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ABB Electrification Wind Offering

Utility, EPC, Developer, Service Low Voltage Parts

Allen Austin, Sr. Market Development Manager – Americas, Renewable Energy & Power Generation, Electrification Business



ABB wind offers a large product portfolio: From low to medium voltage

Explore the industry's broadest portfolio in wind

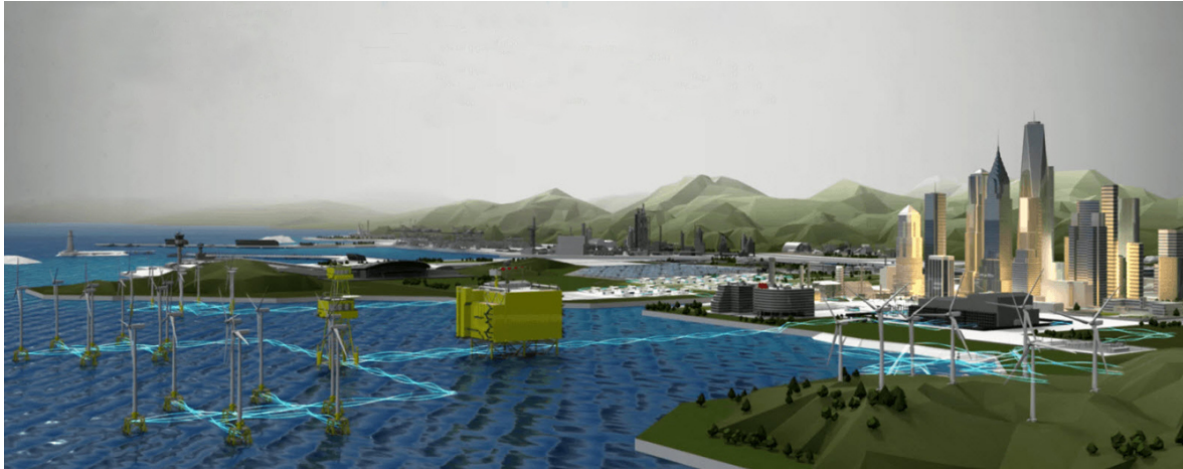


ABB offers the industry's most comprehensive portfolio of products, systems, solutions and services.

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

ABB's solution portfolio is covering the whole scope of wind applications ranging from small onshore installations up to full scale offshore wind farms

A proven track record in wind since the 1990s.

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

ABB wind competitive offerings

Explore the industry's broadest portfolio in utility scale wind

Low 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 wind farms.

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

From generator to interconnect - Low to Medium Voltage: ABB offers the complete range of solutions from generator and converters in the turbine up to the collection and connection of the power to medium grids.

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).



Systems and Solutions for successful utility plant design

ABB key offerings in utility segment

Electrical balance of plant

ABB's solutions for wind power plants are designed to meet grid standards, 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 wind power plant process and a complete capability in design, engineering, and commissioning.

Grid integration (Medium voltage)

As an intermittent, widely dispersed source of energy, wind 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 components and solutions.

Turnkey stations

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

ABB solutions include all critical complete plug-and-play portfolio for transformer stations inside the power collection and low and medium voltage eHouses. Also battery energy storage modules

Energy storage and Battery chargers

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

As a major contribution to achieving stringent environmental targets, our battery systems maximize the efficient use of renewable energy sources by reducing their inherent intermittency, facilitating integration into the grid.

Grid connection

ABB offers a range of products and solutions that help to efficiently connect wind farms to the medium-voltage 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 wind plants of all sizes.

Plant automation

ABB offers a versatile and scalable automation solution designed for monitoring and control of wind power plants. The solution includes our ABB Ability monitoring system for major components and systems.

SCADA ABB Ability™

ABB wind offers the largest product portfolio: Low to Medium Voltage

System & Solutions: Electrification options for wind plants of all sizes

Wind turbine nacelle

Low Voltage & Connection

Switch gear, Panel boards and switch boards – ReliaGear
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, basket tray, conduit, cable ties and strain relief

Medium Voltage Products

Air-insulated switchgear
Gas-insulated switchgear
Dead tank circuit breaker
Recloser, breakers and disconnects
Voltage and current sensors
surge arrestors
Transmission line and current limiting fuses
Transmission line connection and protection relays
Wireless communications
Packaged solutions
Mobile substations
Automation and SCADA

OEM Replacement parts

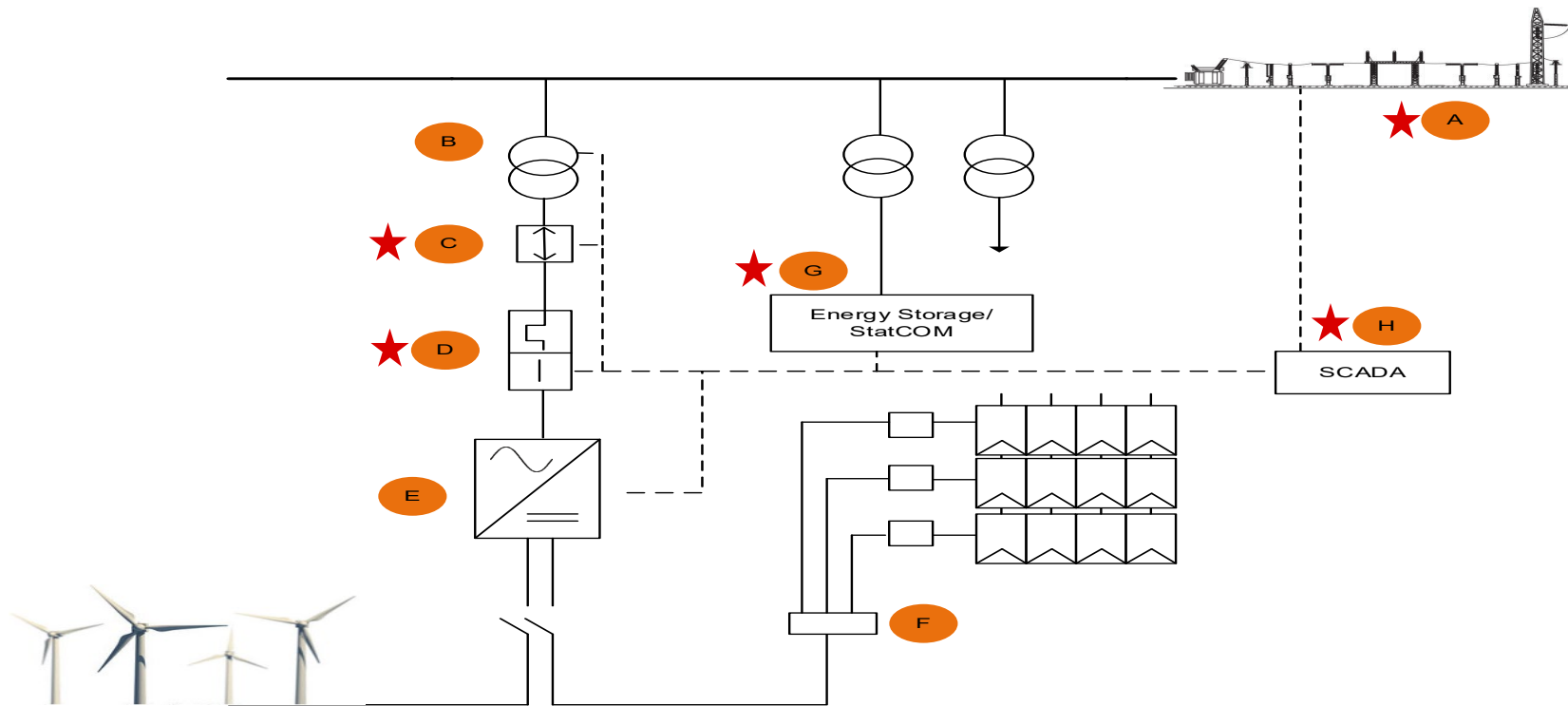
LV and MV components for converters, yaw and pitch control panels and lubrication control panels:
Breakers, Contactors, Relays
Power supplies
Disconnects
Lighting control panels
Panel boards and switch boards – ReliaGear
Power monitoring
Surge protection, Ground fault
Voltage and current sensors
Wire duct, Cable tray, cable ties

Energy Storage / Chargers

Energy storage:
– EssPro PCS
– EssPro EBOP
– EssPro Grid Tie
– storage(BESS) modules and solutions
Battery chargers: and UPS
– Integritas wall, and floor mounted
– Infinity Industrial

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

Wind plant grid connection - electric balance of plant

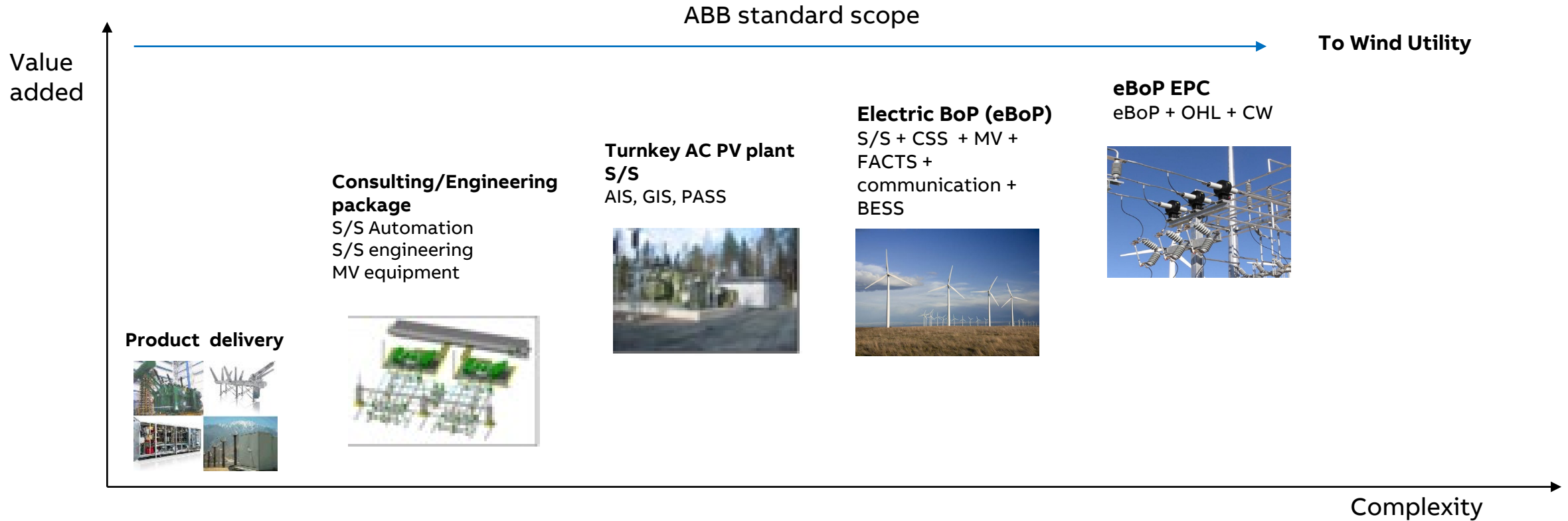
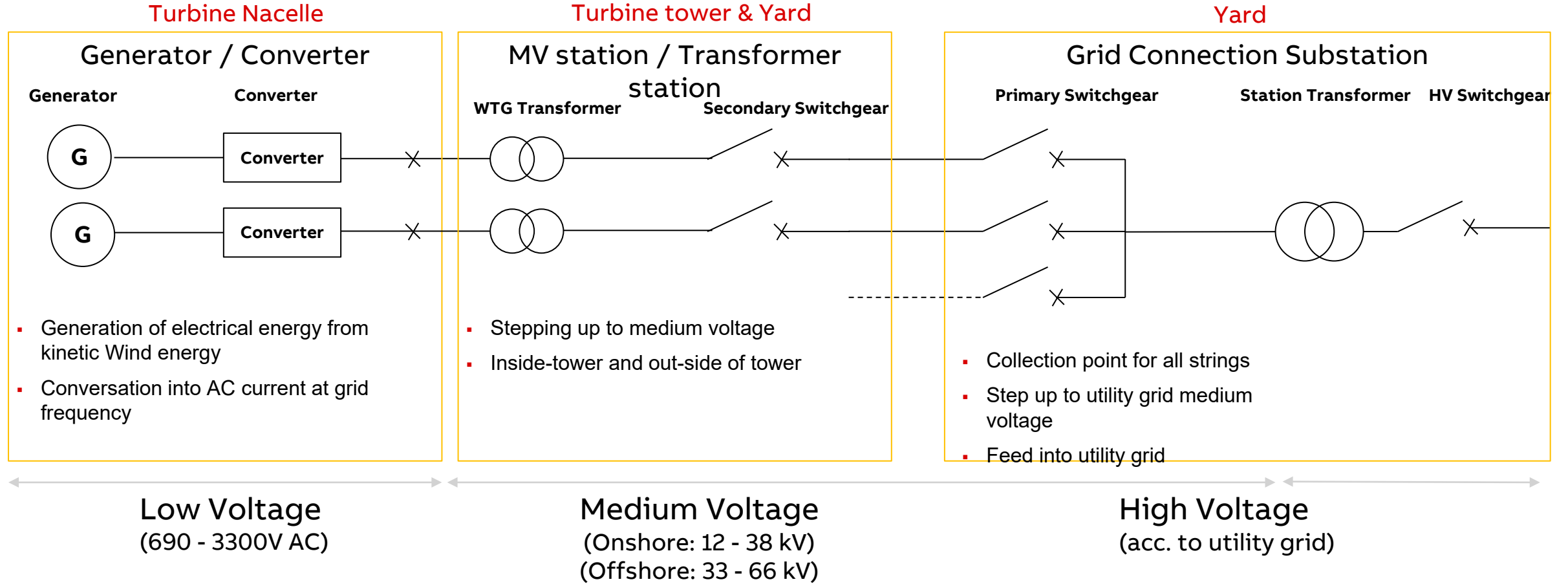


ABB can deliver from products to engineering packages or turnkey S/S
BoP available in specific markets

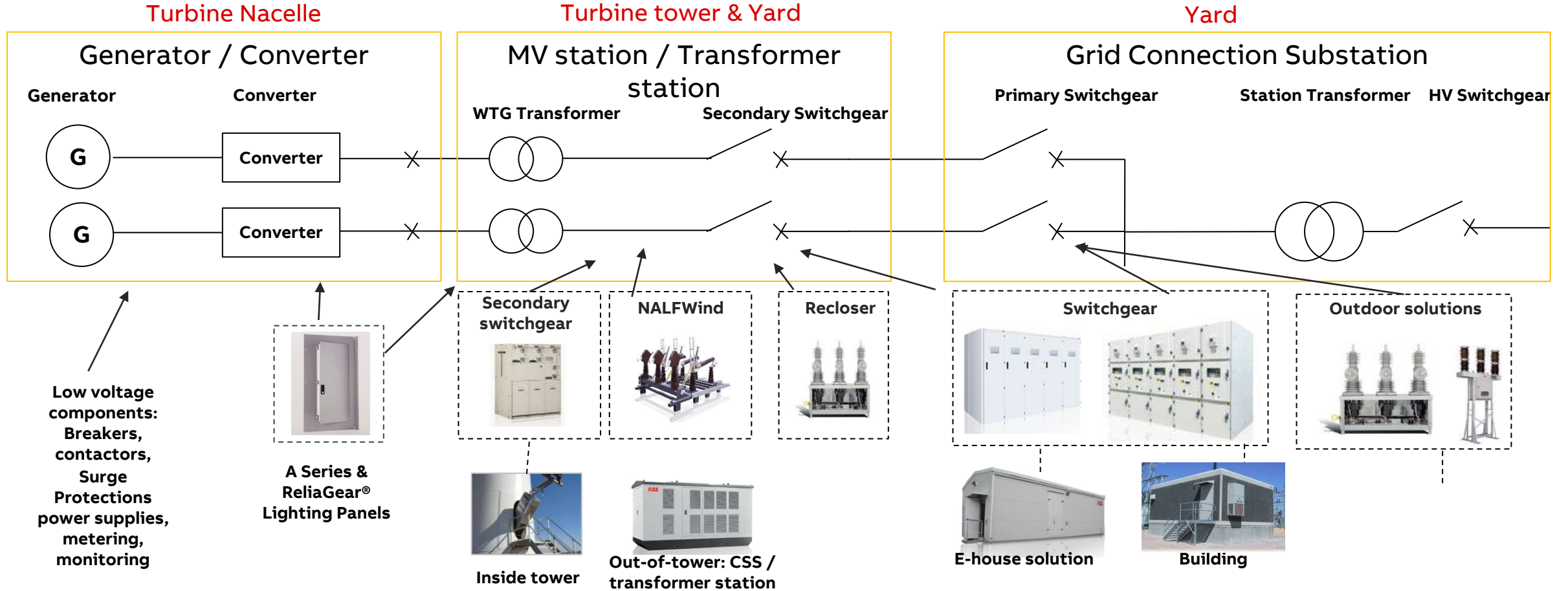
Medium Voltage Products

Typical Wind power plant – overview



Medium Voltage Products

Wind power plant – main components (example)



Wind farms: Low/Medium voltage systems, components and sensors

Sold to Utilities, Developers, EPCs and their distributors

Utility applications

Medium Voltage Solutions

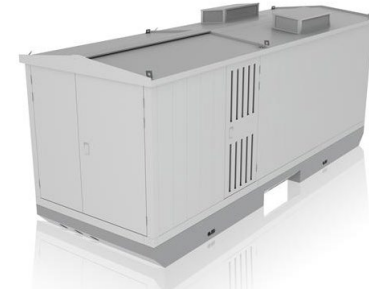
Electrical houses



Compact secondary substations



Energy storage modules



Skid mounted unit- substations



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

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

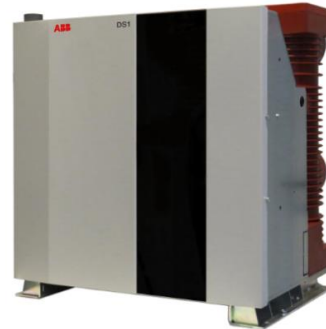


DS1

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



Utility applications

Special solutions

Alternative relays

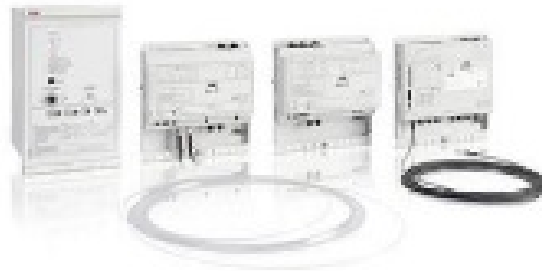
Electromechanical and solid-state relays
Solid state electronic components provide a similar function to electromechanical relays but do not have any moving components, increasing long-term reliability.



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.



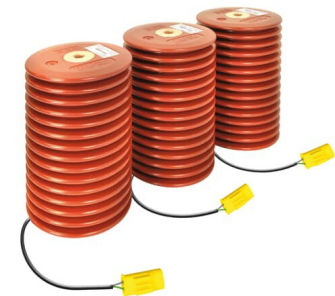
Ultra-Fast Earthing Switch UFES

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



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



Instrument transformers

Traditional primary measurement solutions proven through the ages

100 years+ old technology

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

Also 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 & solid state)



The role of instrument transformers (ITs)

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.



What you must know

Minimum information when specifying ITs

Basic information

Indoor or outdoor use
System voltage & 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 & 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

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)



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



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

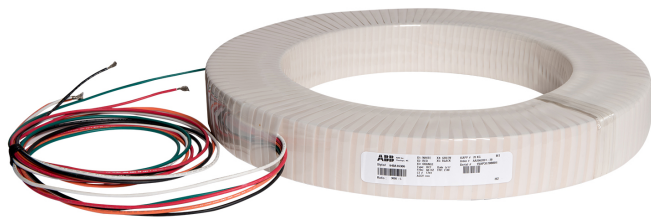


IT product lines for utility applications

MV & HV applications

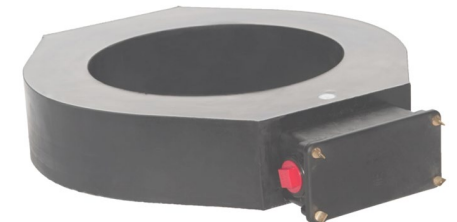
Bushing current transformers (indoor)

- 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



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

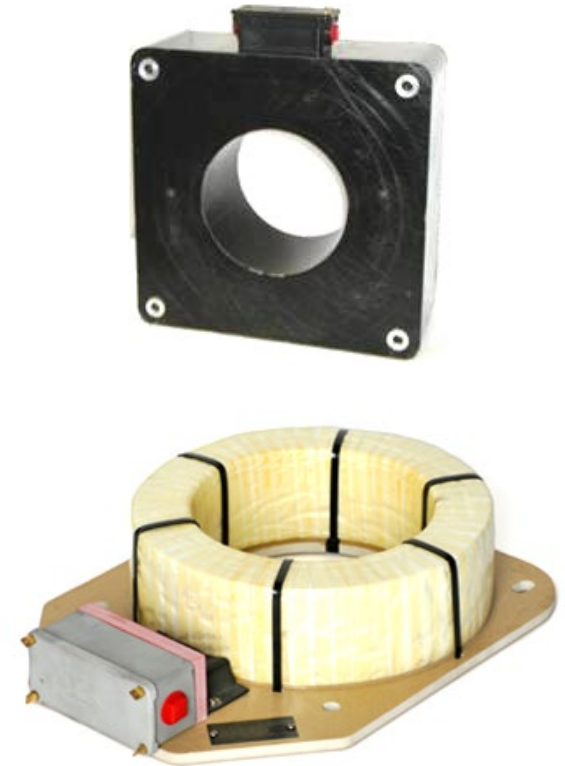
Extensive product offering of proven designs with decades of field experience

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



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



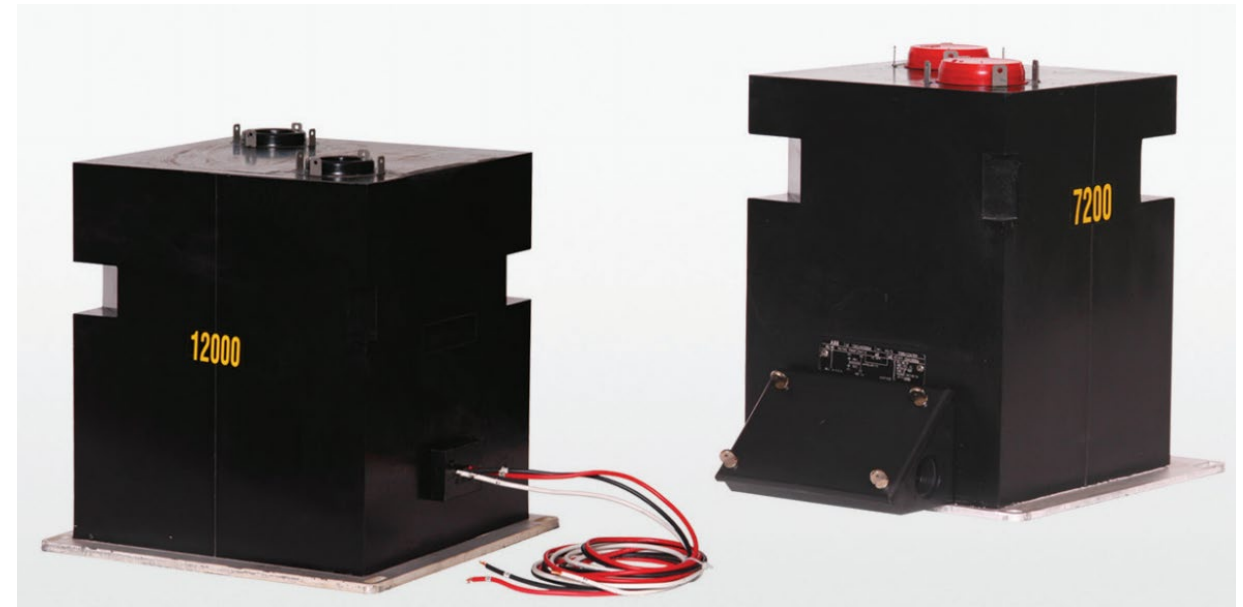
CO-9740

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-95/12S
 - 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



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

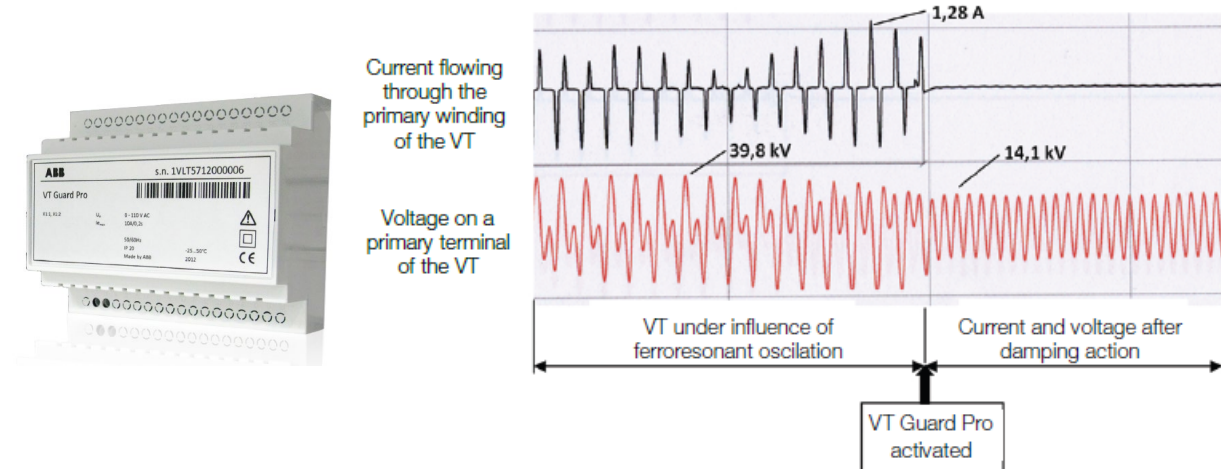


VT Guard Pro

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



Other IT products not commonly used by utilities

Other specialty designs

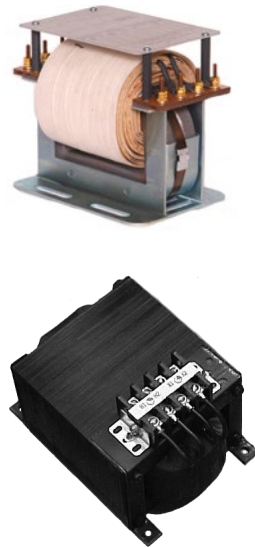
Indoor medium voltage

- Typically used in switchgear and metal clad enclosures for primary revenue metering and protection



Auxiliary CTs and PTs

- An Auto transformer
- Change the overall ratio of main current transformer
- Can be used as VT



Control power transformer

- Control Power Transformers (CPT)
- Available from 2.5kV to 15kV
- From 5kVA, 10kVA & 15kVA



Zero sequence CTs

- BYZ-863/865
- Used for ground fault detection



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 error

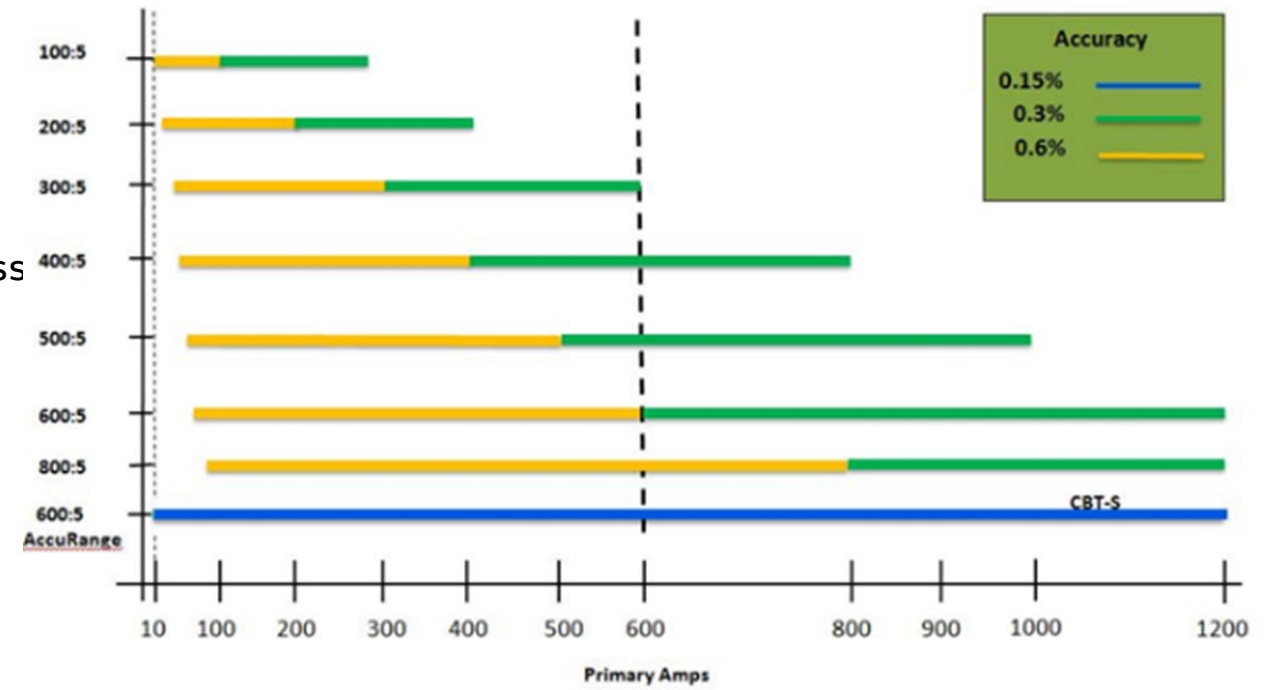
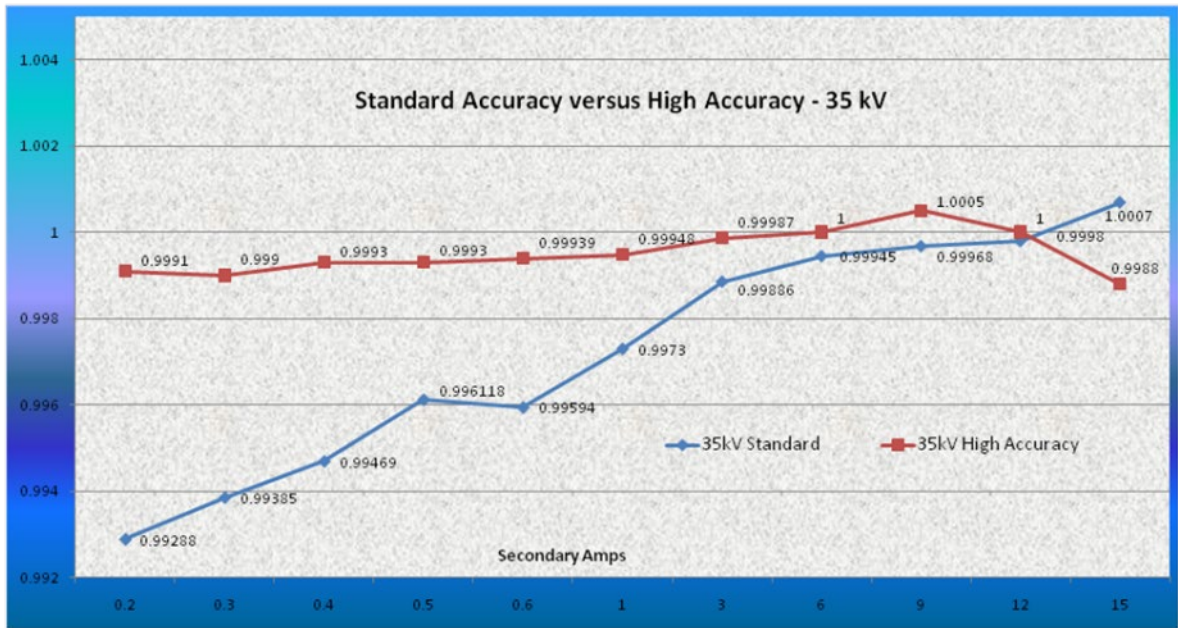


ABB AccuRange technology

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



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
- Collaboration within ABB globally and with a Swiss university to create the software model which had not previously existed
- Multiple aspects of design changes – design details are trade secret and cannot be shared

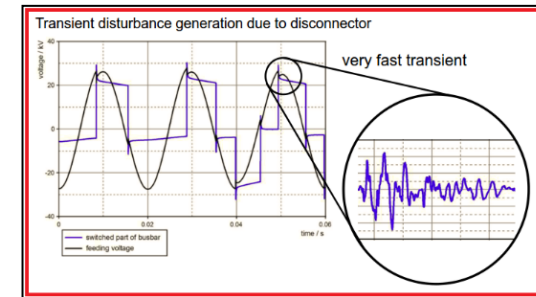
Improved safety

- 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

ResiVolt technology

Product offered with and without ResiVolt™ certification

Same body style offered in both standard offering (similar to competition) and with ResiVolt™

- Needed to replace legacy portfolio – some locations or customers may not require or desire ResiVolt™ VFT resistance
- Many design enhancements don't directly affect VFT resistance
- ResiVolt™ versions include design variant testing and certification and include an extended warranty by default (additional value proposition)

WHY use same physical body and most of design same with a ResiVolt™ variant?

- Efficiency in factory production
- Avoided having to create both non-ResiVolt™ and ResiVolt™ designs
- Allows competing more effectively in applications not prone to VFTs without devaluing ResiVolt™ offering
- Increases understanding and belief that our design has something unique in the design for VFT mitigation

ResiVolt Technology

Building belief and grabbing mindshare

Evidence backed explanation of field issues

Demonstrate ABB leadership in addressing issue

Gain acceptance not just an ABB product issue

Join with customers in mindset of solving industry challenge
TOGETHER

Grab mindshare by showing

- Building the first VFT capable impulse generator in the United States, only 1 other in North America
- Collaborative investigation and conclusion with utility – co-authored whitepaper
- ABB investing heavily in the technology – evidence presented with new building and impulse tester
- Build belief in issue and technology through industry groups
- Differentiated mindshare through trademark (ResiVolt™) and design certification process (with applied sticker – visual reminder of value)



Building additional to house first ever VFTO impulse tester in the US



Existing ABB impulse tester, having to “raise the roof” for new tester

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



CVC-150 and -200 are currently only offered in PUR, -150 HCEP will be released in 2020 and -200 HCEP in late 2021

CVC combination ITs

Improving safety, assembly and reliability in primary metering units (PMU)

Traditional configuration of CTs and VTs



Streamlined configuration of CVCs

Streamlined, smaller footprint

Substantial reduction in assembly time

Fewer connections, less cable for fewer potential failure points

Safer assembly - No more cantilevered or upside-down units!



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



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



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

Benefits of sensors vs traditional ITs

Safety – One of the most important benefits

Low voltage, low energy output signals

No need for primary fuses on voltage sensors

Secondary can be left open (current sensor) or short-circuited (voltage sensor)

Increased safety for personnel during testing/ operation

WARNING!!! The secondary circuit of traditional CTs should never be opened or left open when current is flowing in the primary. If the secondary circuit is open, the primary current will drive the core to saturation, inducing abnormally high and possibly lethal PEAK voltages.

Damage due to traditional CT arcing



Key benefits of sensors vs traditional ITs

Reduced chances of failure – simpler construction, less internal failure points

Reduced footprint - lighter weight, smaller form factors

More linear response, esp. when harmonics present

Simplified installations – less wiring, smaller footprint, lighter weight (e.g. PT drawout trays in switchgear may be avoided)

Reduced energy use, esp. in tight compartments (Example MV voltage sensor over life: 0.040 kWh loss vs 7,500 kWh!)

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

Typically, no risk of ferroresonance (voltage sensor vs PT)

Upgrade of switchgear parameters without additional costs

- Indoor sensors can often be retrofitted in existing structures with new relays

Standardization - one sensor covers full voltage or current range of traditional IT family

- Improved inventory management

- Change-out flexibility

- Simpler documentation



Sensor challenges



Cabling

Sensor & 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 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 & 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	<ul style="list-style-type: none">• IEC 60044-8 (2002)• IEC 61869-10 (2017)
Voltage sensors	<ul style="list-style-type: none">• IEC 60044-7 (1999)• IEC 61869-11 (2017)

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

VLS – voltage sensor

15kV, 25kV and 34.5kV

Weight:

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

Installs live

Lightweight, simple retrofit

3-10V or 120V output

1% accuracy

FDIR – reclosers/distribution switches

VVO/VVC/CVR – capacitor banks

Outage management – padmount switchgear

Voltage sensor

Used for



VCS-110 current and voltage combination sensor

15kV

Combo sensor

Voltage sensing 1% accuracy, $<1.5^\circ$ phase error

Current sensing 1% accuracy, $<1^\circ$ 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 33rd 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

Used for

FDIR (fault detection, isolation and recovery)

VVO/CVR – capacitor banks, independent feeder monitoring, distribution switches



25 kV, 34.5 kV – planned

VKS-110 is the current only equivalent of VCS

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)

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



Utility Applications

Products and Solutions

Protection relays



Microprocessor relays are programmable and the characteristic and behavior can be programmed. 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.

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.

Battery Energy Storage System (BESS), Utility & Commercial

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

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

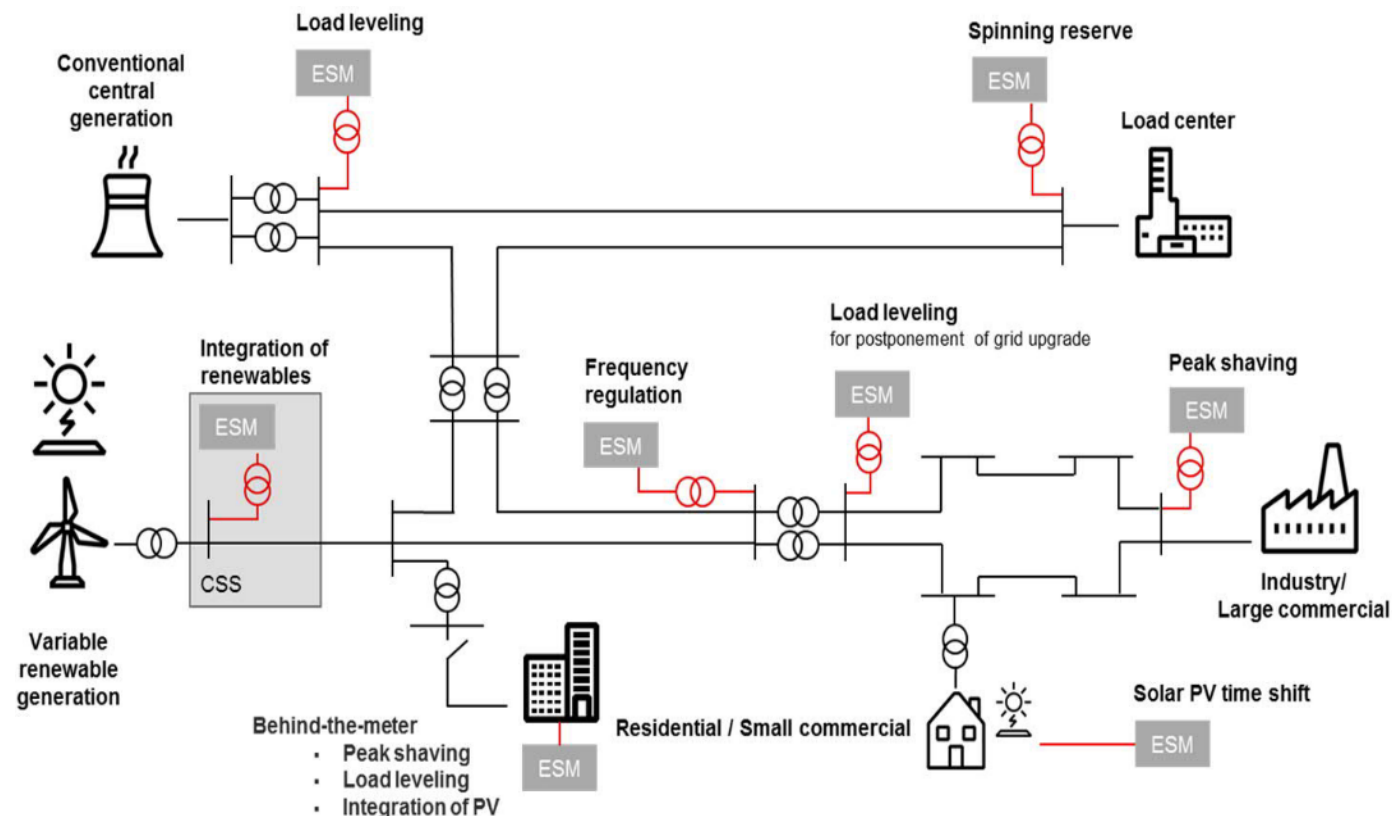
ESM provides back up power, improves load factor and manages demand peaks

Residential and commercial

ESM lowers energy costs and provides backup power for critical loads

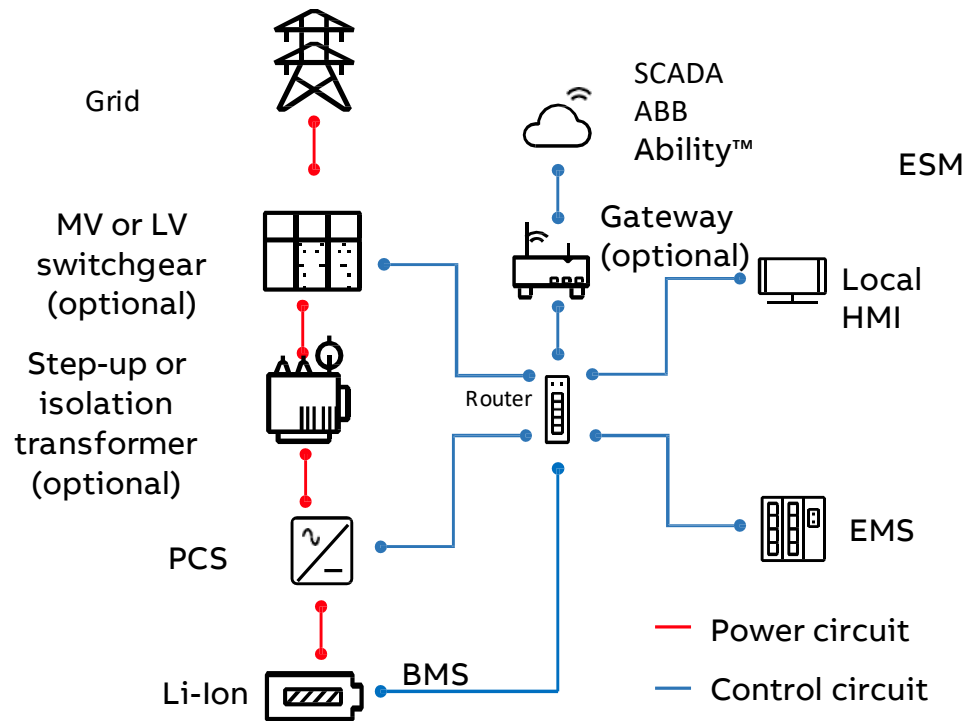
Electrification of transportation

ESM reduces demand on grid and enables fast DC charging without increasing demand



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

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.



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?

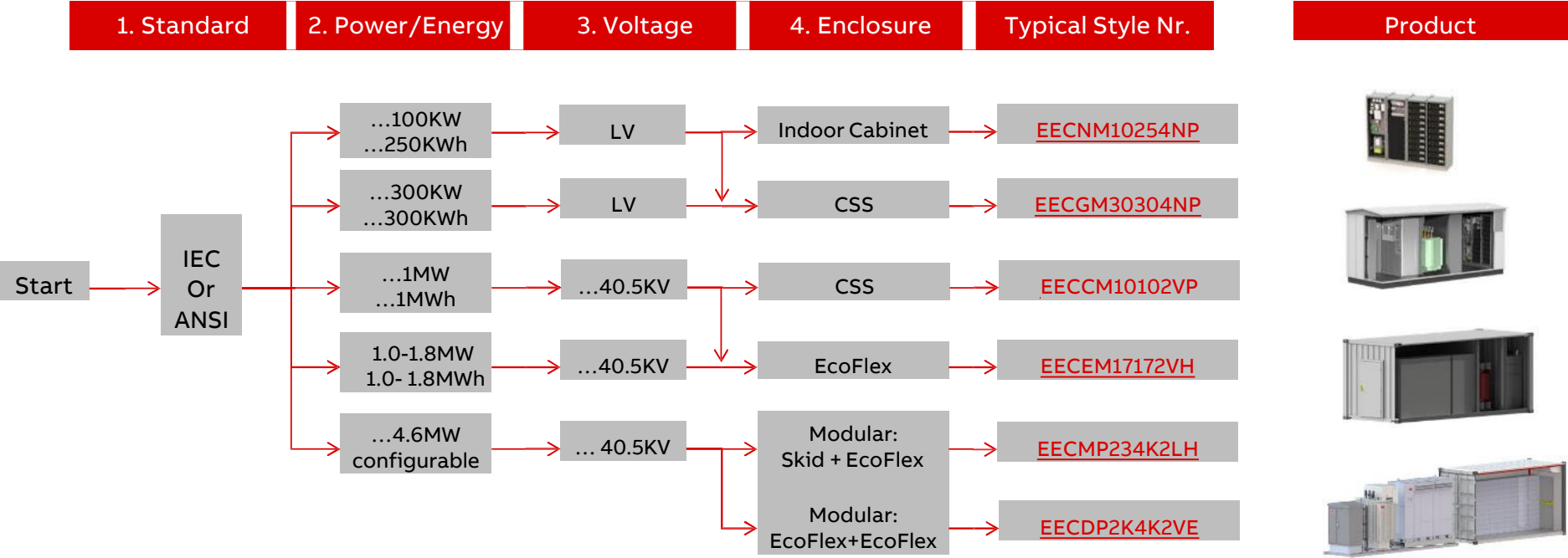
- Installation in public domain
- Indoor access to equipment for maintenance
- Seismic requirement
- Transportation and site work condition
- Temperature and altitude
- All-in-one or modular type

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

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




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 Compact design, simple indoor installation	One-piece delivery Internal arc tested for safety, metal and GRP option





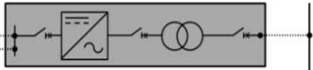
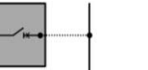


Mid-Power offering

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 Internal arc tested for safety, metal and GRP options	One-piece delivery Robust for easy transportation and installation

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 Internal arc tested	Scalable solution Economic solution, ease of installation Internal arc tested	Scalable solution Robust structure for easy transportation and installation Internal arc tested

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

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

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

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		Easy to ship, load and offload
	Maximize ROI with pre-engineered and factory tested solutions		Robust and scalable solution
			Relocatable solution adaptable for temporary power needs

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

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 allows scalability, reduction of installation costs, high reliability and reduced project execution times.



Values



Internally arc tested, and electrically compartmentalized to provide improved safety



Easy to ship, load and offload



Maximize ROI with pre-engineered and factory tested solutions



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

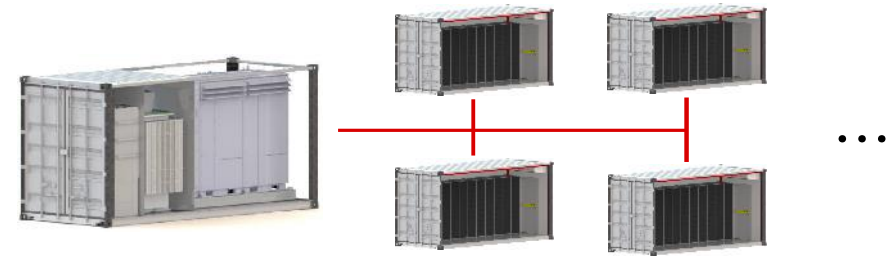


Maximize ROI with pre-engineered and factory tested solution

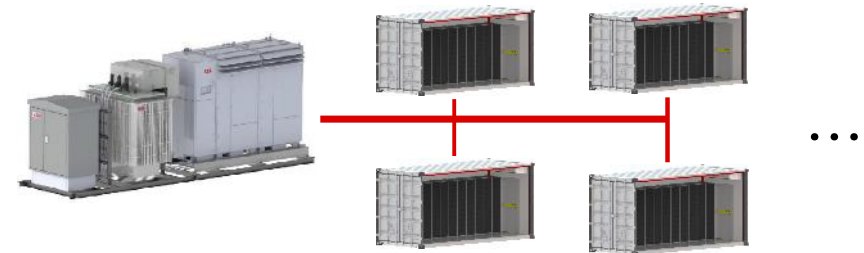


High reliability with extensive risk and failure mode analysis

EcoFlex + EcoFlex



Skid + EcoFlex



Wind solution

Integrated energy storage with solar/wind generation

Customer challenges

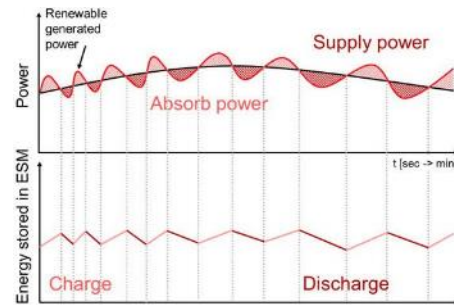
Solar/wind power hard to properly forecast
Renewable generation not aligned with the demand
Renewable mandates and incentives
Tax benefit for storage systems



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



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

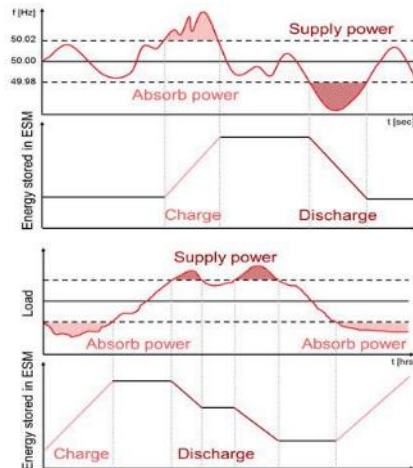
New power generation plant costs too much and takes long time

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

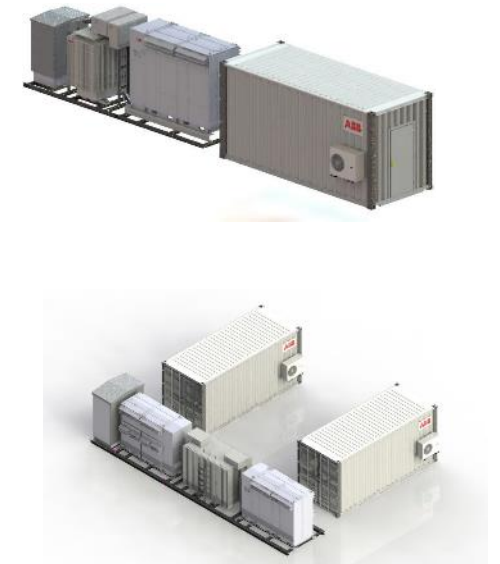
Frequency regulation

- Increases reliable operation

Load leveling

- Postpone investments in grid

Picture



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

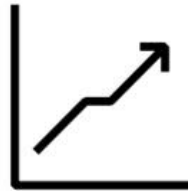


Maximize the return of investment

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



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™

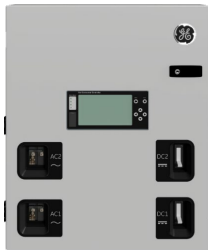
Ease of transportation due to standardize solutions

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



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

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

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



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



Wind farm construction and connection components

Sold to Wind industry distributors, installers and contractors

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



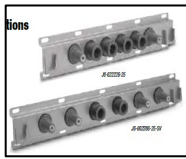
Elastimold MV
Connectors, splices,
and terminations



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 Fuses

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

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



Don't see the lugs you need listed here?
Many other sizes and configurations of Color-Keyed® lugs are available. Download the Thomas & Betts Lug Link™ app and see how easy it is to select and configure lugs.

Color-Keyed®



Contact your local WESCO Branch for more information.

ABB in the growing renewables market – Wind & Battery Energy Storage

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

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Sr. Market Development Manager-Americas

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