sames

SA9105F

THREE PHASE BIDIRECTIONAL POWER/ENERGY METERING IC WITH INSTANTANEOUS PULSE OUTPUT

FEATURES

- Performs bidirectional one, two or three phase power and energy measurement
- Meets the IEC 521/1036 Specification requirements for Class 1 AC Watt hour meters
- Operates over a wide temperature range
- Uses current transformers for current sensing
- Excellent long term stability
- Easily adaptable to different signal levels
- Precision voltage reference on-chip
- Two pulse output formats available
- Protected against ESD

DESCRIPTION

The SAMES SA9105F Three Phase bidirectional Power/Energy metering integrated circuit generates pulse rate outputs for positive and negative energy directions, the frequency of which is proportional to the power consumption. The SA9105F performs the calculation for active power.

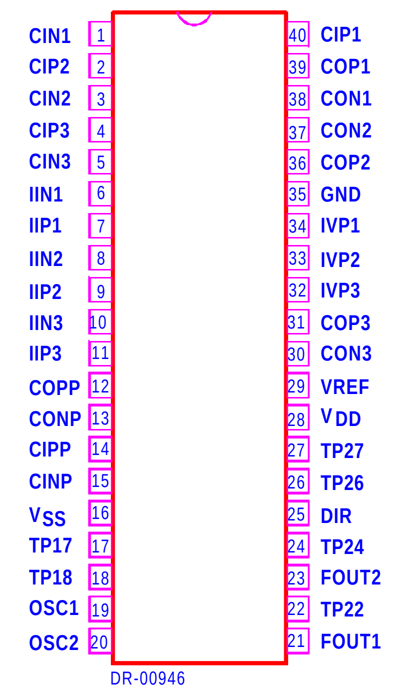
The method of calculation takes the power factor into account.

Energy consumption is determined by the power measurement being integrated over time.

This innovative universal three phase power/ energy metering integrated circuit is ideally suited for applications such as residential and industrial energy metering and control.

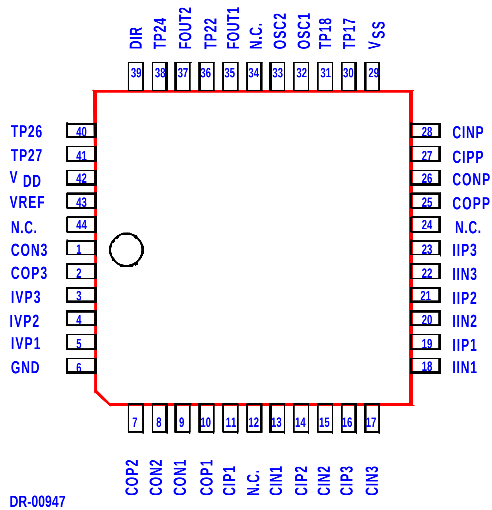
The SA9105F integrated circuit is available in 40 pin dual-in-line plastic (DIP-40), as well as in 44 pin plastic leaded chip carrier (PLCC-44) package types.

PIN CONNECTIONS



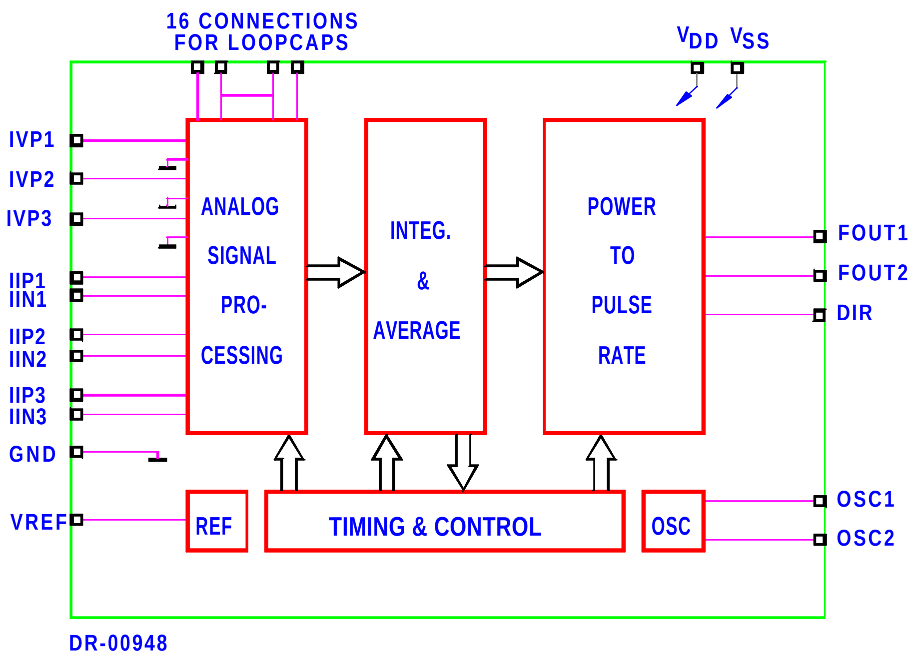
Package: DIP-40

PIN CONNECTIONS



Package: PLCC-44

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS *

Parameter	Symbol	Min	Max	Unit
Supply Voltage	V_{DD}-V_{SS}	-0.3	6.0	V
Current on any Pin	I_{PIN}	-150	+150	mA
Storage Temperature	T_{STG}	-40	+125	°C
Operating Temperature	T_O	-40	+85	°C
Current at any pin	I_P	-100	+100	mA

* Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only. Functional operation of the device at these or any other conditions above those indicated in the operation sections of this specification, is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(Over the temperature range -10°C to +70°C#, unless otherwise specified.)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Operating Temp. Range #	T_O	-25		+85	°C	
Supply Voltage	V_{DD}-V_{SS}	4.5		5.5	V	
Supply Current	I_{DD}			10	mA	
Nonlinearity of Power Calculation		-0.3		+0.3	%	1% - 100% of rated power
Current Sensor Inputs (Differential)						
Input Current Range	I_{II}	-25		+25	µA	Peak value
Voltage Sensor Inputs (Asymmetric)						
Input Current Range	I_{IV}	-25		+25	µA	Peak value
Pins FOUT1,FOUT2,DIR Output Low Voltage Output High Voltage	 V_{OL} V_{OH}	 V_{DD}-1		 V_{SS}+1	 V V	 I_{OL} = 5mA I_{OH} = -2mA
Pulse Rate: FOUT1, FOUT2	f_p	0 0		64 180	Hz Hz	Specified linearity Min and max limits
Oscillator	Recommended crystal: TV colour burst crystal, f = 3.5795 MHz					
Pin VREF Ref. Current Ref. Voltage	 $-I_R$ V_R	 45 1.1	 50 	 55 1.3	 µA V	With R = 24 kΩ connected to V_{SS} Referred to V_{SS}

Extended Operating Temperature Range available on request.

PIN DESCRIPTION

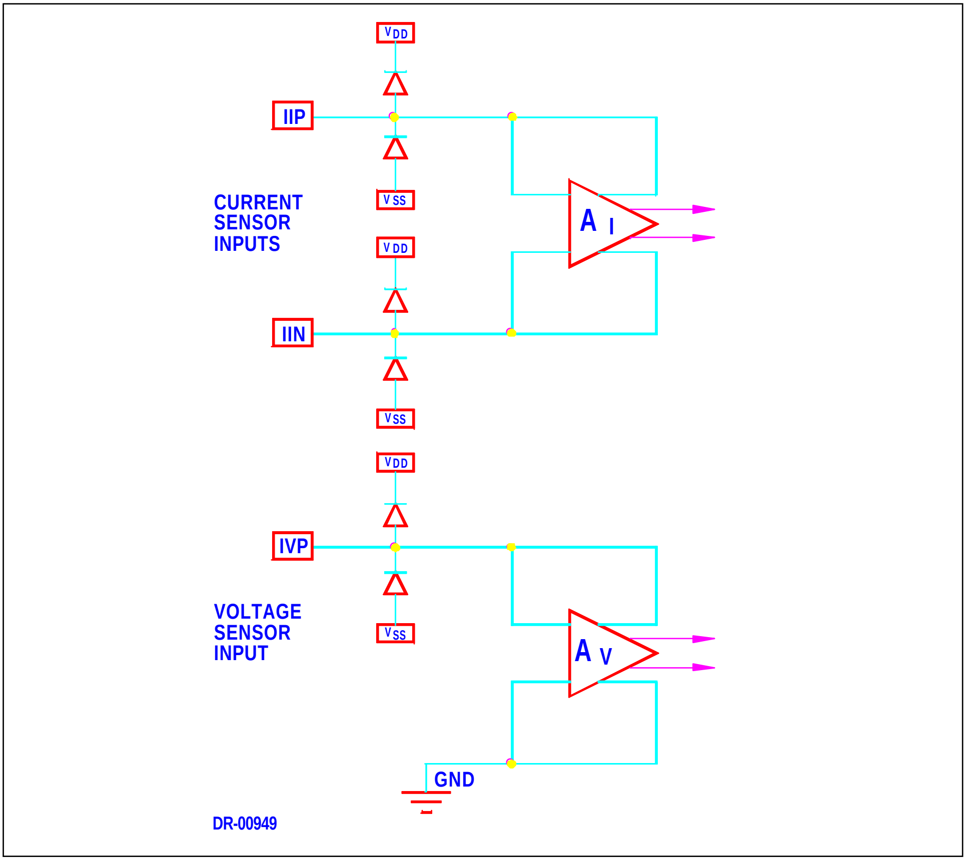
Pin PLCC	Pin DIP	Designation	Description
6	35	GND	Ground
42	28	V_{DD}	Positive Supply Voltage
29	16	V_{SS}	Negative Suply Voltage
5	34	IVP1	Analog input for Voltage : Phase 1
4	33	IVP2	Analog input for Voltage : Phase 2
3	32	IVP3	Analog input for Voltage : Phase 3
18	6	IIN1	Inputs for current sensor : Phase 1
19	7	IIP1	
20	8	IIN2	Inputs for current sensor : Phase 2
21	9	IIP2	
22	10	IIN3	Inputs for current sensor : Phase 3
23	11	IIP3	
32	19	OSC1	Connections for crystal or ceramic resonator
33	20	OSC2	(OSC1 = Input ; OSC2 = Output)
35	21	FOUT1	Pulse rate outputs
37	23	FOUT2	
39	25	DIR	Direction indication output
9	38	CON1	Connections for outer loop capacitors of A/D converters
10	39	COP1	
8	37	CON2	
7	36	COP2	
1	30	CON3	
2	31	COP3	
26	13	CONP	
25	12	COPP	
13	1	CIN1	Connections for inner loop capacitors of A/D converters
11	40	CIP1	
15	3	CIN2	
14	2	CIP2	
17	5	CIN3	
16	4	CIP3	
28	15	CINP	
27	14	CIPP	
43	29	VREF	Connection for current setting resistor
41	27	TP27	Test pin. Connect to V_{SS}
30	17	TP17	Manufacturer's test pins (Leave unconnected)
31	18	TP18	
36	22	TP22	
38	24	TP24	
40	26	TP26	

2. Analog Input Configuration

The current and voltage sensor inputs are illustrated below.

These inputs are protected against electrostatic discharge through clamping diodes, in conjunction with the amplifiers input configuration.

The feedback loops from the outputs of the amplifiers A_I and A_V generate virtual shorts on the signal inputs. Exact duplications of the input currents are generated for the analog processing circuitry



3. Electrostatic Discharge (ESD) Protection

The SA9105F integrated circuit's inputs/outputs are protected against ESD.

4. Power Consumption

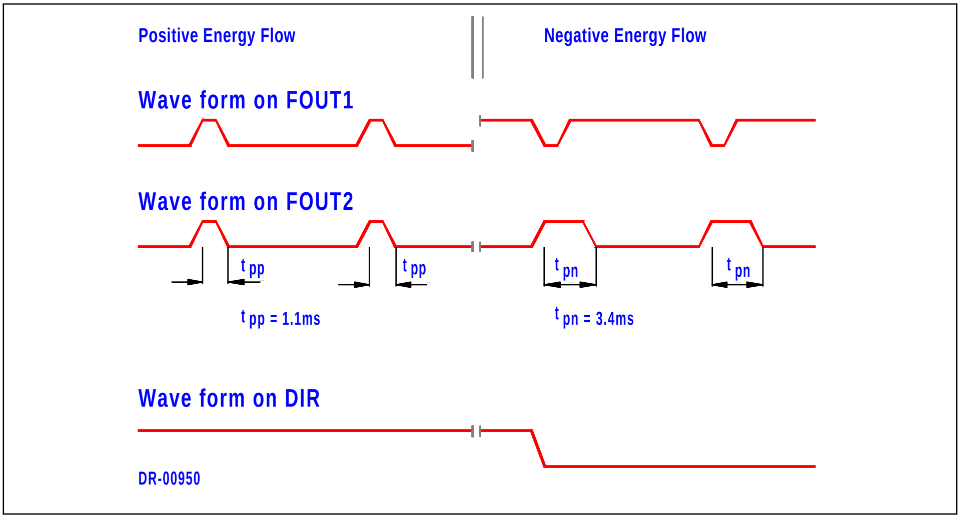
The overall power consumption rating of the SA9105F integrated circuit is less than 50mW with a 5V supply.

5. Pulse Output Signals

The calculated power is divided down to a pulse rate of 64Hz, for rated conditions on both FOUT1 and FOUT2.

The format of the pulse output signal, which provides power/energy and direction information, is the only difference between the signals on FOUT1 and FOUT2.

The direction of the energy flow is defined by the mark/space ratio on FOUT1, while the pulse width defines the direction on FOUT2.



An integrated anticreep function ensures no metering at zero line currents.

The formula for calculating the Output Frequency (f) is given below:

$$f = 11.16 * FOUTX * \frac{FOSC}{3.58MHz} * \frac{(I_{I1}\ I_{V1}) + (I_{I2}\ I_{V2}) + (I_{I3}\ I_{V3})}{3 * I_R^2}$$

Where FOUTX = Nominal rated frequency (64Hz)

FOSC = Oscillator frequency (2MHz ...... 4MHz)

I_{I1}, I_{I2}, I_{I3} = Input currents for current sensor inputs (16µA at rated line current)

I_{V1}, I_{V2}, I_{V3} = Input currents for voltage sensor inputs (14µA at rated line voltage)

I_R = Reference current (typically 50µA)

TYPICAL APPLICATION

In the Application Circuit (Figure 1), the components required for a three phase power metering application are shown. Terminated current transformers are used for current sensing.

The most important external components for the SA9105F integrated circuit are:

C_7, C_9, C_{10} and C_{11} are the outer loop capacitors for the integrated oversampling A/D converters. The typical value of C_7 is 2.2nF and the value of C_9, C_{10} and C_{11} is 560pF.

The actual values determine the signal to noise and stability performance. The tolerances should be within ± 10%.

C_4, C_5, C_6 and C_8 are the inner loop capacitors for the integrated oversampling A/D converters. The typical value of C_4, C_5, C_6 and C_8 is 3.3nF. Values smaller than 0.5nF and larger than 5nF should be avoided.

Terminated current sensors (current transformers) are connected to the current sensor inputs of the SA9105F through current setting resistors (R_8 ..R_{13}).

The resistor values should be selected for an input current of $16\mu A_{RMS}$ into the SA9105F, at the rated line current.

The values of these resistors should be calculated as follows:

Phase 1:

$R_8 = R_9 = (I_{L1}/16\mu A_{RMS}) * R_{18}/2$

Phase 2:

$R_{10} = R_{11} = (I_{L2}/16\mu A_{RMS}) * R_{19}/2$

Phase 3:

$R_{12} = R_{13} = (I_{L3}/16\mu A_{RMS}) * R_{20}/2$

Where I_{LX} = Secondary CT current at rated conditions.

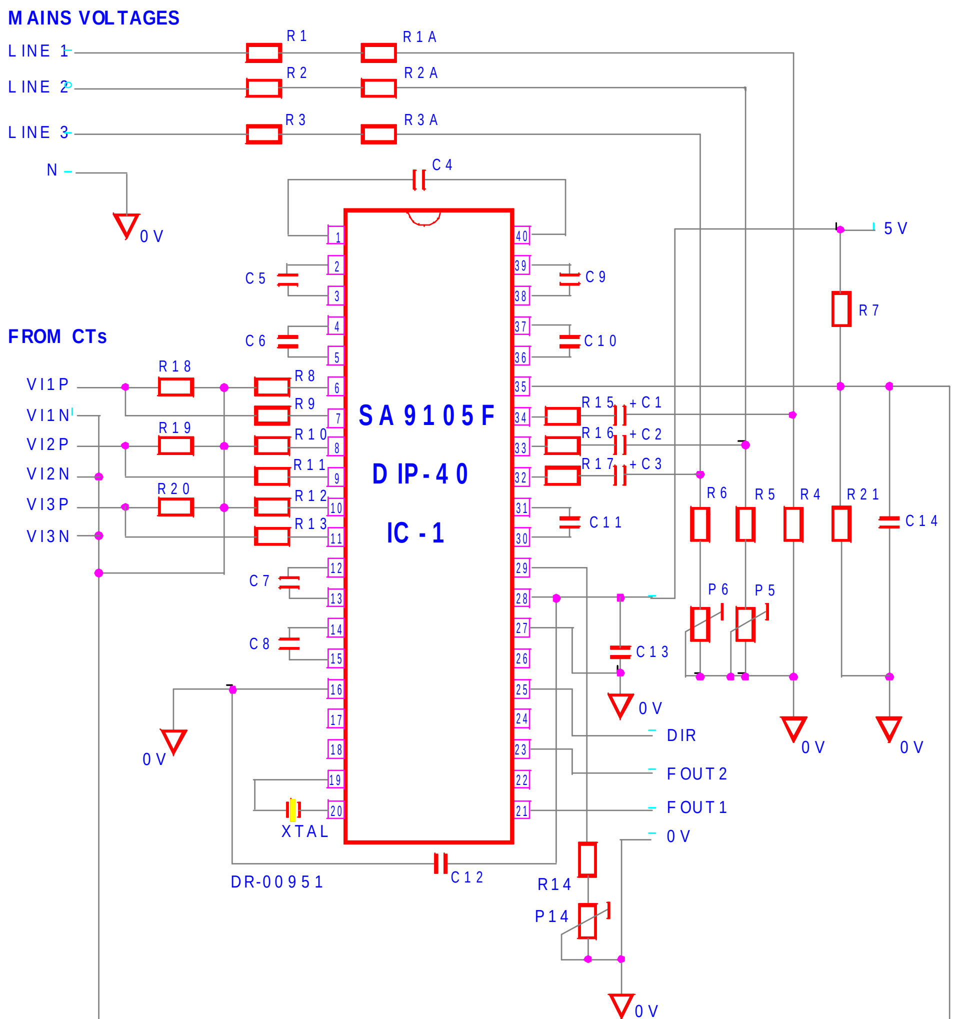
R_{18}, R_{19} and R_{20} = Current transformer termination resistors for the three phases.

$R_1 + R_{1A}$, R_4 and R_{15} set the current for the phase 1 voltage sense input. $R_2 + R_{2A}$, $R_5 + P_5$ and R_{16} set the current for phase 2 and $R_3 + R_{3A}$, $R_6 + P_6$ and R_{17} set the current for phase 3. The values should be selected so that the input currents into the voltage sense inputs (virtual ground) are set to $14\mu A_{RMS}$ for nominal line voltage. Capacitors C1, C2 and C3 are for decoupling and phase compensation.

$R_{14} + P_{14}$ defines all on-chip bias and reference currents. With $R_{14} + P_{14} = 24k\Omega$, optimum conditions are set. R_{14} may be varied within ± 10% for calibration purposes. Any changes to R_{14} will affect the output quadratically (i.e: $\Delta R = +5\%$, $\Delta f = +10\%$).

XTAL is a colour burst TV crystal (f = 3.5795 MHz) for the oscillator. The oscillator frequency is divided down to 1.7897 MHz on-chip, to supply the digital circuitry and the A/D converters.

Figure 1: Application Circuit for Three Phase Power/Energy Measurement.



Parts List for Application Circuit: Figure 1

Item	Symbol	Description	Detail
1	IC-1	SA9105FPA	DIP-40
2	XTAL	Crystal, 3.5795 MHz	Colour burst TV
3	R1	Resistor, 200k, 1%, ¼W	
4	R1A	Resistor, 180k, 1%, ¼W	
5	R2	Resistor, 200k, 1%, ¼W	
6	R2A	Resistor, 180k, 1%, ¼W	
7	R3	Resistor, 200k, 1% , ¼W	
8	R3A	Resistor, 180k, 1%, ¼W	
9	R4	Resistor, 24k, 1%, ¼W	
10	R5	Resistor, 22k, 1%, ¼W	
11	R6	Resistor, 22k, 1%, ¼W	
12	R7	Resistor, 820 Ω, 1%, ¼W	
13	R8	Resistor	Note 1
14	R9	Resistor	Note 1
15	R10	Resistor	Note 1
16	R11	Resistor	Note 1
17	R12	Resistor	Note 1
18	R13	Resistor	Note 1
19	R14	Resistor, 22k, 1%, ¼W	
20	R15	Resistor, 1M, 1%, ¼W	
21	R16	Resistor, 1M, 1%, ¼W	
22	R17	Resistor, 1M, 1%, ¼W	
23	R18	Resistor	Note 1
24	R19	Resistor	Note 1
25	R20	Resistor	Note 1
26	R21	Resistor, 820Ω, 1%, ¼W	
27	P5	Potentiometer, 4.7k	Multi turn
28	P6	Potentiometer, 4.7k	Multi turn
29	P14	Potentiometer, 4.7k	Multi turn
30	C1	Capacitor, electrolytic, 1µF, 16V	Note 2
31	C2	Capacitor, electrolytic, 1µF, 16V	Note 2
32	C3	Capacitor, electrolytic, 1µF, 16V	Note 2
33	C4	Capacitor, 3.3nF	
34	C5	Capacitor, 3.3nF	
35	C6	Capacitor, 3.3nF	
36	C7	Capacitor, 2.2nF	
37	C8	Capacitor, 3.3nF	
38	C9	Capacitor, 560pF	
39	C10	Capacitor, 560pF	
40	C11	Capacitor, 560pF	

Parts List for Application Circuit: Figure 1 (Continued)

Item	Symbol	Description	Detail
41	C12	Capacitor, 820nF	Note 3
42	C13	Capacitor, 100nF	
43	C14	Capacitor, 100nF	

Note 1: Resistor (R_8, R_9, R_{10}, R_{11}, R_{12} and R_{13}) values are dependant upon the selected values of the current transformer termination resistors R_{18}, R_{19} and R_{20}.

Note 2: Capacitor values may be selected for DC blocking and to compensate for phase errors caused by the current transformers.

Note 3: Capacitor (C12) to be positioned as close to Supply Pins (V_{DD} & V_{SS}) of IC-1, as possible.

ORDERING INFORMATION

Part Number	Package
SA9105FPA	DIP-40
SA9105FFA	PLCC-44

Any sales or technical questions may be posted to our e-mail address below:
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For the latest updates on datasheets, please visit our web site:
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