sames

SA9102C

SINGLE PHASE UNIDIRECTIONAL POWER/ENERGY METERING IC PULSE OUTPUT

FEATURES

- Performs unidirectional power and energy measurement
- Meets the IEC 521/1036 Specification requirements for Class 1 AC Watt hour meters
- Protected against ESD
- Total power consumption rating typically 25mW
- Adaptable to different types of current sensors
- Operates over a wide temperature range
- Precision voltage reference on-chip
- Different pulse rate options available

DESCRIPTION

The SAMES SA9102C Single Phase unidirectional Power/Energy metering integrated circuit generates a pulse rate output, the frequency of which is proportional to the power consumption. The SA9102C performs the calculation for active power.

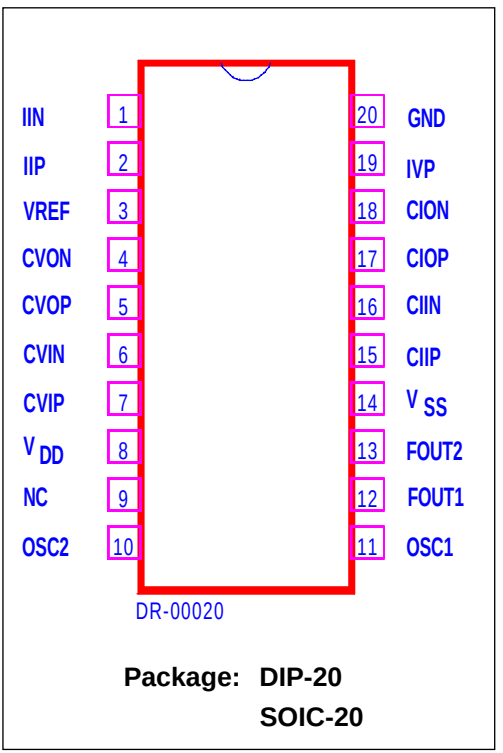
This method of calculation takes the power factor into account.

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

This innovative universal single phase power/energy metering integrated circuit is ideally suited for energy calculations in applications such as electricity dispensing systems (ED's), residential municipal metering and factory energy metering and control.

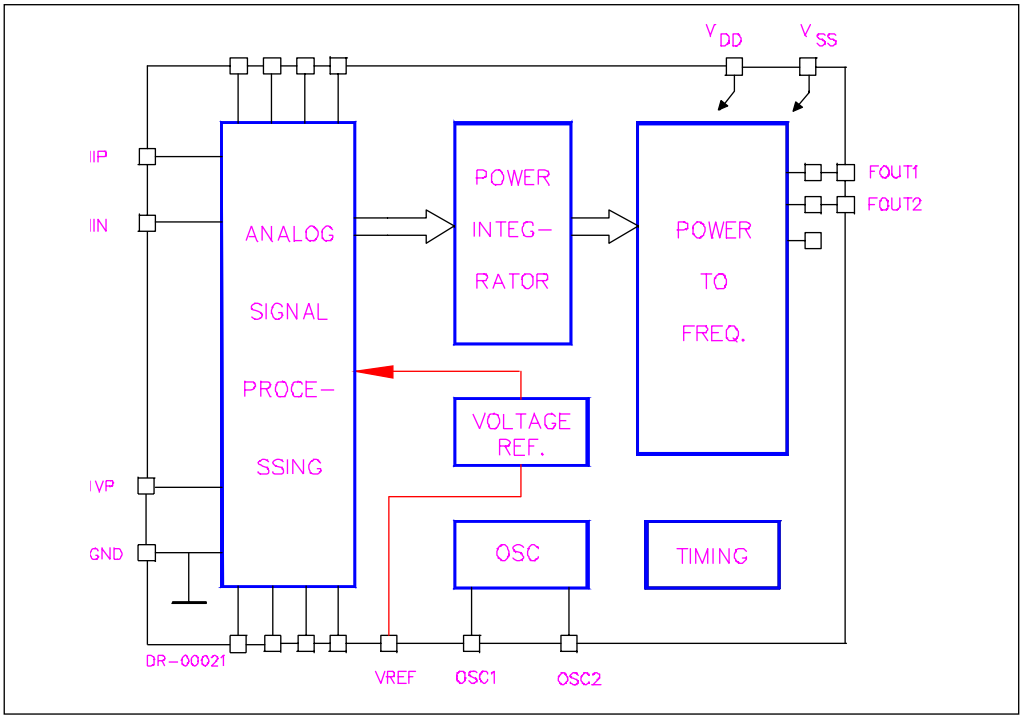
The SA9102C integrated circuit is available in both 20 pin dual-in-line plastic (DIP-20), as well as 20 pin small outline (SOIC-20) package types.

PIN CONNECTIONS



Package: DIP-20
SOIC-20

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}	-200	+200	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 condition above those indicated in the operational sections of this specification, is not implied. Exposure to Absolute Maximum Ratings for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V_{DD} = 2.5V, V_{SS} = -2.5V, over the temperature range -10°C to +70°C#, unless otherwise specified.)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Supply Voltage: Positive	V_{DD}	2.25		2.75	V	
Supply Voltage: Negative	V_{SS}	-2.75		-2.25	V	
Supply Current: Positive	I_{DD}		5	10	mA	
Supply Current: Negative	I_{SS}		5	10	mA	
Current Sensor Inputs (Differential)						
Input Current Range	I_{II}	-25		+25	µA	Peak value
Voltage Sensor Input (Asymetrical)						
Input Current Range	I_{IV}	-25		+25	µA	Peak value
Pins FOUT1, FOUT2 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	f_P	10 0.5		1160 1600	Hz Hz	Specified linearity Min and max limits
FOUT2[1]	f_{P2}		f_P/290			
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 = 24kΩ connected to V_{SS} Referred to V_{SS}

Note 1: An option of FOUT2 = f_p/4 is available on request.

Extended Operating Temperature Range available on request.

PIN DESCRIPTION

Pin	Designation	Description
20	GND	Ground
8	V_{DD}	Positive Supply Voltage
14	V_{SS}	Negative Supply Voltage
19	IVP	Analog input for Voltage
1	IIN	Inputs for current sensor
2	IIP	
11	OSC1	Connections for crystal or ceramic resonator
10	OSC2	(OSC1 = Input : OSC2 = Output)
12	FOUT1	First pulse rate output
13	FOUT2	Second pulse rate output
4	CVON	Connections for outer loop capacitor of
5	CVOP	A/D converter (Voltage)
6	CVIN	Connections for inner loop capacitor of
7	CVIP	A/D converter (Voltage)
15	CIIP	Connections for inner loop capacitor of
16	CIIN	A/D converter (Current)
17	CIOP	Connections for outer loop capacitor of
18	CION	A/D converter (Current)
3	VREF	Connection for current setting resistor
9	NC	Not connected

FUNCTIONAL DESCRIPTION

The SA9102C is a CMOS mixed signal Analog/Digital integrated circuit, which performs power/energy calculations across a power range of 1000:1, to an overall accurancy of better than Class 1.

The integrated circuit includes all the required functions for 1-phase power and energy measurement, such as two 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 SA9102C generates pulses, the frequency of which is proportional to the power consumption. Two frequency outputs' (FOUT1 and FOUT2) are available, with a third frequency option available on request.

1. Power calculation

In the Application Circuit (Figure 1), the voltage drop across the shunt will be between 0 and 16mV (0 to 80A through a shunt resistor of 200µΩ). This voltage is converted to a current of between 0 and 16µA, by means of resistors R_1 and R_2.

The current sense input saturates at an input current of ±25µA peak.

For the voltage sensor input, the mains voltage (230VAC) is divided down through a divider to 14V. The current into the A/D converter input is set at 14µA for a nominal mains voltage, via the resistor R4 (1MΩ).

In this configuration, with a mains voltage of 230V and a current of 80A, the output frequency of the SA9102C power meter chip at FOUT1 (Pin 12) is 1.16kHz. In this case 1 pulse will correspond to an energy consumption of 18.4kVA/1160Hz = 15.9Ws.

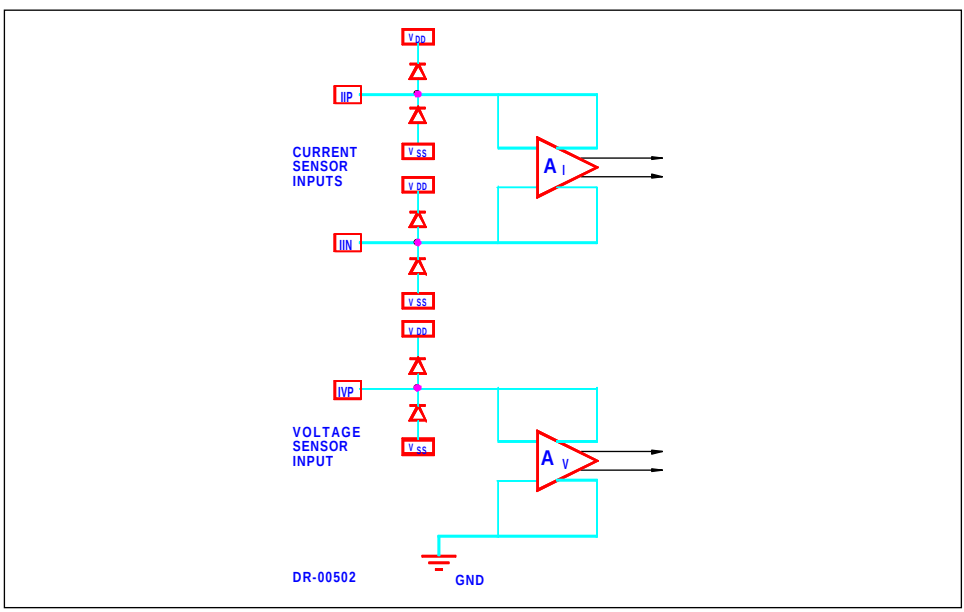
The output frequency at FOUT2 is FOUT1/290 (i.e. The frequency ouput at pin 12 is divided by 290).

2. Analog Input configuration

The input circuitry of 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 signal processing circuitry.



3. Electrostatic Discharge (ESD) Protection

The SA9102C integrated circuit's inputs/outputs are protected against ESD according to Mil-Std 883C, method 3015.

4. Power Consumption

The power consumption rating of the SA9102C integrated circuit is less than 50mW.

TYPICAL APPLICATIONS

In the Application Circuits (Figures 1 and 2) the components required for power metering applications, are shown.

In Figure 1 a shunt resistor is used for current sensing. In this application, the circuit requires a +2.5V, 0V, -2.5V DC supply.

In the case of Figure 2, when using a current transformer for current sensing, a +5V, 0V DC supply is sufficient.

The most important external components for the SA9102C integrated circuit are:

C_1 and C_2 are the outer loop capacitors for the two integrated oversampling A/D converters. The value of these capacitors is 560pF.

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

C_3 and C_4 are the inner loop capacitors of the A/D converters. The optimum value is 3.3nF. The actual values are uncritical. Values smaller than 0.5nF and larger than 5nF should be avoided.

R_2, R_1 and RSH are the resistors defining the current level into the current sense input. The values should be selected for an input current of 16µA into the SA9102C at maximum line current.

Values for RSH of less than 200µΩ should be avoided.

$R_1 = R_2 = (I_L/16\mu A) * R_{SH}/2$

Where I_L = Line current

RSH = Shunt resistor/termination resistor

R_3, R_6 and R_4 set the current for the voltage sense input. The values should be selected so that the input current into the voltage sense input (virtual ground) is set to 14µA.

R_7 defines all on-chip bias and reference currents. With R_7 = 24kΩ, optimum conditions are set. R_7 may be varied within ±10% for calibration purposes. Any change to R_7 will affect the output quadratically (i.e.: R_7 = +5%, f_p = +10%).

The formula for calculating the output frequency (f) is given below:

$$f = 11.16 * FOUTX * \frac{FOSC}{3.58MHz} * \frac{I_I \cdot I_V}{I_R^2}$$

Where FOUTX = Nominall rated frequency (4Hz or 1160Hz)

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

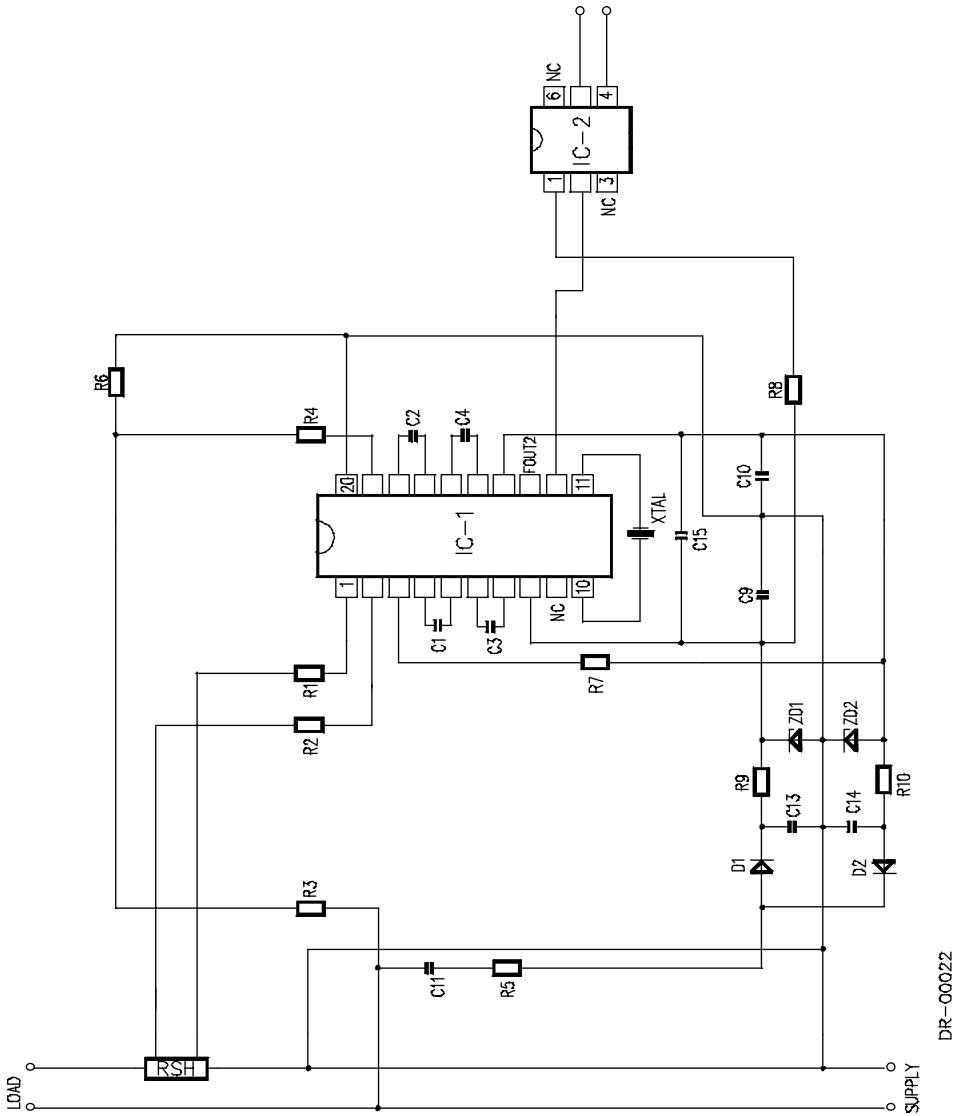
I_I = Input currents for current input (16µA at rated)

I_V = Input current for voltage input (14µA at rated)

I_R = Reference current (typically 50µA)

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

Figure 1: Application Circuit using a Shunt Resistor for Current Sensing.



Parts List for Application Circuit: Figure 1

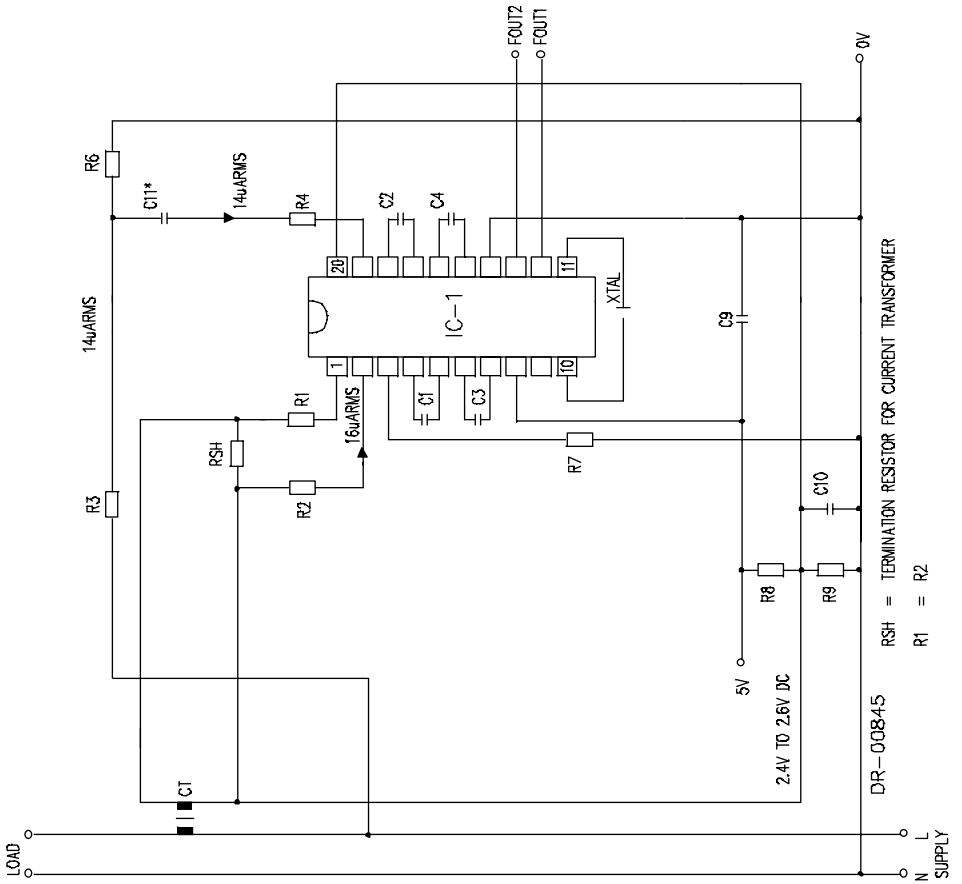
Item	Symbol	Description	Detail
1	IC-1	SA9102C	DIP-20/SOIC-20
2	IC-2	Optocoupler 4N35	DIP-6
3	D1	Diode, Silicon, 1N4148	
4	D2	Diode, Silicon, 1N4148	
5	ZD1	Diode, Zener, 2,4V, 200mW	
6	ZD2	Diode, Zener 2,4V, 200mW	
7	XTAL	Crystal, 3.5795MHz	
8	R1	Resistor, 1% metal	Note 1
9	R2	Resistor, 1% metal	Note 1
10	R3	Resistor, 390k, (230VAC), 1% metal	
11	R4	Resistor, 1M, 1/8W, 1%, metal	
12	R5	Resistor, 470Ω, 1W, 5%, carbon	
13	R6	Resistor, 24k, 1/4W, 1%, metal	
14	R7	Resistor, 24k, 1/4W, 1%, metal	
15	R8	Resistor, 680Ω, 1/4W, 1%	
16	R9	Resistor, 680Ω, 1/4W, 1%	
17	R10	Resistor, 680Ω, 1/4W, 1%	
18	C1	Capacitor, 560pF	
19	C2	Capacitor, 560pF	
20	C3	Capacitor, 3.3nF	
21	C4	Capacitor, 3.3nF	
22	C9	Capacitor, 100nF	
23	C10	Capacitor, 100nF	
24	C11	Capacitor, 0.47µF, 250VAC, polyester	
25	C13	Capacitor, 100µF	
26	C14	Capacitor, 100µF	
27	C15	Capacitor, 820nF	Note 2
28	RSH	Shunt Resistor	Note 3

Note 1: Resistor (R1 and R2) values are dependant upon the selected value of RSH.

Note 2: Capacitor (C15) to be positioned as close to Supply Pins (V_{DD} & V_{SS}) of IC-1 as possible.

Note 3: See TYPICAL APPLICATIONS when selecting the value of RSH.

Figure 2: Application Circuit using a Current Transformer for Current Sensing.



Note: Capacitor C11 may be selected for phase compensation and DC blocking.

Parts List for Application Circuit: Figure 2

Item	Symbol	Description	Detail
1	IC-1	SA9102C	DIP-20/SOIC-20
2	XTAL	Crystal, 3.5795MHz	Colour burst TV
3	RSH	Resistor	Note 1
4	R1	Resistor, 1% metal	Note 2
5	R2	Resistor, 1% metal	Note 2
6	R3	Resistor, 390k, (230VAC), 1% metal	
7	R4	Resistor, 1M, 1/4W, 1%, metal	
8	R6	Resistor, 24k, 1/4W, metal	
9	R7	Resistor, 24k, 1/4W, 1%, metal	
10	R8	Resistor, 2.2k, 1/4W, 5%	
11	R9	Resistor, 2.2k, 1/4W, 5%	
12	C1	Capacitor, 560pF	
13	C2	Capacitor, 560pF	
14	C3	Capacitor, 3.3nF	
15	C4	Capacitor, 3.3nF	
16	C9	Capacitor, 820nF	Note 3
17	C10	Capacitor, 100nF	
18	C11	Capacitor	
19	CT	Current transformer	

Note 1: See TYPICAL APPLICATIONS when selecting the value of RSH.

Note 2: Resistor (R1and R2) values are dependant upon the selected value of RSH.

Note 3: Capacitor (C9) to be positioned as close to Supply Pins (V_{DD} & V_{SS}) of IC-1, as possible.

Note 4: Capacitor (C11) selected to minimize phase error introduced by current transformer (typically 1.5µF)

ORDERING INFORMATION

Part Number	Package
SA9102CPA	DIP-20
SA9102CSA	SOIC-20

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