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Application Note

DECS-450 and DECS-2100: Two Solutions for Replacing Aging WTA Static Exciter System

This Application Note addresses various solutions for retrofitting and upgrading Westinghouse WTA analog static excitation system with the Basler DECS-450 or DECS-2100 Digital Excitation Control System.

Characteristics of the WTA

For many decades, the Westinghouse Electric Company produced the WTA voltage regulator/exciter, the workhorse for many of their large, base load generators. The WTA shown in Figure 1 is a predecessor to the more recent WTA 300 model.

This particular WTA system is used as a mobile static exciter and has twelve 500 amp Trinistat power rectifier drawers in parallel with each other for a total output rating of 6000 Adc. With this power drawer redundancy, several power drawers could be removed from service for repair, but perhaps at reduced generator output. Three phase power input to the system's power rectifier drawers was obtained from a power transformer, 60 Hz station power source. Reliability was a priority to assure that these large generators stayed on line. In addition to the parallel power drawers, many of these WTA systems had redundant firing circuit modules as shown in Figure 2.

The WTA systems operated in either a manual mode or an automatic voltage regulator mode whose circuitry was located in the Regulator Logic Module shown in Figure 3. Various plug-in circuit card modules performed the regulator function, as well as other common auxiliary functions such as maximum excitation limiters, volts-per-Hertz limiter and other protective functions common to solid-state voltage regulators to prevent the generator from operating outside of its design capabilities. Typically, the WTA has a motorized base adjust potentiometer to set the reference point for manual operation. In the signal mixer circuitry, the Automatic Voltage Regulator (AVR) output signal biases the base reference setpoint with buck/boost signals that provide the fast excitation response necessary for the long time constants associated with these large generators.

As with many old technology excitation systems including the WTA, lack of product support and spare parts cause owners of these old systems to search for new solutions for maintaining and upgrading these excitation systems.

Figure 1: WTA voltage regulator/exciter

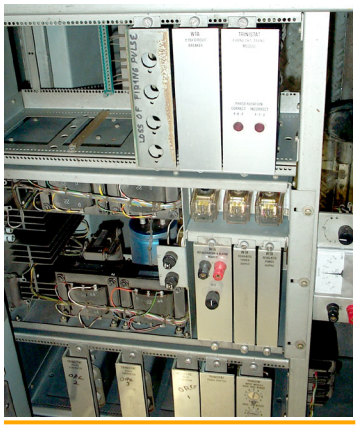

Figure 2: Existing redundant firing circuit modules from WTA system are replaced

Figure 3: WTA Regulator Logic Module are replaced

The Basler Digital Solutions

Basler Electric has two options for upgrading the WTA regulator/static exciter systems utilizing the latest digital excitation control system technology.

- The first option is to replace the "front end" regulator portion of the WTA using the DECS-2100 ECM controllers and associated panels, but keeping the power drawers, breakers, and power potential transformer. Some owners choose this option because of the comparatively high cost of a complete excitation system replacement and the inability to remove the existing cabinet. Keeping the power potential transformers and modern power semiconductors have generally proven to be reliable.
- The second option is to replace the entire regulator system including the Trinistat power rectifiers with either a new DECS-450 control/rectifier bridge(s) system in a NEMA type enclosure as shown in Figure 4 or the DECS-2100 control/rectifier bridge system in a NEMA type enclosure as shown in Figure 5. At the discretion of the owner, the power stepdown transformer may be reused or replaced.

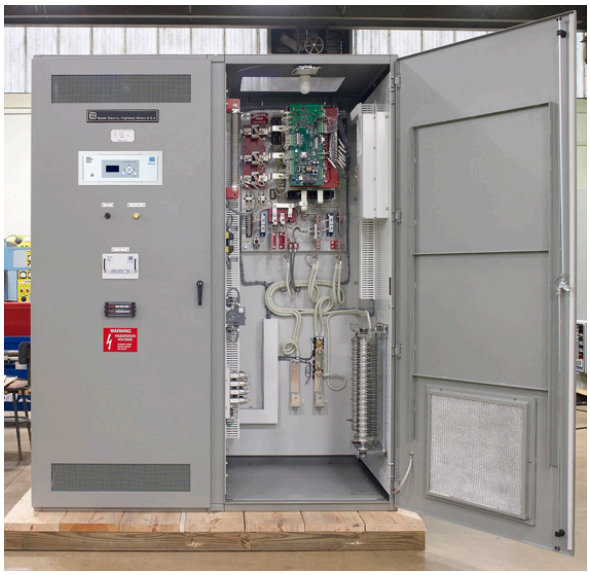

Figure 4: DECS-450 with rectifier bridge

Figure 5: DECS-2100 Digital Excitation Control System

DECS-2100 Front-End Retrofit

In a DECS-2100 front-end retrofit, all existing control equipment is removed and replaced with updated technology. A DECS-2100 front-end retrofit replaces the WTA voltage regulator, all logic control modules, and even the current pulse transformers.

The new retrofit system, typically located on the rectifier bridge, usually contains four pan chassis assemblies that will be installed in the existing WDR cabinet. The first pan chassis may include one or two ECM-2 controllers. Full control redundancy is achieved by using two ECM-2 controllers. Also included on this chassis are interposing relays, an eight channel Ethernet port, USB hub, two PT cards, and one CT card (Fig. 6).

The second panel contains the I/O (input/output) modules. The standard upgrade kit has two digital I/O modules and one analog input/output module. Typically, each ECM-2 controller has its own set of digital and analog I/O boards (Fig. 7). This approach offers the most robust approach to control and I/O redundancy. Alternately, the ECM-2 controllers may share a single set of digital and analog I/O boards if space is an issue or a special I/O configuration is needed.

The third panel consists of the ac and dc transducers, along with associated power supplies and control transformers. This chassis also contains an integrated ground detector relay for rotor field protection (Fig. 8).

The fourth panel includes all of the bridge control modules that perform the firing function. The number of bridge control modules depends on how many SCR power drawers are included in the system. Each SCR power drawer requires a bridge control module (Fig. 9).

The DECS-2100 front-end retrofit is also supplied with an IDP-1500 Interactive Display Panel (Fig. 10). It has a high resolution, 15.6 inch (39.6 cm) color touchscreen which provides control, metering, alarm, and graphical screens. The IDP-1500 has more flexibility and features than the annunciation panel on WTA systems.

The existing non-linear resistor field protection circuit is replaced with a new DX/CB-2 module and accompanying field discharge resistor(s).

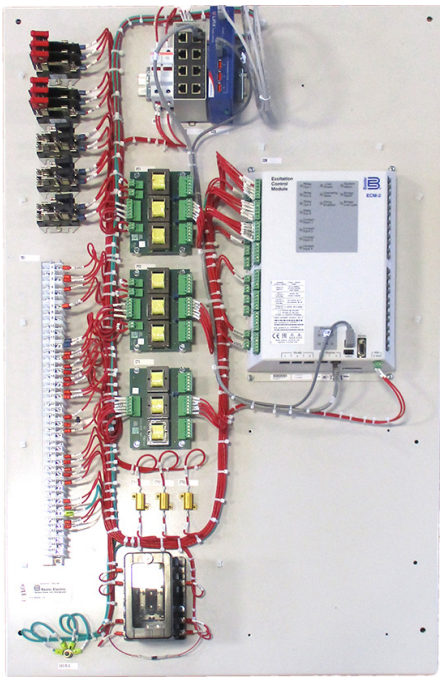

Figure 6: Control panel 1 (Typical Installation)

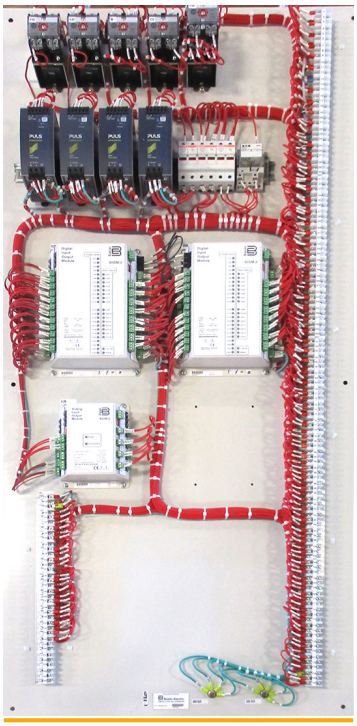

Figure 7: Control panel 2 (Typical Installation)

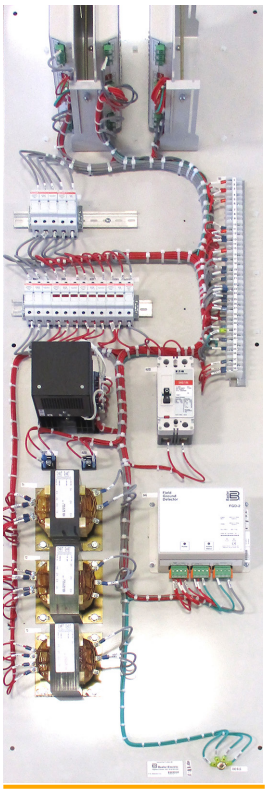

Figure 8: Control panel 3 (Typical Installation)

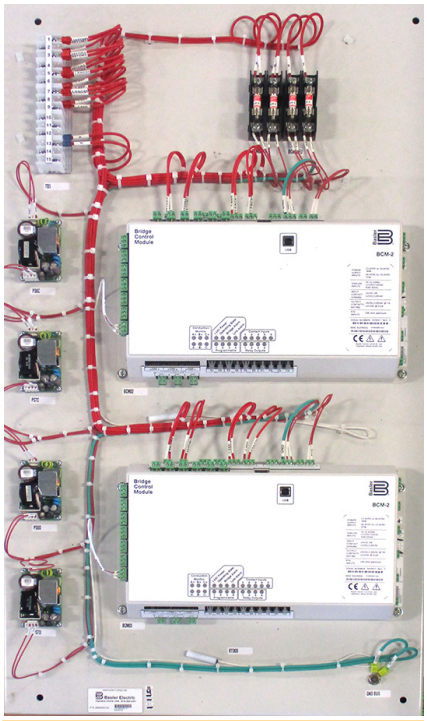

Figure 9: Control panel 4 (Typical Installation)

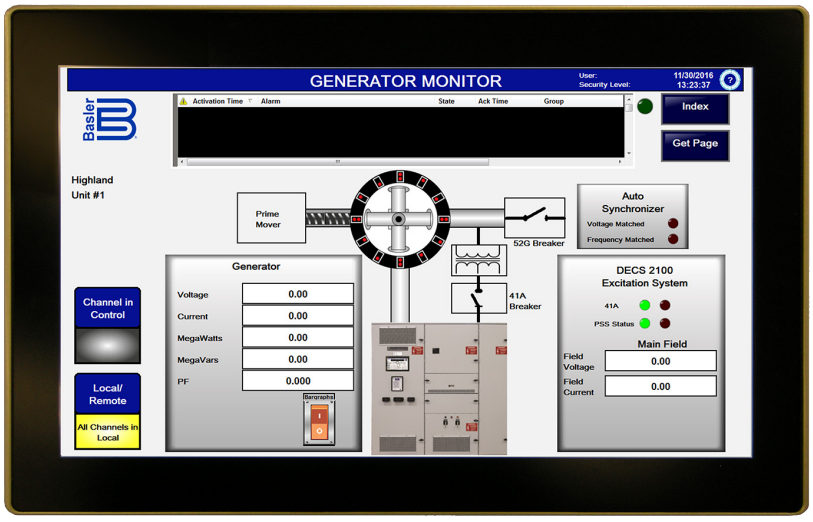

Figure 10: IDP-1500

DECS-2100 Feature Highlights

As shown in the previous pictures, the DECS-2100 can be offered with prepackaged panels for insertion into the existing cabinet where appropriate. But for a long term solution, a complete replacement static exciter is suggested, keeping the power potential transformer where it is in good health. Regardless of the approach implemented, the DECS-2100 is a multi-microprocessor excitation control system that provides advanced technology to precisely control, protect, and monitor synchronous generators, including new and existing applications that are driven by all types of prime movers, such as steam, gas, and hydro. Its multifunctional design allows the DECS-2100 to operate as a voltage regulator or as a static exciter, providing excitation currents up to 10,000 Adc.

Features include:

- +0.1% Voltage Regulation Accuracy
- Performance response <20 ms
- Redundant Controllers with Independent Supervisory Channel (options)
- Six-SCR Power Rectifier Bridges Fixed or Low-, Medium- and High-Voltage Drawer types Patented Active Current Balance Algorithm
- Patented Active Current and Temperature Balance Algorithm
- Multiple Excitation Limiters with online and offline settings and dual setpoints
- Generator optimization by real time limiter set point recalibration
- Optional Integrated Power System Stabilizer, IEEE Type PSS2A/2B with dual settings groups
- Negative Field Forcing for highest performance
- Multiple Operating Modes with Auto-following and multiple protection functions with online and offline settings and dual settings groups
- Programmable input/output terminations and sequencing provisions
- Frequency Response Analysis Tools with Phase Plot Compensator for assisted Power System Stabilizer tuning
- PID Gain Autotuning
- Auto Synchronizing (25A) option
- Built-in Field Ground Protection (64F)
- High Initial Response Per IEEE 421.2
- RS-232, RS-485, Ethernet, and USB ports for communications and data acquisition
- BESTCOMS™*Pro*, a sophisticated software configuration program for setup and testing
- Continuous self-diagnostic capabilities
- Transient event recording and data logging
- Incorporates fiber optics for critical signals
- Provisions for Field Flashing from Station Service

Controller Configuration Tool (BESTCOMS™*Pro*)

BESTCOMS*Pro* is an easy-to-use software tool for configuring, monitoring, and maintaining the DECS-2100 Digital Excitation Control System. It provides operators and maintenance personnel with password access to the operational parameters and optional configuration management of the DECS-2100 Digital Excitation System through a laptop or desktop PC. See Figure 11.

Figure 11: BESTCOMS™*Pro* showing a step response with the PSS enabled

DECS-450 Feature Highlights

The DECS-450 Digital Excitation Control System shown in Figure 12 is a highly flexible and accurate microprocessor based controller whose electrically isolated analog output commands the firing control of a six SCR rectifier bridge(s) for control. The DECS-450 also monitors generator parameters to prevent the generator from operating beyond its designed capability range. To protect the generator, the DECS-450 incorporates an underexcitation limiter (UEL), overexcitation limiters (OEL), stator current limiters (SCL), and a volts-per-Hertz limiter (V/Hz). The OEL and SCL limiter set points may be automatically modified by an external analog input signal representing variable hydrogen pressure levels or ambient air temperature. Built-in protective elements with primary and secondary

Figure 12: DECS-450 Digital Excitation Control System

settings also monitor generator and excitation parameters for backup protection.

The DECS-450 has four control operating modes that include Automatic Voltage Regulator mode with droop or line drop compensation, Field Current/Field Voltage Regulation modes for manual control, Var and Power Factor control modes. When in the manual (FCR/FVR) mode, the excitation limiter action described above can be programmed to be active.

The optional Power Systems Stabilizer is an IEEE Type PSS2A, Integral of Accelerating Power type that provides positive damping for low frequency power oscillations in the 0.1–5 Hz frequency range. A built-in Dynamic System Analyzer and BESTCOMS*Plus*® software with Bode Plot and Real Time Monitor allow for fast field testing and tuning of the DECS-450 and PSS.

Examples of the user friendly, Windows® based BESTCOMS*Plus* communication software used for programming the DECS-450 settings are shown in Figures 13 and 14.

Data logging features of the DECS-450 include Sequence of Event Recording and Oscillography for post fault troubleshooting. The DECS-450 can accept an IRIG-B signal to ensure accurate time synchronization with logged fault

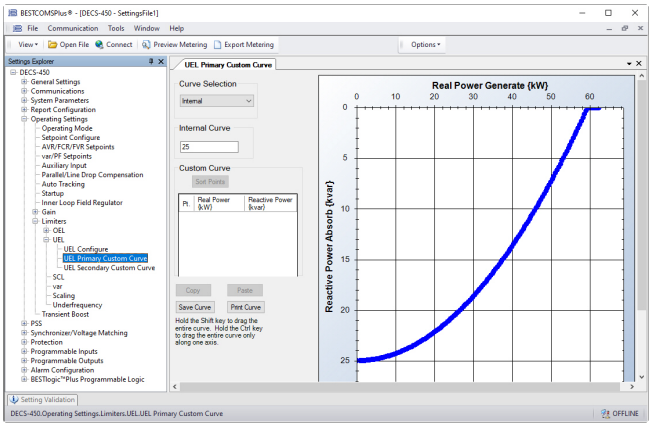

Figure 13: Custom 5 Point UEL Limiting via BESTCOMS*Plus*®

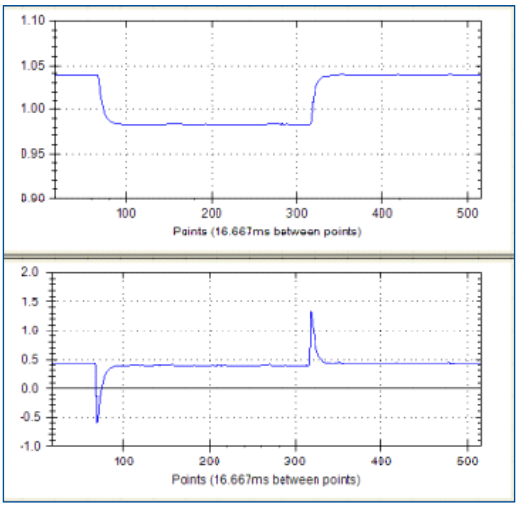

Figure 14: Real Time Monitoring up to six channels

information from other devices. Modbus communication is available for interfacing to a DCS or SCADA system.

See the DECS-450 Features Table on the next page.

DECS-450 Features

- UL Recognized, CSA Qualified, CE Compliant
- Oscillography - 1,200 points, 6 programmable parameters, holds up to 6 records
- Meets ANSI C37.90.1 for Surge Withstand and Fast Transient
- Meets RFI (Radio Frequency Interference)
- Meets Conducted and Radiated Noise per IEC 60255-22-6 (Conducted) & 60255-22-3 (Radiated)
- Field current or field voltage regulator for standby mode and NERC testing
- Operating Temperature Range –40° to 60°C
- Voltage Regulation - 0.1% Accuracy
- Var/Power Factor Controller
- Automatic Nulling - Nulling between operating modes and redundant DECS
- Selectable Underfrequency or Volts/Hertz Ratio Limiter
- Minimum Excitation Limiter - Flexible 5 point map on real/ reactive power axis or Internal generated UEL curve
- Maximum Excitation Limiter
- Var Limiter
- Stator Current Limiter
- Dual PID Setting Groups - Allows for programmed changes in PID gain settings for use with Power System Stabilizer or alternate transmission systems
- Auto Tuning of the Voltage Regulator PID gains
- Auto Voltage Matching - Automatically matches generator voltage to bus voltage
- Autotracking for bumpless transfer between Automatic Voltage Regulator (AVR), manual control, and redundant controller where applicable
- Auto Synchronizing (Device 25A) option
- 3 Preposition Set points - Programmable for AVR, Manual, Var/PF Controller
- Reactive Droop or Line Drop Compensation, Network Reactive line sharing via Ethernet communications for multiple machine on a single bus
- Loss of Voltage Sensing - Transfers to manual control automatically due to loss of voltage sensing at the voltage regulator
- Sequence of events - stores 2,047 records
- Real time chart recorder, data logging including oscillography and sequence of event information for data capture up to six channels
- Built-in Dynamic Analyzer for measuring frequency response of generator and excitation system using Signal Generator
- Protection
  - Generator Overvoltage
  - Generator Undervoltage
  - Loss of Voltage Sensing
  - Field Overvoltage with Dual Settings Groups
  - Field Overcurrent with Dual Settings
  - Generator Overfrequency
  - Generator Underfrequency
  - Generator Reverse Power
  - Generator Loss of Excitation
  - Synch Check when 25A is disabled
  - Exciter Diode Monitor for Brushless Exciters
  - Generator Below 10Hz
  - Volts per Hertz: coordinates with the V/Hz limiter function
  - Loss of Field Isolation Transducer
  - Control Power Input Failure
  - Crowbar Activated
  - Field Over Temperature
  - Watchdog Timer: monitors the microprocessors and provides a trip contact if a microprocessor fault occurs
- Field overvoltage, generator over/ undervoltage, field overcurrent, and loss of field protections have dual set points selectable via programmable logic
- HMI Metering, Operating Screen - Metering, Control, Annunciation
- IRIG-B Time Synchronization stamp
- Generator Field Temperature Monitoring (Static Exciter)
- 5 Analog Transducers Outputs
- Optional Built-in Power System Stabilizer, Type 2A/2B/2C, Integral of Accelerating Power
- Phase Plot Compensator for Power System Stabilizer assisted tuning
- 6 SCR Bridge Rectifier
- RS-485
- Ethernet over Modbus® TCP
- BESTCOMS*Plus*® common operating software to Basler Electric product family
- BESTlogic™*Plus* programmable logic
- Expandable Inputs and Outputs via remote modules

DECS-450 and DECS-2100 Auto Tuning

New to the DECS-450 is PID auto tuning via BESTCOMS*Plus*® operating software, similar to that provided in the DECS-250 product line. Auto tuning is used during commissioning with the generator spinning. After initiation, the auto tuning is performed in less than a minute that will determine the PID gains for the controller. It accomplishes this with the spinning machine open circuit by performing number of voltage step changes to the generator output resulting in suggested gains. Additionally, the auto tuning will determine the machine Time Constants of the Exciter (te) (where applicable) and Generator (T'do"), which is required data for generator modeling. The PID auto tuning process speeds commissioning to enable the generator to become fully operational sooner to the system.

DECS-450 and DECS-2100 Phase Plot Compensator

The built-in Dynamic Frequency System Analyzer will perform a frequency response in minutes, compared to the older methods of obtaining data that took three days and machine down time for hookup and teardown. For systems today that require a power system stabilizer, a Phase Plot Compensator is provided with the Dynamic Frequency Analyzer to assist in evaluating the power system stabilizer Lead/Lag filters selection that are derived from the Frequency Response of the generator system. When the red and blue curves align as shown in Figure 15, proper compensation is achieved and test validation is then required.

BESTspace™

The DECS-450 and DECS-2100 offer a setup commissioning tool in BESTCOMS*Plus* and BESTCOMS*Pro* operating software that allows one to set up preferred monitoring screens from the Metering Explorer. BESTspace allows one to save the file as a "default" and it will come up on the preferred screen every time BESTCOMS is opened. Valuable time saved during setup speeds the commissioning preparation time for startup. See Figure 16.

For More Information

For information about Basler's complete range of exciter solutions and to access product documentation, Application Notes, and Technical Papers, visit www.basler.com.

To discuss your application, please contact a Basler Electric Excitation System Application Specialist at +1 618.654.2341 or info@basler.com.

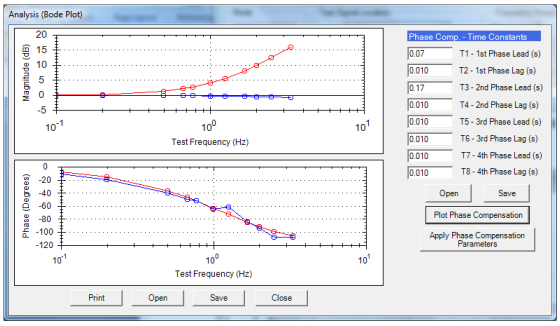

Figure 15: Frequency Response Results using Built-in Dynamic Analyzer

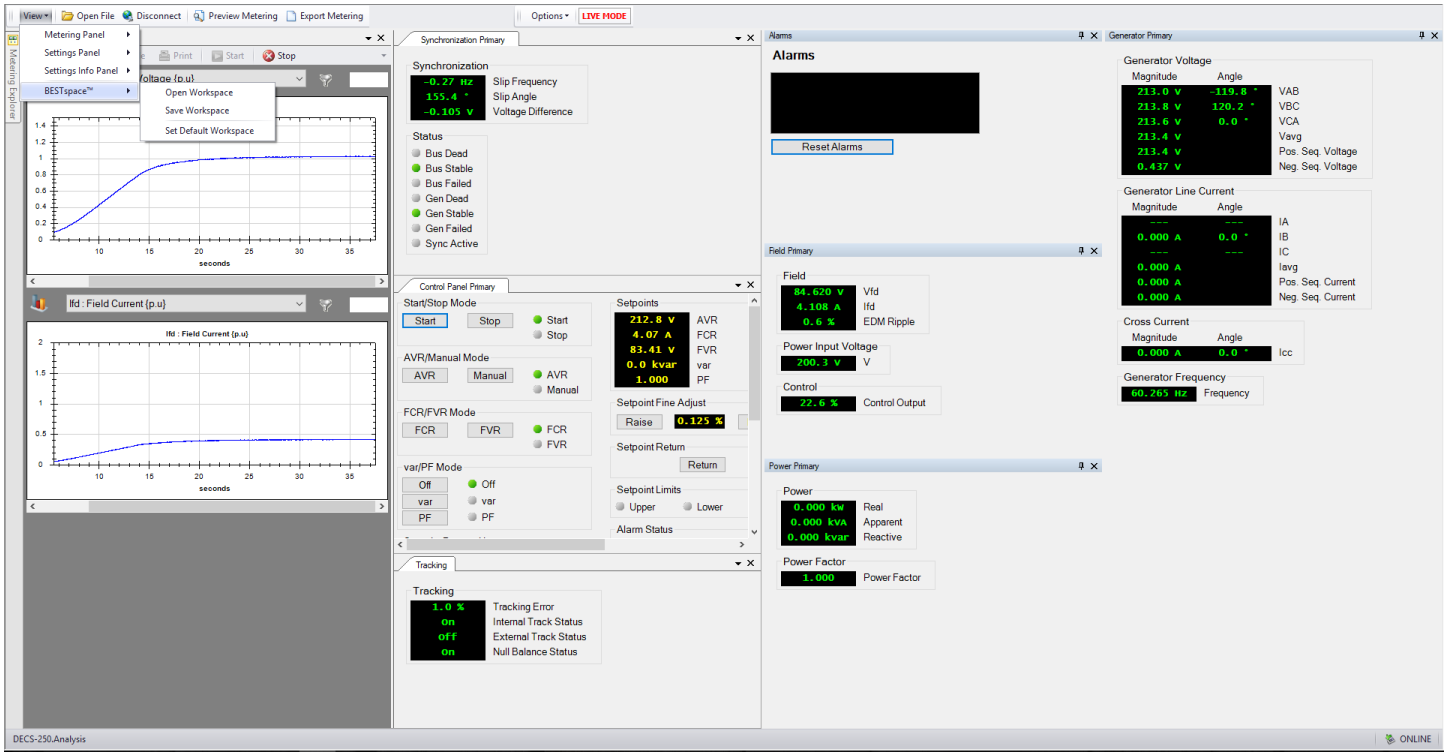

Figure 16: BESTspace

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