# INTEGRATED SWITCHING DEVICES

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## *ABSTRACT*

Electricity is an essential requirement of most facets of our lives and is often recognized as a basic human need. Electricity is the key to accelerating economic growth, generation of employment, elimination of poverty and enabling human development, especially in the rural areas. Generally, the growth of rural electricity networks which are predominantly overhead line connection, has taken place in a haphazard manner giving rise to an inefficient and unreliable networks. Ageing equipments and inefficient layout of this equipment has not only lead to huge losses, but also result in break down and power outages. In many developing countries governments have initiated programs to improve and expand the existing networks. This paper presents an innovative solution to solve the problem associated with setting up substations within such networks, especially in rural and semi-urban areas.

## INTRODUCTION

Rural electrification has been almost entirely carried out by extending the grid. Rarely has local resources been utilised for generating power. The distribution networks have grown in a disorganised fashion; there was no master plan. The method followed by the power utilities has been "to connect a village to be electrified to the nearest village that has been electrified". This has given rise to an inefficient distribution network. In many developing countries governments have initiated programs to improve and expand the existing networks.

The problems associated with setting up of substations within such networks are:

a) **Larger foot print:** Substation equipments like breakers, instrument transformers, disconnectors and surge arresters are sourced from different suppliers and erected on individual structures there by occupying more floor space and taking additional time to install and commission.

b) **High watt loss:** Substation equipments are interconnected by loose jumpers using power connectors. Improper connection of jumper leads to huge power loss in the system.

c) **Poor Reliability:** As these equipments are sourced from road side vendors, they are not always reliable.

d) **High safety risk:** The absence of safety interlock between the installed equipment is a safety threat to operating personal during equipments maintenance. In rural areas, the equipments are operated using unskilled labourers and will represent a higher safety risk

This paper presents an innovative solution to combine different equipment into one factory assembled integrated solution to solve the problems associated with setting up substations within such networks.

## NEED FOR THIS SOLUTION

Medium voltage distribution network is a vital portion of the electrical grid system as it takes the electrical energy to the door steps of the end users. The process of restructuring, privatisation and deregulation has created a highly competitive market environment for electrical energy. The focus is on delivering uninterrupted power supply to the customers at a competitive price. Hence, the utilities are under tremendous pressure to upgrade and modernise their systems to meet the end users demand in a cost effective manner. From this point of view, an integrated, intelligent, easy to install, easy to operate, safe and reliable product concept is not an out of context solution.

With increasing infrastructure development in rural and semi-urban areas, land has become a scarce commodity not only in urban areas, but also in rural and semi-urban areas as well. Hence, a compact integrated device with smaller footprint is a great value enabler. Also in rural and semi urban areas it is difficult to find competent operating and maintenance staffs. Hence, simple, easy to install, easy to operate and maintain, reliable and safe product concept will be very much suitable for such application. As the rural electrical network is predominantly over head connected, the present practice of establishing connection with individual equipments by line conductors involves more number of joints which in turn leads to higher watt loss. An integrated factory assembled equipment will greatly reduce this loss.

## CONVENTIONAL SUBSTATION LAYOUT

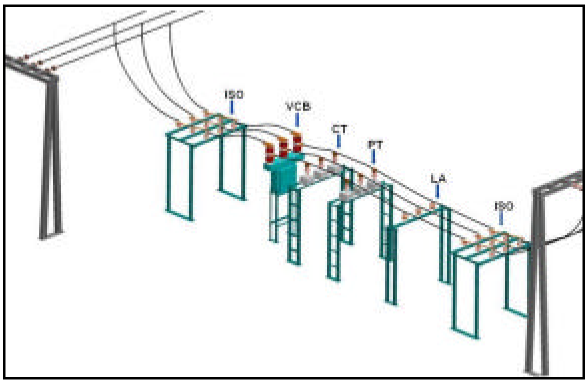


*Fig1. Layout of Conventional way followed in Substation*

Figure 1 Shows the typical layout of a medium voltage distribution substation. It has been like this for many years. The conventional design has an individual structure for equipment and uses isolators on both sides of the circuit breaker. Instrument transformers and surge arresters are also connected between the circuit breaker and disconnector.
Apart from occupying large floor space, inter connection between these equipments using long ACSR conductor leads to inefficient electrical joints resulting in higher watt loss. As these equipments are being procured from different suppliers, a lot of coordinated effort is required for procurement. Hence, the project realisation time from initiation to installation and commissioning is enormous.
As most of these equipments are sourced from road side vendors, quality and reliability risk of these equipments are very huge. Also, achieving inter functional coordination and fulfilling safety interlock requirements between different equipments is often a difficult task.

## INTEGRATION – AS A DIFFERENTIATOR

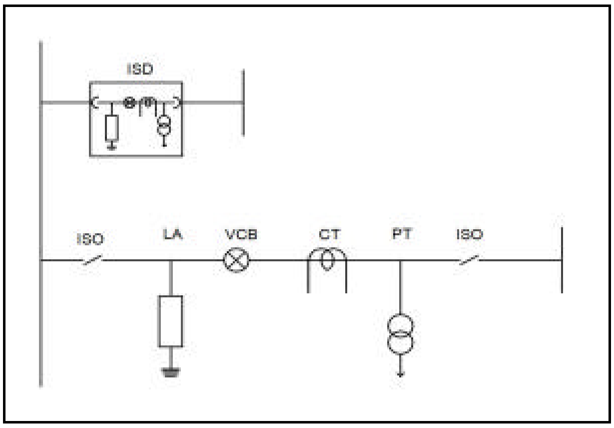


*Fig2 Comparision concept-ISD with present substation practice*

The present invention “Integrated Switching Devices (ISD)” as shown in figure 2 is aimed at providing solution to the short comings in the existing system. It includes switching devices (Breaker & Isolators), metering equipment (current and voltage transformers), protection device (surge arrestor) and control & communication devices (control circuits, HMI and bay controller) integrated and housed on a simple structure made easy for installation and commissioning. By means of a vertically movable arrangement of the breaker unit, disconnecting functionality is ensured at both sides of the breaker. The equipments are fixed using quick clamping techniques which will help to remove and replace the equipment during renewal or repair there by reducing the down time considerably and increase the availability of the supply. Maintenance and repair of the integrated equipments can be carried out at ground level which provides easy and safe access. This solution provides an economical way of delivering a smart, compact, highly reliable substation within optimum floor space.

## DESIGN OF INTEGRATED SOLUTION

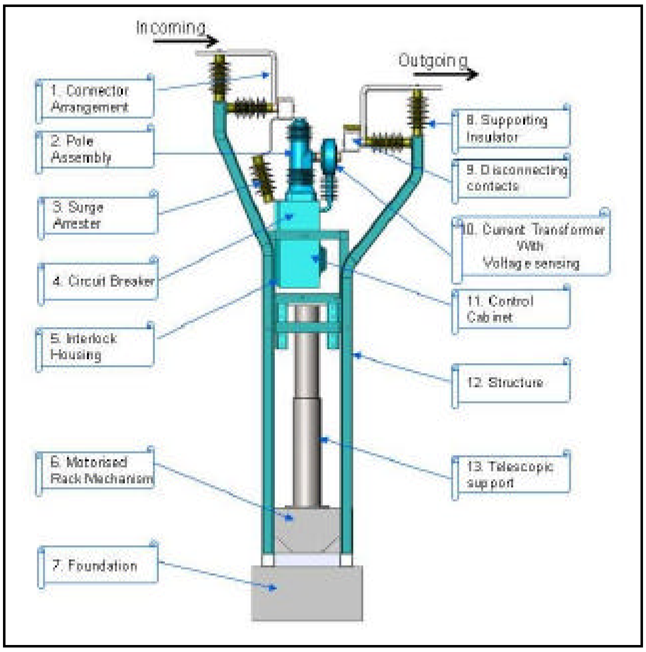


*Figure3: Integrated Switching Devices (ISD) in service*

*Fig4. ISD in Isolated Position*

The circuit breaker (4) , which is the heart of this proposed solution, consists of three individual poles(2). The vacuum interrupter and the connection terminals are embedded in to each pole and the current and voltage sensors (10) are connected to the pole terminal. The poles (2) and the sensors (10) are, made out of hydrophobic cycloaliphatic epoxy resin, well suited for outdoor application. These poles are fixed on an enclosure which contains the operating mechanism, control elements and the kinematic linkages. The circuit breaker assembly is fixed on a screw jack mechanism (6) as shown in the figure 3. The breaker can be moved up and down by means of the manual screw jack arrangement or by a motor to provide the disconnector functionality for the integrated unit. Interlocks (5) are provided to prevent the movement of the breaker when it is in closed condition. This assembly is fixed on a structure (12) which contains the support insulators (8) and the connector arrangement (1) for connecting the unit to the overhead lines. The surge arresters (3) are fixed on the incoming terminal side. Sufficient electrical clearances are provided between the supply side and the disconnecting contacts (9) to facilitate safe operation. As the entire arrangement is assembled and tested at factory, installation and commissioning efforts are greatly reduced. The electrical connections between different parts are optimised and hence, the watt loss is minimum.

## ADVANTAGES

The proposed solution has the following advantage

- Compact
- Smaller foot print
- Easy to install
- Easy to operate
- Easy to maintain
- Enhanced operator safety
- Reliable
- Reduced Life Cycle cost
- Less logistics

## INTELEGENT AUTOMATION.

In recent years the requirement of rural electrification process has changed with requests for more operation, information from remote sites, and improved control possibilities. At the same time new and improved technologies have evolved, which provide solutions to these new demands. The integrated switching device with its integrated sensors and combined functionalities supports this automation process very well. New "intelligent" interfaces can be incorporated in ISD. These new IED's (Intelligent Electronic Device) combined with the latest information, communication and secondary equipment technology shall form a base for enhanced protection, control and monitoring of substations which will replace all electrical wires by high-speed communication links, except for the auxiliary power supply. Auxiliary relays for protection and control logics shall be replaced by programmable logic controller functionality.

## AUTOMATION STRATEGY:

The automation strategy determines which type of communication system is to be utilized. Two typical implementations are shown in Figure 5 and are noted below:

? Wide area network such as a dedicated wireless network or cellular technology.

? Local wireless network with a local hub, which may be located in the substation connected to the automated feeder.

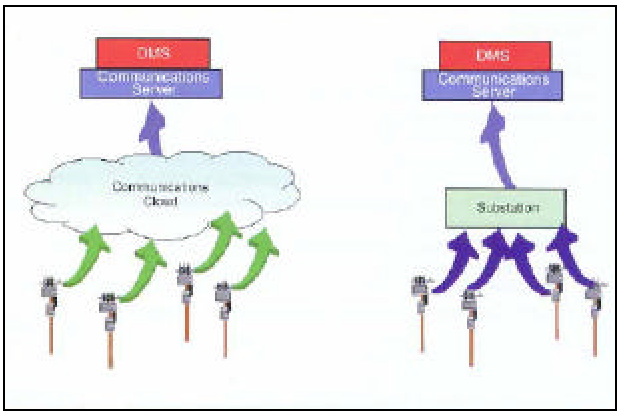


*Figure 5: Wide area vs local communication deployment.*

An example of a local deployment from a substation is illustrated in figure 6.


*Figure 6: Integration of substation and feeder equipment communications.*

The new generation feeder automation IEDs based on ABB Relion® product platform gives the flexibility to the users to select the appropriate level of automation required for their specific need.

## SMART GIRD APPLICATI ON

One crucial function of Smart Grids is that it provides a reliable power supply through the use of digital information, automated control system. The process bus shall be used for the communication between the IED integrated in the ISD and the protection and control devices in the control room. The process bus can also be used for direct communication between the ISDs in the switchyard. The process bus transmits all process information between the control room equipment and the switchyard with enough speed and accuracy. A WEB server for access to all station information via INTRANET (Private Intranet) shall be is connected to the process bus.

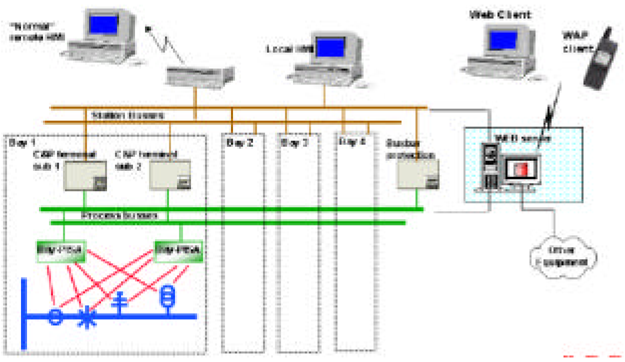


*Fig 6. Schematic view of the control and protection system*

All signals in the switchyard are taken to or from a Data Acquisition and control units (DACU). Then the DACU is connected to the central control system via the process bus. Therefore the long distance cabling is reduced to two optical fibres and one power supply per DACU.

## CONCLUSION

In this paper, a new concept of Integrated Switching Device (ISD) is proposed for outdoor overhead connected distribution network system. This new architecture includes devices like circuit breaker, disconnector, instrument transformer, surge arrester, protection and communication IEDs integrated in to one compact factory assembled, tested and ready to use units. This solution is simple, more economical, reliable and safer than the present existing solutions.

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