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**SINGLE PHASE WATT MEASUREMENT MODULE  
WITH A 5 DIGIT LED DISPLAY**

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**FEATURES**

- Performs power measurement and directly drives a 5 digit (7 segment) LED display
- Accuracy better than 1% ( $\pm 1$  count)
- Protected against ESD
- Total power consumption rating below 800mW
- Uses a shunt resistor or for current sensing
- Operates over a wide temperature range
- Precision voltage reference on-chip

**DESCRIPTION**

The SAMES single phase Watt measurement module, the PM9106AP includes an on-board 5 digit (7 segment) Light Emitting Diode (LED) display. Active power is directly displayed in watts, with a full scale of 20 000 watts.

The measured power is updated approximately every 2 seconds, giving an average power reading for this period.

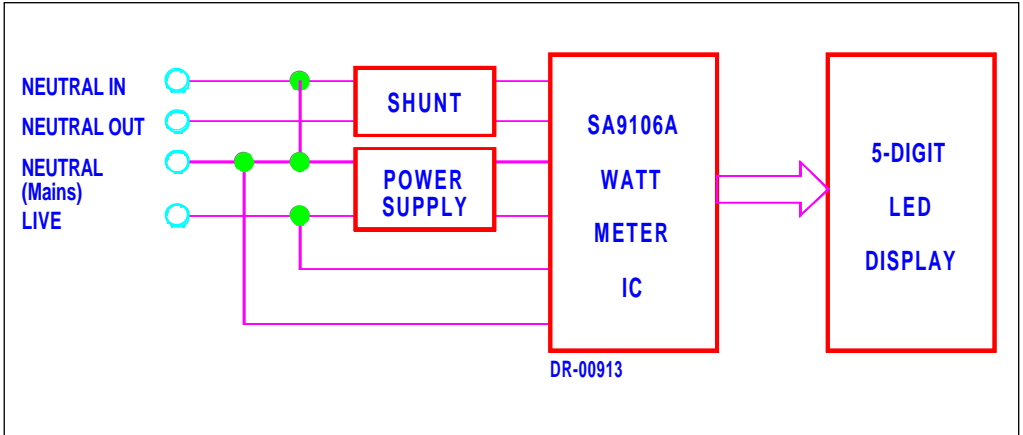
This method of calculation takes the power factor into account.

This innovative universal Watt measurement module is ideally suited for the display of the measured power in single phase, industrial and domestic power measurement applications.

The application utilises the SAMES SA9106AP single phase Watt measurement integrated circuit for power measurement and display.

As a safety measure, this application shows the current sensor connected to the neutral line. In practice, the live line may be used for current sensing, provided that the supply connections (MAINS) are reversed on the module.

**BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS\***

Parameter	Symbol	Min	Max	Unit
Supply Voltage (Note 1)	$V_{AC}$		540	V
Current Sense Input (Note 1)	$V_{IV}$	-2.5	+2.5	V
Storage Temperature	$T_{STG}$	-25	+125	°C
Operating Temperature (Note2)	$T_O$	-10	+70	°C

Note 1: Voltages are specified with reference to Live.

Note 2: The SA9106AP integrated circuit is specified to operate over the temperature range -10°C to +70°C. The module functionality will however depend upon the external components used.

\*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 operational 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	$V_{AC}$	180	230	265	V	Continuous operation
Power Consumption <sup>1</sup>				800	mW	$V_{AC} = 230V$

Note 1: Power consumption specifications exclude power consumed by the current sensor.

Note 2: Isolation voltage may be specified, depending on customer requirements.

## PIN DESCRIPTION

Designation	Description
MAINS	Voltage supply connection to Neutral line
	Voltage supply connection to Live line
NEUTRAL IN	Connection to positive side of current sensor
NEUTRAL OUT	Connection to negative side of current sensor

## FUNCTIONAL DESCRIPTION

### 1. Power Calculation

In the Application Circuit (see Figure 2), the output current from the current sensor will be between 0 and 16 $\mu$ A (0 to 80A through a shunt resistor of 625 $\mu$  $\Omega$ ). The current input stage saturates at input currents greater than 18 $\mu$ A<sub>RMS</sub>. The mains voltage (230V + 15% -20%) is used to supply the circuitry with power and for the power calculation, together with the current information from the current sensor (shunt resistor).

The SA9106AP integrated circuit may be adjusted to accommodate any voltage or current values. The method of calculating external component values is described in paragraph 5 (Circuit Description).

SAMES offers two evaluation module options, namely 230V/80A and 115/80A.

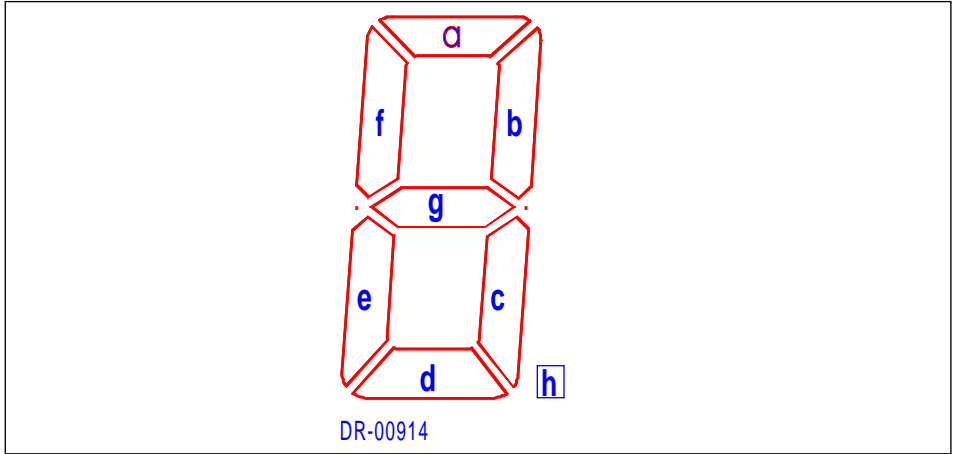
The calculated power is directly displayed on a 5 digit (7 segment) LED display. The update interval is approximately every 2 seconds.

**2. LED Display**

The PM9106AP has an on-board LED display comprising 5 (7 segment) common cathode digits, as well as a sign LED.

The sign LED is addressed by DIG [5], the most significant digit by DIG [4] and the least significant digit by DIG [0].

The position of the segments a, b, c, d, e, f and g are given in the diagram below:



The full scale power displayed is 20 000 watts. An overflow is indicated by a flashing display.

**3. Electrostatic Discharge (ESD) Protection**

The device's inputs/outputs are protected against ESD according to Mil-Std 883C, method 3015. The modules resistance to transients will be dependant upon the protection components used.

**4. Power Consumption**

The overall power consumption rating for this power metering application (Figure 2), is under 800mW, excluding the current sensor.

**5. Circuit Description**

The Application Circuit (Figure 2) shows the components required for the Watt measurement module, using a shunt resistor for current sensing.

The most important external components for the SA9106AP device 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 signal to noise and stability performance. The optimum tolerances should be within  $\pm 10\%$ .

$C_3$  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  $R_{SH}$  are the resistors defining the current level into the current sense input. The values should be selected for an input current of  $16\mu A_{RMS}$  into the SA9106AP at rated line current.

Values for RSH of less than  $200\mu\Omega$  should be avoided.

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

Where  $I_L$  = Line current  
 $R_{SH}$  = Shunt resistor/termination resistor

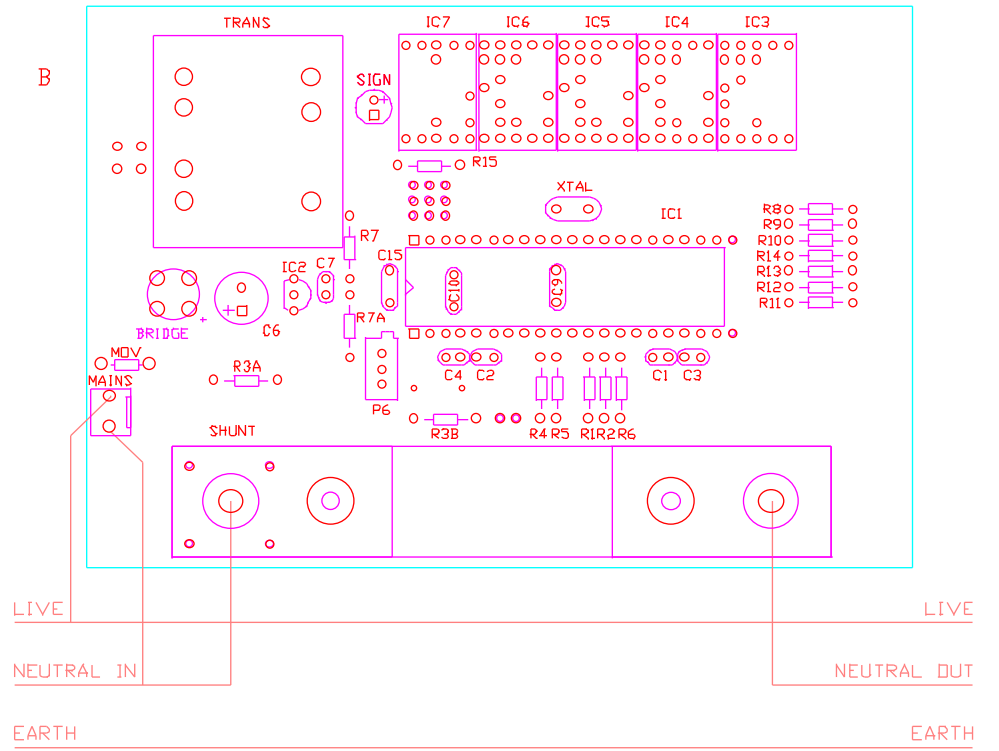
$R_3$ ,  $R_5$  and  $R_4$  set the current for the voltage sense input. The values should be selected so that the input current into the voltage sense input (virtual ground) is set to  $14\mu A$ .

$R_7$  defines all on-chip bias and reference currents. With  $R_7 = 24k\Omega$ , optimum conditions are set.

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

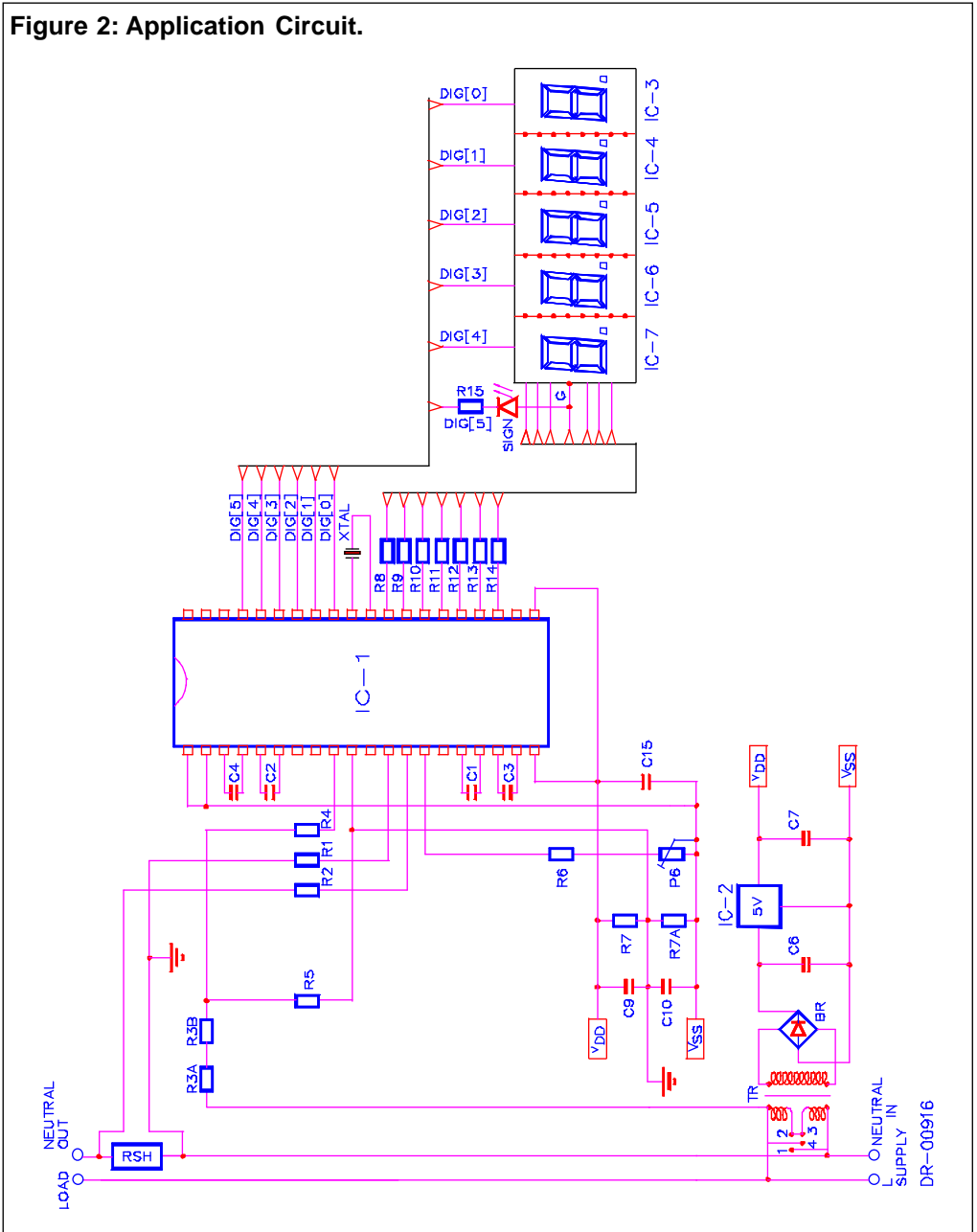


Figure 1: Connection Diagram



DR-00915

Figure 2: Application Circuit.



## Parts List for Application circuit: Figure 2

Item	Symbol	Description	Detail
1	IC-1	SA9106A	DIP-40
2	IC-2	5V 100mA Voltage Regulator	
3	IC-3	ELS-511 HWB, Common cathode 7 segment read-out	
4	IC-4	ELS-511 HWB, Common cathode 7 segment read-out	
5	IC-5	ELS-511 HWB, Common cathode 7 segment read-out	
6	IC-6	ELS-511 HWB, Common cathode 7 segment read-out	
7	IC-7	ELS-511 HWB, Common cathode 7 segment read-out	
8	BR	W04M, Bridge Rectifier	
9	SIGN	Red LED, 3mm diameter, high bright	
10	XTAL	Crystal, 3.5795 MHz	Colour burst TV
11	R1	Resistor, 1% metal	Note 1
12	R2	Resistor, 1% metal	Note 1
13	R3A	Resistor, 1% metal	Note 2
14	R3B	Resistor, 1% metal	Note 2
15	R4	Resistor, 1M, 1/4W, 1% metal	
16	R5	Resistor, 24k, 1/4W, 1%, metal	
17	R7A	Resistor, 820 $\Omega$ , 1/4W, 1%, metal	
18	R7B	Resistor, 820 $\Omega$ , 1/4W, 1%, metal	
19	R8	Resistor, 50 $\Omega$ (Segment G)	Note 3
20	R9	Resistor, 50 $\Omega$ (Segment F)	Note 3
21	R10	Resistor, 50 $\Omega$ (Segment E)	Note 3
22	R11	Resistor, 50 $\Omega$ (Segment D)	Note 3
23	R12	Resistor, 50 $\Omega$ (Segment C)	Note 3
24	R13	Resistor, 50 $\Omega$ (Segment B)	Note 3
25	R14	Resistor, 50 $\Omega$ (Segment A)	Note 3
26	R1	Resistor, 50 $\Omega$ , 1/4W	
27	P6	Trimpot, 5k	Multi-turn
28	C1	Capacitor, 560pF	
29	C2	Capacitor, 560pF	
30	C3	Capacitor, 3.3nF	
31	C4	Capacitor, 3.3nF	
32	C6	Capacitor, 1000 $\mu$ F, 16V, Electrolytic	
33	C7	Capacitor, 100nF	
34	C8	Capacitor, 100nF	
35	C9	Capacitor, 100nF	
36	C15	Capacitor, 820nF	Note 4
37	TRANS	110V x 2 to 2.7V, 1.5VA Transformer	
38	RSH	Shunt Resistor	Note 5



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

Note 2: See the table below, detailing the component values for the selected voltage standard.

Note 3: Resistors (R8 to R14) are current limiting resistors required to set the intensity of the LED display segments.

Note 4: Capacitor (C5) to be positioned as close to Supply Pins ( $V_{DD}$  &  $V_{SS}$ ) of IC-1 as possible.

Note 5: See TYPICAL APPLICATIONS when selecting the value of RSH.

Item	Symbol	Description		Detail
		PM9106APA 115V	PM9106APE 230V	
13	R3A	120k $\Omega$	200k $\Omega$	
14	R3B	82k $\Omega$	180k $\Omega$	

**ORDERING INFORMATION**

Part Number	Description
PM9106APA	115V, 80A Module
PM9106APE	230V, 80A Module

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