PM9110BF

MONOCHIP THREE PHASE BIDIRECTIONAL KILOWATT HOUR METERING MODULE

FEATURES

- Performs bidirectional energy metering and includes a 7 digit LCD driver with announciators
- 4 externally selectable on-chip tariff registers
- An additional total energy register
- Meets the accuracy requirements for Class 1 AC Watt hour meters
- Optical interface for electronic reading according to IEC1107 Mode D
- Pulse output for calibration
- Total power consumption rating below 100mW
- Uses current transformers for current sensing
- Operates over a wide temperature range
- Demonstration software included

DESCRIPTION

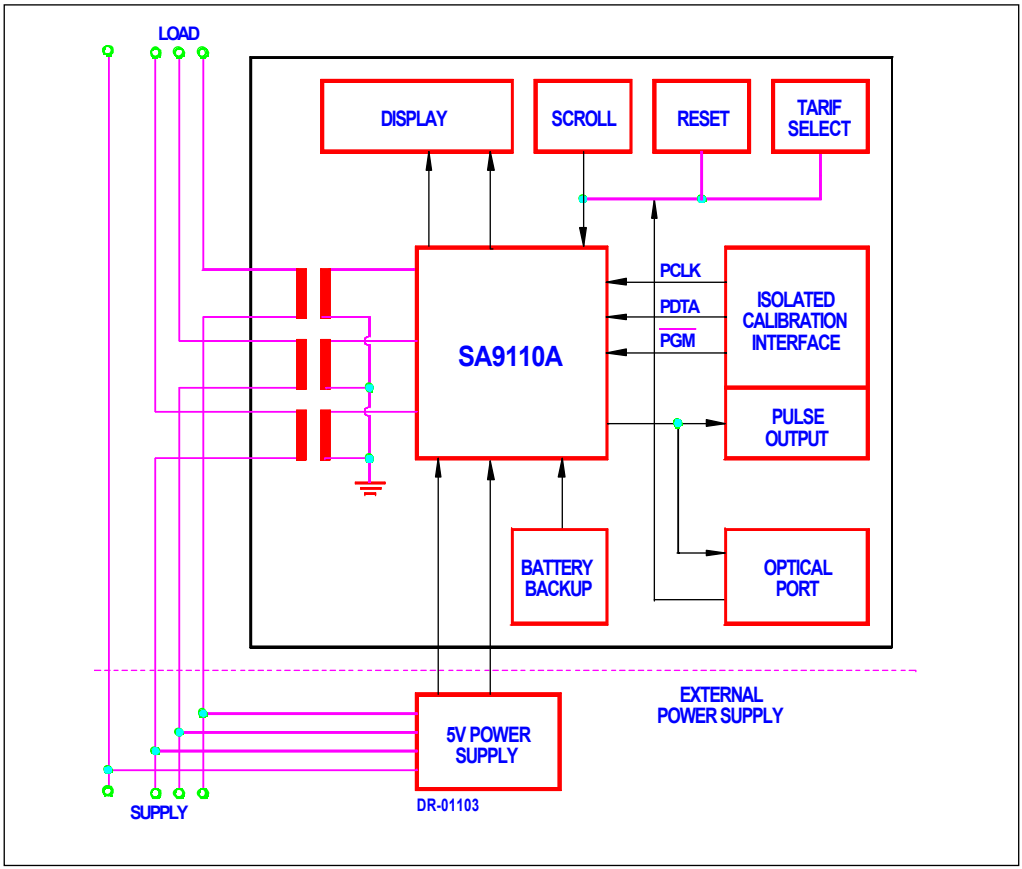
The SAMES monochip three phase bidirectional kilowatt hour metering module, the PM9110BF, provides all the required metering functions including energy measurement, a 7 digit LCD driver, a tariff selection facility, an optical port as well as a pulse output for calibration purposes.

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

This method of calculation takes the power factor into account.

This application utilises the SAMES SA9110AFA monochip three phase bidirectional kilowatt hour metering IC for energy measurement.

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS*

Parameter	Symbol	Min	Max	Unit
Supply Voltage (Note 1)	V_{AC}		540	V
Storage Temperature	T_{STG}	-25	+125	°C
Operating Temperature	T_O	-10	+70 (Note 2)	°C

Note 1: Voltages are specified with reference to Neutral

Note 2: The SA9110A 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. Power consumption figures are applicable to the PM9110BFE only.)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Supply Voltage (x3 Phase) (Continuous)	V_{AC}	180	230	265	V	PM9110BFE
Power Consumption				100	mW	From external power supply
Isolation Voltage[1]	V_{IS}			2500	V	Continuous
Opto-coupler Output Current	I_O			10	mA	V_{OL} = 1V
Opto-coupler Input Current	I_I			10	mA	

Note 1: Isolation voltage may be specified, depending on customer requirements.

PIN DESCRIPTION

Designation	Description
SK1 5-Pin Header connector	Isolated programming interface
SK2 2-Pin Header connector	Isolated pulse output
MAINS	Voltage Supply Connected to Phase 1 Voltage Supply Connected to Phase 2 Voltage Supply Connected to Phase 3 Voltage Supply Connected to Neutral Line (common)
CT1 CT2 CT3	Phase 1 (Orientation indicated on PCB) Phase 2 (Orientation indicated on PCB) Phase 3 (Orientation indicated on PCB)
POWER	5V DC Supply Voltage 0V DC Supply Voltage

FUNCTIONAL DESCRIPTION

1. Energy Calculation

This Application Note should be read in conjunction with the SA9110A Data Sheet.

In the Application Circuit (see Figure 2), the output current from the current sensors will be between 0 and 16μA_{RMS}. The current input stage of the module saturates at input currents greater than18μA_{RMS}. The mains voltage (Voltage + 15% - 20%) is used to perform the energy calculation, together with the current information from the current sensor (current transformers).

The SA9110AFA integrated circuit may be adjusted to accomodate any voltage or current values. The method for calculating external component values is described in section 9 (Circuit Description).

The accumulated energy is directly displayed on a 7 digit LCD. This unique application offers a host of additional features, which are dealt with below.

2. Electrostatic Discharge (ESD) Protection

The device's inputs/outputs are protected against ESD. The modules resistance to transients will be dependant upon the protection components used.

3. Power Consumption

The overall power consumption rating for this power metering application (Figure 2), is under 100mW, excluding the current sensors.

4. Isolation

The programming interface and pulse output are isolated from the module which is at mains potential, via opto-couplers.

5. Isolated Programming Interface

This isolated interface is provided to allow the user to programme the tariff register values, calibration constants and manufacturer/meter identification codes. This port is enabled by inserting the jumpers J8, J9 and J10. The programming may be performed via the parallel port of a personal computer.

The designation of the pins on connector SK1 are given below:

PM9110BF		PC Parallel Connectors (Suggested)	
Pin	**Description**	**Pin**	**Description**
1	GND	18	GND
2	$\overline{PB}$	2	D1
3	PCLK	4	D3
4	PDTA	5	D4
5	$\overline{PGM}$	3	D2

Note: The recommended connections above are applicable for the demonstration software provided with the PM9110BF.

6. Optical Port

The optical port has been designed to meet the IEC1107 Mode D specification. This facillity offers a pulse output as well as a serial data meter reading facility.

Three types of interfacing elements from the PM9110BF are available:

a) Infra-red optical port

b) Red LED

c) Opto-coupler

In order to maximise the intensity of the element, it is suggested that only one of the outputs be used at any one time.

Jumper	Element
J5	Opto Coupler
J6	Infra Red LED
J7	Red LED

7. Liquid Crystal Display (LCD)

The PM9110BF has a LCD comprising of seven digits with announciatiors.

To cater for compatibility with future devices four jumpers are provided for backplane driving configurations. The PM9110BF boards are shipped to the customer with jumpers in a default configuration.

8. Tariff, Scroll and Reset Functions

Tariff Selection

A dual DIP switch provides the user with the facility to set the active tariff register in which consumption will be accumulated.

The active register is indicated on the LCD.

Scroll Facility

The 4 registers may be sequentially displayed by activating the scroll button. The contents of the register selected for display is retained on the display for a period of 10 seconds, provided that the push button is not activated during this period. After the 10 seconds has elapsed, the display defaults to the "active" register defined by the status of the tariff DIP switches.

The register selected for display via the scroll button is indicated by the relevant annouciatiors.

Reset Function

By pressing the Reset button the contents of the RAM of the SA9110A device is set to the default conditions.

Jumpers J8, J9 and J10 must be removed to use this feature.

It is strongly recommended that the provision of this facility is not made available on production meters.

9. Circuit Description

The module is supplied from an external 5V DC supply.

The most important external components 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 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 SA9110A through current setting resistors (R_8..R_{13}).

The resistor values should be selected for an input current of 16μA_{RMS} into the SA9110A at the rated line current.

The values of these resistors should be calculated as follows:

Phase 1:

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

Phase 2:

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

Phase 3:

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

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

R_{18}, R_{19} and R_{20} = Termination resistors of the three current transformers.

$R_{1A} + R_{1B}$, R_4 and R_{15} set the current for the phase 1 voltage sense input. $R_{2A} + R_{2B}$, $R_5 + P_5$ and R_{16} set the current for phase 2 and $R_{3A} + R_{3B}$, $R_6 + P_6$ 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 $14mA_{RMS}$ for rated line voltage. Capacitors C1, C2 and C3 are for decoupling and phase compensation.

R_7 defines all on-chip bias and reference currents. With R_7 = 24kΩ, optimum conditions are set. Any changes to R_7 will affect the output quadratically (i.e: ΔR = +5%, Δf = +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 and supplies the A/D converters and the digital circuitry.

10. Demonstration Software

Serial communication with the SA9110A device is identical to the communication found on the Single Phase family member, SA9109A. For this reason the demonstration software for the Single Phase Application circuit is used for the Three Phase Application.

The software package which accompanies the demonstration unit requires an IBM or compatible PC with MS-DOS installed. This software, supplied on a 1.44M 3½" disk, will allow the user to read and write settings from/to the demonstration unit.

Ensure that the communication connectors are in place prior to start.

Insert the diskette into the drive and at the DOS prompt, type `A:SA9109` [enter]

Context sensitive help screen for each input field or command prompt are available by invoking [alt] H or [F1] key.

An introduction is available by pressing the [F1] key immediately after installation.

Figure 1: Connection Diagram

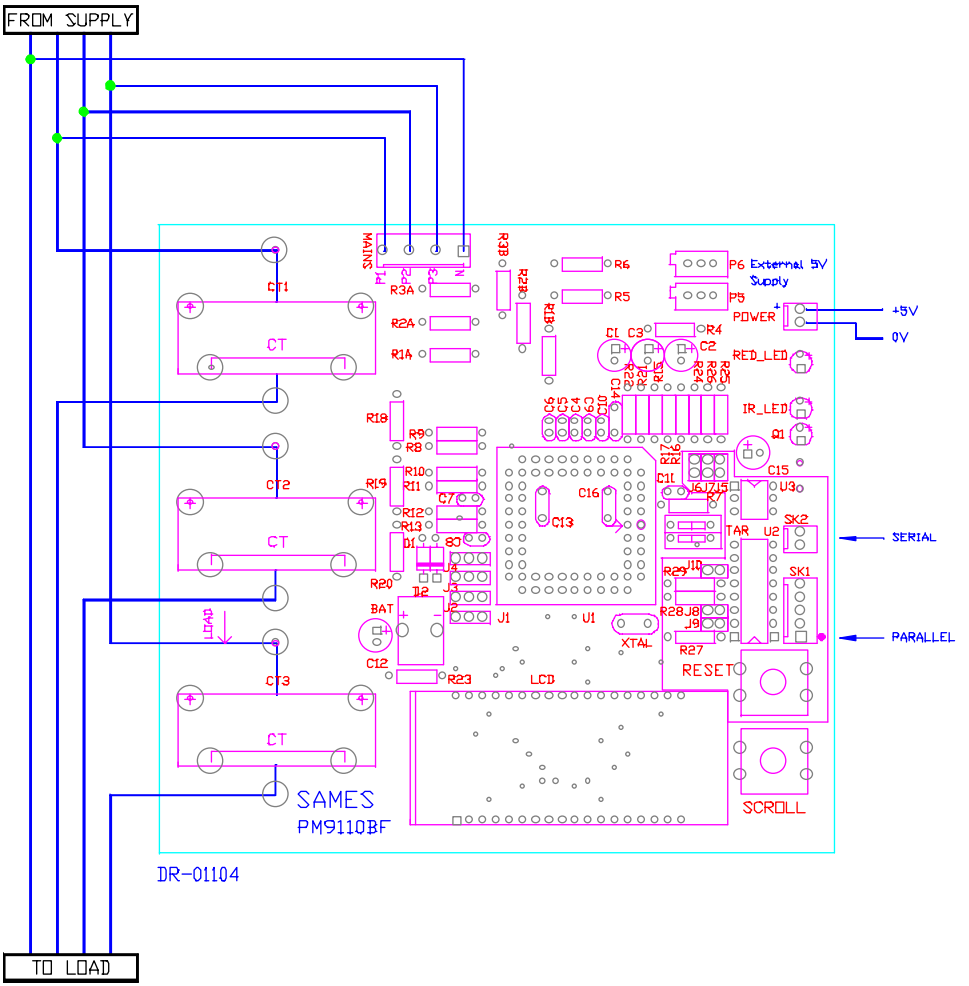
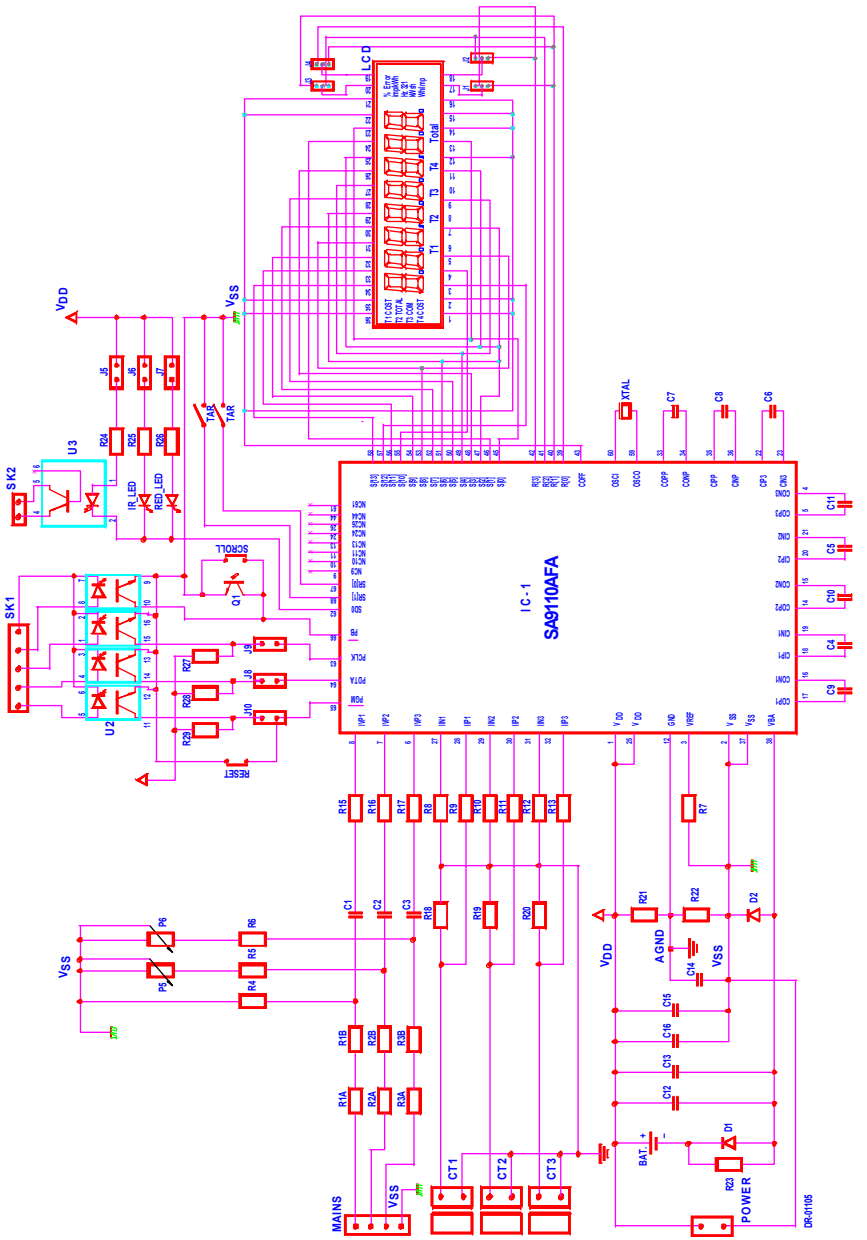


Figure 2: Application Circuit.



Parts List for Application circuit: Figure 2

Item	Symbol	Description	Detail
1	U1	SA9110AFA	PLCC-68
2	U2	ILQ74 (Quad opto-coupler)	DIP-16
3	U3	4N35 (opto-coupler)	DIP-6
4	XTAL	Crystal 3.5795MHz	Colour burst TV
5	R1A	Resistor, 1%, ¼W, metal	Note 4
6	R1B	Resistor, 1%, ¼W, metal	Note 4
7	R2A	Resistor, 1%, ¼W, metal	Note 4
8	R2B	Resistor, 1%, ¼W, metal	Note 4
9	R3A	Resistor, 1%, ¼W, metal	Note 4
10	R3B	Resistor, 1%, ¼W, metal	Note 4
11	R4	Resistor, 24k, 1%, ¼W, metal	
12	R5	Resistor, 22k, 1%, ¼W, metal	
13	R6	Resistor, 22k, 1%, ¼W, metal	
14	R7	Resistor, 24k, 1%, ¼W, metal	
15	R8	Resistor, 2.7k, 1%, ¼W, metal	Note 1
16	R9	Resistor, 2.7k, 1%, ¼W, metal	Note 1
17	R10	Resistor, 2.7k, 1%, ¼W, metal	Note 1
18	R11	Resistor, 2.7k, 1%, ¼W, metal	Note 1
19	R12	Resistor, 2.7k, 1%, ¼W, metal	Note 1
20	R13	Resistor, 2.7k, 1%, ¼W, metal	Note 1
21	R15	Resistor, 1M, 1%, ¼W, metal	
22	R16	Resistor, 1M, 1%, ¼W, metal	
23	R17	Resistor, 1M, 1%, ¼W, metal	
24	R18	Resistor, 2.7Ω, 1%, ¼W, metal	Note 1
25	R19	Resistor, 2.7Ω, 1%, ¼W, metal	Note 1
26	R20	Resistor, 2.7Ω, 1%, ¼W, metal	Note 1
27	R21	Resistor, 820Ω, 1%, ¼W, metal	
28	R22	Resistor, 820Ω, 1%, ¼W, metal	
29	R23	Resistor, 2MΩ, 1%, ¼W, metal	
30	R24	Resistor, 680Ω, 1%, ¼W, metal	
31	R25	Resistor, 2.2kΩ, 1%, ¼W, metal	
32	R26	Resistor, 2.2kΩ, 1%, ¼W, metal	
33	R27	Resistor, 2.2kΩ, 1%, ¼W, metal	
34	R28	Resistor, 2.2kΩ, 1%, ¼W, metal	
35	R29	Resistor, 2.2kΩ, 1%, ¼W, metal	
36	P5	Potentiometer, 4.7kΩ	Multi turn
37	P6	Potentiometer, 4.7kΩ	Multi turn
38	C1	Capacitor, electrolytic, 1µF, 16V	Note 2
39	C2	Capacitor, electrolytic, 1µF, 16V	Note 2
40	C3	Capacitor, electrolytic, 1µF, 16V	Note 2
41	C4	Capacitor, ceramic, 3.3nF	
42	C5	Capacitor, ceramic, 3.3nF	
43	C6	Capacitor, ceramic, 3.3nF	

Parts List for Application circuit: Figure 2 (continued)

Item	Symbol	Description	Detail
44	C7	Capacitor, ceramic, 2.2nF	
45	C8	Capacitor, ceramic, 3.3nF	
46	C9	Capacitor, ceramic, 560pF	
47	C10	Capacitor, ceramic, 560pF	
48	C11	Capacitor, ceramic, 560pF	
49	C12	Capacitor, 100µF, 16V	
50	C13	Capacitor, 100nF	Note 3
51	C14	Capacitor, 100nF	Note 3
52	C15	Capacitor, 100µF, 16V	
53	C16	Capacitor, 820nF	
54	BAT	Battery, 1.2V	
55	IR LED	Infrared light emitting diode	
56	RED LED	Red light emitting diode	
57	Q1	Photo transistor	
58	D1	Diode, 1N4148	
59	D2	Diode, 1N4148	
60	SCROLL	NO, push button	
61	RESET	NO, push button	
62	TARIFF	DIP switch, 2 pole	
63	LCD	OEL-7678*	

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 (C13) to be positioned as close to Supply Pins (V_{DD} & V_{SS}) of IC-1, as possible

Note 4: See the table below detailing the component values for the selected voltage standard

*The LCD display is available from:
JEBON CORPORATION
Unit 709, Poongsan Factoria Town,
1141-2, Baegsok-Dong, Ilsan-District,
Koyangcity, Kyonggi-Do, 411-360, Korea
Tel: +82-31-902-9161 (12 lines)
Fax: +82-31-902-7775/7776

Web site: http://www.jebon.com

Item	Symbol	Description		Detail
		PM9110BFE 230V	PM9110BFA 115V	
5	R1A	200kΩ	120kΩ	
6	R1B	180kΩ	82kΩ	
7	R2A	200kΩ	120kΩ	
8	R2B	180kΩ	82kΩ	
9	R3A	200kΩ	120kΩ	
10	R3B	180kΩ	82kΩ	

ORDERING INFORMATION

Part Number	Description
PM9110BFA	3 X 115V, 3 X 80A Module
PM9110BFE	3 X 230V, 3 X 80A Module

Notes:

Any Sales or technical questions may be posted to our e-mail address below:
energy@sames.co.za

For the latest updates on datasheets, please visit out web site:
http://www.sames.co.za

South African Micro-Electronic Systems (Pty) Ltd

P O Box 15888,
Lynn East, 0039
Republic of South Africa,

33 Eland Street,
Koedoespoort Industrial Area,
Pretoria,
Republic of South Africa

Tel: 012 333-6021
Fax: 012 333-8071

Tel: Int +27 12 333-6021
Fax: Int +27 12 333-8071