Deep Automation

Solutions for material handling

Epiroc

Automate your operation

Deep Automation is Epiroc's cutting-edge set of automation systems and applications used to orchestrate loaders and trucks in underground mining operations. Developed with interoperability in mind and suitable for a variety of operation types, from stoping to block caving.

Explore a deeper level of mining, decision-making and collaboration.

The control room provides a safe area where the operator is not exposed to a hazardous environment.

Enhance your load-haul-dump material handling with Deep Automation by using fleets of underground loaders.

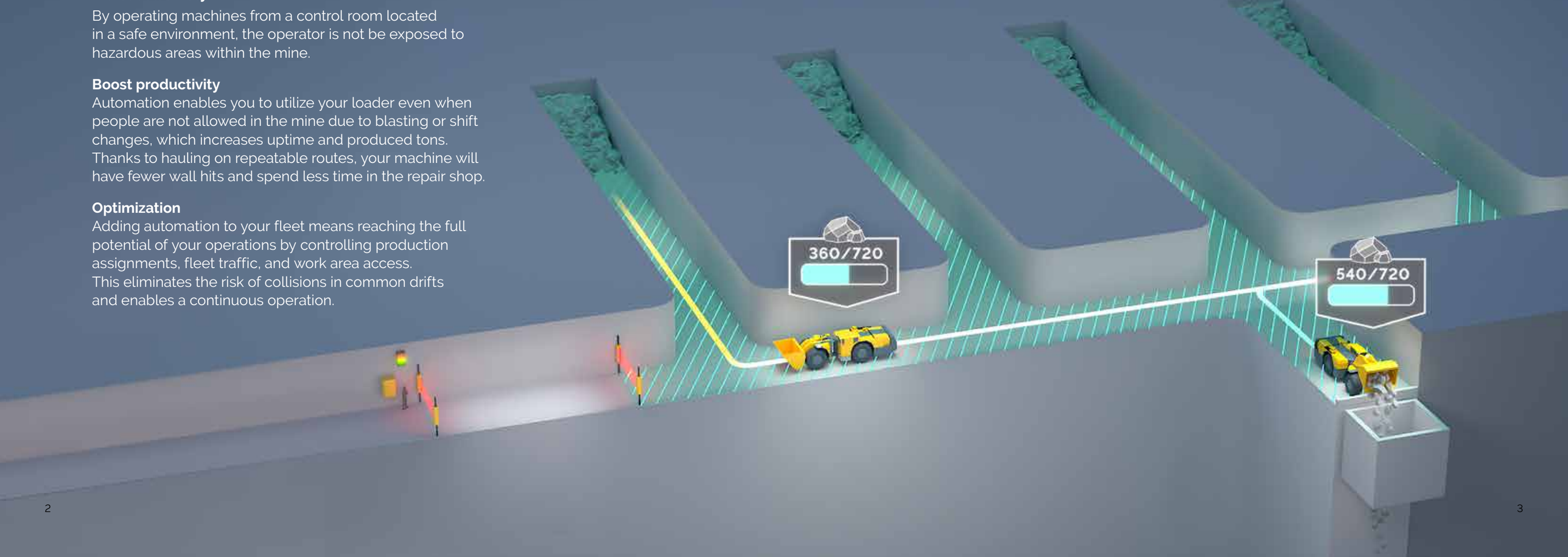
Deep Automation can orchestrate autonomous haulage using fleets of underground mine trucks..

Main benefits

Increased safety
By operating machines from a control room located in a safe environment, the operator is not be exposed to hazardous areas within the mine.

Boost productivity
Automation enables you to utilize your loader even when people are not allowed in the mine due to blasting or shift changes, which increases uptime and produced tons. Thanks to hauling on repeatable routes, your machine will have fewer wall hits and spend less time in the repair shop.

Optimization
Adding automation to your fleet means reaching the full potential of your operations by controlling production assignments, fleet traffic, and work area access. This eliminates the risk of collisions in common drifts and enables a continuous operation.



The easy route to Deep Automation

1

Simulate automation

With Deep Fleet Simulations you can simulate existing or future operations before developing the mine or implementing automation solutions.

2

Set up the safety system

Deep Safety provides peace of mind for operations at all levels, knowing that safe access control is guaranteed.

3

Teach autonomous routes

Record, tune and teach routes to smart machines with Deep Routes.

4

Take control

Deep Control enables you to take control of safety, production assignments and autonomous traffic in real-time.

Increase ramp performance

Automation combined with traffic management can significantly improve the efficiency of truck haulage ramps. This can be achieved by increased utilization of the trucks, for example during shift changes.

Advanced traffic management is part of Deep Automation, enabling orchestration of autonomous traffic and eliminating the risk of congestions.

The reliability and versatility of the system is also the key for stable productivity and high performance.

Deep Automation includes all the features and functions for a mine to run truck haulage ramps in the most efficient and safe manner - with full control over the operation.

Improve stope mining operations

Numerous underground mines operate using sublevel stoping mining methods. This method is preferred for its scalability, flexibility and limited impact on the surface landscape when using waste as backfill.

Teleremote and autonomous operation can effectively improve safety and increase utilization in these type of mines.

By operating machines from the safety of a control room, operators are less exposed to risks associated with potentially toxic dust and exhaust fumes.

Utilization can be greatly improved by spending less time going back and forth to, as well as in and out of, the machine. This enables each operator to typically spend one more hour per shift doing productive work.

Utilization can also be increased by operating from a control room while blasting and venting blast fumes, typically adding one more productive hour per Scooptram or Minetruck per shift.

Deep Automation is built for the flexibility required in stoping mines. With quick deployment and easy commissioning procedures in new areas or stopes.

Next-level block cave mining

Block caving is a high-productivity mining method where automated material handling is a perfect match.

Deep Automation's cross-platform interfaces can integrate and orchestrate not only underground loaders and mine trucks, but other equipment that is essential to run an effective block cave. Successful reference integrations include mobile and stationary rock breakers, secondary break units, inspection robots and more.

The layout of the extraction level stays the same for very long production periods. Advanced extraction schemes dictate from which drawpoints to extract ore, and how much, for the ore body to cave in a controlled manner.

Deep Automation can receive and dispatch load-haul-dump assignments according to the extraction schemes and effectively orchestrate the traffic for continuous flow of material from drawpoints to crushers.

Controlling the material handling flow from a control room greatly reduces the risks associated with extreme rock stress changes and mud rushes that are inevitable in a block cave.

Work safely
Mine smarter
Think deeper

Go smart and green

Our zero-emission underground loaders are part of the Smart and Green series (SG) and are equipped with Epiroc's Rig Control System (RCS), ready for smart functionality such as automation and remote control.

Deep Automation is built with electrification in mind. Configurable production layouts and remote arming capabilities make it easy to send machines for swapping or charging when the opportunity arises. Seeing the whole fleet of machines from a control room makes it easy to decide which machine to charge next.

Give your operations an extra sense

Guided by our 6th Sense methodology, we can help you bring together the people, processes and technology you need to drive change and take the next step on your automation journey.

To unlock the values of new technology and ways of working, Epiroc offers many ways to support you with our experience and expertise. With digitalization as a foundation, we can gain insights to improve your operation together. Through application and product expertise, we can help you make the most of your technology. Thanks to our local presence, service and support offerings, we stay committed for the long run.

6th Sense
Smart, Safe, Seamless.

Machine kit

Includes		IP	Description
2x Sensor and camera tower	Camera	69K	IP camera
	Laser scanner	67	Frequency 75 Hz Angle resolution 1° measuring area 180°
	Air blade*	67	Repelling dirt and dust from cameras and lasers
	Washer	67	Wash dirt and dust from cameras and lasers
	Inertial Measurement Unit (IMU)	67	Accelerometers and gyroscopes
Cabin camera		67	Allows the remote operator to view the boom and bucket as from inside the cabin
Safety module		67	Certified according to EN-ISO 13849-1:2015, Category 4 Performance Level E, Safety Integrity Level (SIL) 3
Common Communication Interface (CCI)		67	Standard RCS App module
Router switch		67	Layer 3 switch, 12x100 Mbps ports
Antenna (Wi-Fi, LTE/4G, 5G)		67	Wlan-Aboard b/g mixed, Profinet client
Total power consumption			300 W
Total weight			260 kg

Provides the automated machine or the teleremote operator with the perception needed to get the job done.

The complete kit is built with components that can withstand the harsh environments and tough applications of many mines.

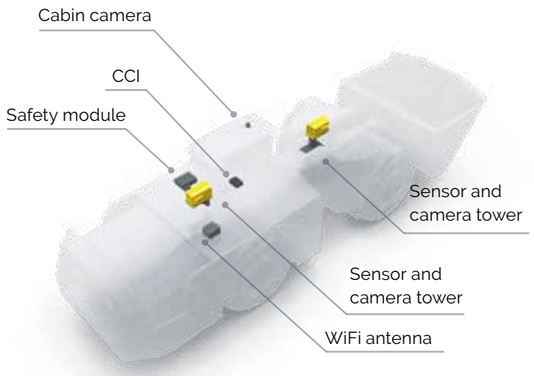
Rig Control System (RCS)

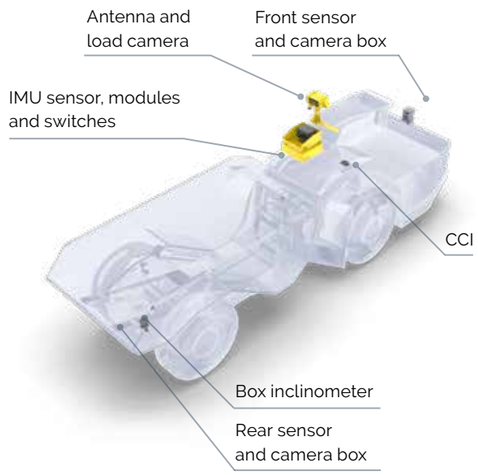
Feature		Description
Teleremote operator support	Quick allocation	Configurable panel buttons to quickly allocate a machine when multiple machines are controlled by multiple operators
	Boom stop control	Level the loader bucket with the road before loading. Effectively avoid digging away the road
	Load assist*	Effective loading by driving into the pile. The bucket pushes and tilts automatically to fill. Only available for loaders.
	Driver assist*	Ensures the machine avoids wall collision. Increases the operators'confidence to drive fast, e.g., when recording autonomous routes.
	Dynamic video quality	Quality of the video stream is automatically adapted to the available network strength
	Camera and laser cleaner*	Remote activation to wash dirt or dust off the camera and laser lenses.
	Fire suppression	Remote activation of on-board fire suppression system
Autonomous functions	Teleremote to auto transition	Transition between teleremote and autonomous mode without stopping
	Auto tram	Autonomous tramming on pre-recorded routes
		Start anywhere on recorded route
	Seamless route switching	Seamless machine transition between autonomous routes without slowing down. Greatly improves flexibility and reduces the number of overlapping routes that need to be recorded
	Auto dump in crusher	Autonomous dumping in crusher or ore-pass
	Load weighing	The machine estimates its load weight
	Road cleaning	Level the bucket with the road to pick up spillage on the way back to the stope or drawpoint

Enables automation and remote control.

Extensive autonomous driving experience from numerous sites.

* Only available for loaders





Desktop operator station

Includes	Description
Table	1600 mm x 900 mm
2x Computer screen	27" HD resolution (1920 x 1080). HDMI port
Operator panel	Joysticks, buttons to control the machine and emergency stop button
Chair	Suspendible chair with adjustable armrests
Computer rack	H 400 mm, W 500 mm, D 550 mm
Admin computer	Standard PC, Windows 10, connected with one of the displays
Automation common machine server (ACMS)	Enables operator stations and automation system to interface the fleet of machines in a controlled way
Total weight	100 kg

Effective operator workstation for fleet control and teleremote operation. Very flexible since it can be placed in a remote operations center office or a container. Very good ergonomics since operators can alternate between sitting down and standing up throughout their workday.

Mobile Remote operator station

Includes	Description
Mobile teleremote station	L 1205 mm x W 1120 mm x H 1370 mm, 250 kg, 10–36 V DC max 15 A 110–240 V AC 50/60Hz
2x Computer screen	21" Resolution 1920x1080
Operator panel	Joysticks and buttons to control the machine and emergency stop button built in the chair's armrests
Admin computer	Standard PC, Windows 10, connected with one of the displays
Automation common machine server (ACMS)	Enables operator stations and automation system to interface the fleet of machines in a controlled way
Total weight	300 kg

Designed for stoping applications with the highest demands on flexibility and agility. Built to fit into the back of a minivan or movable container. Effectively used to teleremotely operate one or a few loaders in near proximity to the production area.

Controlling the machine from an operator station is safe, convenient and effective. The operator's perception is based on a 360 bird's eye view, camera view, virtual rear view mirror and machine dashboard. Functions such as Load Assist and Driver Assist empower the operator to perform at the highest level consistently.

Desktop operator station

Mobile Remote operator station

Deep Fleet Simulations

Features		Description
Virtual site setup	Mine layout	Import and export site maps with configurations
	Place safety barriers	Place safety barriers to construct confined production areas
	Draft safety rule book	Define the site-specific procedures for events such as check-in/out or dynamically changing production area configuration
	Create traffic zones	Construct the granular traffic zone layout
	Record test routes	Record test routes for fleet simulations
	User and role setup	Virtually enroll system users
Production simulations	Loaders	Evaluate and optimize fleet performance in the virtual site. Application experts from Epiroc support this activity.
	Minetrucks	
	Loaders and Minetrucks	
	Optimizations	Maximize flow by iterative design of the automated production area.
Virtual commissioning	Safety rule book verification	Verify that the rule book supports the safety procedures of the site
	Fleet setup	Set up names on machines, equipment and their respective IP-addresses
	Local integrations	Verify local integration with production planning systems, auxiliary equipment, red light servers, rock breakers, ore passes, crushers, conveyors, dust suppression sprinklers, ventilation, etc.
	List of routes	Identify what routes to record at site to run production as intended.
Training	Safety procedures	Operative personnel can virtually check in/out or change production layout
	Production assignments	Learn how to use production assignments effectively for the mining method used at site.
	Fleet operation	Virtually operate the simulated fleet.
	Administration and maintenance	Manage user access, safety system, traffic zones, points of interest, local integrations, etc.

Virtually evaluate the productivity level that can be achieved based on mine layout, production planning and fleet size.

Virtually commission the automation solution for effectively setting up the new site or production area with Deep Automation

Proactively train operators.

Deep Safety

	IP	Description
Deep Safety		Programmable logic controller (PLC) system
		Certified according to EN-ISO 13849-1:2015, Category 4 Performance Level E, Safety Integrity Level (SIL) 3
		Multiple safety zones in a production area
		Up to 35 machines
		Up to 48 operator stations across 10 control rooms (4 x 8 + 2 x 8)
		Up to 20 safety zones in a production area
		Up to 70 barrier cabinets
Main cabinet	65	W 500 x H 500 x D 300
Barrier cabinet	65	W 300 x H 400 x D 190
Safety barrier sensor type options		
Light curtain	The highest safety rating and the default choice. Static setups such as block caves or Minetruck loops often sink setups into the wall.	
Laser scanner	A common choice for temporarily blocking an area.	
Radar sensor	Dust proof and ideal for dynamic mining methods with frequent area changes. Easy to mount on walls or back/ceiling, swift configuration and setup using Inxpect.	
Rope switch	Dustproof and easy to set up or move. Suitable with supporting safety procedures.	
Single beam	Often used as inner barrier in combination with light curtains as outer barriers. For dynamic production areas.	
Safety switch	Use on doors or gates such as emergency exits.	

Improves safety and peace of mind by providing remote-access control to production areas, utilizing different types of safety barriers.

Light curtain

Laser scanner

Radar sensor kit

Rope switch

Single beam sensor kit

Deep Routes

Features		Description
Record	Manual driver	Drive and record routes from the cabin
	Teleremote	Drive and record routes from the teleremote operator station
	Reverse route	Function to create a reverse route. Only one-way recording needed
Tune	Wall distance	Support for tuning distances to walls in recorded routes, e.g., when cornering
	Fairing	Easy to use functions to smoothen and streamline the recorded routes
	Incremental speed increase	Replay the route at incrementally increasing speed until ready for production
	Auto-dump sequence	Easy to use functions to ensure fast and complete emptying of the bucket
	Trim route	Easy to trim start and end of routes
	Extend route	Possible to extend existing routes
Teach	Any machine of same type	Routes recorded by one machine can be used by other machines of same type

Enables quick commissioning and boosts uptime with an easy-to-use application for recording, tuning and teaching routes to smart machines.

Deep Control

Features		Description
Safety	Rule book	Site-specific rule book dictating the allowed safety system interactions and processes
	Check-in	Machine can be safely checked in to a production area
	Check-out	Machine can be safely checked out of a production area
	Remote arming	Remote arming allowed according to the rule book
	Dynamic production area	Allows secondary equipment or manual work during production
Production assignments	Go to point	Point A to point B. Bring machine to check-out, service, refuelling/charging point
	Back and forth	Simulate certain scenarios of machine interactions
	Haul and dump	Haul and dump X tons over multiple cycles. Teleremote loading
	Pause	Pauses the specific assignment. The machine stops where it is
Traffic management	Basic map	See the status of safety barriers in a basic schematic map. No mine map needed
	True map	See the status of all machines in a true scale map. Based on mine layout (CAD)
	Traffic zones	Virtual "geofence" traffic zones that ensure machines cannot collide
	Deadlock avoidance	Avoid deadlock situations, e.g., when multiple machines share a dump point
	Two activities per drive	Multiple machines per extraction drive. Load-and-haul from extraction drive while secondary breaking the same drive
Interoperability	Mine resource planning	Receive production assignments from site specific production systems such as Polymathian's ORB or MineRP Powered by Epiroc
	Stationary equipment	Crusher or ore pass fill levels. Wait if crusher full or on active rock breakers
	Auxiliary equipment	Integrated equipment such as mobile rock breakers, secondary break machines and inspection robots are included in the true map and traffic control
Deployment	Physical server	Epiroc delivers the physical server that the application will run on
	Virtual server	Epiroc deploys the application in your existing infrastructure
	Remote updates	Epiroc can provide remote updates securely to your organization's preference

Maximizes flow of the material handling process by creating overview and control of safety, production assignments and autonomous traffic in real time .

Deep Insights

Includes		Description
Telematics	Epiroc machine data	Machine sends data regarding health and performance to an Epiroc data lake
Information	My Epiroc	Web and mobile app that provides instant information about your fleet's performance
	Tailored reports	Purpose-made reports that fuse Epiroc data with your relevant data sources
Insights	Empowered	Your insights based on the reports and information services from Epiroc
	Epiroc enhanced	Epiroc application experts and data scientists guide and support you to identify actionable insights

Deep Insights provides easy-to-understand dashboards with performance and KPIs for continuous improvement to the automated fleet.

Technical specifications

To safely mine using automation solutions for material handling, several data communication requirements need to be fulfilled. This ensures safe area access control, correct machine location awareness, stable autonomous operation, observability, and serviceability of the system.

Network golden rules

Segment your network and dedicate a virtual local area network (VLAN) for automation to operate on.

Prioritize the various types of network traffic to ensure sufficient quality of service (QoS) for time-sensitive communication such as remote machine controls, safety, and access control.

Ensure sufficient bandwidth and network coverage in relevant areas of your operation

Deep Automation is verified and validated in mines with Wi-Fi, LTE/4G and 5G networks. There are many ways to design and setup networks. Experience and know-how of purposeful network design and setup for safe autonomous solutions can proactively increase chances of success.

Networks

Wi-Fi	LTE/4G	5G
• Wireless network protocols, introduced in 1996, based on the IEEE 802.11 standard. • 2.4 GHz and 5 GHz bands are ideal for line-of-sight use. Obstructions can limit access point ranges to 20-150 meters. • It is common in underground mines to extend the office Wi-Fi network • Wi-Fi is suboptimal for critical underground applications. Mines using it often deploy mixed-purpose wireless LANs, impacting safe autonomous operations. • To address Wi-Fi drawbacks, consider deploying a dedicated WLAN or non-overlapping radio channels.	• Long-Term Evolution (LTE), a wireless broadband standard, was introduced in 2009 by 3GPP • Designed for multiple users and mixed traffic, this system prioritizes fast data transfer, low latency, higher capacity, and advanced antenna techniques for improved signal quality and spectral efficiency • Telecom network drawbacks include reliance on external operators, unlike mines with in-house IT/OT departments.	• 5G, the latest wireless broadband standard by 3GPP, started deploying worldwide in 2019 • 5G shares similarities with 4G but offers higher data throughput and lower latency • 5G's Ultra Reliable Low Latency Communications (URLLC) capabilities are designed for mission-critical applications, ensuring robust data exchange, including safe autonomous haulage solutions

Detailed network requirements such as network segmentation, protocols, ports, data directions, frame rates, signal strength and heartbeat time outs can be provided by Epiroc upon request.

Epiroc offers proactive network audit services that can help verify your network or provide advice on what actions to take before deploying an automation solution on existing network infrastructure.

Epiroc also has the capabilities to offer dedicated point-to-point networks for tele-remote and automation solutions in various regions according to your needs.

Read more about Epiroc's commitment to Cyber Secure products here:

Technical specifications

Smart (S) machines are equipped with Rig Control System (RCS), making them ready for automation and remote control. Smart and Green (SG) machines feature both RCS and electrification technology. Deep Automation can be used to orchestrate fleets including the following machines.

Smart and Green machines

Scooptram ST18 SG

Overview	
Tramming	17 500 kg

Scooptram ST14 SG

Overview	
Tramming	14 000 kg

Smart machines

Scooptram ST18 S

Overview	
Tramming	17 500 kg

Scooptram ST14 S

Overview	
Tramming	14 000 kg

Scooptram ST7

Overview	
Tramming	6 800 kg

Minetruck MT65 S

Overview	
Hauling capacity	65 000 kg

Minetruck MT42 S

Overview	
Hauling capacity	42 000 kg

United in performance. Inspired by innovation.

Performance unites us, innovation inspires us, and commitment drives us to keep moving forward. Count on Epiroc to deliver the solutions you need to succeed today and the technology to lead tomorrow.

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