Single-channel 24-bit High Accuracy ADC

General Description

ET7133 is a single-channel analog front end for low-frequency measurement of electronic scales. The device accepts a low-level input signal directly from the sensor and then produces a serial digital output. Σ-Δ conversion technology is used to achieve 24-bit no-loss code performance. The selected input signal is sent to a dedicated front end with programmable gain based on an analog modulator. On-chip digital filter processes the output signal of the modulator.Sending commands through the communication port to adjust the cutoff point and the output update rate of the filter.and the first notch of the digital filter can be programmed.

ET7133 need 2.6~5.5V single power supply. And it is a fully differential analog input with a reference input.

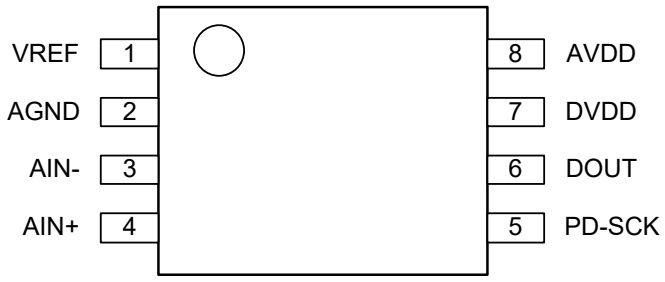
ET7133 is an ideal product for high-precision scale systems, with a special construction to ensure low power consumption and a built-in power-down mode to reduce standby power consumption. Furthermore, the chip has the advantages of high integration, fast response speed and strong anti-interference, which can greatly reduce the cost of the electronic scale system and improve the performance and reliability of the whole system.

Features

- A pair of fully differential input channel ADC
- On-chip direct temperature measurement and digital output
- No missing codes at 24 bits
- On-chip low noise amplifier with a gain of 128 dB
- Nonlinear: ±0.001%
- Selectable output data rate: 10Hz and 40Hz
- Synchronous suppression of 50Hz and 60Hz power interference
- Built-in clock oscillator without any external components
- Simple two-wire serial communication port
- Operating voltage range: 2.6 ~ 5.5V
- Operating temperature range: -40 ~ +85°C
- Package information:

Part No.	Package	MSL
ET7133	SOP8 (6.00mm×4.92mm)	Level 3
ET7133P	DIP8 (9.20mm×7.62mm)	Level 3

Pin Configuration



(SOP8/DIP8) Top View

Pin Function

Pin No.	Pin Name	Description
1	VREF	Reference Input Voltage(1.8V~AVDD)
2	AGND	Ground Pin
3	AIN-	Differential Analog Input Channel Negative Input
4	AIN+	Differential Analog Input Channel Positive Input
5	PD_SCK	Power-down Mode and Serial Clock Input
6	DOUT	Serial Port Data Output
7	DVDD	Digital Power Input (2.6~5.5V)
8	AVDD	Analog power input (2.6~5.5V), The AVDD voltage should not be higher than the DVDD voltage

Serial Communication

The serial communication line consists of pin PD_SCK and DOUT. Used to output data and select output data rate and input signal.

When the data output pin DOUT is high, it indicates that the A/D converter is not ready to output data, and the serial port clock input signal PD_SCK should be low.

When DOUT changes from high to low, PD_SCK should input 25 to 27 clock pulses. The rising edge of the first clock pulse will read the highest bit (MSB) of the output 24-bit data until the 24th clock pulse is completed, and the 24-bit output data is completed bit by bit from the highest bit to the lowest bit. The 25th to 27th clock pulses are used to select the output data rate and input signal for the next A/D conversion, see Table 1. The number of input clock pulses for PD_SCK should not be less than 25 or more than 27, otherwise it will cause serial communication errors.

When the input signal or output data rate of the A/D converter changes, it takes 4 data output cycles for the A/D converter to stabilize. DOUT goes from high to low and outputs valid data only after 4 data output cycles.

Table 1. Input Selection and Output Data Rate Selection

PD_SCK Pulses Number	Input Selection	Rate
25	Differential Signal	10Hz
26	Temperature Measurement	40Hz
27	Differential Signal	40Hz

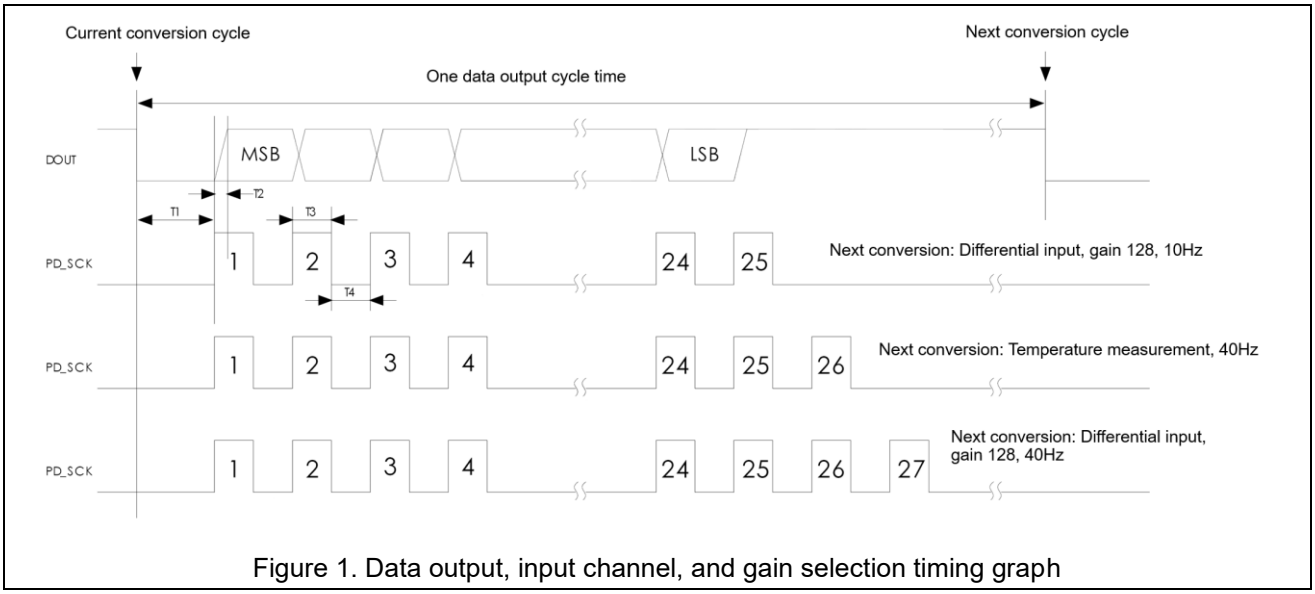


Figure 1. Data output, input channel, and gain selection timing graph

Table 2. Description of timing communication parameters

Symbol	Parameters	Min	Typ	Max	Unit
T1	DOUT falling edge to PD_SCK pulse rising edge	0.1			us
T2	PD_SCK Pulse rising edge to DOUT data valid			0.1	us
T3(1)	PD_SCK positive pulse level time	0.2		50	us
T4	PD_SCK negative pulse level time	0.2			us

Note1: The PD_SCK positive pulse level time cannot exceed the specified maximum value of 50us, otherwise it will lead to incorrect reading of the AD result data.

Output Noise

Table 3 indicates the noise-free bits number of the ET7133 output. The given data applies to the 5V bipolar input range for both AVDD and VREF. These data are typical values and are generated with an analog differential input voltage of 0V.

Table 3. Output Noise (5V voltage)

Data Update Rate	No Noise Bits
10Hz	17bits
40Hz	16bits

Analog Input

(1) Channel analog input range:

The ET7133 includes one analog input pair: AIN+, AIN-. The input pairs provide differential input signals that can handle unipolar and bipolar input channels. It should be noted that the bipolar input signals are referenced to the AIN- terminal.

The analog differential input voltage range is $\pm 0.5\times(V_{REF} / 128)V$, and the absolute value of the analog input voltage is between AGND and V_{AVDD}-1.3V.

(2) Reference input:

The V_{REF} provides the reference input for the ET7133. The reference input range is 1.8V to V_{AVDD}.

System Clock and AD Data Update Rate

(1) System clock:

The ET7133's system clock is provided by an internal oscillator, which is a high-precision oscillator with ultra-low dependence on VDD and temperature.

(2) AD data update rate:

The ET7133 offers selectable output data rates of 10Hz and 40Hz, which can be easily selected through the communication port.

Output Data

The output data code of ET7133 is binary complement and ranges from 800000H (minimum value) to 7FFFFFH (maximum value).

Temperature Measurement

The digital temperature sensor inside the ET7133 chip can be used to read out the temperature inside the chip, i.e. inside the system, directly. Its effective (stable) bit count is 15 bits. Typical temperature measurement accuracy is 20.4 readings per degree (°C) (15 bits). The temperature measurement range is -40°C to 85°C. When using the digital temperature sensor, it should be noted that the temperature sensor within the chip has a large zero and gain difference from chip to chip. If used to measure absolute temperature, both the zero point and gain need to be corrected. If the measured temperature is used to do system temperature-related performance compensation, the zero point and gain do not need to be corrected, as long as the linearity of the temperature measurement meets the requirements.

Reset and Power-down Modes

When the chip is powered on, the power-on auto-reset circuit inside the chip will automatically reset the chip.

The pin PD_SCK input is used to control the power off of the ET7133. When PD_SCK is low, the chip is in normal operation. If PD_SCK goes from low to high and stays high for more than 60us, the ET7133 enters power-down mode. When PD_SCK goes back to low level, the chip will re-enter normal operation. After the chip returns to normal operation from the power-down state, if the conversion rate and input signal selection before the power-down is to be maintained, the power-down cannot be performed in the current data conversion cycle when the clock pulse count changes, but should be performed after the next data conversion cycle when the clock pulse count changes.

The A/D converter needs 4 data output cycles to stabilize after the chip enters normal operation from reset or power-down state. DOUT will change from high to low and output valid data after 4 data output cycles.

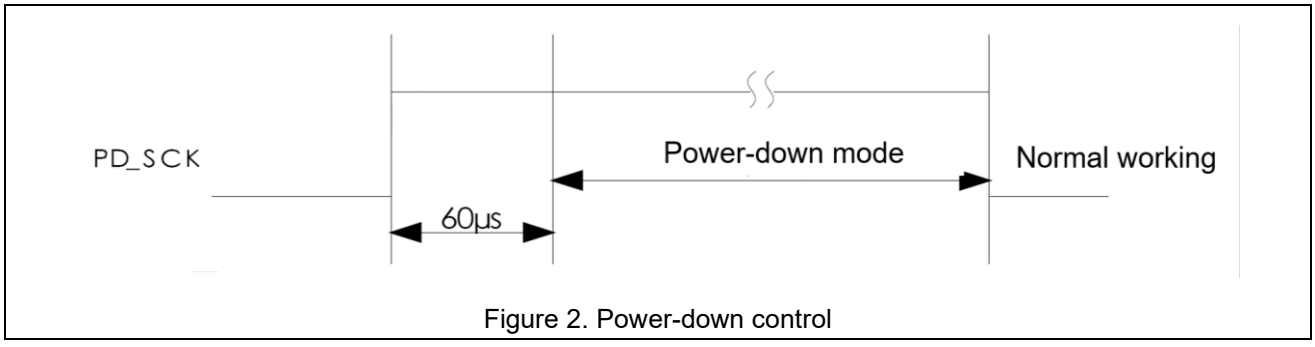


Figure 2. Power-down control

Power Consumption

The power consumption of the ET7133 in various states is shown in table 4.

Table 4. Power Consumption

Operating voltage VDD	Chip status	Total chip current I_{DD} (typical)
3V	Normal working	1080uA
3V	Power-down (standby) mode	0.5uA
5V	Normal working	1200uA
5V	Power-down (standby) mode	0.5uA

Reference Program

C language:(Only for reference)

```
/* ET7133.h Header file*/
#ifndef _ET7133_H_
#define _ET7133_H_

#define CH1_10HZ   0x01
#define CH1_40HZ   0x02
#define CH2_TEMP   0x03

#define CH1_10HZ_CLK    25
#define CH1_40HZ_CLK    27
#define CH2_TEMP_CLK   26

unsigned long Read_ET7133(unsigned char next_select);

#endif

/* ET7133.c Program files*/
#include "ET7133.h"
#include "global.h"   //Define the port
#include "delay.h"    // Delay subroutine

unsigned long Read_ET7133(unsigned char next_select)
{
unsigned char i = 0;
unsigned long data_temp = 0;
for(i = 0;i < 24;i++)
{

SET_SCK_H();        //Defined in the global.h file, set the SCK pin output high
data_temp <<= 1;
delay_us(5);    //5 microseconds delay, customize this function for different MCUs
if(READ_PORT & (1 << PIN_DOUT)) //Determine whether DOUT is high
      data_temp |= 1;
SET_SCK_L(); //Defined in the global.h file, set the SCK pin output low
}
switch(next_select)    //Determine the next data update rate or switch channels
{
      case CH1_10HZ:
            SET_SCK_H();
            delay_1us();
```

```
            SET_SCK_L();
            break;
        case CH1_40HZ:
            SET_SCK_H();
            delay_1us();
            SET_SCK_L();
            delay_1us();
            SET_SCK_H();
            delay_1us();
            SET_SCK_L();
            delay_1us();
            SET_SCK_H();
            delay_1us();
            SET_SCK_L();
            break;
        case CH2_TEMP:
            SET_SCK_H();
            delay_1us();
            SET_SCK_L();
            delay_1us();
            SET_SCK_H();
            delay_1us();
            SET_SCK_L();
            break;
        default:
            break;
}
return(data_temp);    //Return readed data from ET7133
}
```

Absolute Maximum Ratings

Symbol	Characteristic		Value	Unit
V_{CC}	Supply Voltage	AVDD,DVDD	-0.4~6.0	V
V_{IN}	Input Voltage Range	VREF,AIN+,AIN-,PD_SCK	-0.4~V_{CC}+0.4V	V
V_{OUT}	Output Voltage Range	DOUT	-0.4~+6.0	V
T_J	Junction Temperature Range		-40~+150	°C
T_{STG}	Storage Temperature Range		-65~+150	°C
V_{ESD}	Human body mode (HBM)		±4000	V
	Machine Mode (MM)		±300	V

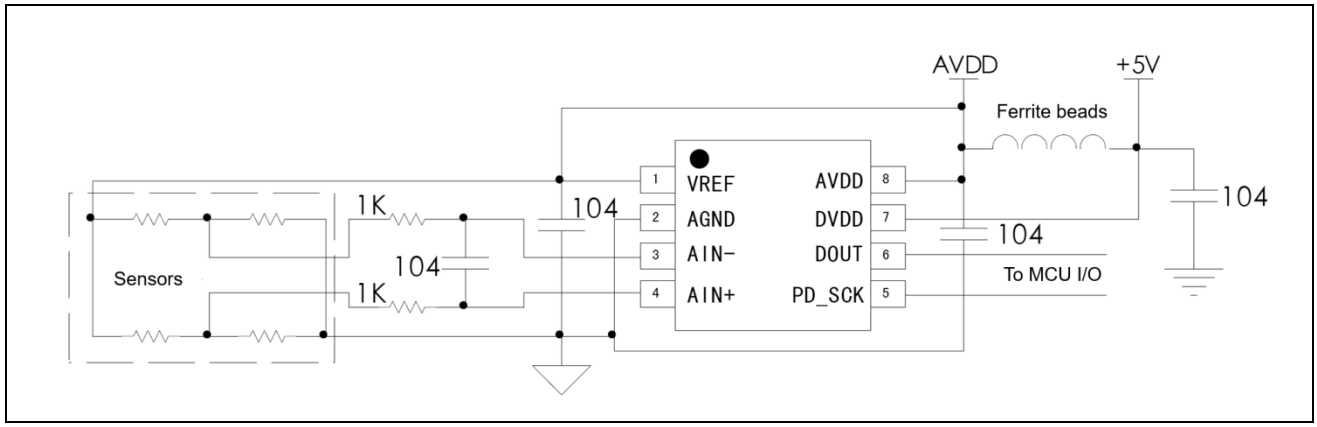
Note: If forced to operate the device under conditions beyond those listed in this table may cause permanent damage to the device, this table lists only the operating stress limits and does not indicate that the device can be operated under the conditions listed in the table or under those other conditions beyond the operating range specified. Prolonged operation at absolute limits can affect device lifetime.

Recommended Operating Conditions

(Unless otherwise noted, T_A= -40°C~+85°C)

Symbol	Characteristic	Min	Typ	Max	Unit
V_{AVDD}	Analog supply voltage	2.6	5.0	5.5	V
V_{DVDD}	Digital supply voltage	2.6	5.0	5.5	V
V_{IH}	Logic voltage high	0.7×V_{DVDD}		V_{DVDD}	V
V_{IL}	Logic voltage low	GND		0.3×V_{DVDD}	V
T_A	Operating Temperature Range	-40		+85	°C
T_J	Junction Temperature	-40		+125	°C

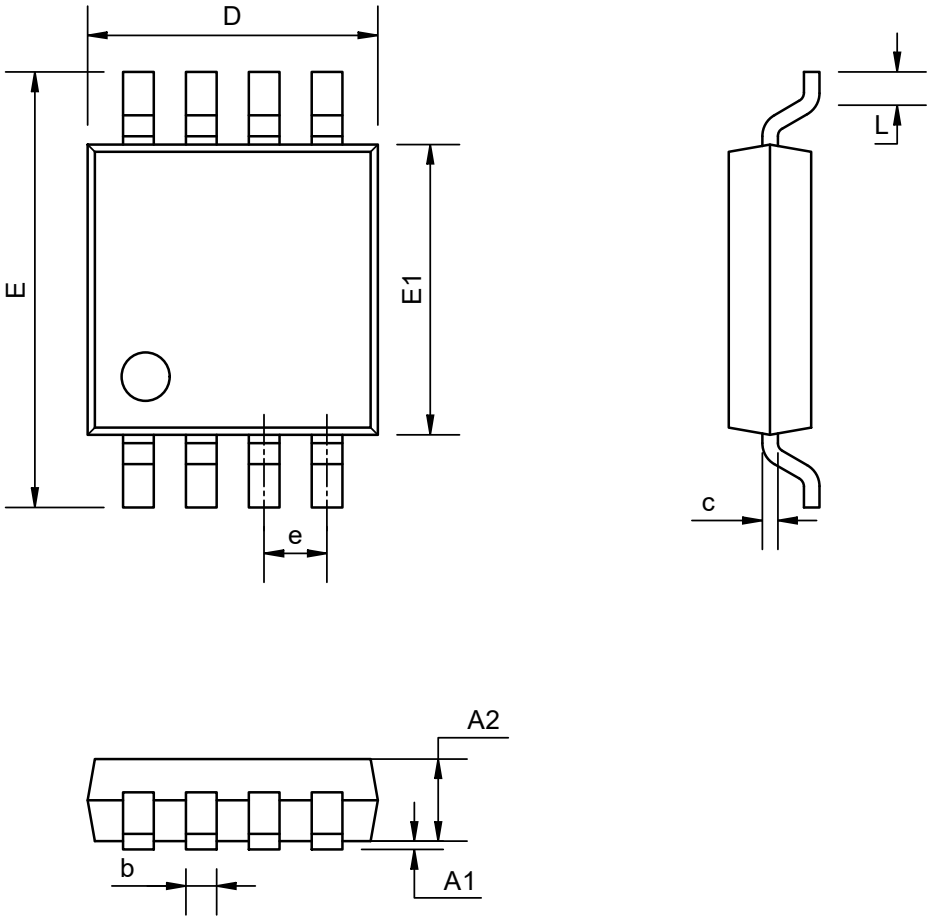
Application Circuits



Note*: This circuit is for reference only.

Package Dimension

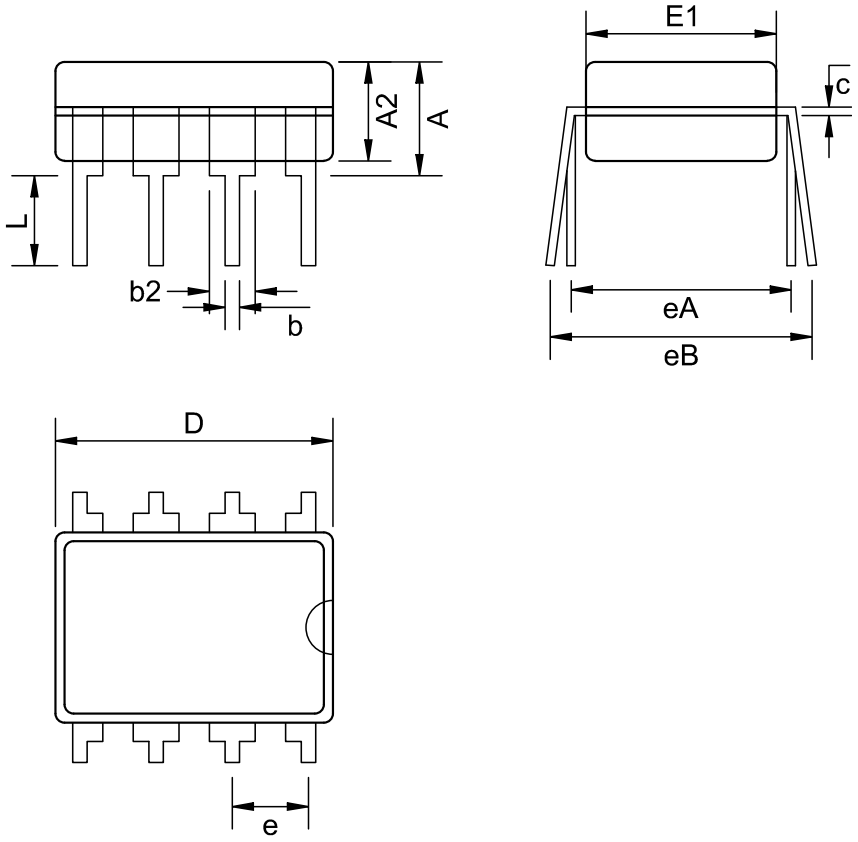
SOP8



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A1	0.06	0.16	0.26
A2	1.30	1.50	1.70
b		0.40BSC	
c	0.15	0.25	0.35
D	4.72	4.92	5.12
E	5.70	6.00	6.30
E1	3.75	3.95	4.15
e		1.27BSC	
L	0.45	0.65	0.85

DIP8



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A			4.31
A2	3.15	3.40	3.65
b	0.41	0.46	0.51
b2	1.27	1.52	1.77
c	0.20	0.25	0.30
D	8.95	9.20	9.45
E1	6.15	6.40	6.65
e	2.54BSC		
eA	7.62BSC		

Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
1.0	2014-03-21	Original Version	Zhu-Jun Li	Huang Xing Xing	Liu Jia Ying
1.1	2023-04-19	Update English version	Maruijie	Yinpeng	Liu Jia Ying