SERVERON®

TM - TBM Installation Guide

Model TM -TBM

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Table of Contents

Table of Figure

PF Live Plus Hardware Installation

PF Live Plus Cabinet

The PF Live Plus Cabinet shown in the following figure contains all the equipment required to condition the input signal for acquisition and to provide electrical protection and isolation. The capacitance rating of the AC Input Boards in the PF Live Plus Cabinet must be chosen so that they are tuned to the capacitance of the bushings or CTs being monitored. These signal are then routed to an Analog to Digital Converter and the resultant Power Factor variables are stored in a on-board long term memory device for periodic statistical analysis to determine if an insulation deterioration condition exists.

Figure 1 - PF Live Plus Cabinet

Signal inputs:

Number of AC analog input channels:	30 AC Max (3 per AC Input Board)
Input impedance:	50 Ω (< 1 kHz)
Signal input mode:	Differential
Maximum full scale voltage:	± 60 V rms
Nominal voltage:	40 V rms
Isolation between inputs:	3000 V
Surge withstand capabilities:	ANSI/IEE C37.90.1-1989 IEC 254
Number of DC analog input channels	32 DC Max (requires an 8 channel DC Input Board)

Signal outputs:

Isolated Alarm Contact Outputs	6 Contacts, Max DC 200V, Max Current DC 1 Amp.
Digital to Analog Output Channels	2 (12 Bit Channels), +/- 5, 0 to 5, or 0 to 10 Volts Analog Output range.

Dimensions:

20 in. tall x 16 in. wide x 8 in. deep (49cm x 40.64cm x 20.32cm)
Weight: 45lbs (10.45Kg)

Environmental:

BTC and Interface Cabinet: -40°C to +65°C, 0 to 95 % humidity non-condensing
Pollution Degree 1

Power Supply:

Isolated supply to cabinet 110/220 volt AC, 50/60Hz, 40W

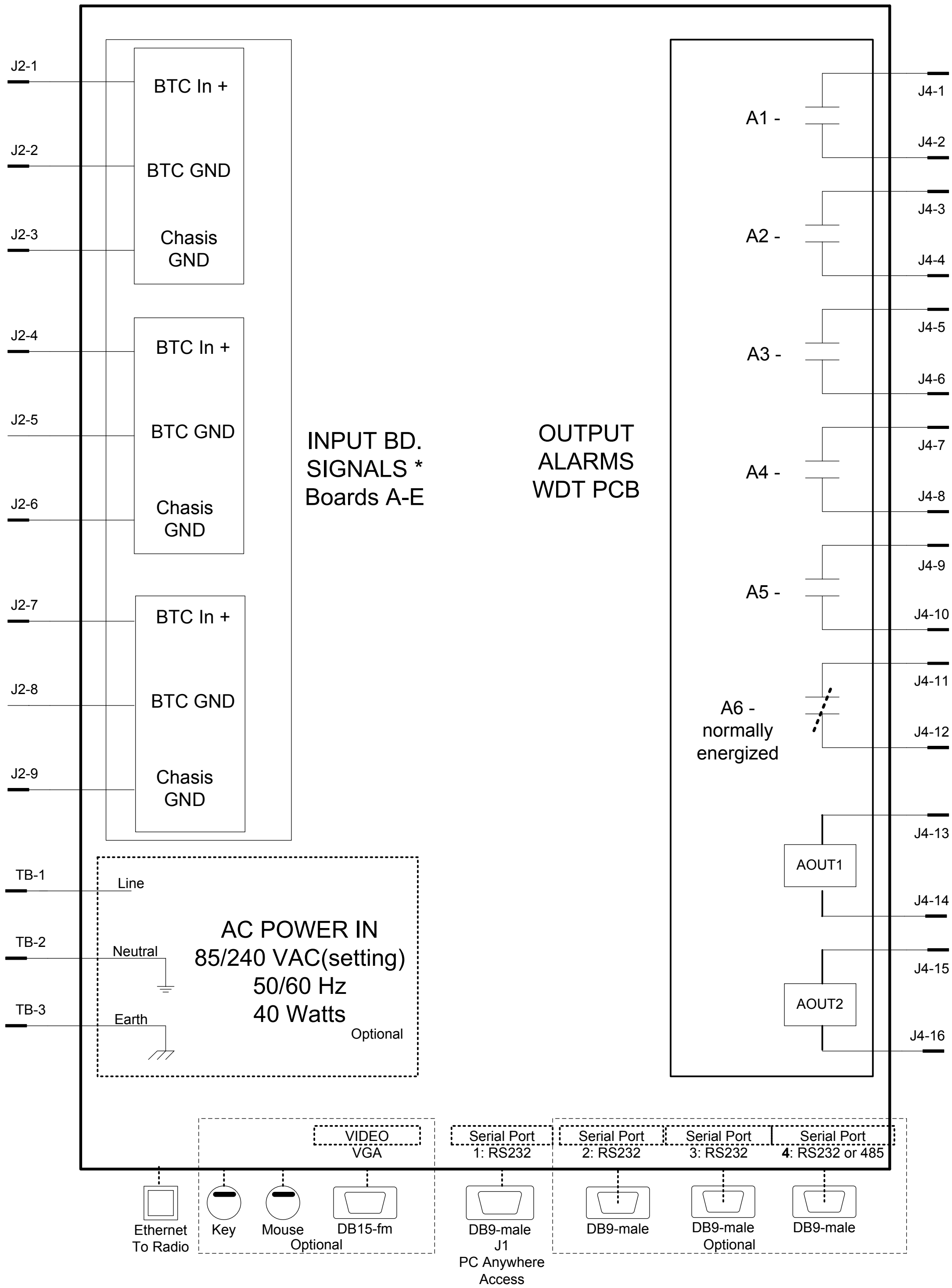

Figure 2 - PF Live Plus Elementary Diagram

Hardware Parts List

- Bushing Tap Coupler (BTC)
- MTU for BPD interface
- PF Live Plus Cabinet
- BTC/MTU 50′ Cable (One per bushing monitored
- Optional wireless modem

BTC

A BTC is used in conjunction with a capacitive divider circuit in the PF Live Plus Cabinet to produce a measurable signal from the test object (CT or bushing). BTCs are essentially capacitive transducers with protection and signal conditioning, clipping voltages to 90 V (Peak to Peak) and limiting continuous voltage to ±60 V RMS. Each BTC and PF Live Plus Cabinet are configured and supplied with a specific designation to a test object in the substation so that it is tuned to the capacitance of the bushing or CT. The BTC circuit is contained in a watertight container, complying with NEMA type-4 protection classification.

The BTC mounting varies depending on the type of CT or bushing to be monitored. Refer to sections 3.2 and 3.3 for mounting instructions.

Figure 3 - Typical BTCs

The BPD interface is shown in figure 3. The BPD interface module (VIM) is connected with the twisted/shielded cable provided. It is connected from the 115V auxiliary terminals in the BPD (See figure 8) to terminals 1 and 2 of the VIM. Terminal 3 is for the shield ground connection. The BTCs are connected with a watertight military connector at the bushing, and terminated in the PFLive Plus cabinet on the AC input board connector. (See Figure 3 for connection information.)

Before starting the installation, it is important to understand the overall system layout and cable and shield connections. Read and understand Section 2, Safety, before installing the system. The following figure shows the signal cable and shield connections from the test object to the BTC and terminated at the PF Live Plus Cabinet.

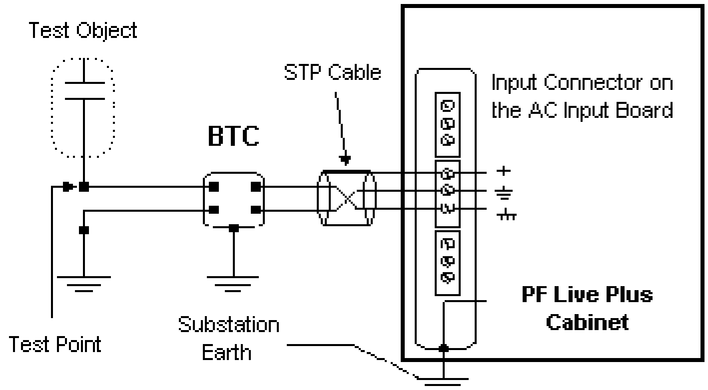

Figure 4 - Signal Cable and Shield Connections

Preparations for Installation

Complete the Installation Checklist, provided in Appendix A. Preparations should include the following configuration documentation:

- Installation schedule
- Cable layout and length
- Channel allocation for hardware installation and software configuration Figure 5 - Test Bushing with BTC connected

Figure 6 – Typical In service BTC connection

Installing the BTC

WARNING

There is always the possibility of voltages being induced at the terminals of a test object because of proximity to energized high-voltage lines or equipment. A residual static voltage charge may also be present at these terminals. Ground each terminal to be tested with a safety ground stick, then install safety ground jumpers, before making or checking connections.

The BTC is coupled mechanically and electrically to the tap-point of each test object via an appropriate adapter bolted or threaded onto the bushing. The BTC is placed physically close to the test point to secure a safe signal voltage through adequate voltage division and protection. See the following figure.

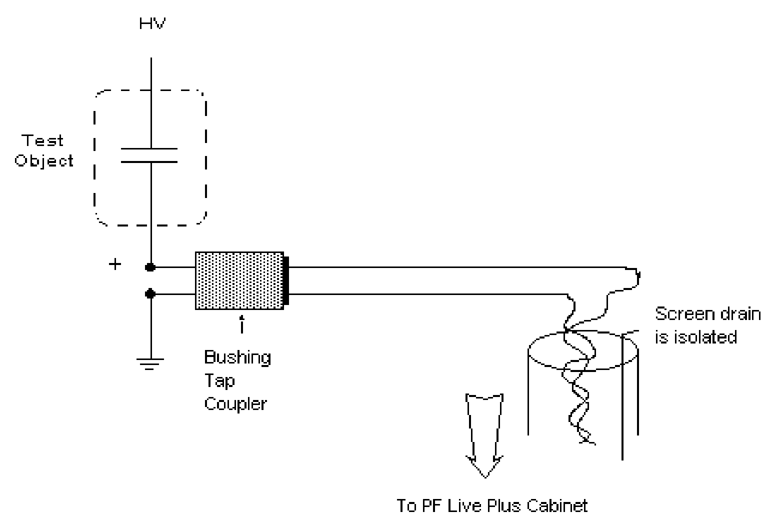

Figure 7 - BTC Connection Diagram

CAUTION

The screen drain of each twisted pair must not be grounded to substation earth at the BTC or test object. The only point to which the individual STP screen drain is connected to earth is via the terminal blocks in the PF Live Plus Cabinet

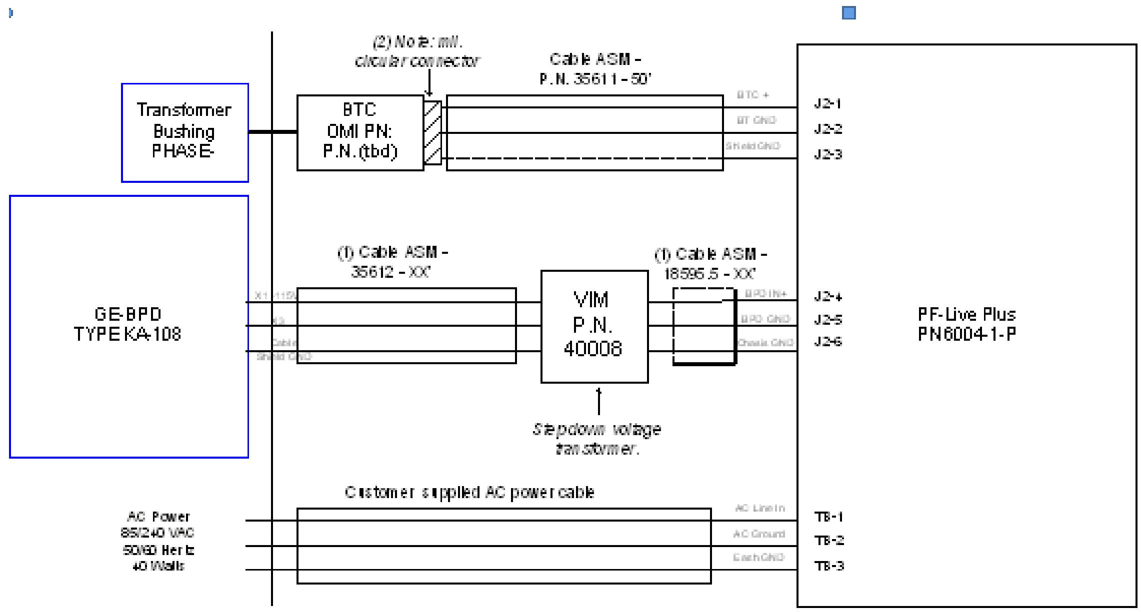

Figure 8 – BTC/BPD wiring diagram

Installing the PF Live Plus Cabinet

Since each combination of BTC and PF Live Plus Cabinet is manufactured and supplied to correspond to a designated test object, be sure the correct cabinet is installed. The following figure provides the dimensions and location of the mounting holes for the PF Live Plus Cabinet.

The Cabinet must be mounted low enough that test personnel can attach the Communications Cable from an external computer, yet close enough to the test object base or support frame to afford short connections to the BTCs assigned to this Cabinet. The PF Live Plus Cabinet must be solidly connected to substation earth.

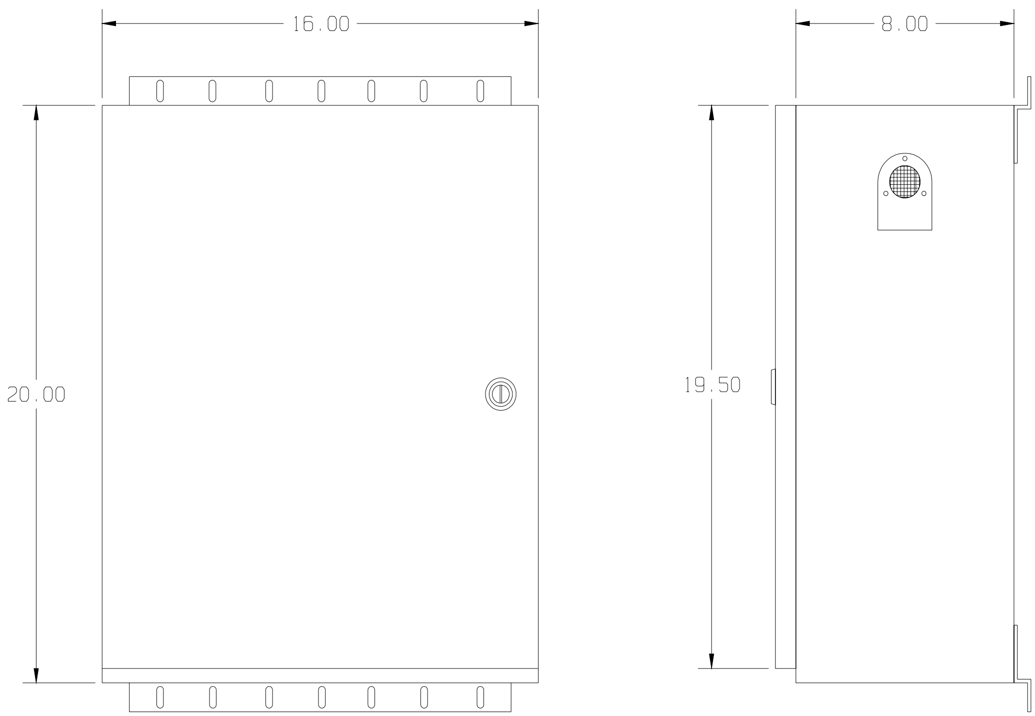

Figure 9 - PF Live Plus Cabinet Mounting Dimensions

PF Live Plus Power and Input/Output Connections

Power Source Connections

The isolated power source should enter the cabinet via a weatherproof hole in the bottom of the cabinet and connected to the J1 connector on the WDT/ALARM board as shown in the following figure. The board has an “IN” designation next to the J1 connector and “E” (Earth), ‘L” (Line), and “N” (Neutral) designations on the board from right to left indicating where the power cable should be connected.

The jumper JMP1 in the lower middle of the WDT/ALARM board should be positioned to the left for a 110-volt power source and to the right for a 220-volt power source. There are “110” and “220” designators on the board next to the JMP1 jumper.

WARNING

There is always the possibility of voltages being induced at the terminals of a test specimen because of proximity to energized high-voltage lines or equipment. A residual static voltage charge may also be present at these terminals. Ground each terminal to be tested with a safety ground stick, then install safety ground jumpers, before making or checking connections. Ensure that the object to be tested is completely de-energized and discharged.

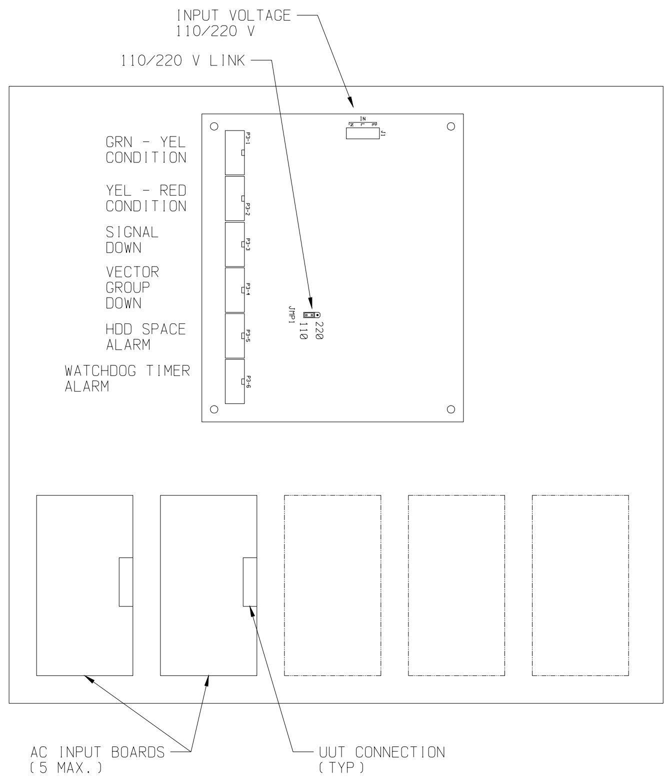

Figure 10 - Power Connections and Jumper Setting

AC/DC Input Signal Connections

WARNING

There is always the possibility of voltages being induced at the terminals of a test specimen because of proximity to energized high-voltage lines or equipment. A residual static voltage charge may also be present at these terminals. Ground each terminal to be tested with a safety ground stick, then install safety ground jumpers, before making or checking connections. Ensure that the object to be tested is completely de-energized and discharged.

The Installation Checklist (Appendix A) requires the capacitance values of each test object so the divider capacitance rating of the PF Live Plus Cabinet can be selected before installation.

Together with the BTC, the capacitor divider circuit in the PF Live Plus Cabinet transforms the voltage across the Test Tap to a voltage signal of approximately 40 V rms. The STP cable from the BTC is connected to the input terminals in the PF Live Plus Cabinet.

Each AC Input board in the PF Live Plus cabinet can handle up to three AC input signals from the bushing tap couplers. The terminal block on the AC Input board has nine connection posts. Each STP from a BTC will use a set of three consecutive connections on the terminal block. The first input on this AC Input board will use the right set of three posts on the terminal block, the second input will use the middle set of three posts, and the third input will use the left set of three posts. The right most connector of each set of three connectors on the nine post terminal block is for the (+) positive signal, the middle connector is for the ground connection, and the left connector is for the shield connection in the STP. The following figure illustrates the terminal block on the AC Input board.

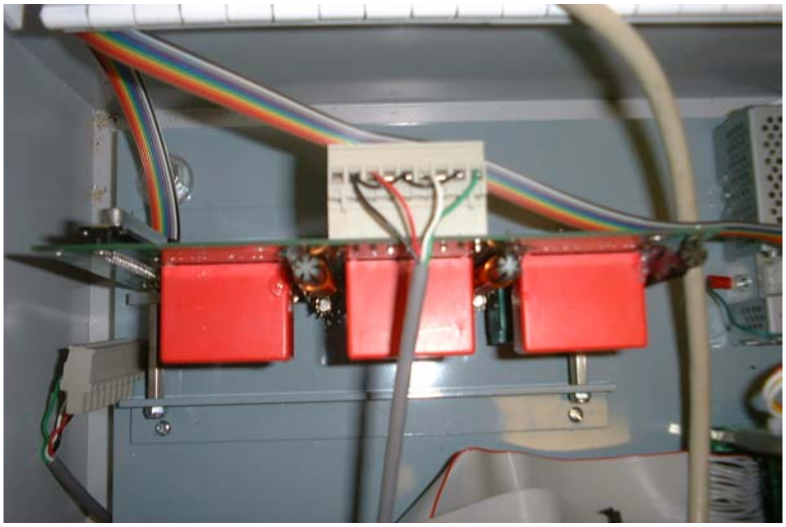

Figure 11 - Terminal Block on AC Input Board

The DC Input board uses the same type of terminal block with nine connector posts. The right most connection is for DC channel 1 and up to eight DC channels can be monitored. The ninth connection on the terminal block is for the ground input.

Digital Alarm Outputs

The digital alarm outputs are connected to the J4 terminal block on the WDT/ALARM board and are designated as "A1" thru "A6" on the board next to the J4 connector. It is highly recommended that at least three of these Digital Alarm outputs (A2, A3, A6) be attached to external SCADA equipment so that the operational status of PF Live Plus can be monitored at a remote location. The alarm conditions associated with these digital outputs are as follows:

- A1 - Normally open and will close if the condition of a unit changes from green to yellow.
- A2 - Normally open and will close if the condition of a unit changes from yellow to red.
- A3 - Normally open and will close if the signal from a single unit is down.
- A4 - Normally open and will close if the signals from a vector group (3 units) are down.
- A5 - Normally open and will close if the available disk space on the computer is below the specified percentage.

A6 - Normally closed and will open if the Monitoring program stops (e.g. when the operating system crashes or the PC hangs).

Analog Alarm Outputs

This feature of PF Live Plus can be used to convert two internal variables, such as selected condition values and display them as a voltage in the 0 to 10 volt range. They are designated as "A/01" and "A/02" on the WDT/ALARM board next to the J4 connector. The high side of the device receiving the output should be connected to one of these two posts and connect the low side of the device should be connected to the associated "GND" post.

Communications

Modem Connection Option

If it is desired to have the PF Live Plus system send Warning, Detail, or Summary Reports by facsimile, then the modem connection option must be installed. Due to the harsh electrical environment at the transformer, the PF Live Plus cabinet must be connected to an external modem in the Control House using 1300 Nanometer Multimode Fiberoptic cable with ST connectors.

This option requires installing a Async Fiberoptic Mini Modem (e.g. Black Box product ME605A-FST) in the PF Live Plus cabinet via a short cable with a DB9 pin female connector to the COM 1 port from the PC104 board and the DB25 male connector on the cable to the DB25 female connector on the Async Fiberoptic Mini Modem. The two ST connectors on the fiber optic cables are fed into the bottom of the cabinet and attached to the modem.

The other ends of the fiber optic cables are attached to the ST connectors of the second Async Fiberoptic Mini Modem and the DB25 pin connector is connected to an external modem attached to a phone line in the Control House.

The serial port on the PFLive Plus can be used to communicate with PCAnywhere, or configured as an ASCII port via RS485 or RS232 directly to SCADA or any remote monitoring system.

Network Connection Option

If it is desired to have the PF Live Plus system accessible on a network, then the network connection option must be installed. Due to the harsh electrical environment at the transformer, the PF Live Plus cabinet must be connected to the Network Hub in the Control House using 1300 Nanometer Multimode Fiberoptic cable with ST connectors.

This option requires installing a Fast Ethernet Media Converter in the PF Live Plus cabinet with a short CAT 5 Patch Cable with male RJ45 connectors on both ends. The cable is used to connect the Converter to the Network connector on the PC104 Processor Board. External power must be supplied to the Converter and the two ST connectors on the fiber optic cables are fed into the bottom of the cabinet and attached to the terminals on the Fast Ethernet Media Converter.

The other ends of the fiber optic cables are attached to the ST connectors of a Fiberoptic Network Hub in the Control House or to a second Fast Ethernet Media Converter and the Converter is then connected to the Network Hub.

Wireless Connectivity

A wireless modem or wireless LAN option is also available and is connected from the PFLive Plus to a receiver connected to the substation LAN or phone system.

UCA Server Option

This PF Live Plus option enables the Monitoring program to utilize the industry standard UCA (Utility Communication Architecture) protocol. Installing the optional UCA Server in PF Live Plus and having the hardware connected to a network enables a gateway between PF Live Plus and the SOS Supervisor. In a typical scenario, UCA Server accepts data requests from the SOS Supervisor and sends the appropriate responses back to SOS Supervisor for each data requests. UCA Server also is able to dynamically create "bricks" associated with each domain, as the user add new units to the PF Live Plus system.

A stand-alone executable file called *sos_ucaserver.exe* has to be installed in the *\sos* directory. PF Live Plus Monitoring starts UCA Server by calling *sos_ucaserver.exe*, after it completes the first sampling of all units. There are also three other MMS-EASE LITE configuration files that have to be under *\sos* to make UCA Server work. These are *lean.cfg, mbufcalc.cfg, and mms_log.cfg* files.

Appendix A - Installation Checklist

Complete one worksheet for each set of three units monitored so an Serveron engineer can use this data to determine the CDU (uF) value and the correct PF Live Plus Cabinet can be ordered.

Feeder / Bay ID : **Voltage :** ________ **kV** **Unit :** Bushing / CT		**Capacitance [PF]**	**Measurement Tap - Point present ?** **[Yes / No] and action**
Red **Phase A**	**Type** : __________ **Manuf.** : __________ **Ser.No** : __________	C_1 = ______	**Yes** [ ] Obtain drawings of tap point or of coupling unit. **No** [ ] For CT decide on isolation method.
White **Phase B**	**Type** : __________ **Manuf.** : __________ **Ser.No** : __________	C_1 = ______	**Yes** [ ] Obtain drawings of tap point or of coupling unit. **No** [ ] For CT decide on isolation method.
Blue **Phase C**	**Type** : __________ **Manuf.** : __________ **Ser.No** : __________	C_1 = ______	**Yes** [ ] Obtain drawings of tap point or of coupling unit. **No** [ ] For CT decide on isolation method.

Appendix B – Product Comparison

Q: What is the principle of operation and how does it differ from other techniques?

A: The power factor (PF) or Tan δ calculation in the PF Live (and the SOS) system is based on the conventional and fundamental Schering Bridge used in laboratories. Data is acquired under software control from transducers connected to the test objects associated with a transformer and then the data is compared to data from another reference standard to produce a power factor value. Our sensor monitoring these minute phase and voltage changes has been proven to detect the incipient fault days before other competitive systems in side by side tests conducted by more than one Industry studies.

The Schering bridge concept is used, where a voltage reference is taken from a bushing that simulates a reference capacitor. The reference device in our design does not have to be associated with the same phase, since the virtual Schering bridge (software algorithm) for the PF Live, will automatically make the proper phase angle adjustments. Relative measurements and evaluation can reduce the affect of influences such as ambient temperature, operating voltages, loading conditions, different aging characteristics, different designs, operating conditions, etc.

The software permits entering the PF value of the last offline test (preferred) nameplate PF values for each sample under test. Using this value, the PF is normalized to a PF result, which is comparable to an off-line test value.

The current sum method is another concept used in the market. It uses the sum of the 3 phases and compares it to the neutral current. This method is very involved, has its limitations in identifying the exact failing bushing, and it has proven to be less sensitive in independent testing of bushing failures.

The common type of bushing failure problem occurs due to a failure in the internal bushing capacitive layers. These failures occur slowly over time with one layer slowly failing and burning through the Kraft paper. On-Line Monitorings' method of monitoring the voltage is very responsive, and can detect these millivolt level changes. The changes are too small for a current probe to react to them. This failure does not get in to the ground until it is very late in the failure mode for the current probes to detect it. This fact was also verified by statements made by researchers at a major Canadian Hydro facility, based on their use of a current probe using the Current Sum method.

Q: How is the bushing/transformer protected from an accidental open circuit conditions at the bushing tap coupler?

A: The bushing tap coupler has an internal capacitor that creates a voltage divider with the bushing capacitance, C1. This voltage division limits the output of the bushing tap coupler to approximately 115Vrms so that it is at a safe level if it gets disconnected from the rest of the system. We also have a 400V spark gap, SG1 across the output of the bushing tap coupler that will limit the output in case of surges or an over-voltage condition. A schematic representation of the circuit is shown below.