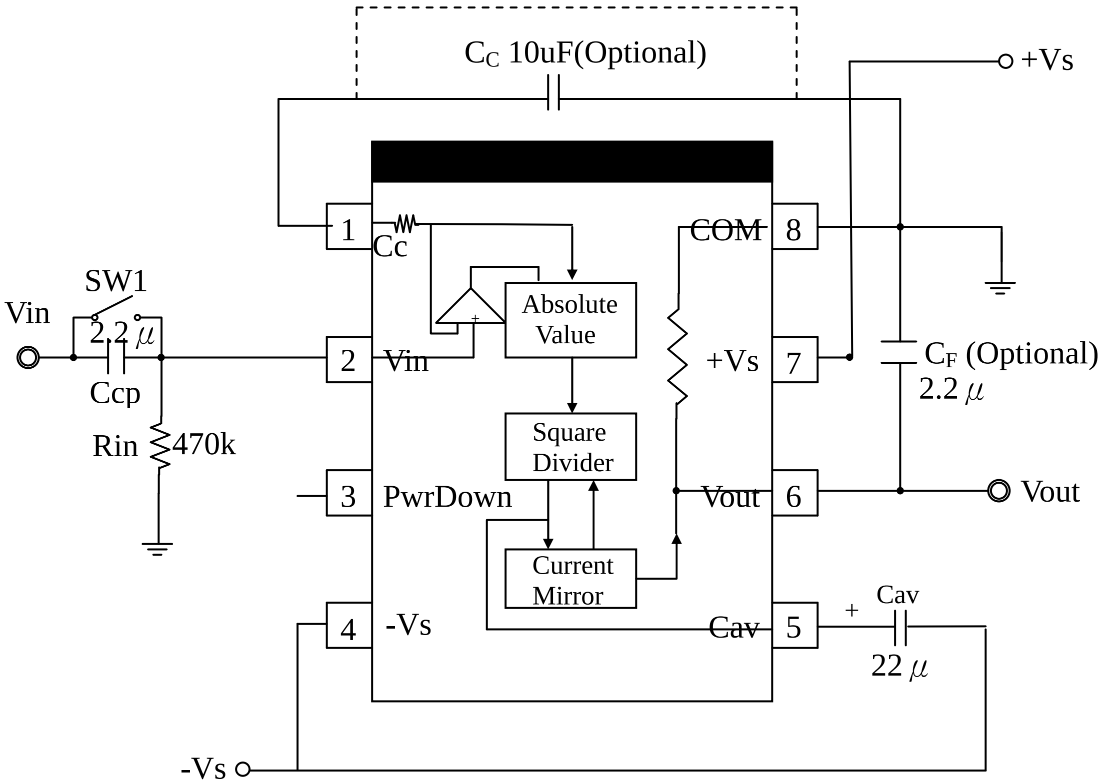


Figure 2. Standard connection for ES737.

Note:

1. SW1 is opened for AC-coupled (Cc is necessary for this case) operation, or closed for direct input.
2. PwrDown pin is pulled to –Vs or keeps floating for normal operation. Connect it to +Vs will force ES737 to enter power down mode.

To Adjust the zero-offset & scale factor trim of ES737 (Figure 3)

The output of some ES737 ICs may have an offset voltage when the input is zero. The amount of this offset voltage might be different in every ES737. We provide pin1-Cc to achieve the reduction of zero offset voltage. The test circuit is shown as below. The 500kohm VR, 100kohm and 100ohm resistors are used to reduce zero offset voltage. Adjusting the 500kohm VR can reduce the zero offset voltage. For purpose of scale factor trimmed, a VR2 could be placed to pin8 to increase the output resistance (20kΩ typ). The voltage of pin6-Vout is equal to (output current)*(output impedance).

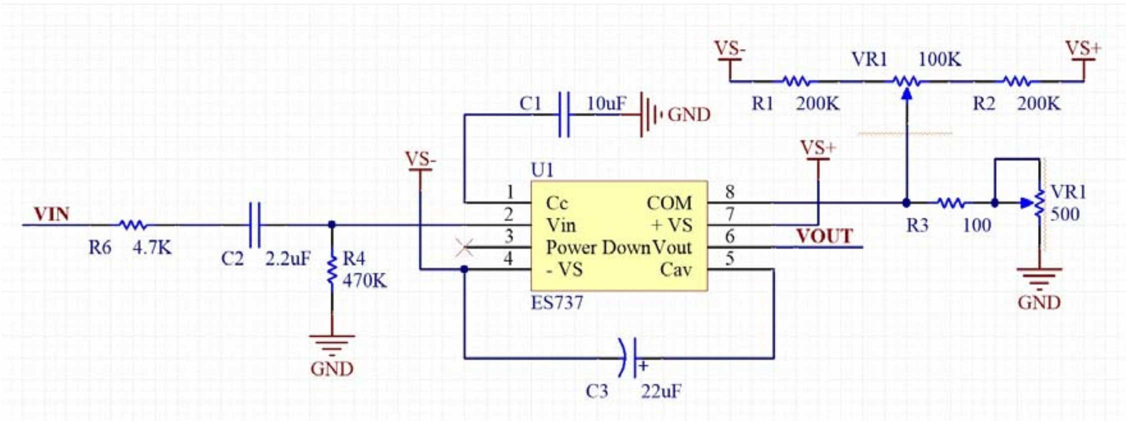


Figure 3. Adjust the zero-offset

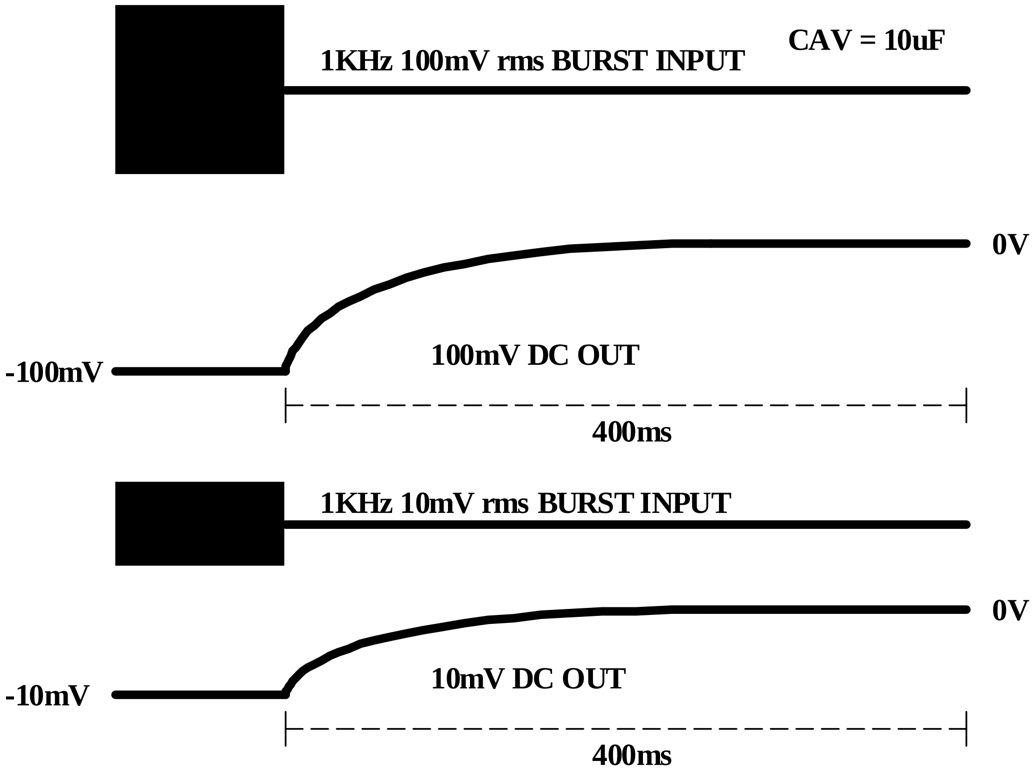
Note:

1. PwrDown pin is pulled to –Vs or keeps floating for normal operation. Connect it to +Vs will force ES737 to enter power down mode.

3. The 100k ohm variable resistor can be used to adjust the zero-offset voltage. VR1 is used for gain control. It could be fixed at 200 ohms and change R6 to 10k VR for gain control.

Fast setting time for all input levels

There is almost no effect of signal input level on the settling time.



Application notes

1. AC-coupled operation

Refer to the standard circuit of ES737 shown in Figure 2. ES737 will work in an AC-coupled operation when the SW1 is opened. In AC-coupled operation, an AC-coupled capacitor (Ccp) and bias resistors Rin must be required. The pin1 connected to Cc capacitor is necessary for this case.

2. Power Down Function

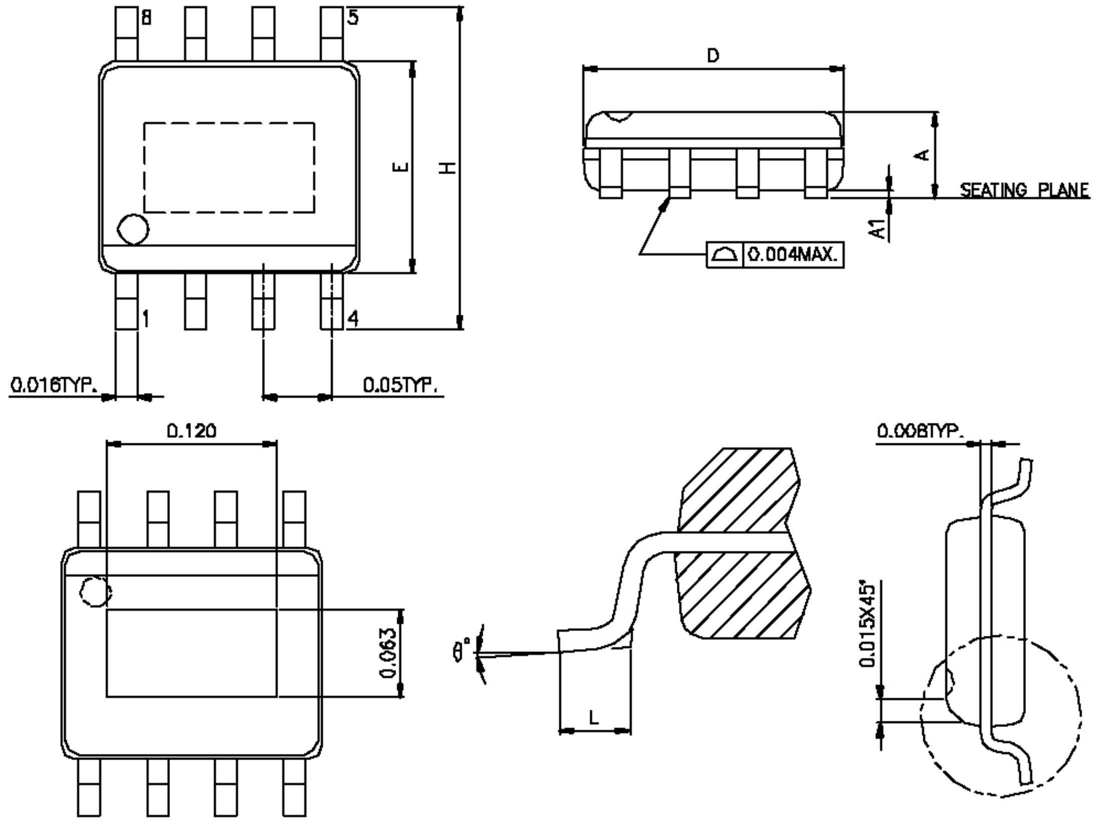
The ES737 provides a power-down enable pin (Pin 3). To enable the device, this pin must be connected to –Vs or keep floating. If it is connected to V+, the device will enter power-down mode.

3. Post Filter C_F

To reduce the output ripple of ES737, a post filter capacitor C_F is required. This capacitor should be connected as shown in figure 2. With post filter, the value of Cav should be just large enough to give the maximum dc error at the lowest frequency of interest. And the output ripple will be removed by the post filter.

Packaging

8 Pin SOP Package



Dimension Parameters

SYMBOLS	MIN.	MAX.
A	0.053	0.069
A1	0.004	0.010
D	0.189	0.196
E	0.150	0.157
H	0.228	0.244
L	0.016	0.050
θ°	0	8

UNIT : INCH

NOTES:

1.JEDEC OUTLINE : MS-012 AA

2.DIMENSIONS "D" DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.MOLD FLASH, PROTRUSIONS AND GATE BURRS SHALL NOT EXCEED .15mm (.006in) PER SIDE.

3.DIMENSIONS "E" DOES NOT INCLUDE INTER-LEAD FLASH, OR PROTRUSIONS. INTER-LEAD FLASH AND PROTRUSIONS SHALL NOT EXCEED .25mm (.010in) PER SIDE.