ES26

Dual true RMS-to-DC Converters

Features

- True RMS-to-DC Conversion
- Computes RMS of AC and DC Signals
- Wide Response:

  * 1MHz Bandwidth for V_{RMS} > 100mV
- Auxiliary dB Output:

  * 50dB Range
- Single-or Dual-Supply Operation
- Low Cost
- Power-Down Function
- Low Power:

  800 μA typical for one RMS core

  1.6mA typical for two RMS cores

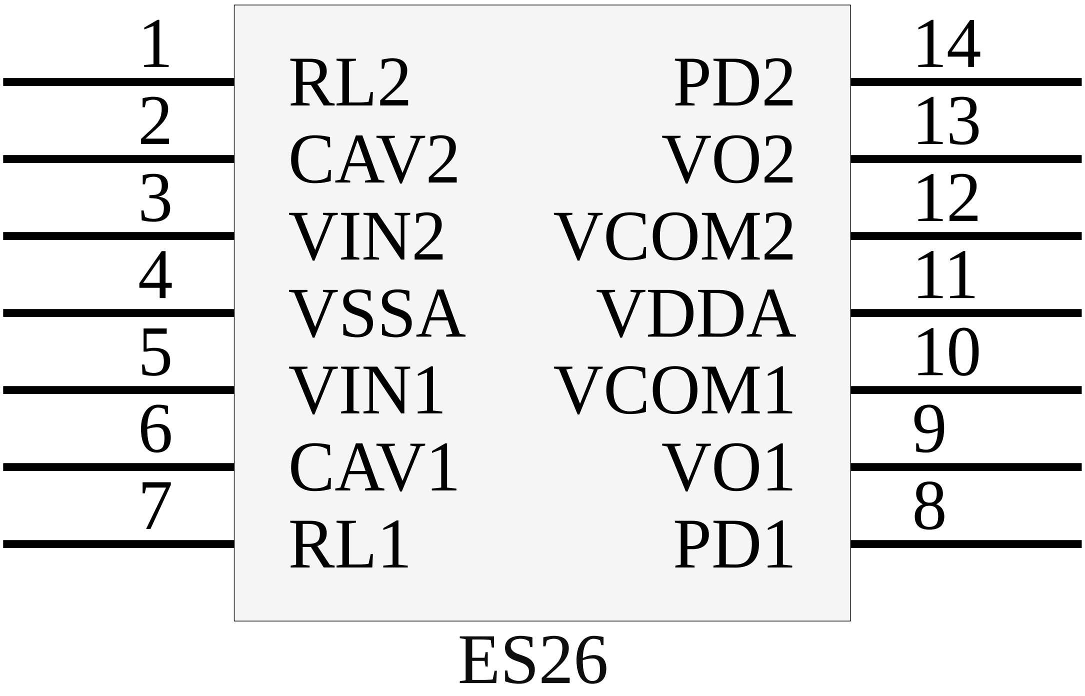
Description

The ES26 is a true RMS-to-DC converter containing two RMS cores. It accepts low-level input signals from 0 to 400 mV RMS complex input waveforms. It can be operated form either a single supply or dual supplies. The device draws less than 1 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



SOP 14 Pin Package

Pin Description

Pin No	Symbol	Type	Description
1	RL2	IO	R_{L2} terminal, connected to COMMON in general
2	CAV2	IO	Averaging capacitor2
3	VIN2	I	Measurement input2
4	-Vs	P	Negative supply voltage
5	VIN1	I	Measurement input1
6	CAV1	IO	Averaging capacitor1
7	RL1	IO	R_{L1} terminal, connected to COMMON in general
8	$\overline{\text{PD1}}$	I	RMS1 circuit power down, active LOW
9	VO1	O	RMS1 output
10	COMMON1	G	Analog ground1
11	+Vs	P	Positive supply voltage
12	COMMON2	G	Analog ground2
13	VO2	O	RMS2 output
14	PD2	I	RMS2 circuit power down, active LOW

Absolute Maximum Ratings

Supply Voltage: Dual Supplies .... ±10V
Single Supply ....+20V
Input Voltage: .... ±10V
Power Dissipation (Package)
SOP..450mW
Operating Temperature Range ....0℃ to +70℃
Storage Temperature Range...-55℃ to +150℃
Lead Temperature (Soldering, 10sec)..300℃

Electrical Characteristics-ES26

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Transfer Equation			$V_{OUT} = [avg.(V_{IN})2]^{1/2}$		
Averaging Time Constant	Figure 3		6		ms/μF C_{AV}
CONVERSION ACCURACY					
Total Error, Internal Trim (Notes 1,2)				±0.5 ±1.0	mV ±% of Reading
Total Error vs. Temperature (0℃ 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 DC		±2.0		±% of Reading
Total Error, External Trim (Note 1)			±0.5 ±0.2		mV ±% of Reading

Electrical Characteristics-ES26(continued)

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

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
ERROR vs. CREST FACTOR[1]						
Additional Error	Crest Factor 1 to 2			Specified Accuracy		±% of Reading
	Crest Factor = 3			0.2		
	Crest Factor = 6			0.5		
FREQUENCY RESPONSE[2,3]						
Bandwidth for 1% Additional Error (0.09dB)	V_{IN} =35mV			75		kHz
	V_{IN}=100mV			99		
	V_{IN} =400mV			450		
±3dB Bandwidth	V_{IN} =35mV			0.53		MHz
	V_{IN} =100mV			1.6		
	V_{IN} =400mV			7.1		MHz
INPUT CHARACTERISTICS						
Input Signal range	Continuous RMS, All Supplies			0 to 400		mV_{RMS}
	Peak Transient	+3V, -5V Supplies			±2.8	V_{PK}
		±2.5V Supplies			±2	
		±5V Supplies			±5	
Safe Input	All Supplies				±12	V_{PK}
Input Resistance			6.9	8.7	10.6	kΩ
Input Offset Voltage					±0.5	mV
OUTPUT CHARACTERISTICS [4]						
Offset Voltage	T_A=+25℃				±0.5	mV
	T_A =T_{MIN} to T_{MAX}			±10		µV/℃
	With Supply Voltage			±0.1		mV/V
Output Voltage Swing	+3V, -3V Supplies		0 to 2			V
	±5V to ±10V Supplies		0 to 1	1.5		
Output Resistance			8	10	12	kΩ

Electrical Characteristics-ES26(continued)

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

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Power SUPPLY					
Rated Performance			+3/-3		V
Dual Supplies		+2/-2.5		±10	V
Single Supply		+5		+20	V
Quiescent Current	The current of one RMS core The current of two RMS core		0.8 1.6	1 2	mA

[1] Error vs. crest factor is specified as an additional error for 200mV_{RMS} rectangular pulse input, pulse width = 200 µs.
[2] Measured at pin 9 (VO1), with pin 10 tied to COM1.
[3] Input voltages are expressed in volts RMS.
[4] Accuracy is specified for 0 to 400mV, 1kHz sine-wave input. Accuracy is degraded at higher RMS signal levels.

Detailed Description

Figure 1 shows the simplified schematic of ES26. It consists of four major subcircuits: absolute value circuit (rectifier), square/divider, current mirror and buffer amplifier. The actual computation performed by the ES26 follows the equation:

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

The input voltage, V_{IN}, applied to the ES26 is converted to a unipolar current I_1 (Figure 1) by the absolute-value/voltage. This current drives one input of the squarer/diviqder that produces a current I_4 , which has the transfer function:

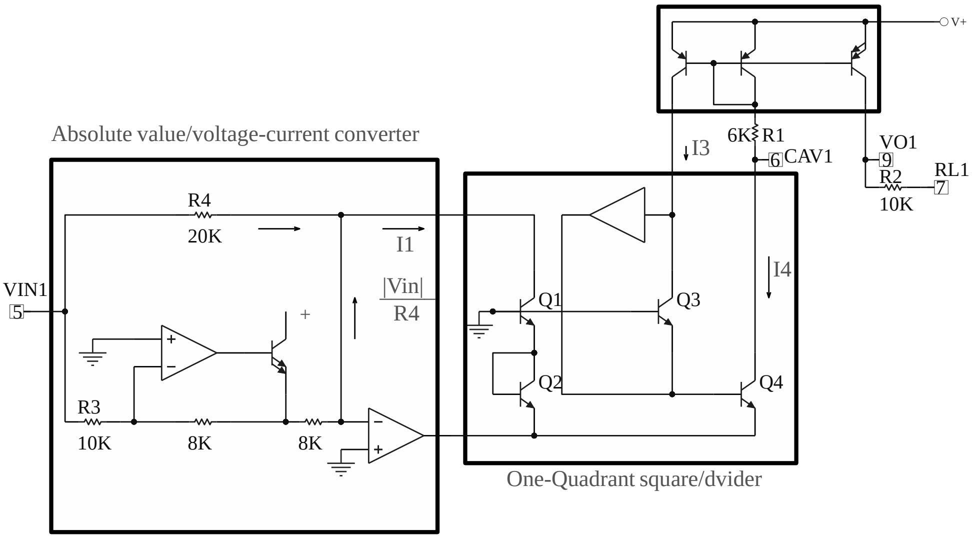
$$I_4 = \frac{I_1^2}{I_3}$$

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 ES26 is:

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

The dB output is obtained by the voltage at the emitter of Q3, which is proportional to the -log V_{IN}. The emitter follower Q5 buffers and level shifts this voltage so that the dB output is zero when the externally set emitter current for Q5 approximates I_3.



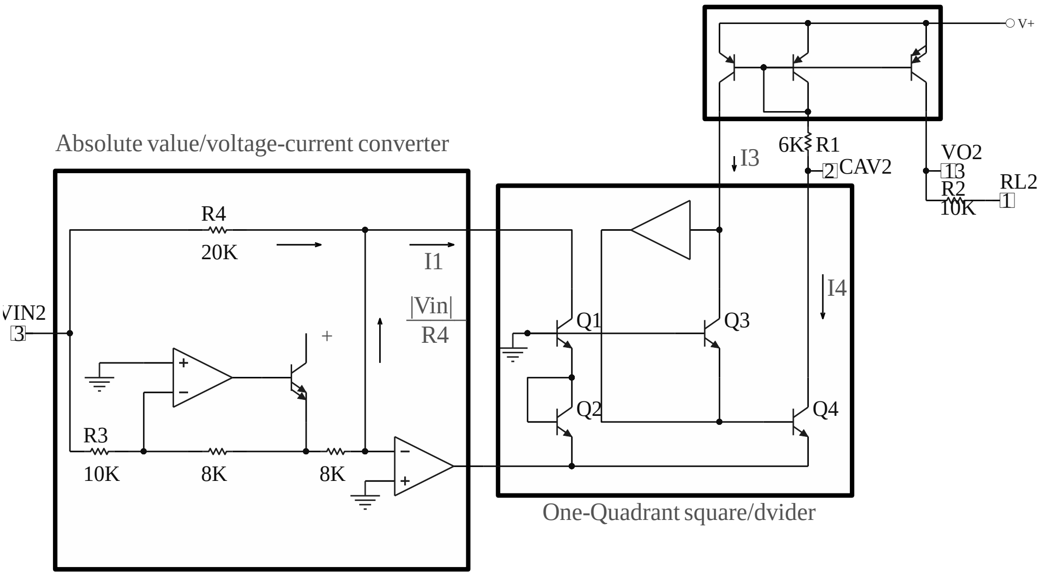


Figure 1. ES26 Simplified Schematic

Standard Connection (Figure 2)

The standard RMS connection requires only one external component, C_{AV}. In this configuration the ES26 measures 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 3 gives practical values of C_{AV} for various values of averaging error over frequency for the standard RMS connections (no post filtering). If a 3uF capacitor is chosen, the additional error at 30Hz will be 1%. If the DC error can be rejected, a capacitor should be connected in series with the input, as would typically be the case in single-supply operation.

The input and output signal ranges are a function of the supply voltages. Refer to the electrical characteristics for guaranteed performance. The buffer amplifier can be used either for lowering the output impedance of the circuit, or for other applications such as buffering high-impedance input signals. The ES26 can be used in current output mode by disconnecting the internal load resistor, RL, from ground. The current output is available at pin 8 with a nominal scale of 100 μA/ V_{RMS} input for the ES26. The output is positive.

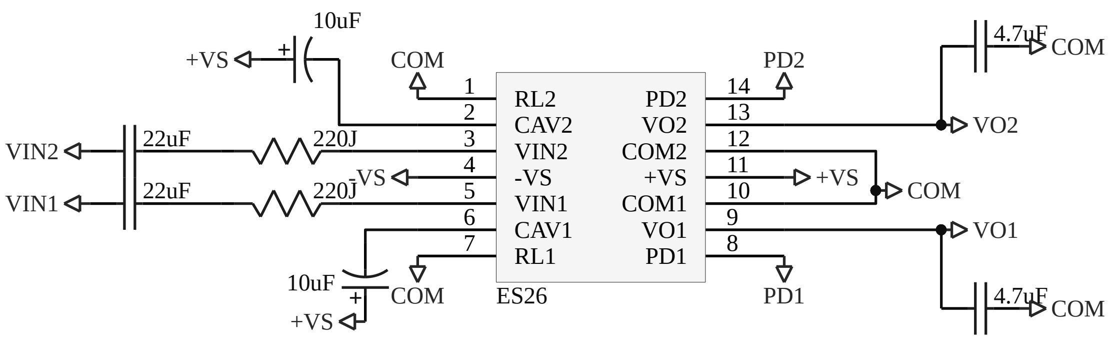


Figure 2. Standard connection for ES26.

- **High-Accuracy Adjustments**

The accuracy of the ES26 can be further improved by the external trimming scheme as shown in Figure 4. The input should be grounded and R4 adjusted to give zero output from pin 6. R1 and R2 are trimmed to give the correct value for a calibrated signal.

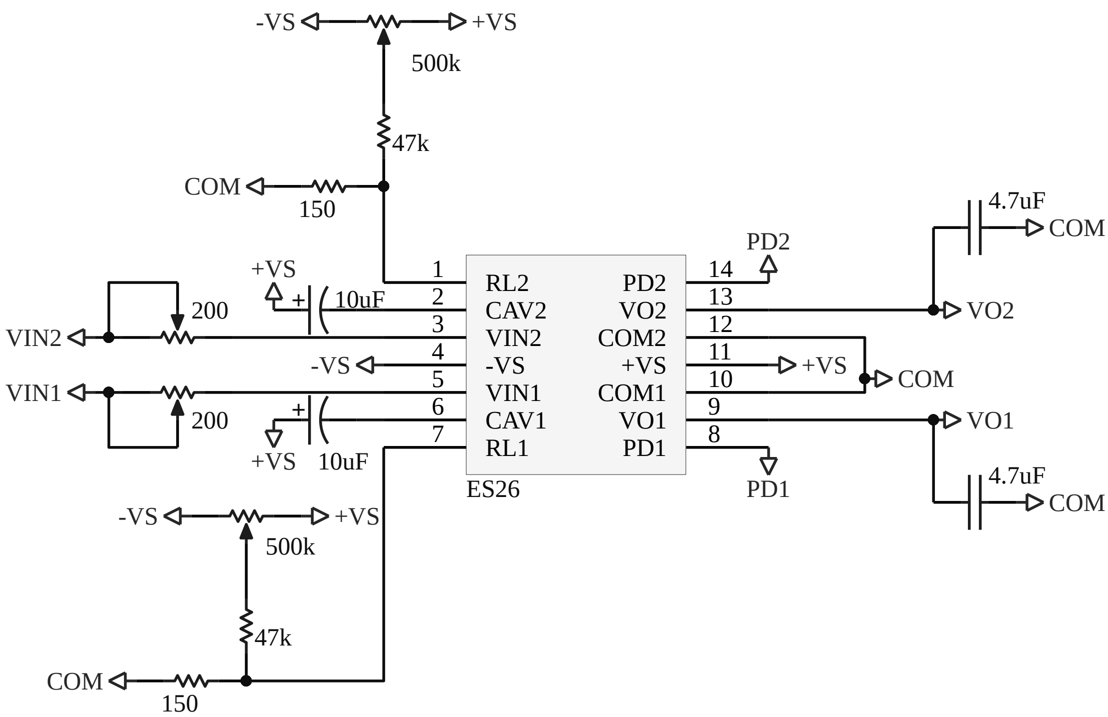


Figure 3. External Gain and Offset Trimming Circuit.

Power-Down Function

The ES26 provides power down pin (Pin 8 & Pin 14). To enable RMS1 or RMS2 circuit, the PD1 or PD2 must be connected to –Vs. If PD1 or PD2 connected to V+, the RMS1 or RMS2 circuit will enter power-down mode. The current it draws at this mode is less than 1uA.

Choosing the Averaging Time Constant

The ES26 computes the RMS value of AC and DC signals. At low frequencies and DC, the output tracks the input exactly; at higher frequencies, the average output approaches the RMS value of the input signal. The actual output differs from the ideal by an average (or DC) error plus some amount of ripple.

The DC error term is a function of the value of C_{AV} and the input signal frequency. The output ripple is inversely proportional to the value of C_{AV}. Waveforms with high crest factors, such as a pulse train with low duty cycle, should have an average time constant chosen to be at least ten times the signal period.

Using a large value of C_{AV} to remove the output ripple increases the setting time for a step change in the input signal level. Figure 3 shows the relationship between C_{AV} and 1 % settling time, where 110ms settling equals 4uF of C_{AV}. The settling time, or time for the RMS converter to settle to within a given percent of the change in RMS level, is set by the averaging time constant, which varies approximately 2:1 between decreasing and increasing input signals. In addition, the settling time also varies with input signal levels, increasing as the input signal is reduced, and decreasing as the input is increased.

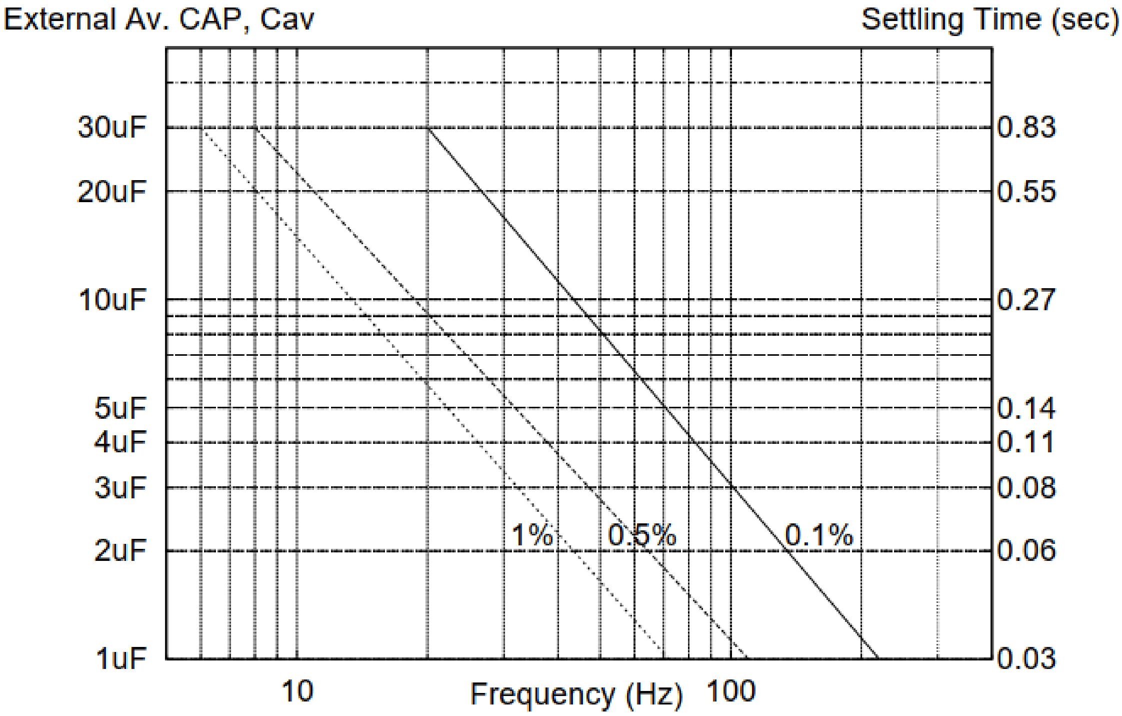


Figure 4. Errors/Settling Time Graph for Standard Connection

Frequency Response

ES26 utilizes a logarithmic circuit in performing the RMS computation of the input signal. The bandwidth of the RMS converters is proportional to signal level. Figure 5 represent the frequency response of the converters from 35mV to 1V for ES26.

The dashed lines indicate the upper frequency limits for 1%, 10%, and ±3dB of reading additional error. Caution must be used when designing RMS measuring systems so that overload does not occur. The input clipping level for ES26 is ±10V.

A $3V_{RMS}$ signal with a crest factor of 3 has a peak input of 9V.

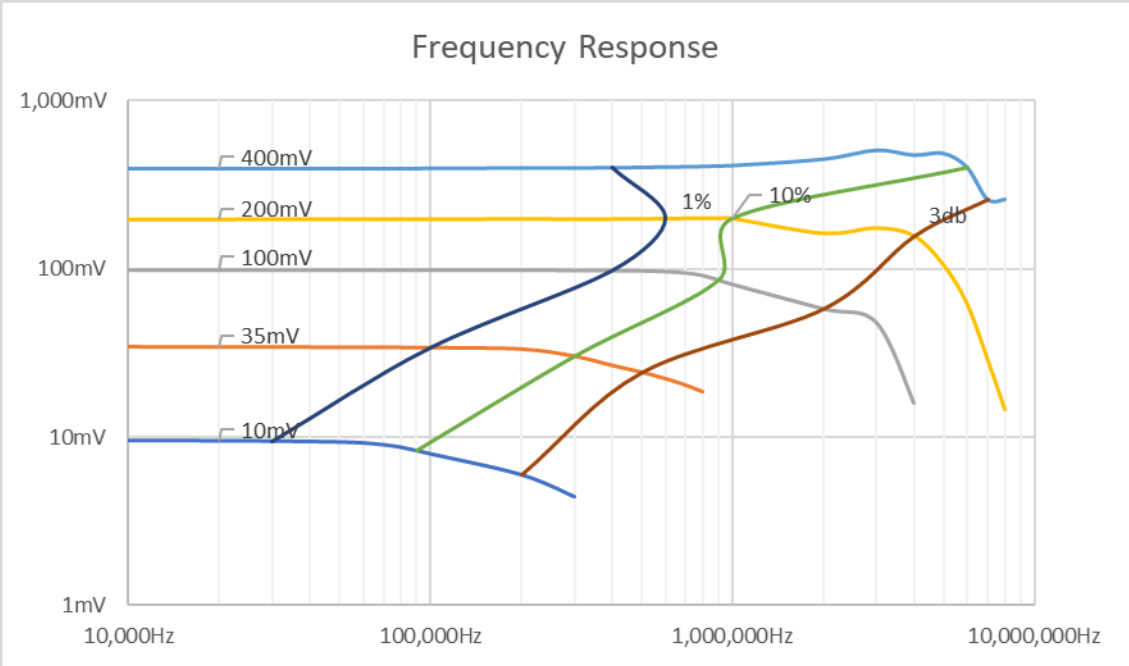
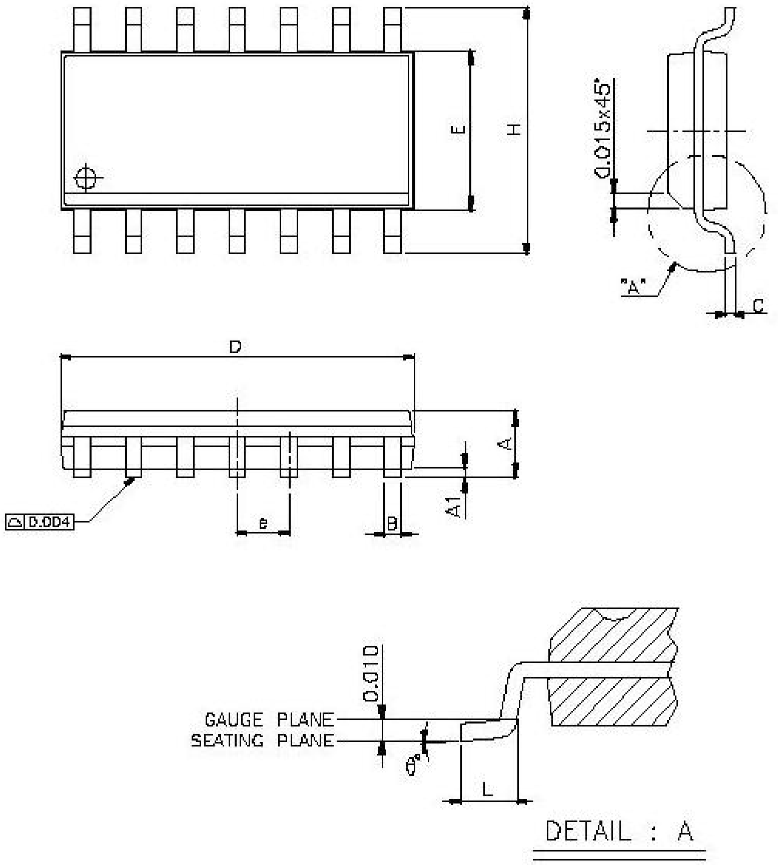


Figure 5. Frequency Response for ES26

Packaging

1.14 Pin SOP Package



2. Dimension Paramenters

SYMBOLS	MIN.	NOM.	MAX.
A	0.058	0.064	0.068
A1	0.004	–	0.010
B	0.013	0.016	0.020
C	0.0075	0.008	0.0098
D	0.336	0.341	0.344
E	0.150	0.154	0.157
e	–	0.050	–
H	0.228	0.236	0.244
L	0.015	0.025	0.050
θ°	0°	–	8°

UNIT : INCH

NOTES:
1. JEDEC OUTLINE : MS-012 AB
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.