# 24-Bit Analog-to-Digital Converter (ADC) with Built-in Temperature Sensor

## DESCRIPTION

Based on Avia Semiconductor's patented technology, HX710 is a precision 24-bit analog-to-digital converter (ADC) with built-in temperature sensor designed for weigh scales and industrial control applications to interface directly with a bridge sensor.

The input low-noise amplifier (PGA) has a fixed gain of 128, corresponding to a full-scale differential input voltage of ±20mV, when a 5V reference voltage is connected to the VREF pin. On chip oscillator provides the system clock without any external component.

On-chip power-on-reset circuitry simplifies digital interface initialization. There is no programming needed for the internal registers. All controls to the HX710 are through the pins.

## FEATURES

- **On-chip temperature measurement**
- **On-chip active low noise amplifier with a gain of 128**
- **On-chip oscillator requiring no external component**
- **On-chip power-on-reset**
- **Simple digital control and serial interface:**
  **pin-driven controls, no programming needed**
- **Selectable 10SPS or 40SPS output data rate**
- **Simultaneous 50 and 60Hz supply rejection**
- **Current consumption:**
  **normal operation < 1.2mA, power down < 1uA**
- **Operation supply voltage range: 2.6 ~ 5.5V**
- **Operation temperature range: -40 ~ +85℃**
- **8 pin SOP-8 or DIP-8 package**
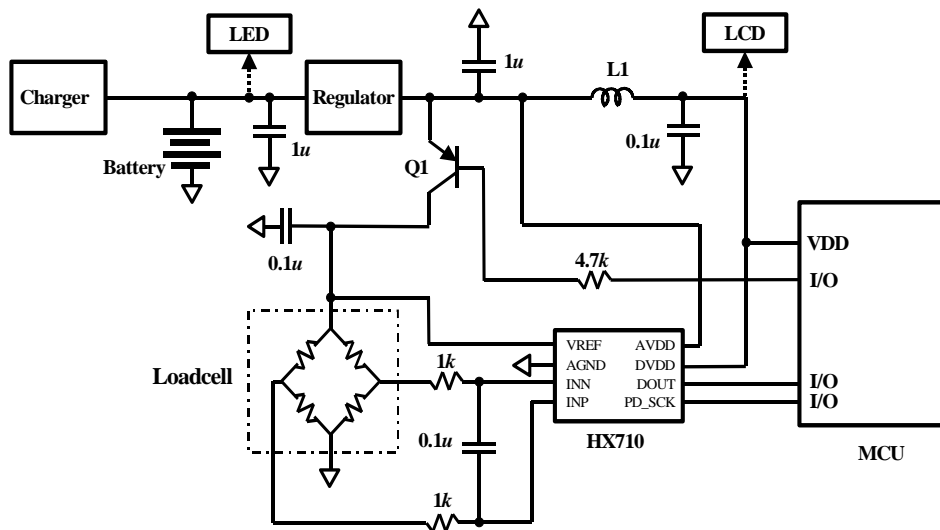


**Fig. 1  Typical weigh scale application block diagram**

## Pin Description

AD Conversion Reference Input   VREF ▭ 1  ●   8 ▭ AVDD   Analog Power

Ground Input   AGND ▭ 2    7 ▭ DVDD   Digital Power

Differential Signal Negative Input   INN ▭ 3    6 ▭ DOUT   Serial Data Output

Differential Signal Positive Input   INP ▭ 4    5 ▭ PD_SCK   Power Down and Serial Clock Input
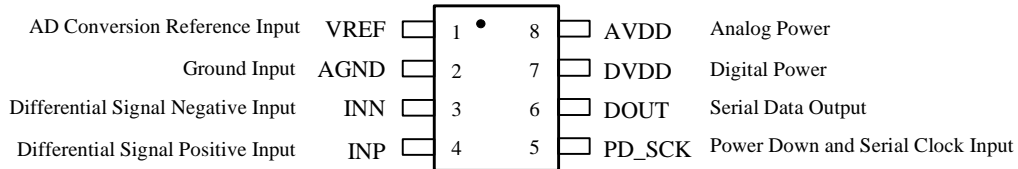
SOP-8 Package

| Pin # | Name | Function | Description |
|-------|------|----------|-------------|
| 1 | VREF | Analog Input | Reference input voltage: 1.8 ~ 5.5V |
| 2 | AGND | Ground | Analog Ground |
| 3 | INN | Analog Input | Differential signal negative input |
| 4 | INP | Analog Input | Differential signal positive input |
| 5 | PD_SCK | Digital Input | Power down control (high active) and serial clock input |
| 6 | DOUT | Digital Output | Serial data output |
| 7 | DVDD | Power | Digital supply: 2.6 ~ 5.5V |
| 8 | AVDD | Power | Analog supply: 2.6 ~ 5.5V |

**Table 1 Pin Description**

**KEY ELECTRICAL CHARACTERISTICS**

| Parameter | Notes | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Full scale differential input voltage range | V(inp)-V(inn) | | ±3.9*VREF | | mV |
| Common mode input range | | AGND+0.9 | | AVDD-1.3 | V |
| VREF input voltage range | | 1.8 | | AVDD | |
| Output data rate | | | 10/80 | | Hz |
| Output data coding | 2's complement | 800000 | | 7FFFFF | HEX |
| Output settling time [1] | | | 400/50 | | ms |
| Input offset drift | | | 0.2 | | mV |
| Input referred noise | | | 50 | | nV(rms) |
| Temperature drift | Input offset | | ±5 | | nV/℃ |
| | Gain | | ±5 | | ppm/℃ |
| Input common mode rejection | | | 100 | | dB |
| Power supply rejection | | | 100 | | dB |
| Power supply voltage | DVDD | 2.6 | | 5.5 | V |
| | AVDD | 2.6 | | 5.5 | V |
| Analog supply current | Normal | | 1100 | | μA |
| | Power down | | 0.3 | | |
| Digital supply current | Normal | | 100 | | μA |
| | Power down | | 0.2 | | |

（1）Settling time refers to the time from power up, reset, input channel change and gain change to valid stable output data.

**Table 2 Key Electrical Characteristics**

**Analog Input**

The differential input is designed to interface directly with a bridge sensor's differential output. It has a fixed gain of 128. The large gains are needed to accommodate the small output signal from the sensor. When a 5V reference is used at the VREF pin, the full-scale differential input voltage range is ±20mV.

**Power Supply Options**

Digital power supply (DVDD) should be the same power supply as the MCU power supply.

Analog power supply (AVDD) should not be higher than the digital supply (DVDD).

A/D conversion reference voltage (VREF) should be connected to loadcell's supply voltage. It can be connected directly to AVDD or through a resistor to reduce the power consumption by the loadcell.

**Clock Source, Output Data Rate and Format**

HX710 uses the on-chip oscillator as clock source. The nominal output data rate is 10 or 80SPS.

The output 24 bits of data is in 2's complement format. When input differential signal goes out of the 24 bit range, the output data will be saturated at 800000h (MIN) or 7FFFFFh (MAX), until the input signal comes back to the input range.

**Serial Interface**

Pin PD_SCK and DOUT are used for data retrieval, input selection, output data rate selection and power down controls.

When output data is not ready for retrieval, digital output pin DOUT is high. Serial clock input PD_SCK should be low. When DOUT goes to low, it indicates data is ready for retrieval. By applying 25~27 positive clock pulses at the PD_SCK pin, data is shifted out from the DOUT output pin. Each PD_SCK pulse shifts out one bit, starting with the MSB bit first, until all 24 bits are shifted out. The 25th pulse at PD_SCK input will pull DOUT pin back to high (Fig.2).

Input selection and output data rate selection is controlled by the number of the input PD_SCK pulses (Table 3). PD_SCK clock pulses should not be less than 25 or more than 27 within one conversion period, to avoid causing serial communication error.

| PD_SCK Pulses | Input | Data Rate |
|---|---|---|
| 25 | Differential input | 10 Hz |
| 26 | Temperature | 40 Hz |
| 27 | Differential input | 40 Hz |

**Table 3 Input and Data Rate Selection**
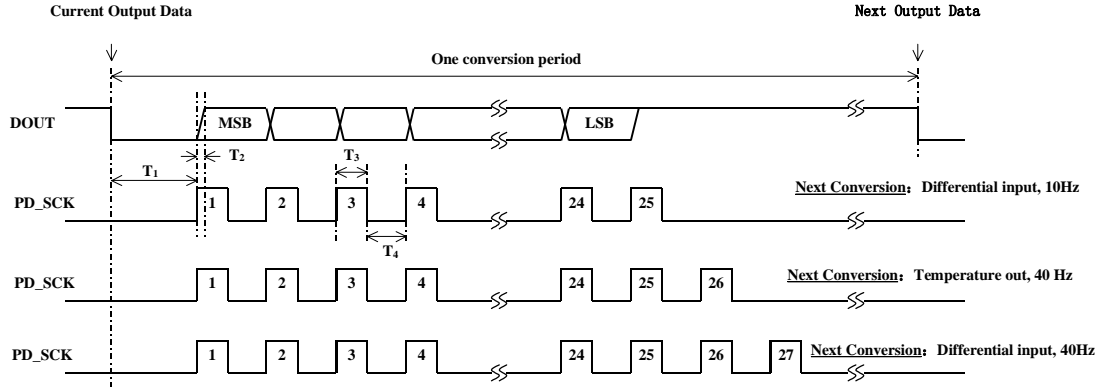
**Fig.2 Data output, input and data rate selection timing and control**

| Symbol | Note | MIN | TYP | MAX | Unit |
|--------|------|-----|-----|-----|------|
| $T_1$ | DOUT falling edge to PD_SCK rising edge | 0.1 | | | μs |
| $T_2$ | PD_SCK rising edge to DOUT data ready | | | 0.1 | μs |
| $T_3$ | PD_SCK high time | 0.2 | 1 | 50 | μs |
| $T_4$ | PD_SCK low time | 0.2 | 1 | | μs |

## Reset and Power-Down

When chip is powered up, on-chip power on rest circuitry will reset the chip.

Pin PD_SCK input is used to power down the HX710. When PD_SCK Input is low, chip is in normal working mode.
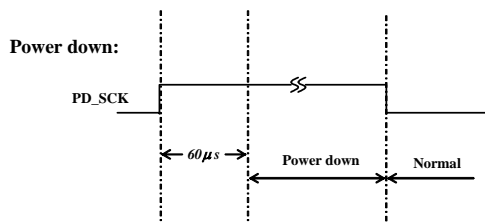


**Fig.3 Power down control**

When PD_SCK pin changes from low to high and stays at high for longer than 60μs, HX710 enters power down mode (Fig.3). When PD_SCK returns to low, chip will reset and enter normal operation mode.

After a reset or power-down event, input selection is default to differential input with 10 Hz output data rate.

## Application Example

Fig.1 is a typical weigh scale application using HX710.

## Reference Driver (Assembly)

```
/*--------------------------------------------------------------
Call from ASM:       LCALL   ReaAD
Call from C:    extern unsigned long ReadAD(void);
                      .
                      .
                 unsigned long data;
                 data=ReadAD();
                      .
                      .
----------------------------------------------------------------*/

PUBLIC       ReadAD
HX710ROM     segment  code
rseg         HX710ROM

sbit         ADDO = P1.5;
sbit         ADSK = P0.0;
/*----------------------------------------------------
 OUT:  R4, R5, R6, R7   R7=>LSB
----------------------------------------------------*/
ReadAD:
    CLR    ADSK                //AD Enable (PD_SCK set low)
    SETB   ADDO                //Enable 51CPU I/O
    JB     ADDO,$              //AD conversion completed?
    MOV    R4,#24
ShiftOut:
    SETB   ADSK                //PD_SCK set high (positive pulse)
    NOP
    CLR    ADSK                //PD_SCK set low
    MOV    C,ADDO              //read on bit
    XCH    A,R7                //move data
    RLC    A
    XCH    A,R7
    XCH    A,R6
    RLC    A
    XCH    A,R6
    XCH    A,R5
    RLC    A
    XCH    A,R5
    DJNZ   R4,ShiftOut         //moved 24BIT?
    SETB   ADSK
    NOP
    CLR    ADSK
    RET
    END
```
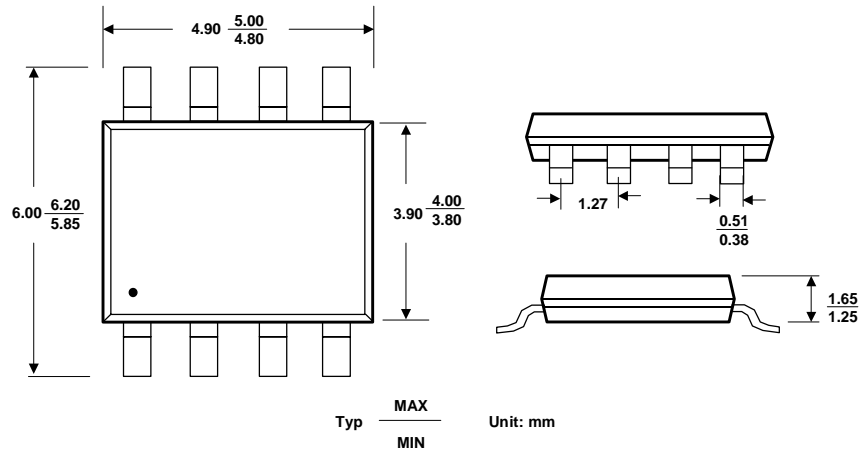
**Reference Driver（C）**

```
//------------------------------------------------------------
sbit    ADDO = P1^5;
sbit    ADSK = P0^0;
unsigned long ReadCount(void){
  unsigned long Count;
  unsigned char i;
  ADDO=1;
  ADSK=0;
  Count=0;
  while(ADDO);
  for (i=0;i<24;i++){
    ADSK=1;
    Count=Count<<1;
    ADSK=0;
    if(ADDO) Count++;
  }
  ADSK=1;
  Count=Count^0x800000;
  ADSK=0;
  return(Count);
}
```

**Package Dimensions**



SOP-8 Package