Station service voltage transformers for low-power applications

For small communities, the cost of a substation is often prohibitive. ABB’s micro substation – a low-cost substation that exploits single-phase station service voltage transformers (SSVTs) – alleviates this situation. SSVTs step down power from high voltage levels to medium or low voltage in one step.

All substations have metering and protection systems that run off a low-voltage (LV) power supply – the so-called control power supply. For reliability, every substation requires two redundant control power supplies. Usually, the main transformer in the substation is the primary source of control power.

If substation power is lost, the grid, via a power transformer, can provide the secondary power source. However, this is an expensive option, both in terms of capital expenditure and the cost of keeping the transformer energized. Drawing power from a feeder connected to a local LV distribution network is another option, but one that is also expensive and prone to disruption. In some cases, the main HV transformer is equipped with a third winding to provide the control power supply. However, this is not an ideal solution because of design, reliability and cost considerations. A further option is a standby generator – a solution with low initial financial outlay, but high lifetime costs.

Fortunately, an SSVT – or an SSMV, which is an SSVT for medium-voltage (MV) levels – can, in many cases, provide the secondary control power supply – for a fraction of the cost and much more easily [1].

The SSVT
An SSVT combines power and instrument transformer characteristics in a product with high reliability, low cost, simplicity and compactness that is ideal for small power applications. The SSVT’s capabilities allow it or an SSMV to meet the power requirements of a remote community or a substation with just a single unit.

The SSVT has a small footprint, is easily configured by virtue of its single-phase design and can supply power from 25 kVA to 333 kVA, subject to certain limitations on voltage, at 50 HZ or 60 HZ. An SSVT or SSMV, though not a replacement for a full substation, can expand the reach of electricity to remote communities – for example, small villages in Africa →1. SSVT/SSMV units are significantly lighter and smaller than a power transformer – ideal for transportation to locations in Africa, or elsewhere, that are not easily accessible. SSVTs/SSMVs can be used as a power source during construction and later configured as a control power source.

An SSVT or SSMV has a single-phase, shell-type construction and is connected between the primary line and ground, with a grounded shield winding interposed between the high-voltage (HV) and low-voltage (LV) sides to protect the secondary from transient voltage surges.
In the SSVT protection scheme, a current transformer (CT) on the HV neutral or ground connection will detect any line-to-ground fault on the secondary winding. A CT on the tank ground wire can detect a ground fault on the primary side. An optional, under-oil, sudden-pressure relay can also detect internal faults just as in a power transformer. In the event of a fault on the primary side, the line protection can isolate the SSVT. At present, up to a 750 kV basic impulse level (BIL), HV dropout fuse protection is available to isolate a defective SSVT/SSMV from the transmission line. Above 750 kV, a single-phase circuit breaker can be used.

Further, a substation using a single-phase SSVT or SSMV can be unmanned and very straightforward, with just an arrestor, HV circuit breaker, isolator, earthing grid and LV distribution board – all in a single-phase configuration. This simple arrangement also reduces footprint.

By eliminating one or more intermediate transformers, no-load losses and copper losses are reduced, making the system more energy-efficient. Also, the SSVT’s oil volume is a fraction of that of a comparable power transformer. SSVTs are virtually silent in operation.

SSVTs with higher kVA ratings are under development, which will allow larger isolated communities to benefit from the convenience of grid electricity. In many countries in Africa, for instance, the direct access to grid power that SSVTs can provide will have a dramatic and fundamental positive effect on their economic and social development.

An SSVT can provide the secondary control power supply – for a fraction of the cost and much more easily.