DYNAMIC RATINGS

C50 Series

Transformer Monitor

- Risk Mitigation
- Reduced Maintenance Cost
- Extended Service Life
- Increased Safety

RESPONSIVE

ASSET HEALTH SOLUTIONS

Multi Functional Platform

The C50 Series provides a robust platform that is easy to configure and can be standardized for all your critical asset monitoring including bushings, circuit breakers and switchgear. The C50 series provides comprehensive monitoring of the entire transformer including powerful integration capabilities with key gas and multi-gas dissolved gas analyzers (DGA) to consolidate all data and communications into a single system. Having all the bushing data, OLTC, cooling system, DGA and other transformer operational data in an easy to access monitoring platform simplifies analysis, diagnosis and management of critical transformer assets.

Full Service Solution

The C50 series of transformer monitors is complemented by the LIFESTREAM® Support Services to ensure the monitoring system is implemented properly. The support team provides training and support for users throughout the life cycle of their asset management programs.

Risk Mitigation

With online condition-based data, users receive alarms when problems first arise allowing early detection so that appropriate actions can be taken before problems escalate. Transformer failure can be catastrophic. Knowing the condition of assets allows users to reduce failure rates and unplanned outages

Reduced Maintenance Costs

The advanced analytics within the monitoring system filter through condition data to automatically identify issues requiring maintenance or attention. This allows operations & maintenance crews to focus on resolving problems rather than manually collecting data for offline condition assessment. The C50 Transformer Monitor provides an optimal analytics platform for condition based maintenance.

Extended Service Life

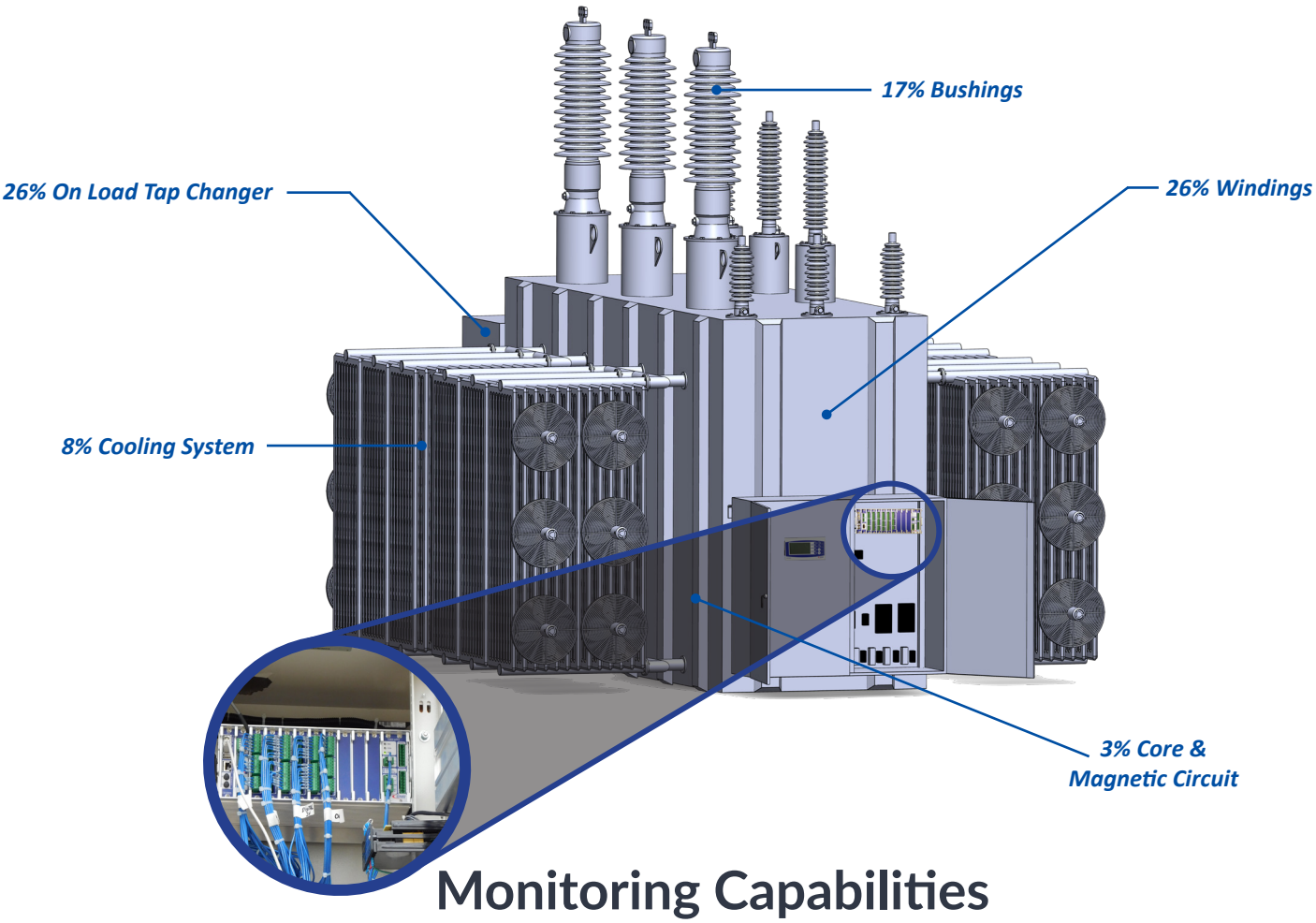
The real time measurement of operational parameters allows visibility into the condition of an asset. Real-time understanding means you can load a transformer with confidence. Using data to make strategic decisions helps maximize asset life and planning for replacement.

Increased Safety

Condition monitoring increases the safety of workers and the public through

- Situational Awareness.
- Reducing trips to site.
- Providing alerts, warnings and instructions.
- Complying to industry safety standards.

Major Failure Locations on Substation Transformers



Monitoring Capabilities

Thermal Monitoring
- Top Oil Temp
- Winding Temp
- Winding Temp (direct measure via fiber)
- Insulation Aging

Bushing Monitoring
- Change in Power Factor Detection
- Change in Capacitance Detection
- Partial Discharge Detection

Renewable Impact Monitoring
- Load Profile Monitoring
- Load Power Factor
- Voltage Level Monitoring

Core & Coil and DETC Monitoring
- DGA (Key Gas/Multigas)
- Moisture Monitoring
- Partial Discharge

OLTC Monitoring
- Time Since Last Thru Neutral
- Tap Change Counter for Each Tap
- Contact Wear for Each Tap
- Excessive Tap Operations in the Last Day
- OLTC Motor Incipient Failure Detection
- OLTC Contact Overheating (delta T)
- Slow Tap Change Alarm
- Monitoring of the OLTC Breather

Control System Monitoring
- Control Panel Heater Monitoring
- Loss of Cooling System Power
- Loss of Aux Power
- Breaker Trip Indications
- Control Cabinet Door Left Open Indication
- Not in Auto Detection

Oil and Preservation System Monitoring
- Oil Level with Alarm (low/high)
- Conservator Bladder Rupture/Leak Detection
- Conservator Breather Monitoring
- Main Tank Nitrogen Pressure Alarm
- Nitrogen Bottle Pressure Monitoring and Alarm
- Nitrogen Regulator Failure Detection

Cooling System Monitoring
- Fan/Pump Current Monitoring (high and low)
- Loss of Cooling System Power
- Cooling Contactor Fail Detection
- Cooling System Breaker Trip Detection
- Cooler Efficiency Detection
- Pump/Fan Run Hours

Risk Mitigation

Bushing Health Monitoring

50% of bushing failures can end in a fire and have a catastrophic impact on transformers as well as impact the safety of workers and the community. Offline testing is typically conducted every few years but failure can happen between offline tests. Unlike offline testing, online monitoring is continuous and is done at normal operating temperature at the network voltage. Continuous online monitoring of bushings provides asset owners with real-time information of bushing capacitance and power factor which can result in early detection of possible failure. The Bushing Health Monitor can capture the moment in time when bushings begin to exhibit symptoms of failure leading to planning for maintenance and outages.

*Available as a stand alone system or as a fully-integrated module for use with the C50 Transformer Monitor.

Partial Discharge Monitoring

Electrical partial discharge monitoring provides a much faster response than online DGA for PD events in the entire electrical circuit. PD Monitoring can diagnose the nature of PD activity and its persistence and severity.

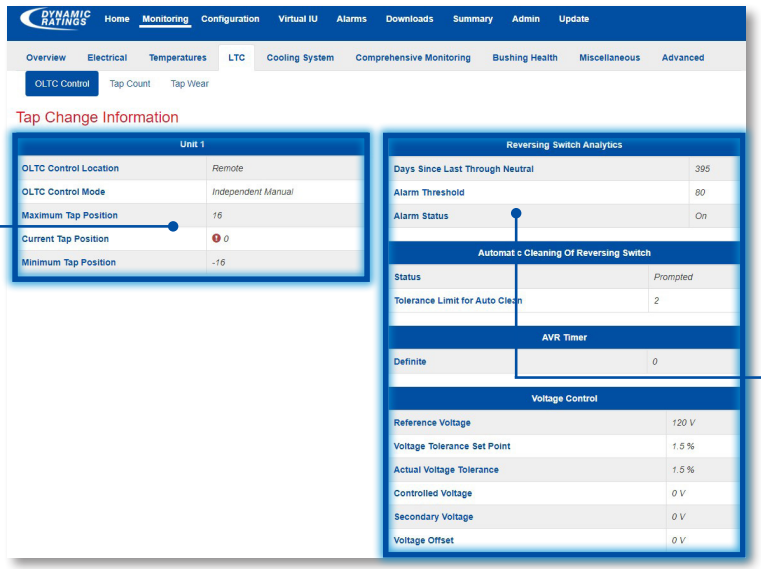
The Dynamic Ratings Partial Discharge Monitor (PDM) directly measures electrical partial discharges (PD) in power transformers and electrical power apparatus. Connection to the bushing capacitance taps provides a direct path for the PD signals and enables the system to see much further inside the transformer. Advanced noise cancellation technologies utilized in the Dynamic Ratings PDM enables the system to automatically differentiate between internal and external signal sources.

When PD occurs inside the core and coil assembly, detection via acoustic monitoring is more difficult. Use of the PDM directly measures the electrical signatures caused by a PD event.

OLTC Monitoring

OLTC has the highest failure rate of all devices on the transformer. When OLTC fails, transformers can no longer regulate voltage which can cause significant negative problems. Monitoring data is critical for OLTC to maintain the reliability of a transformer.

The C50 provides early indication of OLTC/LTC drive or motor problems by monitoring the OLTC/LTC motor current and voltage and alarming on any unexpected deviation. An individual OLTC counter is maintained for each tap position providing a summary of the historic operation of the OLTC/LTC.



Tap Changes Per Position

Indicates frequency of each tap position for condition-based maintenance of LTC.

LTC Information

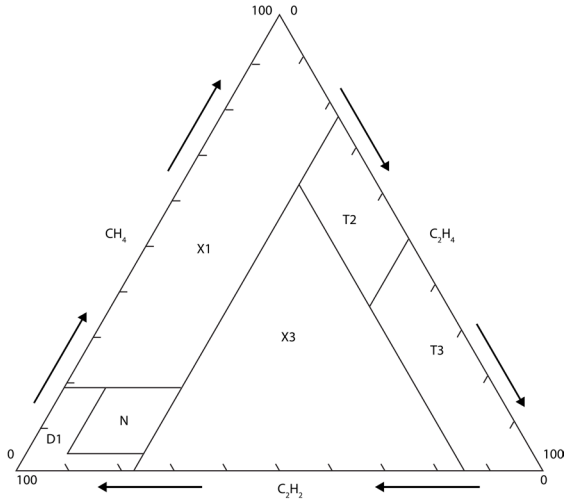
Provides detail measurements of tap changing control hunting analytic to monitor for excessive operation of LTC.

DGA Monitoring

Dissolved Gas Analysis monitoring is a major component of a comprehensive transformer monitoring system. Hydrogen, detected by Dynamic Ratings' key gas DGA, is the earliest indicator of most types of faults within the transformer, especially for insulation problems.

The open architecture design of the C50 Transformer Monitor allows the system to be integrated with a wide array of third party multigas DGAs and moisture monitors. The communication link to these devices utilizes a serial link to ensure information is sent in digital format preserving the precision of the measurements and providing access to additional diagnostic information.

The data is displayed on web pages which enables asset managers to monitor the transformer from anywhere.



Voltage Control

The C50 Transformer Monitor provides voltage control for a transformer. Voltage control with the C50 can reduce the number of devices on an asset to help eliminate potential failure points in the monitoring system. The C50 can be configured to provide primary voltage control or can be used to provide backup control for an existing voltage control system.

Reduced Maintenance Costs

Alarms

Online condition based alarms allow users to detect problems before they escalate into more expensive repairs. The C50 allows asset managers to select which alarms go to which stake holders through multiple SCADA connections and email notifications. Alarms and status points can be grouped with other transformer information to generate common, major, and minor alarm groups to simplify use.

Keys to Fleet Management

Advanced analytics reduce resources required to collect and analyze data and can be better utilized in resolving issues. C50 Transformer Monitor analytics include:

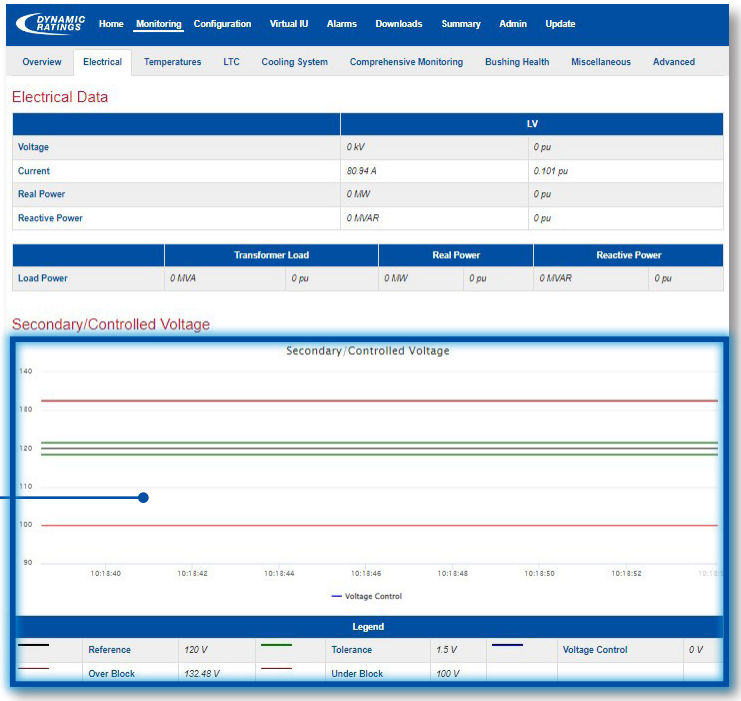
- Active moisture modeling
- Advanced thermal modeling
  - Precise winding temperatures
  - Insulation aging
  - Cooling efficiency
  - Cooling system health
- Insulation Health

C50 Webpage

Every C50 product comes with a software system to analyze and communicate the data gathered into an easy-to-understand format. This also has the added advantage of making information available at any time, and from a remote location. The dashboard provides all the critical information you need to determine the health of your transformer.

Transformer Overview

Provides graphical representation of alarm conditions.

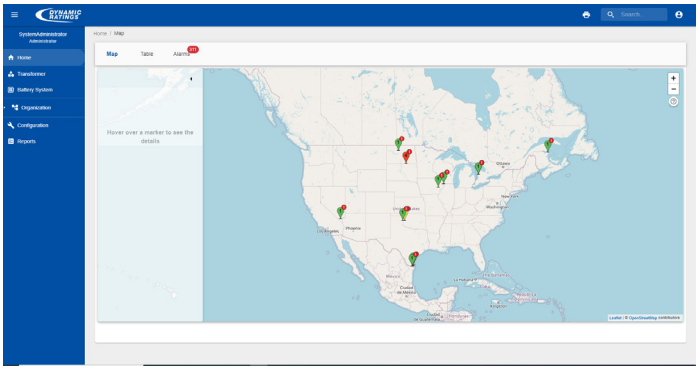


Voltage Control

Trending data shows measured voltage with respect to defined voltage control setpoints for optimization of power quality.

Data Visualization with DynamicMetrix™

DynamicMetrix® is a sophisticated web-based data visualization solution for your assets. DynamicMetrix® aggregates data from multiple monitors, making it easier for asset managers to make prioritization decisions across a large fleet of transformers. Using web-based technology, it is designed to provide easily understandable information about asset status and health at a glance, whether it be current or historical. This allows for greater flexibility and planning in maintenance, reductions in outages, overall optimization of assets, and promotes proactive maintenance as opposed cost-ineffective reactive maintenance.



Extended Service Life

Advanced Thermal Modeling

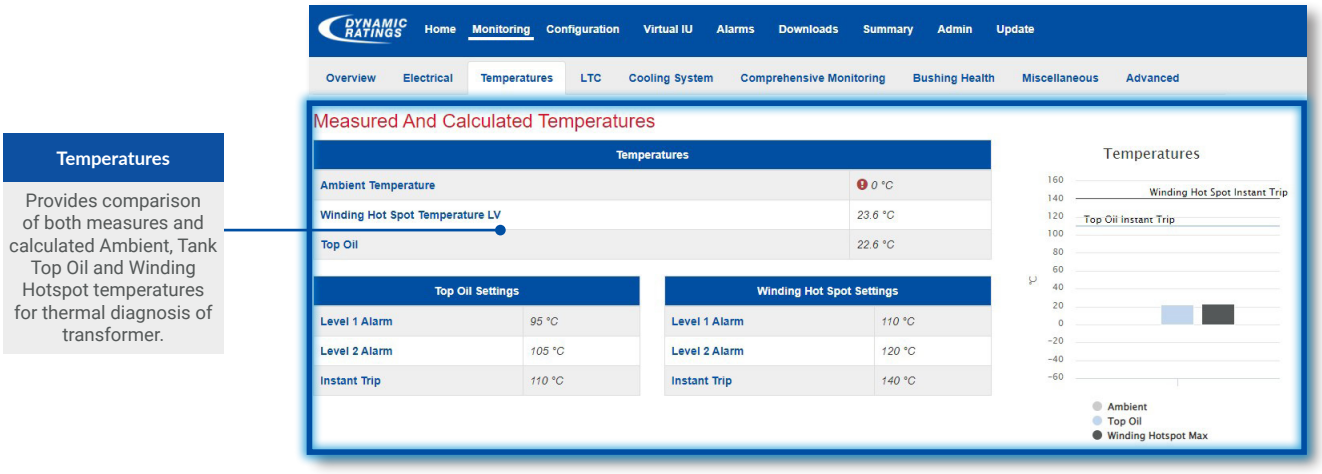
The thermal modeling analytic is designed with the latest industry standards to enhance the precision of modeling with transformer design, cooling system, cooling system health, losses adjusted for each tap position, and cooling efficiency adjusted based on cooling system performance.

Cooling System Health & Control

Cooling system failure can trip the transformer. Monitoring the cooling system can increase operation reliability of a transformer and help with condition-based maintenance such as when to replace fans or pumps.

The C50 thermal model adjusts the calculated winding temperature hot spot based on the health of the cooling system. It is capable of providing a wide range of control functions for various different cooling system designs, providing improved operational performance and overall asset reliability. This system provides:

- Discrete Control: The system can provide discrete control for more than 2 discrete stages of cooling control.
- Dual Speed Fan Control: For low noise applications, the system has dual speed fan control logic built in.
- Parallel Pump Control: For systems designed with parallel pumps, the system automatically manages the duty cycling of the pumps to ensure equal wear.
- Variable Speed Control: For coolers that operate with variable speed fans, the system provides the output to directly drive the VSD system.



Safety

Safety

Safety is a key theme for an asset management strategy. The C50 Transformer Monitor provides:

- Online monitoring through SCADA connectivity to increase situational awareness for crews entering substations
- Advanced analytics to ensure crews are bringing proper equipment and replacement parts to resolve alarms correctly. Less trips to site means less opportunity for safety hazards
- User interfaces to provide key safety warnings, diagnostic interpretations and trouble shooting tips

CASE STUDY:

Rapid Changes in Bushing Health

A prominent U.S. utility was looking for a way to improve system reliability for their 138kV assets. They researched and reviewed options available on the market that included affordable bushing monitoring. After review, the utility chose to pilot the Dynamic Ratings' C50 Transformer Monitor to see if it was worth the investment to become part of the overall solution.

The C50 Transformer Monitors were installed and serviced on the transformers by Dynamic Ratings Field Engineers. One day, after about two years in service, the utility received notification of a major alarm happening at one of the C50 installation sites. Upon further review of the online web pages, the C50 indicated that there was a rapid change happening in the health of a bushing on the transformer.

Dynamic Ratings engineering team took a closer look at the data and recommended that the utility inspect the bushings for a possible oil leak. Low oil in the bushing would explain the decrease in the C1 capacitance of the bushing. The utility dispatched an engineer to investigate the alarm and to look for any signs of an oil leak. During the investigation, the engineer noticed there was no oil present in the sight glass. Upon further inspection, he saw that oil had leaked out of the bushing and down the side of the transformer.

Dynamic Ratings C50 Transformer Monitor was able to detect and notify the utility of a problem with the bushing. Dynamic Ratings team of experts was able to work closely with the utility to determine the problem and prevent a potential bushing failure. The utility was satisfied with their investment into bushing monitoring because it helped to potentially extend the life of their asset, improve situational awareness, save money and improve safety.

Benefits of LIFESTREAM® Support Services

Asset management is more than just installing a monitor. Successful asset management is a process flow of planning, designing, managing, implementing, verifying, and supporting. Dynamic Ratings offers LIFESTREAM® Support Services to ensure successful monitoring throughout the entire life cycle of an asset.

Control Unit

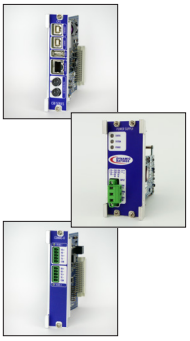
Two frame sizes offered:

- C54 supports four expansion cards
- C59 supports nine expansion cards

Each C50 control unit is comprised of:

- CPU module
- Communications module
- One or more expansion cards (I/O)
- Universal input power supply module

C50 Modules

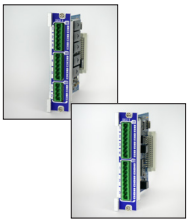


Main Processor (CPU), Universal Power Supply and Communications Modules[1]

The main processor (CPU) module allows configuration using a standard cable. 10/100 Base T (RJ45) and fiber optic (FX) with a built in switch allows connection to a PC without disrupting the second connection. Supports multiple SCADA connections offering the ability to send critical alarms to operations teams, and less critical alarms or diagnostic information to the maintenance or asset health teams. This simplifies substation wiring by consolidating all alarm indications and transmitting to SCADA over a single communications connection.

The power supply module allows operation ranging from 110 to 240 VDC and from 110 to 250 VAC. 48 VDC and other voltages available upon request. Two RS-485 ports and one optional port that can be RS485, RS232 or serial fiber. Can simultaneously operate as either a master or a slave, consolidating information from other devices. This is frequently used for connection to DGA sensors.

[1] Main Processor (CPU) Module, Universal Power Supply Module and Communications Module are mandatory and must be included in any C50 product.



Cooling Control / Monitoring

Cooling control via form C relays, offers a fail-safe system design, and monitoring fans and pumps allows early indication of cooling system failures. Monitoring also includes three Pt100 RTD (3-wire) inputs for monitoring temperatures, four AC current inputs for monitoring transformer load, fan / pump current or other AC currents, and 2 DC analog inputs for any DC sensor such as tap position, nitrogen pressure or other analog signals. DC analog inputs can be configured for 0-1mA, 4-20mA or 0-10VDC. Also analog I/O may be configured as outputs for remote indication.

Annunciator / Data Consolidation

Monitor status of alarm contacts, switch positions, contactor status or other status points on the transformers. Each input has a self-resetting protection against over current conditions, offers over voltage protection, and operates with a 30 – 276 V AC input or a 15 – 390 V DC input.

Additional Alarm / Control Contacts

Expand basic alarm and control functions with additional form C relay outputs, retransmit alarms to SCADA via hard-wired connections, or connect local indicator lights or alarm horns to indicate critical conditions.

Each output is electronically isolated, and the digital output has internal protection against voltage spikes caused by inductive loads.

C50 Modules con't.

OLTC Monitoring

OLTC monitoring of tap position enables tap counter functions, enables contact wear to be calculated for each fixed tap position, and a reversing switching alarm indicates when the reverse switch has not operated within a specified time. Monitoring OLTC motor current identifies problems with the drive mechanism or the motor, and monitoring OLTC differential temperatures identifies potential problems with the tap changer.

Bushing Health Monitoring: Sum of Currents

Continuous online monitoring of bushings provides real-time information which results in early detection of bushing problems. The BHM+ BAU card uses the sum of currents method to connect to up to 6 BAU+ Bushing Sensors for connecting to 2 sets of bushings.

- Temperature Correlation
- Continuous Readings, Diagnostic Web Pages
- Diagnostic Software
- Superior Sensor Design
- Expandable up to 12 Inputs

Bushing Health Monitoring: Voltage Reference

Continuous online monitoring of bushings provides real-time information which results in early detection of bushing problems. The BHM+V card uses the voltage reference method to connect to up to 3 BAU+ Bushing Sensors and 3 voltage inputs to connect to 1 set of bushings and up to 3 voltage reference inputs (from VT/PT).

- Temperature Correlation
- Continuous Readings, Diagnostic Web Pages
- Diagnostic Software
- Superior Sensor Design
- Expandable up to to 12 Inputs

Voltage Control

Voltage control can be integrated into the system with the addition of the voltage control module.

- Line Drop Compensation Using R and X Settings
- Time Delay in Either Definite or Inverse
- Inter-tap Delay Feature

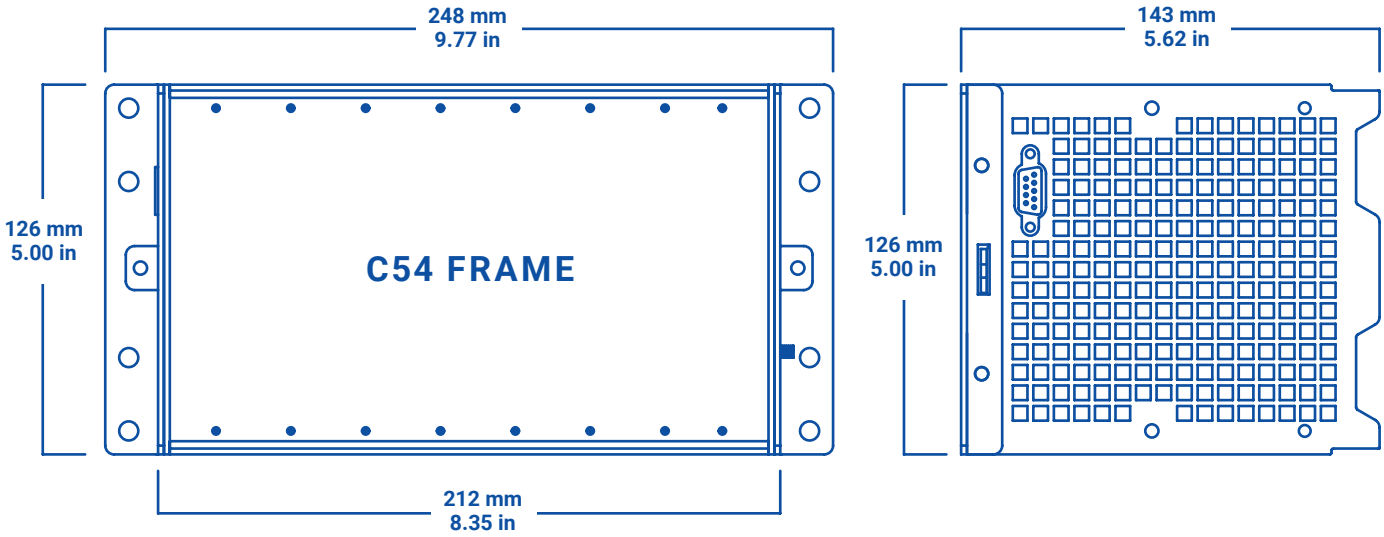
Paralleling is supported using any of the following methods:

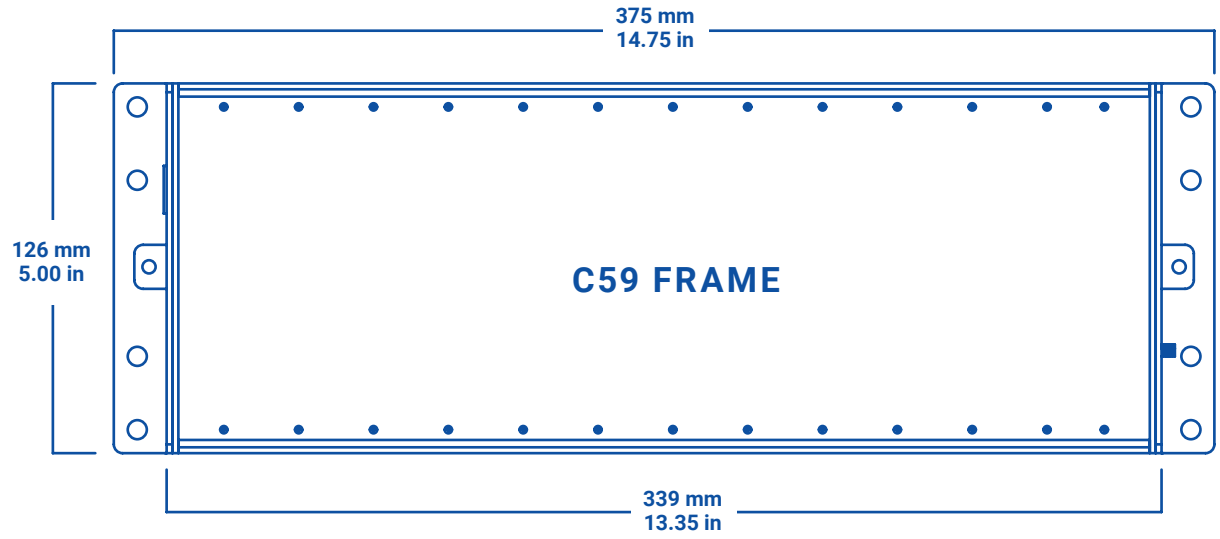
- Circulating Current
- Reverse Reactance
- Master follower with the advantage that the inter-transformer communications are achieved through one fiber connection

Accessories & Specifications

C50 Specifications

Power Requirements	110 - 240 VDC or 110-250 VAC (50 – 60 Hz)
Control Unit Temperature Range	-40°C to 70°C (-40°F to 158°F)
User Interface Temperature Range	-40°C to 70°C (-40°F to 158°F)
Control Unit Mounting Options	DIN rail, panel mount
Interface Unit Mounting Options	DIN rail, panel mount, 19” rack mount





DYNAMIC RATINGS

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Americas
+1 262 746-1230
sales.us@dynamicratings.com

Asia Pacific
+61 3 8544-0700
sales.asia@dynamicratings.com

Europe/ Africa
+44 1617 681111
sales.eu@dynamicratings.com

www.dynamicratings.com

Request a quote from your regional office.