Feeder Automation - AF2000

Technical Information and Application Guide

ABB Power Distribution

Contents

Technology Review

Introduction: What is Distribution/Feeder Automation?

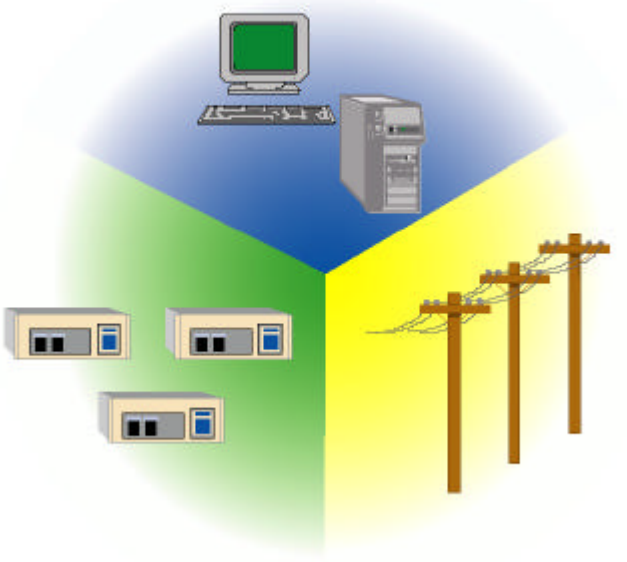
Distribution Automation is the ability to remotely monitor and control the distribution network, collect information, and provide information in a useful manner to the users. Distribution Automation provides a building block for protection, control and monitoring of the distribution system. The definition for feeder automation varies from utility to utility. Some utilities refer to distribution automation as feeder automation, while others may refer to it as substation automation.

Distribution Automation products are designed for interoperability and rapid automation implementation. These products provide Supervisory Control and Data Acquisition System (SCADA) interface and enable feeder automation with or without communications. Feeder automation products help to strengthen existing distribution systems and provide a strong foundation for building a fully implemented feeder scheme in the future.

Drivers for Feeder Automation

Feeder automation products are a powerful tool for improving customer service and reducing operation costs. Solutions not only have to be justified based on hard benefits, which are measurable to the bottom-line (e.g., deferred or eliminated capital expenditures, reduced operating and maintenance costs, increased Kwh sales), they must also satisfy the need of less tangible benefits. Feeder automation products and system solutions can be incrementally integrated and scaled within existing utility feeder infrastructures.

Feeder Automation



A summary of benefits of feeder automation include:

- Early detection and correction of abnormal line conditions
- Reduced frequency and duration of service interruption
- Remote control and automatic restoration
- Improved dispatcher decision-making and field manpower savings
- Reduction of customer cost-of-outage
- Targeted regions or customers for improved reliability and operation

Distribution Systems

The foundation of Distribution Automation is the Recloser. Reclosers have been around for over 30 years and have always been considered one of the “workhorses” of distribution system overcurrent protection. They were originally used not to increase reliability, but because the feeder breaker could not reach to the end of the feeder. Reclosing was normal for almost all utilities since lines were overhead and most temporary faults could be cleared by the recloser before the fuse operated.

The changing environment in the utility world has increased the need for cost efficient operations, increased reliability and an emphasis on the quality of power delivered. The recloser, an old trusted technology, will play a significant role in meeting the needs of today’s utility customers.

There are three aspects of an electric utility power system that help to determine the role of control devices in a distribution automation system.

1. Normal operation
2. Prevention of electrical failure
3. Reduction of the effects of electrical failure

Normal operation may involve capital expenditure to build the infrastructure of a distribution automation system. At the time of this writing, a majority of electric utilities are involved in deregulating their power system. As few as ten years ago, many electric utilities consisted of a combination of generation, transmission and distribution. Now with the unbundling of electric utilities, a majority of them have concentrated their resources on distribution. The main reason can be attributed to maintaining ownership of the electric revenue meters. Revenue meters are as the name implies: a constant source of revenue. They rotate on a jewel everyday and every time the black mark on their dial turns, an electric utility is generating more revenue. Therefore, these electric utilities must take whatever precaution is necessary to insure that power is always delivered throughout their distribution system. Once delivered, power must operate normally, and generate revenue for the electric utility.

Distribution systems are extremely important to the success of an electric utility. Without distribution systems maintaining normal operation, an electric utility may stand to lose its position in the electric power industry and be bought by another stronger electric utility. There are numerous examples of this occurring in the market every week. The single most important objective for mergers is to gain access to the revenue meters located throughout a power system which are like cash registers, continually spinning, making money for the electric utility.

Protection Philosophy and System Design

Feeder Automation Example Typical Scenario

A municipality was experiencing numerous outages at various locations in the city. The disturbances were being blamed on squirrels and birds that climbed onto the distribution lines and pole mounted equipment. These animals were causing faults that resulted in numerous interruptions to entire city blocks of customers. This area had protection from faults by using standard breakers with electro-mechanical time over current relays. These interruptions were affecting many key customers at an industrial park and at an office park where members of the city council operated their respective businesses.

The municipality had been investigating the possibility of installing a centrally controlled distribution automation system for the past five years, but were apprehensive in committing to such a system due to the cost. The municipality visited other utilities that had similar problems and found that the traditional point-to-point wiring between the controller and the RTU was both expensive and difficult to maintain. Adding to their dilemma was concern that if they were to make a capital expenditure on such equipment it may be difficult to maintain and impossible to advance into future technological developments.

They had to find the right solution with a combination of equipment, system integration, communication and software to install on eight reclosers and sixteen sectionalizers. The municipality identified five main requirements that an inexpensive distribution automation solution would provide:

- Elimination of the squirrel and bird caused outages
- Remote monitoring and control
- Ability to address multiple communication points throughout the city
- Service their customers by providing information to identify and explain outages
- Effective energy management to gain load profiling for future expansion

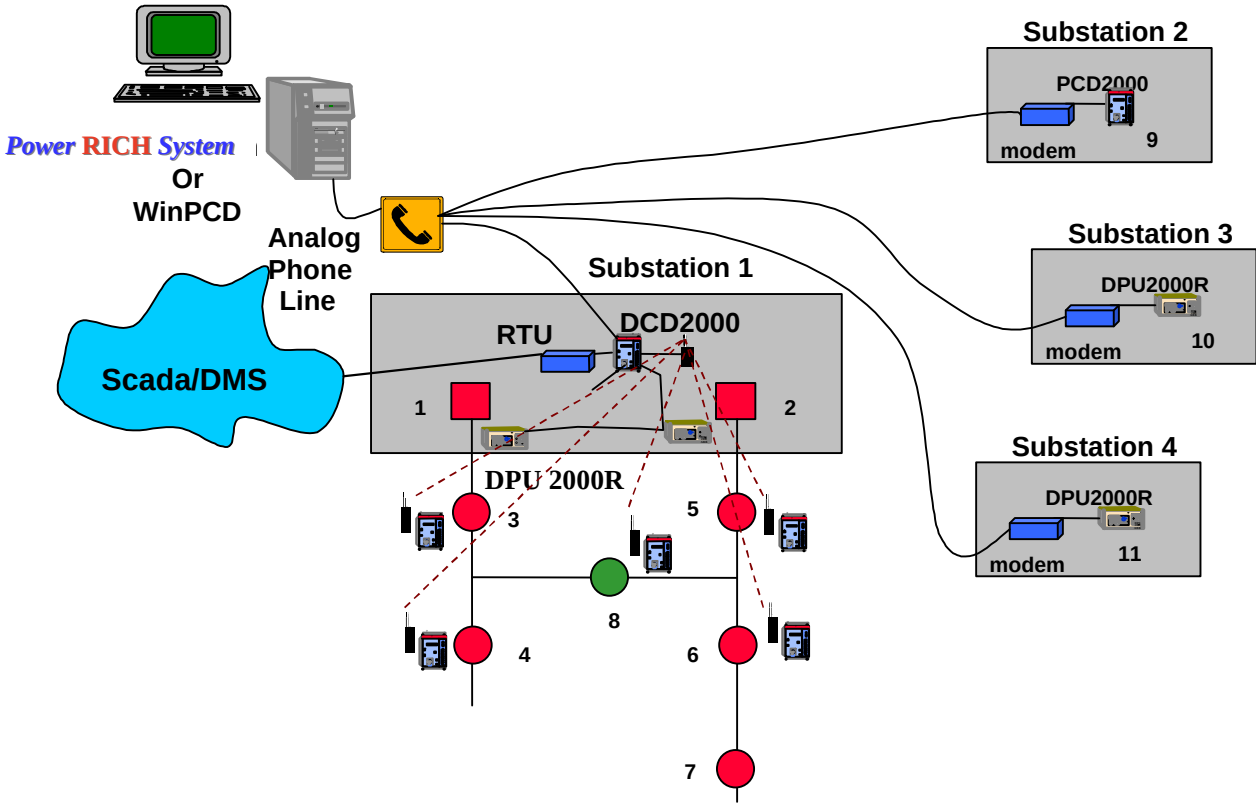
Solution

By choosing feeder automation products, the municipality will receive a total automation solution minimizing their operating and maintenance costs. The municipality will accomplish all five of their main goals and through the metering and operations events, gain more useful information throughout their distribution system.

The distribution automation system illustration shows the typical configuration with: automated equipment on each feeder, a communications node, protective relays in the substation, protective relays in additional substations, and software to view information from the feeder and substation equipment.

The distribution automation in Substation #1 illustrates two reclosers, two switches, and one tie switch monitored for feeder restoration. The substation contains three protective relays. The distribution automation illustrated in Substation #1 can be installed in the same configuration for Substations 2, 3, and 4. All protective relays and their respective control devices were connected to an analog line back to the communications software for remote substation and feeder control/monitoring and remote recloser/switch settings configuration.

User Applications

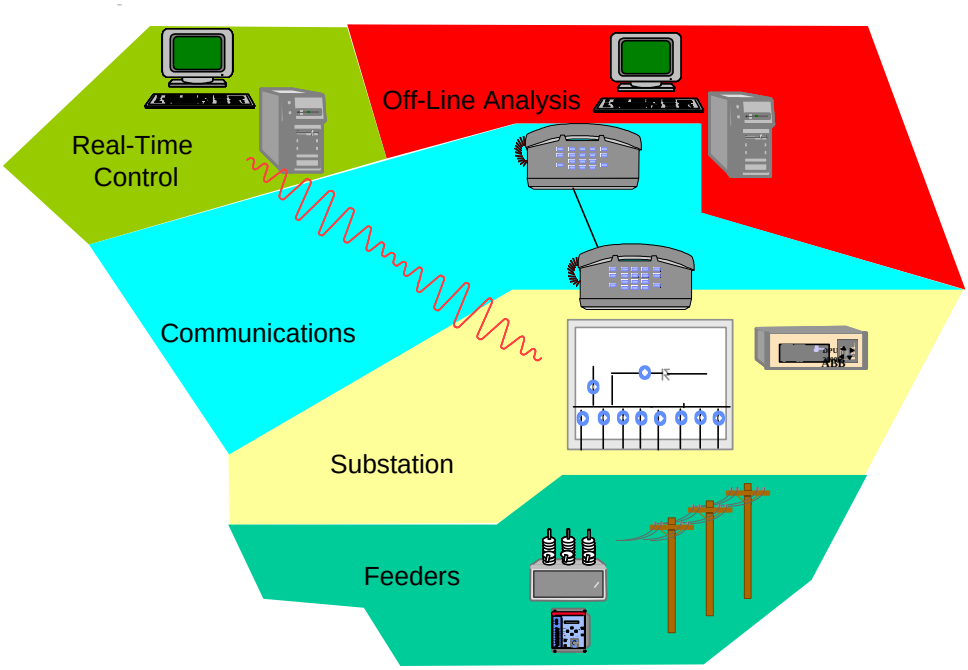


Communications Capabilities

Feeder automation applications have employed a variety of combinations of communication mediums, power line carriers, telephones, pilot circuits, dedicated or trunk VHF/UHF radios, fiber optic cabling in overhead wires, and cellular telephone dial-up modems. The most advantageous and popular is radio.

Rapid advances in wireless, cellular and satellite systems will soon provide cost effective solutions for enterprise connectivity.

Components of Distribution Automation



Power Quality

Power quality is an important consideration in designing any power system. Distribution systems are especially vulnerable to power quality problems. These problems should be taken into account when selecting and purchasing equipment. Power quality issues may be more pronounced in the US market than in the European market because of the different nature of the two systems. Distances for power delivery, density of loads, and customer concentrations are among the aspects that differ. Power quality problems include:

- voltage sags and swells
- momentary interruptions
- harmonics (harmonic current and/or harmonic voltages)

Voltage Sags

Voltage sags and swells are associated with a large motor starting or fault events in the power system. Faults on adjacent or neighboring circuits can result in low voltage (sags) to a customer, resulting in equipment misoperation. These events can last from a few milliseconds to more than a second, and can be single or three phase. Depending on the design of the distribution system, a ground fault on one phase can cause a simultaneous swell on another phase.

Momentary Interruptions

Momentary interruptions are defined as power interruptions to a customer lasting less than 5 minutes (interruptions lasting longer than this are defined as “sustained interruptions”). Momentary interruptions are usually the result of temporary faults on the feeder such as tree contact, lighting, and animals. Momentaries are generally more severe to a customer than sags since there is complete loss of voltage.

Harmonics

Reclosers and other automation products have the ability to monitor harmonics and bring dangerous levels to the attention of the utility before they cause customers to experience problems. Harmonics are caused primarily by non-linear loads. The nature of non-linear power equipment causes a perfect sinusoidal 50/60 Hz voltage waveform to have currents containing other frequencies. Non-linear power equipment includes saturated transformers (including instrument transformers), motors, and generators, but is primarily associated with power electronics. The act of triggering or switching a Silicon Controlled Rectifier (SCR), a diode, an Insulated Gate Bipolar Transistor (IGBT), or a Gate Turn-Off device (GTO), is in principle a non-linear operation. Power electronics devices such as Variable Speed Drives (VSDs) can sometimes exhibit a high level of harmonics, often more than 100% Total Harmonic Distortion (THD). In the case of VSDs, this level of harmonics varies with the selected rpm of the motor and mechanical load on the shaft.

Harmonics are unwanted events in distribution systems. They can cause excessive heating and damage to neutral connections and cables, and can saturate instrument transformers. Harmonics may also precipitate from the original location of the non-linear equipment to other locations like feeders and loads. They also may cause false

tripping or malfunctioning of equipment, false readings from the CTs and VTs especially sensitive relays, computer loads, other VSDs, and Programmable Logic Controllers (PLCs).

Mitigation of Power Quality Problems

There are a variety of power quality problems which include such things as sags, swells, surges, harmonics, interruptions, flickers, etc. An automated system has the ability to monitor these problems as well as the effectiveness of any mitigation practices. Some of the problems and mitigation techniques which might be evaluated as follows:

Problem	Solution
Sags	High speed transfer switch
Surges	Lightning Arrester
Harmonics	Filter
Interruptions	Reclosers

Power Quality Indices

In today's utility environment, distribution system reliability is becoming more and more important. There are several indices developed for reliability of service which utilities are keeping track of and are accountable for. Of these, there are two well-known indices, the System Average Interruption Frequency Index (SAIFI), and the System Average Interruption Duration Index (SAIDI).

Most utilities are measured by the Public Utilities Commission to assure they meet a minimum requirement with respect to SAIFI and SAIDI. However, these indices do not take into account momentary interruptions and storm induced outages. Therefore, two new indices have been introduced, called Momentary Average Interruption Frequency Index (MAIFI) and Storm Average Interruption Duration Index (STAIDI). There have been discussions regarding performance based rates, which will make system reliability of major importance to utilities.

Power Quality Indices Measure Performance

SAIFI	System Average Interruption Frequency Index (sustained interruptions). Designed to give information about the average frequency of sustained interruptions per customer over a predefined area. (Typical = 96 min/yr.)
SAIDI	System Average Interruption Duration Index. Commonly referred to as Customer Minutes of Interruption or Customer Hours, and is designed to provide information about the average time the customers are interrupted. (Typical = 1.2 interruptions/yr)
MAIFI	Momentary Average Interruption Event Frequency Index. Records momentary outages caused by successful reclosing operations of the feeder breaker or line recloser. This index is very similar to SAIFI, but it tracks the average frequency of momentary interruption events. (Typical = 6 interruptions/yr)

Reclosing Applications

Single Phase

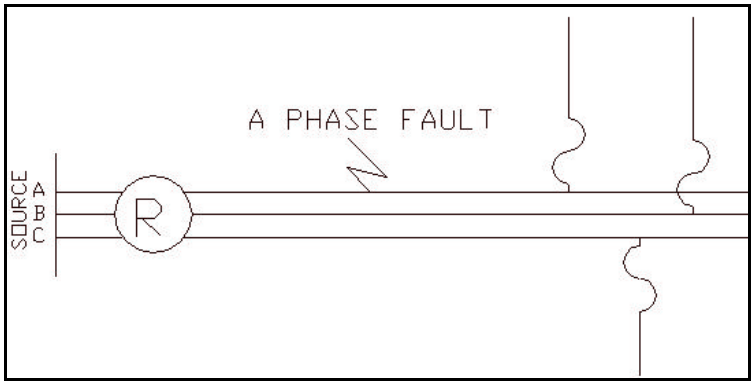
Single phase operation, or “Single Phase Tripping” on a three phase recloser is an advantageous feature for utilities that have rural or residential loads. The obvious benefit is the ability to reduce un-necessary three-phase interruptions and outages due to single phase faults by a factor of 2/3. This yields much greater overall customer satisfaction, while minimizing revenue billings lost.

Single Phase Tripping Application

In the following example, a three phase line is protected by a re-closer, and a fault occurs as shown on phase A. Assuming the fault is permanent in nature, with a conventional three phase recloser, the unit will trip two fast operations, and then two slow operations. Since there is no fuse between the recloser and the fault, this means that all the customers will have 3 interruptions and then an outage until the fault is manually cleared and the recloser closed.

With the Single Phase Tripping option in a recloser, you can program the control device to trip on A phase only, through the fast and slow curves, and lockout on that phase only. This means that customers on A and B phase will not see any interruptions. If the utility has determined that it is not preferable to lockout on one phase, the control device can be programmed to lockout on three phases. The control device can even be programmed to trip on a single phase up to a certain demand current (integrated over time) and switch to a three phase only mode if the current exceeds this threshold.

Single Phase Tripping



Single Phase Tripping Features

The single phase tripping option is designed to be very flexible in order to meet virtually all customers needs. The following describes the specifics of single phase tripping operation:

Three global modes are available:
1. Three phase tripping
2. Single phase tripping OPUP
3. Single phase tripping OOAP

Three phase tripping mode operates in the same way as a unit without single phase tripping operation.

Single phase tripping is where only the detected phase or phases will trip when sensing current is detected.

- OPUP mode means only picked up phases are tripped, any phases with normal conditions stay closed.
- OOAP mode means one or all phases. This is where if two phases sense an abnormal condition then all three phases are tripped.

Each of the four phase overcurrent protective elements (one slow (51P), and three fast (50P-1, 50P-2 & 50P-3)) can be individually configured to trip single or three phase.

Each step of the reclose cycle can be individually configured to single or three phase trip or lockout. Two common examples would be:

- The recloser is set up to trip on single phase and lockout on all three phases if fault is permanent.
- The recloser is set up to both trip and lockout on single phase.

Operation counters are recorded on a per phase basis. Each open phase will be shown on the control Human-Machine Interface (HMI) as “OPEN”. The recloser can be manually opened on either a three phase or single phase basis (through the HMI). The recloser can be programmed to trip either single or three phase depending on demand kW if voltage transformers are used. The primary and two alternate protection groups can be set up independently to allow quick reconfiguration between single and three phase tripping. There is an option to suppress ground tripping upon a single phase trip. This will prevent additional tripping when the load is single-phased.

Environmental / Material

Casting-Polyurethane

The success of urethane in the transformer arena made it a natural candidate for the new solid dielectric recloser pole unit. Urethane's low pouring and curing temperatures ease the ability to pour and handle the units while the urethane is in its liquid state. The fact that it's poured under a vacuum rather than injected under pressure helps ensure a stable geometry of the interior assemblies before and after the pour. While all polymers have stresses created because the curing process temperature is higher than ambient, polyurethane's low modulus of elasticity allows the material to adjust to these stresses through elongation. Because urethane has some elasticity, it is ideally suited for the sharp, repetitive shocks exhibited by the operation of vacuum bottles interrupting load or fault current. The finite element analysis studies (mechanical and electrical) done by ABB for the pole unit design, ensure long and trouble free life of the encapsulated vacuum bottle, sensor and current path.

Polyurethane encapsulating materials are:

- Environmentally sound; no oil or gas
- Proven outdoor performance
- Permanent flexibility, low stress, superior arc track resistance
- Resistant to ozone and ultraviolet rays
- Easy to transport: rugged, light, non-brittle
- Resistant to vandalization

27kV High Voltage Unit

Product Description

Product Description

AF2000

ABB's AF2000 family of distribution and automated feeder products were developed to address both present and evolving utility needs in automation and control applications. The AF2000 Automated Feeder product family provides utilities with a powerful tool in the battle for improving customer power quality and reducing operating costs.

The AF2000 family of products is the result of extensive R&D efforts to establish products that meet the requirements for today's distribution systems with advanced features and flexibility needed for the changing demands in distribution management and automation. New demands for managing distribution systems calls for devices that are inherently reliable and intelligent. Emphasis is on SCADA and distribution automation connectivity while providing an easy migration path to feeder automation.

The AF2000 family of feeder automation intelligent electronic devices (IEDs) provides a solution for distribution reclosers (PCD2000), switches (SCD2000 and ISD2000), and allows integration of substation and feeder automation systems with an intelligent communications node (DCD2000).

ABB's AF2000 family is comprised of the VR-3S recloser with its companion controller, the PCD2000 Power Control Device, the VS-3S Switch with the SCD2000 Switch Control Device, the ISD2000 Integrated Switch Device, the LCM Loop Control Module that integrates Loop control features within the PCD2000 and SCD2000 controllers. The DCD2000 Data Control Device facilitates SCADA system communication integration. It provides a self-contained, easy to install router solution for creating a network of wireless radios, RS-485 networks, fiber optic networks and modem access.

Utility requirements for ease of integration has been addressed by the adoption of widely accepted "open" communication protocols (MODBUS, DNP3.0, IEC 870-5-101). Operator training is minimized by maintaining a common look and feel for the different devices.

New features include integrated sensing, integrated control for magnetic actuators in the feeder primary equipment, comprehensive power quality and fault monitoring, extensible feeder automation capability such as single-phase protection and Loop sectionalizing and communication adaptability within the IEDs. This is part of the overall ABB "Building Block" approach to feeder automation.

Highlights

The new AF2000 family of feeder automation products will provide a global solution that provides:

- A comprehensive AF solution for utilities
- New enhanced functionality such as power quality monitoring
- SCADA ready capability for ABB AF primary equipment – a major market requirement in the new environment
- Standard solutions that allow integration of feeder and substation automation

VR-3S Recloser

ABB's VR-3S interrupting unit is a distribution pole mounted and substation recloser. Used with the PCD2000 intelligent controller, it provides local and remote operation with protection, control, metering and communication for feeder automation. The VR-3S recloser integrates patented magnetic actuation technology that provides for a lightweight, reliable unit ideally suited for interrupting fault currents on the distribution circuits. Independently operated modules allow for single phase or three phase operation.

The basic functional components of an automatic recloser are a high-speed circuit breaker, overcurrent protection, trip logic and automatic reclosing logic. When an overcurrent of sufficient magnitude flows through the recloser, the tripping action is initiated and the circuit interrupting contact opens. After a preset time delay, the recloser contacts are automatically closed re-energizing the line. If the fault still persists, this tripping and reclosing sequence is repeated a predetermined number of times until a lockout function is initiated. If the fault was transient and cleared during any period when the recloser was open then the recloser will remain closed. After a short time delay the recloser logic will reset to its original condition and will be ready for the next operation.

Single Phase Tripping Option for the VR-3S Recloser

The VR-3S recloser is a first of its kind in the industry. It includes fast acting, maintenance free, independent-pole magnetic actuation instead of a high maintenance, ganged-pole mechanism. It also incorporates solid dielectric insulation instead of oil or SF6 gas and is substantially lighter weight than oil filled reclosers. It is available in 15, 27 and 38 kV ratings, 560 or 800 Amps continuous current. The VR-3S and its PCD2000 control now has the capability to operate on single phases! The single phase tripping VR-3S provides greater feeder protection flexibility. This improves customer power quality and in turn puts the utility in a better competitive position, now and years down the road.

VR-3S

Product Description

27kV VR-3S Recloser

Vacuum interrupters

- Maximum reliability
- Minimum and even contact wear
- Long life: thousands of operations with out scheduled maintenance
- Integral part of pole assembly

Polyurethane encapsulating material

- Environmentally sound: no oil or gas
- Proven outdoor performance
- Permanent flexibility, low stress, superior arc track resistance
- Resistant to ozone and utlraviolet rays
- Easy to transport: rugged, light, non-brittle
- Resistant to vandalization

Integrated sensors

- Sized not to saturate at rated fault cur rents
- Encapsulated in polyurethane for protection

Mechanical trip

- Hook-stick operated emergency trip lever
- Yellow handle does not come down on lockout

Air insulated outdoor cabinet

- Stainless steel enclosure
- Eliminates environmental and maintenance concerns of oil or gas
- Spare cable for voltage signals
- Knockouts to bring voltage signals and power

Open/Close indicators

- Individual phase position indicators
- Highly visible from the ground

Magnetic actuators

- Reliable: dramatic reduction in moving parts
- Virtually maintenance-free: over ten thousand operations without scheduled maintenance

Contemporary Design

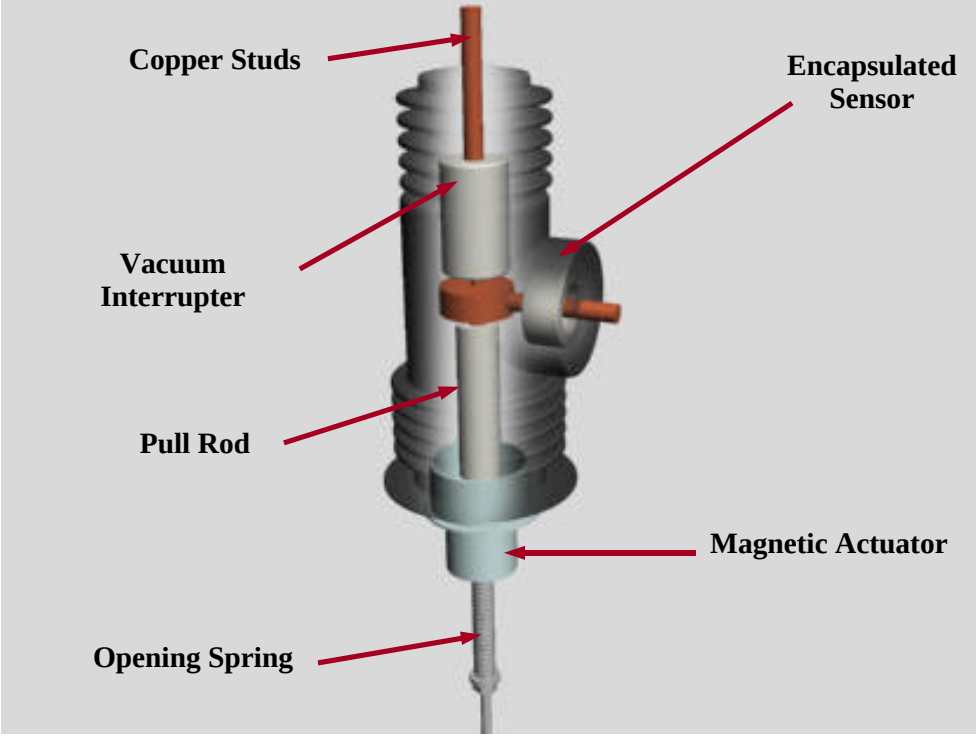
Pole Assembly

The polyurethane pole assembly of ABB's VR-3S consists of an encapsulated vacuum interrupter, a current sensor and magnetic actuator. The CT/Sensor is fully encapsulated in polyurethane for improved reliability and lower maintenance. The pole assembly has a standard high creep design of 17.7" (450 mm) for the 15 kV rating, 29.8" (760 mm) for the 27 kV rating, and 40.4" (1026 mm) for the 38kV rating.

Each pole assembly has a pull rod, which links the magnetic actuator with the vacuum bottle. The magnetic actuator's linear motion is transferred through the insulated pull rod to the vacuum interrupters, providing a simple mechanical link for contact parting.

Each pole comes equipped with an integrated current sensor, which provides the required signals for all current protection, metering, and data gathering functions of the control. For full protective and metering capabilities, external Voltage Transformers (VT's) should be installed. The VT's secondary needs to be connected to the PCD2000 control's CT/PT input board. As an option, VT's can be ordered with the unit.

Pole Assembly



Vacuum Interrupter

Vacuum interrupters have been in commercial use since the late 1950s. The significant advantages of switching with vacuum interrupters—extremely high switching rate, virtually no-maintenance, and long life—were immediately apparent. Today, cost-effective vacuum interrupters cover the application range of 600V to 38 kV and interrupting currents from hundreds of Amperes to 80 kA.

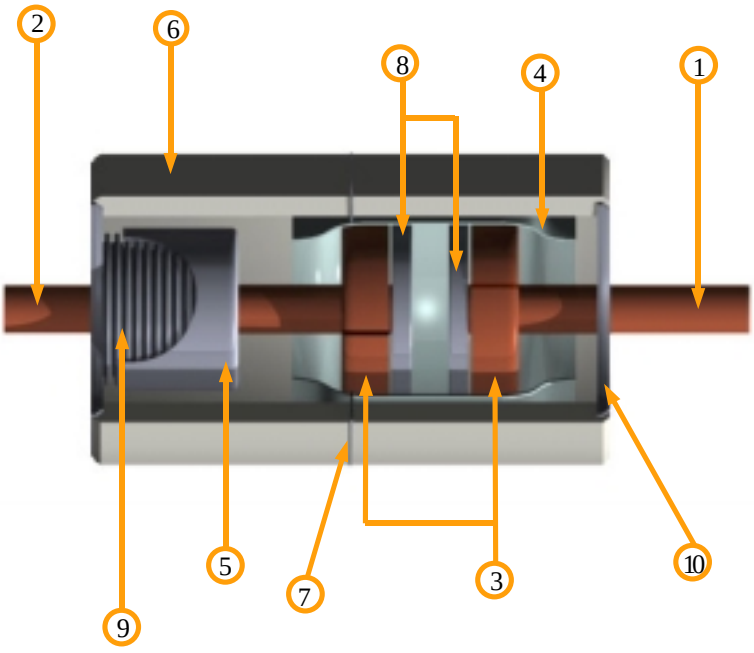
Vacuum interrupters provide maximum reliability due to their extended mechanical life minimum and even wear. Sealed contacts will not degrade the dielectric properties of the insulation medium.

The figure illustrates a schematic diagram of a typical vacuum interrupter, sometimes called a vacuum bottle.

The two interrupter contacts are immersed in a vacuum-tight, sealed envelope, typically made of ceramic or glass. Depending on the voltage rating, the enclosure can be made of either one or two ceramic cylinders (6). Flexible bellows (9) provides means for mechanical movement of the contact stem (2) within the vacuum.

Vacuum Interrupter

1. Fixed contact stem
2. Moving contact stem
3. Fixed and moving contact subsystems
4. Vapor (or ion) shield
5. Bellow shield
6. Ceramic enclosure (envelope) shown as two ceramic cylinders joined in the middle
7. Metal-to-ceramic sealed joints
8. Contacts
9. Metal bellows
10. Metal end plates



The contacts are surrounded by a vapor shield (4), made of a stainless steel, copper or FeNi, to protect the inside of the ceramic from arc metal vapor and preserve the dielectric integrity between the two ends of the switch. A metallic collar (7) between the two ceramic cylinders (6) serves as a seal and as support for the vapor shield (4). The contacts are made typically out of two components. The mechanical strength and means for controlling the arc are provided by copper elements (3). Special, OFHC (oxygen free, high conductivity) copper is used for vacuum interrupter manufacturing. For higher interrupting current ratings, the contact subsystem (3) can have special geometry arrangements to generate magnetic fields to control the arcing during the arcing phase and to assist the arc interruption at current zero. The contact surfaces (8) are made from a number of specially designed materials, such as CuCr (Copper Chromium), CuBi (Copper Bismuth) or AgWC (Silver Tungsten Carbide) to optimize the switching performance, contact life, and interrupting ratings.

In closed position, current flows freely between moving and fixed contacts. When the moving contact is separated from the fixed contact under current, an arc is drawn. The arc vaporizes a small quantity of the metal from the surface contact. Typically the arc voltage is independent of the flowing current and is only of the order of several volts. Therefore the arc energy is very small)product of arc voltage, arc current and time) which allows the vacuum interrupters to be compact and have long life.

When the main power frequency current approaches zero, the arc products (plasma) quickly diffuse due to the ambient vacuum. The recovery of dielectric strength between the contacts is very fast. A typical interrupter regains its full dielectric strength in a few to several microseconds. It is also significant that in most cases the current can be interrupted in vacuum even when the contact gap is not fully open at the instant of current zero. Even a partial gap, less than a millimeter, can interrupt full current. This makes vacuum interrupters fast devices, limited in the interrupting time only by the mechanical drive. Because the contacts are lightweight, the mechanical drive energy required by the vacuum switch is low compared to other switching technologies.

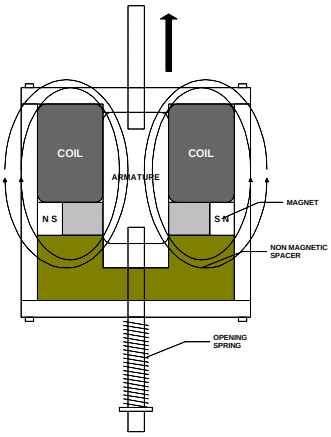
Benefits

- Minimum maintenance
- Long contact life
- Life in excess of 10,000 mechanical and/or load operations
- Industry proven technology
- Preferred interrupting technology for medium voltage apparatus

Magnetic Actuation

ABB's VR-3S and VS-3S are equipped with magnetic actuator technology. Magnetic actuators increase the unit's reliability by dramatically reducing the mechanism's moving parts. The magnetic actuator as compared to conventional stored energy mechanisms is far less complex. In contrast, conventional mechanisms rely on a more complex mechanical design incorporating more parts and less reliable mechanical links.

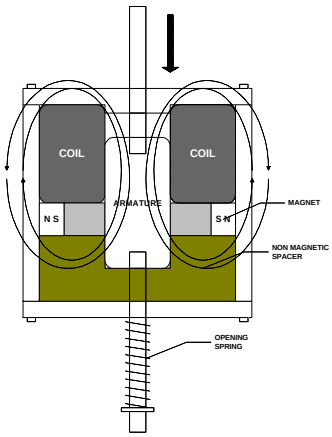
The magnetic actuator is a bi-stable device, meaning that it does not require energy to keep it in the open or closed position. When an open or close command is initiated, a current pulse energizes the coil for a very small period of time, enabling the required motion.



- Greater Reliability
- Dramatic reduction in moving parts
- Virtually maintenance-free
- Designed for thousands of operations without scheduled maintenance

The magnetic actuator is a device composed of a permanent magnet, a moving armature and an electrical coil. It is much simpler than the traditional stored energy mechanisms and solenoid based designs. The magnetic actuator has only one moving part. This reduction in moving parts dramatically increases the units reliability, while drastically minimizing maintenance costs. The magnetic actuator is virtually maintenance-free, allowing thousands of operations without scheduled maintenance. A powerful Neodymium Iron Boron (NdFeB) magnet provides the required force to hold the recloser in the closed position.

When the coil is energized with current in the proper polarity, the flux produced works together with the flux generated by the permanent magnet and drives the armature to the closed position (compressing the opening spring). Once closed, the coil is de-energized and the armature is held in position via the flux generated by the permanent magnet. In the closed position, the armature is against the top plate of the actuator forming a low reluctance path for the magnetic flux. The static latching force of several hundred pounds is provided by the permanent magnet alone. The coil energization is not required. The magnet itself, is mounted on a metal ring to prevent damage from contact with the armature as the armature assembly moves back and forth.



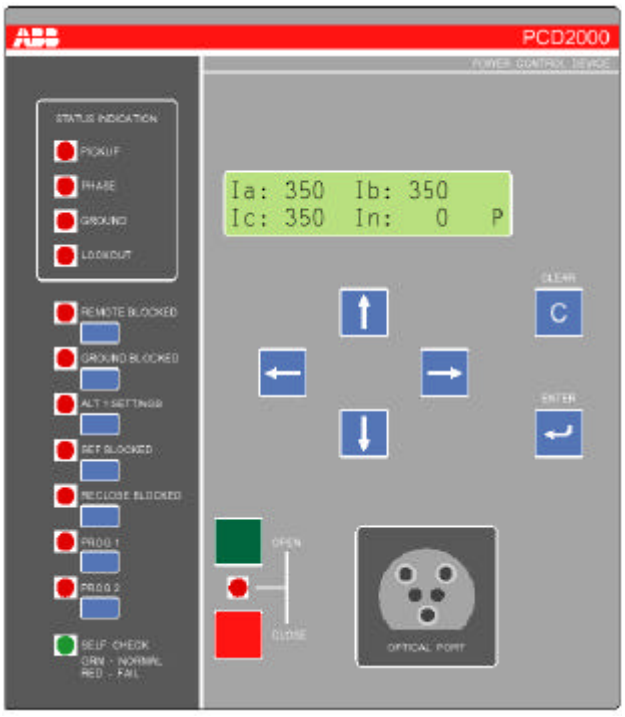
When the coil is momentarily energized with current in the reverse polarity, the flux produced opposes the flux generated by the permanent magnet. This temporarily offsets the holding force between the armature and the top plate. When this occurs, the opening spring moves the armature away from the top plate. As the gap increases the holding force falls off very rapidly and the opening spring drives the armature to the open position and holds it there (Coil is not energized). The non magnetic spacer prevents the armature from attaching to the bottom plate with the same latching force as exists in the closed position by inserting an air gap in the flux path.

PCD2000

The Power Control Device PCD2000 is an intelligent electronic device that provides complete recloser control in feeder automation applications. The PCD2000 provides fully integrated protection, metering, and communication capabilities. It enables sophisticated automation of electrical protection and switching equipment. The control can be operated remotely to facilitate automation system reconfiguration, fault analysis, and protection. It also has a powerful data gathering capability to allow analysis of system loading, planning and future upgrading. Remote battery testing and fault interruption accumulation make maintenance planning simple, and eliminates time-based maintenance procedures. For the user, all of these features save time, resources and money.

The PCD2000 is housed in a stainless steel control cabinet, NEMA 3R with drip shield. There is ample space for communications equipment. The cabinet is equipped with a battery that provides typical backup capability for 24 hours. For added security, the three-point latch with handle is constructed to accommodate a padlock.

PCD2000



Product Description

VR-3S with PCD2000: Single Phase Tripping

ABB's single-phase tripping feature implemented in the PCD2000 and VR-3S recloser is the first of its kind in the electric power industry. It provides better system reliability, continuity of service, and minimizes lost revenue billings.

The single phase tripping option is designed to be extremely flexible in order to meet the most demanding customer requirements. Single-phase tripping in the PCD2000 is a firmware upgrade that allows single-phase monitoring and tripping. This is done through the standard protection elements on a per-phase basis. Fault current is independently monitored on each phase to initiate the respective pole's tripping action. There are two modes of operation for single-phase tripping: OPUP (Only Picked Up Phases) and OOAP (One Or All Phases).

If three-phase tripping is required, then the PCD2000 can be configured to return to a three-phase tripping mode allowing the PCD2000 to operate in its normal configuration with single-phase tripping disabled.

VR-3S with PCD2000: Loop Control Module

The VR-3S and PCD2000 will also provide the additional capability for loop control protection accommodating a total of up to 6 VT's.

This LCM will provide ABB customers the ability to improve their distribution systems with reclosers for the following applications: restoration, loss of voltage transfer delay, automatic timed reset, midpoint recloser, normally open tie recloser, sectionalizing recloser and establishing a new open point.

Retrofit

The PCD2000 retrofit package is designed to connect the PCD2000 intelligent controller with other manufacturer's high voltage cabinet. All necessary wiring to a compatible connector, for seamless integration, is included. A total solution for ABB's customers achieved with this upgrade include control wiring, HMI and SCADA protocols.

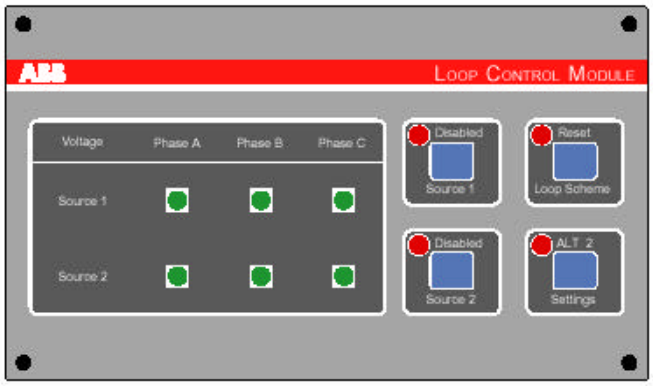
Loop Control Module

ABB's Loop Control Module (LCM) is designed to be completely compatible with the PCD2000 and SCD2000 controls. The LCM is a sophisticated option that consists of: the Loop Control Panel (see Front Panel) and COM5 communication module inserted into the PCD2000 interfaced together via simple control cable.

LCM is designed to detect either normal voltage or loss of voltage, from one or two sources, and initiates preprogrammed logical steps to isolate the faulted section depending upon the voltage configuration and feeder location.

LCM is designed to implement a loop control function to sectionalize or remove the faulted section from the distribution system. This new control module employs a design to provide sectionalizing control of either a recloser or a switch and the restoration of a distribution system by closing the tie-point recloser from another electrical source.

LCM Front Panel



Loop Control Scheme

Loop control schemes extend the reliability and implementation of distribution automation to establish a more effective operating power system in expectation of a competitive environment. Automating any distribution system outside an electric utility substation environment could be realized through the use of recloser loop control schemes, using the ABB VR-3S reclosers and PCD2000 controllers equipped with the loop control module.

A recloser loop control scheme typically utilizes a predetermined number of PCD2000 and LCM controlled VR-3S reclosers installed in series between two substation feeder circuits. The LCM feature provides isolation of any faulted section within a given distribution circuit while simultaneously re-establishing service to all customers unaffected by the faulted section within a relatively short period of time. Loop control schemes are typically located at or near key customers at various locations throughout the distribution system. Ideally, loop control schemes are implemented to reduce the number of outages and to maintain reliable electrical power to a utility's customer base.

Product Description

VS-3S Switch

New demands for managing distribution systems call for devices inherently reliable and intelligent. They require a built-in capability for data gathering and communications, along with extremely low maintenance. The ABB solution meets each of these demands with the VS-3S Switch. It brings powerful microprocessor control to switch technology, advanced management capabilities for system reconfiguration, fault location, fault restoration, load leveling, monitoring, power quality and communications.

A Millennium Ahead

The VS-3S accomplishes the job of a traditional switch reliably and efficiently. Safe and stable, the VS-3S offers an environmental edge, eliminating the need for gas or oil. Encapsulated vacuum interrupters produce clean interruptions with minimum and even contact wear over a wide temperature range. Like the unit's simplified magnetic actuators, these vacuum interrupters are capable of thousands of operations without scheduled maintenance. This makes the VS-3S the perfect choice for distribution automation applications where multiple operations are required.

Benefits

- Digital information and communications to enhance system-wide performance.
- Eliminates Maintenance - The absence of air, oil or SF6 as an interrupting and insulating medium minimizes the maintenance and servicing required. The sealed vacuum contacts and the absence of a spring driven mechanism eliminate any weathering concerns and assures a long life.
- Extended Duty Cycle - The number of operations far exceeds any other interrupting medium (10,000 loadbreak operations without visible wear). This is essential for feeder automation applications and locations, which require multiple switching operations.
- Environmentally Friendly - The solid dielectric is environmentally friendly, leaks are not a concern. The cabinets are made entirely from stainless steel, so no rusting will ever occur.
- Quick Installation - The use of a solid dielectric allows a compact design to reduce size and weight. Therefore, installations are quicker and easier.

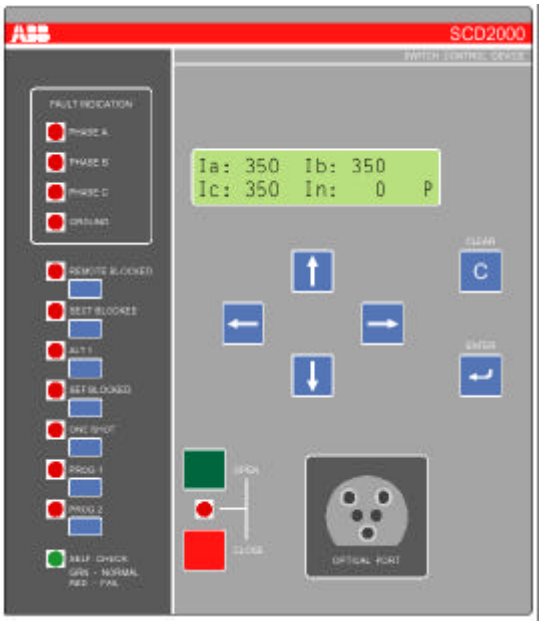
The VS-3S with the SCD2000 switch sectionalizer can automatically isolate a faulted section of the distribution line when in conjunction with an automatic circuit recloser. Sectionalizers do not interrupt fault current but count the operations of the associated automatic recloser and after a preset number of operations and during the automatic recloser open time, initiate opening themselves isolating the line past the sectionalizer, provided the sectionalizer detected the fault beyond it. This allows the healthy section of the distribution line between the automatic recloser and the sectionalizer to be restored to service. The recloser will automatically reset and be ready for another complete operating sequence. This insures smaller sections of the distribution system are interrupted for permanent faults. Information received from installed PCD2000 and SCD2000 will save time and money for the electric utility by direct-

SCD2000

The Switch Control Device (SCD2000) is a digital controller, integrating monitoring and control of padmount, metal-clad and pole-top loadbreak switches. The controller can be operated remotely to allow system configuration, fault analysis, and data acquisition. It also has a powerful data gathering capability which enables the user to do system loading analysis, planning, and future upgrading. Remote battery testing and load interruption accumulation make maintenance planning simple and eliminates time-based maintenance procedures.

The SCD2000 is optimized for control of loadbreak switches in medium voltage distribution circuits. The SCD2000 can be seamlessly integrated with other ABB Intelligent Electronic Devices (IEDs) such as the PCD2000 and Data Control Device (DCD2000) to provide an integrated automation system for electrical switching and system protection.

SCD2000 Front Panel



Product Description

PCD2000 **Packaged in a modular case design to allow easy upgrade and maintenance. The unit is housed in a 6-slot card case with the following:**	SCD2000 **Packaged in a modular case design to allow easy upgrade and maintenance. The unit is packaged in a 6-slot card case with the following:**
Functions Found in Both Types	
• Power Supply or UPS Module • CPU Module • PT and CT Inputs Module • Magnetic Actuator Driver Module • Digital I/O Module (optional) • Communication Modules (optional)	
Protective Functions	**Control Functions**
• Phase overcurrent protection. (ANSI, IEC, Recloser and User Programmable Curves) • Ground overcurrent protection. (ANSI, IEC, Recloser and User Programmable Curves) • Negative sequence time overcurrent protection • Multi-shot reclosing • Directional time overcurrent protection (Positive and negative sequence polarizing elements) • Voltage protection (under and overvoltage elements) • Frequency protection (multiple independent under and overfrequency elements) • Directional power flow elements (positive and negative sequence)	• Sectionalizing switching • Automatic sectionalizer functions • Loss of voltage load transfer • Fault current indication • Phase imbalance indication • Load shed, load restoration and over frequency switching functions
Additional Features	
• Metering: Current, Voltage, Watts, Watt-hours, VARs, VAR-hours, Power Factor and Frequency • Peak demand: Current, Watt and VARs with time stamp • Fault locator with distance and fault resistance • Selectable settings tables: Primary, Alternate 1, and Alternate 2 • Operations (sequence of events) record for last 512 operations • Breaker failure detection • Summation of unit interrupting duty and unit operations counter • Continuous self-diagnostics of power supply, memory elements and microprocessors • Load profile capability: Watts, VARs and voltage for 5, 15, 30, or 60 minute intervals • Fault summary and detailed fault records for last 128 trip operations • User programmable time overcurrent curves • Oscillographic data storage analyzer captures 64 cycles of current and voltage waveform data • Integrated battery charging and monitoring for AC designs • Front panel selectable recloser control function overrides: Remote Block, Ground Block, Alternate Settings 1 Enable, Optional Sensitive Earth Fault, Reclose Block, Local Battery Test. (All of these functions have front panel pushbuttons and LED status indicators) • Front mounted optically isolated meter port • Communication card has rear RS-232 and RS-485 ports with optional fiber optic port • AC or DC powered for flexibility • ANSI and IEC versions available	• Metering: Currents, Voltages, Watts, Watt hours, VARs, VAR hours, Power Factor and Frequency • Peak demand: Currents, Qatts and VARs with time stamp • Power quality monitoring • Fault locator with distance and fault resistance • Fault summary and detailed fault records for last 128 trips • Operations (sequence of events) record for last 512 operations • Switch failure detection • Unit operations counter • Continuous self-diagnostics of power supply, memory elements and microprocessors • Load profile capability: Watts, VARs and voltage for 40, 80 or 160 days • Oscillographic data storage analyzer captures 64 cycles of current and voltage waveform data • Integrated battery charging and monitoring for AC designs • Front panel open/close pushbuttons with LED status indicator • AC or DC powered for flexibility • ANSI and IEC versions available • Front panel selectable switch control function overrides: Remote Blocked Sect. Blocked, Alt 1 settings, Sensitive Earth Blocked, One Shot, Rocal Battery Test • Front mounted optically isolated meter port • Communication card has rear RS-232 and RS-485 ports with optional fiber optic port

ISD2000

VS-3S with ISD2000: Retrofit and Simple Switch Applications

The Integrated Switch Device (ISD2000) is a highly integrated control device optimised for low cost control of magnetic actuator based mechanisms. The ISD2000 has two basic application configurations: Interposer and Switch Control.

As an Interposer the ISD2000s operates as an interposing driver for direct interface to magnetic actuator based mechanisms. Additionally, the ISD 2000 can be used as a simple on/off interposing device. This allows adaptation of standard, contact driven control devices to ABB's magnetic actuator operated switching mechanisms. The ISD2000 is used with ABB VR-3S and VS-3S magnetic actuator based reclosers and sectionalizers. This product is beneficial for customers who do not want to incur additional costs by purchasing a new or different controller. The ISD2000 may also be used in applications where the distances between the PCD2000 or SCD2000 controllers exceeds 100 feet from the primary switching mechanism.

As a switch control, the ISD2000 is microprocessor-based controller for monitoring and controlling magnetically actuated poletop loadbreak switches. The ISD2000 acts as a fully integrated low cost switch control including ac/dc power supply, magnetic actuator driver, energy storage, serial communications, and discrete I/O. Optional voltage/current sensing card increases unit functionality by enabling phase or ground fault overcurrent indication and voltage measurement. The ISD2000 provides a low cost alternative to the SCD2000 for those applications that do not require an extensive local programming interface, data monitoring or communication capability.

The ISD2000 supports a wide range of magnetically actuated outdoor switches for automated feeder (AF) applications and includes voltage and current sensing options. It also has the capability to locally or remotely control switch operation.

The ISD2000 integrated Switch Device has one isolated RS-232 communication port for remote control or setup. Modbus protocol is supported for easy system integration. A utility software program for unit configuration is supplied by ABB.

The ISD2000 can be integrated with other ABB IEDs such as the SCD2000, PCD2000 and DCD2000 to provide an easy to implement, sophisticated automation system for electrical switching and system protection.

The ISD2000 is packaged in a metal case that can be easily mounted to a panel. All connections to the ISD2000 are clearly identified on the front of the case. Optional voltage and current sensing cards can be added. Sensor cards allow interface to standard PT (120 VAC) or CT (1 or 5 Amp) devices or high impedance sensors such as impedance voltage dividers and Rogowski coils for current sensing.

Product Description

Benefits

- Fully integration magnetic actuator-based switch control including energy storage capacitors
- Automatic actuator coil continuity check
- Integrated switch position integrity check
- Remote control via RS232 serial communication port
- Built in discrete I/O
- Fault current indication (with optional voltage/current sensing cards)
- Optional high impedance V/I sensor interface card
- Supports Modbus ASCII and Modbus RTU protocols
- Continuous self-diagnostics of power supply, memory elements and microprocessors
- Load profile for load current, peak RMS current, temperature and timestamp with user selectable storage times of 5 to 60 minutes
- AC or DC powered for flexibility

ISD2000

DCD2000

ABB's Data Control Device (DCD2000) is an intelligent electronic device for communication networking in feeder automation applications. The DCD2000 is a digital serial networking routing device for substation communication networks, based on industry standard protocols. The DCD2000 simplifies the task of creating a network of RS-232 based wireless radios, RS-485 networks, and fiber optic networks while integrating modem access and system diagnostics.

The DCD2000 facilitates implementation of an optimized communication network for power distribution protection and control devices such as the PCD2000, SCD2000, and the ISD2000. Its open design provides numerous configuration options, enabling the user to add automation applications to the network such as SCADA, Programmable Logic Controllers (PLC) and substation human machine interfaces (HMI).

The DCD2000 consists of four modules connected to a front panel interface and packaged in a hardened case suitable for semi-flush mounting. Network port connections are clearly identified at the rear of the unit.

DCD2000 Front Panel

Product Description

Highlights

The DCD2000 communications gateway provides an integrated communications package for the various communications mediums. In addition, the DCD2000 gateway provides access for multiple masters to the PCD2000 and the SCD2000 on the distribution system such as through PLC, RTU and dial-up modem for metering, power quality or fault location applications. MODBUS ASCII/RTU or DNP 3.0 protocols are supported.

With respect to the automation of distribution circuits, the highest level device is the DCD which is used as the communication router from the lower echelon of products. DCD2000 provides two-way protocol communication to the PCD2000, SCD2000 and ISD2000 and electric utility SCADA. The DCD2000 interconnected to the PCD2000, SCD2000 and ISD2000 help electric utilities meet the goals of distribution automation and demand side management of their distribution systems.

- Multiple master support in Modbus and DNP 3.0 protocols
- Configurable communication port and gateway modes
- Up to four RS-232 ports (two of the ports can be configured as RS-485 ports), and one fiber optic port
- Easy system configuration using the front panel interface
- Modem supports Modbus initiated TAP protocol for sending alphanumeric pager messages
- Monitor mode for viewing communication network activity
- Extended temperature modem with auto answer and inactivity timeout
- Supports multiple control applications driving multiple network applications

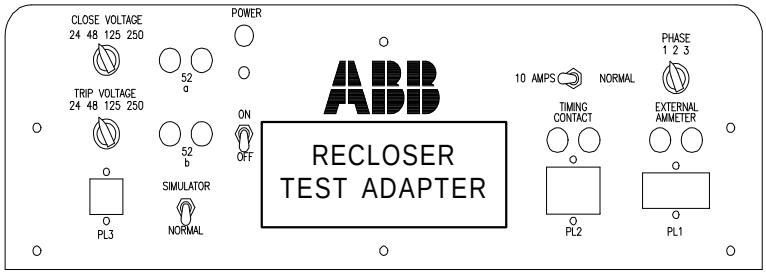
Accessories

The ABB Recloser Test Adapter Metmate, is designed to be used in conjunction with the MET Set for testing all ABB reclosers using the PCD2000, DPU2000, and DPU2000R controls. It is connected in series between the MET Set and the PCD2000, DPU2000 and DPU2000R devices. Once dialed in to the correct settings, it becomes a transparent component for testing ABB reclosers. It is easy to use and includes an instruction manual. It comes in a rugged, hard plastic case, and the appropriate cables are specified.

Benefits

- Increases the maximum current output from 3 to 10 Amps
- Can be used on any of the available Trip/Close voltages
- Can be used for testing the ABB VR-3S recloser and the ABB ESV retrofit package
- May be used for testing the control cabinets only or in combination with a recloser/breaker
- NEW! Now single-phase operation can be tested on VR-3S units with the single phase tripping option (Order S#: 1C11125G04)

Interface Panel on the ABB Recloser



Selection Guide

To order the Recloser Test Adapter, choose one of the three options below (The cable to connect to the Cooper MET Test Setä is included with each option):

- Recloser Test Adapter with cable for testing ABB VR-3S reclosers: S#: 1C11125G01
- Recloser Test Adapter with universal cable for testing ABB ESV reclosers: S#: 1C11125G02
- Recloser Test Adapter with cables for testing both ABB VR-3S And ESV reclosers ABB VR-3S reclosers: S#: 1C11125G03
- Recloser Test Adapter for testing ABB VR-3S recloser with Single Phase Tripping Option (will also work for three phase VR-3S recloser): S#: 1C11125G04

Summary

ABB feeder automation products provide state-of-the-art technology for on-line feeder control and monitoring. These solutions allow for rapid integration by being SCADA READY, providing RTU protocols and interfaces. These solutions also provide for automation without communications, such as sectionalizing or restoration, with the capability for future integration into the SCADA system. ABB views every project as a key strategic development in distribution automation. ABB will work together with electric utility engineers to implement an ABB solution on their distribution system.

ABB Distribution Automation provides:

- SCADA READY components for feeder automation
- Reduced costs in operation and maintenance
- Improved distribution system reliability with enhanced system knowledge
- Quicker information to Customer Service to identify and explain
- Customer satisfaction by understanding their individual load profiles
- Familiarity with new technological automation concepts
- Reduction of system wide outages
- Effective energy management through automation
- Enhancement of safe operating practices

Technical Specifications

VR-3S

This specification applies to three-phase circuit reclosers with a rated maximum system voltage up to 38kV, a maximum continuous current rating of 800 Amps, and 12 or 12.5 kA symmetrical interrupting rating. The recloser is designed for pole mounted or substation installation.

VR-3S Recloser Ratings

Recloser Ratings			
	15kV	**27kV**	**38kV**
Nominal Operating Voltage	2.4 —14.4kV	24.9kV	36kV
Maximum Design Voltage	15kV	27kV	38kV
Maximum Continuous Current	560/800A	560/800A	560/800A
Maximum Interrupting Current	12/12.5A	12.5kA	12.5/16kA
BIL	110kV	125kV	170kV
Dry Withstand 60Hz 1 Min.	50kV	60kV	70kV
Wet Withstand 60Hz 10 Sec.	45kV	50kV	60kV
Phase Spacing	15.5 in. (394mm)	15.5 in. (394mm)	18 in. (457mm)
Minimum External Creep	17.0 in. (432mm)	29.75 in. (756mm)	40.4 in. (1026mm)
Minimum External Strike Distance	10 in. (254mm)	12.25 in. (311mm)	16.5 in. (419mm)
Maximum Interrupting Time	0.040 sec. max.	0.040 sec. max	0.040 sec. max.
Maximum Closing Time	0.048 sec. max.	0.048 sec. max.	0.060 sec. max.

Technical Specs			
Materials	Vacuum interrupter encased in outdoor polyurethane		
Current Sensors	0.3% accuracy; one per phase encased in polyurethane		
Operating temperature	-50^{o} C to $+70^{o}$ C		
Weight (including frame)	435 lbs (197 Kg)	495 lbs (225 Kg)	565 lbs (339 Kg)
Testing	Tested to applicable ANSI and IEC standards		
Life test	10,000 mechanical operations without visible effect		
Control Voltages	24-240 VAC (nominal) or 24-250 VDC (nominal)		
LV Cabinet Weight	100 pounds/45 kg (with SCD2000 and battery pack)		

PCD2000 Ratings and Tolerances

Parameter	Value		
Current Input Circuits **Input Rating** **Input Burden** **Frequency** **Voltage Input Circuit** **Burden** **69/120 V Wye** **120/208 V Delta** **Frequency**	5 A (16 A continuous, and 450 A for 1 second) 1 A (3 A continuous, and 100 A for 1 second) Less than 0.1 VA @ 5 A 50 or 60 Hz Voltage Rating based on the VT connection setting 0.04 VA for VPH-N at 120 VAC 160 V continuous and 480 V for 10 s 260 V continuous and 480 V for 10 s 50 or 60 Hz		
Binary (Contact) Input Circuits Burden	0.075 VA at 24 VDC 0.140 VA at 48 VDC 0.360 VA at 125 VDC 0.730 VA at 250 VDC		
Control Power Burden	120 VAC at 0.17 A, Range = 102 to 132 VAC 24 VDC at 0.70 A, Range = 19 to 28 VDC 48 VDC at 0.70 A, Range = 38 to 56VDC 125 VDC at 0.70 A, Range = 70 to 150 VDC 250 VDC at 0.70 A, Range = 200 to 280 VDC		
Binary Contacts Output Rating Each Contact at Tripping	120 VAC 30 A	125 VDC 30 A	250 VDC 30 A
Continuous Break (Inductive)	5 A 2 A	5 A 0.3 A	5 A 0.1A
Operating Temperature Range	-40°C to + 70°C (operating temperatures below –20°C may reduce LCD display visibility)		
Tolerances Over Temperature Range of –30°C to + 70°C			
Element	**Pickup**	**Dropout**	**Timing (whichever is greater)**
51P/51N **50P/50N** **46/67P**	±3% of setting ±7% of setting ±3% of 51P setting	98% of setting 98% of setting 98% of setting	±7% or ± 16 milliseconds ±7% or ± 16 milliseconds ±7% or ± 16 milliseconds
67N **27/59/81V/79V** **81**	±3% of 51N setting ±3% of setting ±0.01% Hz	98% of setting 99.5% of setting ±0.01% Hz	±7% or ± 16 milliseconds ±7% or ± 16 milliseconds ± 1 Cycle
Ammeter **Voltmeter** **Power Meter** **Frequency**	±1% of 51P and 51N time overcurrent pickup setting ±1% of the VT connection setting ±2% of I x V, 51P pickup setting x VT connection setting 0.01 HZ from 30-90 Hz, at 120 VAC input on VA		
Transient Immunity	Surge withstand capability SWC and fast transient tests per ANSI C37.90.1 and IEC80255-22-1 Class III for all connections except communication or AUX ports Isolated communication ports and AUX ports per ANSI C37.90 using Oscillary SWC Test wave only and per IEC80255-22-1 class III and 80255-22-4 class III Impulse voltage withstand test per IEC80255-5 EMI test per trial use standard ANSI C37.90.2		
Humidity	Per ANSI C37.90 up to 95% without condensation		
Dielectric	3150 VDC for 1 s all circuits to ground except communication ports per IEC80255-05 2333 VDC for 1 s for isolated communication ports		

Technical Specifications

VS-3S Switch Ratings

Switch Ratings			
	15kV	**27kV**	**38kV**
Nominal System Voltage	15kV	24kV	36kV
Maximum Design Voltage	15.5kV	27kV	38kV
Maximum Continuous Current	630/800A	630/800A	630/800A
Maximum Interrupting Current	630/800A	630/800A	630/800A
Momentary Current Rating	31.5kA	31.5kA	31.5kA
3 Second Withstand Rating	10kA	10kA	10kA
Rated Frequency	50/60hz	50/60hz	50/60hz
Rated Impulse withstand Voltage (BIL)	110kV	125kV	170kV
Dry withstand 60Hz 1 Min	50kV	60kV	70kV
Wet Withstand 60Hz 10 Sec.	45kV	50kV	60kV
Bushing Creepage Distance	17.7” (450mm)	30.0” (760mm)	40.4 (1026mm)
Bushing Strike Distance	10.5” (267mm)	13.4” (340mm)	16.5” (419mm)

Technical Specs	
Materials	Vacuum interrupter encased in outdoor polyurethane
Current Sensors	0.3% accuracy; one per phase encased in polyurethane
Operating Temperature	-50^{o} C to +70^{o} C
Weight (including frame)	435 lbs (197 Kg) 495 lbs (225 Kg) 565 lbs (339 Kg)
Testing	Tested to applicable ANSI and IEC standards
Life Test	10,000 mechanical operations without visible effect
Control Voltages	24-240 VAC (nominal) or 24-250 VDC (nominal)
LV Cabinet Weight	100 pounds/45 kg (with SCD2000 and battery pack)

SCD2000 Ratings and Tolerances

Parameter	Value
Current Input Circuits **Input Rating** **Input Burden** **Frequency** **Voltage Input Circuit** **Burden** **69/120 V Wye** **120/208 V Delta** **Frequency**	5 A (16 A continuous, and 450 A for 1 second) 1 A (3 A continuous, and 100 A for 1 second) Less than 0.1 VA @ 5 A 50 or 60 Hz Voltage Rating based on the VT connection setting 0.04 VA for VPH-N at 120 VAC 160 V continuous and 480 V for 10 s 260 V continuous and 480 V for 10 s 50 or 60 Hz
Binary (Contact) Input Circuits Burden	0.075 VA at 24 VDC 0.140 VA at 48 VDC 0.360 VA at 125 VDC 0.730 VA at 250 VDC
Control Power Burden	120 VAC at 0.17 A, Range = 102 to 132 VAC 24 VDC at 0.70 A, Range = 19 to 28 VDC 48 VDC at 0.70 A, Range = 38 to 56 VDC 125 VDC at 0.70 A, Range = 70 to 150 VDC 250 VDC at 0.70 A, Range = 200 to 280 VDC
Binary Contacts Output Rating Each Contact at Tripping	120 VAC 125 VDC 250 VDC 30 A 30 A 30 A
Continuous Break (Inductive)	5 A 5 A 5 A 2 A 0.3 A 0.1A
Operating Temperature Range	-40°C to + 70°C (operating temperatures below –20°C may reduce LCD display visibility)

Tolerances Over Temperature Range of –30°C to + 70°C

Element	Pickup	Dropout	Timing (whichever is greater)
Fault Detector **27/59/81V** **81** **46**	±0.01% Hz ±5% of setting	±0.01% Hz 99.5% of setting	±1 Cycle ±7% or ±16 milliseconds
Ammeter **Voltmeter** **Power Meter** **Frequency**	±1% of time overcurrent pickup setting ±1% of the VT connection setting ±2% of I x V, 51P pickup setting x VT connection setting 0.01 HZ from 30-90 Hz, at 120 VAC input on VA		

Transient Immunity	Surge withstand capability SWC and fast transient tests per ANSI C37.90.1 and IEC80255-22-1 Class III for all connections except communication or AUX ports Isolated communication ports and AUX ports per ANSI C37.90 using Oscillary SWC Test wave only and per IEC80255-22-1 class III and 80255-22-4 class III Impulse voltage withstand test per IEC80255-5 EMI test per trial use standard ANSI C37.90.2
Humidity	Per ANSI C37.90 up to 95% without condensation
Dielectric	3150 VDC for 1 s all circuits to ground except communication ports per IEC80255-05 2333 VDC for 1 s for isolated communication ports

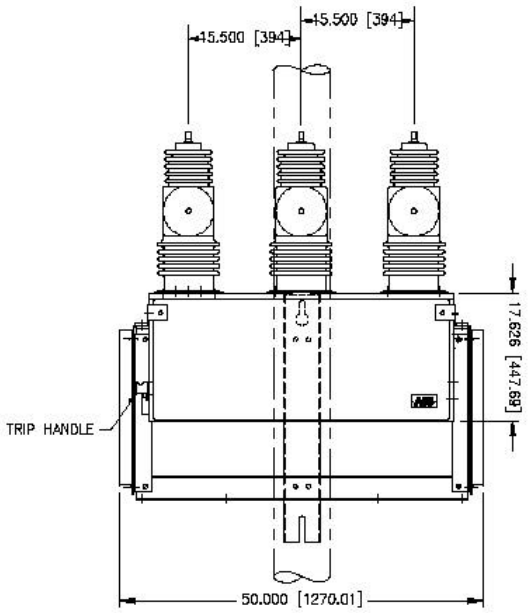
ISD2000 Ratings and Tolerances

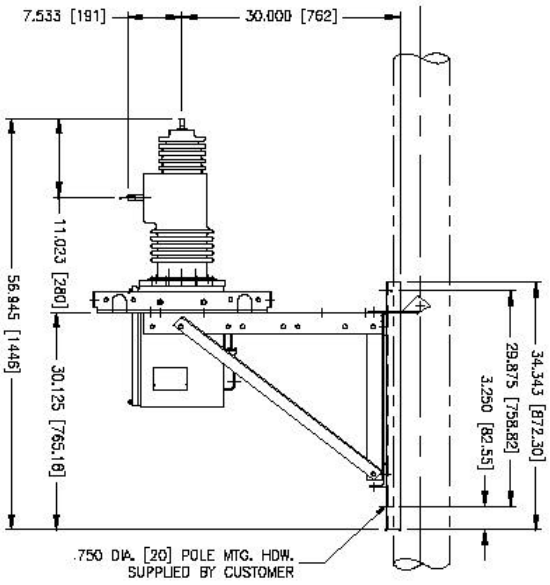
<table>
<tr><th>Parameter</th><th colspan="5">Value</th></tr>
<tr><td>Power Requirements</td><td>Voltage Range</td><td>Nominal Current (Amps)</td><td>Max. Input Current (Amps)</td><td colspan="2">Frequency</td></tr>
<tr><td>48 VDC</td><td>40 to 150 VDC</td><td>0.15</td><td>3.00</td><td colspan="2">NA</td></tr>
<tr><td>125 VDC</td><td>40 to 150 VDC</td><td>0.09</td><td>7.00</td><td colspan="2">NA</td></tr>
<tr><td>115 VAC</td><td>105 to 135 VAC</td><td>0.10</td><td>0.50</td><td colspan="2">47 to 63 Hz</td></tr>
<tr><td>230 VAC</td><td>210 to 270 VAC</td><td>0.05</td><td>0.25</td><td colspan="2">47 to 63 Hz</td></tr>
<tr><td>Control Inputs
Switch Status Outputs
Form C Contacts</td><td colspan="5">20 VDC at 0.5 mA To 150 VDC at 4 mA
250 VAC, 6 A continuous</td></tr>
<tr><td>Actuator Control Outputs</td><td colspan="5"><table><tr><th>Power Level</th><th>Output Current (Amps)</th></tr><tr><td>Low</td><td>18</td></tr><tr><td>Medium</td><td>21</td></tr><tr><td>High</td><td>24</td></tr></table></td></tr>
<tr><td colspan="6">Switch Pole Position Inputs</td></tr>
<tr><td>Dielectric
Compliance Standard</td><td colspan="5">2.54 kV, 1 second minimum application to power supply input, status output contacts, control inputs, isolated RS-232 port and DC circuit (control and power supply) applied group to group and group to frame per ANSI C37.90-1989, Section 8.</td></tr>
<tr><td>Transient Immunity
Compliance Standards</td><td colspan="5">Power input and contact outputs conductively via a coupling network per ANSI C37.90.1-1989 using oscillatory SWC Test Wave and 5 kV fast transient and IEC 1000-4-4 EMC Fast Transient/Burst Immunity.</td></tr>
<tr><td>Environmental
Operating Temperature
Storage Temperature
Humidity</td><td colspan="5">-40° to 70° C (-40° to 158° F)
-50° to 85° C (-58° to 185° F)
Up to 100% non-condensing</td></tr>
<tr><td>Dimensions</td><td colspan="5"><table><tr><th>Dimension</th><th>Inches</th><th>Millimeters</th></tr><tr><td>Length</td><td>10.46</td><td>265.7</td></tr><tr><td>Width[1]</td><td>9.95</td><td>252.7</td></tr><tr><td>Height</td><td>3.72</td><td>94.5</td></tr></table>1. Includes mounting brackets on enclosure base.</td></tr>
</table>

DCD2000 Ratings and Tolerances

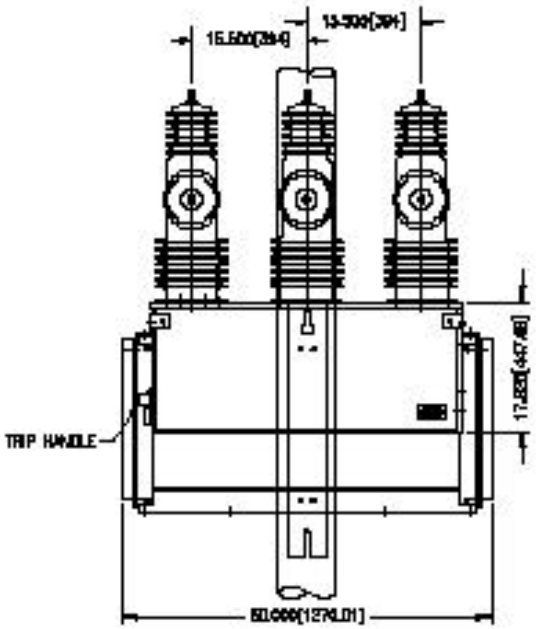
Parameter	Value		
Power Supply Requirements	**Voltage Range**	**Max. Input Current**	**Frequency**
48 VDC	38 to 65 VDC	0.6 A	NA
125 VDC	70 to 140 VDC	0.3 A	NA
250 VDC / 120 VAC	140 to 280 VDC 96 to 130 VAC	0.16 A (DC) 0.24 A (DC)	47 to 63 Hz
CPU Module Microprocessor CPU RAM DSP EPROM DSP RAM	20 MHz, 32-bit microprocessor 64k 3k 16k		
Communications CPU Module Microprocessor CPU RAM EEPROM	25 MHz, 32-bit microprocessor 256k 8k		
Dielectric Compliance Standard	2.54 kVDC, 1 second minimum application to power supply input, self check relay output, gateway communications ports 1 through 4 applied group-to-group and group to frame per ANSI C37.90-1989 Section 8.		
Transient Immunity Compliance Standard	Isolated communication ports (capacitive coupled to the communication cable), power supply input, self check output, and AUX ports per ANSI C37.90.1–1989 using oscillatory SWC Test Wave and 5 kV fast transient.		
Environmental Operating Temperature Humidity	 -40^{o} to 60^{o} C (-40^{o} to 140^{o} F) Up to 95% without condensation per ANSI C37.90		
Weight	Approximately 9 lbs. (4 kg)		

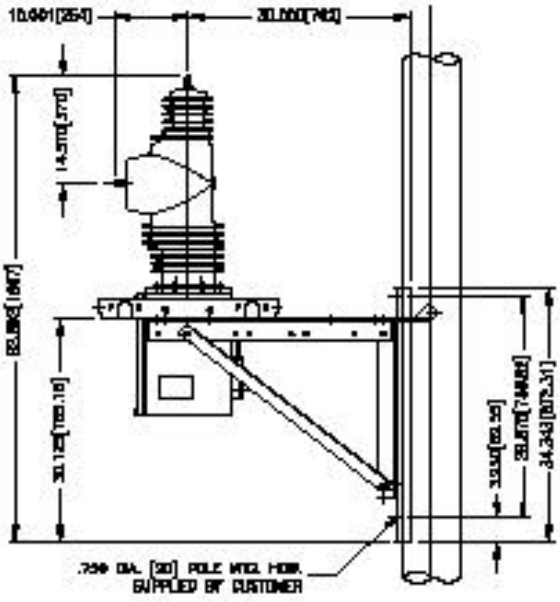
15kV Recloser Drawing



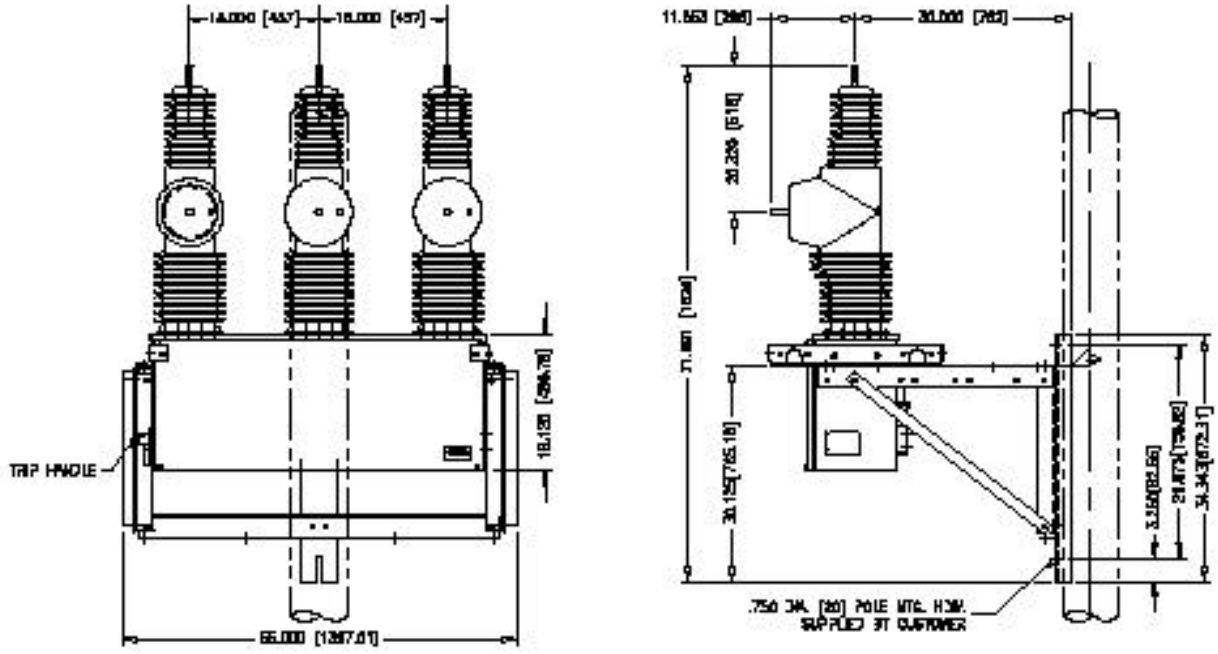


27kV Recloser Drawing

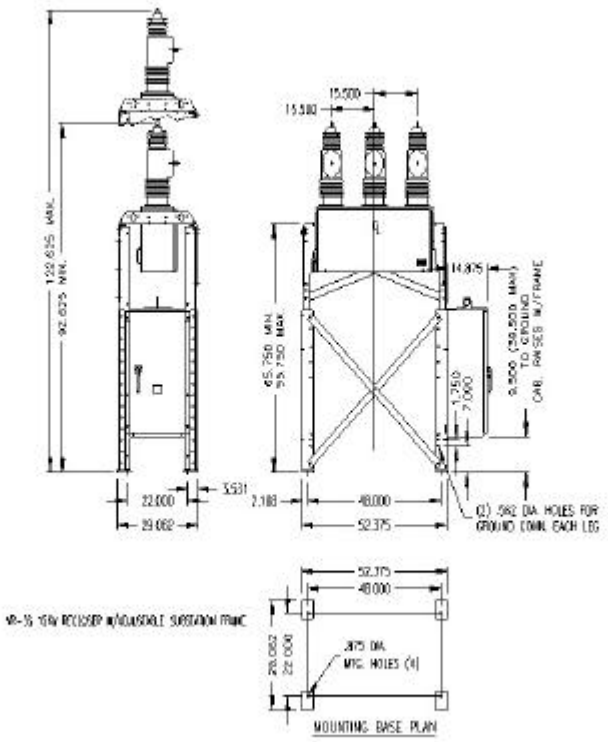




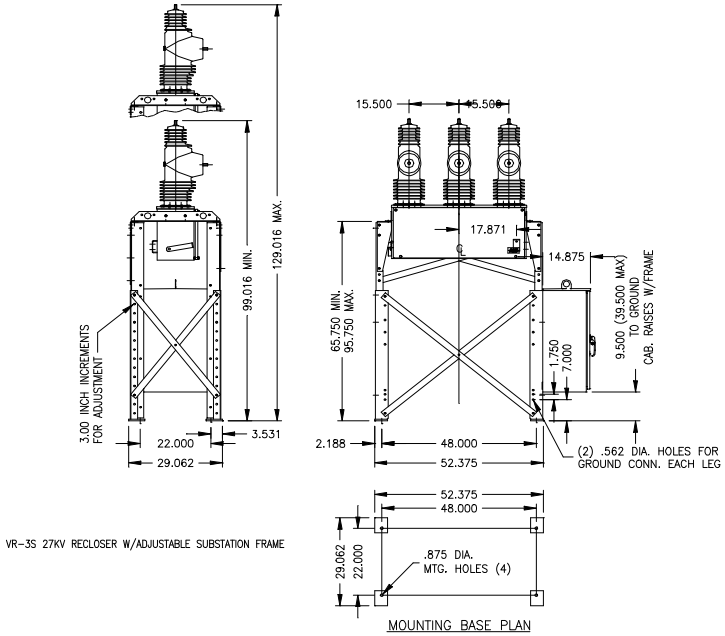
38kV Recloser Drawing



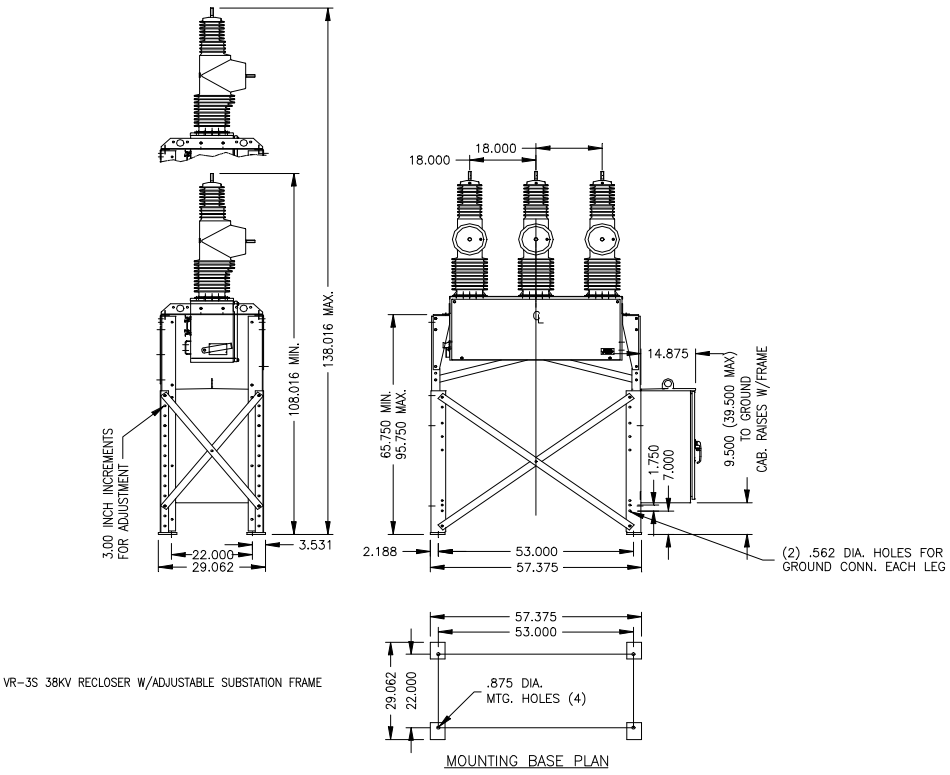
15 kV Substation Frame



27 kV Substation Frame



38 kV Substation Frame



VR-3S 38KV RECLOSER W/ADJUSTABLE SUBSTATION FRAME

ABB Power Distribution
655 Century Point
Lake Mary, FL 32746
1-800-929-7947
Fax 407-732-2132
www.abb.com/distribution