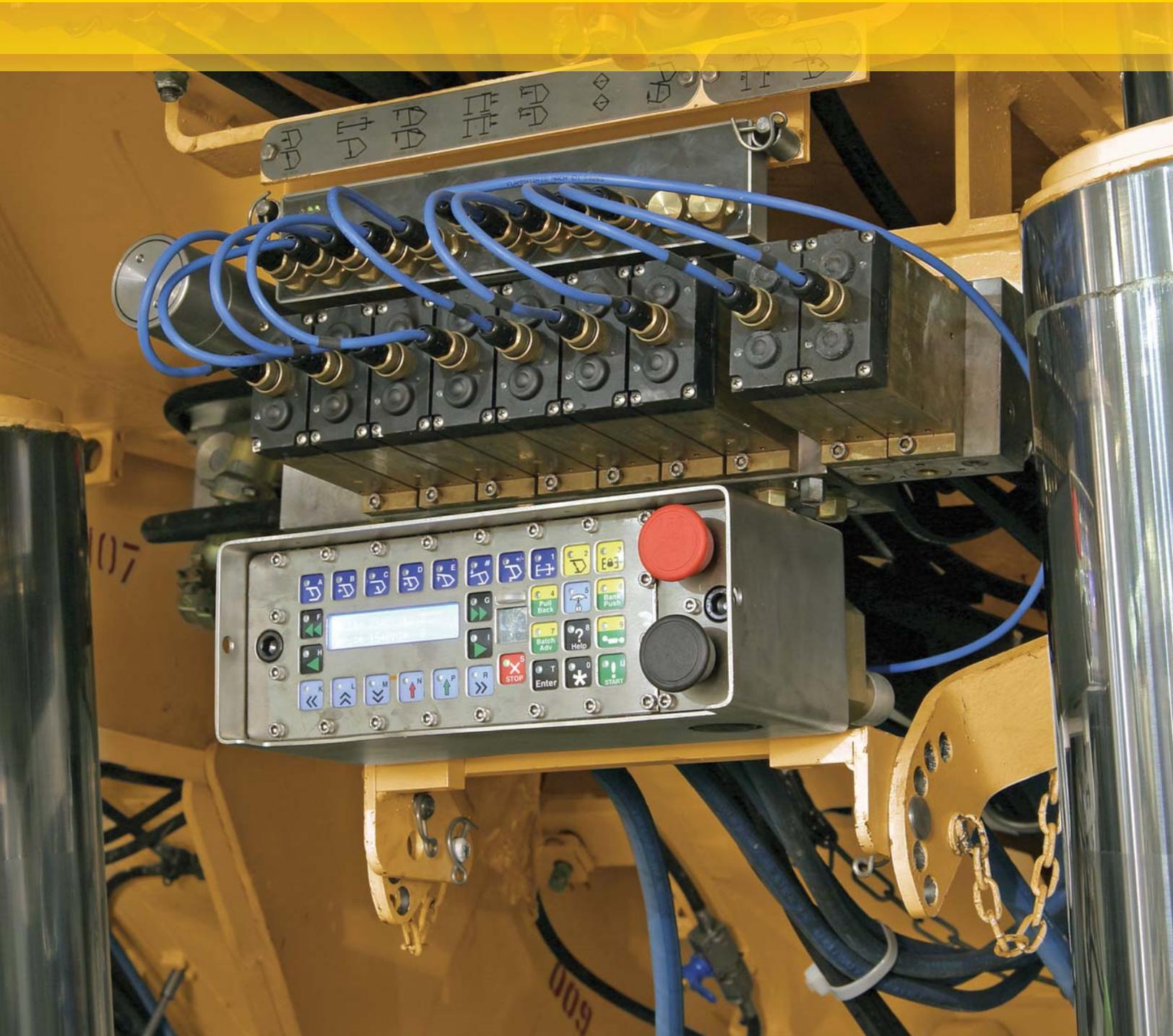


# Longwall Automation



## Longwall Automation Features

### State-of-the-art Technology

*Cat® programmable mining controls featuring the latest micro controller technology and increased computing power offer for full functionality to provide enhanced control of all longwall system components.*

### High Productivity

*Longwall automation enables full utilization of plow, shearer and AFC capacity.*

### Longer Service Life

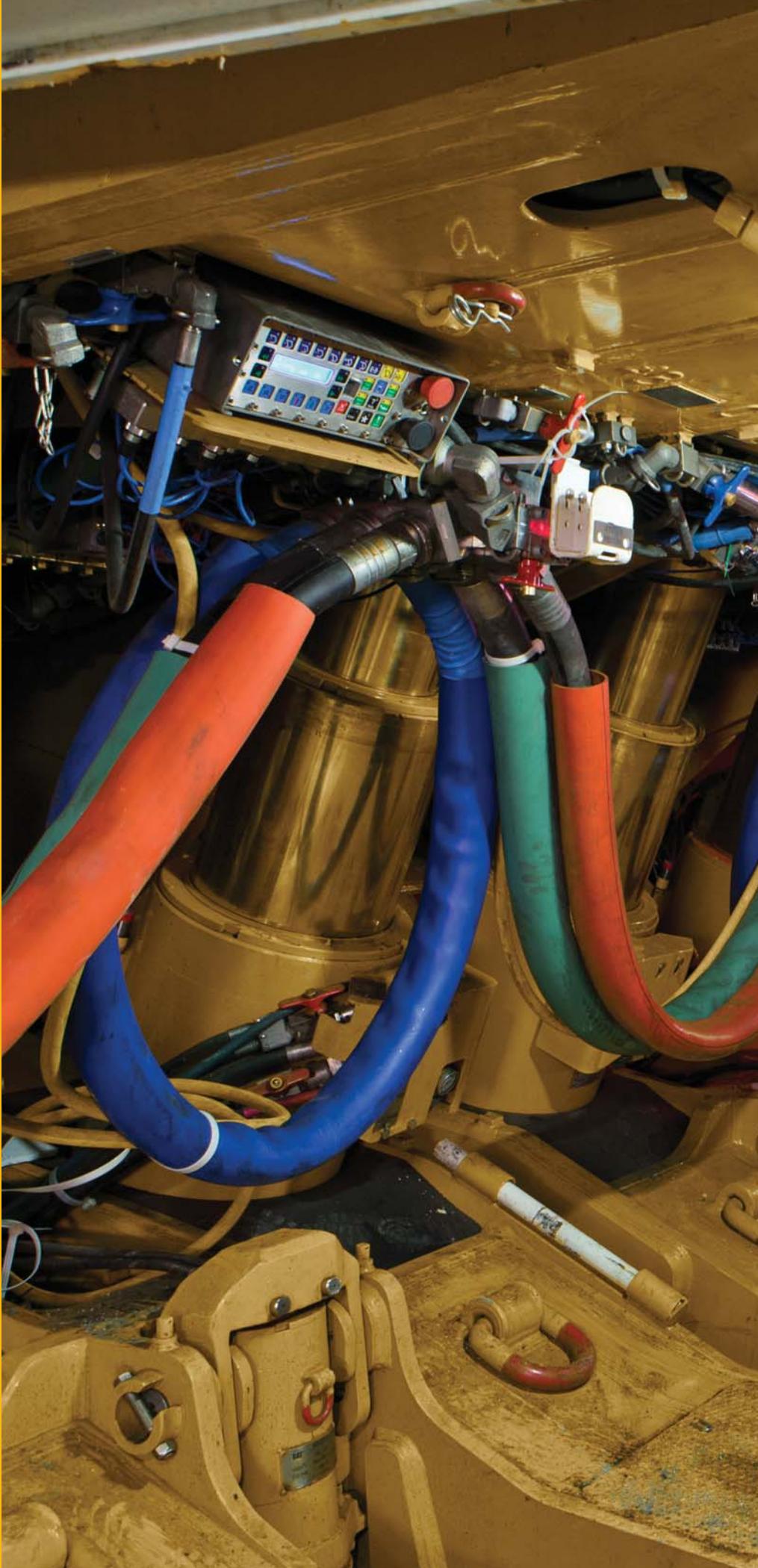
*Protection of all longwall system components through real-time condition monitoring.*

### Increased Safety

*Minimized exposure of mine personnel to unsafe and dust-laden underground areas.*

### Improved Maintenance

*Optimized planning and execution of maintenance tasks and comprehensive diagnostics.*



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# Cat<sup>®</sup> Longwall Automation

## Unparalleled Control of the Entire System



Excellent automation is the basis for the success of a longwall – the quality and reliability of the automation system are key factors in the success of the operation. Caterpillar is the only manufacturer that is able to provide a complete modular family of powerful controllers that integrate fully with Cat<sup>®</sup> longwall equipment. This means one-stop shopping, no interfacing problems and products customized to your needs.

### Full Range, Full Integration

Based on the successful Cat<sup>®</sup> PM4 series, the PMC<sup>™</sup> family is a new generation of controllers designed to meet the control needs of a whole range of applications in underground mining and explosion-hazard areas. State-of-the-art micro controller technology and increased computing power allow a completely new dimension of automation, offering all the functionality you need for enhanced control of drives, roof supports, cutting systems and ancillary equipment. It also offers features for advanced networking, visualization and automation.



*Roof support control unit PMC-R*

## Design Criteria

Cat longwall automation systems are designed to:

- Maximize automation of the whole longwall
- Maximize production
- Maximize safety
- Optimize use of equipment
- Minimize component overload
- Minimize exposure of mine personnel to unsafe and dust-laden areas
- Ease of use

## Benefits

The integration of the various machines (plow or shearer, AFC, and roof supports) allows optimal tuning of the complete system. This results in numerous benefits for the user, including:

- Full utilization of plow, shearer and AFC capacity
- Protection of the system from overload
- Minimized chain downtime, extended service life of drives
- Optimization of chain tension, dependent on load, for all load conditions
- Maximum possible startup torque for heavy-load start
- Machine speed adjusted to the conveyor load, no overload of system
- Timely movement of roof supports to avoid delays
- Optimal setting of roof supports with optional increase in set pressure
- Optimal spraying to minimize airborne dust
- Control of system from low-dust areas
- Protection of steel components through monitoring
- Unattended plow longwalls
- Simple installation and setup of components
- Simple maintenance
- Reliable mine duty system
- Use of visualization for maintenance tasks and comprehensive diagnostics
- Surface monitoring and more



*Roof supports*



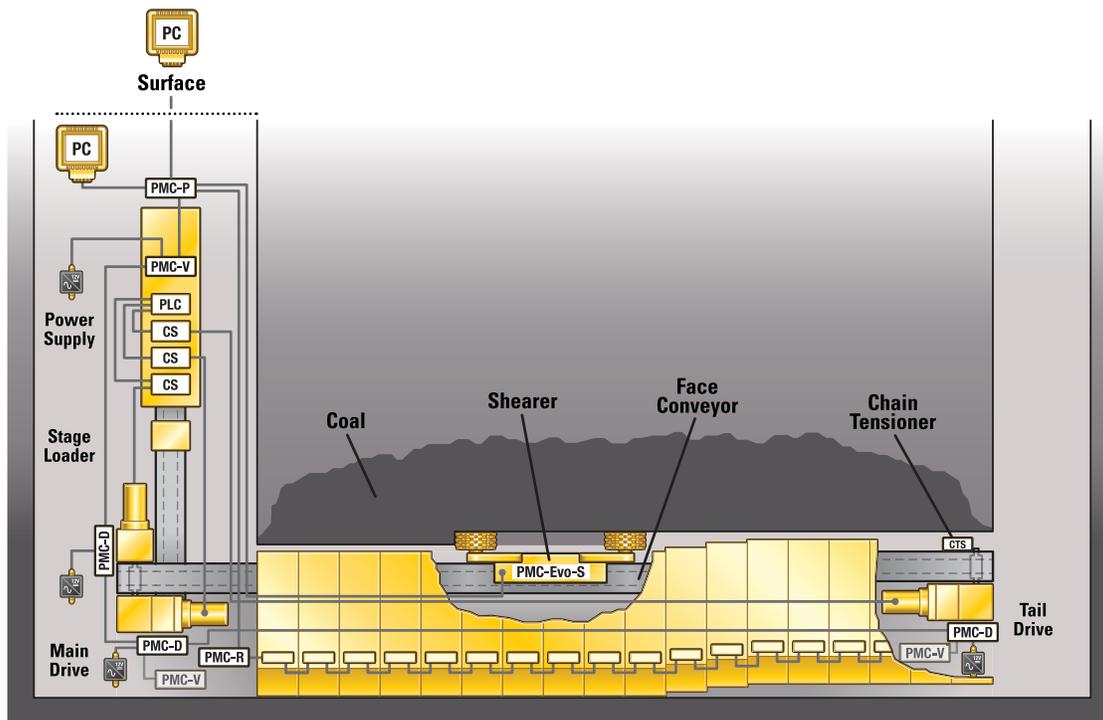
*Shearer longwall*



*Plow longwall*

# The Family of Programmable Mining Controls (PMC)

A Controller for Every Need



The PMC system offers a tailored control unit for each of the various longwall functions:

- PMC-R for roof support systems
- PMC-D as drive control
- PMC-V for visualization and parameter setup of the drive system
- PMC-P node computer to act as interface between the Cat controller network, third-party systems and the mine computer. The module implements data transmission to the surface via optical fiber, modem or copper wire.
- MCU2 for visualization and control of all longwall operations at the surface or with an explosion-proof computer underground

## Features

### Power

All units use a 32-bit RISC CPU and are programmed in a state-of-the-art programming language commonly used for control systems. This allows easy software review and changes, highest safety standards, and customized adjustment.

### Reliability

The stainless steel housing used for the PMC family is based on the proven PM4 housing.

### Networking

Caterpillar has developed a control system that treats the entire longwall as a single integrated machine. Within this system PMC-D (Drive) and PMC-V (Visualization) controllers are networked using the field bus system. This allows high-speed communication via one twisted cable pair over a range of up to 7 km (4.3 mi) without repeaters.

### **Modularity**

Because PMC controllers are modular, each tailored control is located next to the device it is controlling. This minimizes data transfer problems and simplifies troubleshooting.

### **Rigorous Testing**

All components are designed and manufactured in accordance with the latest standards and are subject to strict quality control. Circuit boards use the latest surface-mount technology and are secured in special trays to provide superior protection against shock and vibration. Rigorous quality control testing such as function control, vibration and pressure testing ensures the highest in-service reliability of the finished product. Each unit is tested underwater in accordance to IP68.

### **Explosion-Proof**

The PMC family complies with international standards, governing intrinsically safe and explosion-proof systems such as EN 1804 part 4, and meets the majority of mechanical and environmental requirements of operators worldwide – one design, worldwide approval.



*Configuration of PMC-D and PMC-V connected to a CST drive*

### **Robustness**

The PMC family is based on the highly successful PM4 system and draws on experience gained with 18,000 installed units worldwide. With housings made of stainless steel, the control units and peripherals are protected from dust and water ingress and have an IP68 rating.

This results in high reliability, high availability and low failure rates over a long service life.

### **Functionality**

The basic system offers extensive functionality, including:

- Automatic setup of the communication between the control units of the entire system
- Controlling and setting of parameters for the system
- Measured value handling
- Distribution of information and error messages
- Logbook
- Loading of application software onto the entire system
- Visualization in different languages, including English, Chinese and Russian



*PMC controllers are protected by stainless steel housings to withstand harshest conditions underground*



## Robust, User-friendly Interface

Commands are entered via 30 keys on the front panel of the unit. These are clearly identified by function symbols. The keyboard provides tactile feedback, giving operators a clear indication of the validity of their entries. Each entry is also confirmed visually by an LED integrated into each key and by a beep.

## Custom Keys

The 30-key keypad allows a large number of additional special functions to be assigned to membrane keys, eliminating access problems for customer-specific software functions.

On the standard version of the PMC-R system information is viewed via a two-line, LCD display which is easy to read from different angles. The information default display shows the main face data, such as leg pressure, ram cylinder stroke, shield number or shearer/plow position. Error messages are displayed, if any occur. The LCD display can also display Cyrillic and Chinese characters.

## System Software

There is an extensive and mature library of software for all mining methods, including, for example, control of bi-directional adjacent neighbor functions, limited remote control for single functions of up to five shields (visible range) in standard faces and remote control in faces without operators.

Functions such as batches and bank push, etc. are included, as well as roof support functions initiated based on shearer position. The shearer position is monitored by infrared or communication link.

## Simple Access

The menu provides access to all data available in the roof support. This includes all sensor values, status information and local parameters, etc.

System information – such as global parameters and network status – are also accessible. Parameters can easily be changed at any control unit in the system, eliminating the need to employ the use of a master computer to perform this task. Parameter change can be password-protected.



*PMC-R roof support control*



*Back of the PMC-R*

## Benefits

- Highest availability through distributed intelligence in the longwall
- Flexibility and extreme reliability
- Safe, low-maintenance solenoid valves in service in automated plow and shearer longwalls worldwide
- Minimal downtime due to rugged design
- Extremely short startup time through Plug and Play
- Optional: MCU2 at main drive and/or auxiliary drive and/or on surface for control of longwall operations
- Wide range of sensors for pressure, distance, infrared, inclination or proximity sensors for various tasks available

# PMC-D

## Dedicated Drive Control



PMC-D – used for measurement and control tasks



Junction box, pressure sensor and high speed servo valve for the CST drive system

### Other Functions

PMC-D can also be used for the following applications:

- Fully automated chain tensioning system for Cat chain conveyors
- Any underground drive system with sensors and actuators
- Room and Pillar equipment
- Belt conveyor systems
- PMC-D/20 for additional transmission of condition monitoring data

In combination with Cat Controlled Start Transmission (CST) drives, the PMC-D controller offers control of AFC drives with unparalleled integration of overall system control. Typically dedicated to a gearbox or drive and mounted close to it, the PMC-D contains all the necessary hardware and tried-and-tested CST control algorithms to control a drive system effectively. The drive control software is based on that used in other members of the PMC family.

Connected to a junction box in the CST gearbox, the PMC-D collects all gearbox data (clutch pressure, oil temperature, input and output speed), calculates the necessary slip and controls the pressure for the CST clutch via a high-speed proportional valve.

### Smooth Operator

Enhanced control functions offered by the 32-bit RISC technology allow an extended function range and state-of-the-art control features including more reliable and smoothly controllable overload function, estimation of remaining lifetime, and automatically controlled creep speed.

### Powerful Standard Software

Software is available for various modes of operation of CST systems, including sequential no-load motor startup, synchronized AFC soft-start and heavy-load startup, accurate load sharing, fast overload protection and data logging.

### Sensors for Everything

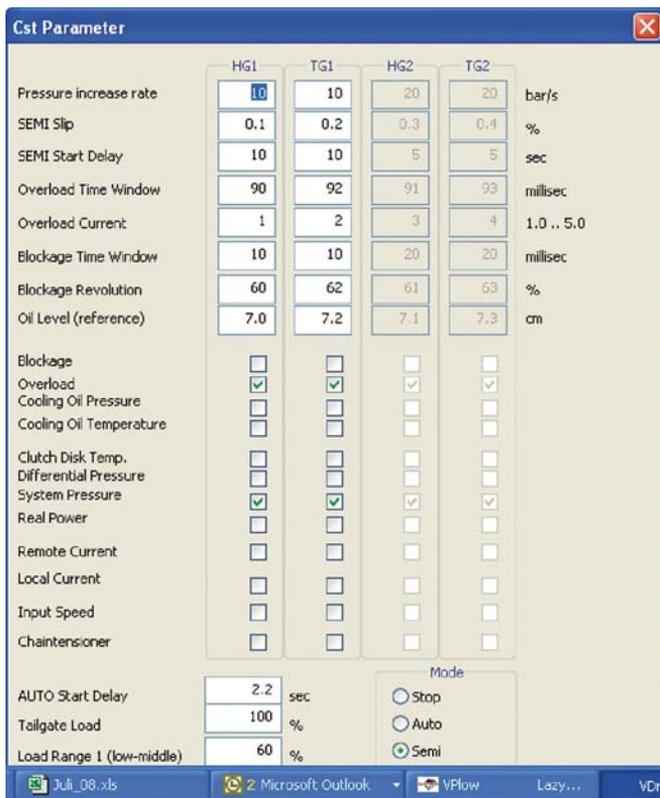
The PMC-D supports a wide range of sensors for use in CST systems, including:

- Pressure sensors for clutch pressure and cooling oil pressure
- Pressure switch for system pump pressure and high-pressure filter
- Temperature sensors for oil sump and clutch disk
- Stroke sensor used for oil level
- Proximity switches for input and output speed

## Controlled Start Transmission

Cat CST drives with PMC-D control unit offer high power with safe startup of the face conveyor, full utilization of installed power, long service life and compact dimensions. Cat CST drives offer:

- Intelligent compact drive for longwall conveyors with up to 1200 kW (1,930 hp) drive power
- Maximum short-duration output torque (3 sec) of 650 000 N·m (479,415 lbf·ft)
- Clutch delivers maximum efficiency with minimum operational slip
- Minimal energy loss and heat dissipation
- Very precise speed and torque control using a high-dynamic clutch
- Freely selectable parameters for startup, load sharing and overload protection



VDrive showing CST parameters



The PMC-V display shows all data available from the gearboxes. This includes all sensor values, status information, all global and local parameters, network status, etc. The change of parameters is easily possible with the 24-key numerical keypad. Important system parameters are password protected.

## PMC-V User-friendly Visualization

Every longwall with installed PMC-Ds must have at least one PMC-V. Most install three for operator convenience: one for the driver's cabin, one for the main drive and one for the tail drive.

The PMC-V can interrogate, access and display all parameters, data and error messages, as well as data of third-party equipment and power distribution equipment.

With interfaces to all controllers in the network, the PMC-V has a 10.16 cm (4.0 in) VGA display for data visualization and display of trends, graphics and error messages.

### User-friendly Interface

The PMC-V contains 24 keys for easy operation. Data is graphically presented either as an overview or in appropriate groups. Data can be printed out at the surface.

### Control of Drives

The PMC-V provides an operator interface to all installed PMC-D units. It allows the operator to set parameters and to store and view system data.

In addition to all data from gearboxes, the PMC-V can display messages in different languages including English, German, Russian and Chinese. A 24-key keypad facilitates operation and allows changes to parameter settings.

# MCU2

## Visualization and Control Unit



The MCU2 comprises a PC or ExPC (ruggedized Cat PC for use in explosion-hazard areas) and a suite of programs that are easy to learn and use. The MCU2 can also be used as a mining control center on the surface.

There are visualization programs for the various control tasks. They allow parameters to be read and set as well as visualization of operational data. Each component also allows logging of operational data and has a replay function for visualization.

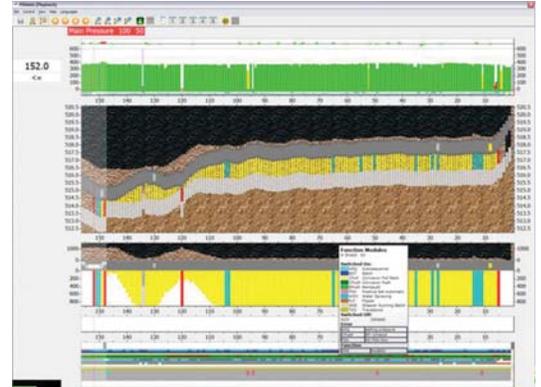
- VShield
- VPlow
- VShearer
- VDrive
- VLongwall: Allows switching between the various visualization programs running on the MCU2
- VTrend: Visualizes the operation mode in a determined time period and allows the analysis of failures

### Main View

The main view shows the actual conveyor position versus the targeted position in a multi-color graph. Prop pressure values and advancing stroke values measured are presented as bar charts. Information about the shield status as well as details on position and direction of movement of the mining machine complete the main view.

The three-dimensional representation of the longwall is based on the same data as the two-dimensional representation of the master control unit. The MCU2 and the graphic program can be linked locally or through a network.

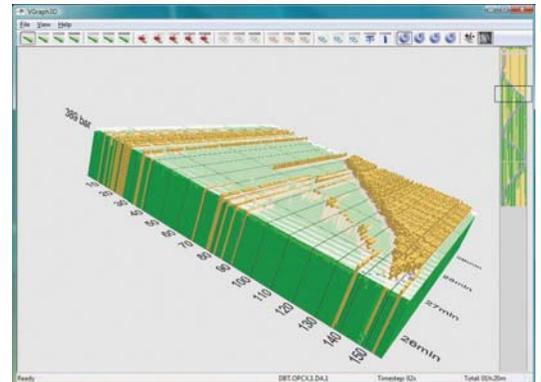
The visualization possibilities are rounded off by 3D representations of the measured values; here pressure distribution represented as a function of time and support number.



**VShield** – Allows visualization of all roof support control steps, messages and faults. It also allows convenient local or longwall-wide setting of roof support parameters.



**VPlow** – Visualizes a plow system with solenoid switches and setting of the parameters of the UEL drive controllers.



Zones of high pressure can be identified very easily.



MCU2 – Visualization and Control Unit

**VShearer** – This program allows parameter setting and visualization of operational parameters and status of a Cat shearer.



**VDrive** – Visualizes the conveyor gearbox controllers. A range of sensor values can be displayed graphically and all parameters can be changed.

## PC Power Underground

Whether for comprehensive data acquisition, safe and secure data exchange with the surface, visualization of current longwall data or central control and maintenance of machines, our mine-safe computers meet all the hardware and software requirements for underground mining and has the ATEX certification (Group I).

Our underground equipment meets regulatory requirements for key mining markets including Australia, China and the U.S.

Take our ExPC for example: With state-of-the-art computer technology and a 483 mm (19 in) graphic display, it opens up a completely new dimension of data processing, recording and visualization underground and/or in explosion-hazard areas.

### Ruggedized Housing

The explosion-protected housing, armored glass screen and waterproof keyboard with built-in mouse ensure that the ExPC can work safely and efficiently even in dusty and explosion-hazard areas. Intrinsically safe ports and network connection guarantee smooth data exchange with other control systems.

# PMC-P

## Bringing All Together

The PMC-P (Provider) is a node computer that provides the interface between individual controllers and equipment and the computer network or third-party systems. It converts protocols to allow data exchange.

The PMC-P also coordinates elements of the longwall. For example, if the shearer is cutting large quantities of coal, it must either speed up the conveyor drives or, if that is not possible, slow down the shearer. It also passes shearer position data to drive controllers so that they can fold in the roof support flipper at the appropriate time to prevent collision.

Data transmission to the surface via optical fiber, modem or copper wire is also implemented by the PMC-P.





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