sames

SA9122E

SINGLE PHASE UNIDIRECTIONAL POWER/ENERGY METERING IC WITH SEPERATE 64 SEGMENT LCD DRIVER

FEATURES

- Performs unidirectional power and energy measurement
- On-chip 64 segment LCD driver
- Meets the IEC 521/1036 Specification requirements for Class 1 AC Watt hour meters
- Total power consumption rating below 25 mW
- Adaptable to different types of current sensors
- Operates over a wide temperature range
- Different pulse rate options available for power information
- LCD data input via a serial interface

DESCRIPTION

The SAMES SA9122E Single Phase unidirectional active Power/Energy metering integrated circuit includes a seperate on-chip 64 segment Liquid Crystal Display driver. The power/energy metering circuit generates a pulse rate output, proportional to the power consumption, while the LCD driver is programmable via a serial interface.

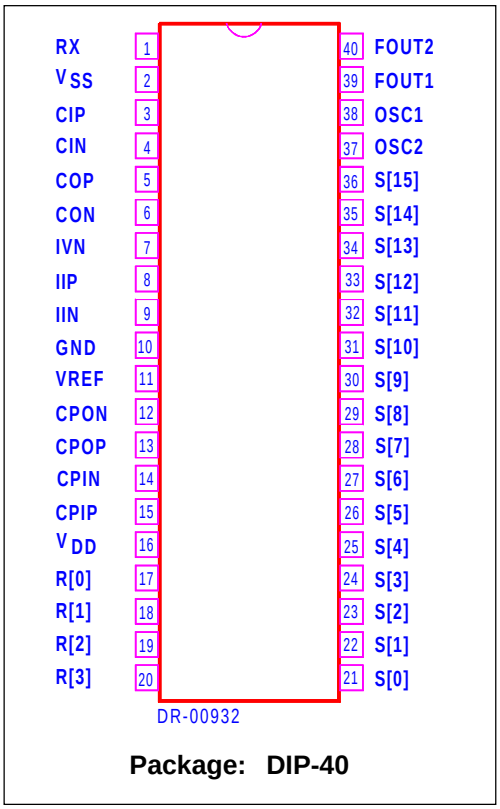
The method of power calculation takes the power factor into account. Energy consumption is determined by the power measurement being integrated over time.

The LCD driver is capable of driving 8 decimal digits (7 segment) and 8 announciators on a 4 track multiplexed backplane display.

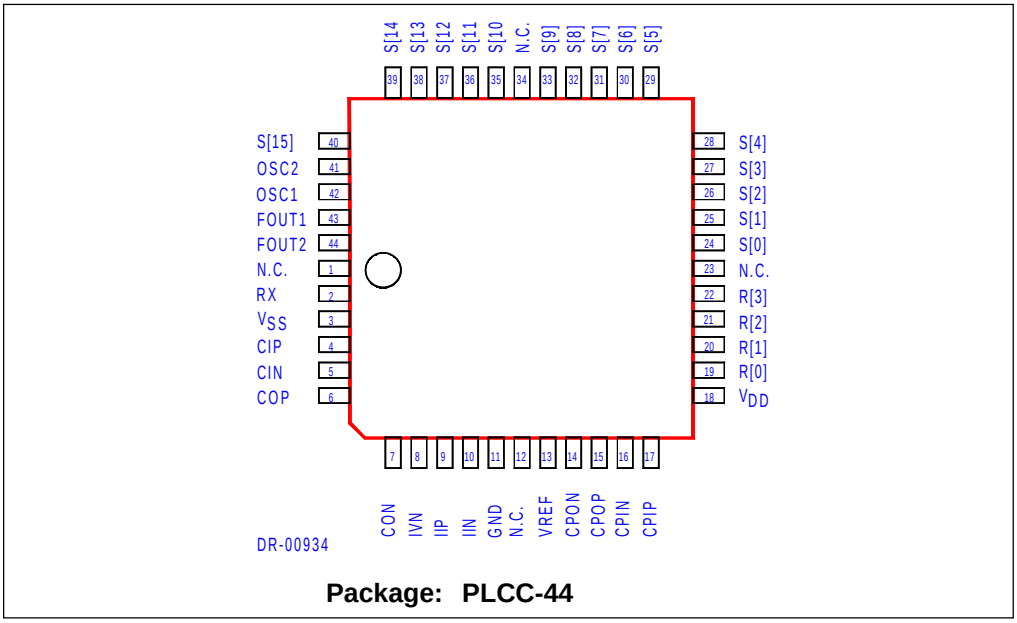
This innovative combination energy metering/ LCD display driver integrated circuit has been designed to provide meter designers with flexibility in the choice of the µ-controller employed, and is ideally suited for applications such as residential municipal metering and factory energy metering and control.

The SA9122E integrated circuit is available in both 40 pin dual-in-line plastic (DIP-40), as well as 44 pin plastic leaded chip carrier (PLCC-44) package types.

PIN CONNECTIONS

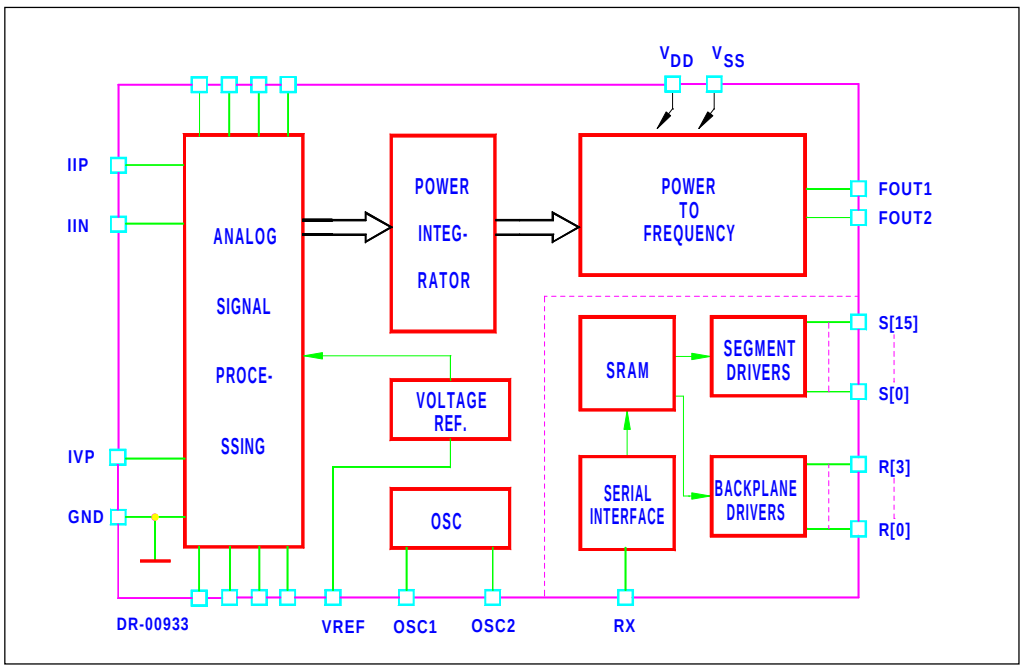


Package: DIP-40



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 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	7	mA	
Supply Current: Negative	I_{SS}		5	7	mA	
Current Sensor Inputs (Differential)						
Input Current Range	I_{II}	-25		+25	µA	Peak value
Voltage Sensor Input (Asymmetrical)						
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 3000	Hz Hz	Specified linearity Min and max limits
FOUT2[1]	f_{P2}		f_P/290			

ELECTRICAL CHARACTERISTICS (Continued)

Parameter	Symbol	Min	Typ	Max	Unit	Condition
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}
LCD backplane Voltage	V_B		V_{DD} & V_{SS}		V	R[0] ... R[3]
LCD segment Voltage	V_s		1/3 V_{DD} 2/3 V_{DD}		V	S[0] ... S[15]

Note1: Two additional bondout options at FOUT2 are available on request: $f_p/4$ and $f_p/16$.

Extended Operating Temperature Range available on request.

PIN DESCRIPTION

PLCC-44	DIP-40	Designation	Description
11	10	GND	Ground
18	16	V_{DD}	Positive Supply Voltage
3	2	V_{SS}	Negative Supply Voltage
8	7	IVN	Analog input for Voltage
10	9	IIN	Inputs for current sensor
9	8	IIP	
42	38	OSC1	Connections for crystal or ceramic resonator
41	37	OSC2	(OSC1 = Input ; OSC2 = Output)
14	12	CPON	Connections for outer loop capacitor of
15	13	CPOP	A/D converter (Voltage)
16	14	CPIN	Connections for inner loop capacitor of
17	15	CPIP	A/D converter (Voltage)
4	3	CIP	Connections for inner loop capacitor of
5	4	CIN	A/D converter (Current)
6	5	COP	Connections for outer loop capacitor of
7	6	CON	A/D converter (Current)
13	11	VREF	Connection for current setting resistor
2	1	RX	Serial data input
44	40	FOUT2	Pulse rate outputs
43	39	FOUT1	

PIN DESCRIPTION (Continued)

PLCC-44	DIP-40	Designation	Description
19	17	R[0]	Output drivers for LCD back planes
20	18	R[1]	
21	19	R[2]	
22	20	R[3]	
24	21	S[0]	Output drivers for LCD segments
25	22	S[1]	
26	23	S[2]	
27	24	S[3]	
28	25	S[4]	
29	26	S[5]	
30	27	S[6]	
31	28	S[7]	
32	29	S[8]	
33	30	S[9]	
35	31	S[10]	
36	32	S[11]	
37	33	S[12]	
38	34	S[13]	
39	35	S[14]	
40	36	S[15]	
1		NC	Not connected
12		NC	
23		NC	
34		NC	

FUNCTIONAL DESCRIPTION

The SA9122E 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, and includes a seperate 64 segment LCD display driver function.

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 SA9122E generates pulses, the frequency of which is proportional to the power consumption. Two frequency outputs (FOUT1 and FOUT2) are available, with additional frequency options available on request. The pulse rate follows the instantaneous power measured.

The separate Liquid Crystal Display driver function included on-chip, drives up to 64 segments on a 4 track muliplexed backplane display, programmable via a serial interface having a RS232 protocol.

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_{RMS} at nominal mains voltage, via resistor R4 (1MΩ).

In this configuration, with a mains voltage of 230V and a current of 80A, the output frequency of the SA9122E power meter chip at FOUT1 is 1.16kHz. In this case, 1 pulse will correspond to an energy consumption of 18.4kW/1160Hz = 15.9Ws.

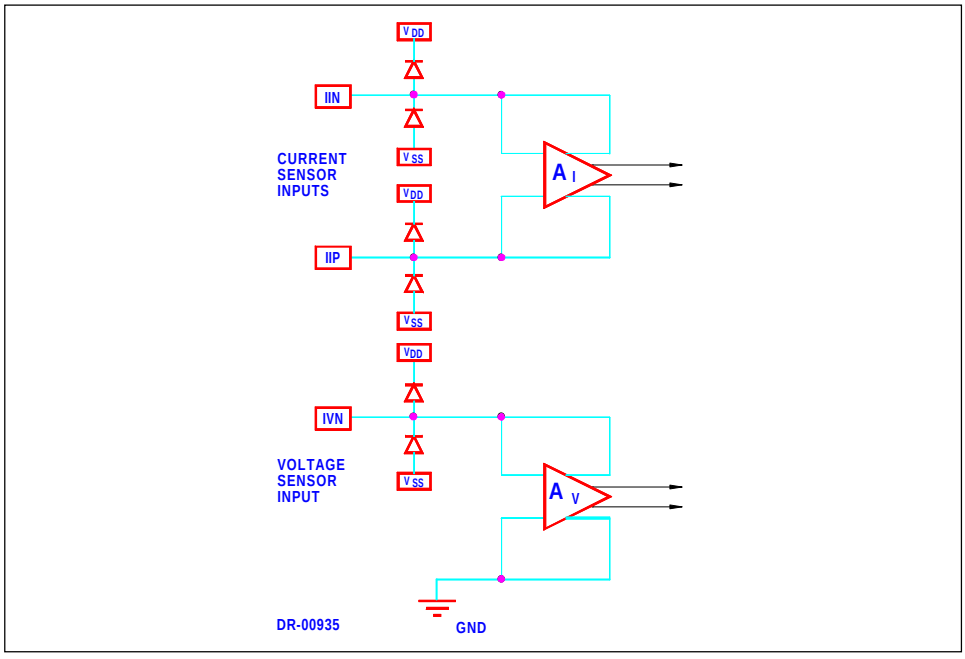
The output frequency at FOUT2 is FOUT1 /290 (i.e. The frequency ouput at FOUT1 divided by 290).

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.

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.

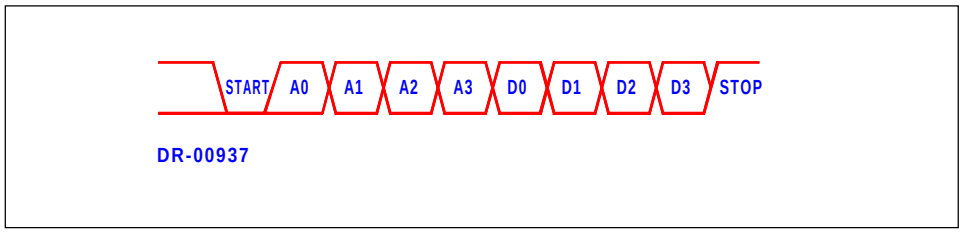


3. LCD Programming Protocol

Programming of the SA9122E's on-chip Liquid Crystal Display memory is performed via a serial interface having a RS232 data format. The data for display is transferred on RX at 19 200 baud.

The format of the data as well as the data memory map, is given below:

Data format on RX



LCD memory map

Inserting a '1' into a memory location turns the segment on and a '0' turns the segment off.

A3	A2	A1	A0	D3	D2	D1	D0	Pin
0	0	0	0					**S[0]**
0	0	0	1					**S[1]**
0	0	1	0					**S[2]**
0	0	1	1					**S[3]**
0	1	0	0					**S[4]**
0	1	0	1					**S[5]**
0	1	1	0					**S[6]**
0	1	1	1					**S[7]**
1	0	0	0					**S[8]**
1	0	0	1					**S[9]**
1	0	1	0					**S[10]**
1	0	1	1					**S[11]**
1	1	0	0					**S[12]**
1	1	0	1					**S[13]**
1	1	1	0					**S[14]**
1	1	1	1					**S[15]**
				R[3]	**R[2]**	**R[1]**	**R[0]**	

4. Electrostatic Discharge (ESD) Protection

The SA9122E integrated circuit's inputs/outputs are protected against ESD according to Mil-Std 883C, method 3015.

5. Power Consumption

The power consumption rating of the SA9122E integrated circuit is less than 25mW.

TYPICAL APPLICATIONS

In the Application Circuit (Figure 1), the components required for this power metering application, 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.

The most important external components for the SA9122E 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 $16\mu A_{RMS}$ into the SA9122E at maximum line current.

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

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

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 $14\mu A_{RMS}$.

R_7 defines the reference current (I_R). 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 is given below:

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

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

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

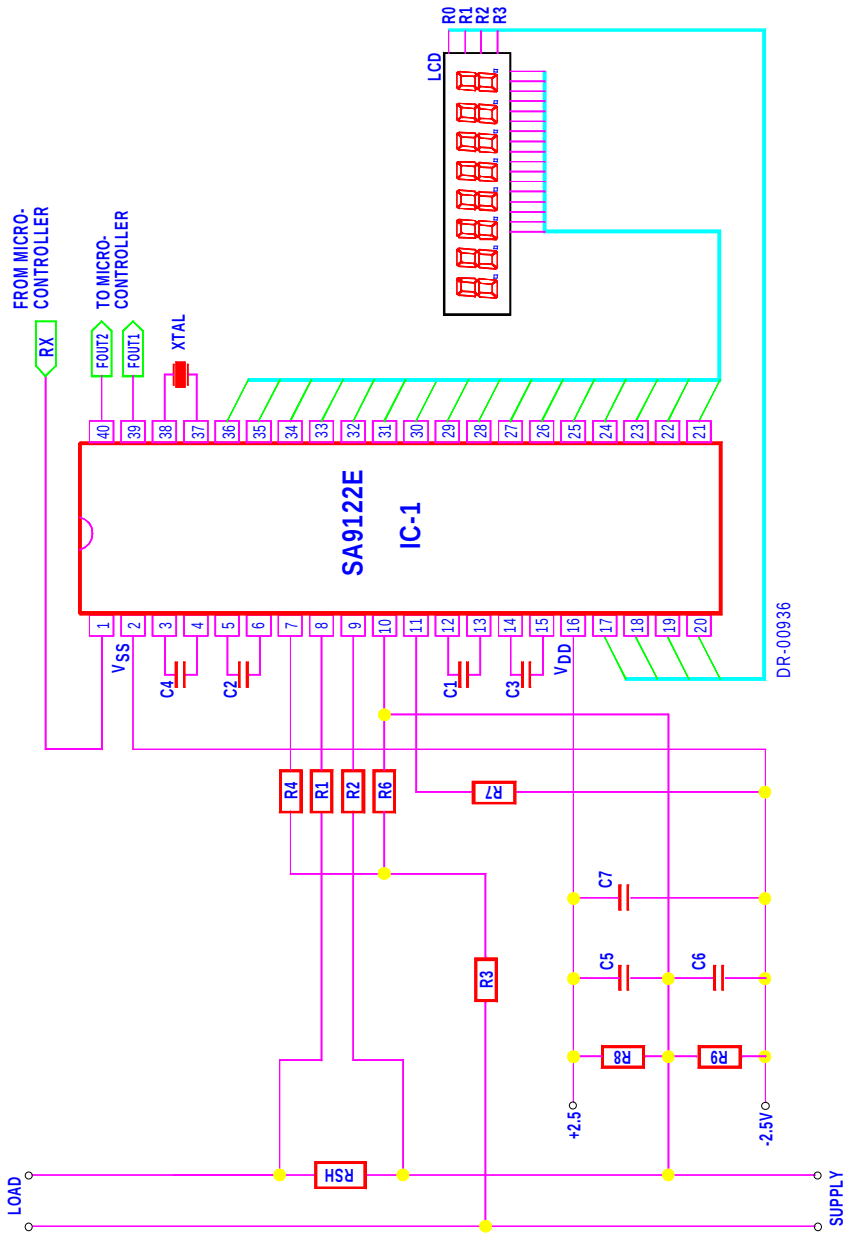
I_I = Input current for current sensor input (16µA at rated line current)

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

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 using a Shunt Resistor for Current Sensing.



Parts List for Application Circuit: Figure 1

Item	Symbol	Description	Detail
1	IC-1	SA9122E	DIP-40/PLCC-44
2	XTAL	Crystal, 3.5795MHz	Colour burst TV
3	R1	Resistor, 1% metal	Note 1
4	R2	Resistor, 1% metal	Note 1
5	R3	Resistor, 390k, (230VAC) 1%, metal	
6	R4	Resistor, 1M, 1/4W, 1%, metal	
7	R6	Resistor, 24k, 1/4W, 1%, metal	
8	R7	Resistor, 24k, 1/4W, 1%, metal	
9	R8	Resistor, 820Ω, 1/4W, 1%	
10	R9	Resistor, 820Ω, 1/4W, 1%	
11	C1	Capacitor, 560pF	
12	C2	Capacitor, 560pF	
13	C3	Capacitor, 3.3nF	
14	C4	Capacitor, 3.3nF	
15	C5	Capacitor, 100nF	
16	C6	Capacitor, 100nF	
17	C7	Capacitor, 820nF	Note 2
18	LCD	LCD 64 Segment, 4 back plane	
19	RSH	Shunt Resistor	Note 3

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

Note 2: Capacitor (C7) 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.

ORDERING INFORMATION

Part Number	Package
SA9122EPA	DIP-40
SA9122EFA	PLCC-44

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energy@sames.co.za

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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