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Grid Integration Report
[Kulpala and Paddapukur] Bangladesh

Wakil Ahmed Arnob, Shisher Shrestha, Md. Abdullah Al Matin, Archisman Mitra

About IWMI: The International Water Management Institute (IWMI) is an international, research-for development organization that works with governments, civil society, and the private sector to solve water problems in developing countries and scale up solutions. Through the partnership, IWMI combines research on the sustainable use of water and land resources, knowledge services, and products with capacity strengthening, dialogue, and policy analysis to support the implementation of water management solutions for agriculture, ecosystems, climate change, and inclusive economic growth. Headquartered in Colombo, Sri Lanka, IWMI is a CGIAR Research Center with offices in 14 countries and a global network of scientists operating in more than 30 countries.

About CGIAR: CGIAR is a global research partnership for a food-secure future. CGIAR science is dedicated to transforming food, land and water systems in a climate crisis. Its research is carried out by 13 CGIAR Centres/Alliances in close collaboration with hundreds of partners, including national and regional research institutes, civil society organizations, academia, development organizations and the private sector. www.cgiar.org

About SoLAR: Solar Irrigation for Agricultural Resilience (SoLAR) in South Asia aims to sustainably manage the water-energy and climate interlinkages in South Asia through the promotion of solar irrigation pumps (SIPs). The project's main goal is to contribute to climate-resilient, gender-equitable, and socially inclusive agrarian livelihoods in Bangladesh, India, Nepal, and Pakistan by supporting government efforts to promote solar irrigation. This project responds to government commitments to transition to clean energy pathways in agriculture. All countries in this project have NDC commitments to reduce greenhouse gas (GHG) emissions, and SIPs can play a significant role in reducing emissions in agriculture.

About SDC: The Swiss Agency for Development and Cooperation (SDC) is the agency for international cooperation of the Federal Department of Foreign Affairs (FDFA). Swiss International Cooperation, an integral part of the Federal Council's foreign policy, aims to contribute to a world without poverty and in peace for sustainable development. SDC, through its Global Program Climate Change and Environment (GPCCE), helps find solutions to global challenges linked to climate change. It engages in global political dialogue and manages specific projects in the fields of energy, climate change adaptation, sustainable development of mountainous regions, and prevention of natural hazards that are likely to influence regional and international policy.

About IDCOL: Infrastructure Development Company Limited (IDCOL) was established on 14 May 1997 by the Government of Bangladesh. The Company was licensed by the Bangladesh Bank as a non-bank financial institution (NBFI) on 5 January 1998. Since its inception, IDCOL is playing a major role in bridging the financing gap for developing medium to large-scale infrastructure and renewable energy projects in Bangladesh. The company now stands as the market leader in private sector energy and infrastructure financing in Bangladesh.

Authors: Wakil Ahmed Arnob, Shisher Shrestha, Md. Abdullah Al Matin, Archisman Mitra

Wakil Ahmed Arnob: Management Trainee, Renewable Energy Projects, IDCOL

Shisher Shrestha: National Researcher - Renewable Energy Water and Climate Change Climate Change Adaptation, IWMI

Md. Abdullah Al Matin: Assistant Vice President (Technical), Renewable Energy Projects, IDCOL

Archisman Mitra: Regional Researcher· Economics and Impact Assessment, IWMI

Please send inquiries and comments to iwmi-solar@cgiar.org

A free copy of this publication can be downloaded at https://solar.iwmi.org/reports/

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WAVE FOUNDATION

WAVE Foundation

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1. Introduction

Solar-based irrigation systems are an innovative and an environment-friendly solution for the diesel-dependent agro-economy of Bangladesh. The deployment of Solar Irrigation Pumps (SIP) in agriculture has the potential to simultaneously address two of the Sustainable Development Goals (SDGs) – one of which is SDG-2 (zero hunger), and another is SDG-7 (affordable and clean energy). SIPs are seen as one of the most promising uses of renewable energy that simultaneously provide access to energy and contribute to food production. Presently, the country has 1.34 million diesel pumps and 0.27 million electric pumps for irrigation purposes[1]. The diesel-run pumps consume at least 1 million tons of diesel worth $900 million per year, and the electricity-run pumps consume about 150 megawatt of power [BPDB-2015-2016]. It is important to note that Bangladesh has good solar resources, with high availability during the peak irrigation season; therefore, solar pumping of water for irrigation is a potential solution for its largely agro-based economy. The Infrastructure Development Company Limited (IDCOL), a government-owned financial institution, is implementing the Off-grid Solar Irrigation Pumps (SIPs) Program for their Partner Organizations (POs) to off-grid areas to reduce dependency on diesel and to benefit the farmers and marginalized populations.

However, the demand for irrigation in Bangladesh is seasonal, and the primary use of solar irrigation pumps is between 4-5 months during the year, mostly for the Boro crop that is grown between Jan-May. For the rest of the year, SIPs remain mostly unutilized. Since these SIPs tend to remain under-utilized over a significant portion of the year, which could be as high as 210 days in a year, most of the electricity generated from solar panels is getting wasted. If arrangements are made to supply electricity from these systems into the national grid during the off-season, paths to exploit the untapped potential will open up. Simultaneously, the Government envisions providing access to clean, affordable, and grid-quality electricity to all its citizens, as manifested by its efforts to expand the national grid. Thus, it is very likely that both the technical and financial challenges of integrating a huge number of off-grid SIP systems to the national grid will need to be tackled in the near future. The Sustainable and Renewable Energy Development Authority (SREDA) of Bangladesh has already piloted a successful Solar Grid Integration System in *Kushtia* district and has prepared a draft guideline for grid integration of SIPs. The guideline envisages the power distribution company to buy excess electricity from solar irrigation systems[2]. As a result, solar irrigation systems are going to become more popular, and additional revenue from grid integration of SIPs will make SIPs financially sustainable and work to support smaller farmers and marginalized communities, including women and youth.

[1]https://www.worldbank.org/en/results/2015/09/08/solar-powered-pumps-reduce-irrigation-costs-bangladesh

[2]https://www.bangladeshpost.net/posts/first-grid-integration-of-solar-irrigation-pump-successful-17684

2. Background on Grid Integration Pilot

2.1 Grid Integration of Solar Irrigation Pump [Model]

Under IDCOL, the WAVE Foundation is implementing three individual Solar Irrigation Grid Integration systems on an individual system basis. Technical solutions are there for integrating solar-powered irrigation pumps into the national grid during the off-season where the SIP already exists. For grid integration of individual SIPs, a DC circuit breaker, an interlocking switch, an inverter, and a unidirectional meter are required. During off irrigation season, when the SIP is not operational, the PV array will only export electricity to the grid via the inverter. The component specifications of the SIP systems shall comply with the standards to be set by Sustainable and Renewable Energy Development Authority (SREDA) and the local body *Palli Bidyut Somitis* (PBS) under the Bangladesh Rural Electrification Board (BREB). It will be the net amount of exported electricity at the end of settlement period as per this guideline.

Although the plan is to do grid integration of three SIPs under WAVE, both the sponsor and the local *Palli Bidyut Somitis* wanted to start the grid integration pilot with two sites and connect the third site after some experience with the first two sites. Accordingly, this report gives the details of the two SIPs of WAVE that has been grid integrated in the initial step in 2022.

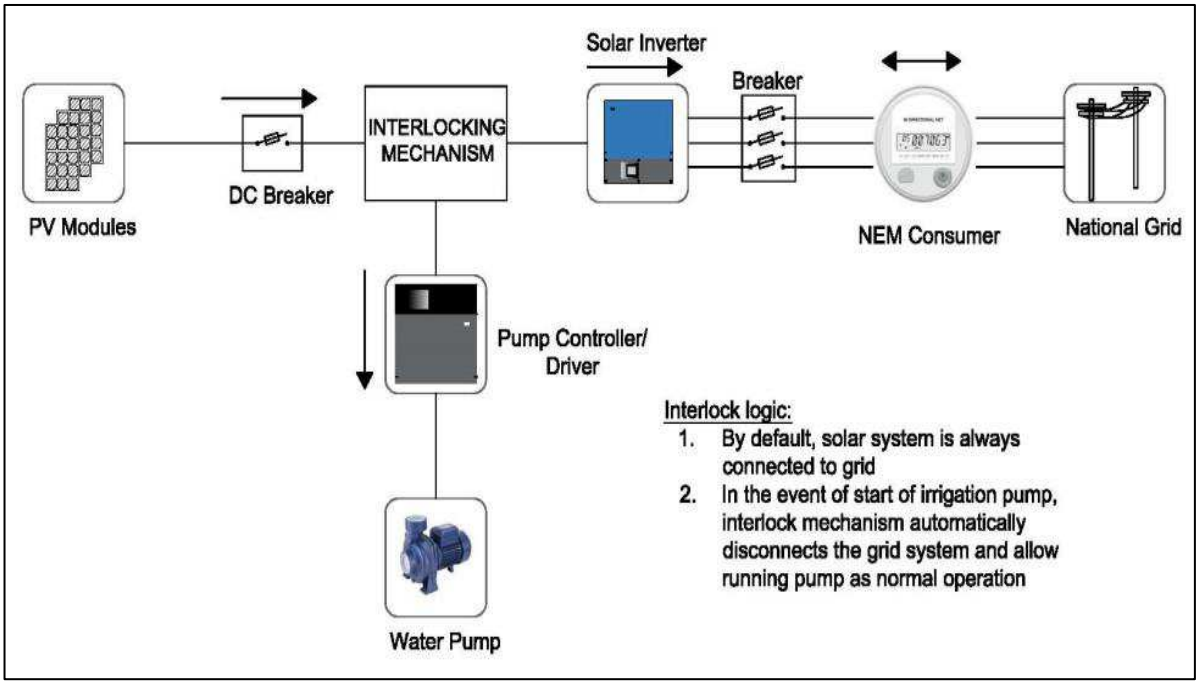


Figure 3.3: Schematic diagram of grid integration of individual SIP (Three Phase)
Source: SIP Draft Guideline by Sustainable Renewable Energy Development Authority (SREDA)

2.2 Site selection

The **process and the rationale** for the selection of **pilot locations** and as per the SREDA SIP Grid Integration Policy, is that excess power can only be exported from the SIP to the grid, so sites have been selected where the pumps are near the grid line and comparatively have less irrigation coverage.

2.3 Site Details

WAVE has done the grid integration at two sites namely Kulpala (Site 1), and Paddapukur (Site 2) in an individual system mode. Another site of WAVE will be grid-integrated in 2023 based on the experience with these two sites.

Site 1: Kulpala Solar Irrigation Pump, Alamdanga, Chuadanga

SITE NAME	Kulpala Solar Irrigation Pump
SIP ID	3.25
LOCATION	Alamdanga, Chuadanga
PROJECT COST	60,64,707 BDT
SUPPORTED BY	IDCOL
FINANCED BY	IDCOL
EPC CONTRACTOR	Sherpa Power Engineering
COMMISSIONING DATE	March 2021
TECHNICAL DETAILS	
FLOW RATE	24,00,000 Lit/Day
BORING DEPTH	200 ft
Solar PV SIZE (kWp)	43.68 KWp
Individual Panel Size (Wp)	390 Wp
Number of Panels	112
Pump Size (kW)	18.5 KW
Controller Size (kW)	22 KW
GPS COORDINATES	23.7031850, 88.7833400

Site 2: Paddapukur Solar Irrigation Pump, Moheshpur, Jhenaidah

SITE NAME	Paddapukur Solar Irrigation Pump
SIP ID	2.27
LOCATION	Moheshpur, Jhenaidah
PROJECT COST	6350760 BDT
SUPPORTED BY	IDCOL
FINANCED BY	IDCOL
EPC CONTRACTOR	Sherpa Power Engineering
COMMISSIONING DATE	September 2019
TECHNICAL DETAILS	
FLOW RATE	2200000 Lit/day
BORING DEPTH	200 ft
Solar PV SIZE (kWp)	43.520 KWp
Individual Panel Size (Wp)	320 Wp
Number of Panels	136

Pump Size (kW)	18.5KW
Controller Size (kW)	22 KW
GPS COORDINATES	23.328471, 88.779980

3. Detailed Commissioning Report

Figure 1: WAVE Grid integration sites

3.1 System summary of grid-connection infrastructure

Site 1: Kulpala, Alamdanga, Chuadanga

TRANSFORMER	
Size (kVA)	15 KVA x 3 Nos
Type	Step Up
INVERTER	
Size (kW)	33 KW
Number of Inverters	1
Manufacturer	Sungrow
Model	Sungrow SG 33CX
Serial Number	A2170302981
SOLAR ARRAY	
TOTAL PV SIZE (kWp)	43.68 KWp
SOLAR ARRAY SIZE (kWp)	620 Wp

NUMBER OF ARRAY	7
INDUVIDUAL PANEL SIZE (Wp)	390
NUMBER OF PANELS	112
LT LINE	
Number of Poles	1
Length of Cable (m)	390 ft
Cable Size (mm)	45 RM/Sq. mm Covered
Type of Cable	Covered
HT LINE	
Number of Poles	3
Length of Cable (m)	300 m
Cable Size (mm)	96 RM / Sq. mm BARE
Type of Cable	Bare

Site 2: Paddapukur, Moheshpur, Jhenaidah

TRANSFORMER	
Size (kVA)	15 KVA x 3 Nos
Type	Step Up
INVERTER	
Size (kW)	33 KW
Number of Inverters	1
Manufacturer	Sungrow
Model	Sungrow SG 33CX
Serial Number	A2170302774
SOLAR ARRAY	
TOTAL PV SIZE (kWp)	43.58KWp
SOLAR ARRAY SIZE (kWp)	5440Wp
NUMBER OF ARRAY	8
INDUVIDUAL PANEL SIZE (Wp)	320
NUMBER OF PANELS	136
LT LINE	
Number of Poles	1
Length of Cable (m)	315ft
Cable Size (mm)	45 RM/Sq. mm Covered
Type of Cable	Covered
HT LINE	
Number of Poles	3
Length of Cable (m)	300 m
Cable Size (mm)	96 RM / Sq. mm BARE
Type of Cable	Bare

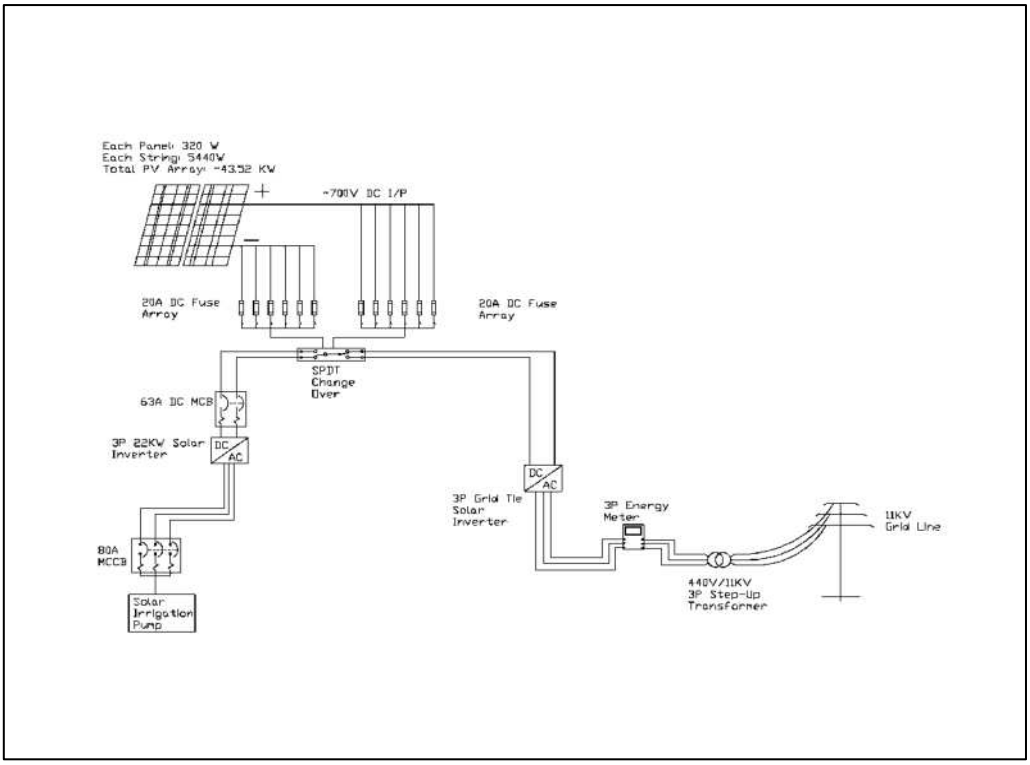


Figure 2: Schematic Electrical Diagram of the System

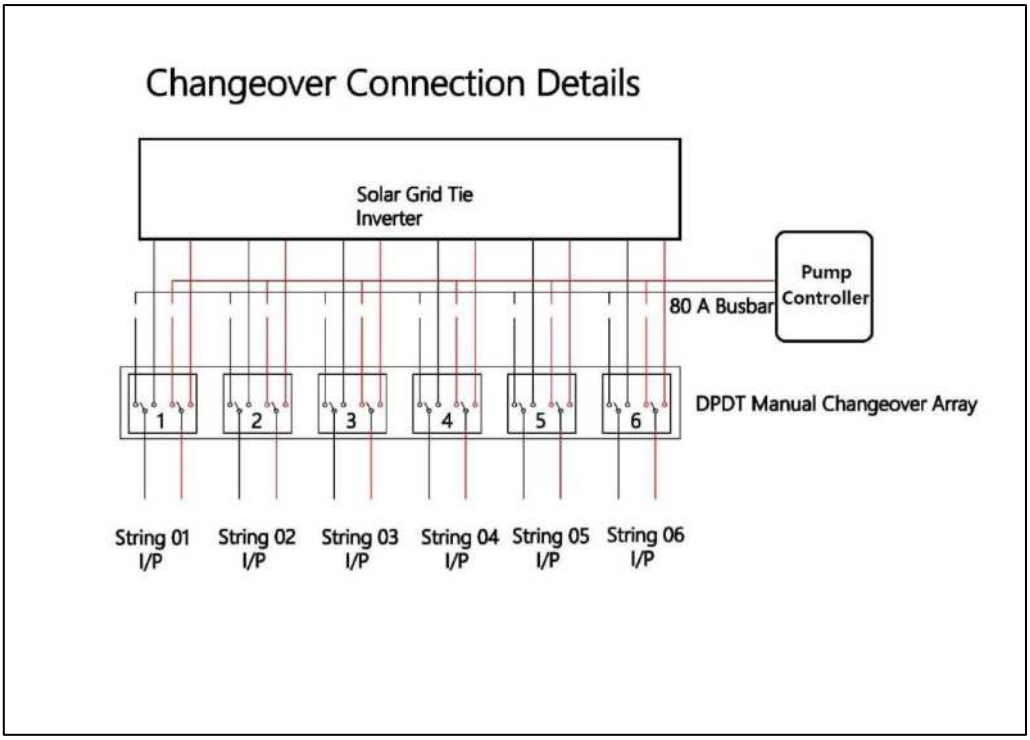


Figure 3: Changeover Diagram

Figure 4: Inverter Specifications

Type designation	SG33CX	SG40CX	SG50CX
Input (DC)			
Max. PV input voltage		1100 V	
Min. PV input voltage / Start-up input voltage		200 V / 250 V	
Nominal PV input voltage		585 V	
MPP voltage range		200 – 1000 V	
MPP voltage range for nominal power		550 – 850V	
No. of independent MPP inputs	3	4	5
Max. number of PV strings per MPPT		2	
Max. PV input current	78 A	104 A	130 A
Max. current for input connector		30 A	
Max. DC short-circuit current	120 A	160 A	200 A
Output (AC)			
AC output power	36.3 kVA @ 40 ℃ / 33 kVA @ 45 ℃	44 kVA @ 40 ℃ / 40 kVA @ 45 ℃	55 kVA @ 40 ℃ / 50 kVA @ 45 ℃
Max. AC output current	55.2 A	66.9 A	83.6A
Nominal AC voltage		3 / N / PE, 230 / 400 V	
AC voltage range		312 – 528 V	
Nominal grid frequency / Grid frequency range		50 Hz / 45 – 55 Hz, 60 Hz / 55 – 65 Hz	
THD		< 3 % (at nominal power)	
DC current injection		< 0.5 % In	
Power factor at nominal power / Adjustable power factor		> 0.99 / 0.8 leading – 0.8 lagging	
Feed-in phases / connection phases		3 / 3	
Efficiency			
Max. efficiency / European efficiency	98.6 % / 98.3 %	98.6% / 98.3%	98.7% / 98.4%
Protection			
DC reverse connection protection		Yes	
AC short circuit protection		Yes	
Leakage current protection		Yes	
Grid monitoring		Yes	
DC switch / AC switch		Yes / No	
PV String current monitoring		Yes	
Q at night		Yes	
PID recovery function		optional	
Overvoltage protection		DC Type II / AC Type II	
General Data			
Dimensions (W*H*D)	702*595*310mm	782*645*310mm	782*645*310mm
Weight	50 kg	58 kg	62 kg
Isolation method		Transformerless	
Degree of protection		IP66	
Night power consumption		≤2 W	
Operating ambient temperature range		-30 to 60 ℃ (> 45 ℃ derating)	
Allowable relative humidity range (non-condensing)		0 – 100 %	
Cooling method		Smart forced air cooling	
Max. operating altitude		4000 m (> 3000 m derating)	
Display		LED, Bluetooth+APP	
Communication		RS485 / Optional: Wi-Fi, Ethernet	
DC connection type		MC4 (Max. 6 mm²)	
AC connection type		OT or DT terminal (Max.70 mm²)	
Compliance		IEC 62109, IEC 61727, IEC 62116, IEC 60068, IEC 61683, VDE-AR-N 4105:2018, VDE-AR-N 4110:2018, IEC 61000-6-3, EN 50438, AS/NZS 4777.2:2015, CEI 0-21, VDE 0126-1-1/A1 VFR 2014, UTE C15-712-1:2013, DEWA	
Grid Support		Q at night function, LVRT, HVRT,active & reactive power control and power ramp rate control	

5BB 5 busbar solar cell design

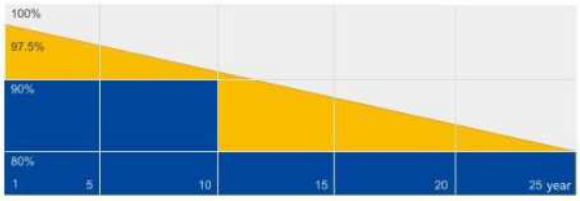
Low cost

PID Anti-PID

Highly reliable due to strict quality control

Superior Warranty

- 12-year product warranty
- 25-year linear power output warranty



Comprehensive Certificates

- IEC 61215, IEC 61730, UL 1703, IEC TS 62804, IEC 61701, IEC 62716, IEC 60068-2-68
- ISO 9001: 2015 Quality management systems
- ISO 14001: 2015 Environmental management systems
- OHSAS 18001: 2007 Occupational health and safety management systems
- IEC TS 62941: 2016 Terrestrial photovoltaic (PV) modules – Guidelines for increased confidence in PV module design qualification and type approval

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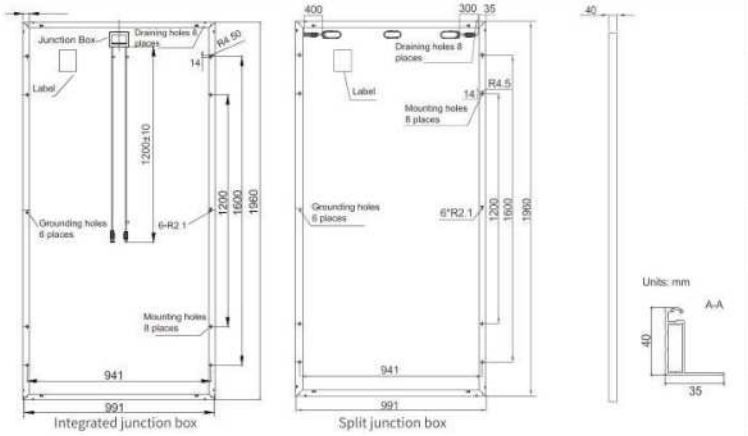
Specificantions subject to technical changes and tests.
JA Solar reserves the right of final interpretation.

JA SOLAR

JAP72S01 315-335/SC Series

MECHANICAL DIAGRAMS



Remark: customized frame color and cable length available upon request

SPECIFICATIONS

Cell	Poly
Weight	22kg±3%
Dimensions	1960mm×991mm×40mm
Cable Cross Section Size	4mm²
No. of cells	72(6x12)
Junction Box	IP67, 3 diodes
Connector	MC4 Compatible(1000V) QC 4.10-35(1500V)
Packaging Configuration	27 Per Pallet

ELECTRICAL PARAMETERS AT STC

TYPE	JAP72S01 -315/SC	JAP72S01 -320/SC	JAP72S01 -325/SC	JAP72S01 -330/SC	JAP72S01 -335/SC
Rated Maximum Power(Pmax) [W]	315	320	325	330	335
Open Circuit Voltage(Voc) [V]	45.85	46.12	46.38	46.40	46.70
Maximum Power Voltage(Vmp) [V]	37.09	37.28	37.39	37.65	37.83
Short Circuit Current(Isc) [A]	9.01	9.09	9.17	9.28	9.35
Maximum Power Current(Imp) [A]	8.49	8.58	8.69	8.77	8.87
Module Efficiency [%]	16.2	16.5	16.7	17.0	17.2
Power Tolerance	0~+5W				
Temperature Coefficient of Isc(α_Isc)	+0.058%/℃				
Temperature Coefficient of Voc(β_Voc)	-0.330%/℃				
Temperature Coefficient of Pmax(γ_Pmp)	-0.400%/℃				
STC	Irradiance 1000W/m², cell temperature 25°C, AM1.5G				

Remark: Electrical data in this catalog do not refer to a single module and they are not part of the offer.They only serve for comparison among different module types.

ELECTRICAL PARAMETERS AT NOCT

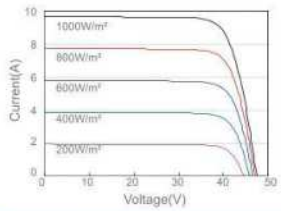
TYPE	JAP72S01 -315/SC	JAP72S01 -320/SC	JAP72S01 -325/SC	JAP72S01 -330/SC	JAP72S01 -335/SC
Rated Max Power(Pmax) [W]	233	237	241	244	248
Open Circuit Voltage(Voc) [V]	42.84	43.04	43.24	43.41	43.63
Max Power Voltage(Vmp) [V]	34.45	34.64	34.82	35.03	35.21
Short Circuit Current(Isc) [A]	7.23	7.29	7.35	7.40	7.46
Max Power Current(Imp) [A]	6.77	6.84	6.91	6.97	7.04
NOCT	Irradiance 800W/m², ambient temperature 20°C, wind speed 1m/s, AM1.5G				

OPERATING CONDITIONS

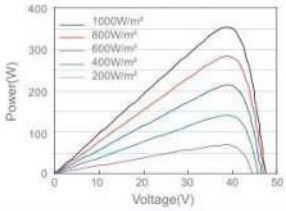
Maximum System Voltage	1000V/1500V DC(IEC)
Operating Temperature	-40°C~+85°C
Maximum Series Fuse	20A
Maximum Static Load,Front	5400Pa
Maximum Static Load,Back	2400Pa
NOCT	45±2°C
Application Class	Class A

CHARACTERISTICS

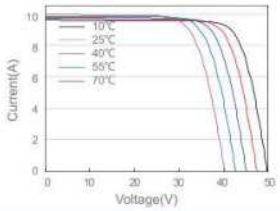
Current-Voltage Curve JAP72S01-325/SC



Power-Voltage Curve JAP72S01-325/SC



Current-Voltage Curve JAP72S01-325/SC

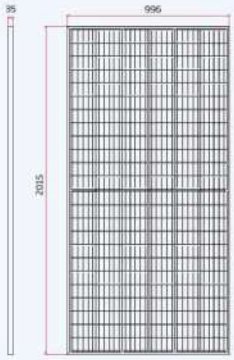


Premium Cells, Premium Modules

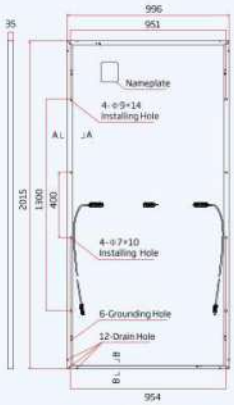
Version No. : Global_EN_20180513A

Figure 5: Panel Specifications

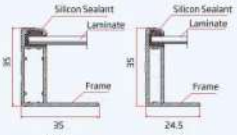
DIMENSIONS OF PV MODULE(mm)



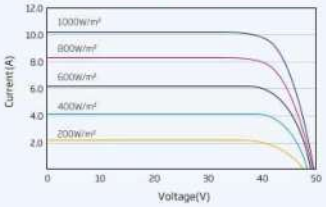
Front View



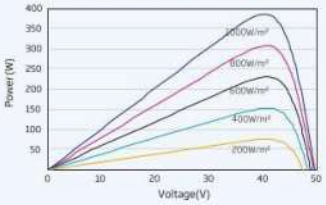
Back View



I-V CURVES OF PV MODULE(390W)



P-V CURVES OF PV MODULE(390W)



ELECTRICAL DATA (STC)

Peak Power Watts-P_{MAX} (Wp)*	385	390	395	400	405	410	415
Power Tolerance-P_{MAX} (W)	0 ~ +5						
Maximum Power Voltage-V_{MPP} (V)	40.1	40.5	40.8	41.1	41.4	41.7	42.0
Maximum Power Current-I_{MPP} (A)	9.61	9.64	9.69	9.74	9.79	9.84	9.89
Open Circuit Voltage-V_{OC} (V)	48.5	49.7	50.1	50.4	50.8	51.2	51.5
Short Circuit Current-I_{SC} (A)	10.03	10.08	10.13	10.18	10.23	10.29	10.34
Module Efficiency η_m (%)	19.2	19.4	19.7	19.9	20.2	20.4	20.7

STC: Irradiance 1000W/m², Cell Temperature 25°C, Air Mass AM1.5.
*Measurement tolerance: ±3%.

ELECTRICAL DATA (NMOT)

Maximum Power-P_{MAX} (Wp)	291	296	299	303	307	311	314
Maximum Power Voltage-V_{MPP} (V)	37.9	38.6	38.9	39.1	39.4	39.7	39.9
Maximum Power Current-I_{MPP} (A)	7.68	7.66	7.70	7.74	7.78	7.82	7.87
Open Circuit Voltage-V_{OC} (V)	45.8	46.9	47.3	47.6	47.9	48.3	48.6
Short Circuit Current-I_{SC} (A)	8.08	8.12	8.16	8.20	8.24	8.29	8.33

NMOT: Irradiance at 800W/m², Ambient Temperature 20°C, Wind Speed 1m/s.

MECHANICAL DATA

Solar Cells	Monocrystalline
Cell Orientation	144 cells (6 × 24)
Module Dimensions	2015 × 996 × 35 mm (79.33× 39.21× 1.38 inches)
Weight	22.0 kg (48.5 lb)
Glass	3.2 mm (0.13 inches), High Transmission, AR Coated Heat Strengthened Glass
Encapsulant Material	EVA
Backsheet	White
Frame	35 mm (1.38 inches) Anodized Aluminium Alloy
J-Box	IP 68 rated
Cables	Photovoltaic Technology Cable 4.0mm² (0.006 inches²), Portrait: N 280mm/P 280mm(11.02/11.02inches) Landscape: N 1400 mm /P 1400 mm (55.12/55.12 inches)
Connector	TS4

TEMPERATURE RATINGS

NMOT(Nominal Module Operating Temperature)	41°C (±3°C)
Temperature Coefficient of P_{MAX}	- 0.36%/°C
Temperature Coefficient of V_{OC}	- 0.26%/°C
Temperature Coefficient of I_{SC}	0.04%/°C

MAXIMUM RATINGS

Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (IEC)
	1500V DC (UL)
Max Series Fuse Rating	20A

(Do not connect Fuse in Combiner Box with two or more strings in parallel connection)

WARRANTY

12 year Product Workmanship Warranty
25 year Power Warranty

(Please refer to product warranty for details)

PACKAGING CONFIGURATION

Modules per box: 30 pieces
Modules per 40' container: 660 pieces

Trinasolar

CAUTION: READ SAFETY AND INSTALLATION INSTRUCTIONS BEFORE USING THE PRODUCT.

Version number: TSM_EN_2020_APAC_B

www.trinasolar.com

3.2. Array details

Site 1: Kulpala, Alamdanga, Chuadanga

Number of Arrays/Strings	7		
String 1			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6RM		Material: Copper
Wire length to combiner box (m)	10 m		
String 2			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size(mm2)	6 RM		Material: Copper
Wire length to combiner box (m)	10 m		
String 3			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6 RM		Material: Copper
Wire length to combiner box (m)	15 m		
String 4			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6 RM		Material: Copper
Wire length to combiner box (m)	15 m		
String 5			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*

String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6 RM		Material: Copper
Wire length to combiner box (m)	19 m		
String 6			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6 RM		Material: Copper
Wire length to combiner box (m)	19 m		
String 7			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size(mm^2)	6 RM		Material: Copper
Wire length to combiner box (m)	24 m		

Site 2: Paddapukur, Moheshpur, Jhenaidah

Number of Arrays/Strings	6		
String 1			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6RM		Material: Copper
Wire length to combiner box (m)	10 m		
String 2			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size (mm^2)	6 RM		Material: Copper
Wire length to combiner box (m)	10 m		
String 3			
Parameter	Designed Value	Field Value	Remark

No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size(mm2)	6 RM		Material: Copper
Wire length to combiner box (m)	15 m		
String 4			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size(mm2)	6 RM		Material: Copper
Wire length to combiner box(m)	15 m		
String 5			
Parameter	Designed Value	Field Value	Remark
No of panels in series	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size(mm2)	6 RM		Material: Copper
Wire length to combiner box (m)	19 m		
String 6			
Parameter	Designed Value	Field Value	Remark
No of panels inseries	16		
No of panels in parallel	7		
String Voc	806.4	787	*Using multi-meter*
String Vmp	653	645	*During operation*
String Imp	9.69	7.3	*During operation*
Wire size(mm2)	6 RM		Material: Copper
Wire length to combiner box(m)	19 m		

3.3 On-grid Inverter details

Site Name: Kulpala, Alamdanga, Chuadanga

Item	Remarks
Inverter Manufacturer	Sungrow Power Company Ltd
Number of Inverter	1
Model	Sungrow SG 33CX
SN of Inverter 1	A2170302981
Wire Size	25 RM

Wire length	30 ft (DB box to Inverter to AC breaker)			
Wire Material	Copper			
COMMISSIONING DATA				
Inverter 1	**V_{OC}**		**V_{MP}**	
	Designed	**Measured**	**Designed**	**Measured**
Input A	806.4	787	787	645
Input B	806.4	787	787	634
Input C	806.4	787	787	642
Input D	806.4	787	787	589
Input E	806.4	787	787	678
Input F	806.4	787	787	672

Site Name: Paddapukur, Moheshpur, Jhenaidah

Item	Remarks			
Inverter Manufacturer	Sungrow Power Company Ltd			
Number of Inverter	1			
Model	Sungrow SG 33CX			
SN of Inverter 1	A2170302774			
Wire Size	25 RM			
Wire length	30 ft (DB box to Inverter to AC breaker)			
Wire Material	Copper			
COMMISSIONING DATA				
Inverter 2	**V_{OC}**		**V_{MP}**	
	Designed	**Measured**	**Designed**	**Measured**
Input A	806.4	787	787	679
Input B	806.4	787	787	668
Input C	806.4	787	787	642
Input D	806.4	787	787	599
Input E	806.4	787	787	673
Input F	806.4	787	787	677

3.4 Protection Device details (Same for both sites)

Lightning Arrestor	
Item	**Value**
Lightning arrestor type	Copper Conventional Type Lightning Arrester
No. of LA	1
LA height (>1.5meters)	3.5 m
LA1 Earthing wire length(m)	10 m
Wire size (mm^2)	6 No copper wire
LA2 Earthing wire length (m)	20 m
Wire size (mm^2)	6 number copper wire
Earthing Rod	

Length (m)	3.3 m
Diameter (mm)	6.35
Type	Copper
Depth(m)	18.5
Chemical Earthing (Yes / No)	Yes
Earthing resistance	0.49
Wire length for inverter Body Grounding (m)	3 m
Wire size (mm^2)	6 No copper wire
Material	Copper
Wire length for structure Body Grounding (m)	27 m
Wire size (mm^2)	16 RM
Material	Copper
Surge Protection Device (AC)	
Type/Class:	Built in Inverter
No.of SPDs	
Rating(kA)	
SPD to Grounding:	
Surge Protection Device (DC)	
Type/Class	DC/PV SPD (PV 40/1000-V-CD)
No. of SPDs	3
Rating (kA)	Imax 40KA
SPD to Grounding:	Yes

4. Implementation of the Grid Connection Pilot

The step-by-step process regarding the implementation of grid integration is given below -

Inception Meeting with Concerned Stakeholders: At the beginning of the project, an inception meeting was arranged with the concerned stakeholders, like IDCOL, BREB, SREDA, and local PBS to share the objectives, methodology, and work plan of the project.

Sharing Meeting with the Local Stakeholder: The second step was to share the objectives and ideas about project implementation and highlight the importance of their role in project implementation, with the local administration, agriculture office, *Polli Bidyut Somiti* (PBS) zonal and local office.

Focus Group Discussion: Conducting a focus group discussion of primary selected sites with farmers and local people. In this step, the operating hours and demand for irrigation from the farmers' side was also considered and noted.

Site Assessment and Selection: Conducting a site assessment or site selection is an important step for designing and installation of a system. During the site assessment, all necessary information to optimize system design was collected, to plan for a time-efficient and safe installation.

Design Finalization of the Innovation: The selected design of the project was finalized by sharing it with the concerned local stakeholders and IDCOL, SREDA, and PBS Authority. GAZI and the technical team of the innovation led the activities.

Procurement, Construction, Installation, and Monitoring: After getting funds from IDCOL, based on the modification, a new refined design of innovation was constructed. During construction, close monitoring was done so that the quality of the construction work was assured. Experts from GAZI and the local electricity authority used to visit the construction site and provide feedback and suggestions. Total procurement was conducted by the Organizational Procurement Committee (OPC) as per the procurement policies. The transmission line of 11 KV was constructed by the contractor of local PBS.

Commissioning of the Innovation: The process of testing the SIP grid integration system to confirm that it is producing electricity and interacting directly with the electricity grid is known as system commissioning. So, this commission activity is performed after the installation of the system within a certain time period.

Operation, Training, and Maintenance: After the construction of the SIP Grid Integration System, orientation training was arranged for the project staff and the caretaker of the pump for proper operation and maintenance of the system.

Monitoring & Data Collection: From the start of the operation of the pilot, various data collection and monitoring is being done to test its effectiveness. Both qualitative and quantitative data will be collected to measure the SIP Grid Integration System.

Final Report Preparation and Submission: A final report will be prepared and submitted based on all the work, data, activities, and conditions of the project, and information related to the innovation.

4.1 Technical details

Site 1

TRANSFORMER	
Size (kVA)	15KVA (3Nos)
Type	Single Phase 440 VAC to 11 KV
INVERTER	
Size (kW)	33 KW
Number of Inverters	1
Manufacturer and Model	Sungrow SG 33CX
LT LINE	
Number of Poles	1
Length of Cable (m)	390 ft
Cable Size (mm)	45 RM
Type of Cable	Covered
HT LINE	
Number of Poles	3

Length of Cable (m)	300 m
Cable Size (mm)	96 RM
Type of Cable	Bare

Site 2

TRANSFORMER	
Size (kVA)	15KVA (3 Nos)
Type	Single Phase 440 VAC to 11 KV
INVERTER	
Size (kW)	33 KW
Number of Inverters	1
Manufacturer and Model	Sungrow SG 33CX
LT LINE	
Number of Poles	1
Length of Cable (m)	315 ft
Cable Size (mm)	45 RM
Type of Cable	Covered
HT LINE	
Number of Poles	3
Length of Cable (m)	300 m
Cable Size (mm)	96 RM
Type of Cable	Bare

4.2 Financial details for both sites

Total Cost of Grid Integration	26,40,940
Grant	13,20,470
Sponsor Contribution	13,20,470
IDCOL Loan	0

Detail cost with BoQ for both sites

SL	Product Description	Unit	Qty	Unit Cost (BDT)	Total
1	Grid Tied MPPT Inverter, Capacity: 33-36 kW (including Remote Monitoring)	set	2	347000	694000
2	Step-up Transformer 15kVA Single phase	set	6	72810	436860
3	Combiner Box with surge protective devices	set	2	22850	45700
4	Main Distribution Box (MDB) MDB with SPD as per Technical Specifications.	set	2	92500	185000
5	Transmission line with PBS charges (2sites)	Job	1	503165	503165
6	Total Cable and Accessories	coil	1	237500	237500

10	HT Cable for Transformer to Grid(25m), 11kV HT cable	coil	0.25	251516	62879
11	Dropout Fuse Set	Set	2	35000	70000
12	Lightning Arrester (Polymer)	Set	2	12690	25380
13	Earthing, 1 x 120ft	Set	2	21300	42600
14	Transformer and MDB Box Security System	Set	2	65368	130736
15	Bidirectional Meter and its socket	Set	2	57800	115600
16	Transport, Installation and Commissioning	job	2	45760	91520
Total (Including VAT & TAX)					**2640940**

5. Monitoring and O&M

Ground water level, maximum power, energy generation, coverage, etc, are being monitored at the monthly frequency. Inspectors of IDCOL visit SIP sites on a routine basis, and if they find any technical problem, they inform the PO (Partner Organization) and the supplier. If the technical problem is identified by any supervisor of PO, they inform the supplier and IDCOL. In both cases, the monitoring team (HO) and the inspector dedicated to that site will track the issue until it is solved.

6. Conclusion

Potential Challenges:

- Local *Palli Bidyut Samitis* are not well acquainted with the Solar Irrigation Grid Integration Policy.
- There are several hidden and additional charges that hamper the total approval, installation, and operation of grid integrated systems.
- 100% solar power sharing in the grid from SIP is not possible due to following a policy of net metering system by the PBS.

The installation of the system and the continuous operation over the last few months show that the integration of the additional power to the grid is profitable. However, since the entire electricity generated is not integrated into the grid, the electricity tariff is low, and there is delay in getting revenue; more time is needed to determine its exact payback period for grid integration.

IWMI INDIA
IWMI India office, 2nd Floor, CG Block C, NASC Complex, DPS Marg,
Pusa, Opp Todapur, New Delhi 110 012, India
Email: iwmi-delhi@cgiar.org

IWMI
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International Water
Management Institute (IWMI)

Headquarters
127 Sunil Mawatha,Pelawatta,
Battaramulla, Sri Lanka

Mailing address:
P. O. Box 2075, Colombo, Sri Lanka
Tel: +94 11 2880000
Fax: +94 11 2786854
Email: iwmi@cgiar.org
www.iwmi.org