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# ABB Electrification Solar Offering

## OEM/Residential/Commercial/Utility Offering

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# ABB solar offers the largest product portfolio

## Explore the industry’s broadest portfolio in solar

ABB offers the industry’s most comprehensive portfolio of products, systems, solutions and services

Optimize the performance, reliability and return on investment of any solar installation

From residential rooftops to commercial and industrial applications and utility-grade power plants

With a proven track record in solar since the 1990s

Global presence and expertise from solar systems to grid connection and integration to smart grids we are your expert partner


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# ABB solar competitive offerings

Explore the industry’s broadest portfolio in utility scale solar

## From low voltage to medium voltage

ABB has over 140 years of experience developing power electronics equipment. With the most sophisticated engineering and power electronics professionals.

ABB has expertise and experience needed to deliver a complete solution to maximize revenues by optimizing the efficiency and uptime of the PV plant.

Successfully manufacturing, deploying, connecting, integrating and deploying solar PV plants requires a deep understanding of utility-scale applications.

ABB can connect everything from the direct current (DC) output of the PV panels up to the medium voltage grid, along with system design and optimization expertise.

And, don’t forget about Service, ABB offers a wide range of services to help you get the most power from your plant – ranging from remote monitoring to full operation and maintenance (O&M).


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# Systems and solutions for successful utility plant design

ABB key offerings in utility segment

## Electrical balance of plant

ABB's solutions for PV power plants are designed to maximize plant performance and provide owners with a rapid return on investment and long plant operating life.

Optimized standard concepts for each stage of the PV power plant process and a complete capability in design, engineering, and commissioning.

## Turnkey stations

ABB turnkey solutions capitalize on ABB's long expertise in the development and manufacturing of secondary substations and medium voltage (MV) components.

## Grid connection

ABB offers a range of products and solutions that help to efficiently connect PV plants to the grid.

In-depth knowledge of renewable power generation technologies and comprehensive experience with grid codes and utility practices in use around the world enables us to provide grid connection solutions for PV plants of all sizes.

## Grid integration

As an intermittent, widely dispersed source of energy, solar presents a challenge to power grids. It demands sophisticated solutions to balance supply and demand and avoid stress on the grid.

ABB has the advanced technologies needed for successful grid integration for installations of all sizes both at the connection point and at the system level with our smart grid solutions.

## Energy storage

With our range of dynamic battery energy storage systems for solar applications, ABB has developed an effective and efficient approach that enables energy produced from a PV system to be stored and then used when required.

Our battery systems do not produce any CO2 emissions. They also maximize the efficient use of renewable energy sources.

## Plant automation

ABB offers a versatile and scalable automation solution designed for monitoring and control of PV power plants. The solution spans from plant automation including panel position control, plant diagnostics and power management, with ABB Ability enabling remote operations and management of PV plants.

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# ABB solar offers the largest product portfolio

Components, systems and solutions: grid connection options for PV plants of all sizes

## Low voltage

Switch gear

Breakers' Disconnects

Safety switches

Contactors and Relays

Insulation monitors

Meters and timers

Fuse holders

Power supplies,

Power monitoring

Connecting and grounding

Wire and cable management;

Cable tray, nonmetallic flex conduit, cable ties and ground connectors

## Medium voltage

Air-insulated switchgear

Gas-insulated switchgear

Dead tank circuit breaker

Reclosers, contactors

Breakers and disconnects

Voltage and current sensors

Packaged solutions

Transmission line and current limiting fuses

Transmission line connection and protection relays

Automation and SCADA

Connecting and grounding solutions

## Substations

AIS substations

GIS substations

Hybrid substations

Mobile substations

Containerized and prefabricated substations

Energy storage solutions

Power quality improvement solutions

Surge arresters

Capacitors

## Energy Storage / Chargers

Energy storage:

- EssPro PCS
- EssPro EBOP
- EssPro Grid Tie

Battery chargers:

- Integritas wall, and floor mounted
- Infinity Industrial

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# Utility applications: power-plant products

## Tap into our power-plant expertise

Successfully deploying solar PV plants as well as connecting and integrating these into the grid requires a deep understanding of utility-scale applications.

ABB has the expertise and experience needed to deliver a complete solution to maximize revenues by optimizing the efficiency and uptime of the PV plant.

ABB can provide every element you need – connecting everything from the AC output of the inverters up to the medium voltage grid, along with system design and optimization expertise.

We also offer a wide range of services to help you get the most from your plant – ranging from remote monitoring to full operation and maintenance (O&M)

**ABB offers you a broad portfolio, reliability, innovation and economic efficiency so that you can achieve even more with your solar projects.**
**“Count on us because they count on you”**

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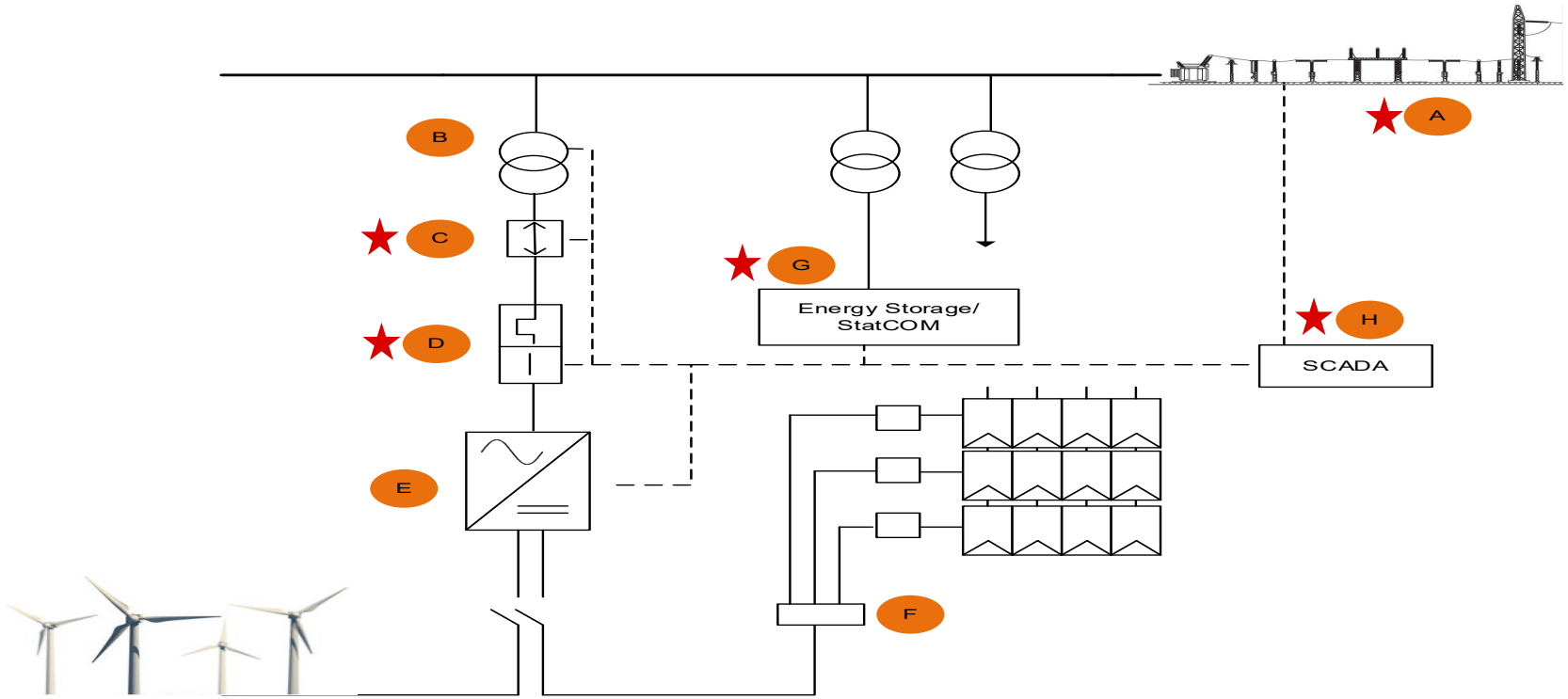
# Utility applications: power-plant products

## Solutions - products, systems, software and services




**A.** Substation **B.** MV Transformers **C.** Metering System **D.** LV AC Protection **E.** DC/AC Inverters **F.** DC JunctionBoxes **G.** Power Converter Solution **H.** Plant Controller -SCADA

★ = **ABB offering**

# ABB's offering for collection and connection

## Solar PV plant grid connection - electric balance of plant

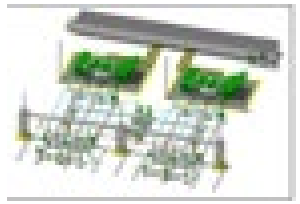
ABB standard scope

Value added

Solar Utility

**Product delivery**

**Consulting/Engineering package**
S/S Automation
S/S engineering
MV equipment



**Turnkey AC PV plant S/S**
AIS, GIS, PASS

**Electric BoP (eBoP)**
S/S + CSS + MV + FACTS + communication + BESS

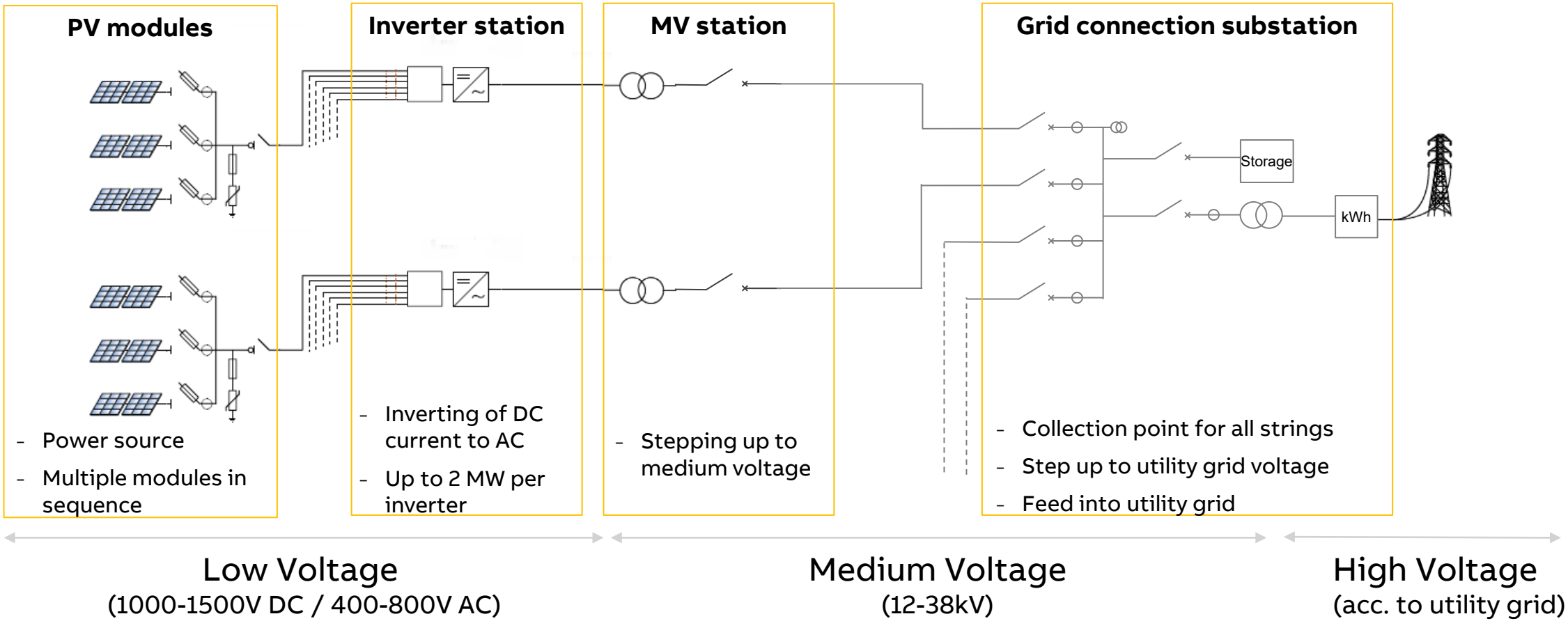
**eBoP EPC**
eBoP + OHL + CW

Complexity

**ABB can deliver from products to engineering packages or turnkey S/S**
**BoP available in specific markets**

# Solar applications: power-plant products

## Typical Solar plant diagram – power sections

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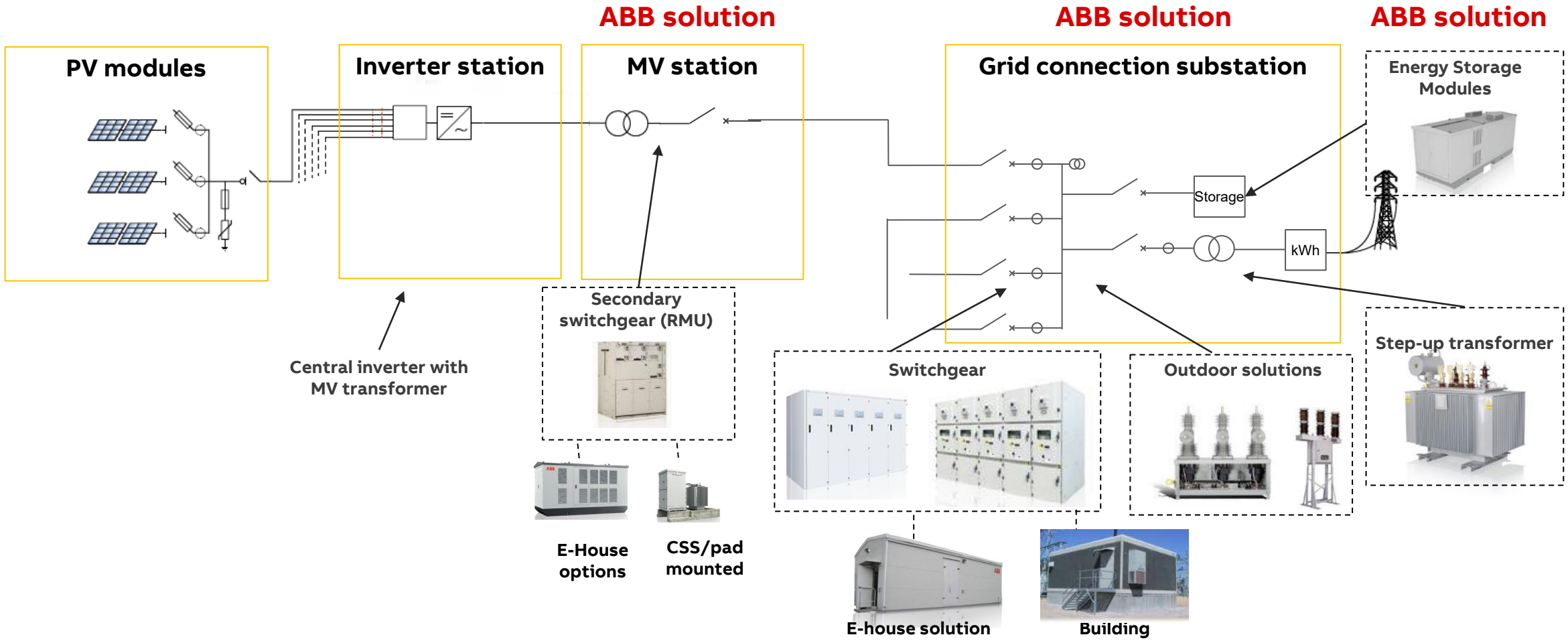
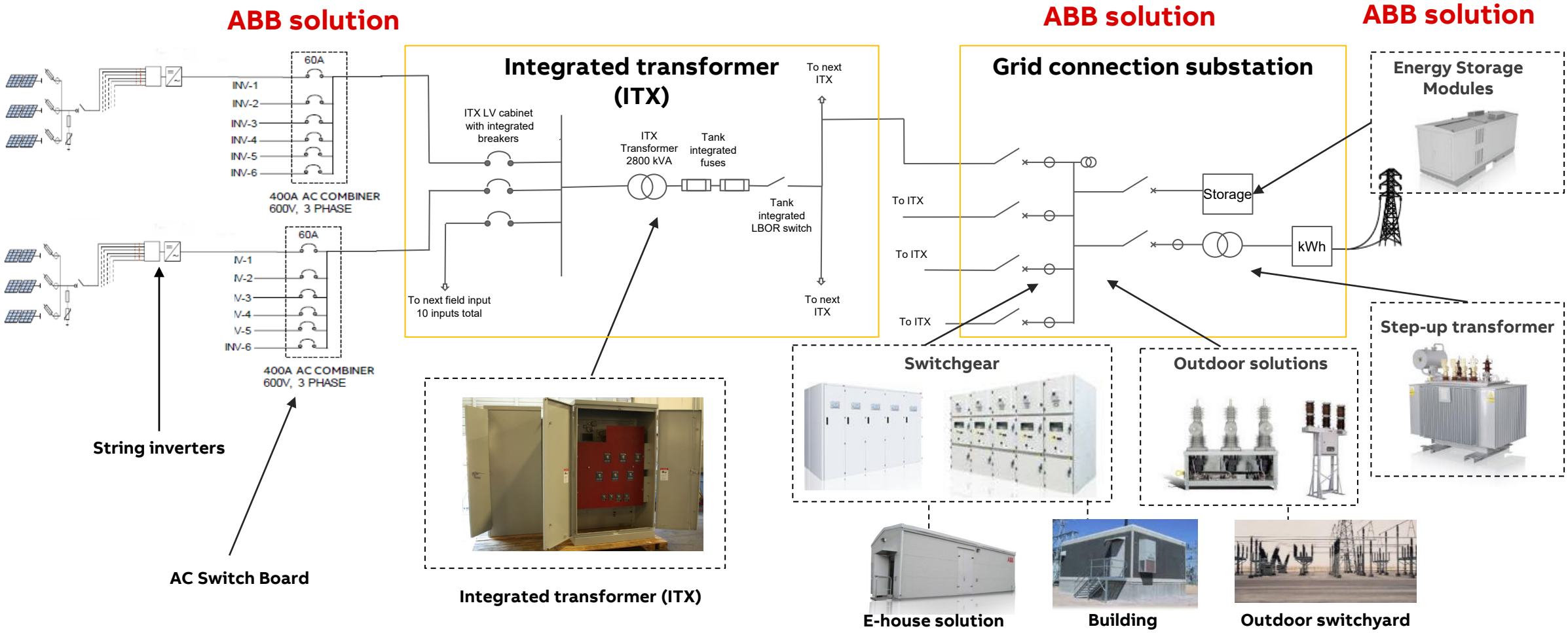
# Utility applications: power-plant products

## Utility scale solar plant diagram using central inverters – main components



# Utility applications: power-plant products

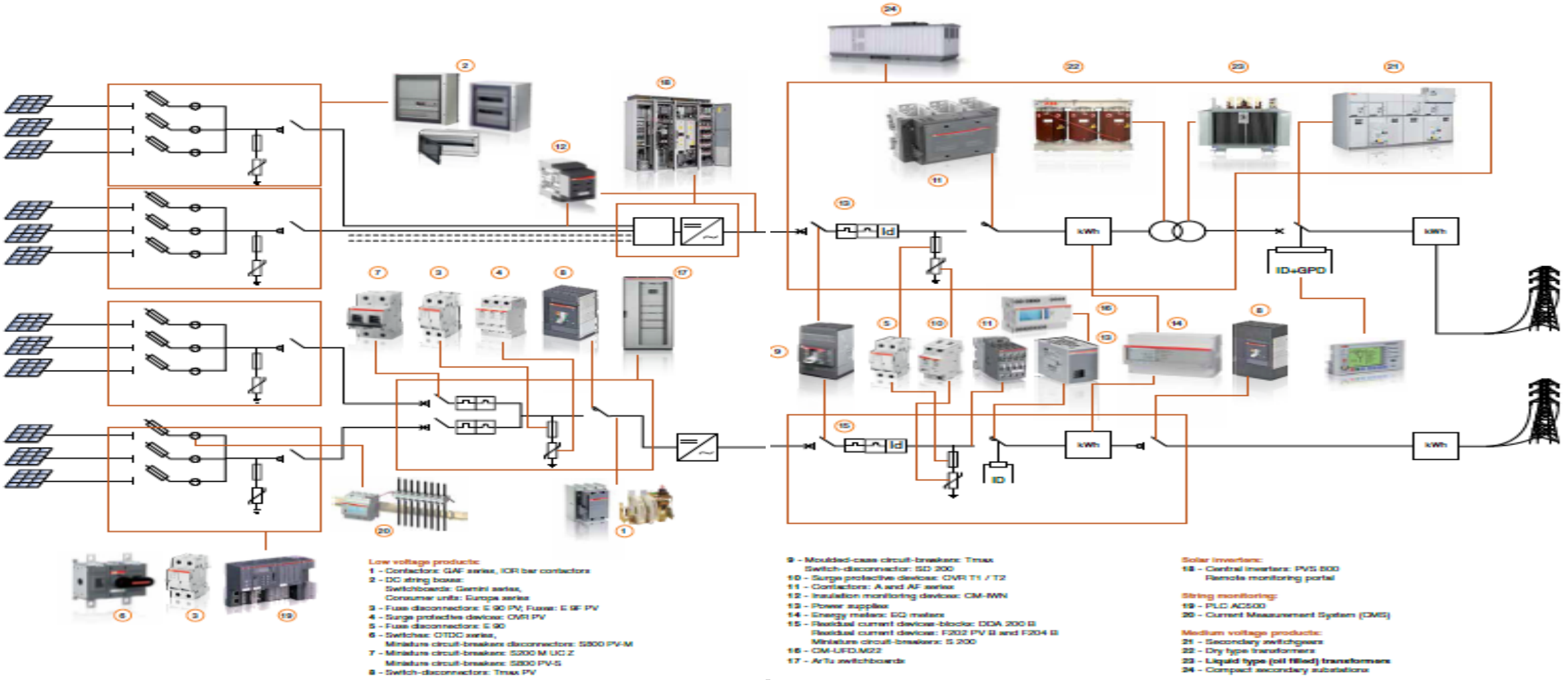
## Utility scale solar plant diagram using string inverters – main components



# Offering for the OEMs: Combiner Boxes, Inverters, Skids

# Electrification products in solar

OEM offering: solar combiner boxes, inverters/inverter skids, panel builders



# Offering for the Solar distributors and rooftop installers

# Electrification products in solar

Residential and commercial rooftop used as AC junction boxes


## Spec Setter* general duty

AC general duty safety switches

- Fusible, non-fusible
- 30-600A, 240VAC
- N1, N3R

## Spec Setter* heavy duty

AC heavy duty safety switches

- Fusible, non-fusible
- 30-1200A, 240 & 600VAC
- N1, N12, N3R, N4X 304/316
- Clear line shield 30-200A
- Viewing windows 30-200A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# Meet the largest window on the market*


**Extra value**

**Extra certainty**

**Extra simple**

With its enhanced window enabling at-a-glance safety checks the all-new ABB safety switch with extra large viewing window helps deliver premium safety for your customers.

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* As of March 1, 2021

# Extra Certainty

See the difference for yourself


**Existing viewing window (30-200A)**

- Small window (1.5”x 3” to 1.5” x 6 .5”)
- Stainless steel construction suitable for some mill duty
- Obstructed view of contacts
- No view of fuses


**New extra large viewing window (30-200A)**

- Premium window is **190% to 850% larger**
- Rugged and dust-tight design **robust enough for indoor and outdoor use**
- **Clear view of contacts and fuses** for **instant verification**

©ABB

# Electrification products in solar

Residential and commercial rooftop solar panel clamps and grounding

## Kindorf solar panel products

Application: residential and commercial rooftop

Hold down clamps and grounding washers

Corrosion resistant materials

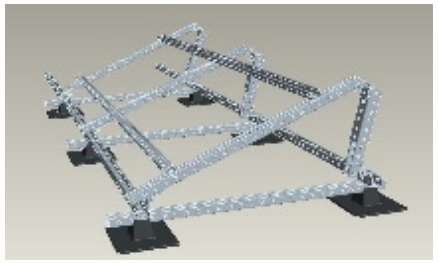
Ease of installation-slotted design

Works with all brands of solar panels

**Solar Panel Hold-Down Clamp: SHC-T-SSH**

**Solar Panel Hold-Down Clamp: SHC-L-SSH**

**Solar panel grounding washer: DTSW14**



**Kindorf Channel/Strut And pre-engineered systems**



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# Electrification products in solar

Residential and commercial rooftop solar wire management

## TnB Ty-Rap Cable Edge Solar Clips

Application: residential and commercial rooftop

Solar panel wire management

U-style cable management parallel to frame

Holds up to four #10 AWG solar cables

Corrosion resistant materials

Temperature rated: -85 to +194 deg F

Heat stabilized Nylon 6.6 option: -85 to +220 deg F

Quick and easy installations - no tools required

90-degree installation available

**Ty-Rap GD-001-TB**

**Ty-Rap TC 402**

**Ty-Rap TC 403**

## Ty-Rap® High Performance Cable Ties

Polyamide 12 UV-resistant version, remains flexible in cold & dry environments

Ages better and has a better chemical resistance than Polyamide 6.6

Lower moisture absorbing material than 6.6 nylon

For use in temperatures from -40°F to 185°F (-40°C to 85°C)

**Ty-Rap TYC28MX**

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# Offering for Utilities, Developers, EPCs and distributors

Low & medium voltage componets and  systems

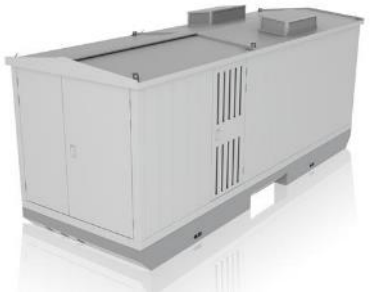
# Utility applications: power-plant products

Medium voltage solutions

## Electrical houses

## Compact secondary substations

## Energy storage modules



## Skid mounted unit - substations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# Utility applications

## Medium Voltage Switching Products

### Air-insulated primary switchgear

Metal-clad and arc-resistant ANSI switchgear:

Arc-resistant SafeGear®:

- up to 4000 A, 63 kA, 15 kV
- smallest footprint available in the industry

ReliaGear® ND:

- ABB's narrow-design
- 31.5kA, 5 and 15 kV

Advance®:

- up to 50kA, 15kV, 4000A

### Gas-insulated primary switchgear

Full line of gas insulated primary switchgear:

ZX2:

- 38kV (85kV/200kV), 4000, 40kA
- Flexible/adaptable design, ETL labeled

ZX2.2

- 38kV (85kV/200kV), 4000, 40kA
- Disconnect & earth switch on cable side of CB

### Gas-insulated secondary switchgear

SafeRing is a ring main unit (RMU) for the secondary distribution network. SafePlus is a metal enclosed compact switchgear system for distribution applications.

- RMU Safering: up to 40.5 kV, 630A
- Compact switchgear SafePlus: up to 40.5 kV, 630A

### Dead tank vacuum magnetic CB

ANSI, Magnetic actuator, Vacuum interruption

- R-Mag 15.5kV , …3700A
- R-Mag 27kV, …2000A
- R-Mag 38kV, …2000A

### Recloser

Mechanically ganged operation

- OVR-15, OVR-27
- Controller: ABB Relion
- 3ph network
- Pole & substation

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# Utility applications

Outdoor apparatus – fuse cutouts and disconnectors

## Fuse cutouts for distribution applications

3 Types

- ICX, fuse holder interchangeable with S&C, Cooper, ..
- ICX LBU, fuse switch application (breaking chamber)
- NCX, non interchangeable fuse holder (ABB type only)
- Ratings
  - 15, 27, 38kV
  - Up to 200A , …20kA
- Insulators types; porcelain, silicon rubber, polymer concrete.
- Protection of overhead lines (laterals) and loads such as distribution transformers
- Protection and visible break

## Overhead disconnect switches

Up to 38kv, ..900A ,..25kA

- SID, single insulator disconnect
- LSID, load break single insulator disconnect
- DCD, double insulator single phase disconnect switch
- RBD, single phase by-pass disconnect switch
- Sectionalize and isolate OHL or equipment for maintenance
- Isolating CBs, etc. reclosers by-pass

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# Utility applications

Indoor circuit breakers and switches

## ADVAC / AMVAC

Generator breakers : ADVACG, VD4G

– 15KV 4000A 63KA

Distribution breakers :

– ADVAC – spring actuator
  15KV 4000A 63KA
– AMVAC – magnetic actuator
– 27KV 4000A 50KA

## VD4-CS

Safe and relentless operation of 38KV power quality

VCB with servomotor drive for 20,000 transient free operations

– 20,000 operations with extreme low probability of re-strike
– No inrush reactors
– Optimize assets combines protection (circuit breaker) and switch (frequent operations) features
– 1200A capacitive current

## DS1

Synchronous transient-free capacitor switch

The first diode-based MV switch worldwide at 15KV

– Transient free
– 50,000 maintenance free operations
– No inrush reactors
– Compact solution
– Embedded diagnostics
– 600A capacitive current

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# Utility applications

## Automation and communication

### Protection and numerical relays

Based on the use of microprocessors. Electromechanical and static relays have fixed wiring, and the setting is manual.

Numeric relays are programmable, and the characteristic and behavior can be programmed. Most numerical relays are also multifunctional.

Multi-function relays for device protection, switch control, arc flash protection, sync and load shedding applications

### Communication devices

Used when connecting protection relays to wired communication media (fiber-optic, galvanic), to convert between communication protocols or between communication systems.

### Test switch and accessories

Designed and manufactured to allow quick and easy multi-circuit testing of switchboard relays, meters and instruments by any conventional system.

They have been especially designed for the measurement of potential elements, current elements and make-before-break short-circuit elements related to current transformer (CT) circuits.

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# Utility applications

Special solutions

## Alternative relays

Electromechanical and solid-state relays

Solid state electronic components provide a similar function to electromechanical relays but do not have any moving components, increasing long-term reliability.

## Arc fault protection

Solutions designed to detect an internal arc in 1.5 ms and eliminate it in less than 4 ms, improving safety and availability of the power system.

Operating the network with a conventional solution with an operating time of 80 – 100 ms results in cable fire and copper and steel melting.

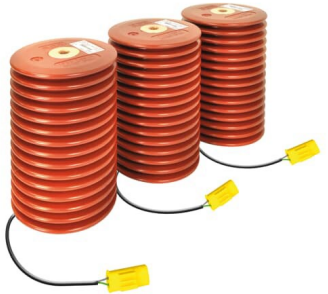
## Ultra-Fast Earthing Switch UFES

Innovative arc quenching

Highest level of safety for LV and MV systems against the internal arc faults

In case of an internal arc fault the arc detection relay trips the UFES, which initiates a three-phase earthing to break the arc voltage immediately.

The switching time is less than 1.5 ms, the arc flash is extinguished in less than 4 ms



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# Offering for Utilities, Developers, EPCs and distributors

Instrument transformers and sensors

# Instrument transformers (ITs)

## Traditional primary measurement solutions proven through the ages

100+ year old technology

Uses ferromagnetic circuit to tightly couple primary and secondary, with special attention to maximizing accuracy of translation of voltage and current signals

Able to transfer power from primary to secondary

Typically 1 or 5 amp current output, 120 or 240 volt voltage output

Wide array of meters and relays supporting (electromechanical and solid state)






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# The role of instrument transformers

Dry type ITs in ABB's indoor and outdoor portfolio are used in a three main types of applications

## Metering applications

Providing voltage and current signals to power and energy meters for both revenue (tariff) metering and non-revenue (non-tariff) metering applications.

## Protection and control applications

Providing voltage and current signals to protection and control relays and controllers for protecting and managing the power grid.

## Power supply applications

Small dry type form factor of ITs perfect for supplying power to protection and control apparatus.

May be used for both measurement and supply in the same application.


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# IT product lines for utility applications

Overview

## LV applications (600 V)

600 V metering

- Current and voltage transformers
- Used for secondary revenue metering

600 V plastic case Its

- Offered in a variety of internal window diameter sizes
- Used in switchgear and outdoor vacuum breaker applications (R-Mag)

## Outdoor medium voltage

Utilized in utility substations

Designed for metering and relaying on outdoor circuits

AccuRange® high accuracy extended range (HAER) CTs

ResiVolt™ VFT resistant VTs

Combination CT/VT ITs

## Station post CTs

15 – 34.5 kV, 110 – 200 kV BIL

Window and bar type designs

Metering accuracy 0.3

LG and LGX

- Inner diameter = 4.5 – 8.75”
- Metering accy 0.3 & 0.15S, relaying to C800

KOTD-110, -150, -200

- Inner diameter 4-5”
- Relaying to C800

KOT-60, -75, -11, -15

- Inner diameter = 3.25”
- Relaying to C200

## Generator CTs

Indoor and outdoor

Metering and protection

Board mounted and resin cast

Basic impulse level: 0.6 kV

Extensive product offering of proven designs with decades of field experience

Durable design against water intrusion and vibration

Highly customizable


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# IT product lines for utility applications

Special solutions

## Split-core CTs – monitoring, metering and protection

Metering accuracy to 0.3 class

Relaying accuracy to C800

Convenient mounting around primaries which cannot be opened

- Common for retrofit solutions

SP window sizes up to 41"

CO window sizes of 2½", 5½", 9

SP-061

CO-9740

## Submersible VTs

Indoor VT for use in a subsurface installation

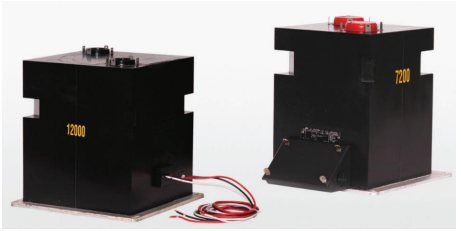
VIL-95/12

- Designed with secondary junction box for intermittent submersible operation where VTs are not permanently submerged under water

VIL-95/12

- Designed with secondary wires directly encapsulated into the polyurethane for a water-tight connection allowing installation where they me permanently submerged

Uses dead-front elbow connectors for primary





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# IT product lines for utility applications

Ferroresonance mitigation

## FSR-983 outdoor saturable reactor

600V class

Matched to specific PT

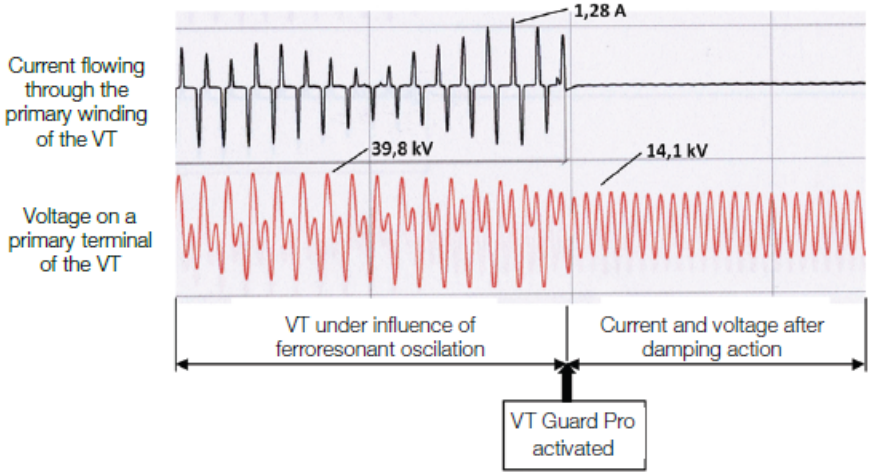
Ideal for retrofit applications to passively damp circuit to avoid resonance

## VT Guard Pro

Ideal for active elimination of ferroresonance risk in new deployments

Used in open-delta connection of three single-phase VTs

Requires additional LV winding on PT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# ABB AccuRange® technology

## Extended range high accuracy current transformer technology

600 V to 34.5 kV voltage classes

ABB was the original developer of this technology

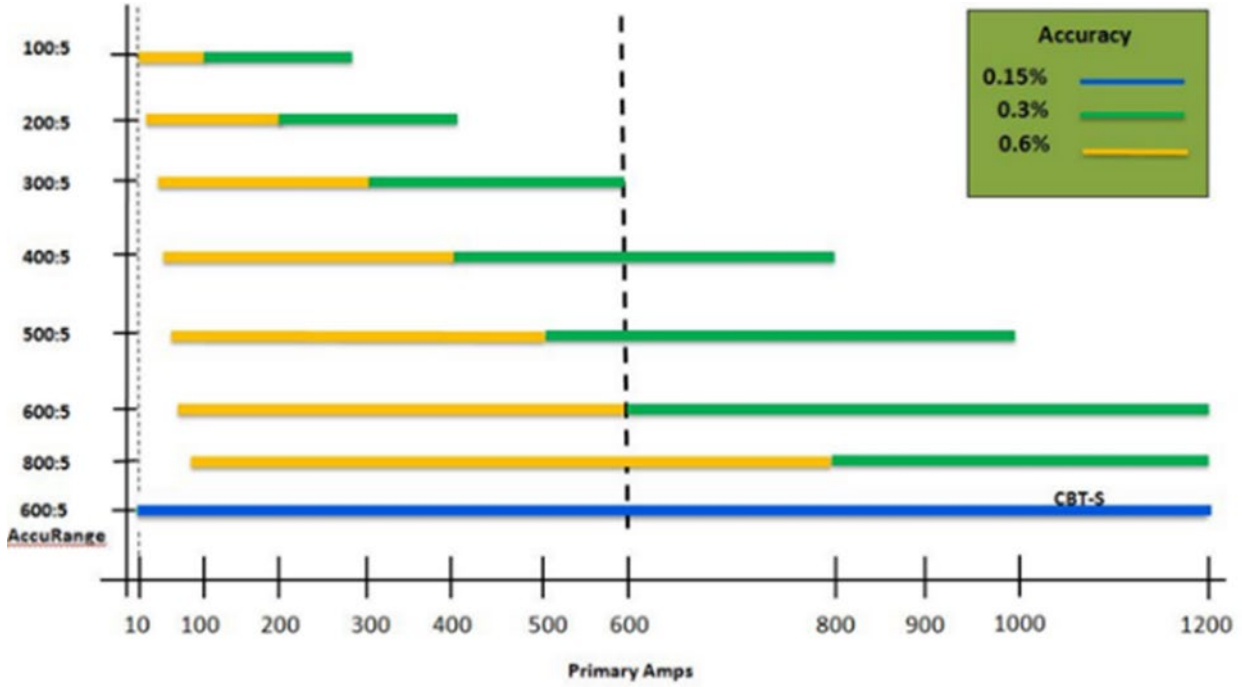
Accuracy of +/- 0.15% from 1% of the rated current to the rated factor

– Exceeds the highest accuracy 0.15S IEEE accuracy class

Increase revenue, most prominently on MV products

Reduce part numbers and inventory, MV and LV

Reduce meter multiplier diversity – simplify operations with less chance of billing errors

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# ResiVolt technology

## World's first dry-type voltage transformers designed for very fast transient (VFT) resistance

Enhanced withstand to VFT overvoltages
- Common in renewable and frequent line switching installations
- Near reclosers, solar/wind farm interconnections, etc.

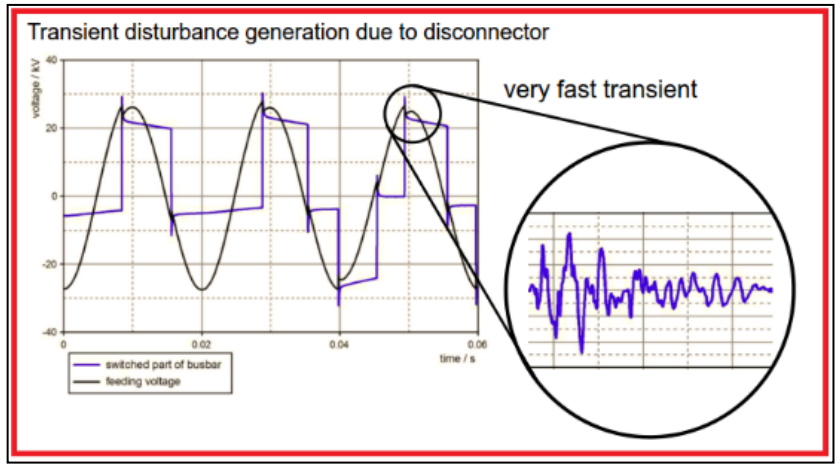
Optimized using advanced mechanical and electrical modeling for field performance
- ABB testing exceeds IEC 61869-3, class 7.2.3 and CAN/CSA 411.1, class 6.6 requirements for basic impulse and fast impulse transient withstand
- Large multi-year global effort to investigate models and designs to mitigate the effects of VFT

Global ABB collaboration and collaboration with a Swiss university to create the software model which had not existed previous to this
- Multiple aspects of design changes – design details are trade secret and cannot be shared

Improved safety
- Withstand VFT without insulation degradation, reducing the chance of catastrophic failure

Unparalleled reliability
- Minimizes failures at critical interconnection or metering points

Extended factory warranty (36 months instead of normal 12/18 months) included on all ResiVolt VTs




**For more information on the VFT phenomenon – contact the factory**
**Voltage transformer type designations that end in "R" are part of ABB's ResiVolt product family**

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# CVC combination ITs

## Application benefits

Streamlined footprint

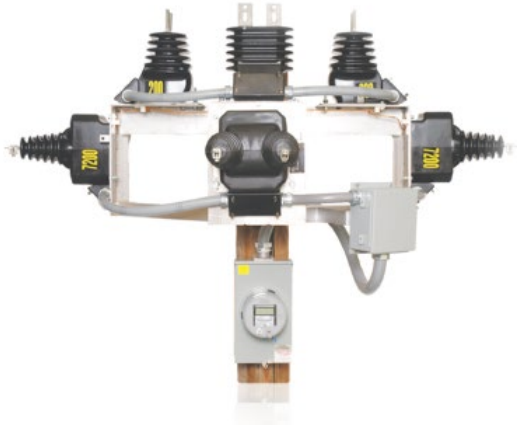
- Lighter weight, less complicated 3 phase installations – safer, simpler, more fool proof
- Significant operational savings
- Lightest combination units in the industry

HCEP encapsulant

- Superior to all other HCEP and CEP in market
- ABB helped invent HCEP and has a special formulation that is the best in the industry

Application variety

- Standard accuracy – metering + protection/relaying
- HAER – high accuracy on CT with extended range current capability for metering only



**Traditional configuration of CTs and VTs**

**Streamlined configuration of CVCs**

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# Sensors for utility applications

Advanced primary measurement solutions responding to emerging challenges

25+ years old technology

Use solid state components and little or no ferromagnetic material in circuit

Lack of magnetic core – very low energy output – cannot typically transfer power to secondary

Numerous form factors for indoor and outdoor applications (voltage only, current only, combination)

Wide variety of outputs – from 0-10 V, 120V and 600 A





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# Sensors for utility applications

Features

## Hybrid Rogowski coil

Rogowski coil with some iron in magnetic circuit

Accurate current sensing provides a 10 V output

Current sensing 1%-2% accuracy depending on design

Compatible with wide selection of intelligent electronic devices

## Low-power CTs

Current transformer based on iron core with optimized output power

1A output for real-time reading of the current wave form

Current sensing 1%-2% accuracy depending on design

Compatible with wide variety of controllers

## Resistive voltage dividers

Accurate voltage sensing provides 3-10 V or 120 V outputs

Voltage sensing 0.5% to 1% accuracy, depending on design

Compatible with wide selection of intelligent electronic devices

©ABB

# Key benefits of sensors vs. traditional ITs

**Reduced chances of failure**
simpler construction, fewer internal failure points

**Safe**
Increased safety for personnel during testing/operation

**Easy, affordable upgrade**
Indoor sensors can often be retrofitted in existing structures with new relays

**Integration**
Typically no risk of ferroresonance (voltage sensor vs PT)

**Efficient**
Reduced energy use, esp. in tight compartments

**Flexibility toward varying load**
linear response, extensive dynamic range (no core saturation)

**Simplified installations**
Less wiring, smaller footprint, lighter weight

**Standardization**
One sensor covers full voltage or current range of traditional IT family

# Sensors for utility applications

ABB DistribuSense® MV sensor offering

**VLS**

**Voltage sensor**

Voltage output

**KLS**

**Current sensor**

Current output

**VKS**

**Current sensor**

Voltage output

**VCS**

**Combination – voltage and current**

Voltage outputs

**WLS**

**Combination – voltage and current**

Current and voltage outputs



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# Sensors for utility applications

## RSS-1 - submersible current sensor

Introducing the world's first **truly hermetically sealed**, rustproof, waterproof submersible, split core current sensor

- **True hermetic sealing** – no exposed metal parts, truly submersible without degradation
- **Low energy output** – no safety risk from open circuit
- **Voltage clipping** – output limited in faults to protect receiving device from damage, yet gives enough magnitude for fault indication
- **Crosstalk mitigation** – unique winding structure to ensure accuracy without degradation from current "cross talk" from adjacent conductors
- **Easy install** – quick "tools free" install, easy to deploy even with PPE typical in the application

**RATINGS SUMMARY**

- 600A : 10V
- Accuracy 1%
- RF 2.0 cont.
- NEMA Type 6P/IP68W compliant (2 meters depth)
- 5.5 lbs (10 lbs with 75 ft cable)

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# Battery Energy Storage Systems (BESS) and Battery chargers

# Battery Energy Storage applications

## Applications

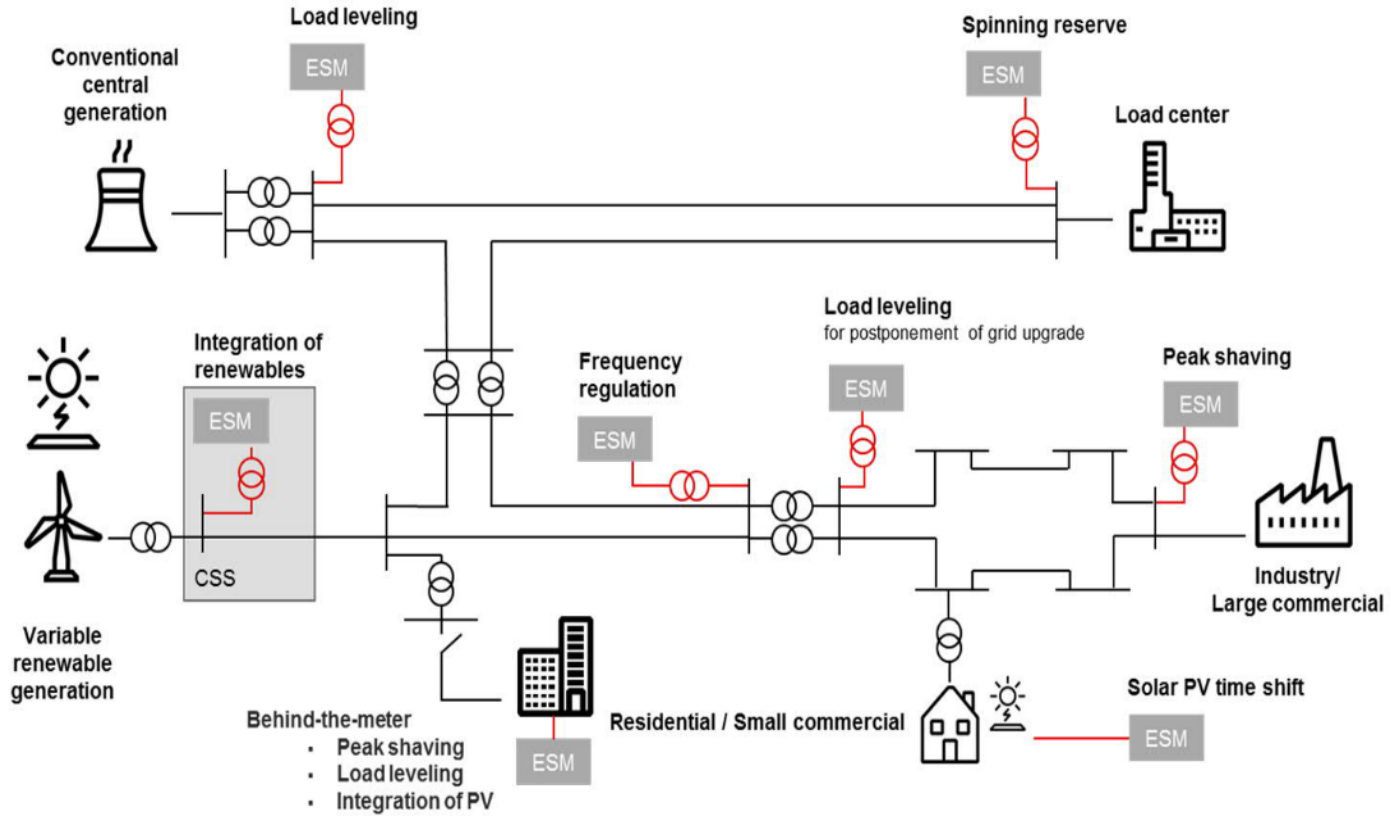
**Renewables**
ESM(Energy Storage Module) aligns solar and wind generation peaks with demand peaks.

**Utility distribution grid**
ESM balances fluctuating demand without oversizing equipment.

**Industrial loads**
ESM provides back up power, improves load factor and manages demand peaks

**Residential and commercial**
ESM lowers energy costs and provides backup power for critical loads

**Electrification of transportation**
Reduces demand on grid and enables fast DC charging without increasing demand charges





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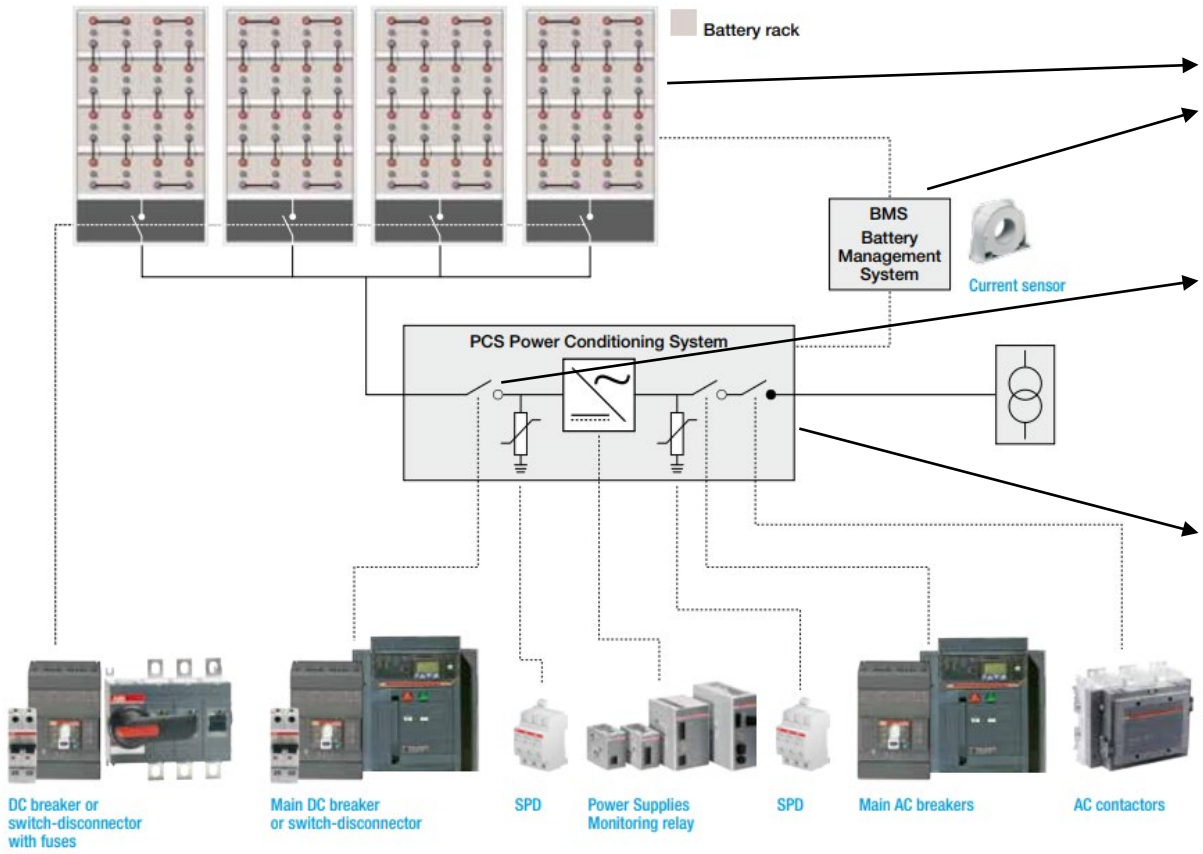
# Battery Energy Storage Systems(BESS) components for the OEM

Sold to PCS( Power Conversion System) OEMs, BMS(Battery Management System(OEMs), EMS(Energy Management System) OEMs, ESM(Energy Storage Module) OEM’s and their distributors

# Components for the Energy Storage Systems OEMs

**Sold to PCS( Power Conversion System) OEMs, BMS(Battery Management System(OEMs), EMS(Energy Management System) OEMs, ESM(Energy Storage Module) OEM's and their distributors**

Figure 4




## Selection parameters

**Battery side – DC***
- **Voltage:** up to 1500VDC
- **Protection device*:** semiconductor fuse or MCB/MCCB
- **Duty:** load break and short-circuit fault level/withstand rating
- **Short-circuit:** fault level or withstand rating required

**DC Main disconnect/isolation**
- **Voltage:** up to 1500VDC
- **Isolation:** Disconnect switch or breaker disconnect
- **Duty:** load break/no-load break
- **Short-circuit:** fault level or withstand rating required

**AC Side**
- **Voltage:** up to 690VAC
- **Protection device:** MCCB/ACB/Fusible switches
- **Duty:** load break
- **Short-circuit:** fault level or withstand rating required

- **Automatic AC or DC disconnection (optional)****



* Subject to high fault currents on battery type and withstand rating required (Flow: 2-5xIn, Lead-acid: >100xIn, Li-ion: 45-55xIn)
**MCB:** miniature circuit breaker | **MCCB:** molded case circuit breaker

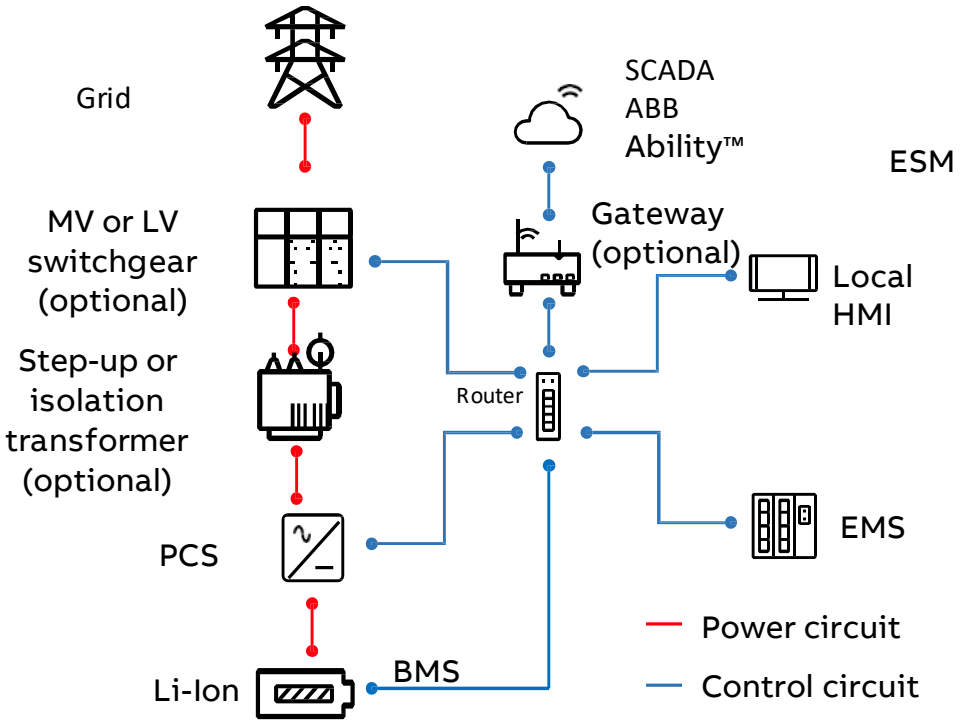
ACB: air circuit breaker
Breaker disconnect: breaker working as a disconnect switch w/o protection
** can be accomplished with motorized devices or contactors

# Battery Energy Storage System (BESS), Utility & Commercial

Sold to Utilities, Developers, Municipalities, EPCs and their distributors

# Energy storage solutions

## Scope of a typical energy storage module (ESM)




**Enclosure options for wide array of site conditions:**

- Compact secondary substation (CSS), EcoFlex eHouse or skid
- Modular design for tight or complex spaces

**Productized solution** for improved delivery and startup time

**Proven ABB technology**

- Power conversion system (PCS)
- Medium voltage/low voltage switchgear
- Transformer
- Energy Management System (EMS) and local HMI

**Ratings**

- Power: starting at 25kW (not residential)
- Energy: configurable by battery parallel connection
- Grid connection voltage: up to 40.5kV

**Typical customer base** is utilities, industrials, EV, buildings

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# ABB Energy Storage Modules (ESM) Modular Design

## Proven, global and reliable

The global need for energy storage is growing at a rapid rate driven by items such as economic growth, increasing solar and wind resources, the electrification of transportation and backup power needs.

Energy storage modules (ESM) from ABB offer an integrated engineered and tested system solution for a wide variety of applications across industry, infrastructure, residential and utility sites.

**Choosing ABB solutions with proven technology enables:**

- **Fast project completion** - System engineering, factory system testing and reduced or eliminated site preparation costs, lowers schedule risk and improves project benefits.
- **Reliable solutions** - Internal arc tested MV equipment to IEC standards for safety, enclosure offerings for harsh environments and years of global installed base experience provide peace of mind.
- **Communication** - From local monitoring and control to dynamic optimization of resources, the platform supports a wide range of monitoring and control needs and will support advancements over the life of the equipment.


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# Selecting the correct energy storage solution

## 5 steps – major questions to consider

Step 1: Required standard?

- IEC/ANSI

Step 2: Required power and energy, and its application?

- Required power [kW]
- Required energy [kWh]
- Application (examples: load shifting, backup power, etc.)

Step 3: Network connection voltage?

Step 4: Site conditions?

- Installation in public domain
- Indoor access to equipment for maintenance
- Seismic requirement
- Transportation and site work condition
- Temperature and altitude
- All-in-one or modular type

Step 5: Control system?

- EMS (Energy Management System, which has control algorithm in ESS) without HMI (display, report, data storage)
- EMS with HMI
- External SCADA communication
- Integration with renewable or other system


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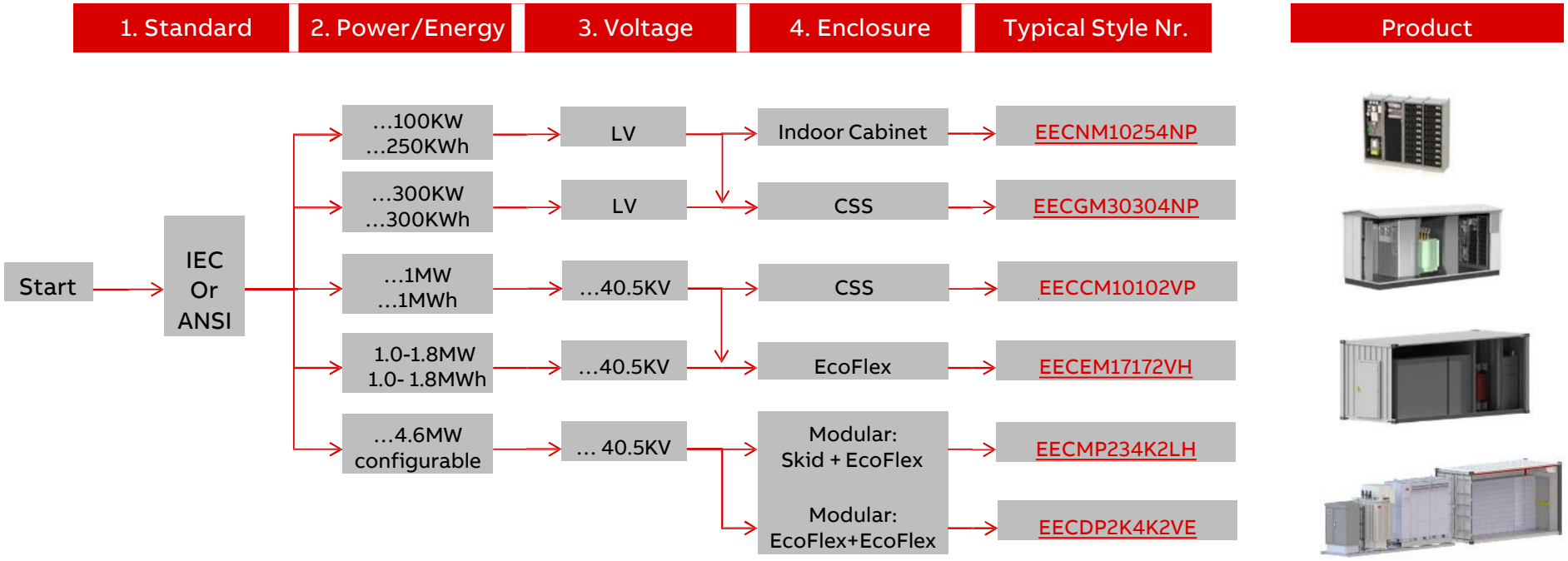
# Energy Storage Module Package Selection

## Selection logic



# Energy storage module other auxiliary selections

Overview of optional selections available for all the packages

## A. Power electrical

Different electrification technologies can be selected

| Products | Sample |
|---|---|
| MV transformer | Oil or dry SafeRing SafePlus |
| Low voltage | Breakers |
| Control power distribution board | Various control power |

## B. Control system

PLC options
Comm600 controllers
ZEE600 controller
with the EMS

ESM control system can be monitored and controlled by SCADA system for ease of interface between all the electrical equipment

It can then connect through existing 3G/4G broadband

## C. Ancillary equipment

eHouse or EcoFlex:
- Natural cooling
- HVAC cooling
- Fan cooling
- Fire detection and suppression

Control power and battery connection panel (BCP) for protection and control

UPS for protection and control power

## D. ABB Ability™

All the packages can be ABB Ability enabled

The whole system can be monitored, controlled, and commanded from remote locations

# Energy storage form factor module package selection

Enclosure type and features to consider

## Skid

Open air secondary skid unit is an ideal power conversion solution system for a high-power Energy Storage Module with outdoor equipment design.

- Pre-engineered solution reduces delivery time
- Economical and fast installation solution
- Pre assembled and tested single piece solution
- Easy to install and operate

## EcoFlex container

The metal enclosed EcoFlex is utilized for mid and high-power energy storage, and is a modular design, type tested to withstand internal arc according IEC 62271-202

- Stackable, expandable ISO standard enclosures
- Easy to ship, load and offload
- Robust and scalable solution
- Relocatable solution can be adapted for temporary power

## Compact secondary substation (CSS)

CSS is ideal for low power Energy Storage. Available in multiple materials: metal or new innovative glass reinforced polyester (GRP), and type tested to withstand internal arc according IEC 62271-202.

- Pre engineered solution to minimize project engineering
- Available in multiple configurations, and a variety of sizes and materials to cover all requirements
- Simple and quick installation
- Internally arc tested, to provide maximum safety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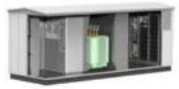
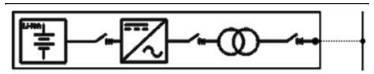
# Energy Storage Module Packages

Overall offering

## Low-power offering

| ESM Type | Community Energy Storage (CES) | CES |
|---|---|---|
| Power | Up to 100kW | Up to 300kW |
| Energy | Up to 250kWh | Up to 300kWh |
| Enclosure type | Indoor panel | CSS |
| Layout |  |  |
| SLD |   | |
| Key feature | One-piece delivery<br>Compact design, simple indoor installation | One-piece delivery<br>Internal arc tested for safety, metal and GRP option |

## Mid-Power offering

| ESM Type | Distribution Energy Storage (CES) | DES |
|---|---|---|
| Power | Up to 1.0MW | Up to 1.8MW |
| Energy | Up to 1.0MWh | Up to 1.8MWh |
| Enclosure type | CSS | EcoFlex |
| Layout |  |  |
| SLD |  | |
| Key feature | One-piece delivery<br>Internal arc tested for safety, metal and GRP options | One-piece delivery<br>Robust for easy transportation and installation |

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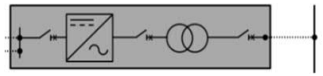
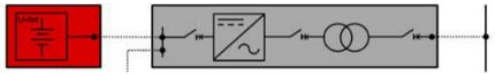
# Energy Storage Module Packages

Overall offering

## High-power offering + complete solutions

| ESM Type | Connection Energy Module (CEM) | CEM | DES | DES |
|---|---|---|---|---|
| Power | Up to 4.6MW | Up to 4.6MW | Up to 4.6MW | Up to 4.6MW |
| Energy | N/A (w/o battery) | N/A (w/o battery) | Configurable (with battery) | Configurable (with battery) |
| Enclosure type | Skid | EcoFlex | Skid(CEM) + EcoFlex(Battery) | EcoFlex(CEM) + EcoFlex(Battery) |
| Layout |  |  |  |  |
| SLD |  | |  | |
| Key feature | Economic solution, ease of installation | Robust for easy transportation and installation<br>Internal arc tested | Scalable solution<br>Economic solution, ease of installation<br>Internal arc tested | Scalable solution<br>Robust structure for easy transportation and installation<br>Internal arc tested |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# Energy Storage Module

Community energy storage - indoor

## Electrical specifications

| DC input | |
|---|---|
| DC operating voltage range | 633-822 V (at PF=1) |
| Max. DC operating current | 1200A |
| DC grounding | Floating only |

| AC output | |
|---|---|
| Output power (S) | 100kVA |
| Output energy | 250kWh |
| Nominal voltage | up to 690V |
| Frequency | 50/60Hz |
| Power factor range | 4-quadrant, 0 to 1 |

## Description

Energy storage module for low voltage connection.

This equipment is integrated into an enclosure suitable for use in indoor conditions including the fans, HMI, control and communication equipment for local and remote operation.

## Values

High reliability with extensive risk and failure mode analysis

Maximize the return of investment with pre-engineered and factory tested solution


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# Energy Storage Module

Community energy storage (CSS)

## Electrical specifications

| DC input | |
|---|---|
| DC operating voltage range | 633-822 V (at PF=1) |
| Max. DC operating current | 1200A |
| DC grounding | Floating only |

| AC output | |
|---|---|
| Output power (S) | 300kVA |
| Output energy | 300kWh |
| Nominal voltage | up to 800V |
| Frequency | 50/60Hz |
| Power factor range | 4-quadrant, 0 to 1 |

| Equipment | |
|---|---|
| Enclosure | CSS |
| Transformer type | N/A |
| Medium voltage switchgear | N/A |

## Description

Energy storage module for low voltage connection with CSS enclosure in multiple materials with metal or new innovative glass reinforced polyester (GRP). The enclosures are designed to protect the equipment from external environmental influence and to be located in public areas. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

## Values

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Available in multiple configurations, sizes and materials
- Maximize ROI with pre-engineered and factory tested solutions
- Simple and quick installation

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# Energy Storage Module

Distribution energy storage (DES)

## Electrical specifications

| DC input | |
|---|---|
| DC operating voltage range | 633-822 V (at PF=1) |
| Max. DC operating current | 1200A |
| DC grounding | Floating only |

| AC output | |
|---|---|
| Output power (S) | 1000kVA |
| Output energy | 1000kWh |
| Nominal voltage | up to 40.5V |
| Frequency | 50/60Hz |
| Power factor range | 4-quadrant, 0 to 1 |

| Equipment | |
|---|---|
| Enclosure | CSS |
| Transformer type | Oil-filled, dry type |
| Medium voltage switchgear | ABB SafeRing/SafePlus |

## Description

Energy storage module for medium voltage connection with CSS enclosure in multiple materials with metal or new innovative glass reinforced polyester (GRP). The enclosures are designed to protect the equipment from external environmental influence and to be located in public areas. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

## Values

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Available in multiple configurations, sizes and materials
- Maximize ROI with pre-engineered and factory tested solutions
- Simple and quick installation

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# Energy Storage Module

Distribution energy storage – EcoFlex eHouse

## Electrical specifications

| DC input | |
|---|---|
| DC operating voltage range | 845-1096 V (at PF=1) |
| Max. DC operating current | 2400A |
| DC grounding | Floating only |

| AC output | |
|---|---|
| Output power (S) | 1800kVA |
| Output energy | 1800kWh |
| Nominal voltage | up to 40.5V |
| Frequency | 50/60Hz |
| Power factor range | 4-quadrant, 0 to 1 |

| Equipment | |
|---|---|
| Enclosure | EcoFlex |
| Transformer type | Oil-filled, dry type |
| Medium voltage switchgear | ABB SafeRing/SafePlus |

## Description

Energy storage module for medium voltage grid connection with EcoFlex enclosure. The enclosures are designed to protect the equipment from external environmental influences and to protect operation personnel. The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

## Values

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Maximize ROI with pre-engineered and factory tested solutions
- Easy to ship, load and offload
- Robust and scalable solution
- Relocatable solution adaptable for temporary power needs


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# Energy Storage Module

Connection equipment modules with skid

## Electrical specifications

| | |
|---|---|
| **DC input** | |
| DC operating voltage range | 680 to 1500V (at PF=1) |
| Max. DC operating current | 2400A |
| DC grounding | Floating only |
| **AC output** | |
| Output power (S) | Up to 2300kVA |
| Output energy | N/A |
| Nominal voltage | up to 40.5V |
| Frequency | 50/60Hz |
| Power factor range | 4-quadrant, 0 to 1 |
| **Equipment** | |
| Enclosure | Skid |
| Transformer type | Oil-filled, dry type |
| Medium voltage switchgear | ABB SafeRing/SafePlus |

## Description

ABB's connection equipment module (CEM) is a packaged power conversion system for energy storage applications that performs the bidirectional AC/DC energy conversion between the grid and the battery system.

The secondary skid unit is an economical way for high-power energy storage with outdoor equipment design.

## Values

- Easy to install and operate
- Flexible, modular concept allows for ease of scalability
- Pre-assembled and tested single piece solution
- Optimized solution to maximize ROI
- Pre-engineered solution reduces delivery time

©ABB

# Energy Storage Module

Connection Equipment Modules with EcoFlex

## Electrical specifications

| | |
|---|---|
| **DC input** | |
| DC operating voltage range | 680 to 1500V (at PF=1) |
| Max. DC operating current | 2400A |
| DC grounding | Floating only |
| **AC output** | |
| Output power (S) | Up to 2300kVA |
| Output energy | N/A |
| Nominal voltage | up to 40.5V |
| Frequency | 50/60Hz |
| Power factor range | 4-quadrant, 0 to 1 |
| **Equipment** | |
| Enclosure | EcoFlex |
| Transformer type | Oil or dry type |
| Medium voltage switchgear | ABB SafeRing/SafePlus |

## Description

ABB's Connection Equipment Module(CEM) is a packaged power conversion system for energy storage applications that performs the bidirectional AC/DC energy conversion between the grid and the battery system.

The enclosures are designed to protect the equipment from external environmental influences and operation personnel. The pre-engineered solution allow scalability, reduction of installation costs, high reliability and reduced project execution times.

## Values

- Internally arc tested, and electrically compartmentalized to provide improved safety
- Maximize ROI with pre-engineered and factory tested solutions
- Easy to ship, load and offload
- Robust and scalable solution
- Relocatable solution adaptable for temporary power needs

# Energy Storage Module

Distribution energy storage – modular design

## Description

ABB's Energy Storage Module is a packaged solution that stores energy for use at a later time to maximize system efficiency.

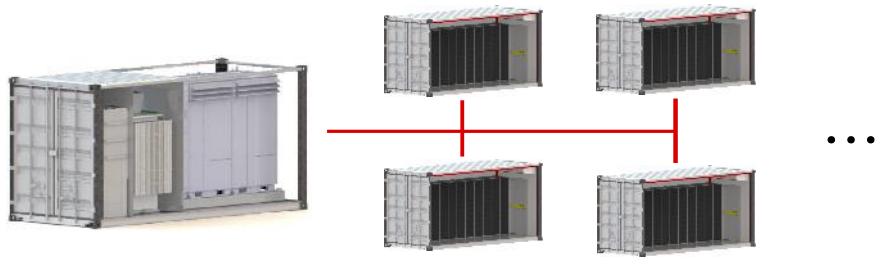
The different versions of the pre-engineered and industrialized ESM allow scalability, reduction of installation costs, high reliability and reduced project execution times.

This design utilizes a Connection Equipment Module and battery modules for a complete solution.

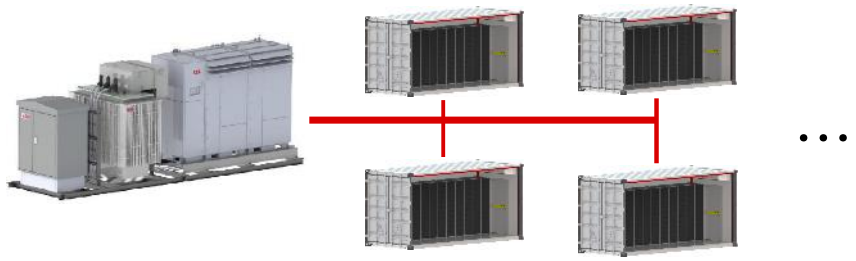
## Values

- Improved safety with arc tested equipment
  Easy to install and operate
- Flexible with modular concept to allow ease of scalability in power and capacity
- Maximize ROI with pre-engineered and factory tested solution
- High reliability with extensive risk and failure mode analysis

## EcoFlex + EcoFlex



## Skid + EcoFlex



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# Wind solution

Integrated energy storage with solar/wind generation

## Customer challenges

Solar/wind power hard to properly forecast

Renewable generation not aligned with the demand

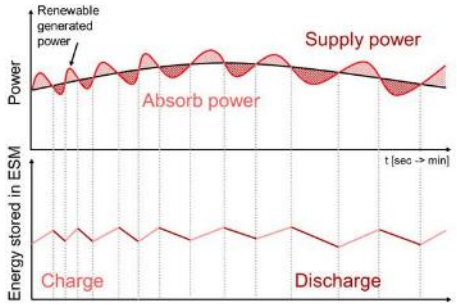
Renewable mandates and incentives

Tax benefit for storage systems

## Application

Battery energy storage system with solar/wind power generation

Peak shaving, supplement power quality, store excess power




## Value

**One-piece delivery**

– Simple installation

**Factory assembled and tested**

– Reduce site testing and commissioning.

**Safety**

– Mitigate site safety risk.

**Capacity firming**

– Increase reliability and improves efficiency of the renewable plant

**Tax and regulatory incentives**

– Potential tax benefits or incentives for clean grid technology

## Typical equipment

V switchgear

Distribution transformer

Renewable integration

Local control

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# Large-scale utility solution

Scalable energy storage for grid utility customer

## Customer challenges

Economic and population growth leads to increasing demand for power

Coal plant retirements, reducing baseload power capacity

Growth in renewables, reducing reliability on the electrical grid

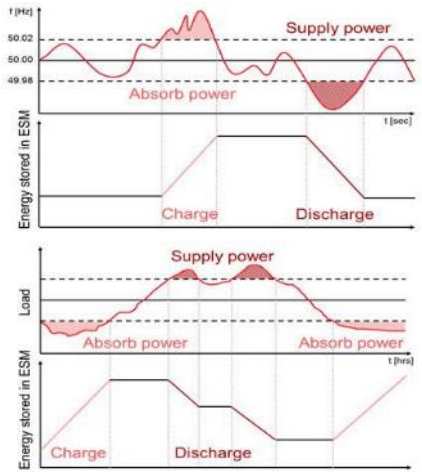
New power generation plant costs too much and takes long time

Economic power generation by load leveling

## Application

Scalable energy storage with modular system

Continuity and power resilience




## Value

**Pre-engineered solution**

– Schedule improvement

**Scalability**

– Modular design

**Transportation**

– Robust structure (EcoFlex)

**Factory assembled and tested**

– Reduce site commissioning

**Safety**

– Mitigate site safety risks

**Frequency regulation**

– Increases reliable operation

**Load leveling**

– Postpone investments in grid

## Picture

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# Why choose ABB for your energy storage solution needs

Value proposition

## Trustworthy partner

World leader in digital industries to serve customers

Pioneering technology leader focused on digital industries

Strong global team

## Maximize the return of investment

Pre-engineered and industrialized products with reduced project engineering

Reduced installation and transportation costs

Maximized uptimes due to factory assembled and tested solutions

## High reliability

Protected equipment from environmental influences

Factory tested solution

Designed to withstand severe environmental conditions

Undergone extensive risk and failure mode analysis

Advanced and efficient temperature control provided for the inverter and battery system.

IEC compliant

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# Why choose ABB for your energy storage solution needs

Value proposition

## Flexible

Modular concept to allow ease of scalability in power and capacity

From low-voltage to a wide range of AC medium-voltage levels

Engineered footprint to optimize customer's requests

Different options of MV switchgear from ABB's SF6 gas-insulated secondary switchgear portfolio (also available with air-insulated switchgear)

Performs all energy storage applications in given power range

## Safe and easy to install and operate

Internally arc tested for public and service personnel

No live parts accessible

Locking system for all enclosure doors prevents unauthorized entry of personnel

Local and remote monitoring and control, easy integration to customer SCADA and ABB Ability™

Ease of transportation due to standardize solutions

Pre-assembled and tested at ABB premises to reduce on-site times

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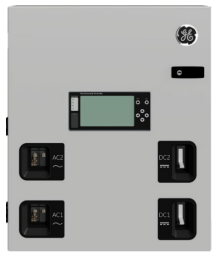
# Industrial and utility products: switchgear battery chargers

## Integritas wall chargers



Large capacity (20-150A), small footprint

Modular with hot-swappable rectifiers

Only 3 Phase 480V wall mounted charger in industry

Markets:

- Utility substation and switchgear control-renewables
- Pumping station and motor operation

## Integritas floor chargers

Large capacity (20-800A), small footprint

Configurable distribution

Modular with hot-swappable rectifiers

Markets:

- Utility substation and switchgear control-renewables
- Heavy industrial, marine, off-shore
- Power generation and distribution

## Infinity industrial

Configurable communication DC system

Configurable distribution

Modular with hot-swappable rectifiers

Markets:

- Utility communication systems-renewables
- Power generation control power
- Oil and gas communication and control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# Wall mounted battery chargers

## General features / options

Modular design for easy upgrade and maintainability

Advanced controller with secure protocols (SNMPv3, HTTPS, SSL, SSH), MODBUS, IPv6, NERC compliance with full remote access. DNP3 and IEC61850 options.

Input and output surge protection and ground fault detection

-40°C to 75°C operation

## Single phase chargers (infinity based)

Modular rectifier constructions

Nominal input: 120 – 277 VAC

Input AC type: 1F, 3F unbalanced Delta (3PH,G) or WYE (3PH,N,G)

Outputs:

- 24V: 21 – 29VDC; 100A modules
- 48V: 42 – 58VDC; 50A modules
- 125V: 95 – 160VDC; 20A modules

## True three-phase chargers (GP based)

Modular rectifier constructions

Input Voltage: 380 – 480 VAC 3F Delta (3W+G)

Outputs:

- 24V: 21 – 29VDC; 100A modules
- 48V: 42 – 58VDC; 100A modules
- 125V: 95 – 160VDC; 50A modules
- 250V: 180 – 290VDC; 25A modules

## Info

Dimensions and mounting

- H: 28.25” (718mm) W: 17.5 – 23” (356 - 584mm) D: 14” (356mm)
- Reversible mounting brackets for wall or rack mount

Battery support / monitoring

- Complete suite for capacity and battery health testing
- VRLA, lead calcium and NiCad support


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# Floor mounted battery chargers

## General features and options:

- Modular design for ease upgrade and maintainability
- Multi-voltage operation to support controls, fire systems and equipment drives
- Designated advanced controller with secure protocols (SNMPv3, HTTPS, SSL, SSH), MODBUS, IPv6, NERC compliance with full remote access per Charger Group
- Sectionalized input surge protection with AC breakers
- Output distributions with surge protection and ground fault detection
- Remote and local emergency shutdown
- -40°C to 75°C operation

## Outputs and capacities:

- Each 1RU shelf can provide the following output capacity:
  - 24V – 300A
  - 48V – 150 to 225A
  - 125V – 60A
- Sample P&W LM6000:  two independent 24V systems with 600A capacity and one 125V system (5 shelves) with 375A capacity.
- Configurable output distribution with up to 12 breaker outputs per row of distribution

## Configurable parameters:

- Input and output voltages
- Output capacity and type
- Battery connectivity
- Output distribution for field configurations
- Motor starter
- Input transformer for wider range operation


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# Infinity-S dual voltage

**Features:**
- Low cost
- High density
  - **-48V 800A** +300A +24V
  - **+24V 800A** +240A -48V
- Flexible distribution – 1 or 2 panels, 26 selectable voltage positions each
- Flexible growth scenarios
- Universal power shelf
- High efficiency
- ECO priority ready
- Advanced controller features

**Rectifiers:**
- NE050AC48TEZ – 50A, 48V
- NE100AC24TEZ – 100A, 24V
- 96-97% efficiency

**Converters:**
- NE030DC48 – 30A, 48V
- NE075DC24 0 75A, 24V


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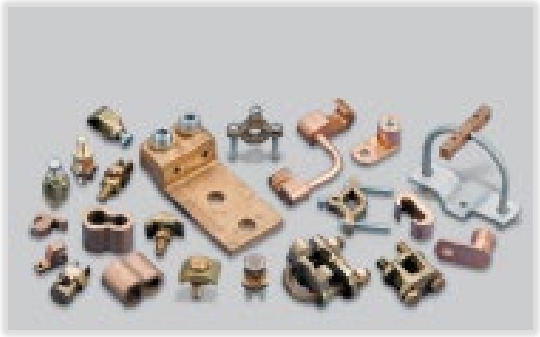
# Solar plant construction and connection components

Sold to Solar distributors, installers and contractors

# Utility applications: power-plant products

Construction and connection components:

## Grounding systems



## Solar panel-installation products

## Nylon Conduits and fittings

## Solar clips

## Cable ties UV rated

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# Conduit and piping

P&C flex
Fittings
Elbows
Straight pipes








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# Conduit and piping continued

## Carlon PVC Products

- Straight pipes
- P&C flex conduits
- Fittings
- Elbows
- Junction boxes
- PVC cement


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# Lugs and wire termination

## Lugs and wire termination

### Color-Keyed® Connectors for Aluminum/Copper Code Conductor

**Designed and Approved for Use with Either Aluminum or Copper Conductors**

- Temperature rating of 90° C
- Filled with oxide-inhibitor compound
- Rated for 600V to 35kV applications
- Material: High-conductivity wrought aluminum
- Finish: Electro-plated tin

### Color-Keyed® Connectors for Copper Code Conductor

**Designed and Approved for Use with Copper Conductors**

- Rated for 600V to 35kV applications
- UL® Listed for flex strandings
- Color coded to help installer select the proper application dies
- Material: High-conductivity wrought copper
- Finish: Electro-plated tin

### Color-Keyed Battery Smart Tool Dieless Crimper

- Dieless Crimper
- #8-750kcmil
- (2) Milwaukee Tool batteries
- 30% faster than previous model

# Utility applications: power-plant products

## Construction, connection and protection components

Blackburn E-Z Ground Compression Connectors

Blackburn Narrow-Tongue Lugs

Joslyn VerSaVac MV Capacitor Switches

Fisher Pierce Fault Indicators, Sensors and Controls

Kindorf Cobra Clamps

Elastimold MV Molded Vacuum Interrupters

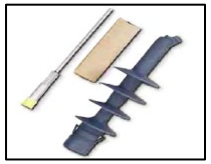
PMA Conduit Fittings

PMA Conduit

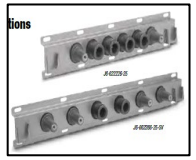
PMA Strain Relief

Elastimold MV Connectors, splices, and terminations

Elastimold 200 & 600amp MV Surge Arrestors



Elastimold MV Overhead Terminations



Elastimold MV Multi-Point Junctions

Ocal Conduit Straight, Elbows

OPR External Lightning Protection

Joslyn Lightning and Surge protection For stand alone equipment

Hi-Tech MV Current Limiting Fusses

**Construction Solutions**

- Blackburn: ground connectors and lugs
- Joslyn: MV capacitor switches, 15-38KV
- Fisher Pierce: indicators, sensors and controls
- Kindorf: cobra clamp, metal framing and strut
- PMA: fittings, conduits and strain relief
- Elastimold: MV connectors
- Elastimold: MV surge arrestors
- Elastimold: MV overhead terminations
- Elastimold: MV multi-point junctions
- Elastimold: MV molded vacuum interrupters
- Ocal: conduit; straight, elbows
- OPR: external lightning protection
- Kindorf: strut and pre-engineered framing
- Hi-Tech: MV current limiting fuses, 15KV, 35KV
- Joslyn: lightning and surge protection

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# ABB in the growing renewables market – Solar & Battery Energy Storage

## Solutions Low to Medium Voltage- Products, systems, software and services


*Allen Austin*

**Sr. Market Development Manager-Americas**

**Renewable Energy & Power Generation**
**Electrification business**

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# Additional technical slides

# What you must know

Minimum information when specifying ITs

## Basic information

Indoor or outdoor use

System voltage and BIL

Metering class and rated burden

Protection/relay class

Frequency (if other than 60 Hz)

Operating ambient temperature (if other than 30OC)

Mounting orientation

## … specifically for CTs

Primary current, taps if applicable

Secondary current, taps if applicable

Window, bar, or wound primary type

Gapped core, remanence control

Continuous current rating factor (RF)

Short-time thermal and mechanical ratings

## … specifically for VTs

Primary voltage, taps if applicable

Secondary voltage, taps if applicable

L-L or L-G connected

Primary fuses

Thermal capacity – VA (for light power use)

Over-voltage ratings, continuous and short-time duty, IEEE Group class

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# IT product lines for utility applications

LV applications (600 V)

## 600 V metering

Current and voltage transformers

Encapsulated in thermoplastic rubber (TPR)

Available in current and voltage designs

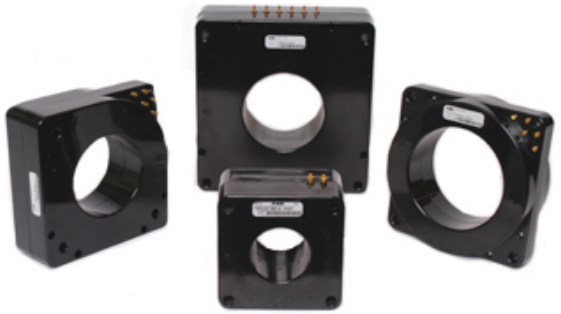
Used for secondary revenue metering

AccuRange high accuracy extended range (HAER) CTs


## 600 V plastic case ITs

Offered in a variety of internal window diameter sizes

Used in switchgear and outdoor vacuum breaker applications (R-Mag)



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# IT product lines for utility applications

MV applications (5 – 34.5 kV)

## Outdoor medium voltage

- Utilized in utility substations
  - Designed for metering and relaying on outdoor circuits
- Materials
  - HCEP (hydrophobic cycloaliphatic epoxy)
  - PUR (polyurethane)
- AccuRange® high accuracy extended range (HAER) CTs
- ResiVolt™ VFT resistant VTs
- Combination CT/VT ITs
- Station post CTs




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# IT product lines for utility applications

## Station post CTs – metering and protection

LG and LGX

- 15 – 34.5 kV, 110 – 200 kV BIL
- Window (4.5-8.75” ID) and bar type designs
- Metering accy 0.3 & 0.15S (AccuRange CT), relaying to C800
- CEP tube

KOTD-110, -150, -200

- 15 – 34.5 kV, 110 – 200 kV BIL
- Window (4-5” ID) and bar type designs
- Metering accy 0.3, relaying to C800

KOT-60, -75, -11, -15

- 15 – 34.5 kV, 110 – 200 kV BIL
- Window (3.25” ID) and bar type designs
- Metering accy 0.3, relaying to C200

Marketing message

- Optimizing pricing to promote business across station post CT product family
- Working to develop better selection guide for these ITs

# IT product lines for utility applications

MV and HV applications

## Bushing current transformers (indoor)

- Ring-type current transformers
- Polyester or cotton tape wrap
- Typical applications include high voltage circuit breakers and power transformers

## Bushing current transformers (outdoor)

- Urethane insulation
- Basic impulse level: 0.6 kV
- 15 kV – 765 kV Application:
  - Slips over the primary bushing of power transformers and oil-filled breakers
  - Substation metering and protection

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# IT product lines for utility applications

Generator applications

## Generator CTs – metering and protection

- Indoor and outdoor
- Board mounted (155°C insulation, up to 32” ID) and resin cast (130°C insulation, up to 51” ID)
- Basic impulse level: 0.6 kV
- Extensive product offering of proven designs with decades of field experience
- Durable design against water intrusion and vibration
- Highly customizable
- Application:
  - Mounted over generator bushing
  - 2000 amperes to 50,000 amperes
  - Proprietary shield windings to prevent stray flux interference
  - IEEE/IEC designs sold worldwide

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# IT product lines for utility applications

Split core, retrofit applications

## Split-core CTs – monitoring, metering and protection

- Metering accuracy to 0.3 class
- Relaying accuracy to C800
- Convenient mounting around primaries which cannot be opened
  - Common for retrofit solutions
- SP window sizes up to 41"
- CO window sizes of 2½", 5½", 9", sq. (custom sizes available)

SP-061

CO-9740

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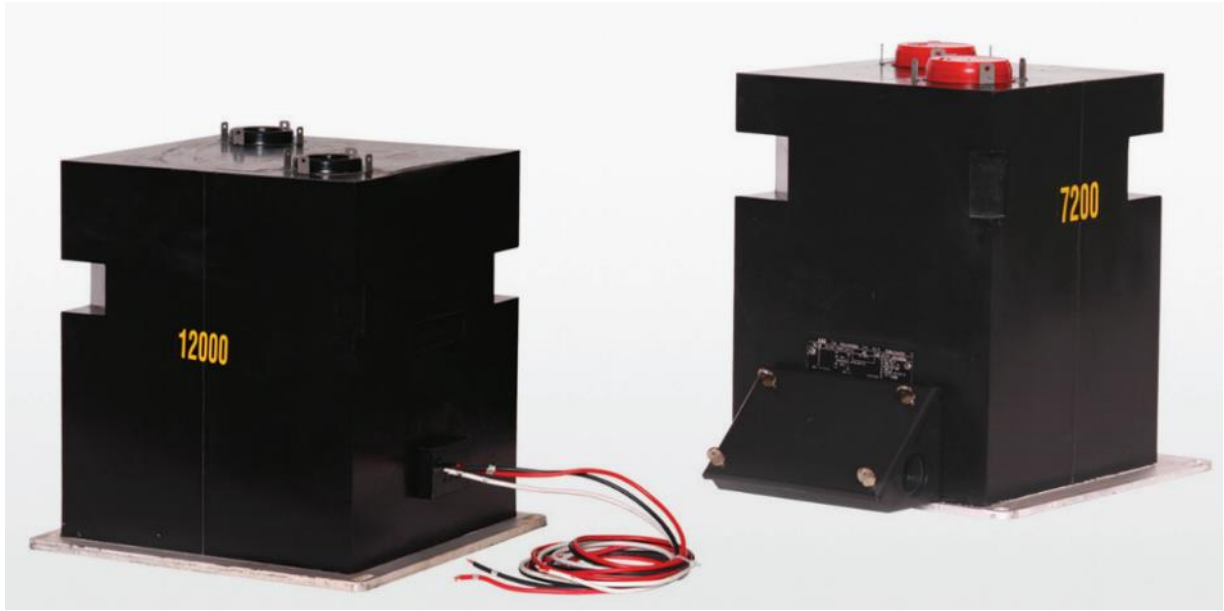
# IT product lines for utility applications

## Submersible VTs

**VIL-95/95S and VIL-12/12S – control power, relaying, or metering applications.**

- Indoor VT for use in a subsurface installation
- VIL-95/12
  - Designed with secondary junction box for intermittent submersible operation where VTs are not permanently submerged under water
- VIL-95/12
  - Designed with secondary wires directly encapsulated into the polyurethane for a water-tight connection allowing installation where they me permanently submerged
- Uses dead-front elbow connectors for primary

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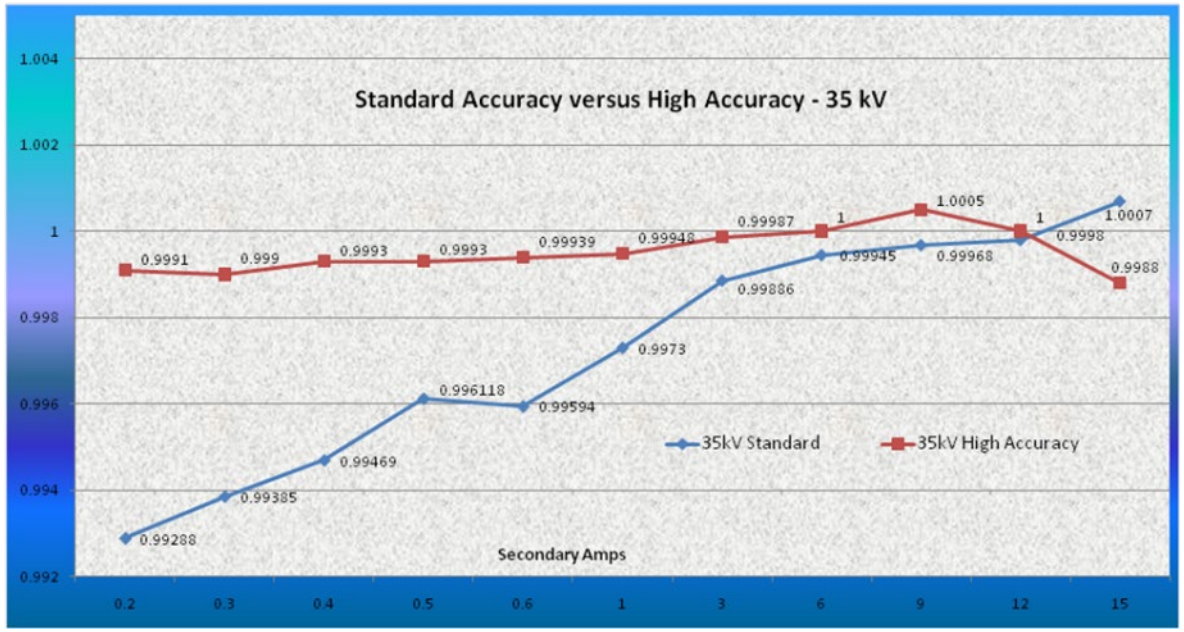
# ABB AccuRange technology

Extended range high accuracy current transformer technology

## Excellent linearity over wide dynamic range




## Field study of ABB Pinetops, NC facility

How it works – increase current flowing into the meter

Benefits – more current leads to increased revenue

| CT Type | KWH | % improvement | Add'l revenue |
|---|---|---|---|
| High accuracy | 8,384,070 | 0.82% | $8,404 |
| Standard accuracy | 8,315,880 | | |

$8,400 in additional annual revenue for a minor increase in CT selling price – use this in value added selling

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# Primary metering units

## Pre-configured and flexible options

5 – 34.5 kV, 60 – 200 kV BIL

Pre-configured configurations available

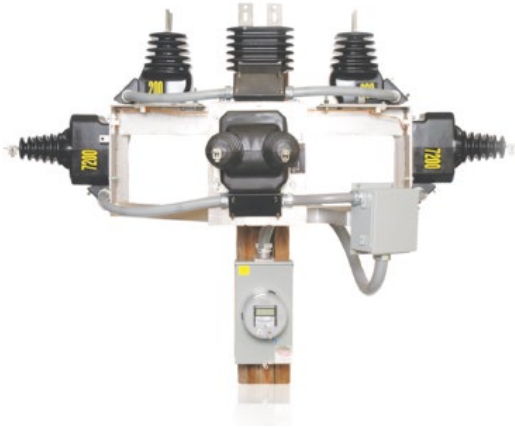
- Three-phase, four-wire (3CTs & 3VTs, or 3CTs & 2VTs)
- Three-phase, three-wire (2CTs & 2VTs)

Other configurations available upon request, can also include sensors

Any CT/VTs can be used

Pole-mount or padmount cabinet options are available

- Both are growing areas of interest in the market and we are continuing to expand our portfolio



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# Sensor challenges

## Cabling

Sensor and cable impedance must be matched (less sensitive at high ratio, LEA output voltages)

## May be sensitive to magnetic fields

Current cross talk and line sag may affect accuracy

## Lack of power transfer to secondary to power devices

Secondary devices such as relays, controllers and other IEDs must be connected to an external power supply

## Percentage error still not comparable to traditional ITs

Linearity is much better, but correction factors must be to used to improve accuracy

## Lack of standardization in IEEE

Standards exist in Europe (added to IT standards) but are limited in N. America

No standard for “burden” – using impedance values (e.g., 1 M-ohm) vs. VA ratings as with traditional ITs

Varied output and current voltage levels

## Limited selection today of meters and relays compatible with sensors

To ensure accurate measurement and proper performance, the sensor and IED must be compatible. Contact the manufacturer or sales representative to ensure sensor compatibility.

## General understanding of sensors is less as opposed to ITs

# Sensors

## Standards for ANSI markets

ITs are primarily covered by IEEE C57.13-2016; this standard does not cover sensors

IEEE standards / guides for current & voltage sensors

- IEEE PSIM Working Group formed recently to work on an IEEE Guide that will be focus on testing of end-to-end sensor systems
- IEEE C37.235-2007 - Guide for the Application of Rogowski Coils used for Protective Relaying Purposes
- IEEE C37.92-2005 - Standard for Analog Inputs to Protective Relays From Electronic Voltage and Current Transducers
- Recent switchgear standards (IEEE C37.20.2-2015) explicitly address the use of current and voltage sensors

However, this should not limit your applications

- IEC standards cover sensor physical device characteristics and is likely to be referenced in forthcoming IEEE guides

| | |
|---|---|
| Current sensors | • IEC 60044-8 (2002)<br>• IEC 61869-10 (2017) |
| Voltage sensors | • IEC 60044-7 (1999)<br>• IEC 61869-11 (2017) |

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# VLS – voltage sensor

15kV, 25kV and 34.5kV

**Voltage sensor**

Weight:

- 15kV: 10 pounds
- 25kV: 15 pounds
- 34.5kV: 21 pounds

Installs live

Lightweight, simple retrofit

3-10V or 120V output

1% accuracy

---

**Used for**

FDIR – reclosers/distribution switches

VVO/VVC/CVR – capacitor banks

Outage management – padmount switchgear

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# VCS-110 current and voltage combination sensor

15kV

**Combo sensor**

- Voltage sensing 1% accuracy, <1.5$^{O}$ phase error
- Current sensing  1% accuracy, <1$^{O}$ phase error with LEA output
- Weight: 35 pounds
- Line sag and current crosstalk immune
- 120V or 3-10V output for voltage
- 10V output @ 600A current (Includes voltage clipping to protect controller)
- Acts as a line post insulator, allowing for easy installation without primary taps or cutting the line
- Options with fault current measurement to 12kA and improved harmonic response to 33$^{rd}$ harmonic
- Primary cable capture feature – “V design” is easier to install the cable
- Larger creep than competitive designs for this voltage class
- ABB assisted in development of HCEP with Huntsman and has the longest experience in the industry with this material

25 kV, 34.5 kV – planned

VKS-110 is the current only equivalent of VCS

**Used for**

- FDIR (fault detection, isolation and recovery)
- VVO/CVR – capacitor banks, independent feeder monitoring, distribution switches

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