IST8101

ASIC for

Magnetic current sensor

Datasheet

Table of Contents

1. General Description

IST8101 is an ASIC chip to control and process the signal from the magnetic current sensors. It enables the contact-free measurement of both the AC and DC current with high accuracy within the full operating temperature. With an intelligent switching design, IST8101 reduces the electrical offset and offset drift to an extremely low level.

IST8101 integrates multiple functions in one chip, which includes: multi-vibrator with duty cycle detection, digital-to-Analog convertor, fault detection, feedback and self-test circuits. It provides the analog output signal which is proportional to the primary current, the alarm flags and self-test functions compliance with both IEC 62752:2016 and UL2231, overcurrent detection and reference output. IST8101 has embedded E-fuse memory to store the sensor parameters and chip configurations. IST8101 can also drive a feedback coil to achieve wide measurement range. I^2C interface for digital output and communication are also available for various configurations' setting.

Features

- Drive and sensing the inductive magnetic sensor
- Measure both the AC and DC current with high accuracy
- Intelligent switching design to utilize extremely low electrical offset
- Analog and I2C digital output
- Alarm flags and self-test compliance with IEC 62752 and UL2231
- Single 5V supply
- Compact form factor, 4 x 4 x 0.85mm^3, 32-pin QFN package
- AEC-Q100 compliance

Applications

Residual current measurement in EV charge cable

Leakage current measurement

System power consumption

Current sensing in invertors

Standard compliance

IEC 62752:2016

UL2231-2: 2nd Ed

2. Block Diagram, Package Dimensions and Application Circuits

2.1 Block diagram

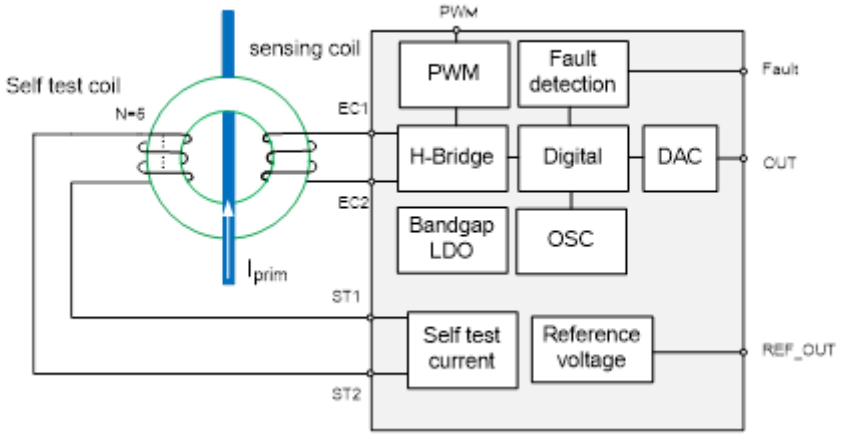

Figure 1.

2.2 Package, Pin Description, and floor plan

IST8101 adopts the thermally enhanced QFN package with built-in thermal pad. The package is shown in figure 2(a). The die is mounted on this thermal pad to increase thermal conductivity. And this thermal pad is connected with the GND pad as well. The exposed thermal pad on the bottom of package is required to be sold on the PCB and ground. Figure 2(b) shows the floor plan of the whole chip. Figure 2(c) shows the layout recommendation. The C1 should be located as close as possible to pin17 and pin 18, because the pin 17 and pin 18 are regulator input. The capacitor C7 is placed closest to pin 12 and pin13. The capacitor C8 is placed closest to pin 14 and pin15. The capacitor C6 is placed closest to pin 16.

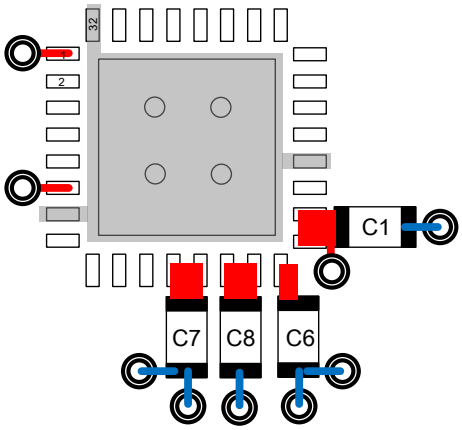

Figure 2. Layout recommendation

Pin No.	Name	I/O Type	Description
1	VD5A	PWR	Input power
2	TC1	AI	Test coil connection
3	TC2	AI	Test coil connection
4	OUT	AO	DAC output
5	TESTA	DI	Enable selection of Test coil (internal pull down, 100KOhm)
6	VD5A	PWR	Input power
7	GNDA	PWR	VS_A, analog ground
8	REF_OUT	AO	2.25V output
9	REF_IN	AI	External reference voltage input
10	CLK_SEL	AI	Clock selection (internal pull down,100KOhm) Low: internal clock; High: external crystal (40MHz)
11	TST	AO	Analog test pin
12	VD_O	PWR	2.5V LDO input for OSC circuit
13	VD_D	PWR	2.5V LDO output for digital circuit
14	VIN	PWR	4.5V LDO input
15	VD_A	PWR	4.5V LDO output for analog circuit
16	VD_H	PWR	4.5V LDO output for HB
17	VD5A	PWR	Input power
18	VD5A	PWR	Input power
19	PWM	DO	Signal output
20	GNDA	PWR	VS_A, analog ground
21	EC2	AI	Sensor coil connection
22	EC1	AI	Sensor coil connection
23	XO	DO	Crystal OSC connection
24	XI	DI	Crystal OSC connection
25	NC		
26	HRESET	DI	Hardware reset; reserve for testing
27	OC	DO	Overcurrent alarm, active low
28	AC30mA	DO	AC 30mA alarm, active low (IEC62752) CCID20 alarm, active low (UL2231)
29	DC6mA	DO	DC 6mA alarm, active low (IEC62752) CCID5 alarm, active low (UL2231)
30	SDA	DIO	I2C data, internal pull up resistor=74kOhm
31	SCL	DIO	I2C clock, internal pull up resistor=74kOhm
32	GNDD	PWR	VS_D, digital ground

2.3 Application circuit

IST8101 offers the open-loop operation. The open-loop operation is to measure the magnetic field generating by the primary current directly and the output signal is from the OUT pin (Pin 6).

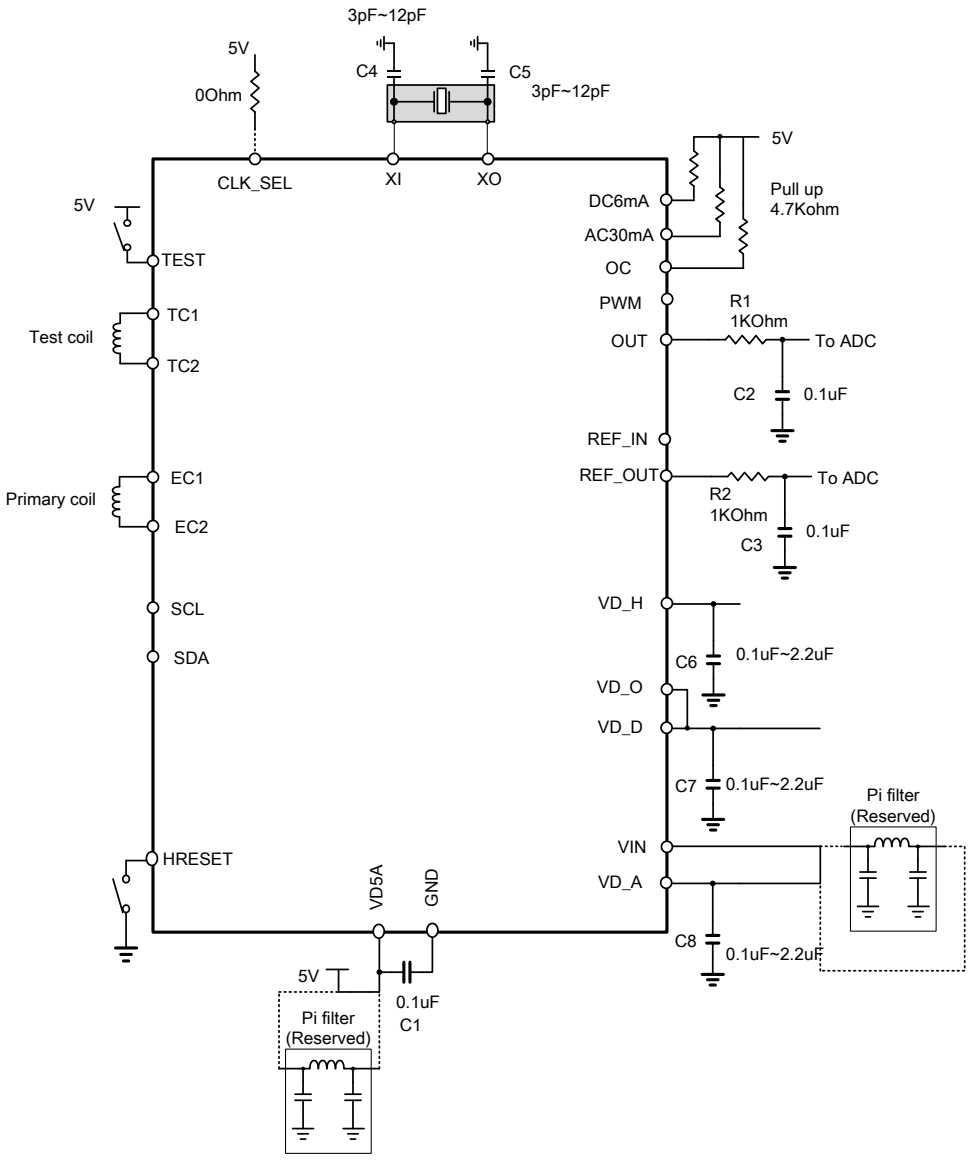

Figure 3. Application circuits for the open-loop operation.

C1, C6,C7 and C8 are decoupling capacitors and are required to connect closely to the chip pins.

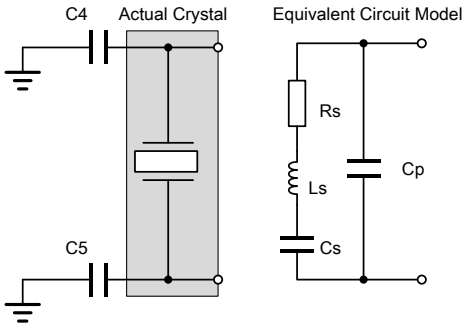

Figure 4. Equivalent circuit of crystal

Figure 4 is an equivalent circuit of quartz crystal. By Choosing C4,C5 (C4, C5 are approximately 3pF to 12pF) >Cp. The oscillating frequency is given as

$$fs = \frac{1}{2\pi\sqrt{LsCs}}$$

Let Ls=4.06mH, Cs=3.925fF, Cp=780fF, the oscillating frequency equals 40MHz.

3. Electrical Specifications

3.1 Absolute Maximum Ratings

Parameter	Symbol	Limits	Unit
Supply Voltage	VDD	-0.3 to 6.0	V
Storage temperature	Ts	-40 to 150	°C
Electrostatic Discharge Voltage Human-body model (HBM)	VESD_HBM	±2000	V
Electrostatic Discharge Voltage Charged-device model (CDM)	VESD_CDM	-800 to 800	V

If the device is used in conditions exceeding these limits, it may cause permanent damage.

3.2 Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating Temperature	TA	-40		125	°C
Power Supply Voltage	VDD	4.75	5	5.25	V

3.3 Electrical Specifications

Operating conditions: TA=+25℃; VDD=5V;

Parameter	Symbol	Conditions	Min.	Typ.	Max	Unit
Output	V_{OUT}		0	2.25	4.5	V
DAC gain*1	Gain		-8		8	V/V
DAC gain step				0.015625		V/V
Sensitivity of Duty cycle ratio	Sen_D	Rs=104Ohm Coil turn N=185	0.007	0.009	0.011	%/mA
		Rs=205Ohm Coil turn N=185	0.011	0.015	0.019	%/mA
Current consumption	Ic	ASIC+Coil, Rs=205Ohm N=185		8.5	10	mA
Current consumption of H-bridge		Rs = 205 Ohm N=185		5	6	mA
Current consumption of ASIC		No including coil		3.5	4	mA
Electrical offset current of ASIC	IOE	-40 ~ 125ºC Chopper off		±0.14	±0.3	mA
		Chopper on		±0.05		
Sensitivity drift △S/S over the temperature*2		No coil, No Temperature compensation, -40 ~ 125ºC		545	950	ppm/K
Note *1: The gain ratio of DAC circuit, with unit of V/V. Note *2: The sensitivity drift includes the resistor (Rs), the chopper switches and the H-bridge switches.						
Fault detection						
Fault detection of primary current (DC)	DC6mA	Alarm threshold of DC current, compliance with IEC62752:2016	3.5	4.75	6	mA
Fault detection of primary current (AC)	AC30mA	Alarm threshold of AC current (rms), compliance with IEC62752:2016	15	22.5	30	mA rms

Fault detection of primary current	CCID5	Alarm threshold of CCID 5, compliance with UL2231				
Fault detection of primary current	CCID20	Alarm threshold of CCID 20, compliance with UL2231				
Voltage reference						
Output voltage	Vref_out		2.22	2.25	2.28	V
Output current					20	mA
Temperature drift					150	ppm/K
Load regulation				0.25	0.4	mV/mA
Self test						
Sink current to the self test coil	UL2231	CCID5, AC5mA (rms)	1000	1100	1222	uA
		CCID20, AC20mA (rms)	4000	4400	4890	uA
	IEC62752	DC6mA	1200	1320	1470	uA
		AC30mA (rms)	6000	6600	7340	uA
Leakage current		Test = 0			1	uA
Temperature drift of ST current		-40~125℃			800	ppm/K
Chip clock						
Oscillator frequency	f_{OSC}	for chip operation	20	80	120	MHz
Temperature drift of Oscillator frequency		-40~125℃		547	900	ppm/K
Chip temperature sensor						
Temperature sensor sensitivity	TS	for internal usage	4.6	5	5.4	Count/K
Noise, TA=-40~105 ºC						
VREF noise	VN	10Hz		11.6	23	uV/√Hz
		1KHz		0.8	1.6	uV/√Hz
Temperature sensor noise	TN	No average	1.5	2	3	Count
H-Bridge noise	HN			0.0010	0.0020	%
Oscillator jitter	OJ	80MHz		1.9	3	ns(rms)
Duty cycle noise	DCN	Rs=104Ohm, No average Sen=5.5count/mA Sen= 0.18mA/count		0.36	0.72	mA(rms)

		Rs=205Ohm, No average Sen=9.5count/mA Sen= 0.105mA/count		0.2	0.4	mA(rms)

4. Ordering Information

Order Number	Package Type	Packaging	
IST8101	QFN-32 pin	Tape and Reel: 3k pieces per reel	 8101: Product Code Y: Last number of the year WW: week number (Week of January 1 is week “01”)

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