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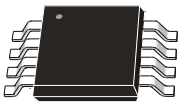
TSC1214

Datasheet

Low-side digital power monitor, with I²C bus interface



MiniSO8

Features

- 14-bit ADC for current sensing and ±80 mV range
- 11-bit ADC for voltage and temperature
- 2.7 V to 4.5 V power supply voltage
- Low-side and bidirectional current sensing
- Internal die temperature monitoring
- I²C digital interface for device control
- Internal 32768 Hz time base
- Operating free air temperature range: -40 °C to +85 °C

Applications

- Low voltage power supply monitoring

Maturity status link
TSC1214

Description

The TSC1214 is a digital current, voltage, and temperature monitoring Analog Front End (AFE), meant to monitor a low voltage power supply. It implements a double monitoring path for current based on a 14-bit ADC and voltage or temperature based on an 11-bit ADC. The device is programmable through the I²C interface.

The TSC1214 comes in a plastic MiniSO8 package and can operate in the -40 °C to +85 °C ambient temperature range.

1 Block diagram and pin description

Figure 1. Internal block diagram

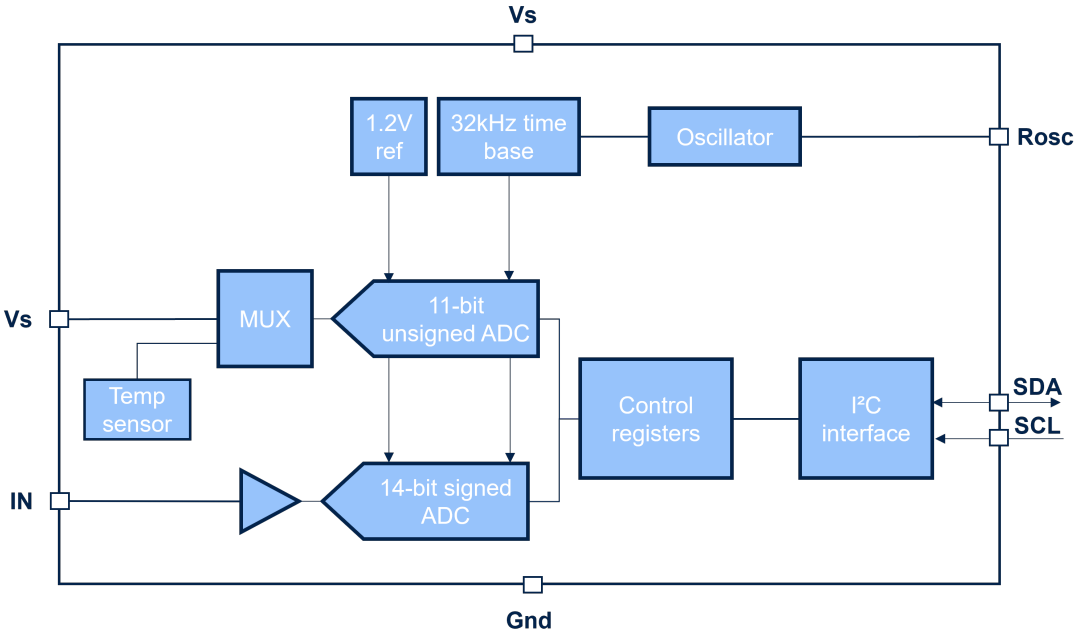


Figure 2. Pin connections (top view)

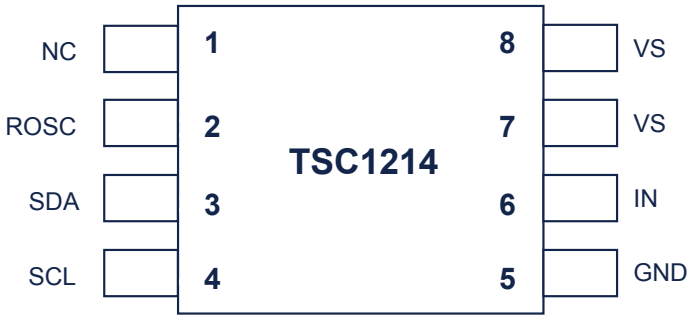


Table 1. Pin description

Pin	Pin name	Type	Description
1	NC	Non connected	-
2	ROSC	Analog input	Oscillator bias resistor
3	SDA	Digital input / output	I²C serial data
4	SCL	Digital input	I²C serial clock
5	GND	Ground	Analog and digital ground
6	IN	Analog input	Current sense input
7	VS	Supply	Power supply
8	VS	Supply	Power supply

2 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{max}	Maximum voltage on any pin	7	V
V_{io}	Voltage on I/O pins	-0.3 to +7	V
T_{stg}	Maximum storage temperature	-55 to +150	°C
T_j	Maximum junction temperature	+150	°C
$R_{th\text{-}ja}$	Junction to ambient thermal resistance (for MiniSO8)	190	°C/W
ESD	Human Body Model (HBM)	2000	V

Table 3. Operating conditions

Symbol	Parameter	Value	Unit
V_S	Analog supply voltage	2.7 to 4.5	V
T	Operating free-air temperature range	-40 to +85	°C

3 Electrical characteristics

2.7 V < V_S < 4.5 V, -20 °C < Ta < 70 °C.

Table 4. Electrical characteristics

Symbol	Parameters	Test conditions	Min.	Typ.	Max	Unit
SUPPLY						
I_{CC}	Operating current consumption	Average value over 4 s			100	µA
Isdty	Standby current consumption	Standby mode, input = 0 V			2	µA
Ipdn	Power down current consumption	V_S < UVLOth, input = 0 V			1	µA
UVLOth	Undervoltage threshold	V_S decreasing	2.5	2.6	2.7	V
UVLOhyst	Undervoltage threshold hysteresis			100		mV
POR	Power On Reset threshold	V_S decreasing		2		V
Current sense ADC						
V_{IN}	Input voltage range		-80		+80	mV
I_{IN}	Input current for IN pin				500	nA
LSB_I	1 LSB step size for current sense ADC	14 bits		11.77		µV
ADC_I_offset	Current sense ADC offset	IN = 0 V	-3		+3	LSB
ADC_I_time	Current sense ADC conversion time	32768 Hz clock		500		ms
ADC_I_acc	Current sense ADC gain error	@ 25 °C			0.5	%
		-20 °C < Ta < 70 °C			1	
F_{OSC}	Internal time base frequency	R_{OSC} = 200 kΩ, 0.1%		32768		Hz
Osc_acc	Internal time base accuracy	Vs = 3.6 V, 25 °C			2	%
		2.7 V < V_S < 4.5 V and -20 °C < Ta < 70 °C			2.5	
Supply voltage and temperature sensor characteristics						
V_S	Supply voltage input range		2.7		4.5	V
LSB_V	LSB step size for supply voltage ADC			2.44		mV
LSB_T	LSB step size for temperature sensor			0.125		°C
ADC_V_time	Supply voltage ADC conversion time	32768 Hz clock		250		ms
ADC_V_acc	Supply voltage ADC gain error	2.7 V < V_S < 4.5 V	-0.5		+0.5	%
Temp_acc	Temperature sensor accuracy		-3		+3	°C
Digital characteristics (SCL, SDA)						
V_{IH}	Input high voltage		1.2			V
V_{IL}	Input low voltage				0.35	
V_{OL}	Low-level output voltage	SDA ; I_{OL} = 4 mA			0.4	V

4 Typical performance curves

T_A = 25 °C V_S = 3.3 V, unless otherwise stated.

Figure 3. Standby current vs. temperature

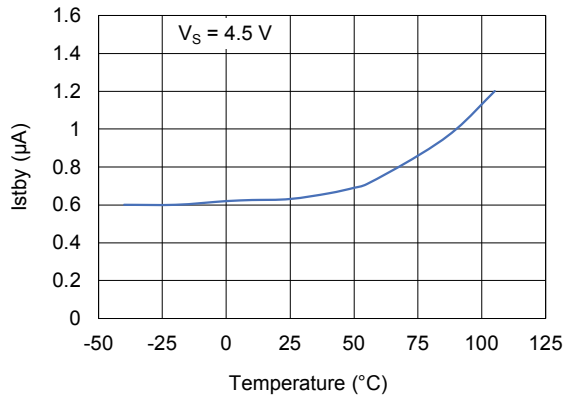


Figure 4. Current measurement accuracy vs. temperature

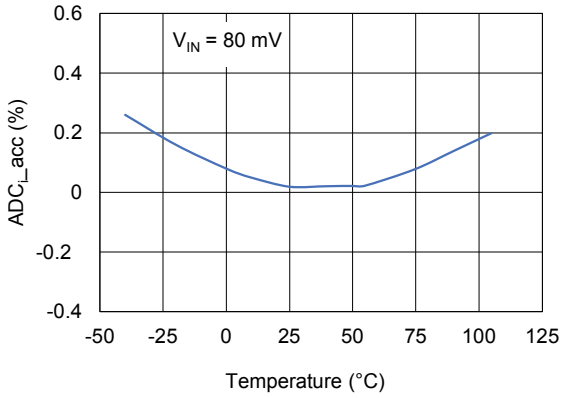


Figure 5. Oscillator frequency accuracy vs. temperature

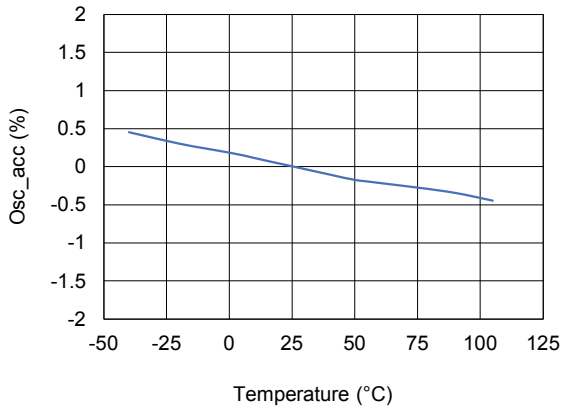
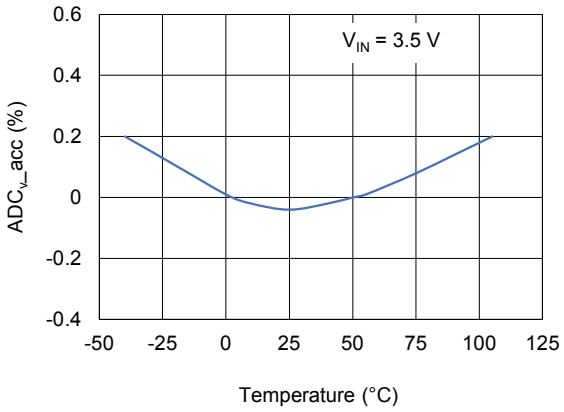


Figure 6. Supply voltage measurement accuracy vs. temperature



5 Application information

Figure 7. **Typical application schematics using TSC1214**

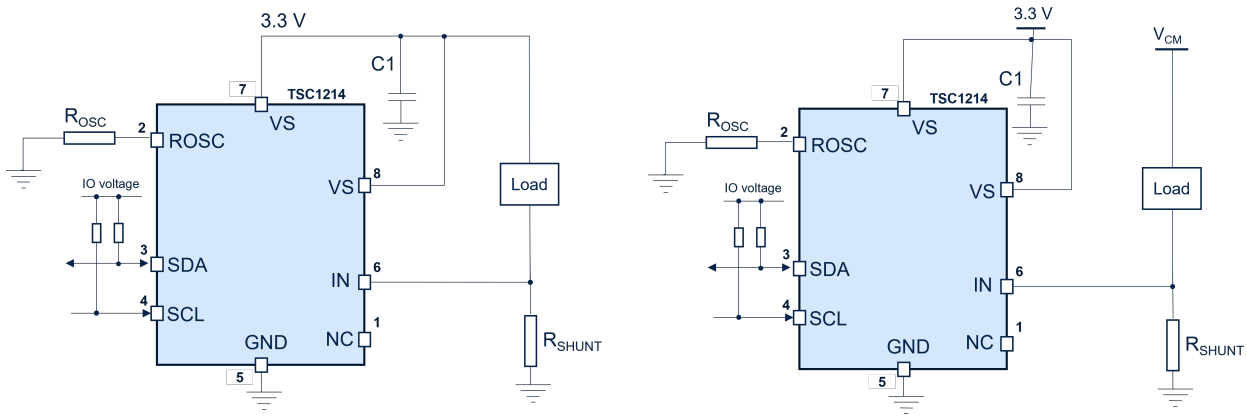


Table 5. **External components list**

Name	Value	Tolerance	Comments
R_{SHUNT}	10 mΩ to 50 mΩ	1%	Shunt resistor to sense the current
R_{OSC}	200 kΩ	0.1%	Internal oscillator bias resistor
C1	1 µF	-	Supply decoupling capacitance

5.1 Functional description

5.1.1 Digital current sensing

The TSC1214 is a current, voltage, and temperature digital monitor. The low-side bidirectional current is measured through a shunt resistor placed between the IN pad and the ground. The current sense 14-bit ADC has a 500 ms conversion time. The ADC output is in two's complement format. When a conversion cycle is completed, the value is stored in the REG_CURRENT registers (see Table 9), and can be read by the controller. Those registers are updated at the end of each conversion.

5.1.2 Supply voltage and temperature monitoring

The power supply voltage and chip temperature (close to the load temperature) are measured by means of an 11-bit ADC and a multiplexer. This takes place concurrently with the current sensing with a dedicated A/D converter, which means that it does not affect the performance of the current sensing. To reduce the power consumption, a conversion takes place only every two seconds, alternatively for load voltage and temperature (so each value is refreshed every four seconds).

The conversion cycle time is 250 ms. The resolution is 2.44 mV for the power supply voltage and 0.125 °C for the temperature.

When a conversion cycle is completed, the values are stored respectively in the REG_VOLTAGE and REG_TEMPERATURE registers (see Table 9).

5.2 I²C interface

5.2.1 Read and write operations

The interface is used to control and read the registers. It is compatible with the Philips I²C registered trademark (version 2.1). It is a target serial interface with a serial data line (SDA) and a serial clock line (SCL).

- SCL: input clock used to shift data
- SDA: input/output bidirectional data transfers

A filter rejects the potential spikes on the bus data line to preserve data integrity.

The bidirectional data line supports transfers up to 400 kbit/s (fast mode). The data is shifted to and from the chip on the SDA line, MSB first.

The first bit must be high (START) followed by the device address and read/write bit control. The TSC1214 address is 70 h followed by the R/W bit. The TSC1214 then sends an acknowledgement the end of an 8-bit long sequence. The next 8 bits correspond to the register address followed by another acknowledgement.

The data field is the last 8-bit long sequence sent, followed by a last acknowledgement.

Table 6. TSC1214 address format

b7	b6	b5	b4	b3	b2	b1	b0
1	1	1	0	0	0	0	R/W

Table 7. Register address format

b7	b6	b5	b4	b3	b2	b1	b0
RegADDR7	RegADDR6	RegADDR5	RegADDR4	RegADDR3	RegADDR2	RegADDR1	RegADDR0

Table 8. Device data format

b7	b6	b5	b4	b3	b2	b1	b0
DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0

Figure 8. Read operation

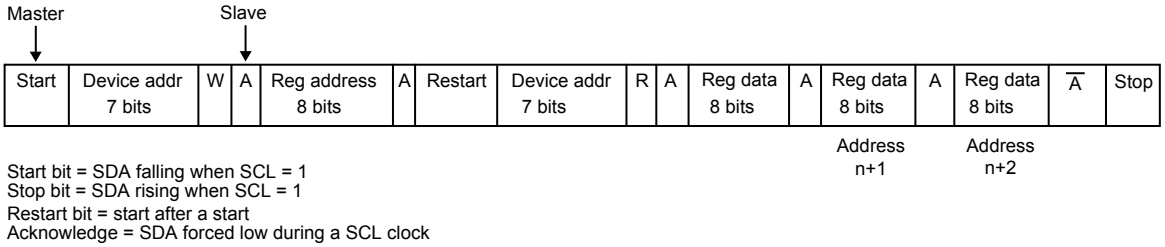
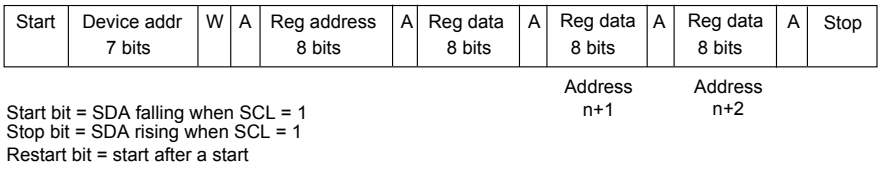


Figure 9. Write operation



5.3 Register map

The register space provides 8 control registers. The mapping of registers is shown in Table 9, with a detailed of registers 0 (REG_MODE) and 1 (REG_CTRL) shown in Table 10 and Table 11. All registers are reset to default values at power-on or reset, and the PORDET bit in register REG_CTRL is used to indicate the occurrence of a power-on-reset.

Table 9. Register map

Control Register name	Type	Address (decimal)	Description
REG_MODE	R/$\overline{W}$	0	Mode register
REG_CTRL	R/$\overline{W}$	1	Control and status register
REG_CURRENT_LOW	R	6	Load current value, bits 0-7
REG_CURRENT_HIGH	R	7	Load current value, bits 8-15
REG_VOLTAGE_LOW	R	8	Power supply voltage value, bits 0-7
REG_VOLTAGE_HIGH	R	9	Power supply voltage value, bits 8-15
REG_TEMPERATURE_LOW	R	10	Temperature value, bits 0-7
REG_TEMPERATURE_HIGH	R	11	Temperature value, bits 8-15

Values held in consecutive registers (such as the current value in the REG_CURRENT_LOW and REG_CURRENT_HIGH registers) must be read with a single I²C access to ensure data integrity. It is possible to read multiple values in one I²C access, all values are consistent.

The load current is coded in 2's complement format, and the LSB value is 11.77 µV.

The power supply voltage is coded in binary format, and the LSB value is 2.44 mV.

The temperature value is coded in 2's complement format, and the LSB value is 0.125 °C.

The temperature of 0 °C corresponds to code 0

Table 10. REG_MODE – address 0

Bit name	Pos.	Type	Def.	Description
	[3..0]		0	Unused bits.
DEVICE_ON	4		0	0: standby mode. The TSC1214 is in low power mode and conversion is not operating. When the TSC1214 is powered on, by default it is set to standby mode. 1: operating mode. To start conversion, the DEVICE_ON bit must be set to 1.
	[7..5]		0	Unused bits.

Table 11. REG_CONTROL – address 1

Bit name	Pos.	Type	Def.	Description
	[3..0]		0	Unused bits.
POR_DETECT	4	R	1	Power on reset (POR) detection bit: 0 = no POR event occurred, 1 = POR event occurred.
		W	0	Soft reset: 0 = release the soft-reset and clear the POR detection bit, 1 = assert the soft-reset and set the POR detection bit.
	[7..5]			Unused bits.

6 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK packages, depending on their level of environmental compliance. ECOPACK specifications, grade definitions and product status are available at: www.st.com. ECOPACK is an ST trademark.

6.1 MiniSO8 package information

Figure 10. **MiniSO8 package outline**

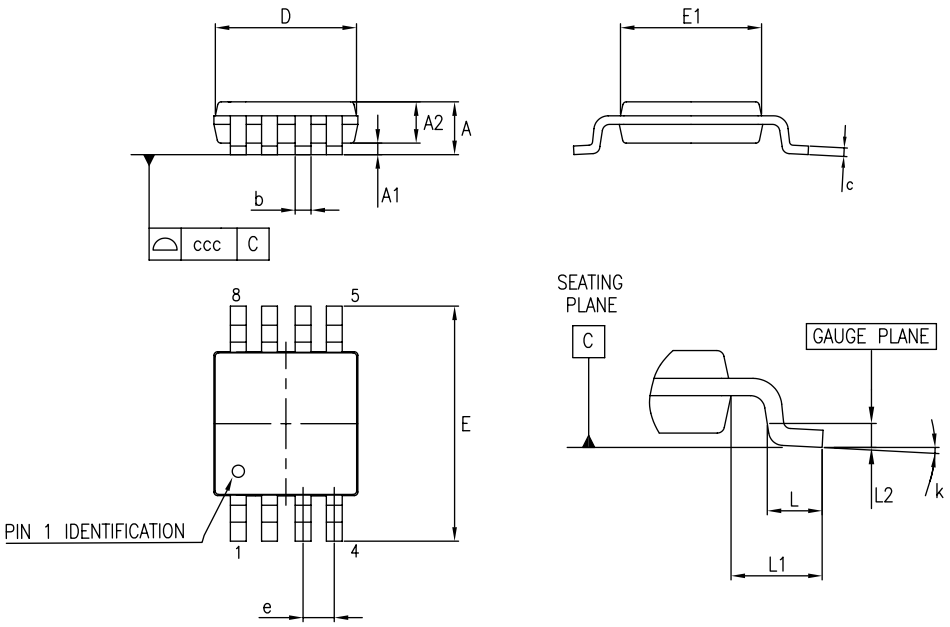
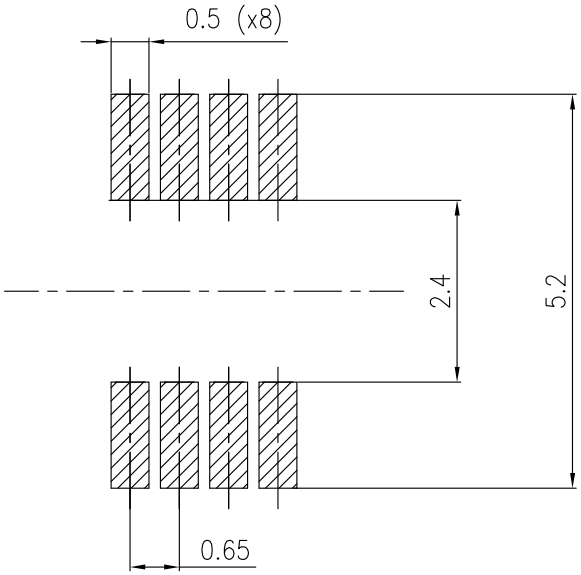


Table 12. **MiniSO8 mechanical data**

Ref.	Dimensions					
	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.1			0.043
A1	0		0.15	0		0.006
A2	0.75	0.85	0.95	0.03	0.033	0.037
b	0.22		0.4	0.009		0.016
c	0.08		0.23	0.003		0.009
D	2.8	3	3.2	0.11	0.118	0.126
E	4.65	4.9	5.15	0.183	0.193	0.203
E1	2.8	3	3.1	0.11	0.118	0.122
e		0.65			0.026	
L	0.4	0.6	0.8	0.016	0.024	0.031
L1		0.95			0.037	
L2		0.25			0.01	
k	0°		8°	0°		8°
ccc			0.1			0.004

Figure 11. **MiniSO8 recommended footprint**



7 Ordering information

Table 13. **Order codes**

Order code	Package	Packaging	Marking
TSC1214IST	MiniSO8	Tape & Reel	1214

Revision history

Table 14. **Document revision history**

Date	Revision	Changes
06-Aug-2024	1	Initial release.

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