

# Cat<sup>®</sup> Command

for Underground



## Command for Underground Features

- Purpose built with rugged reliability offering features targeted for underground mining.
- Enhanced safety through removal of the operator from potentially hazardous environments.
- Ergonomic system enabling operators to work in a comfortable office environment.
- Increased utilization and productivity while reducing machine damage.
- Reduced operation interruption due to shift changes.
- Removal of the need to evacuate for ventilation after blasting.
- Enables machines to operate faster and safer than traditional remote control systems.
- Improved accuracy in tunnel navigation.



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**Command for underground enables remote operation of load-haul dump machines. Developed out of the need to reduce human exposure to injury, the system removes the operator from hazardous environments and allows them to work in a safer, more comfortable, ergonomic operator station. Command for underground increases productivity and safety, making a measurable impact on your mine's bottom line.**

# Command for Underground Overview

Enhanced safety for your underground operation.



Cat® MineStar™ System is the industry's broadest suite of integrated mine operations and mobile equipment management technologies configurable to suit your operation's needs.

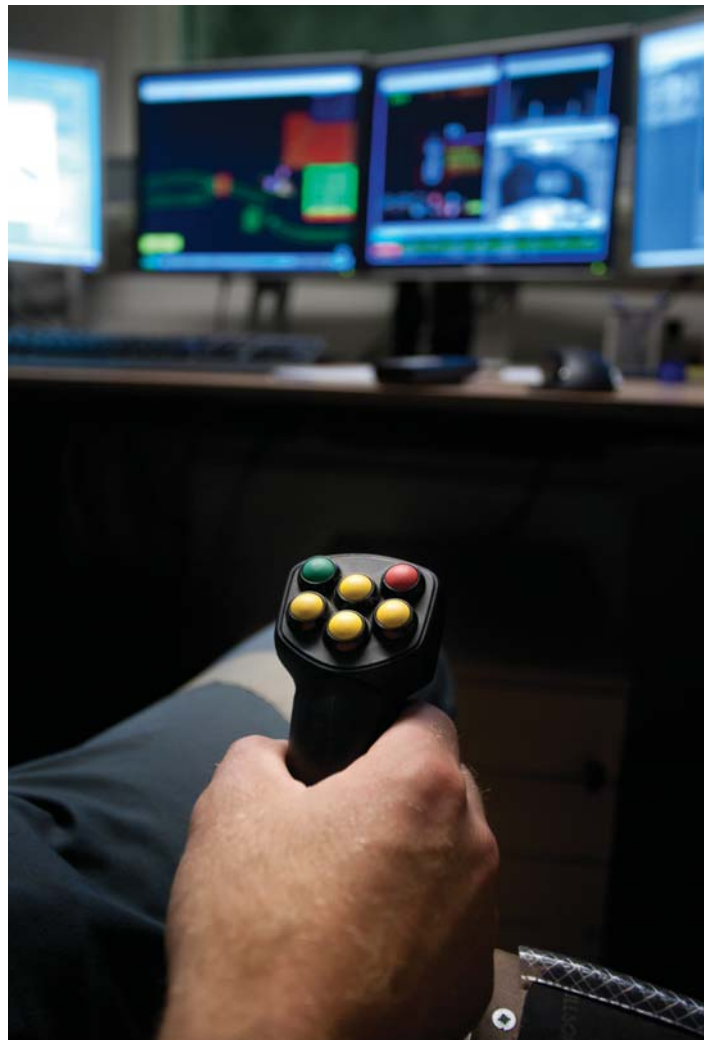
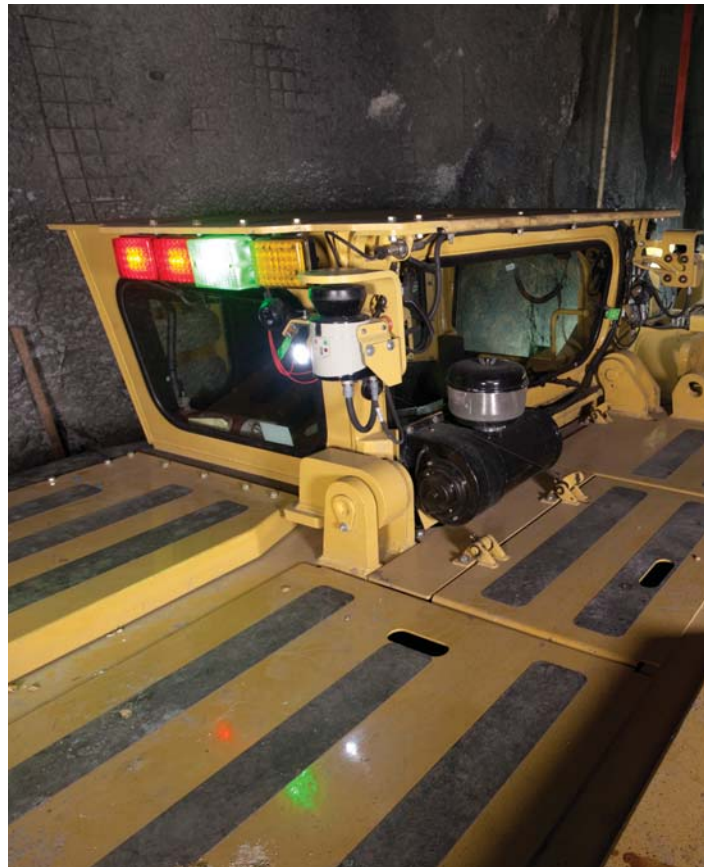
Command, a capability set of Cat MineStar System, provides remote control, semi-autonomous and autonomous systems for both surface and underground mobile mining equipment. By integrating the capabilities of Fleet, Terrain, Detect and Health, it delivers dramatic improvements in safety, productivity and availability at your operation.

Productivity improvements and safety enhancements are combined into a robust semi-autonomous system for your mining operation. Unlike traditional line of sight remote control systems, Command for underground does not require the operator to climb on and off the machine at various points in the load-haul-dump cycle. Instead, they remain in a safe, ergonomic work environment, often far from the machine. Not only is the operator in a safe environment, but there's no need to stop production for shift changes or to vent after blasting in order to resume manned machine operations.

Additionally, the system eliminates exposure to noise and dust, and the hazard of working in close proximity to a running machine. Certain functions of the underground mining process are automated by the system, increasing efficiency and reducing the chance of machine damage.

Command for underground combines machine guidance capabilities with mine infrastructure to enable automated tramming through narrow mine drives. This feature enables the machine to be operated in a higher gear while avoiding contact with drive walls. This significantly reduces machine damage and component wear, while boosting productivity and enabling machine up-sizing.

All operational functions utilized in the cab are controlled through seat mounted joysticks in the remote operator station. On-board cameras, along with guidance systems, provide the operator with a real-time view of the machine's location and status.



# Enhanced Safety

Removing the operator from potentially hazardous environments.



As the mining industry places greater emphasis on improving underground safety, Command for underground is here to help. The system enables safe machine operation while putting the operator in a more comfortable, ergonomic environment, reducing fatigue and exposure to dust, noise, and vibration.

In addition to improving operator safety, the system has features that reduce hazards around the working area of the machine.

- The Area Isolation System detects if a person enters the operations area or if the remotely controlled machine leaves the area. Should either of these events occur, the entire system will shut down.
- If any part of the system is non-functional, Command for underground will not operate.
- Zones within the operations area can be configured to regulate machine speed and to establish “no go” areas at required points.

# Improved Efficiency

Helping you move more material every day.

The system also has inherent productivity advantages, including second gear tramming, virtually continuous equipment utilization, minimized shift-changes, and eliminating the need to vent after blasting.

Guidance assisted steering nearly eliminates drive wall collisions, reducing maintenance costs. This allows a larger machine in the same space as a smaller manned machine, increasing efficiency and payload per pass.

Separate radio networks can be fed to a single operator station allowing the control of multiple machines in different areas of the mine. Automatic camera switching and the staggering of load cycles ensures the operator maintains safe control of all machines at the same time.





# Operator Station

Designed for operator comfort and optimized control.

## Operational Control

Command for underground offers three levels of operational control that are supplemented with video from on-board cameras to provide a real-time view of the machine's location and status.

Teleremote operation enables the machine to be run from a distant location with the operator providing all machine input.

In Copilot mode, the operator monitors the machine's location on a mine plan and uses the joysticks to give the machine directional input if necessary. On-board scanners, combined with radio network infrastructure, ensure the machine self-steers along a safe path. The most advanced element of control, Autopilot, allows the machine to auto tram, dump, and return for operator control of the loading process. At any time, full operator control of the system can be obtained through teleremote mode.

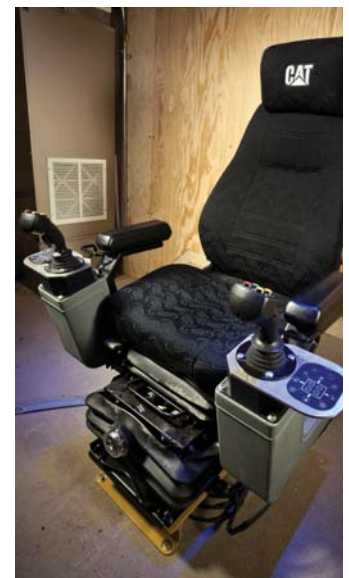
The operator station allows machines to be operated from an ergonomically designed seat in a safe control room environment. It can be mobile or in a fixed location either underground or on the surface.

The operator station houses a computer system, three monitors and a seat with two joysticks; one controlling the movement of the machine, the other controlling the bucket.

The bucket control joystick enables raising, lowering, dumping and tilting of the machine implement and uses scroll buttons to navigate the joystick menu displayed on the monitor. The motion control joystick maneuvers the machine forward, reverse, left and right, while managing the upshift and downshift of gears.

The operator receives visual feedback from the machine as well as health information for monitoring the equipment status. Three monitors display a host of key information elements that enable the operator to properly run the machine.

- The strategic monitor displays the operations area map and is a visual reference for the location of the machine within the operations area.
- The tactical monitor displays data from the articulation sensor, laser detection and ranging (LADAR) scans, front and rear video images and a dash panel showing machine operating status.
- The safety monitor displays the status of the Area Isolation System and Personal Barrier System (gate proximity switch or LADAR curtain).



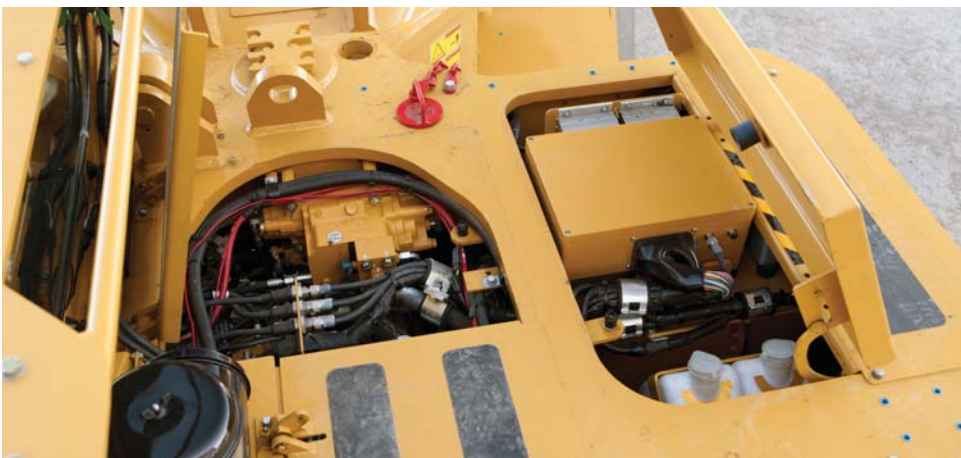
# Machine Automation System

Rugged on-board components for harsh environments.



The Machine Automation System consists of the on-board hardware components that make the system function. LADARs, cameras, lights, sensors, antennas, and control modules combine to create a system that provides improved safety and productivity for your underground mining operation.

On-board LADARs scan hundreds of linear distance readings per second providing a 2-dimensional digital profile of the drive walls. This information, along with other sensor data from the engine control module is transmitted via the Local Area Radio Network to the operator station. The machine can then be seen on the mine map, while cameras enable the operator to view the machine location in the mine drive in real-time.







## Area Isolation System

Enables a safe and secure operations area.



The Area Isolation System ensures that Command for underground will not operate in the event of personnel entering or equipment leaving the operations area while the machine is being controlled from the operator station. The system has the ability to be relocated to allow for changing operational needs.

A barrier control panel is located at each entry to the operations area. Connected to either a gate proximity switch or LADAR, these barriers ensure that the machine is disabled if it has detected entry into the operations area.

Users can choose either a gate proximity switch or LADAR to control access to the confined operations area. The gate proximity switch notifies the system when the gate is opened or closed. The LADAR provides a laser curtain that is highly sensitive to any movement in the immediate area.

The Area Isolation System safety protocols automatically shutdown the system if the barrier is breached. The engine stops and parking brakes engage. The system will also terminate if the Machine Automation System LADARs detect a change in the drive layout, which is not consistent with a pre-defined map of the operational area.



## Customer Support

Providing you with unmatched global support.

For more than 25 years, Caterpillar has been providing electronic components and systems for the mining industry – real-world technology solutions that enhance the value of Cat products, making customers more productive and profitable. Your Cat dealer is ready to assist you with mining technology systems and knowledgeable support.

Poor operating practices can cause significant wear on machines, requiring additional servicing and maintenance. Command for underground controls machines as intended by the manufacturer, reducing downtime caused by:

- Coasting
- Riding of brakes
- High-speed directional changes
- Collisions

Your Cat dealer can help with these and other preventive maintenance measures to keep your equipment up and running efficiently.

## Local Area Radio Network

Communicating critical information for safe and productive operations.

The Local Area Radio Network (LARN) is a wireless Ethernet data network that enables communication between the machine and the operator station. The network uses the 802.11a/b/g standard protocols in the 2.4 GHz RF spectrum.

Signals from the Machine Automation System roam between LARN antennas as the machine moves within the operations area. The signals work primarily over line-of-sight, but can reach a short distance around corners. Video images and data are sent via the LARN.



## Machine Automation System Specifications

Automation Components	
Power Input	24 V
Operating Temperature	-20°-60° C
Sealing	IP67
Connectors	Various
On-machine Radio	
Power Input	9-72VDC, 8W
Operating Temperature	-25°-70° C
Sealing	IP66
Dimensions	127 × 118 × 57 mm
Weight	0.8 kg
Connectors	2 × M12 4-Pin Ethernet M12 Power 2 × N-Type RF
RF Frequency	2.4 GHz
RF Power Output	100 mW
Mode	Bridge
RF Range	Up to 100 m from Access Point (line of sight)

## Local Area Radio Network Specifications

Radio	
Power Input	9-72VDC, 8W
Operating Temperature	-25°-70° C
Sealing	IP66
Dimensions	127 × 118 × 57 mm
Weight	0.8 kg
Connectors	2 × M12 4-Pin Ethernet M12 Power 2 × N-Type RF
RF Frequency	2.4 GHz
RF Power Output	100 mW
Mode	Access Point
RF Range	Up to 200 m between Access Points (line of sight)
Network Switch	
Power Input	12-48VDC, 6W
Operating Temperature	-25°-70° C
Sealing	IP68
Dimensions	214 × 106 × 57 mm
Weight	1.1 kg
Connectors	6 × M12 4-Pin Ethernet M12 5-Pin Power
Ethernet Cabling	
Connectors	M12 4-Pin Ethernet
Lengths	2, 5, 20, 60, 96 meters
Power Cabling	
Connectors	Mini-Change 3-Pin
Current Rating	13A
Lengths	2, 5, 20, 60, 100 meters

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