sames

SA9105A

THREE PHASE UNIDIRECTIONAL POWER/ENERGY METERING IC WITH PULSE OUTPUT

FEATURES

- Performs unidirectional 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
- Three pulse rate outputs available
- Protected against ESD

DESCRIPTION

The SAMES SA9105A Three Phase unidirectional Power/Energy metering integrated circuit generates a pulse rate output, the frequency of which is proportional to the power consumption. The SA9105A performs the calculations of active power.

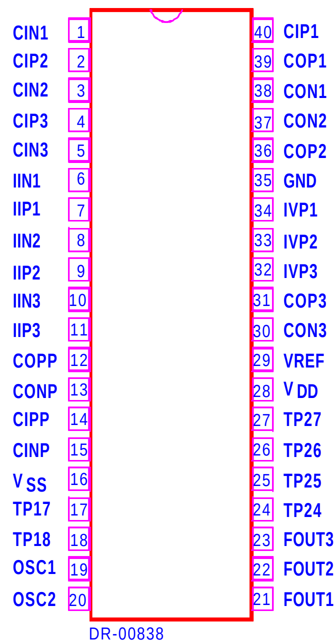
The method of calculation takes the power factor into account.

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

The output of this innovative universal three phase power/energy metering integrated circuit, is ideally suited for applications such as residential and industrial energy metering and control.

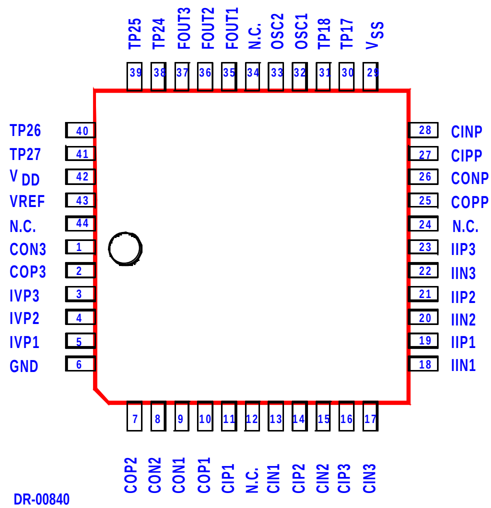
The SA9105A integrated circuit is available in 40 pin dual-in-line plastic (DIP-40), as well as in 44 pin plastic leaded chip carrier (PLCC-44) packages types.

PIN CONNECTIONS



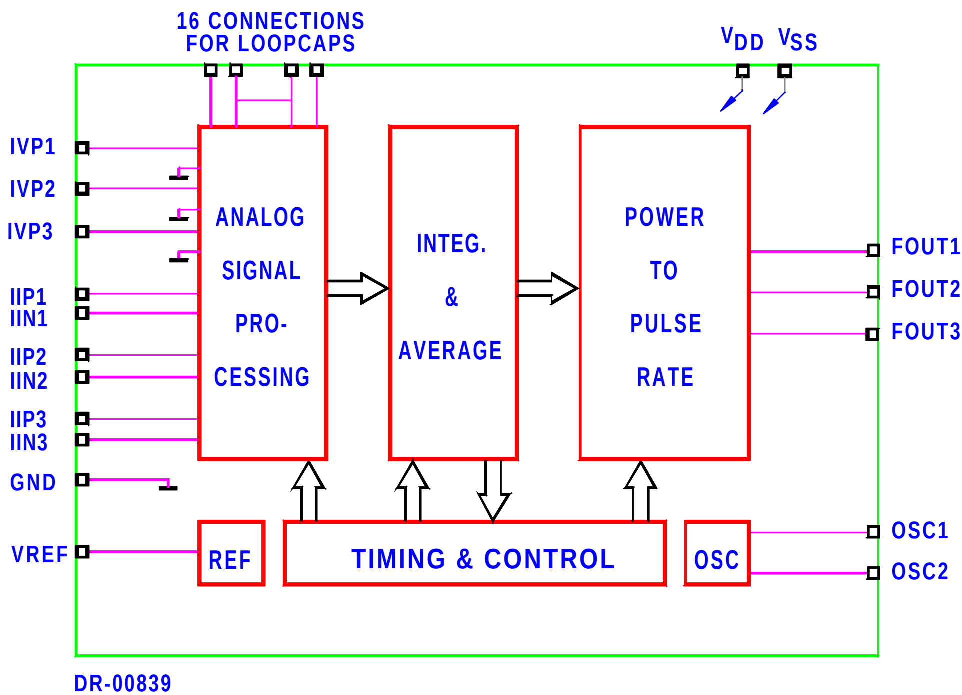
Package: DIP-40

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

* 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
Supply Voltage	V_{DD}-V_{SS}	4.5		5.5	V	
Supply Current	I_{DD}			15	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,FOUT3						
Output Low Voltage	V_{OL}			V_{SS}+1	V	I_{OL} = 5mA
Output High Voltage	V_{OH}	V_{DD}-1			V	I_{OH} = -2mA
Pulse Rate: FOUT1	f_p	10 0.5		1160 3000	Hz Hz	Specified linearity Min and max limits
FOUT2	f_{p2}		f_p/4			
FOUT3	f_{p3}		f_p/290			
Oscillator	Recommended crystal: TV colour burst crystal, f = 3.5795 MHz					
Pin VREF						With R = 24 kΩ
Ref. Current	$-I_R$	45	50	55	µA	connected to V_{SS}
Ref. Voltage	V_R	1.1		1.3	V	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
36	22	FOUT2	
37	23	FOUT3	
9	38	CON1	Connections for outer loop capacitors of A/D
10	39	COP1	converters
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
11	40	CIP1	converters
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
30	17	TP17	Manufacturer's Test Pins (Leave unconnected)
31	18	TP18	
38	24	TP24	
39	25	TP25	
40	26	TP26	
41	27	TP27	

PIN DESCRIPTION (Continued)

Pin PLCC	Pin DIP	Designation	Description
12		NC	Not connected
24		NC	
34		NC	
44		NC	

FUNCTIONAL DESCRIPTION

The SAMES SA9105A is a CMOS mixed signal Analog/Digital integrated circuit, which performs three phase power/energy calculations over a range of 1000:1, to an overall accuracy of better than Class 1.

The integrated circuit includes all the required functions for 3-phase power and energy measurement such as oversampling A/D converters for the voltage and current sense inputs, power calculation and energy integration. Internal offsets are eliminated through the use of cancellation procedures.

The SA9105A generates pulses, the frequency of which is proportional to the power consumption. Three frequency outputs (FOUT1, FOUT2 and FOUT3) are available.

1. Power Calculation

In the Application Circuit (Figure 1), the mains voltages from Line 1, Line 2 and Line 3, are converted to currents and applied to the voltage sense inputs IVP1, IVP2 and IVP3.

The current levels on the voltage sense inputs are derived from the mains voltage (3 x 230 VAC) being divided down through voltage dividers to 14V. The resulting input currents into the A/D converters are 14µA through the resistors R_{15}, R_{16} and R_{17}.

For the current sense inputs the voltage drop across the current transformers terminating resistors are converted to currents of 16µA for rated conditions, by means of resistors R_8, R_9 (Phase 1); R_{10}, R_{11} (Phase 2) and R_{12}, R_{13} (Phase 3).

The signals providing the current information are applied to the current sensor inputs IIN1, IIP1; IIN2, IIP2 and IIN3, IIP3.

In this configuration, with the mains voltage of 3 x 230 V and rated currents of 80A, the output frequency of the SA9105A energy metering integrated circuit at FOUT1 is 1.16kHz. In this case 1 pulse will correspond to an energy consumption of 3 x 18.4 kW/1160Hz = 47.6 Ws.

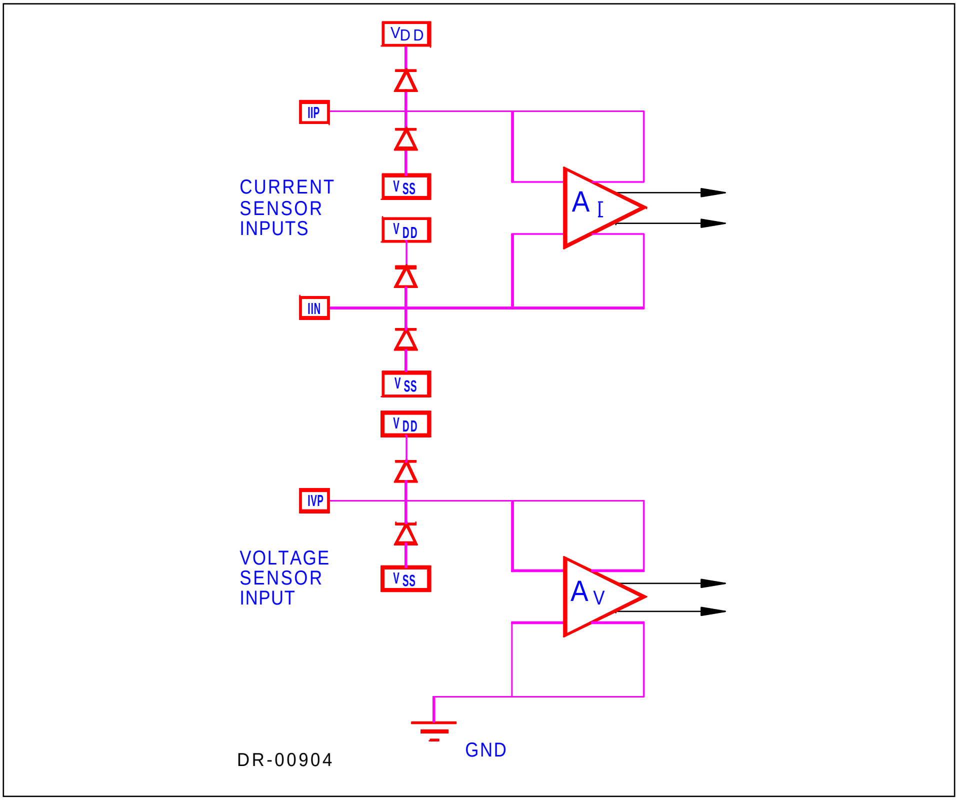
The output frequency at FOUT2 is FOUT1/4. At FOUT3 the output frequency is FOUT1/290.

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 SA9105A integrated circuit's inputs/outputs are protected against ESD according to Mil-Std 883 method 3015. The SA9105A integrated circuit's resistance to transients is also dependant upon the external protection components used.

4. Power Consumption

The overall power consumption rating of the SA9105A integrated circuit is less than 75mW with a 5V supply.

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 SA9105A 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 SA9105A through current setting resistors (R_8 ..R_{13}).

The resistor values should be selected for an input current of 16µA into the SA9105A at the rated line current.

The values of these resistors should be calculated as follows:

<u>Phase 1</u>:

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

<u>Phase 2</u>:

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

<u>Phase 3</u>:

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

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 current into the voltage sense inputs (virtual ground) are set to 14µA 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: $\Delta R = +5\%$, $\Delta f = +10\%$).

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 (4Hz, 290Hz or 1160Hz)

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

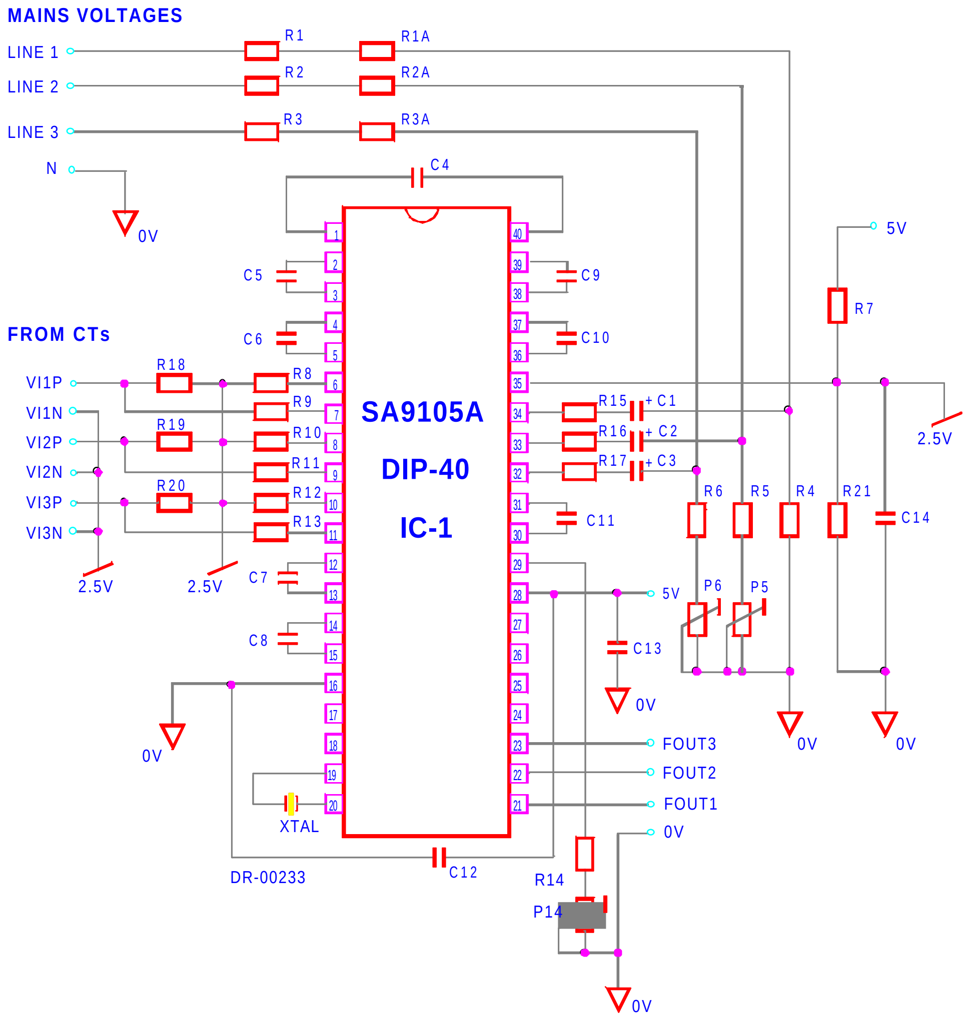
I_{I1}, I_{I2}, I_{I3} = Input currents for current inputs (16µA at rated)

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

I_R = Reference current (typically 50µA)

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	Integrated SA9105A	DIP-40/PLCC-44
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, 200k, 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 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
SA9105APA	DIP-40
SA9105AFA	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 out web site:
http://www.sames.co.za

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