

# Temperature sensor

## SPECIFICATION

### 1 FEATURES

- TSMC CMOS 40 nm
- Operating temperature range -40 ...+125 °C
- Built-in 10 bit R-2R DAC
- Two serial connected diodes for better sensor accuracy
- Dual voltage design for lower current consumption
- Low current consumption 95 uA
- Small area
- No external components required
- Interrupt generation programmable value
- Supported foundries: TSMC, UMC, Global Foundries, SMIC

### 2 APPLICATION

- On chip temperature measurement
- Pseudostatic analog digitization
- Sensitive analog circuit
- Navigation receiver
- High clock digital VLSI

### 3 OVERVIEW

Temperature sensor consists of built-in 10-bit R-2R DAC powered with fixed supply voltage level from low drop-out voltage regulator, two serial connected diodes and own reference voltage former. Controller converts diodes voltage level, which depends on temperature linearly to digital code. After conversion is done it sets “ready” flag to “1” and outputs 10-bit code. The sensor can operate in two modes: single measurement and continuous measurement.

The block is designed on TSMC CMOS 40 nm technology.

### 4 STRUCTURE

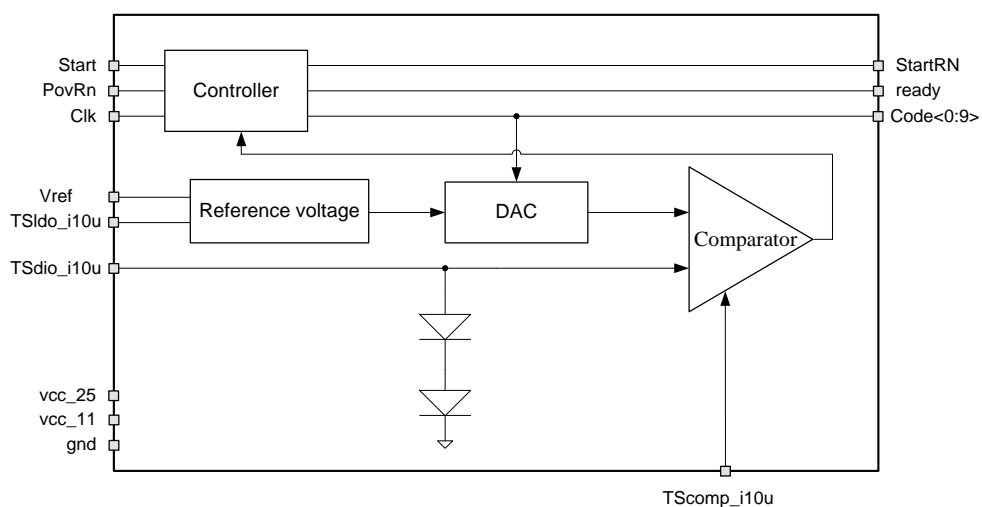


Figure 1: Temperature sensor structure

## 5 PINS DESCRIPTION

Name	Direction	Description
TSdio_i10u	I	Diode reference current (10 $\mu$ A)
TScomp_i10u	I	Comparator reference current (10 $\mu$ A)
TSldo_i10u	I	Voltage source reference current (10 $\mu$ A)
vref	I	Reference voltage
code<9:0>	O	Temperature code
PowRn	I	Supply voltage reset
Start	I	Start measure
clk	I	Clock frequency
StartRN	O	Automatic reset mode
ready	O	Ready status
vcc_25	IO	Supply voltage 2.5 V
vcc_11	IO	Supply voltage 1.1 V
gnd	IO	Ground

## 6 LAYOUT DESCRIPTION

The block dimensions are given in the table 1.

Table 1: Block dimensions

Dimension	Value	Unit
Height	240	$\mu\text{m}$
Width	295	$\mu\text{m}$

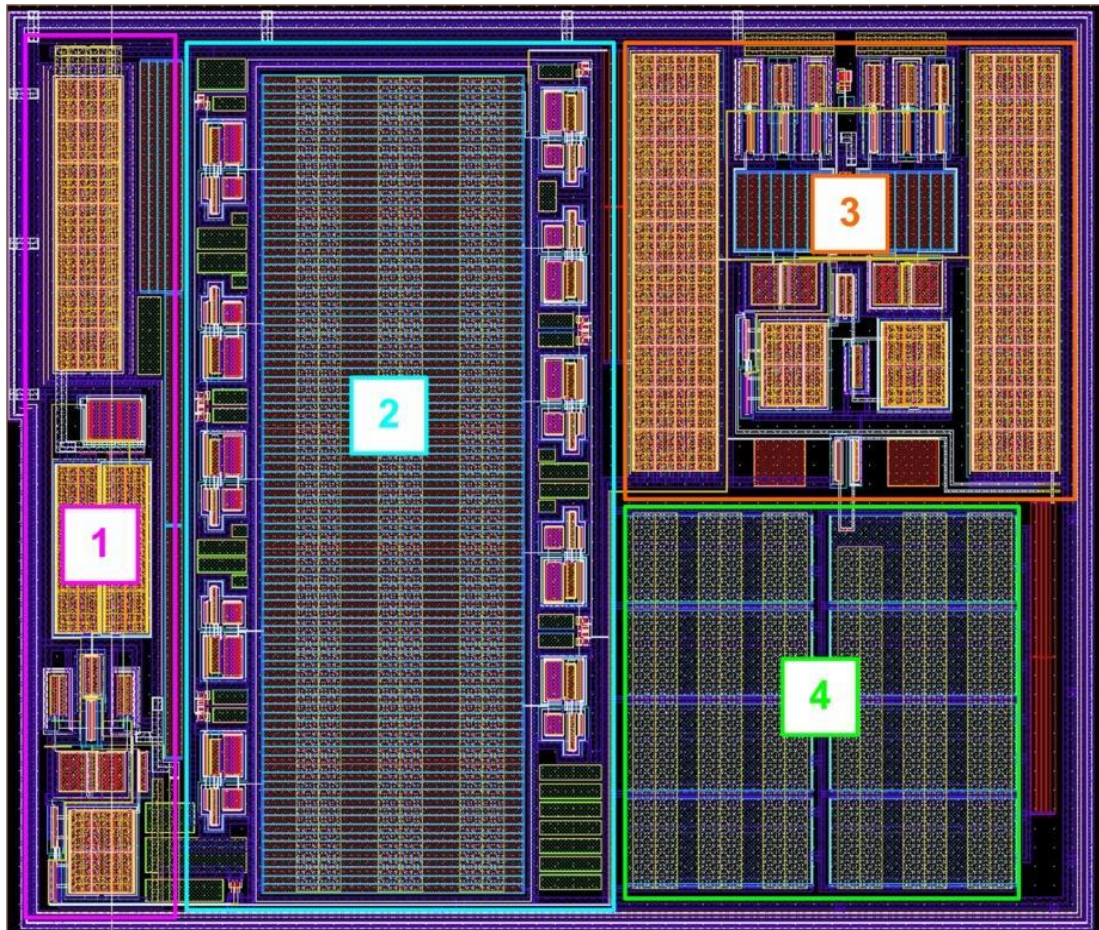


Figure 2: Device layout

1. Reference voltage source
2. DAC
3. Comparator
4. Diodes

## 7 OPERATING CHARACTERISTICS

### 7.1 TECHNICAL CHARACTERISTICS

Technology \_\_\_\_\_ TSMC CMOS 40 nm  
 Status \_\_\_\_\_ pre-silicon verification  
 Area \_\_\_\_\_ 0.07 mm<sup>2</sup>

### 7.2 ELECTRICAL CHARACTERISTICS

The values of electrical characteristics are specified for  $V_{cc_{25}} = 2.4 \div 2.6$  V,  $V_{cc_{11}} = 1.0 \div 1.2$  V and  $T = -40 \div 125^\circ\text{C}$ . Typical values are at  $V_{cc_{25}} = +2.5$  V,  $V_{cc_{11}} = 1.1$  V and  $T = +85^\circ\text{C}$ , unless otherwise specified.

Parameter	Symbol	Condition	Value			Unit
			min	typ.	max	
Supply voltage	$V_{cc_{25}}$	-	2.4	2.5	2.6	V
Supply voltage	$V_{cc_{11}}$	-	1.0	1.1	1.2	V
Temperature range	T	-	-40	85	125	°C
Clock frequency	$F_{clk}$	-	1	50	50	kHz
DAC resolution	K	-		10		bit
Accuracy step	N	-		0.5		±°C
Absolute accuracy	$\delta$	-		4.9		±°C
Current consumption	$I_{cc}$		-	95	105	uA
Stand-by current	$I_{stb}$	-	-		0.1	nA
Input logic-high level	$V_{IH}$	For digital inputs	$0.7 V_{cc}$	-	$V_{cc}+0.25$	V
Input logic-low level 2.5V	$V_{IL_{25}}$	For digital inputs 2.5 V	-0.25	-	0.3	V
Input logic-low level 1.1 V	$V_{IL_{11}}$	For digital inputs 1.1 V	-0.1	-	0.15	V

## 8 DELIVERABLES

Depending on license type IP may include:

- Schematic or NetList
- Layout or blackbox
- Verilog, lef and lib files
- Extracted view (optional)
- GDSII
- DRC, LVS, antenna report
- Test bench with saved configurations (optional)
- Documentation