

# SOLAR POWER PLANT AUTOMATION

**Submitted by:-**

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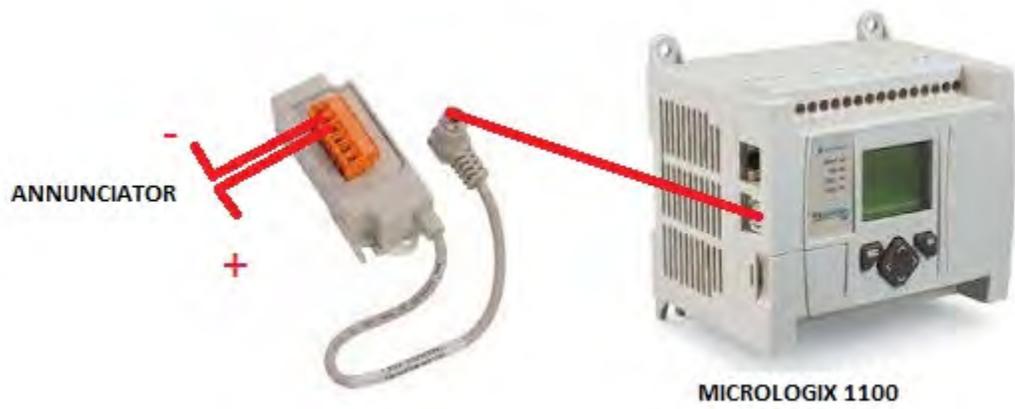
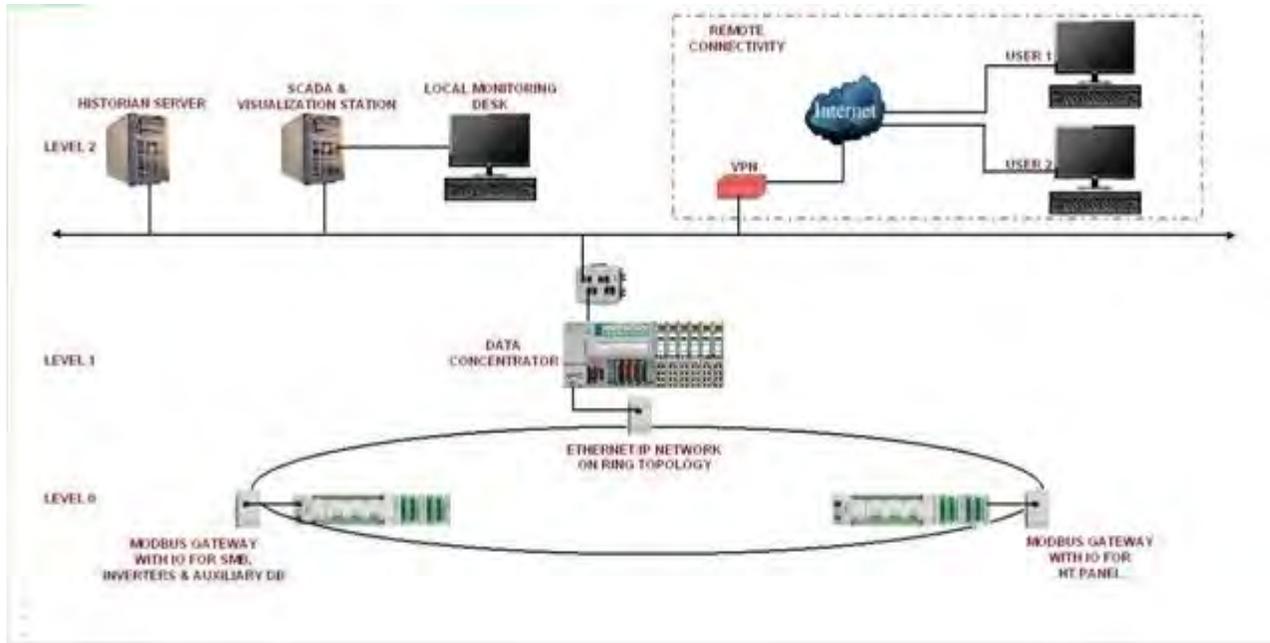
## **1. ABSTRACT:**

Supervisory control and data acquisition (SCADA) systems are used in Solar power plants for monitoring, control, remote communication purpose. The ingredients of SCADA system in solar power plants is introduced in this manual. solar plant does not have any moving parts, as a result we need live and historical details about the plant, using a plant scada system that monitors all the critical field devices such as inverters , weather station, mfm , smb, lt/ht panel . All this combined to provide a live and plant comprehensive view of the entire solar plant with continuous alert system, viewed from anywhere (at site/corporate office) - on PC/Mobile .

I-logicon Scada provides continuous 24x7 SCADA monitoring of:

- Power generation at plant, sub-plant, string level
- Energy exported to the Grid
- Environment ambient temperature, irradiation & wind speed
- Equipment Health Monitoring - inverters, grid equipment and modules (helping O&M field and remote staff, and owners)
- Detailed Reports and Graphs in near real time for effective O&M and Remote Monitoring
- Plant Performance - generation performance, uptime & efficiency, helping O&M and Plant Owners.

## 2. SCADA & REPORTING ARCHITECTURE :



### **3. SCADA Components :**

25 Display

Features :

- 1) Real time monitoring of plant data
- 2) Alarms and events with history
- 3) Real time and Historical Trend (SMBs and Inverters)

Remote Monitoring Software:

Features:

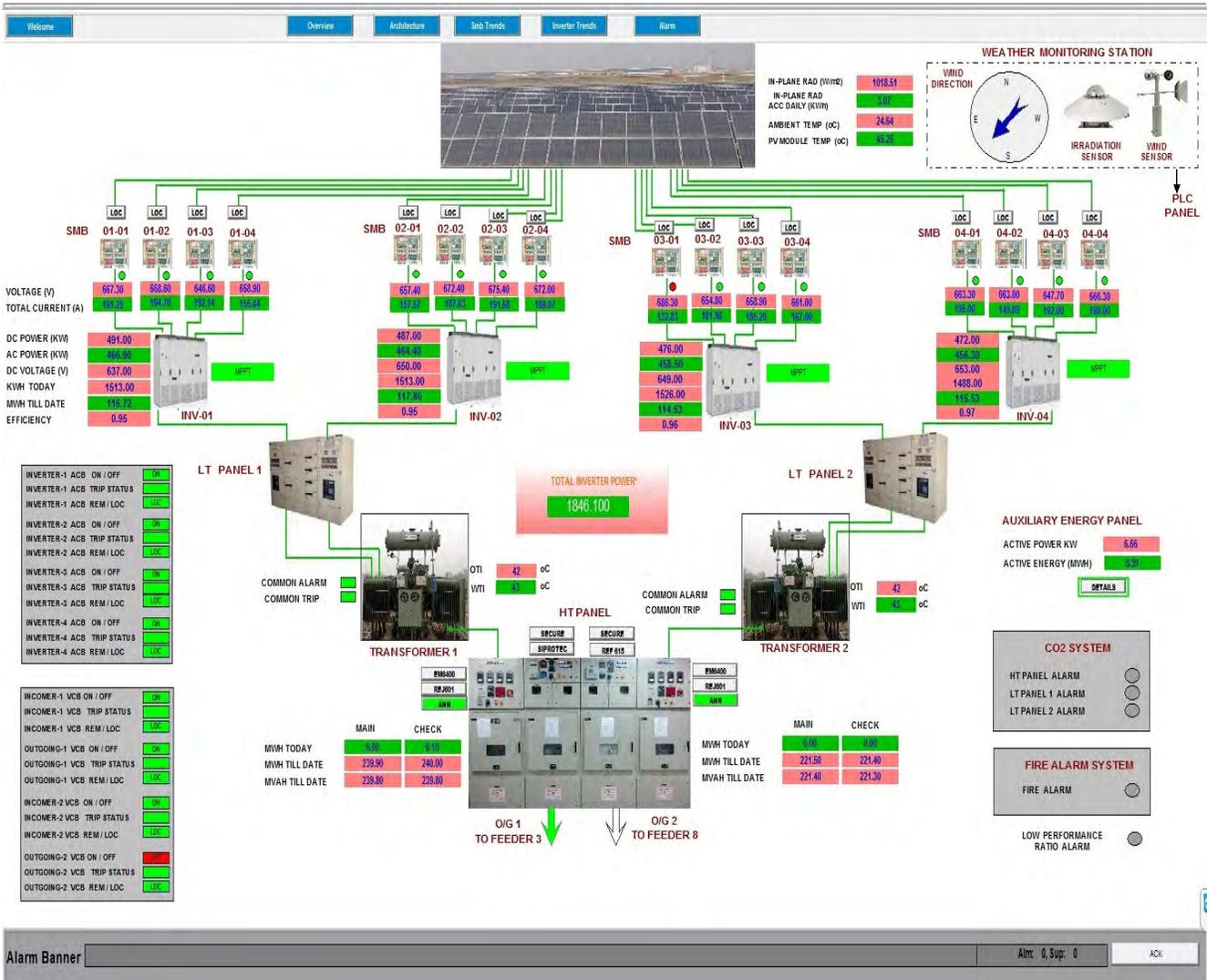
- 1) Remote Scada client through secure VPN network .

Reporting System

Locally and Remote view the Reports.

# SCADA Screens

## OVER VIEW



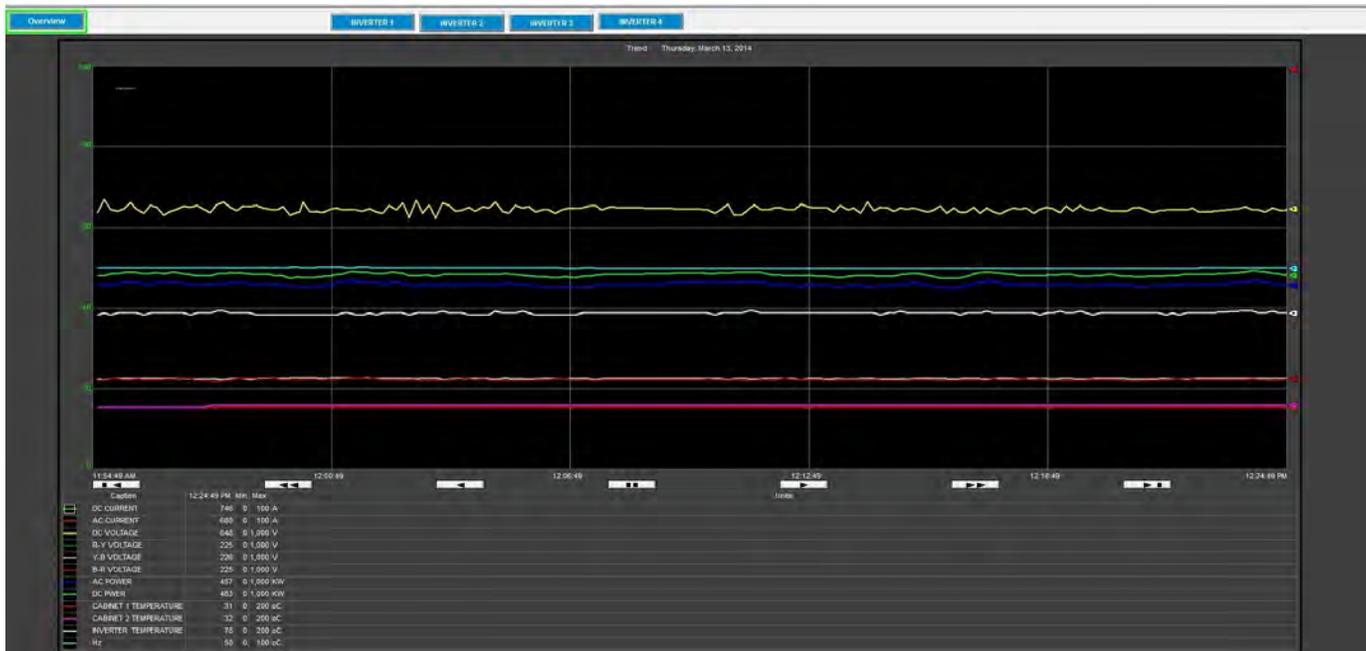
Here all the plant parameters can be monitored .Which includes SMB data , Inverter data , LT & HT panel breaker status data , HT panel Relays , MFM and Annunciator data.

Complete Plant Overview includes data collection from RTU 1 , RTU 2 and Data Concentration Unit.

- 1) LT panel and HT panel Breaker status
- 2) SMB data include string current , total string current , Power
- 3) Inverter data include AC / DC parameters , inverter status .

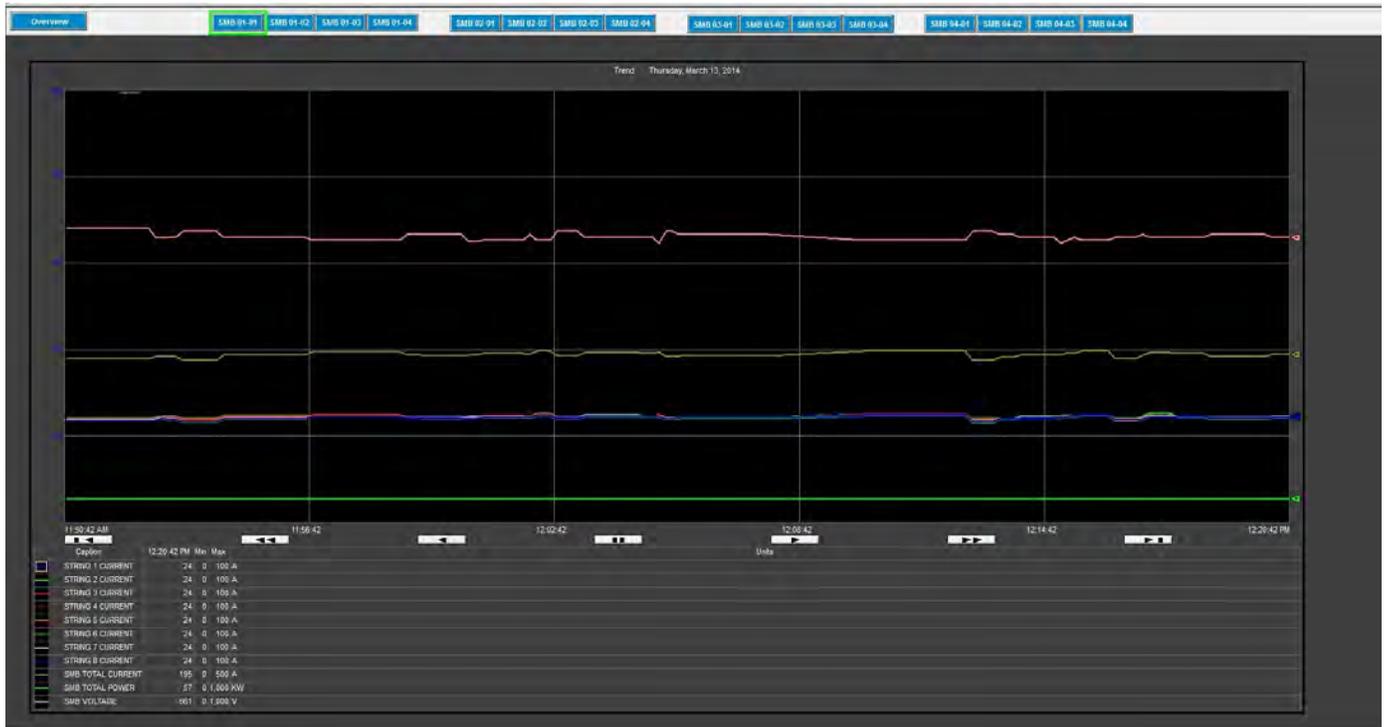
- 4) Weather monitoring station monitoring includes Radiation , Accumulated radiation daily , Humidity , Ambient Temperature , Module Temperature etc.
- 5) Aux Panel Monitoring includes auxiliary consumption .
- 6) HT panel Incomer Relay data , Outgoing relay data , Incomer MFM 's and Annunciator alarms and trip status.
- 7) CO2 suppression system and Fire Alarm status.
- 8) Alarm Banner Includes Most recent alarm.
- 9) Navigation to all the below mentioning pages are available in the overview screen.

## INVERTER TREND



Inverter trend include Real time and Historical trending of Inverter data. Historical trend data available for a period of one week.

## SMB TREND



Smb trend includes Realtime and Historical Trending of SMB data .Historical Trend values are available upto a period of one week.

## SMB LEVEL DATA

STRING - /EnerParc_Scada_rev1//			
SMB 01-02			
SL. NO	STRING MONITORING BOX	CURRENT(A)	CAL CURRENT (A)
1	STRINGS 1-2-3	24.20	25.54
2	STRINGS 4-5-6	24.49	25.54
3	STRINGS 7-8-9	24.42	25.54
4	STRINGS 10-11-12	24.15	25.54
5	STRINGS 13-14-15	24.26	25.54
6	STRINGS 16-17-18	23.93	25.54
7	STRINGS 19-20-21	24.23	25.54
8	STRINGS 22-23-24	23.96	25.54
TOTAL STRING AVAIL		24	
VOLTAGE		654.70	V
TOTAL CURRENT		193.64	A
TOTAL POWER		57.09	KW
SMB TEMP		36.00	oC
SURGE PROTECTION		<span style="background-color: green; color: green;">████████</span>	

**Legend**

- String Healthy ●
- String Alarm ●
- String Fault ●

## INVERTER DATA

INVERTER - /EnerParc\_Scada\_rev1//
✕

INVERTER 3

SL. NO	ANALOG PARAMETERS	UNITS	INVERTER
1	DC VOLTAGE	V	667.00
2	DC CURRENT	A	728.00
3	DC POWER	KW	485.00
4	VOLTAGE , V1	V	224.00
5	VOLTAGE , V2	V	226.00
6	VOLTAGE , V3	V	222.00
7	CURRENT L1	A	684.00
8	AC POWER	KW	464.90
9	AC ENERGY(TODAY)	KWh	1639.00
10	AC ENERGY CUMULATIVE	MWh	114.64
11	PF		1.00
12	FREQUENCY	Hz	50.09
13	INVERTER TEMPERATURE	Deg.	77.00
14	CABINET 1 TEMPERATURE	Deg.	30.00
15	CABINET 2 TEMPERATURE	Deg.	29.00
16	PVA STATE		MPPT

**SUPPLY FAULT WORD**

CHARGING FAULT

PVS800 TEMP

EXT EVENT DI4

SHORT CIRCUIT

NET VOLT FLT

EARTH FLT

**SUPPLY FAULT ALARM**

PVS800 TEMP

PLIM EXT TEMP

RUN DISABLED

NET LOST

EXTERNAL EVENT DI4

**PVA FAULT WORD**

CH2 COM LOSS

DC BRK TRIP

DC BRK LEVEL

DC BRK POS

AUTO RESET F

EXT EVENT DI4

**PVA FAULT ALARM**

PVA RUN ENABLE

AUTO RESET A

UDC HIGH LIM

EXT EVENT DI4

LAST FAULT CODE

3142

## MULTIFUNCTION METER

INCOMER 1 MFM				INCOMER 2 MFM			
SL. NO	ANALOG PARAMETERS	UNITS	INCOMER 1	SL. NO	ANALOG PARAMETERS	UNITS	INCOMER 1
1	VOLTAGE V1	kv	11.32	1	VOLTAGE V1	kv	11.31
2	VOLTAGE V2	kv	11.32	2	VOLTAGE V2	kv	11.32
3	VOLTAGE V3	kv	11.20	3	VOLTAGE V3	kv	11.26
3	VOLTAGE L-L	kv	11.22	3	VOLTAGE L-L	kv	11.21
3	VOLTAGE L-N	kv	6.52	3	VOLTAGE L-N	kv	6.51
4	CURRENT L1	A	47.56	4	CURRENT L1	A	47.44
5	CURRENT L2	A	46.75	5	CURRENT L2	A	46.95
6	CURRENT L3	A	50.73	6	CURRENT L3	A	49.32
7	POWER FACTOR		-1.00	7	POWER FACTOR		-1.00
8	FREQUENCY	Hz	50.03	8	FREQUENCY	Hz	50.04
9	ACTIVE POWER	KW	938.77	9	ACTIVE POWER	KW	929.40
10	MWH FORWARD	MWH	232.20	10	MWH FORWARD	MWH	229.19
11	MWH REVERSE	MWH	0.00	11	MWH REVERSE	MWH	0.00
12	MVAH FORWRD	MVAH	235.87	12	MVAH FORWRD	MVAH	231.94
13	MVAH REVERSE	MVAH	0.00	13	MVAH REVERSE	MVAH	0.00

1) There are two sets of energy meters at Incomer 1 and Incomer 2 at HT panel.

## ABT ENRGY METERS

ABT ENERGY PARAMETERS					ABT ENERGY PARAMETERS				
SL. NO	ANALOG PARAMETERS	UNITS	OUTGOING 1 MAIN	OUTGOING 1 CHECK	SL. NO	ANALOG PARAMETERS	UNITS	OUTGOING 2 MAIN	OUTGOING 2 CHECK
1	VOLTAGE V1	KV	11.20	11.20	1	VOLTAGE V1	KV	0.00	0.00
2	VOLTAGE V2	KV	11.30	11.31	2	VOLTAGE V2	KV	0.00	0.00
3	VOLTAGE V3	KV	11.18	11.20	3	VOLTAGE V3	KV	0.00	0.00
4	CUURRENT L1	A	25.47	25.32	4	CUURRENT L1	A	0.00	0.00
5	CURRENT L2	A	24.68	24.34	5	CURRENT L2	A	0.00	0.00
6	CURRENT L3	A	29.22	29.04	6	CURRENT L3	A	0.00	0.00
7	POWER FACTOR		-1.00	-1.00	7	POWER FACTOR		0.00	0.00
8	FREQUENCY	Hz	50.03	50.03	8	FREQUENCY	Hz	0.00	0.00
9	MWH IMPORT	MWH	2.10	2.30	9	MWH IMPORT	MWH	1.70	1.60
10	MWH EXPORT	MWH	240.50	240.50	10	MWH EXPORT	MWH	221.50	221.40
11	MVAH IMPORT	MVAH	2.40	2.50	11	MVAH IMPORT	MVAH	1.80	1.80
12	MVAH EXPORT	MVAH	240.40	240.40	12	MVAH EXPORT	MVAH	221.40	221.30

- 1) There are Two sets of Secure meters for both Outgoing feeders and each set of Secure meters contains Main and Check meters for redundancy.

## WEATHER MONITORING STATION



The screenshot shows a SCADA window titled "WEATHER\_PAR - /EnerParc\_Scada\_rev1//". The interface displays a "WEATHER MONITORING SYSTEM" with several data points. The data is organized into sections: Wind, Equipment 1, Enclosure/Ambient/PV Temperatures, and Battery/Humidity. Values are shown in large orange digits on a dark background.

WEATHER MONITORING SYSTEM	
WIND SPEED (m/s)	4.43
WIND DIRECTION(Deg)	296.74
EQUIPMENT1	
IN-PLANE RAD (W/m2)	969.40
IN-PLANE RAD (Wh)	1.35
IN-PLANE RAD ACC DAILY (KWh)	3.41
ENCLOSURE TEMP (oC)	26.94
AMBIENT TEMP (oC)	25.07
PV MODULE TEMP (oC)	45.50
BATTERY VOLT (V)	13.67
RELATIVE HUMIDITY (%)	42.47

## INCOMER PROTECTION RELAY

REJ601 - /EnerParc\_Scada\_rev1//

### RELAY REJ 601 PARAMETERS

SL. NO	ANALOG PARAMETERS	UNITS	STATUS
1	PRIMARY CURRENT I1	A	50.38
2	PRIMARY CURRENT I2	A	49.63
3	PRIMARY CURRENT I3	A	53.00
3	EARTH CURRENT I0	A	0.00

**BINARY INPUT**

UNIT READY

NO TRIP

EARTH TRIP

PHASE TRIP

TRIP CIRCUIT SUPER VISION

EMERGENCY STOP

**BINARY OUTPUT**

MASTER TRIP RELAY

TRIP CIRCUIT HEALTHY

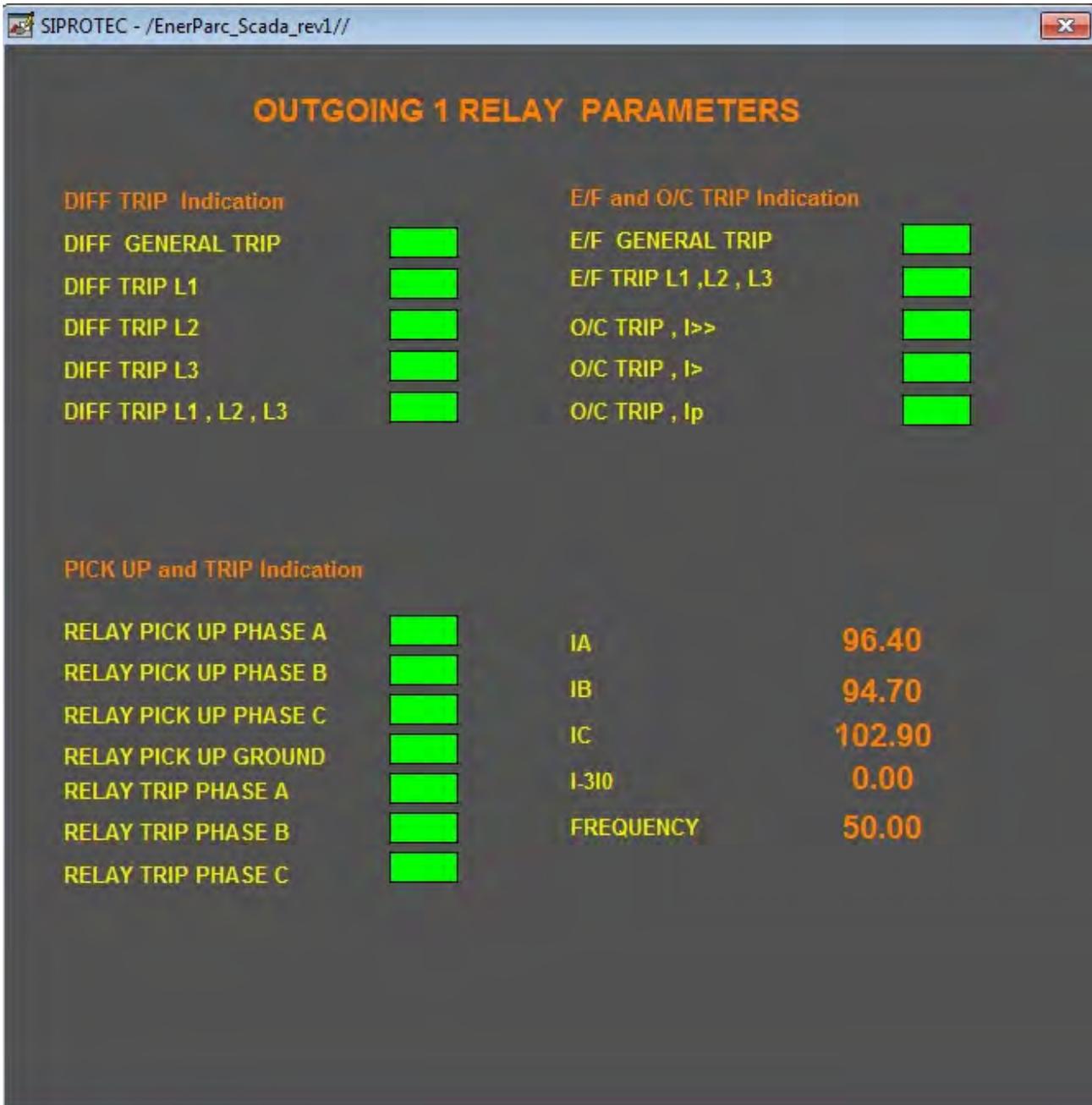
REALLY INTERNAL FAULT

OVER CURRENT FAULT

EARTH FAULT

- 1) There are two Protection relays monitoring at Incomer 1 and Incomer 2.
- 2) Alarm and indications based on fault .

## OUTGOING 1 PROTECTION RELAY



- 1) Siemens Siprotec 7SD61 Relay parameters
- 2) Alarms based on fault

## OUTGOING 2 PROTECTION RELAY

The screenshot displays the 'OUTGOING 2 RELAY PARAMETERS' interface. It is organized into several sections, each with a title in orange text. Each section contains a list of parameters, with the text in yellow and a corresponding green rectangular indicator to its right, signifying that the parameter is active or 'operated'.

**PHASE OVER CURRENT DETECTION**

- LOW STAGE OPERATED
- HIGH STAGE 1 OPERATED
- HIGH STAGE 2 OPERATED
- INSTANTANEUS OPERATED

**EARTH FAULT DETECTION**

- LOW STAGE 1 OPERATED
- LOW STAGE 2 OPERATED
- HIGH STAGE OPERATED
- INSTANTANEUS OPERATED

**PHASE OVER VOLTAGE DETECTION**

- STAGE 1 OPERATED
- STAGE 2 OPERATED
- STAGE 3 OPERATED

**PHASE UNDER VOLTAGE DETECTION**

- STAGE 1 OPERATED
- STAGE 2 OPERATED
- STAGE 3 OPERATED

**RESIDUAL OVER VOLTAGE DETECTION**

- STAGE 1 OPERATED
- STAGE 2 OPERATED
- STAGE 3 OPERATED

- 1) ABB REF615 Relay parameters
- 2) Alarms based on fault

## ANNUNCIATOR



The screenshot shows a window titled "ANN1 - /EnerParc\_Scada\_rev1//". Inside the window is a table with three columns: "SL. NO", "PARAMETERS", and "INCOMER 1". The table lists 14 parameters, all of which have a red bar in the "INCOMER 1" column, indicating an active alarm or trip.

SL. NO	PARAMETERS	INCOMER 1
1	DC FAIL	Red Bar
2	AC FAIL	Red Bar
3	OVER CURRENT FAULT TRIP	Red Bar
4	EARTH FAULT TRIP	Red Bar
5	86 RELAY OPTD	Red Bar
6	EMERGENCY TRIP	Red Bar
7	WINDING TEMP HIGH ALARM	Red Bar
8	WINDING TEMP HIGH TRIP	Red Bar
9	OIL TEMP HIGH ALARM	Red Bar
10	OIL TEMP HIGH TRIP	Red Bar
11	BUCHOLZ ALARM	Red Bar
12	BUCHOLZ TRIP	Red Bar
13	MOG ALARM	Red Bar
14	PRV TRIP	Red Bar

- 1) Incomer 1 and Incomer 2 Annunciators data .
- 2) Alarms and indications based on the annunciation window status.

## MFM AUXILIARY PANEL

SL. NO	ANALOG PARAMETERS	UNITS	INCOMER 1
1	VOLTAGE V1	kv	0.42
2	VOLTAGE V2	kv	0.42
3	VOLTAGE V3	kv	0.41
3	VOLTAGE L-L	kv	0.42
3	VOLTAGE L-N	kv	0.24
4	CURRENT L1	A	15.89
5	CURRENT L2	A	15.89
6	CURRENT L3	A	15.89
7	POWER FACTOR		0.82
8	FREQUENCY	Hz	50.00
9	ACTIVE POWER	KW	8.90
10	MWH FORWARD	MWH	8.39
11	MWH REVERSE	MWH	0.00
12	MVAH FORWRD	MVAH	0.00
13	MVAH REVERSE	MVAH	0.00

## ALARM SUMMARY

Alarm Date	Alarm Time	Tag Description	Alarm Type	Alarm Severity	Ack Date	Ack Time	Operator Name
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Alarms will be available in the alarm summary. Latest alarms will show in alarm banner available at the bottom of overview screen. Historical alarms are available for a period of 1 week. Alarm and log viewer is using for viewing old alarms.

## 4. Report Formats.

### • Daily Energy Generation Report

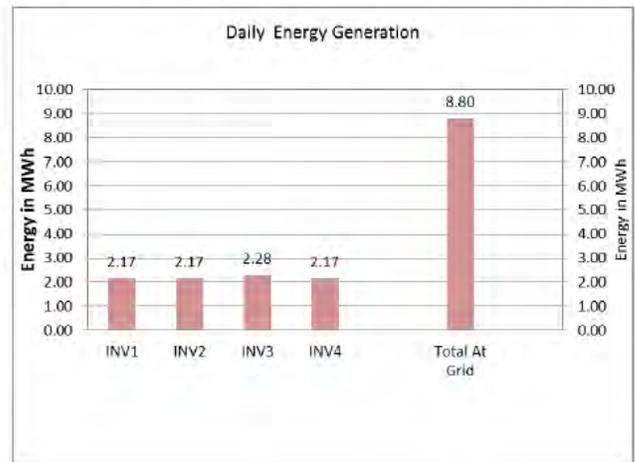
#### Daily Energy Generation Report - 2.14 MWp Solar Power Plant

Project Name	2.14 MWp Solar Power plant	Start Date and Time	End Date and Time
Location	Delhi International Airport	06/Apr/2014 00:00	06/Apr/2014 23:59

SL No	PV Module	Module Wp	Inverter	Number of inverters	Module configuration		No of Modules	Installed Power	Energy Produced FTD	Performance Ratio	Specific Yield	Tilt	Azimuth
					Series / String	Parallel / Inv							
					MWp	MWh		%	MWh/MWp	Deg	Deg		
1	Canadian Solar-CS6P	245	ABB-PVS-630	4	24	91	8736	2.14	8.80	#VALUE!	4.11	43	0

Weather data					
SL No	Description	Min	Max	Avg	Units
1	In-plane Radiation	0.00	981.99	508.58	W/m2
2	Amb Temp	19.80	38.35	19.80	Deg C
3	PV Module Temp	17.13	59.00	47.62	Deg C
4	Wind Speed	0.00	6.68	2.00	m/s
5	RH	14.34	80.65	33.31	%

Sl No	Description	Value	Units
1	Total Solar Radiation (in-plane) Measured	5.184	kWh/m2
2	Total Solar Radiation (in-plane) During Grid Down Time	#VALUE!	kWh/m2
3	Total Solar Radiation (in-plane) Measured Excl Rad During Grid Down Time	#VALUE!	kWh/m2
4	Max power generated in a day (4 inv together)	1.672	MW
5	Total Energy generated (4 Inv together) - at Inv output	8.788	MWh
6	Total Energy generated at the Feed-in Point (Energy meter)	8.800	MWh
7	Total Energy Imported at Feed-in Point (Energy Meter)	0.000	MWh
8	Total Energy generated at the Feed-in Point (Energy meter)	8.750	MVAh
9	Total Energy Imported at the Feed-in Point (Energy meter)	0.050	MVAh
10	Performance Ratio	#VALUE!	%
11	PLF (Plant Load Factor)	17.131	%
12	Total Energy Till date	712.890	MWh
13	Total Grid Down Time	0.00	Hrs:Min
14	Grid Down Time during Plant Operation	0.00	Hrs:Min
15	Inverter 1 Down Time	0.00	Hrs:Min
16	Inverter 2 Down Time	0.00	Hrs:Min
17	Inverter 3 Down Time	0.00	Hrs:Min
18	Inverter 4 Down Time	0.00	Hrs:Min
19	Auxiliary Consumption	0.131	MWh



### • Weekly Energy Generation Report

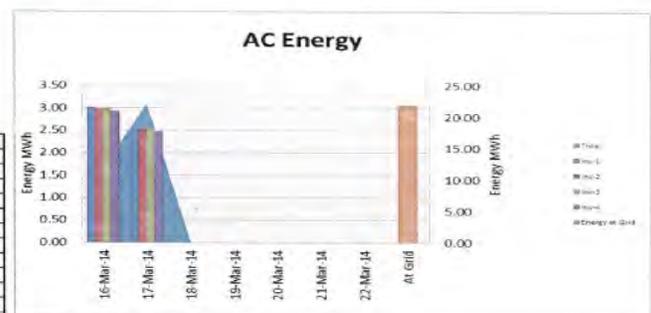
#### Weekly Energy Generation Report - 2.14 MWp Solar Power Plant

Project Name	2.14 MWp Solar Power plant	Start Date of the Week	16-Mar-14	End Date of the week	22-Mar-14
Location	Delhi International Airport				

SL No	PV Module	Module Wp	Inverter	Number of inverters	Module configuration		No of Modules	Installed Power	Energy Produced	Performance Ratio	Specific Yield	Tilt	Azimuth
					Series / String	Parallel / Inv							
					MWp	MWh		%	MWh/MWp	Deg	Deg		
1	Canadian Solar- CS6P	245	ABB-PVS-630	4	24	91	8736	2.14	21.90	#VALUE!	10.23	43	0

Weather data					
SL No	Description	Min	Max	Avg	Units
1	In-plane Radiation	0.00	1010.43	664.24	W/m2
2	Amb Temp	14.21	33.76	25.70	Deg C
3	PV Module Temp	11.94	59.25	45.07	Deg C
4	Wind Speed	0.00	5.86	2.85	m/s
5	RH	23.68	95.50	46.42	%

Sl No	Description	Value	Units
1	Total Solar Radiation (in-plane) Measured- for a Week	12.38	kWh/m2
2	Total Solar Radiation (in-plane) During Grid Down Time for a Week	#VALUE!	kWh/m2
3	Total Solar Radiation (in-plane) Excl Rad during Grid Down Time for a Week	#VALUE!	kWh/m2
4	Max power generated in a Week (4 inv together - Peak time)	1.71	MW
5	Total Energy generated (4 Inv together) - at Inv output	21.95	MWh
6	Total Energy generated at the Feed-in Point (Energy meter)	21.90	MWh
7	Total Energy Imported (Energy Meter)	0.00	MWh
8	Total Energy generated at the Feed-in Point (Energy meter)	21.90	MVAh
9	Total Energy Imported (Energy meter)	0.05	MVAh
10	Performance Ratio	#VALUE!	%
11	PLF (Plant Load Factor)	6.09	%
12	Total Energy Till date	518.41	MWh
13	Total Grid Down Time	0.00	Hrs:Min
14	Grid Down Time during Plant Operation	0.00	Hrs:Min
15	Inverter1 Down Time	0.00	Hrs:Min
16	Inverter2 Down Time	0.00	Hrs:Min
17	Inverter3 Down Time	0.00	Hrs:Min
18	Inverter4 Down Time	0.00	Hrs:Min
19	Auxiliary power consumption	0.20	MWh



• **Monthly Energy Generation Report**

Monthly Energy Generation Report - 2.14 MWp Solar Power Plant

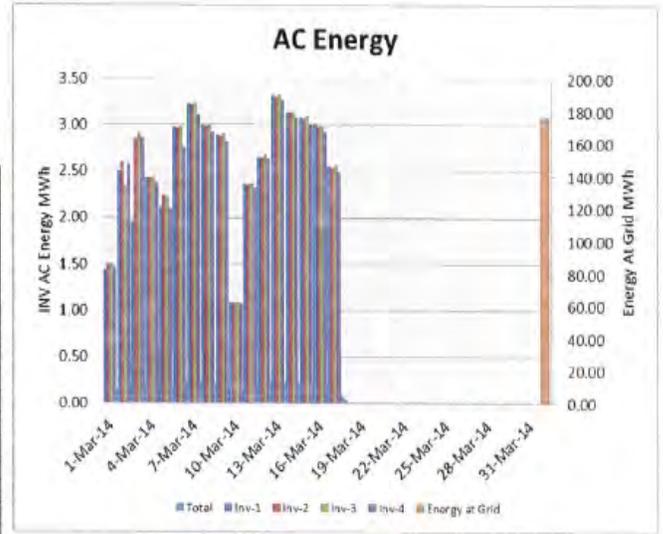
Project Name	2.14 MWp Solar Power plant
Location	Delhi International Airport

Month :	3	2014
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PV plant Brief Details													
SL No	PV Module	Module Wp	Inverter	Number of inverters	Module configuration		No of Modules	Installed Power	Energy Produced	Performance Ratio	Specific Yield	Tilt	Azimuth
					Series / String	Parallel / Inv							
1	Canadian Solar-CS6P	245	ABB-PVS-630	4	24	91	8736	2	176	#VALUE!	82	43	0

Weather data					
SL No	Description	Min	Max	Avg	Units
1	In-plane Radiation	0.00	1134.69	608.94	W /m2
2	Amb Temp	9.61	33.76	21.70	Deg C
3	PV Module Temp	7.03	59.25	37.89	Deg C
4	Wind Speed	0.00	14.95	3.21	m /s
5	RH	22.88	99.93	55.27	%

Sl No	Description	Value	Units
1	Total Solar Radiation (in-plane)Measured - for a Month	98.45	kWh /m2
2	Total Solar Radiation (in-Plane)Measured During Grid Down Time-For a Month	#VALUE!	kWh /m2
3	Total Solar Radiation(in-plane)Excl Rad During Grid Down Time-for a Month	#VALUE!	kWh /m2
4	Max power generated in a Month (4 inv together - Peak time)	2.05	MW
5	Total Energy generated (4 Inv together) - at Inv output	176.88	MWh
6	Total Energy generated at the Feed-in Point (Energy meter)	176.40	MWh
7	Total Energy Imported at Feed-in Point(Energy Meter)	0.70	MWh
8	Total Energy generated at the Feed-in Point (Energy meter)	176.25	MVAh
9	Total Energy Imported at Feed-in Point(Energy Meter)	0.85	MVAh
10	Performance Ratio	#VALUE!	%
11	PLF (Plant Load Factor)	11.45	%
12	Total Energy Till Date	518.47	MWh
13	Total Grid Down time	2.02	Hrs.Min
14	Grid Down Time During Plant Operation	1.58	Hrs.Min
15	Inverter 1 Down Time	3.28	Hrs.Min
16	Inverter 2 Down Time	1.55	Hrs.Min
17	Inverter 3 Down time	5.04	Hrs.Min
18	Inverter 4 Down Time	5.07	Hrs.Min
19	Auxiliary power consumption	2.36	MWh



**THANK YOU**