sames

SA9106A

SINGLE PHASE WATT MEASUREMENT IC WITH INTEGRATED 5 DIGIT LED DISPLAY DRIVER

FEATURES

- Performs bidirectional power measurement and directly drives a 5 digit (7 segment) LED display
- Accuracy better than 1% (± 1 count)
- Protected against ESD
- Total power consumption rating below 50mW
- Adaptable to different types of current sensors
- Operates over a wide temperature range
- Precision voltage reference on-chip

DESCRIPTION

The SAMES SA9106A Single Phase Watt measurement integrated circuit has an integrated Light Emitting Diode (LED) display driver for a 5 digit (7 segment) display. The SA9106A performs the power calculations for active power.

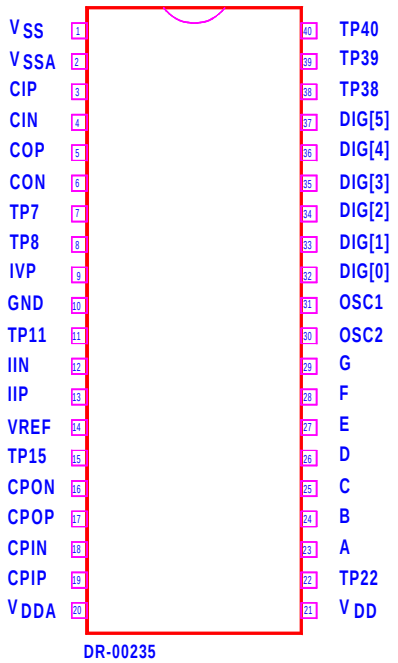
The method of calculation takes the power factor into account.

The measured power is displayed in Watts and is updated approximately every 2 seconds, given an average power reading for this period.

This innovative universal Watt measurement integrated circuit is ideally suited for the display of the measured power in industrial and domestic power measurement and multi plug sockets.

The SA9106A integrated circuit is available in 40 pin dual-in-line plastic (DIP-40) as well as 44 pin plastic leaded chip carrier (PLCC-44) package types.

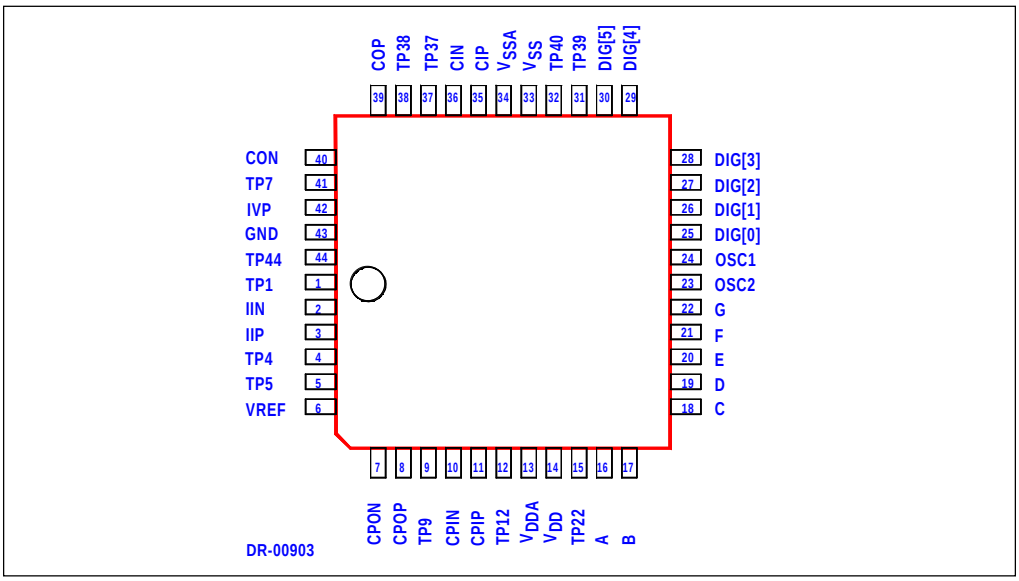
PIN CONNECTIONS



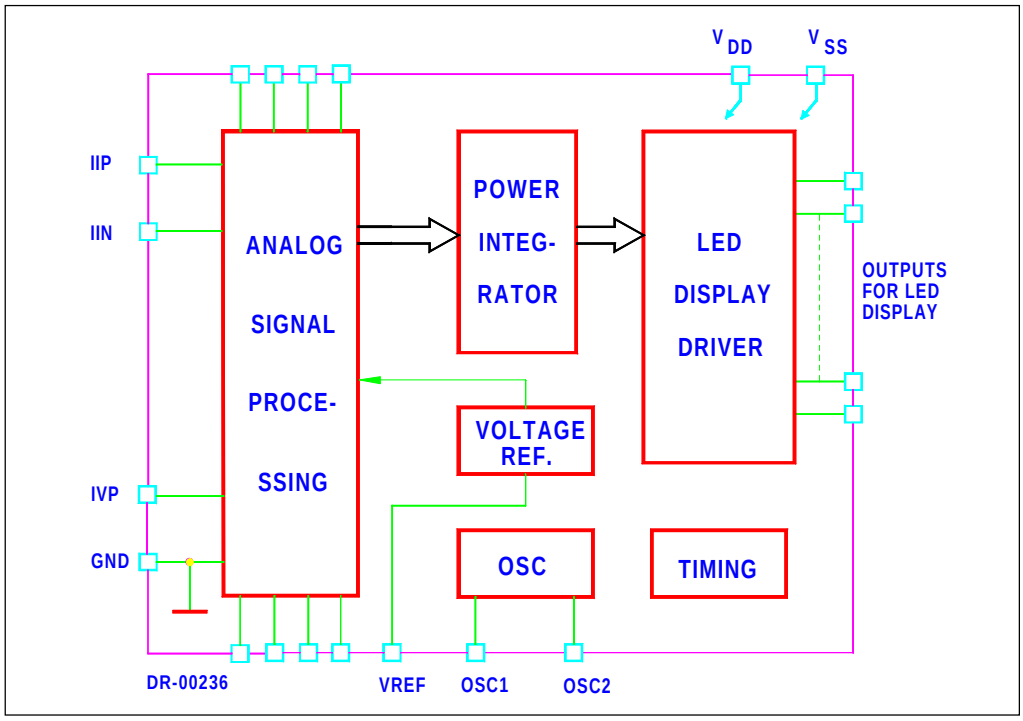
DR-00235

Package: DIP-40

PIN CONNECTIONS



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	-25	+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} and V_{DDA} = 2.5V, V_{SS} and V_{SSA} = -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 (Asymetric)						
Input Current Range	I_{IV}	-25		+25	µA	Peak value
Display outputs Digit Outputs Segment Drivers	 I_{OL} I_{OH}	 80 20			 mA mA	 V_{OL} = V_{SS} + 0.5V V_{OH} = V_{DD} - 0.5V
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_7 = 24kΩ connected to V_{SS} Referred to V_{SS}

[#] Extended Operating Temperature Range available on request.

PIN DESCRIPTION

Pin PLCC	Pin DIP	Designation	Description
43	10	GND	Ground
14	21	V_{DD}	Positive Supply Voltage
13	20	V_{DDA}	
33	1	V_{SS}	Negative Supply Voltage
34	2	V_{SSA}	
42	9	IVP	Analog input for Voltage
2	12	IIN	Inputs for current sensor
3	13	IIP	
24	31	OSC1	Connections for crystal or ceramic resonator
23	30	OSC2	(OSC1 = Input ; OSC2 = Output)
16	23	A	Light Emitting Diode (LED) display segment outputs
17	24	B	
18	25	C	
19	26	D	
20	27	E	
21	28	F	
22	29	G	
25	32	DIG [0]	Light Emitting Diode (LED) display digit outputs
26	33	DIG [1]	
27	34	DIG [2]	
28	35	DIG [3]	
29	36	DIG [4]	
30	37	DIG [5]	
7	16	CPON	Connections for outer loop capacitor of A/D converter (Voltage)
8	17	CPOP	
10	18	CPIN	Connections for inner loop capacitor of A/D converter (Voltage)
11	19	CPIP	
35	3	CIP	Connections for inner loop capacitor of A/D converter (Current)
36	4	CIN	
39	5	COP	Connections for outer loop capacitor of A/D converter (Current)
40	6	CON	
6	14	VREF	Connection for current setting resistor
41	7	TP7	Manufacturer's Test Pins (Leave unconnected)
	8	TP8	
	11	TP11	
	15	TP15	
15	22	TP22	
	38	TP38	

PIN DESCRIPTION (Continued)

Pin PLCC	Pin DIP	Designation	Description
31	39	TP39	Manufacturer's Test Pins (Leave unconnected)
32	40	TP40	
1		TP1	
4		TP4	
5		TP5	
9		TP9	
12		TP12	
37		TP37	
38		TP38	
44		TP44	

FUNCTIONAL DESCRIPTION

The SA9106A is a CMOS mixed signal Analog/Digital integrated circuit, which performs bidirectional power calculations across a power range of 1000:1, to an overall accurancy of better than 1% (± 1 count). An on-chip LED display driver directly drives a 5 digit (7 segment) LED display. The measured power is displayed in Watts.

The integrated circuit comprises of all the required functions 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.

1. Power Calculation

In the Application Circuit (Figure 1), the voltage drop across the shunt will be between 0 and 50mV (0 to 80A through a shunt resistor of 625μΩ). 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 sense input, the mains voltage (230VAC) is divided down through a divider to 14V. The resulting current into the A/D converter input is set at 14μA at nominal mains voltage, via resistor R4 (1MΩ).

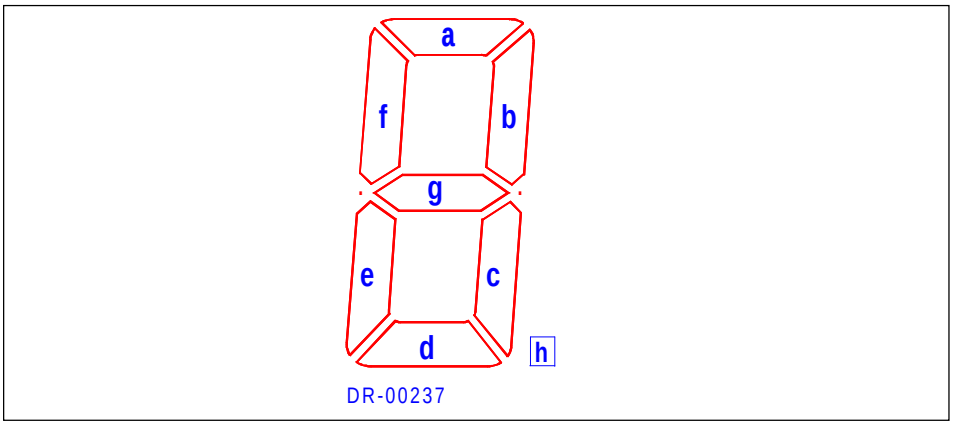
In this configuration, with a mains voltage of 230 V and a current of 80A, the displayed power is 18 400 Watts.

2. LED Display Driver

The SA9106A has an on-chip LED display driver capable of driving 5 digit (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 shown in the diagram below:

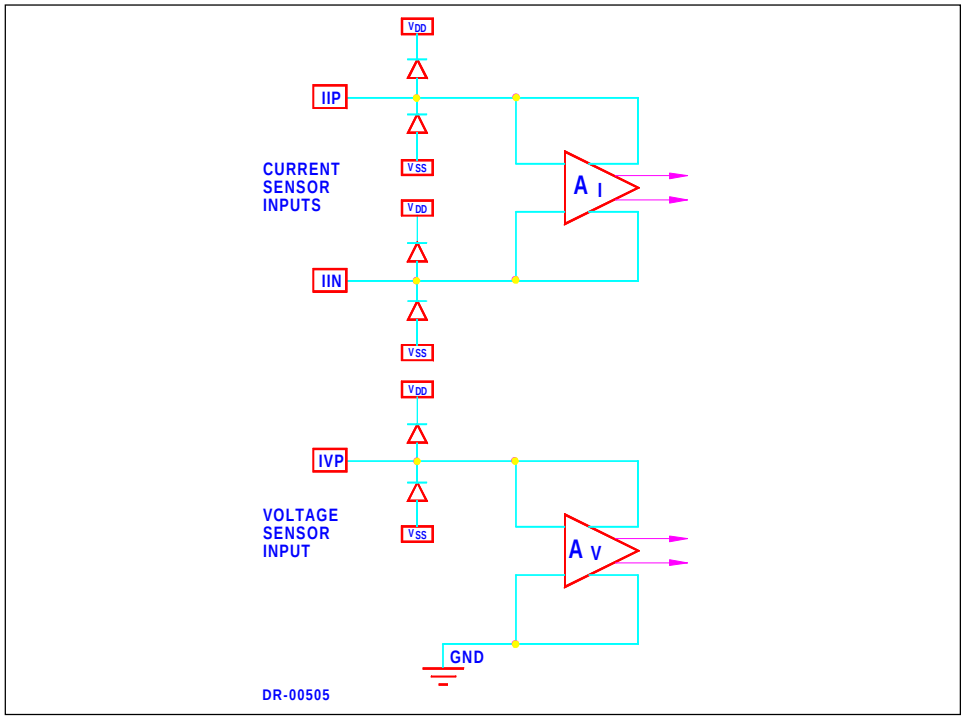


3. Analog Input Configuration

The input circuitry of the current and voltage sensor inputs are illustrated below.

These inputs are protected against electrostatic discharge through clamping diodes.

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.



4. Electrostatic Discharge (ESD) Protection

The SA9106A integrated circuit inputs/outputs are protected against ESD according to Mil-Std 883C, method 3015.

5. Power Consumption

The power consumption rating of the SA9106A integrated circuit is less than 50mW, excluding the display.

TYPICAL APPLICATIONS

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

In Figure 1 a shunt resistor is used for current sensing. In this application, the circuitry 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 SA9106A 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 SA9106A at maximum line current.

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

$R_1 = R_2 = (I_L/16\mu A) * RSH/2$

Where I_L = Line current

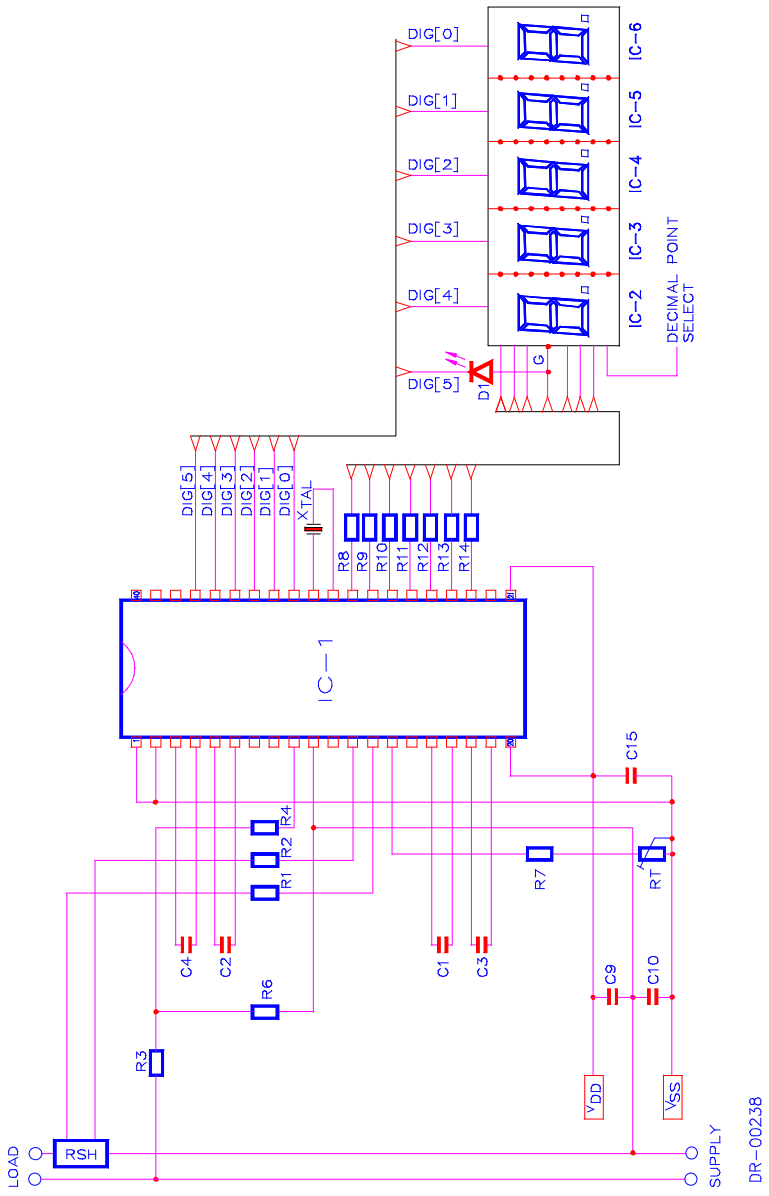
RSH = Shunt resistor/termination resistor

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 together with the trimpot RT defines all on-chip bias and reference currents. The bias resistor value ($R_B = R_7 + RT$) may be varied within ±10% for calibration purposes. Any change to R_B will affect the displayed value quadratically (i.e.: R_B = +5%, Display value = +10%).

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.

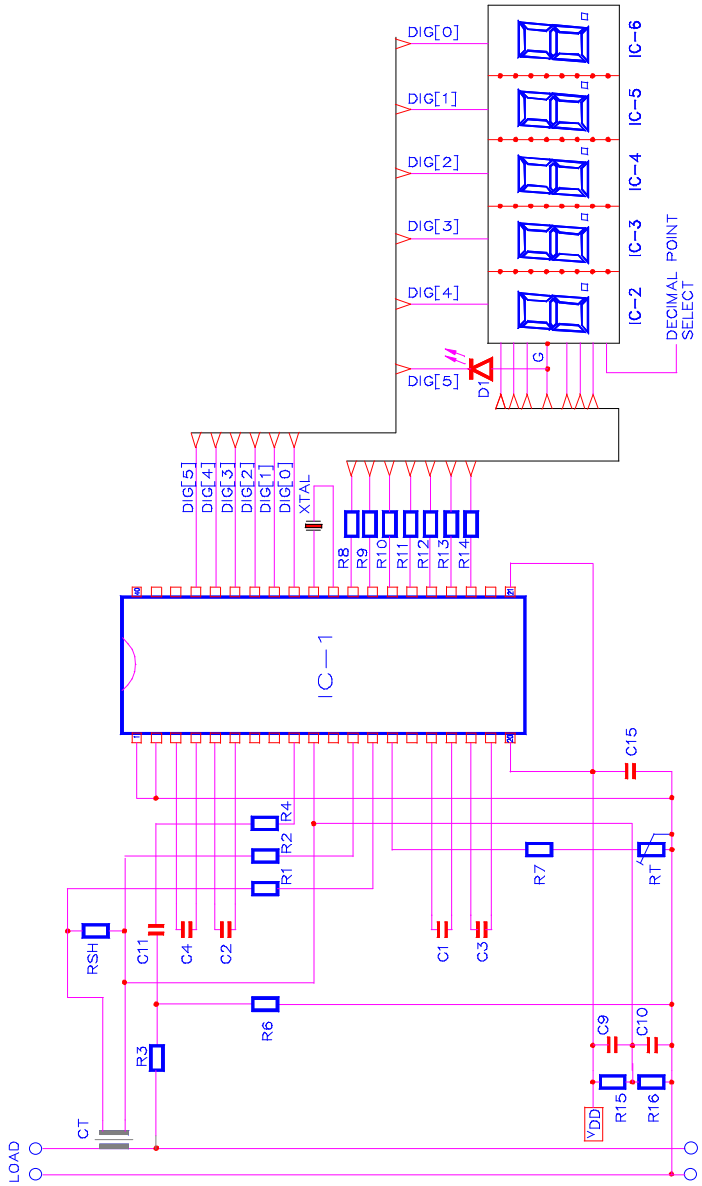


Parts List for Application Circuit: Figure 1

Item	Symbol	Description	Detail
1	IC-1	SA9106A	DIP-40/PLCC-44
2	D1	Light Emitting Diode	
3	XTAL	Crystal, 3.5795 MHz	Colour burst TV
4	R1	Resistor, 1% metal	Note 1
5	R2	Resistor, 1% metal	Note 1
6	R3	Resistor, 390k, (230VAC) 1%, metal	
7	R4	Resistor, 1M, 1/4W, 1% metal	
8	R6	Resistor, 24k, 1/4W, 1% metal	
9	R7	Resistor, 22k, 1/4W, 1% metal	
10	R8	Resistor, (Segment G)	Note 2
11	R9	Resistor, (Segment F)	Note 2
12	R10	Resistor, (Segment E)	Note 2
13	R11	Resistor, (Segment D)	Note 2
14	R12	Resistor, (Segment C)	Note 2
15	R13	Resistor, (Segment B)	Note 2
16	R14	Resistor, (Segment A)	Note 2
17	RT	Potentiometer 4.7k	Multi turn
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	C15	Capacitor, 820nF	Note 3
25	RSH	Shunt Resistor	Note 4

Note 1: Resistor (R1 and R2) values are dependant upon the selected value of RSH.
Note 2: Resistors (R8 to R14) are current limiting resistors required to set the intensity of the LED display segments.
Note 3: Capacitor (C15) to be positioned as close to Supply Pins (V_{DD} & V_{SS}) of IC-1 as possible.
Note 4: 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	SA9106A	DIP-40/PLCC-44
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, (230 VAC). 1%, metal	
7	R4	Resistor, 1M, 1/4W, 1%, metal	
8	R6	Resistor, 24k, 1/4W, metal	
9	R7	Resistor, 22k, 1/4W, 1%, metal	
10	R8	Resistor	Note 3
11	R9	Resistor	Note 3
12	R10	Resistor	Note 3
13	R11	Resistor	Note 3
14	R12	Resistor	Note 3
15	R13	Resistor	Note 3
16	R14	Resistor	Note 3
17	R15	Resistor, 820Ω, 1/4W, 1%	
18	R16	Resistor, 820Ω, 1/4W, 1%	
19	D1	Light emitting diode	
20	RT	Potentiometer 4.7k	Multi turn
21	C1	Capacitor, 560pF	
22	C2	Capacitor, 560pF	
23	C3	Capacitor, 3.3nF	
24	C4	Capacitor, 3.3nF	
25	C9	Capacitor, 100nF	
26	C10	Capacitor, 100nF	
27	C11	Capacitor	Note 4
28	C15	Capacitor, 820nF	Note 5

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: Resistors (R10 to R16) are current limiting resistors required to set the intensity of the LED display segments.
Note 4: Capacitor (C11) selected to minimize phase error introduced by current transformer (typically 1.5µF).
Note 5: Capacitor (C15) to be positioned as close to Supply Pins (V_{DD} & V_{SS}) of IC-1, as possible.

ORDERING INFORMATION

Part Number	Package
SA9106APA	DIP-40
SA9106AFA	PLCC-44

NOTES:

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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