DHASH PV TECHNOLOGIES LTD

Dhash®

Innovating tomorrow

Advancing solar performance starts with getting the Right PV Junction box

INDIA'S LARGEST INTEGRATED PV JUNCTION BOX MANUFACTURER

63GW
MANUFACTURING

DHASH GROUP OF COMPANIES

INTEGRATED INNOVATION
ACROSS SOLAR PV, AUTOMATION &
POLYMER TECHNOLOGY

The DhaSh **GIGA** Factory

Sira, Tumkur, Karnataka

[Commercial Production By: Oct -2025]

Spread Across

80,000 Sq Mt

63 GW Junction Box Manufacturing Capacity

25 GW PV Ribbon & PV Busbar Manufacturing

1000 Km/Day Cable Manufacturing Using e-beam Technology

MADE IN INDIA

INDIA'S LARGEST INTEGRATED PV COMPONENT MANUFACTURER

Summary

- PV Junction box & Its role
- PV Junction box – Key Raw Materials for Reliability
- What happen when junction box fails
- Junction box failure images
- Common Junction box failure – Where it starts
- Common Junction box failure – What fails inside the box
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- Thermal Runaway
- Crossmating in PV Connectors
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- Lab Testing Capacity
- Benchmarking analysis for DhaSh Trio & Connector
- Technical Developments

PV Junction Box & It's Role

- A **PV junction box** is a **sealed black enclosure** mounted on the **rear side of a solar module** that safely collects DC power from the solar cells and transfers it to next module via pv cables.

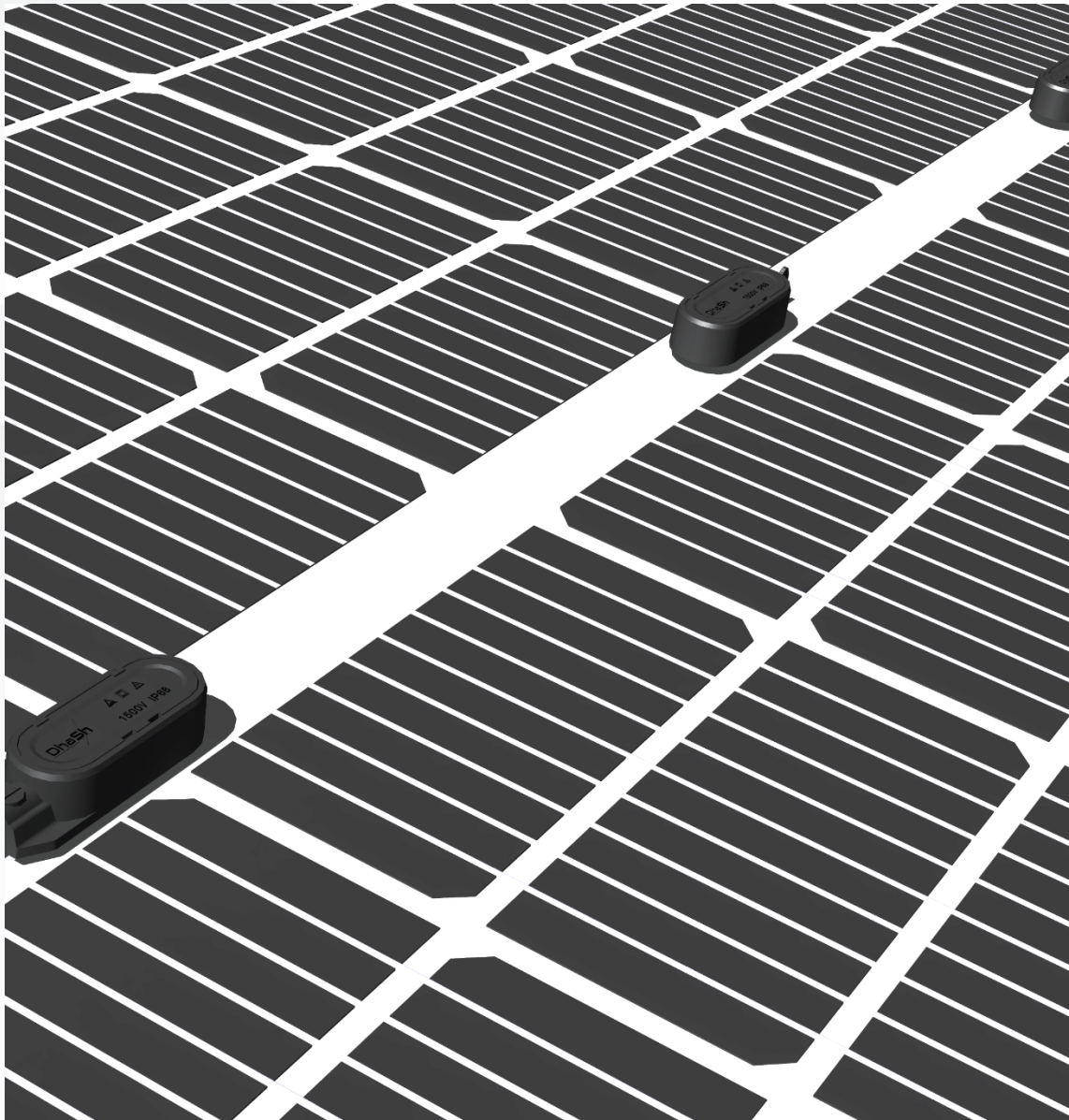
- **Its role**

⚡ Acts as the **electrical interface** between the module and the PV system.

🔥 Houses **bypass diodes** to protect cells during shading and other current mismatch situations

🛡️ Provides **environmental, thermal, and electrical protection. One of the important barriers against water & moisture ingress.**

✅ Ensures **safe and reliable operation** over the module lifetime



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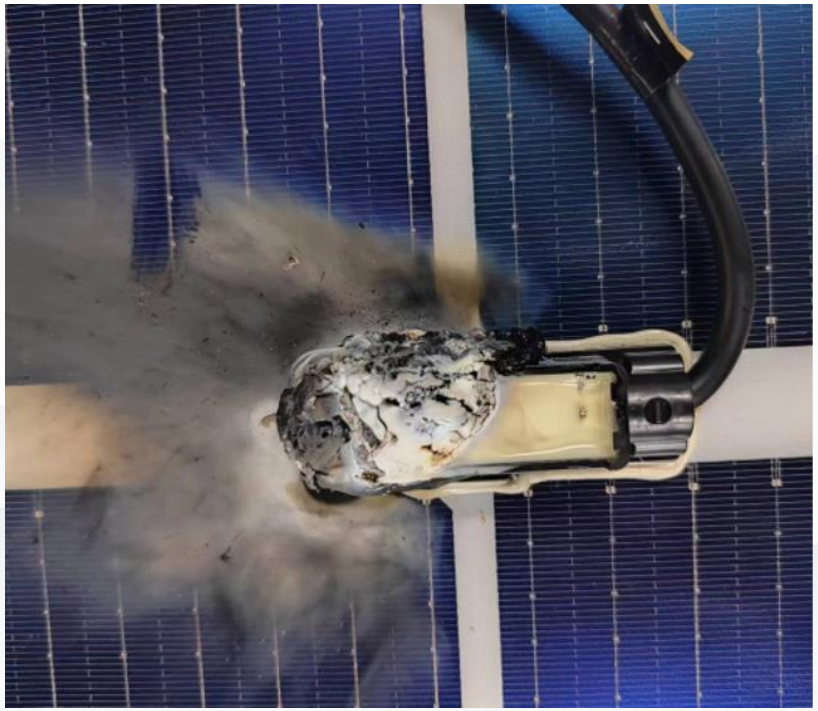
Pv Junction box -Key Raw Materials for Reliability

Material	Purpose
Engineering Plastic Enclosures	Mechanical protection, UV & heat resistance
Copper Contacts / Heat Sinks	Efficient electrical conductivity
Bypass Diodes	Prevent hot spots, protect modules
Cables & Connectors	Power transmission to next module and up to inverter
Seal plugs & Gaskets	Water and dust ingress protection
Potting	Electrical insulation & thermal stability

"Small BOM share, disproportionately large impact on reliability."

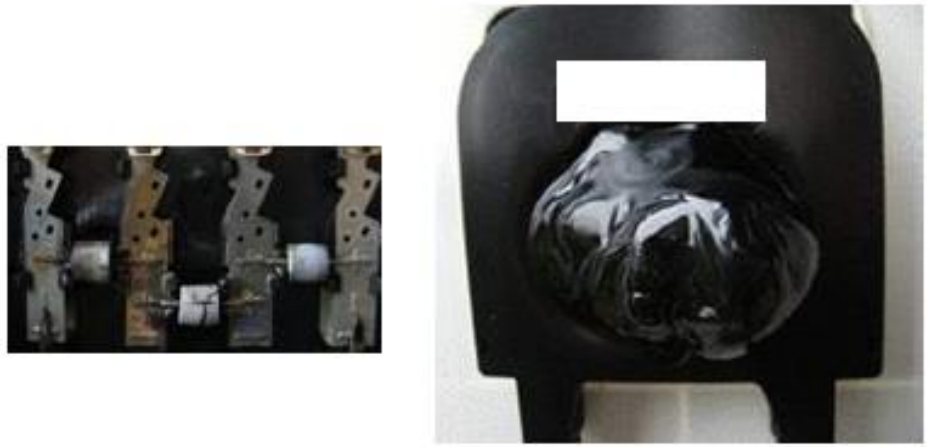
What Happens When the Junction box fails



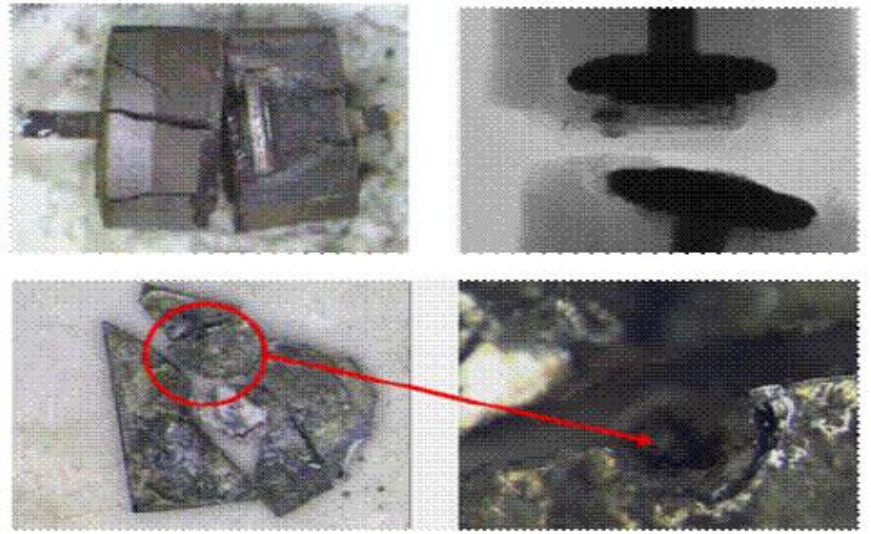
⚡ Reduced or lost energy output
🔥 Overheating / hot spots
⚡ Electrical arcing / short circuits
🔴 Fire hazard
⚡ Damage to panels or equipment

“One weak BOM choice can erase years of energy yield”
Buyer beware: Examining failures in the 2024 PV Module Reliability Scorecard - PV Tech

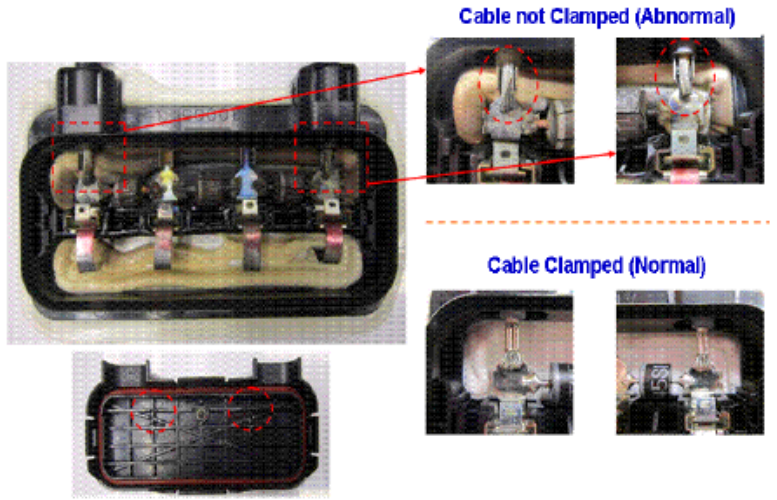
Junction box Failure Images



The faulty example for burnt bypass diode junction box



The faulty examples for rework cable of junction box.



The faulty example for cable without clamping in JB.

Sources: Reliability Investigation of PV Junction Boxes based on 1GW worldwide field database

Common Junction box Failures

PV Junction Box Failures: Where It Starts

🔥 Thermal stress & diode heating
(can be both catastrophic as well as wear out)
💧 Moisture ingress & corrosion,
especially due to poor sealing by sealant/potting
🔌 Weak terminations (soldering/welding/crimping)
🔌 Incomplete or cross-mating of connectors
🛠️ Installation-induced damages, non-standard Installation practices at site, lack of sufficient O&M protocols, etc.

Common Junction box Failures

What Fails Inside the Box

⚡ Bypass diode failure
- Short → power loss and may be burn out failure
- Open → Thermal runaway

Material degradation
- Poor enclosure grades
- Thermal/UV aeging

Improper Design

Heat Accumulation

Insufficient creepage/clearance leading to dielectric tracking

Dust & particulate intrusion

Poor Busbar Terminations
- Dry Soldering

Undersize Cable Selection
- High Contact Resistance

Cross Mating/Partial Issue
- High Contact Resistance

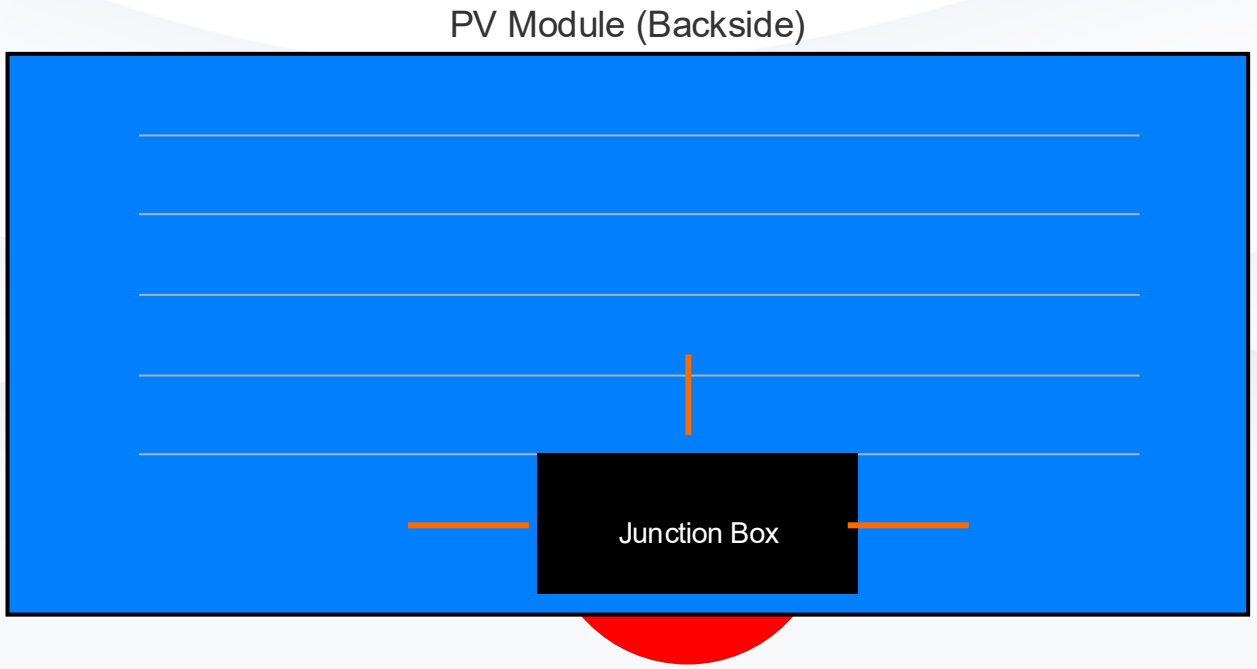
Burn out failure

Sealing failure

(water & moisture ingress)

"Most failures are not catastrophic — even they evolve as a part of wear & tear failure inside the junction box."

Thermal Stress at the Junction box



High Temperature Thermal Cycling ⚠ Reliability Risk

The junction box is the primary thermal stress point in a PV module, directly affecting safety and long-term reliability

Why thermal stress occurs

❑ **Bypass diodes generate localized heat**
- **Normal operation** : Diodes in reverse bias, Irev against ambient temperature
- **Bypass mode operation** : Diodes in forward bias, heat dissipation across bypass diode(s) as a combined effect of module Isc at elevated ambient temperature condition and forward voltage drop across the specific diode under bypass operation.

❑ Limited heat dissipation at the **rear of the module**

Key stress conditions
- Repeated **day–night thermal cycling**
- **Hotspot formation** under shading or inter-module huge Imp mismatches
- High ambient temperatures shooting Irev.

Impact on reliability
- Diode degradation or failure
- Aging of enclosure and potting materials
- Increased power loss and safety risk
- Reduced module lifetime

Thermal Runaway

Typically occurs when a pv module transits from cloudy state to sunny state, bypass diodes inside Junction Boxes transiting from forward bias to reverse bias.

If the heat dissipation capability of the diode & junction box in combination is weak, the heat accumulated initially from forward bias operation can't be dissipated in time during its transition to reverse bias, and eventually the thermal balance is compromised.

The rising temperature causes higher reverse leakage current, which in turn will result in a temperature increase - this vicious circle is thermal runaway.

Reference : IEC 62979:2017

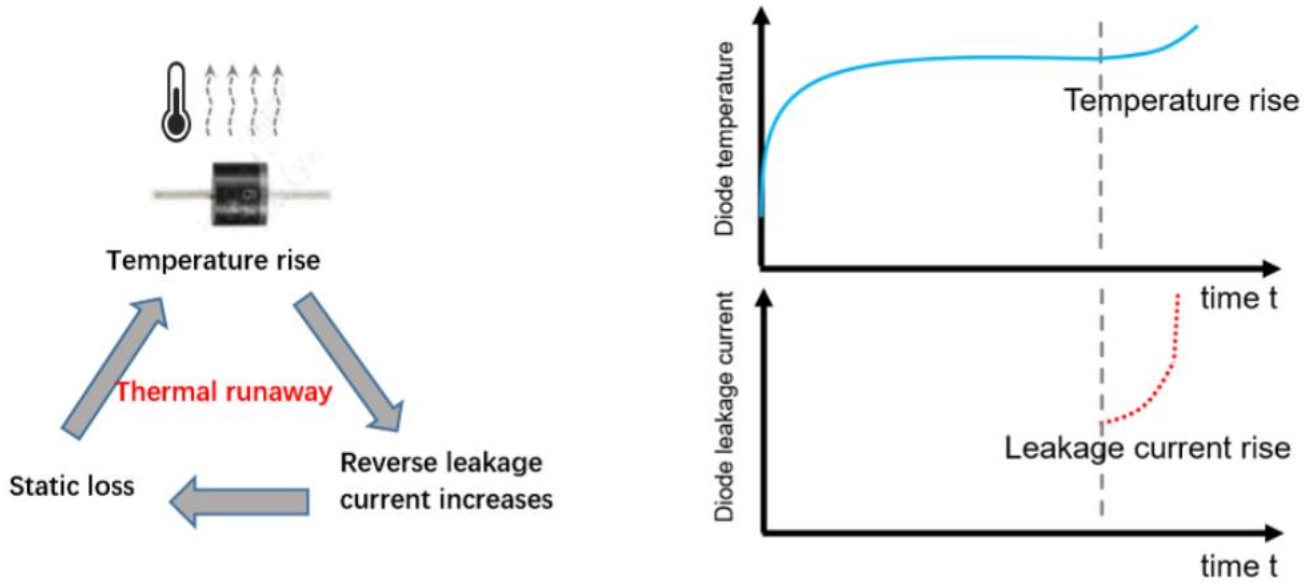


Fig. 3 Mechanism behind diode thermal runaway

Sources: Analysis of Thermal Runaway in Large Current Junction Boxes, Longi Solar

Cross Mating in PV Connectors

Cross mating usually refers to events of mating between two different makes or models of connectors, having different geometry especially in terms of construction of the connector terminals.

When we call " compatibility", it doesn't merely mean "mechanical compatibility" but compatibility, ensuring safe & reliable operation at installation site.

Potential risks associated with any cross-mating events for pv connectors:

- **Increased contact resistance**
- Mismatch in contact geometry, spring force, plating thickness or air gaps after mating.
- Leads to localized I^2R losses and abnormal temperature rise
- **Overheating and burn out/melting risk**
- Elevated contact resistance under continuous DC load
- Can cause softening of polymer housing, contact relaxation, and progressive heating
- **Incomplete or unreliable locking**
- Locking features may engage partially or falsely or up to a very less mating length.
- **Accelerated corrosion and aging**
- Dissimilar plating materials and plating materials thickness
- **Ingress protection (IP) failure**
- Seal and dimensional mismatch compromises IP68 rating
- Moisture ingress leads to corrosion, tracking, and insulation degradation
- **Loss of certification and warranty**
- Violates IEC 62852 / UL 6703 connector system approval
- Manufacturer warranty and system compliance become invalid

ESD (Electrostatic Discharge) Failure

High Static Charge Generation

Sl. No	Stage/Station	Checkpoint	Acceptance Level
1	JB feeding/pick up	ESD implementation & ESD Grounding	Grounded Wired Wrist Straps for manual process M/c grounding for auto process Equipment Grounding < 1Ω Personnel Grounding (0.8-1.2 x 10^6 Ohms)
	JB placement	Static Charge Generation at all stations where there is a contact of human or metal with diode.	< 100V
2	Auto soldering	Process parameter	Current/Holding Time/Tip Height/Pressure, Tip Voltage and Tip Current Measurement etc.
3	Auto soldering	Visual inspection	Good soldering, no mechanical stress on diode
4	Potting application	Part A / Part B actual ratio	Meeting ratio specifications defined by potting make
5	Curing chamber	Temp, Humidity setting	No condensations on JB surface
6	Flasher	Contact block resistance/ mating counterpart status	Contact block res. < 40mΩ Counterpart pin (contact block) matching with JB connector pin No loose contacts/sparks/ Grounding Power Supply Calibration report & testing mechanism How we can relate actual applied V/I with displayed V/I on PSU display
7	Hipot	M/c connections	Connections to ensure to high voltage bias across diodes *Power supply live terminal with shorted cell connectors and return/negative terminal on frame*
8	Post EL	Relaxation time after hipot (if any)?	Time gap/dwell must be sufficient to ensure JB/diode temperature stabilization
		Diode/JB temperature stabilization?	
		Current/voltage ramp rate	Must be a controlled soft start (50-200mS ramp) *Sudden spikes/inrush creates ESS on diodes*
		Pulse width & duration (if applicable)	Pulse width within M/C supplier's specification *Can cause cumulative thermal stress on bypass diodes*
		Current injection value validation	Fluctuations against set value
		Ground to neutral voltage	<2V
		EL body grounding	Minimal (<1Ω)
		Power Supply Calibration report & testing How we can relate actual applied V/I with displayed V/I on PSU display	

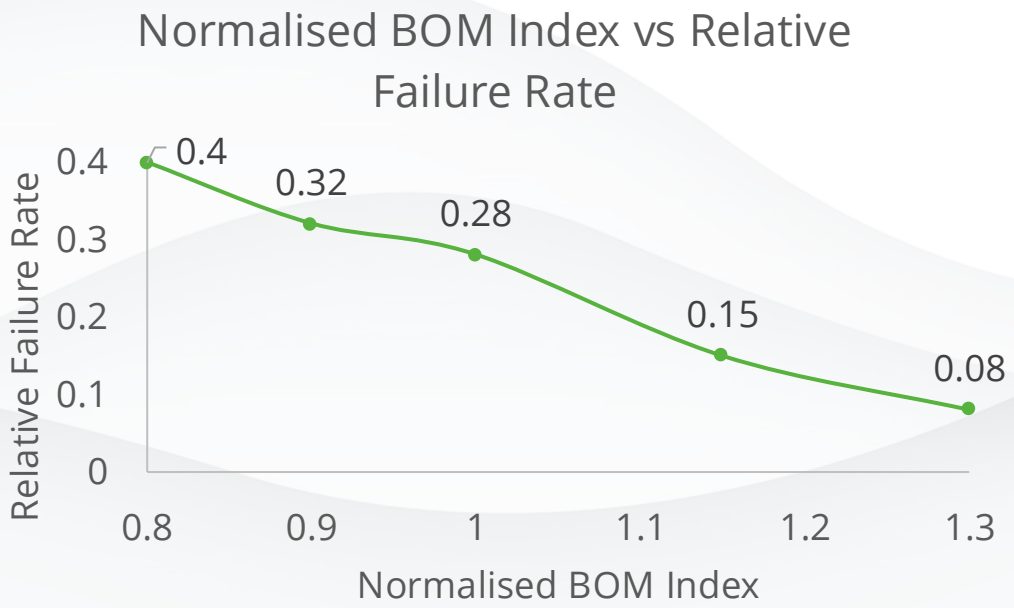
ESD Norms

ESD Summary – Solar Module Manufacturing

- ESD control is required to protect **solar cells, bypass diodes, and junction box electronics**.
- Critical ESD areas include **cell handling, diode soldering, PCB/JB assembly, and testing**.
- Operators must use **wrist straps, ESD footwear, grounded workstations, and ESD-safe tools**.
- **Usage of Nitrile gloves by operators during manual JB assembly immediately spikes local static charge (voltage accumulation**
- **ESD mats, proper grounding, and ESD-safe packaging** are mandatory.
- Maintain **40–60% relative humidity** to reduce static buildup.
- Regular **training, monitoring, and audits** ensure effectiveness.
- Follow **IEC 61340-5-1** and **ANSI/ESD S20.20** standards.

Upfront Cost Vs Lifetime Value

JB BOM Type	Normalized BOM Index (X)	Lifetime Reliability Index (Weight x Performance Score)	Relative Failure Rate (Y) **(1-Reliability Index)**
Aggressive cost-down	0.8	0.6	0.4
Low-cost BOM	0.9	0.68	0.32
Baseline BOM	1	0.72	0.28
Optimized BOM	1.15	0.85	0.15
High-reliability BOM	1.3	0.92	0.08



"Lowest cost ≠ Lowest risk"

Mitigating Junction box Failures

✅ **Robust Design**
- Heat Dissipation
- Low localised temperature generation

✅ **Thermal-robust diode selection**
- Optimum Tj value
- Low forward voltage drop

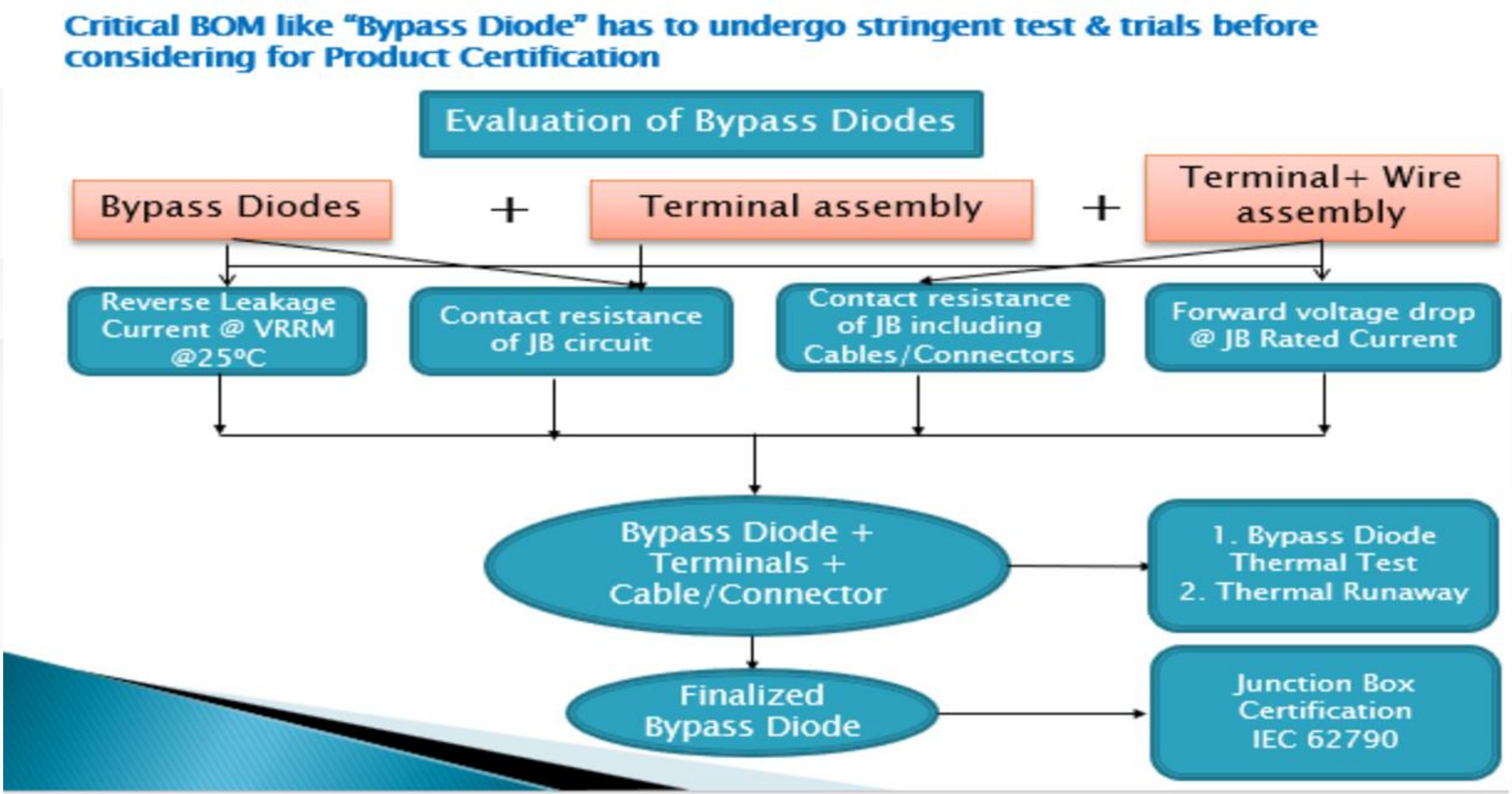
✅ **Optimized materials & BOM**
- UV-stable, flame-retardant polymers
- Adequate copper thickness
- High-quality potting & seals

✅ **Ingress & mechanical protection**
- IP68 sealing
- Robust strain relief & connectors

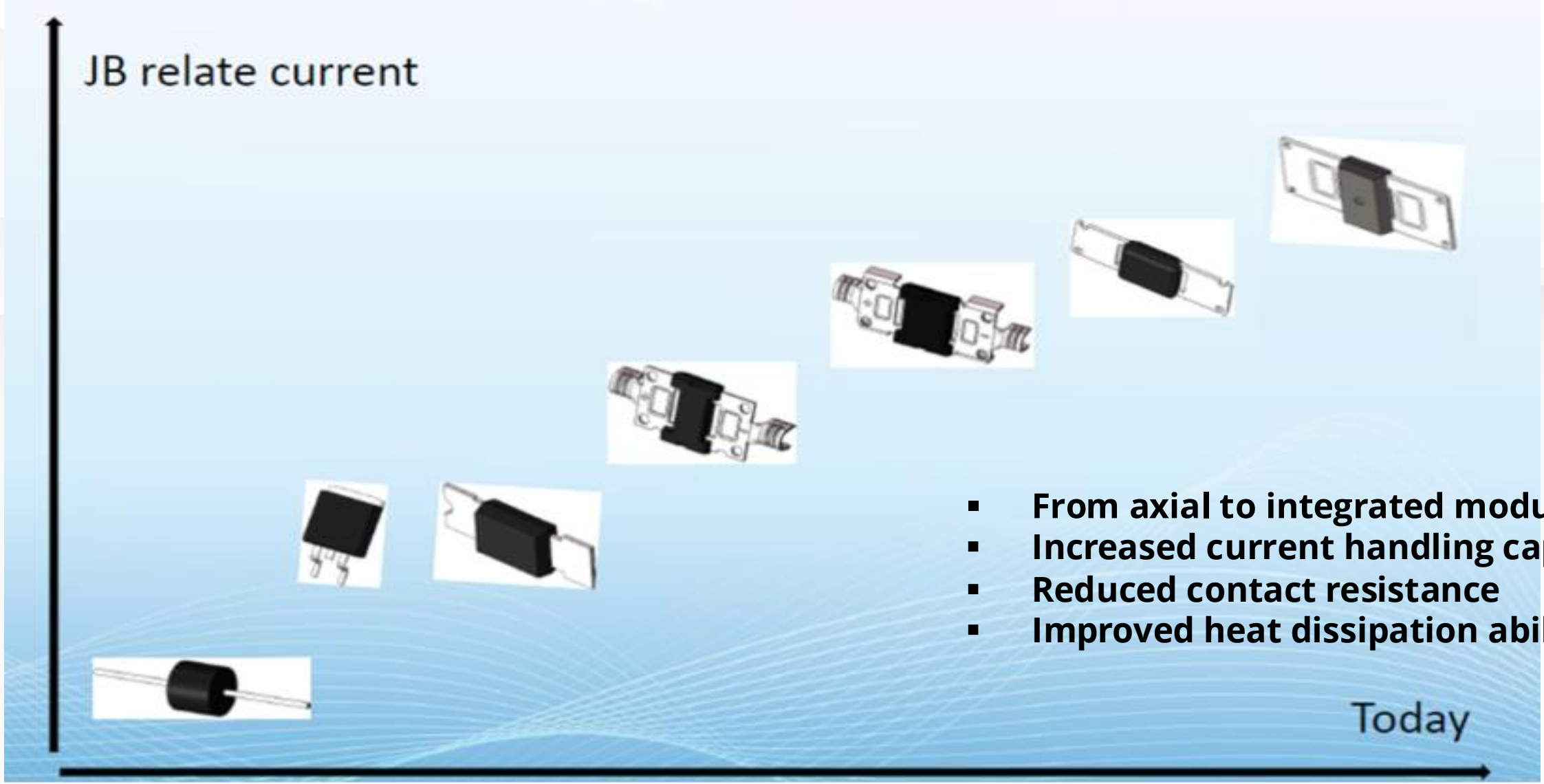
✅ **Installation & quality control**
- Correct torque & crimping
- Standardized installation practices

"Advancing solar reliability starts with engineering the smallest components right."

Critical BOM Selection Process



Right Diode Types for Right Junction box



- From axial to integrated module
- Increased current handling capacity
- Reduced contact resistance
- Improved heat dissipation ability

Increased Module Isc vs Junction Box Rated Current

According to IEC 61215/61730:
JB Rated Current IR > Module Isc*1.25, for mono-facial module
JB Rated Current IR > Isc*(1+30%*Ø)*1.25, for bifacial module, where Ø=bifaciality (normally between 65%~75%)

Below table explains recommended specifications for Junction Boxes based on module Isc:

Cell Size	Cell Type	Approx Module Isc limit (A) (front)	Bifaciality + Irradiance + Safety Factor component (1+30%*75%)*1.25 **(STC/25deg.C)**	Worst case module Isc **(STC/25deg.C)**	Worst case module Isc **(elevated temp./75deg.c)**	JB Rated Current (A) (IR)	Ratio IR/Isc **(worst/elevated)**	Safe Operation % **(at elevated temp.)**
M10	Half Cut	**14.5**	1.53	22.20	22.76	**25**	1.10	10%
G12R	Half Cut	**17**	1.53	26.03	26.68	**30**	1.12	12%
G12	Half Cut	**19**	1.53	29.09	29.82	**35**	1.17	17%

- ✓ With increase in cell wafer sizes, sufficient care to be taken on JB rating as well, for safe operation with increased module current.
- ✓ DhaSh Trio is rated in such a way that there are always sufficient safe margin of operation over worst case module Isc. DhaSh Trio fulfils all the requisites of all types of PV Modules, especially the ones manufactured with G12R & G12 solar cells having very high level of Isc.
- ✓ The operating current of the module will not exceed the rated current of the Junction Box in any of the above cases stated.

DhaSh Extended Reliability Lab – *Examples of few shown below*

Item	Equipment Name	Description
1	Bypass diode tester	Bypass diode thermal test Thermal runaway test
2	Robustness of terminations tester	Chord of anchorage (Pull & Torque/Torsion) Retention to mounting surface
3	Reverse current overload tester	Reverse current rating of junction box (relatable to max series fuse rating of pv module)
4	TC, DH & HF Chamber	Three in one climatic chamber for Thermal Cycling, Damp Heat & Humidity Freeze
5	Power Supply for TC, HF	Current application in positive temperature cycle of TC. Current application in HF test as well, as per standard guidelines.
6	Hipot/High voltage tester & Wet Leakage current tester	Dielectric withstand test Insulation resistance test
7	Sand test chamber	Dust ingress test as per IP6X
8	Impulse voltage tester	Impulse voltage application to ensure all clearances meeting the requirement of reinforced insulation
9	Salt spray chamber	Cyclic salt mist corrosion test
10	Weatherability test chamber	Spray UV test to determine its impact
11	Ignitability tester	To determine ignitability & flame propagation properties
12	Glow wire tester	To determine the heat resistance of product subjected to electrical faults

External Support – from 3rd Party Laboratories

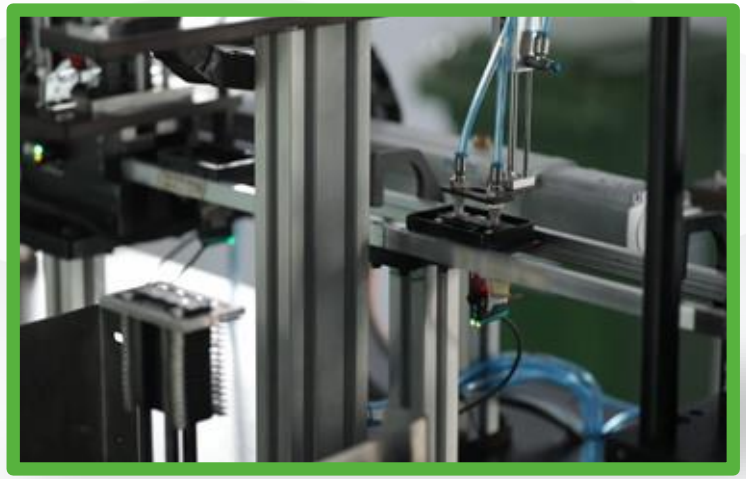
- ✓ 3rd party accredited labs available for IEC & UL testing of JB, Cable & Connector in India.
- ✓ 3rd party accredited labs available for IS 17293 testing of solar dc cables in India..
- ✓ However, 3rd party accredited labs **not available** for **IS 16911 (JB)** and **IS 16781 (Connector)** testing. Laboratories like TUV RH should work in sync with indigenous manufacturers like DhaSh PV to establish IS level testing of JB & Connectors.

Product	IEC	UL	IS	Lab's availability in India			DhaSh In-House Lab Testing
				IEC	UL	IS	
Junction Box	IEC 62790:2020	UL-3730 or UL-62790	IS-16911:2018 IS-62790:2014	**Available**	**Available**	Not available	All required tests as per IEC-62790, available in-house
Cables	IEC 62930:2017	UL-4703	IS-17293:2020			**Aavailable**	All required tests as per IEC - 62930, available in-house
Connectors	IEC 62852:2014 +A1	UL-6703 or UL-62852	IS-16781:2018			Not available	All required tests as per IEC-62852, available in-house
Bypass Diode	IEC 62979:2017	–	IS 62979:2017	Not available	Not available	Not available	All required tests as per IEC-62979, available in-house

Innovating Excellence

DhaSh R&D, Production, Process & Testing

At DhaSh PV Technologies, we take pride in our cutting-edge Research & Development, state-of-the-art Production, and meticulously streamlined Processes that define our commitment to excellence in solar PV manufacturing.



Benchmarking analysis for DhaSh Trio

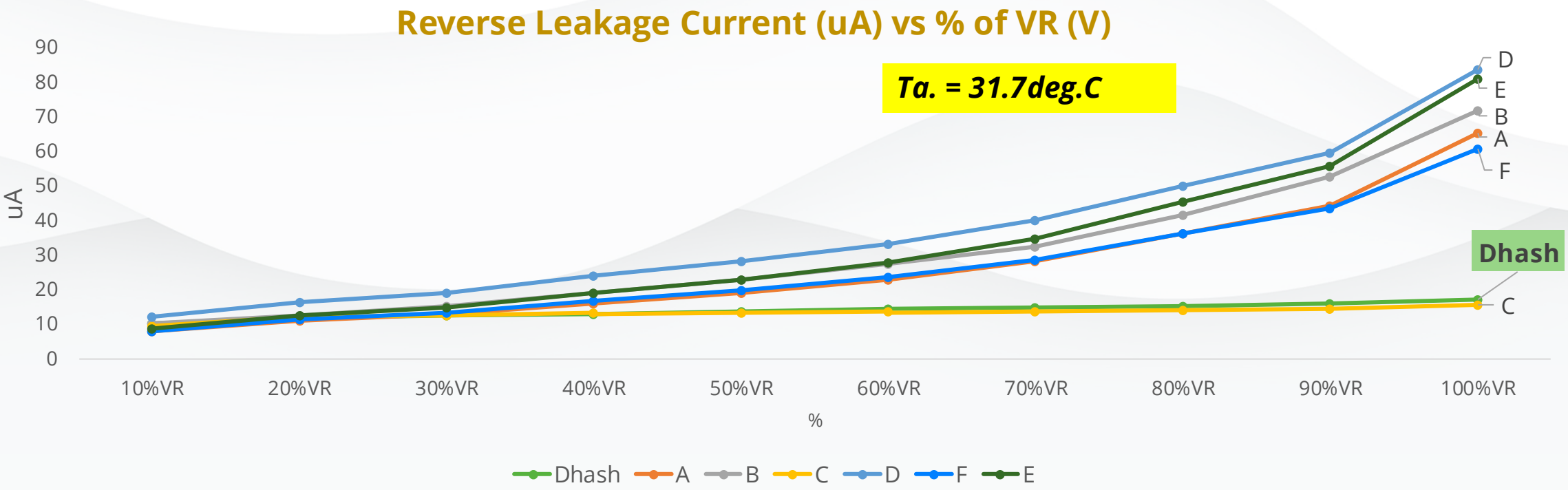
A. Overall JB Resistance with Cables & Connectors

Resistance (mΩ)	DhaSh TRIO 1.2mtr	A 1.2mtr	B 1.2mtr	C 0.3mtr	D 0.3mtr	E 0.3mtr	F 0.3mtr
	12.62	13.29	13.83	4.18	4.40	4.20	4.02

- **Criteria : {<14mΩ with 1.2mtr. / <4.5mΩ with 0.3mtr. @20°C}**
- **Lesser CR for JBox accounts for lower cell to module loss proportionately, which in turn is advantageous for module manufacturers in terms of Pmax bin shift, especially for modules with borderline Pmax values w.r.t any Pmax bin.**
- ***Note – Above data is based on measurement done on actual samples (with available cable lengths) & we can't convert the overall CR values for a fixed cable length, as overall CR not only depends on cable/cable length but also on individual Jbox circuit's & Connector's CR.***

Benchmarking analysis for DhaSh Trio

B. Reverse Test of Individual Diodes @VRRM=45V (Reverse Leakage Current <200µA)

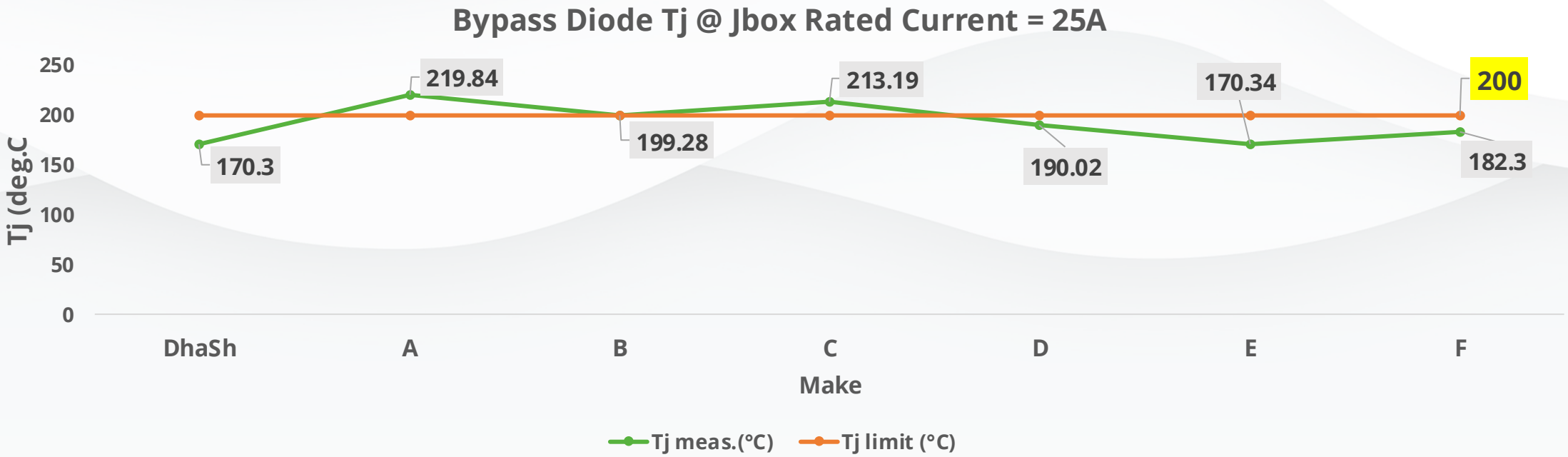


- **Schottky Trench Chip in integrated module diode of DhaSh Trio Jbox measures lesser reverse leakage current compared to other technology chips, keeping localised temperature of bypass diode region at minimum levels during sunny condition (diode under reverse bias). Irev of diode is directly proportional to site ambient temperature conditions (Ta). Lesser the diode's Irev, lesser the JBox localised temperature, safer is the pv module.**

Benchmarking analysis for DhaSh Trio

C. Bypass Diode Thermal Test Findings:

- Junction Temperature Tj (deg.C) measured at Jbox Rated Current (25A)
- Forward Bias – 1hr. / Ta. = 75±5 deg.C
- Pass Criteria for safe operation : ≤ 200 deg.C



- Schottky Trench chips of integrated diodes in DhaSh Trio Jbox yields best results in terms of diode Junction Temp.
- Low forward voltage drop & minimum Tj levels of bypass diodes in DhaSh Trio ensure safe operation of JBox under continuous forward bias (cloudy state/during any fault inside PV Module). Minimum heat dissipation across the diode reduces the risk of wear & tear failure of bypass diodes out of continuous forward bias operation, up to a greater extent.

Benchmarking analysis for DhaSh Trio

Connector compatibility with silicone sealant

P

Q

R

S

T

DhaSh

- Connector models from different makes were directly exposed to Ketoxime/Oxime based silicone sealants inside a closed jar.
- Oxime gas released by sealant during the curing process reacts aggressively with connectors made of Polycarbonate (PC) material, whereas the same oxime gas wasn't found reactive with connectors made of PPO/m-PPE material grade.
- All the connector makes except DhaSh make suffered brittle failure due to restricted chemical compatibility of Polycarbonate (PC) material with silicone sealant's oxime gas.

Superior Connectors & Cables

PV Connectors

- *Contact resistance ≤0.25mΩ*
- *Available in pre-assembled sets for ease of assembly at site in case of any rework activities.*

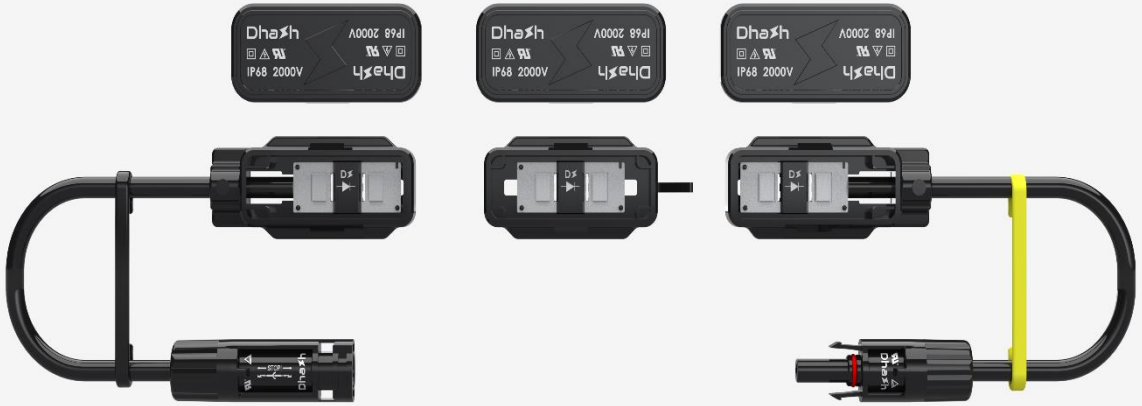
Parameters	DhaSh PV's offerings	Market Offerings
Material grade of enclosure	m-PPE/PA66	PC (more prone to chemical attacks)
CTI value	≥600V (PLC0)	≥600V (PLC0)
RTI value	Up to 120deg.C	normally around 105 or 110 deg.C
Rated Voltage	Up to 2000V DC	1500V DC
Rated Current	45A (4sq.mm) / 55A (6sq.mm)	≤40A
IP Rating	IP68	IP68

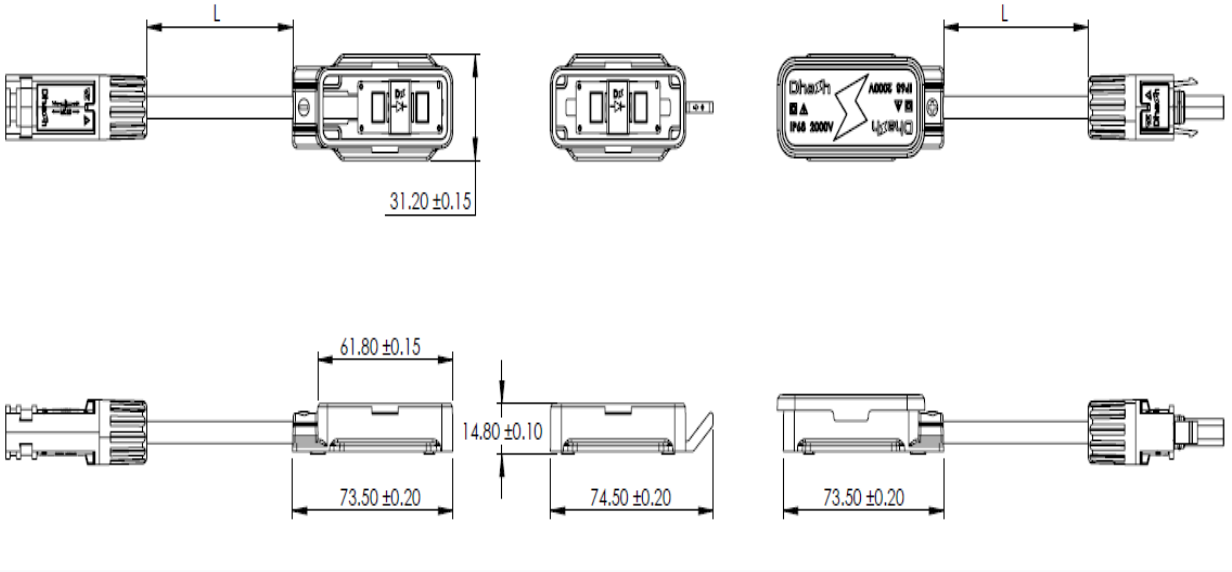
Solar Cables (1Cx4sq.mm/1.8kV DC)

- *XLPO/XLPE cables meeting minimum contact resistance requirement of ≤5.09 mΩ/mtr. for **4sq.mm/12AWG cables,** resulting in lower cell to module Pmax losses.*
- *Minimum copper weight of ≥31gms/mtr.*
- *Insulation thickness ≥ 0.8mm, for better product life & performance in harsh conditions.*

Technical Developments

1. 2000V Junction Box





BASIC TECHNICAL DATA		
Parameters	Unit of measurement	Specifications
Type of Appliance	_	Photovoltaic Junction Box
Type Name or Model No.	_	DSJB18y (y=a, b, c,)
Rated current for each split junction box	Amps	25A y=a 30A y=b 35A y=c
Rated Voltage	V DC	2000
Rated Impulse Voltage	kV	24
Maximum Working Voltage	V DC	135 (with 3 junction boxes connected in series combination)
Reverse Current	Amps	50
Protection Class	_	Class II (Application Class – A)
Degree of protection	_	IP68 (1.2mtr, 45min.)
Pollution Degree (inside)	_	1
Overvoltage Category	_	III
RTI of Housing Material	°C	≥110
RTI of potting Material	°C	105
Flammability class	_	V0, 5VA
Contact Resistance	mΩ	≤1
Temperature Range	°C	-40 to +85
Rewireable	_	No
Connecting Cable	_	Standard: 2pfg 2954; UL 4703 (2KV DC)
Wire Cross Section Area	Sq.mm	4
Cable Diameter (overall)	mm	6.2mm (± 0.2)
Diode Type	_	Refer page 6 of this document for additional information.
No. of Diodes	Nos.	1 per JB
Waterproofing Structure	_	2 component potting
Width of Busbar	mm	Max 8.5
Thickness of Busbar	mm	Max 0.600
Busbar Termination & Connection	_	Resistance welded type termination for external PV cable for (y=a,b,c) Integration for internal connection with bypass diode for all models Soldered-type termination for PV ribbon for all models
Contact Material	_	Copper Alloy, Tin Plated
Bonding Mode	_	Silicon Glue/Sealant
PV Connectors (Male &Female)	_	DS01a / 2pfg 2925; UL 6703, 2KV, 45A
Standard	_	2pfg 2928; UL 3730

Technical Developments

2. 2000V Connector

High performance products designed to meet higher rated voltage requirement on system side (inverters & similar components):

Technical Data

Type of appliance	DC Connector for Photovoltaic System
Type name or model no	DS01a (Male and Female)
Rated voltage	2000V (as per 2pfg 2925);1500V (as per IEC 62852)
Rated current	45A with 4sq.mm & 55A with 6sq.mm
Lower ambient temperature	-40℃
Upper ambient temperature	+85℃
RTI of Enclosure	+105℃ with m-PPE; +120℃ with PA66
ULT	+100℃ with m-PPE; +115℃ with PA66
CTI Value	≥600V (PLC0)
Degree of Protection	IP68
Conductor (Wire) Core Material	Annealed Tinned Copper
Wire cross section area	4.0mm^2 & 6.0mm^2
Wire Outside Diameter (OD)	6.2±0.2mm (4sq.mm); 6.75±0.15mm (6sq.mm)
No. of Wire Strands	56
Application class	A

DHASH PV TECHNOLOGIES LTD

DhaSh Green Energy Pvt. Ltd

Specialized in PV Ribbon, Wires & Cables

As demand for high-efficiency, durable, and **ALMM-compliant solar components** surges, **DhaSh Green Energies Pvt. Ltd** is strategically positioned to meet this growing need. With deep industry roots through DhaSh PV and an already established supply ecosystem, DhaSh Green Energies brings unmatched capability to the PV Ribbon, Wires & Cables space. Our massive production scale, technical expertise, and focus on quality assurance enable us to be a dependable partner for module manufacturers navigating India's rapidly expanding solar market.

DhaSh PV **Ribbon**

Composite **Frames**

DhaSh Composite Frames provide a strong, corrosion-resistant, and lightweight foundation for solar modules. Engineered for durability and consistency, they support faster installation, long-term reliability, and large-scale solar deployment

High Strength Retention

Maintains up to **80% strength**, ensuring long-term structural reliability

25+ Years Durability

Designed for extended operational life in **demanding environments**

Stringent Reliability Tests Passed

- DH3000
- TC 600
- HF30
- DH2000 + UV400
- Salt Spray Test – **Level 8**

Intellectual

Property

DhaSh PV Technologies proudly holds the registered design IP for its PV Junction Connector under Class 13-03. This certified protection underscores our commitment to innovation, safeguards our proprietary design, and strengthens our competitive edge in the global solar PV market.

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 394457-001

तारीख / Date : 05/09/2023

पारस्परिकता तारीख / Reciprocity Date* :

देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *PV JUNCTION CONNECTOR* से संबंधित है, का पंजीकरण, क्लास 13-03 में Dhash Pv Technologies Private Limited के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 13-03 in respect of the application of such design to *PV JUNCTION CONNECTOR* in the name of Dhash Pv Technologies Private Limited.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के उपबंधों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

Controller General of Patents, Designs and Trade Marks

पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India

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International

Certifications

Ensuring Industry-Leading Standards Across All DhaSh Operations

DHASH PV TECHNOLOGIES LTD

200+ Clients In Renewable Energy Sector

(To Name a Few)

DhaSh Overseas Clients

THANK YOU!

Dhash PV Technologies Ltd.

Head Office & Factory

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Gujarat, India.

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Website : www.dhashgroup.com

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Innovating tomorrow

INDIA'S LARGEST INTEGRATED PV JUNCTION BOX MANUFACTURER