HxGN MineProtect CAS 10 Installation Manual

Technical Reference Manual

HxGN MineProtect CAS 10 Installation Manual v1.5

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This document is optimized for printing on A4 paper.

Revision History

Date	Document Version	Software Version	Author	
31.5.2021	1.0	10.0	HBAR	initial
6.7.2021	1.1	10.0	HBAR	Added Display mount/dashboard mount Added Visitor Kit assembly Other added information
22.7.2021	1.2	10.0	HBAR	Added par. 10.1 Error Codes Added GPIO Reverse Switch Added Mast information
7.12.2021	1.3	10.0/10.2	HBAR	Added par. 8.1.2 Radio Interference Power Modes added par 5.17 Insert hint of antenna position in par 5.12 Added Fixed Asset Set QN1915 Added QL1240, QL1241, QL1242 Mast components Added QC1000 installation requirements (horizontal/forward) par. 5.1.6
15.2.2022	1.4	10.0/10.2	HBAR	QL019 cable added as recovery (SERIAL-USB) Added RF 2.4GHz transmitter Added par. 6.3.2 Alternative Display mount with U-Bracket Install verification removed to other doc Added note that battery threshold is configurable and 12 hour grace period
9.5.2022/2.6.22	1.5	10.2	HBAR	Added Brazil compliance information in par. 5.20.4. Adapted Max Tx Power of 2nd radio 2.4 GHz QC1000 RF from 13 to 10 dB

Table Of Contents

1 Document Introduction

The HxGN MineProtect CAS 10 Installation Manual is part of the Hexagon Mining reference manual suite.

The HxGN MineProtect CAS 10 Installation Manual is to be used as a technical reference manual for the hardware installation. Configuration and how to set up the system and features are described in the technical reference manual HxGN MineProtect Configuration Manual. It shall serve the technical personnel to correctly set up installations and enable them to maximize the product's performance.

WARNING:
Operators must be aware of the physical surroundings of their equipment and drive to conditions and mine requirements at all times.

Operating any type of vehicle inside a mine at any time of the day is an inherently dangerous activity which is associated with considerable risks for crew, passengers, third parties, pedestrians, other vehicles and any object in its vicinity. In order to make full and safe use of HxGN MineProtect CAS 10 series products, it is absolutely essential to be fully aware of the risks, operating conditions, restrictions and limitations associated with their use, including to ensure a proper installation and to perform regular software updates. This includes familiarity with and strict adherence to the Hexagon Mining reference manual suite.

It is assumed technical personnel using this manual is familiar with:

- Site-specific safety procedures, Safe Work Procedures (SWPs) and Standard Operating Procedures (SOPs).

Note:
The document uses generic images to show general layout and generic information for various procedures. The site-specific screen layout, menu, and procedure information may vary from what is displayed in the manual.

1.1 Document Conventions

This document uses basic conventions to indicate actions:

Convention Example	Description
Select File > Print	Menu selections, buttons, and icons appear in bold text. In this case, select the File menu and the Print option. Location and capitalization of menu items may vary by mine site.
Ctrl+P	Keyboard shortcut keys. The example indicates to select and hold down the Ctrl key and select the P key.
See xxx Refer to	"See" indicates a reference to another section of this document. "Refer to" indicates reference to another document.
WARNING	Warnings alert the user to dangerous procedures which could cause injury or death.
CAUTION	Cautions alert the user to dangerous procedures which could cause damage to equipment.
Note	Notes supply important information about a procedure which is not covered in the procedure text.

2 Operation Safety Procedures

A vehicle equipped with the HxGN MineProtect CAS 10 System must be operated in the same safe manner as if the HxGN MineProtect CAS 10 System was not installed. The system is not a substitute for normal safe driving procedures and may never be relied upon.

The HxGN MineProtect CAS 10 System will provide no warning for some hazards, such as vehicles, obstacles, and other objects not equipped with properly operating HxGN MineProtect CAS 10.

HxGN MineProtect products are intended as an additional tool in determining potential traffic threats, supporting an alert and conscientious driver. HxGN MineProtect products are never to be used in any application where failure of the products could result in personal injury or material damage. Before using, the latest versions of the respective manuals are to be consulted for familiarization with product operation and limitations.

Hexagon makes no warranties with respect to the product. In no event will Hexagon be liable for lost use, profits, revenue, cost of procurement of substitute goods, or any damages.

Customers agree to indemnify and hold harmless Hexagon, its subsidiaries, and affiliates, and their respective successors and assigns, from and against all third party claims, loss, damage or expense, and any other liabilities whatsoever, which may be incurred by Hexagon. With respect to any of the HxGN MineProtect products.

In addition, Hexagon's current "General Terms and Conditions " apply.

2.1 Contacting Support

For all Hexagon Mining product support:

Contact Method	Details
Web portal	http://hexagonmining.com/customer/portallogin.

3 Product Introduction

3.1 Overview

The main task for HxGN MineProtect series products is to support the operator while he scans the space ahead and around the vehicle with his own eyes, and other (technical) aids. HxGN MineProtect CAS 10 products are simple to use and are designed not to distract the operator from operating the vehicle.

The main components are QC1000 Smart Antenna and as display options QD1400 Display 5 (default) or the QD200 LED Display.

3.2 The Collision Avoidance Principle

The Hexagon collision avoidance device is equipped with a GNSS receiver, additional sensors and transmitter, among which an RF transceiver. The GNSS receiver will provide the unit with a position, speed and heading. This information is continuously broadcasted over the air thanks to the RF transmitter/ receiver.

A vehicle will receive the information from all the surrounding vehicles while transmitting its own information. Based on this information, sophisticated algorithms will determine a collision risk level and indicate it to the operator of the vehicle via the display. At the same time, other vehicles – which do not pose an immediate collision risk – are shown on the display for the purpose of traffic awareness around the vehicle and to allow the operator to avoid risky situation well ahead.

As every vehicle has different dynamics and every mine has different rules, HxGN MineProtect CAS 10 provides a list of features and configuration possibilities which can custom tailored to the needs of our customers.

3.3 Technology used

The Hexagon MineProtect CAS 10 system consists of a Smart Antenna (QC1000) located on the outer side the vehicle, an operator's interface (Display). The Smart Antenna contains all main sensors (GNSS engine, radio transceiver, micro-controller, memory, data interfaces and a series of sensors and other transmitters including networking capabilities such as Wi-Fi/LTE).

The QD1400 is an LCD Display providing the operator with a top view of the traffic situation as well as visual and acoustical warnings (sound patterns over loudspeakers) and other operational

or safety information in the form of symbols, icons and text. It provides both location and type of vehicle of nearby opponent vehicles. It features a touch display for operator input if required.

QD200 LED Display provides a directional information of nearby traffic and danger as well as for acoustical warnings (beeping over buzzer) and one button for input.

The Smart Antenna receives position and movement information from an internal high-sensitivity dual-band, multi-constellation GNSS module. Additional sensors and logic further enhance the accuracy of position measurements. The predicted driving path of the vehicle, in which the CAS 10 system is installed, is calculated and the obtained information is transmitted by radio as a low-power digital burst signal at frequent intervals. Provided they are within receiving range, these signals are received by other vehicles also equipped with CAS 10 or legacy CAS components. The incoming signal is compared with the driving path calculated and predicted for the second vehicle, taking into account configuration parameters like maximum acceleration or vehicle dimension.

If the CAS 10 system determines the risk of dangerous proximity to another vehicle (or to an obstacle equipped with the system), the unit gives the operator a warning of the greatest danger at that moment.

The operating range is very dependent upon the antenna installation in or outside the vehicle. The normal range is about 500m for standard operations, but up to 2 km may be achieved in individual cases. For their radio communication, CAS 10 system use a proprietary patent- and copyright-protected protocol.

3.4   Limitations of the System

CAS 10 system is **not** designed for use

- in deep or narrow open pit mines where availability of GNSS satellites is not sufficient
- in any other application than open pit mining
- on vehicles with excessive vibration

3.5   Legal Statement and Disclaimer

For their radio communication, CAS 10 system use a proprietary patent- and copyright-protected protocol. Any non-licensed use, dissemination, copying, implementation or reverse engineering of the CAS radio communication protocol, their hardware and software or parts of it is forbidden by law and will be prosecuted.

CAS 10 units are only to be used with other CAS 10 units in fleet and it is "over-the-air"-compatible with CAS 4.x units. Otherwise inconsistent function may occur. Hexagon cannot assume any liability from correct or incorrect use of above specified products other than regular warranty according to Hexagon General Terms and Condition.

4 Hardware Overview

4.1 Main Components and Accessories

Material SAP	Material Short Description	Picture	Details
902712	QC1000 HxGN MineDiscover Smart Antenna		Smart Antenna including Mount Module QL1212 for bracket mount.
902717	QD1400 HxGN MineDiscover Display 5		5" LCD Display with Touch Functionality
929039	QL1212 Through-Hole Mount Module Smart Antenna		Through-Hole mount module QC1000 Smart Antenna. Spare part only.
938190	QL1210 Mag Mount Smart Antenna		Magnetic mount module for Smart Antenna for attaching Smart Antenna on magnetic vehicle surfaces, typically on light vehicles.
896490	QM1105 Cable Smart Antenna 5m angled		M16-F (right-angled connector) to M16-M, 5m, PWR-SER-ETH-2xCAN-4xGPIO. Typically used for mast bracket mount on heavy vehicles.
906529	QM1106 Cable Smart Antenna 5m straight		M16-F (straight connector, to M16-M, 5m, PWR-SER-ETH-2xCAN-4xGPIO. Can be used as extension for QM1105.
916130	QM1107 Cable Smart Antenna 6m straight light		M16-F (straight) to M12-M, 6m, PWR-SER-ETH-3xGPIO; Typically used for LV with or without mag mounts.
921242	QM1108 Cable Smart Antenna 6m straight Visitor		M16-F (straight) to M12-M, 5m, PWR-SER-ETH; Typically used for Visitor Unit with mag mount.
916131	QM1110 Junction Harness Smart Antenna		Junction harness to branch out PWR-SER-ETH-2xCAN-4xGPIO from Cable Smart Antenna

916132	QM1111 Junction Harness Smart Antenna Light		Junction harness to branch out PWR-SER-ETH-3xGPIO from Cable Smart Antenna light; Typically used for LV and Visitor Unit
931480	QM1113 Cable, CAS 10 Ethernet Harness		Harness between Junction Harness, Ethernet Switch and Display 5
939550	QM1114 Cable, Ethernet M8-8F to M12-4M, 0.4m		Cable between Junction-Harness for secondary Smart Antenna (beacon) to Ethernet Switch
945888	QX1120 CAS 10 Ethernet Switch		Ethernet Switch with 5 Ethernet connection and power in. Connectors require M12, 4pin, male D-coded
921244	QM1130 Cable Display 5 2.5m		M8-M (straight) to M8-F, 2.5m, PWR-ETH; Typically used for Smart Display
938004	QX1300 CAS 10 Battery Pack		Battery Pack with Power management for Visitor Unit
950290	L-Bracket, Smart Antenna		Bracket to mount Smart Antenna on mast or rail including U-bolts. Includes 3x screws and spring lock washers to mount Smart Antenna
950287	QL1421 RAM mount, Base Plate diamond		RAM-B-238U
950288	QL1422 RAM mount, Arm short		RAM-B-201U-A
950291	QL1423 RAM mount, Base plate round		RAM-B-202U
950286	QL1424 RAM mount, Suction mount base		RAM-B-224-1U Suction mount for temporary installation of QD1400 Display 5 (Visitor Unit) on non-porous, plain surfaces.
951450	QN1999 CAS 10 Vehicles Installation Kit		Installation kit for CAS 10, suits all vehicles. Contains: - standard screws - cable ties - Accessories for DEUTSCH connectors

			- flying leads (red/black 10m) - ring tongue terminals for battery connectors - Blind rivet nuts for QC1400 mount on dashboard. Special tools are required to mount blind rivet nuts and DEUTSCH connectors. Special tools are NOT part of installation kit.
950251	QL1230 CAS 10 Visitor Unit Suitcase		Robust suitcase with organized inlay for all Visitor Unit items. Fits QN1910 and QN1911 with QD200. QL1230 is the empty suitcase.
950248	QL1318 CAS 10 Visitor Vehicle Charger		Vehicle charger with cigarette lighter adapter for visitor unit
6017117	QN1980 Mast Assembly, Haul Truck Set Contains of QL1240 Mast, Main Structure QL1241 Rods, Support Left & Right QL1242 Pole Mast Fiber Glass 8ft		Mast Assembly for mount on hand rails. For QC1000 Smart Antenna. Bracket for Antenna not part of set. CAS 10 requires QL1220 additionally. See par. 8.4.3 for more details on mast assembly.
836819	QL019 USB Programming Cable		Used for troubleshooting and recovery only upon instructions by PD. **1-2 pcs recommended per technician on-site.** USB to serial cable to connect to serial port to laptop.

5 QC1000 HxGN MineDiscover Smart Antenna

5.1 Electrical Specifications

Parameter	Range	Note
Input power nominal	9-36VDC	
Power consumption at 12V nominal	350 mA	
Interfaces	1x ETH, 2x CAN, 4x GPIO, 1x RS-232	For Ethernet, see par 5.6
GNSS	Multi-band GNSS module with integrated multi-band RTK, allowing for 4 concurrent constellations	
RF	868/902-928 MHz	4 Hz refresh rate. See also par 5.4
RF	2.4-2.5 GHz	See also par 5.5 NB: Early versions, QC1000 RA, do not support this feature
UWB ToF	integrated	See par 5.5
Wi-Fi	802.11 b/g/n 2.4GHz, WPA2	Only the 2400 … 2483.5 [MHz] band is active. See par 5.7
Cellular	3G, 4G/LTE	See par 5.8
IMU	9-axis on-board: Accelerometer / Gyroscope/ Magnetometer	
Other sensors (MEMS)	Pressure, humidity, temperature, ambient light	
Data Storage / Memory	4GB SD-card	To store logfiles, settings and configuration
GPIOs	4 General Purpose Input and Output	To interact with actuators or sensors outside the device. See par 5.14

5.2   Mechanical Specifications

Parameter	Range	Note
Diameter	Ø 169 mm (6.65 inch)	
Height	105 mm (4.1 inch)	
Weight	980 g	
Housing material	Polycarbonate (white)/Aluminum Alloy (black)	Including Hexagon branding
Status LED	Multi-color	See par 5.11

5.3   Environmental Specifications

Parameter	Range	Note
Storage Temperature	-40 to 85°C	
Operation Temperature	-20 to 70°C	
IEC 60529 Ingress Protection	IP69K/IP67	with connected cable or protection cap on connector
Flammability	UL94 / IEC 60695-2-12	

5.4   ISM Radio Specifications

The ISM radio is for vehicle to vehicle communication. Depending on the region different bands are in use.

Region	Band (MHz)	Max. output power
EU	868.2	14 [dBm]
South Africa		
USA	902.4 ... 922 with frequency hopping	17 [dBm]
Canada		

Which frequency to use, and with the corresponding bandwidth, is a configuration parameter that is configured at installation, and must be based on country specific regulations.

5.5   2.4 GHz Radio Specifications

This is used for vehicle-to-vehicle (non-safety) communications and used for specific applications to do ranging.

Early versions, QC1000 RA, do not support this feature.

Region	Band (MHz)	Max. output power
all	2.4 – 2.5GHz	10 [dBm]

5.6   UWB ToF Radio Specifications

There is an on-board UWB ToF Radio inside the Smart Antenna.

Region	Band [MHz]	Center Frequency [MHz]	Bandwidth [MHz]	Max. output power
EU	3328 … 4659.2	3993.6	1331.2	- 41.3dBm
South Africa	3328 … 4659.2	3993.6	1331.2	
USA	5948.8 … 7030.4	6489.6	1081.6	
Canada	5948.8 … 7030.4	6489.6	1081.6	

5.7   Ethernet

It is possible to connect the QC1000 unit to the LAN of the vehicle via Ethernet cable. The unit communicates either with 10Base-T or 100Base-T. The Smart Antenna can be connected to a router as a client or act as the router. Furthermore, it can provide the DHCP service in the sub-network (default). If another DHCP server is defined to provide this service, the Smart Antenna DHCP must be disabled.

Hardware set up:

To QC1000 Smart Antenna

Ethernet/Serial/PWR connected to Junction Harness QM1110/QM1111

QM1113 CAS 10 Ethernet Harness

Ethernet/Serial/PWR to QD1400 Display 5

QX1120 CAS 10 Ethernet Switch

Ethernet Cable to external (not part of any set). See options for commercial cables in table below
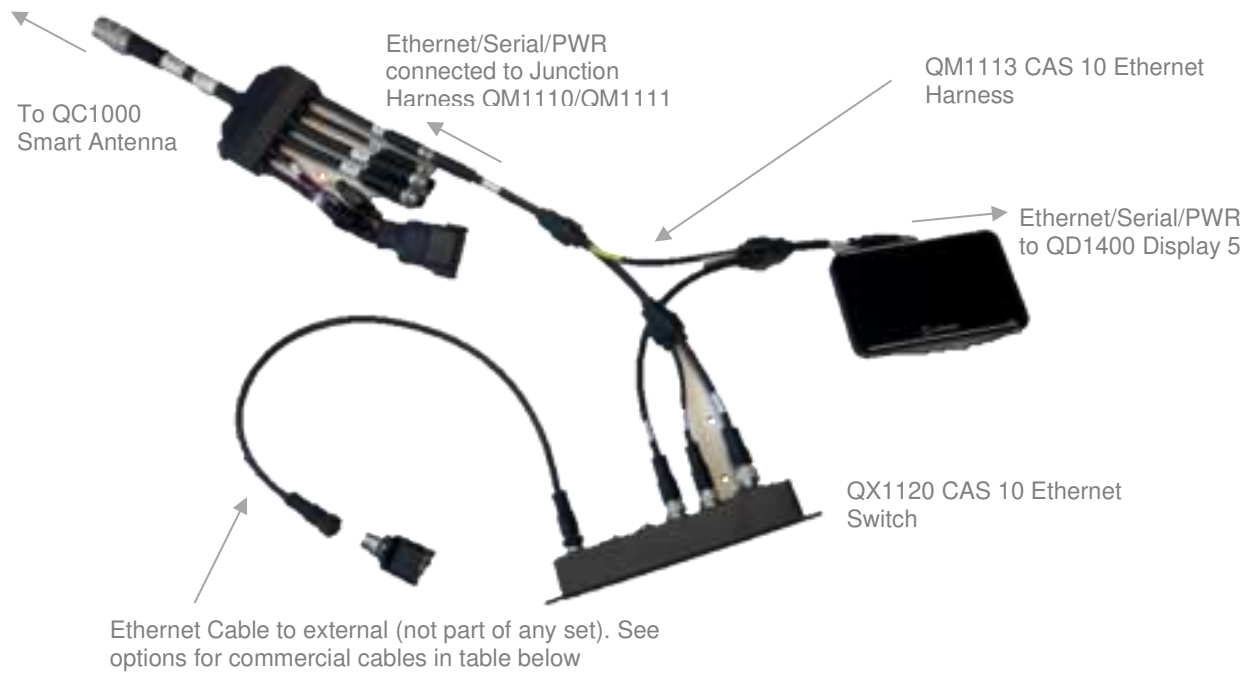
Please note: Hexagon recommends using industrial connectors (M12) instead of RJ45.

Cable	Detail	Model	Picture
Industrial M12	M12D4-MS-MS-PVC TYPE B-1.0M	Example (Digikey) 17-TAD14741111-002-ND	
M12 to RJ45	M12 MALE D-CODE, STRAIGHT, RJ45,	Example (Digikey) 298-13357-ND	
Adapter M12 to RJ45	ADAPT CIRC 4POS TO RJ45 JACK BLK	Example (Digikey) 1754-1180-ND	

5.8   Wi-Fi

Frequency	Band	Max. Output Power
2412 MHz to 2462 MHz	802.11b/g	15dBm
	802.11n	14dBm

5.9 LTE

The LTE module acts as an alternative to the WiFi.

The module supports the following bands:

- LTE FDD: B1/B2/B3/B4/B5/B7/B8/B12/B13/B18/B19/B20/B25/B26/B28
- LTE TDD: B38/B39/B40/B41

With a maximal output power of 23±2 [dBm].

In case of using the 902-922 [MHz] band for ISM radio, the BAND-8 of the LTE module is disabled due to overlapping of frequencies.

5.10 Connector Description

QC1000 features a M16-19p male connector compatible to cables:

- QM1105 Cable Smart Antenna 5m angled
- QM1106 Cable Smart Antenna 5m straight
- QM1107 Cable Smart Antenna 6m straight light
- QM1108 Cable Smart Antenna 6m straight Visitor
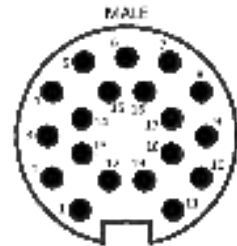
Pin	Name	Description
1	Batt +	Positive power-supply for the unit
2	CAN1-L	Low level CAN bus input/output line → for the communication with Radars / PA … → the same signal as on Pin 19
3	Serial-GND	Reference voltage for the serial communication RS232
4	GPIO-1	Digital Input and Output Analog Input
5	ETH-RX+	Ethernet Receive / Transmit positive channel 2
6	ETH-TX+	Ethernet Transmit / Receive positive channel 1
7	GPIO-3	Digital Input and Output
8	GPIO-2	Digital Input and Output
9	CAN2-L	Low level CAN bus input/output line → dedicated CAN for VIS
10	GPIO-0	Digital Input and Output Analog Input
11	GND	Negative power-supply for the unit
12	CAN1-H	High level CAN bus input/output line → for the communication with Radars / PA … → the same signal as on Pin 18
13	Serial-RX	Receive input for the serial communication RS232
14	Serial-TX	Transmit output input for the serial communication RS232
15	ETH-RX-	Ethernet Receive / Transmit negative channel 2
16	ETH-TX-	Ethernet Transmit / Receive negative channel 1

Pin	Name	Description
17	CAN2-L	High level CAN bus input/output line → dedicated CAN for VIS
18	CAN1-H	High level CAN bus input/output line → for the communication with Radars / PA … → the same signal as on Pin 12
19	CAN1-L	Low level CAN bus input/output line → for the communication with Radars / PA … → the same signal as on Pin 2

5.11   Face plate/Label Description

A label is placed at the lower side of the QC1000 indicating Model, Article Number, Manufacturer and compliance statements. Label is white print on black background.

5.12   User Interface – LED bar

At the front of the Smart Antenna, there is a light bar backed with high-brightness LEDs. LED bar provides indications on system status. The LED bar provides system status during installation as well as during operations.

Condition	LED color	LED intensity	LED timing	Comment
Bootloader started	**RED**	Max intensity	Constant on	For errors like no valid firmware found.
Bootloader error	**RED**	Max intensity	Double blink	This is when there is a permanent error during start-up, such as an unsupported CPU detected.
QC1000 running - OK	**GREEN**	Based on ambient light	Short blink every 5s	Shown in normal operation if no error is present.

QC1000 running - ERROR	**RED**	Based on ambient light	Short blink every 2s	
QC1000 running - IDENTIFICATION	**RED** /**ORANGE**/ **GREEN**	Based on ambient light	Blink each color for a couple of times.	Identification is a request from an external tool. The intent is to make a visible indication on a selected QC1000, so that it can be distinguished from other QC1000s on the same vehicle. After identification mode, LED bar indication reverts back to the correct indication based on status.

5.13   Network Capabilities

QC1000 features full networking capabilities on its internal Network Sub-System:

- DHCP
- DNS
- NTPserver
- Switching and routing including NAT
- Firewall protected
- Access Point

5.14   SIM Card and eSIM capabilities

SIM card form factor: nano

SIM card holder is located on the PCD within the QC1000 housing. **Do NOT open QC1000 at any time** Installation of SIM card must be performed by a Hexagon qualified workshop.

QC1000 features a eUICC (Embedded Universal Integrated Circuit Card) also known as eSIM. Please enquire if you are interested in this feature.

5.15   QN1999 Vehicle Installation Kit

QN1999 contains accessories for installation on all vehicles:

Item	Qty	Purpose
Blind-rivet nut Tubtara M5 UT/ALKS 3	2	Mount RAM mounts to dashboard
Screw M5 x 16 hexalobular socket pan head A2	2	

Split spring lock washer M5	2	see par. 6.3
DEUTSCH connector, DTM06-12SD PWR Junction Harness to Battery	1	Connection of PWR, GPIO, CAN See par. 5.16
DEUTSCH Crimp contacts for DTM06-12S / TE-1062-20-0122	12	
DEUTCH Wedge Lock WM-12S	1	
Flying lead, 1mm2 10m, red	1	Power, connection to battery
Flying lead, 1mm2 10m, black	1	Power, connection to battery
Cable Tie 400 x 4.8mm, Polyamide 6.6, 215.75N, Black, RND Cable	20	Multi-purpose
Cable Tie Fixing	10	
Expandable Braided Polyester Sleeving for 4x 1mm2 10m	1	Sleeve for power cables (flying leads)
Ring Tongue Terminal for M10 / 1mm2	4	Connection to battery (3 sizes). Attach to stripped ends of flying leads using crimp tool.
Ring Tongue Terminal for M8 / 1mm2	4	
Ring Tongue Terminal for M6 / 1mm2	4	

5.16 Pin-out Deutsch Connector (QM1110/QM1111)

Deutsch Connector

Fitting of Deutsch connector with pins must be performed according to standard installation procedures provided by manufacturer and customer-specific configuration.

Pin	QM1110	QM1111	Picture
1	PWR +	PWR +	Pin number on Deutsch connectors are referenced by the dents in the black housing (blue circles). Orange cube can be left or right-hand side.
2	PWR -	PWR -	
3	Switched PWR +	N/A	
4	Switched PWR -	N/A	
5	GPIO-2	GPIO-2	
6	GPIO-3	N/A	
7	VIS-CAN-L	N/A	
8	VIS-CAN-H	N/A	
9	GPIO-0	GPIO-0	
10	GPIO-1	GPIO-1	
11	N/A	N/A	
12	N/A	N/A	

5.17 General Purpose Input Outputs (GPIOs)

A versatile scheme of relaying environmental information from and to the QC1000 unit is available through the GPIOs.

Item	Min	Typical	Max	Unit	
GPIO input voltage to GND (digital & analog)	0		+Batt	V	GPIO leakage current:
GPIO high output voltage to GND	+Batt -1.5	+Batt -0.5	+Batt	V	max ±1.5mA @ 24V
GPIO low output voltage to GND	0	0.5	1.5	V	max ±1mA @ 12V
GPIO output current to GND	-0.4		0.4	A	

5.17.1 Example Installation Reverse Switch

Install Reverse Switch Signal as per diagram below:
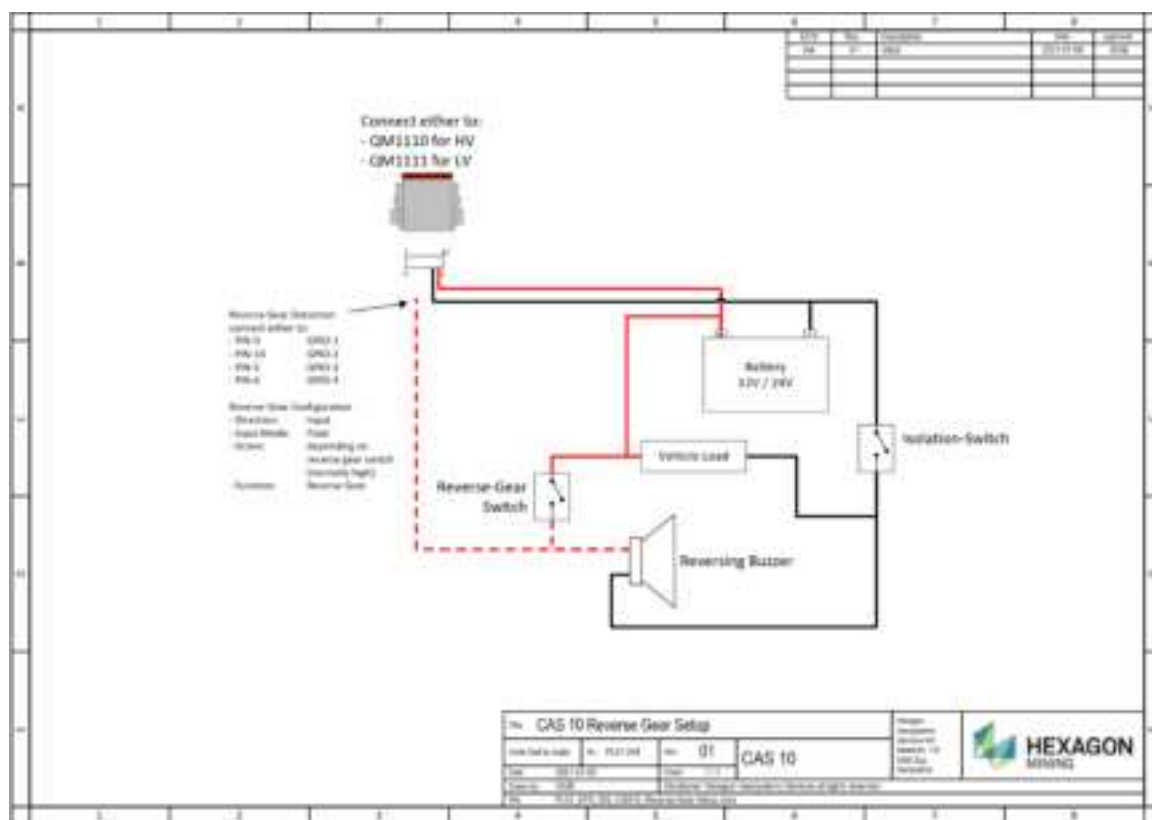
5.18 Power Save Mode

For Safety purposes, QC1000 must be powered at all times (direct connection to battery) when installed on a vehicle. If the unit is powered off e.g. when motor is off, no signal will broadcasted in the Safety channel making the unit invisible to other CAS systems.

The system has 3 main power modes:

- **Normal**: Battery supply voltage okay and vehicle is moving
- **Power Save Mode**: Battery supply voltage drops below threshold

- **Drain Protect:** Battery supply voltage drops below critical threshold. This mode is designed to use minimal power to increase supply battery life for starting the vehicle. CAS System is not operational anymore.

A low power mode kicks in when a vehicle is detected to be "parked" i.e. in stand-still for more than 10 minutes (determined by its GNSS location). Stand-still has a slightly lower power consumption than when vehicle is moving. However, this has marginal impact on battery life.

Depending on initial voltage measurement, 12V or 24 V system is detected by the system and 12V or 24V thresholds are applied.

There is a hysteresis around voltage thresholds which means that the actual battery voltage value is slightly different when the system is running normally and the battery voltage is falling or when rising.

5.18.1 12 V Systems

Battery state \ Move mode Nominal Supply Voltage = 12 V	Driving (typical values)	Parked (typical values)	Comment
Normal Battery **normal**	5-6W 0.42-0.5A	Display in Sleep Mode 4-4.5 W 0.33 0.37 A	Normal behaviour
Power Save Mode - Entering when battery voltage drops below 11.7 V plus 12 hours. - leaving when battery Voltage rises again above 12.3V	Same as normal	3.5 - 4W 0.30 - 0.33A	Power saving
Drain Protect - Entering when battery voltage drops below 11.2 V - leaving when battery voltage rises again above 12.0V		0.5 W 0.04 A	NO SAFETY Red LED on QC1000 When voltage is back, system turns on again.

Battery voltage thresholds are examples. Values are configurable.

5.18.2 24 V Systems

Battery state \ Move mode Supply Voltage = 24 V	Driving (typical values)	Parked (typical values)	Comment
Normal Battery **normal**	5-6W 0.21-0.25A	Display in Sleep Mode 4-4.5 W 0.17 - 0.19 A	Normal behaviour
Power Save Mode - Entering when battery voltage drops below 23.2 V plus 12 hours - leaving when battery Voltage rises again above 23.8V	Same as normal	3.5 - 4W 0.15 - 0.17A	Power saving.
Drain Protect - Entering when battery voltage drops below 21.7 V - leaving when battery voltage rises again above 24.0V		0.5 W 0.02 A	NO SAFETY Red LED on QC1000 When voltage is back, system turns on again.

Battery voltage thresholds are examples. Values are configurable.

5.19   Installation of QC1000

For any vehicle installation, QC1000 must be

- Facing forward (in direction of forward travel)

- Must be mounted horizontally within +/- 15°

- Comply with Radio Interference as in par. 8.1.2

5.19.1 Installation of QC1000 with bracket

Hexagon recommends the installation of QC1000 on a bracket for all permanent installation for its superior stability even in heavy vibration.

QC1000 has 3 thread insert for M8 screws to be fixed on a corresponding hole pattern of a bracket.
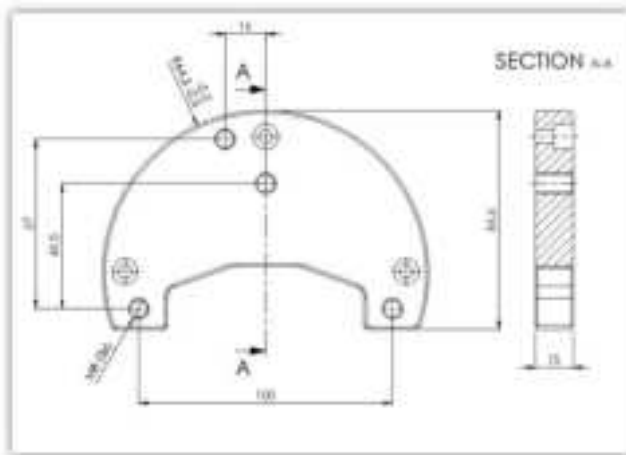
QL1212 Through-Hole Mount Module
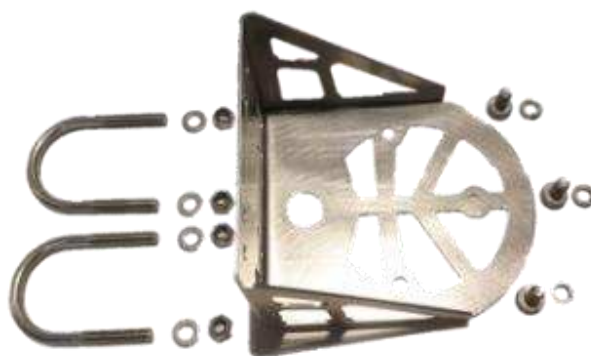
QL1220 L-Bracket with U-bolts and screws/bolts

Commercial in Confidence
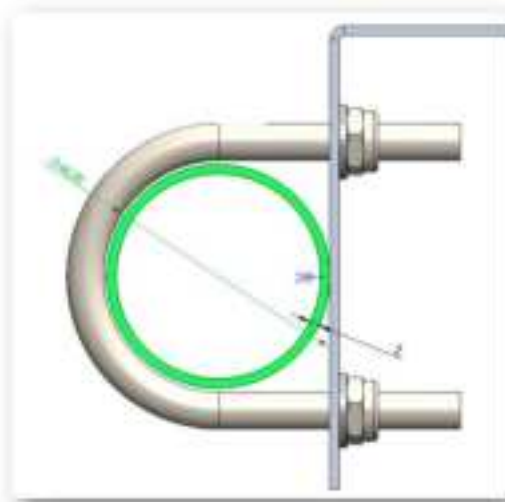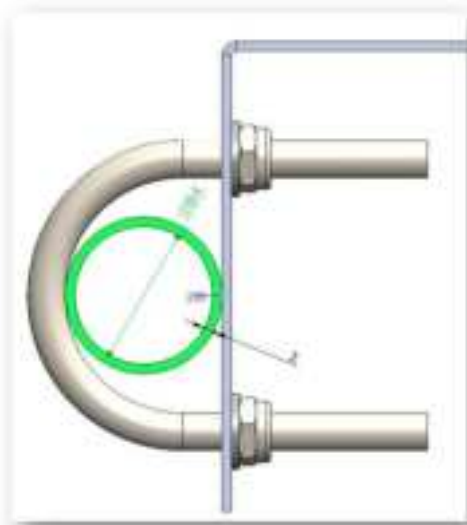
Tube diameter min: 1.5'' (37.4mm)   Tube diameter max: 2''(48.3mm)

5.19.2 Installation of QC1000 with magnetic mount

QL1210 Mag Mount Smart Antenna

QC1000 provides optionally the QL1210 Mag Mount Smart Antenna. Replace the through-hole mount module with QL1210 Mag Mount using the same screws.

QL1210 is fitted with very strong magnets. This magnetic base attaches to any reasonably magnetic material. It allows an easy installation on vehicle roof tops and is ideal for light or other vehicles with moderate vibration.

Attention: Magnets can fly together or on to steel objects causing severe pinching or lacerations to the skin. Keep strong magnets away from head, eyes, heart, and trunk.

Hint: Correct antenna position is crucial. When Smart Antenna is removed temporarily (for example when vehicle is washed or requires replacement), mark location of antenna with sticker or vinyl marker to ensure that antenna position remains the same after re-installation.

5.20 Compliance

5.20.1 CE – Declaration of conformity

Hereby, Hexagon Geosystems Services AG, declares that the radio equipment type QC1000 is in compliance with Directive 2014/53/EU and other applicable European Directives. To receive a copy of the latest Declaration of Conformity (DoC) for the product, either contact your local sales representative or contact us via http://hexagonmining.com/customer/portallogin.

5.20.2 FCC compliance statement

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and

2. This device must accept any interference received, including interference that may cause undesired operation.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

The user shall be cautioned that changes modifications not approved by the responsible party could void the user's authority to operate the equipment.

5.20.3 ISED Canada compliance statement

This device complies with ISED Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'ISDE Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

5.20.4 Compliance Statement Brazil - Agência Nacional de Telecomunicações

Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados.

Este produto não é apropriado para uso em ambientes domésticos, pois poderá causar interferências eletromagnéticas que obrigam o usuário a tomar medidas necessárias para minimizar estas interferências.

This is a class A Product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Para maiores informações, consulte o site da Anatel - https://www.gov.br/anatel/pt-br/

5.20.5 RF Exposure

RF Radiation Hazard Warning

To ensure compliance with FCC and Industry Canada RF exposure requirements, this device must be installed in a location where the antennas of the device will have a minimum distance of at least 20 cm from all persons. Using higher gain antennas and types of antennas not certified for use with this product is not allowed. The device shall not be co-located with another transmitter. Installez l'appareil en veillant à conserver une distance d'au moins 20 cm entre les éléments rayonnants et les personnes. Cet avertissement de sécurité est conforme aux limites d'exposition définies par la norme CNR-102 at relative aux fréquences radio.

5.20.6 Disposal of Product

Improperly dispose of product:

If the product is improperly disposed, you may enable unauthorized persons to use it in contravention of the regulations, exposing themselves and third parties to the risk of severe injury and rendering the environment liable to contamination.

Precautions:

The product must not be disposed with household waste. Dispose of the product appropriately in accordance with the national regulations in force in your country. Always prevent access to the product by unauthorized personnel.

5.20.7 Approved Countries

Please refer to Approved country list.

6 Displays

To convey information for collision avoidance and traffic awareness as well as other system and operational information to the user, a UI/UX interface must be installed. The CAS 10 solution provides two options to choose from:

- QD1400 HxGN MineDiscover Display 5 (standard)

- QD200 Remote Display (optional)

6.1 QD1400 HxGN MineDiscover Display 5

Display 5 features a high-resolution LCD Display with Touch Functionality with high volume speakers for use in heavy machinery (adjustable) and automatic brightness adjustment for day and night operation as well as a fingerprint sensor.

Rear side

6.2 Installation of Displays

Rules:

- The display should be positioned such that the front panel is in direct view of the Operator, the acoustic warning tone can be heard loud and clearly and control button/touch display can be operated easily.
- The view on the front panel may not be obstructed at any time.
- The display may never interfere with the operation of the vehicle (incl. emergency procedures)
- **Special attention is required to not reduce the operator's field of view.**

6.3 Installation of QD1400 Display 5

Standard installation of the QD1400 Display is on the vehicle's dashboard using the RAM mounts as part of the sets:

Step	Items	Comments
Mount QL1421 to back of QD1400 using provided screws and spring washer.	 QL1421 RAM mount, Base Plate diamond 	Do not overtorque! It will damage the threads. Screws: M5x12 plus spring washers **Torque: 0.9-1Nm**

Assemble QL1421, QL1422 and QL1423	 QL1422 Arm, QL1423 Base plate	
Find mounting location by having an operator sitting in normal driving position and taking into account the rules of par 6.4 and agree with customer.	**Hexagon recommends fixed installation of Displays to the dashboard using screwed connection with supplied blind-rivet nuts (part of QN1999 Vehicle Installation Kit).** **If customer does not allow drilling, alternative solutions (Velcro, suction cups or other) need to be evaluated and agreed with customer. These connections require on-site testing.**	
Drill holes for Blind Rivet nut and set blind rivets to dashboard using special tool	Blind-rivet nut Tubtara M5 UT/ALKS 3 	For instructions, see par. 6.3.1
Mount QL1423 on blind-rivets using provided spring-washer and screw (M5). Do not overtorque, risk of loosening blind rivet.		

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6.3.1 Setting of blind-rivets to dashboard

Step	Picture
Drill holes d=7.1mm According to hole pattern of RAM mount	
Blind-rivet special tool (not part of set) (Tubtara)	
Set blind rivet	

Blind rivet set (flat in dashboard)	

6.3.2 Alternative QD1400 Mounting Option: U-Bracket

If primary and recommended option as described above is not possible (e.g. because drilling into dashboards it not allowed), there is alternative option using a U-Bracket which can be attached to the dashboard by means of adhesive tapes. The U-Bracket provides a larger footprint than the RAM-base for this purpose.

Step	Items	Comments
Mount QL1425 to back of QD1400 using provided screws and spring washer.		Do not overtorque! It will damage the threads. Screws: M5x12 plus spring washers (same as for RAM Mount Assembly) **Torque: 0.9-1Nm**

Alternative: mount Display on upper position.		No additional material required. Careful! Small screws, do not overtorque and use small Torx Allen keys for screwing and unscrewing.
Attachment to dashboard	**Hexagon does not make recommendations for the adhesive technology such as double-sided tape, velcro or other. Depending on surface and topology (flat, rounded) different methods may be more suitable.** **Attachment has to be tested for suitability of application.**	
Adjustment of angle of display	 Adjust display angle by loosening and tightening black knurled grip knob (+20° to -10°).	

6.4 QD200 Remote Display

The QD200 Remote Display offers the following attributes:

- Indication of surrounding vehicles through 12 dual color LEDs (red/green) in a circle
- Status Indication through 4 dual color LEDs (red/green): Power, GPS, Reverse and Mode
- Multifunction push-button
- Piezoelectric buzzer
- Ambient light sensor

The maximum length of the display cable is 15m. This can be achieved be connecting several display extension cables together.

The LED brightness is automatically controlled based on ambient light, in order to provide dimming for night operation.

The buzzer, with a maximum volume of 85dB (at 10cm distance), can be automatically controlled based on ambient noise.

The image shows a display while the device is operating in a vehicle, traveling forward ('Reverse LED', second from top, is OFF) and a vehicle (equipped with another Hexagon CAS device) is detected. The LED on in the 12 o'clock position indicates the presence of a vehicle in front. Several colors and sounds indicate different threat levels. Depending on the distance to other vehicles and on the configuration parameters an alarm might be audible. The center compass displays direction and distance of vehicles within the RF transmitter / receiver range but it also serves to display error codes in the case a system failure was detected.

The LEDs on the left side of the display show the status of the system. They indicate if the device has enough power, has acceptable GNSS reception or is traveling backwards as well as other information about the system.

Depending on the configuration, pushing the square button on the right of the display can trigger three functions:

1. Flag special events in the unit's log-file: for example an incident or a situation where the user believes the system didn't perform as expected.
2. Acknowledge an alarm: The operator can stop the warning sound for example when being towed by another vehicle.
3. Pressing the button for 3 seconds or longer seconds will restart the QC1000 Smart Antenna.

All alarms are indicated during a minimum of 1.5 seconds to allow the operator to see and react to it. The alarm will stop once the threat is gone or if one of the two vehicles stops.

6.5   Installation of QD200 Remote Display

- The QD200 Remote Display has a male M8 type connector with 4 contacts. It connects to the QD221 and QD222 extension cables.
- The back side of the display's aluminum housing includes two 8mm deep M4 blind threads, so that the housing can easily be secured. Forcing screws longer than 8 mm into the nuts may cause damage and voids warranty.
- The remote display is light enough to be fixed with 3M dual lock. This is ideal for installations where the owner of the vehicle does not permit to drill holes in the dashboard.

M8 Mounting Hole   M8 Serial Connector

Commercial in Confidence   © Hexagon AB
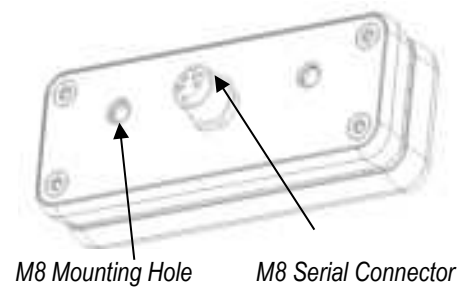
7 CAS 10 Visitor Unit

CAS 10 Visitor Unit suits temporary CAS 10 installations on vehicles for visitors of a mine or short-term contractors to ensure all vehicles are protected by CAS.

CAS 10 Visitor units contain QC1000 Smart Antenna with a magnetic mount and QD1400 Display 5 with RAM mounts and suction cups for quick installations. Part of the set is the QX1300 CAS 10 Battery pack as an independent power source. The battery pack can be connected to the cigarette lighter of the vehicle for prolonged lifetime.

In between use, the battery pack must be charged using the provided QM251 charger (110/230V)

7.1 QX1300 CAS 10 Battery Pack

7.2 Top View

Indicates Battery charge status

Indicates presence of power supply

Button:

When pressed, indicates battery charge (1-4 levels)

Indication	Mode	Meaning
	Orange LED	
	Blinking at 0.5 Hz	Battery being charged
	Continuous	Battery is fully charged
	Blinking at 2.5 Hz	Battery Error
	None	No battery connected/detected or input voltage too low
	Orange LED	
	Continuous	Power Supply is present

	Blinking at 2.5 Hz	Charger error
	None	Power Supply is not present
	Push button	Indicates battery charge level when pushed

7.3 Front Panel

Door to battery compartment. Open to remove battery.

Connector to QM251 Charger or QL318 for cigarette lighter

Connector QD221/QD222Cable to QD200 LED Display

Connector QM1108 Cable and QC1000

Connector QM1130 Cable and QC1400

7.4 Battery Specifications

QC1300 features a Li-Ion-Rechargeable Smart Battery Pack Li-Ion 14.40V / 6.90Ah / 99.40Wh.

Rechargeable Smart Battery Pack Li-Ion
14.40V / 6.90Ah / 99.40Wh
P/N: 110064-05

Parameter	Value		Remark
Cell Type	NCR18650GA		Manufactured by Panasonic
Nominal Voltage	14.40V		-
Nominal Capacity	6.90Ah		-
Minimum Capacity	6.60Ah		-
Maximum Charge Voltage	16.80V		Recommended charge voltage
Maximum Charge Current[2]	4.83A		Recommended charge current: See (2) JEITA controlled charging
Charge time (with maximum charge current)	< 3h at 25°C		-
Charge Method[3]	Controlled Charging using an [SBCS] compliant charger		-
Charge timeout protection	18h		-
Continuous Discharge Current[1]	8.50A	-20°C to 25°C	Referred to ambient temperature values
	6.00A	25°C to 45°C	
	3.00A	45°C to 60°C	
Discharge Cut-off voltage	2.50V		Referred to individual cell voltage
Life Expectancy	300 cycles with ≥ 75% of initial capacity		CC/CV Charge: 1.675A / 16.80V Discharge: 3.35A down to 12.00V @25°C
Shelf Life	12 months with 30% SOC >12 months with 40-60% SOC		Battery is set to shipping mode and stored at 25°C
Battery pack impedance	Max. 180mΩ initial		Measured at 1kHz AC 25°C fully charged battery
Weight	440g		-

For more details, please refer to Manufacturer Specifications.

7.5   QN1910 Visitor Kit Assembly

For logistics reason, QN1910 Visitor kits may require local assembly.

Item	Qty	Description
1	1	QL1230 CAS 10 Visitor Unit Suitcase

2	1	QC1000 HxGN MineDiscover Smart Antenna
3	1	QL1210 Mag Mount Smart Antenna
4	1	QM1108 Cable Smart Antenna 6m straight Visitor
5	1	QD1400 HxGN MineDiscover Display 5
6	1	QM1130 Cable Display 5 2.5m
7	1	QL1421 RAM mount, Base Plate diamond
8	1	QL1422 RAM mount, Arm short
9	1	QL1424 RAM mount, Suction mount base
10	1	QX1300 CAS 10 Battery Pack
11	1	QL1318 CAS 10 Visitor Vehicle Charger
12	1	QM251 Charger for single QuickMount Unit
13	1	QM1319 CAS 10 Visitor Unit Travel Adapter
14	1	Quick Install Manual (A5 format) - pending

1. Take an empty suitcase (item 1) and open it.

2. Take a Smart Antenna out of its box (item 2) and disassemble its QL1212 Through hole mount module (plastic part). We recommend keeping it as a spare part otherwise throw it away.

3. As next step unpack, QL1210 Magmount Module (item 3), take the enclosed screws (3x M5x16), the spring lock washers (3x for M5) and the washers (3x Ø5.3/10/1), put them into the foreseen holes as displayed. Note the order of the fasteners. Then mount the Magmount from underneath into the QC1000 Bottom Part with 1.2Nm torque.

!!! **BE AWARE** !!!
50kg magnetic force

Now you can put the Antenna (modified item 2) into the upper right recess with front (HxGN Logo heading to front).

4. Unpack a RAM mount base plate diamond (item 7), a RAM mount arm (item 8) and a RAM mount suction mount base (item 9) and stick it together.
5. Take a Display (item 5), attach the assembled RAM Mount bracket from step 5 with the screws and spring lock washers which will be found in the Display Box.

Do not use different screw sizes than M5 x 12 and don't forget to put the spring lock washers between

Put the Display into the recess as displayed. The RAM mount arm and suction cup must be orientated to the left.
6. The Battery Pack (item 10) is placed into the upper middle place holder as displayed.
7. Take all cables and put it into the big space to the left as displayed. The Vehicle Charger (item 11) and the Charger for single Quick Mount Unit (item 12) can be placed into the middle of the cables.
8. Then put the QM1319 CAS 10 Visitor Unit Travel Adapter (item 13) on the upper place as displayed.
9. The manual (A5 format, item 14) must be placed into the foreseen holder (14)

10. Close the Suitcase.

8 System Installation

8.1 General Rules and Best Practices

Please check on the following conditions before beginning any work. Differing installations will void the warranty of Hexagon MineProtect systems:

- **Installations may only be carried out by trained electricians.**
- **Only antennas supplied by Hexagon may be used.**

Unless certified, installation and operation of HxGN MineProtect systems must be on the basis of non-interference with existing equipment. When certified, installation and operation must be done according to certification procedures in order to comply with official regulations and requirements.

Never connect Hexagon equipment to critical vehicle signal lines without prior consultation and approval of the vehicle manufacturer and Hexagon's approval.

Connecting the reverse signal to the CAS unit is compulsory in all vehicles that provide such signal. But rather than connecting to critical signal lines use the connection to noncritical signals such as reverse light, reverse buzzer and similar.

After installation, an appropriate entry should be made in the vehicle's technical logs including QC1000 serial number and the installed firmware version. A check should be performed in order reinsure the installation's quality and its accordance with the requirements.

8.1.1 Installation

- The selected installation spot **must** be dry and reasonably free from dust.
- Install all components so that it does not interfere with any of the vehicles operations.
- Installation must comply with Radio Interference requirements as per par. 8.1.2
- A good installation spot provides enough space for the cables and their connectors.
- The mount surface should be flat in order to avoid mechanical stresses on the housing of the QC1000
- The power cable **needs** to be connected directly to the battery contacts, bypassing the ignition and the isolation switch. This is to ensure the CAS system keeps working even when the vehicle is switched off or being serviced**.**
- Fuses are **required** in the power connection for **both** power and ground according to system diagrams.
- **Do not bend any cable** further than its minimum bending radius.
- Cables need to be long enough to avoid tension. If the installed cable is under tension, relocate the units or reroute the cable. If neither is possible replace the cable by a longer one or use extension cables.
- Install the cables in a way (cable ties) allowing easy service and removal. Do not route them over or under access doors or removable plates

8.1.2 Radio Interference

Any other RF transmitters on the vehicle (for example: Wi-Fi/LTE antennas or other) must be placed at least 1 meter away from the QC1000 Smart Antenna.

Transmitters operating in the following frequency bands

- 860 – 880 MHz
- 890 – 940 MHz
- or any with Tx-Power higher than 10W

within 1 km of an operating QC1000 must be checked against potential radio interference. Please submit the following properties to Hexagon Technical Support: frequency, band width, Tx Power, Duty Cycle, antenna gain.

Any metallic objects above QC1000 installation plate shall have a distance of at least 1 meter.

8.1.3 Connection to Battery

pending

8.2 Light Vehicles

8.2.1 System Diagram

8.3 Visitor Unit

8.3.1 System Diagram

8.4 Haul Trucks

8.4.1 System Diagram

8.4.2 QC1000 Location

It is not always possible to position the QC1000 on the topmost location. On haul trucks the bucket might be covering the entire structure of the vehicle and thus making the installation of an QC1000 on the top rather impractical. In this case Hexagon recommends using a pole on which the QC1000 can be mounted. The best position for QC1000 is one of the front corners. If the vehicles transit on the right side of the road than the left corner is most appropriate and vice versa. The pictures below show different configurations for pole sizes and positions.

The QC1000 positions in the above drawings are to be avoided:

Commercial in Confidence © Hexagon AB
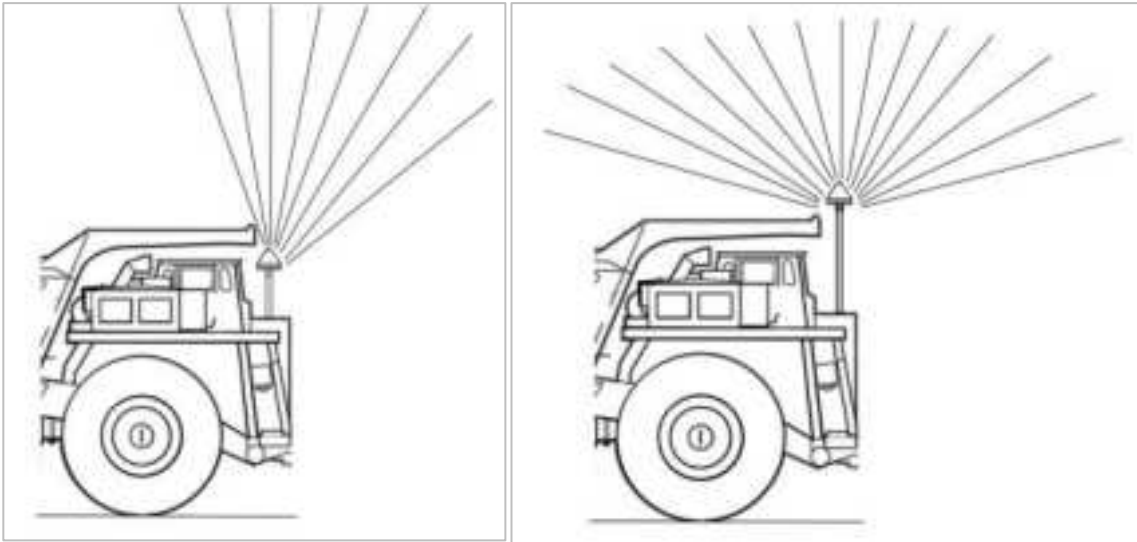
- *THE LEFT PICTURE SHOWS AN ANTENNA DIRECTLY UNDER THE CANOPY. THE ANTENNA'S RECEPTION IS VERY BAD.*
- *IN THE RIGHT PICTURE THE ANTENNA IS POSITIONED LOWER BUT STILL HAS BAD RECEPTION DUE TO BEING UNDER THE CANOPY.*

QC1000 positions in the above drawings improve from left to right:

- *THE THIRD PICTURE SHOWS AN ACCEPTABLE POSITION. THE ANTENNA IS NOT COVERED BY THE CANOPY AND IS AT LEAST 1M FROM ANY METAL STRUCTURE SUCH AS THE CANOPY, THE HANDRAIL OR THE CABIN PLATFORM.*
- *THE FOURTH PICTURE ON THE RIGHT EXTREME SHOWS THE ANTENNA'S RECOMMENDED IDEAL POSITION.*
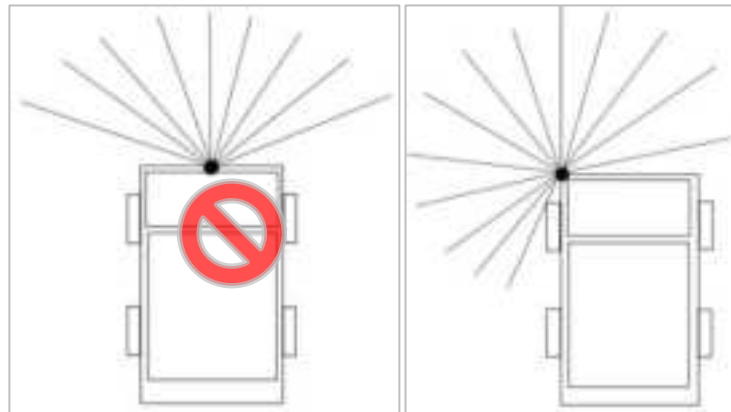
Antenna position with regard to the vehicle body in the top views:

- *THE LEFT PICTURE SHOWS HOW THE CANOPY SHIELDS A CONSIDERABLE PART OF THE GPS AND RF.*
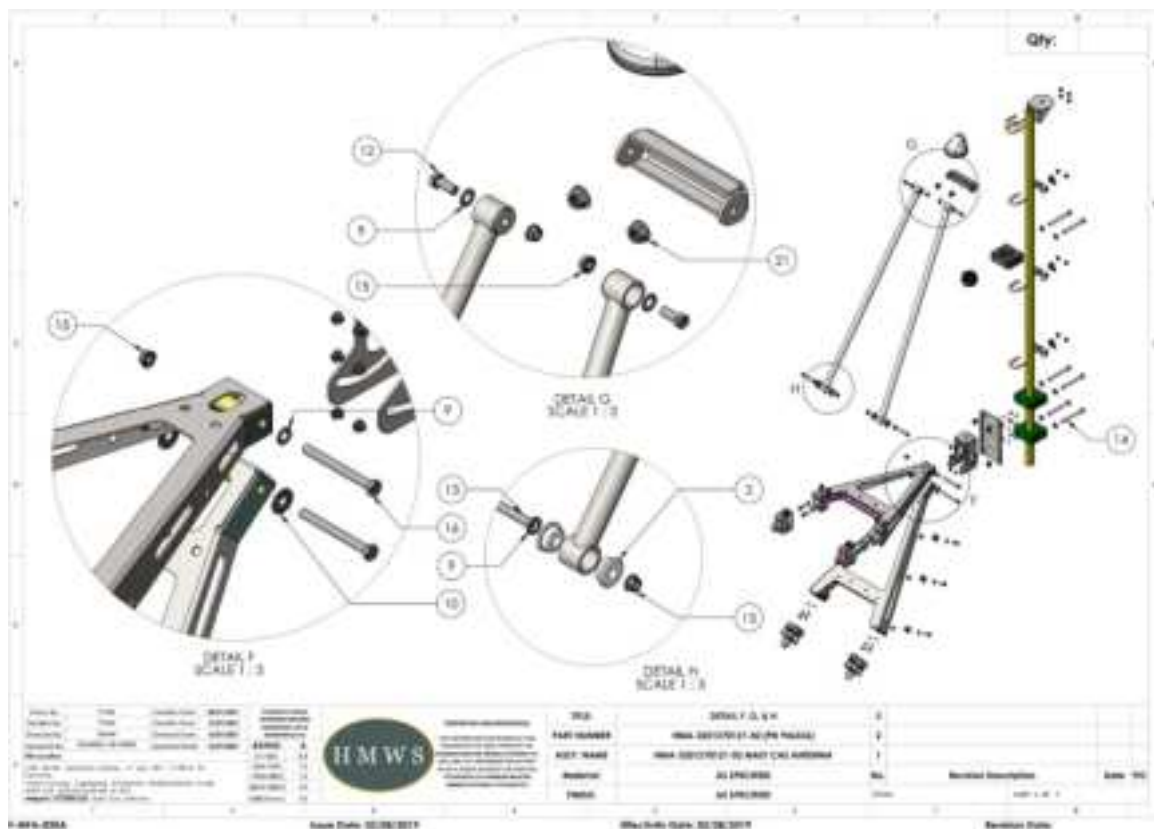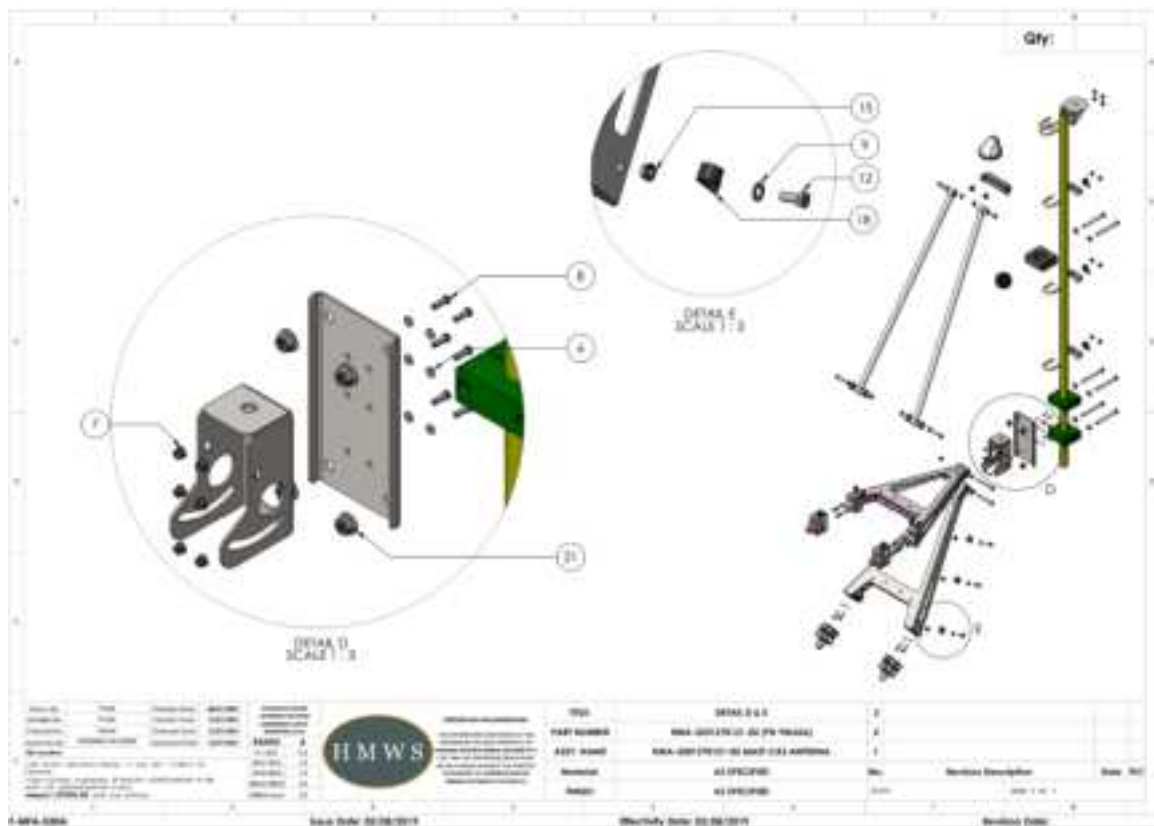- *THIS IS WHY THE RIGHT PICTURE IS HEXAGON'S RECOMMENDED POSITION.*
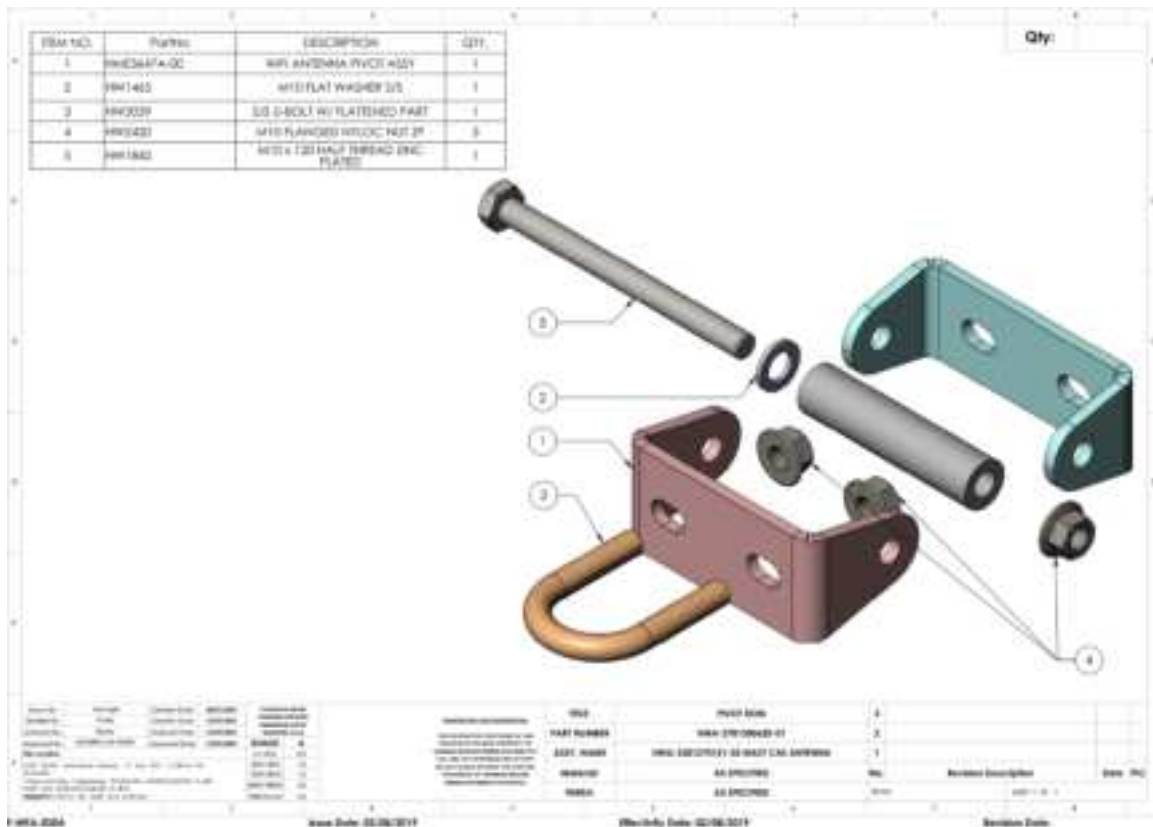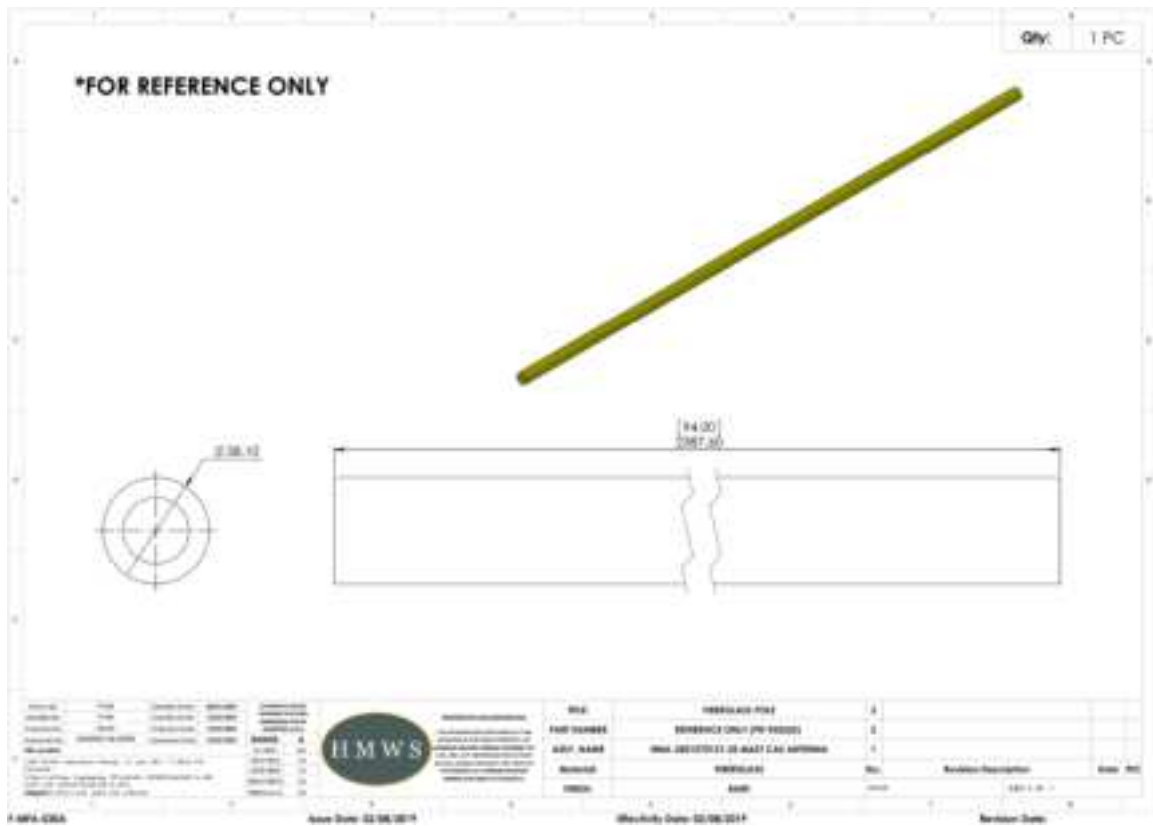
8.4.3 QN1980 Mast Assembly

Ensure correct assembly of mast following the schematics:

*FOR REFERENCE ONLY

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8.5   Other Heavy Vehicles

In this category fall heavy vehicles that do not require a mast installation as there is no obstruction by a canopy as in a haul truck. Typically, this applies to dozers, graders, wheel loaders etc.

8.5.1.1 System Diagram
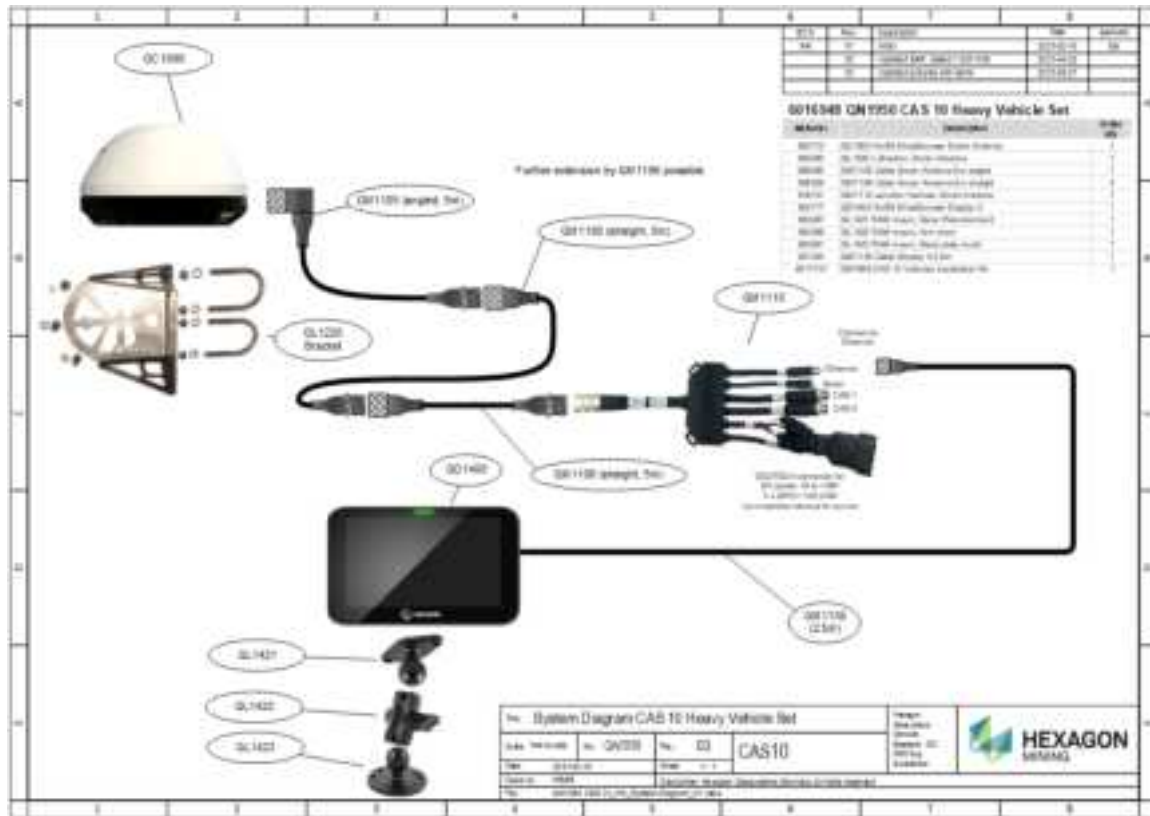
8.5.2   Tracked Vehicles

On tracked vehicles, the antenna must be mounted as close as possible to the axis of rotation.

8.6   Fixed Assets

This is the set typically installed on fixed assets which are intended to make visible on the CAS 10 systems in vehicles. This set contains the Smart Antenna plus bracket and cable. It does not contain a display and requires external power supply.

Ensure connectivity to server also for these units, as configuration and firmware updates are required in the same manner as for all other sets.
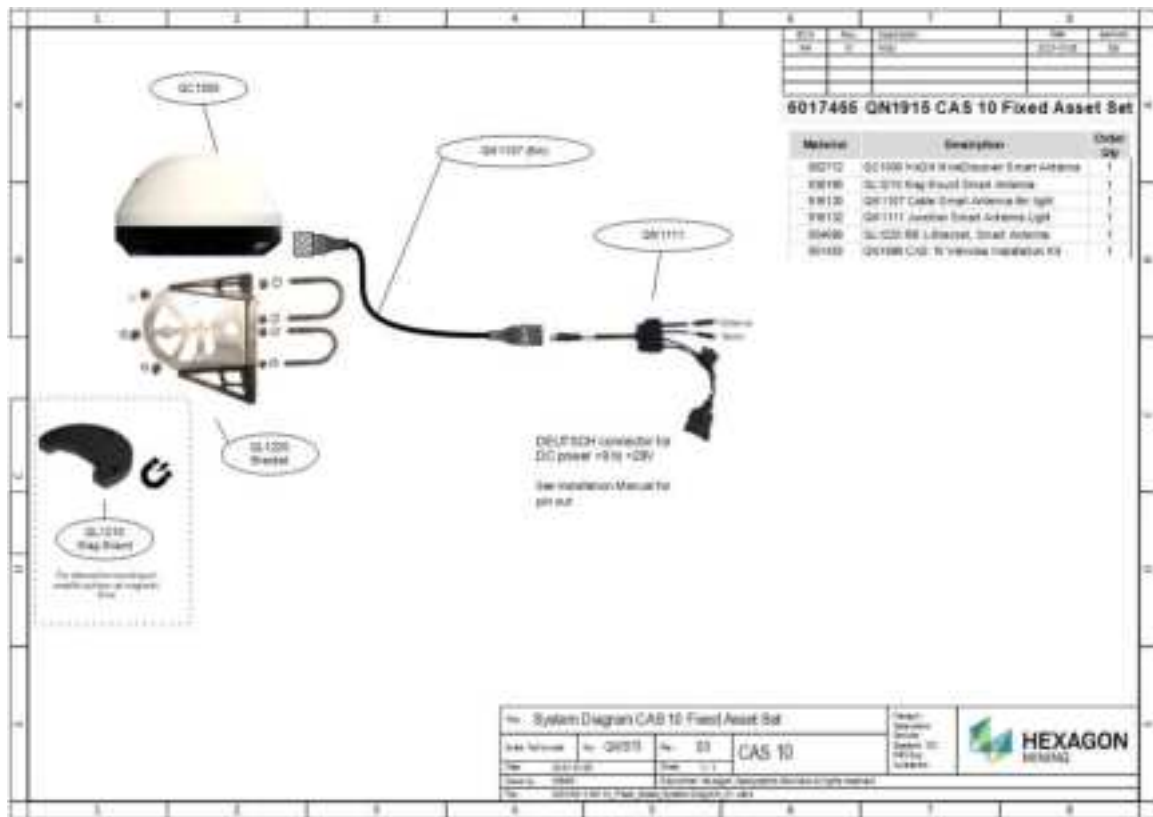
8.7 Shovels and Excavators

Some vehicles can turn or rotate and hence change their heading without any forward or backward movement, such as shovels and excavators. In such cases, it is recommended that a second QC1000 unit (called beacon) is added so that the direction of movement of the vehicle is always defined.

8.7.1 Rotating Vehicle with Single Antenna

Vehicles with unknown heading (e.g. non-moving, tracked, rotating vehicles) are calculated as circular objects. No threat headings will be displayed to the operator of such vehicles

A typical example of unknown heading vehicle where a second antenna can't be installed is a small dozer. For such vehicles the reverse gear must be connected to Hexagon device. This will significantly improve the heading accuracy.

8.7.2 Rotating Vehicle with Dual Antenna (Shovel)

8.7.2.1 System Diagram
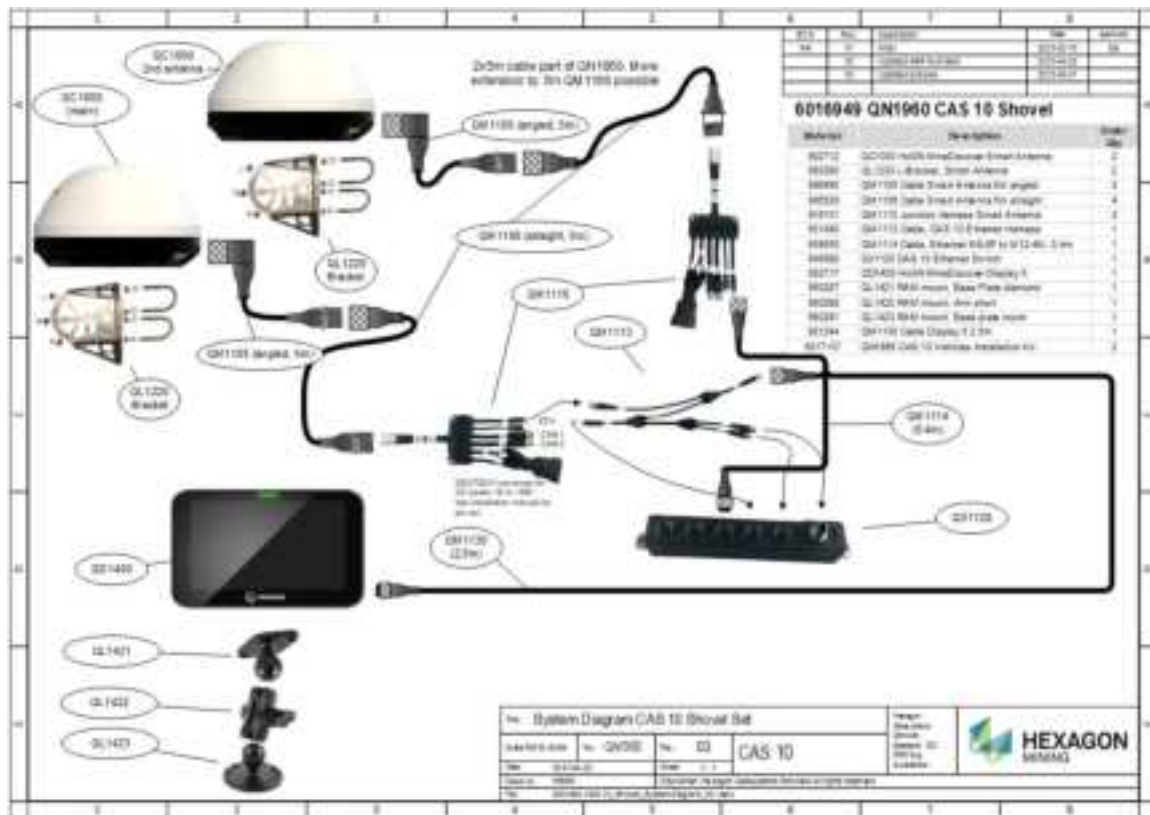
The QC1000 should be installed in the corner of the vehicle, the second QC1000, referred to as a beacon antenna, should be installed in the opposite corner.

It is necessary to have both antennas as far away as possible but at a minimum of 5 meters.

Beacon Antenna

For vehicles that operate in regions of the mine where more than 30% of the view of the sky is obstructed, this distance between main and beacon QC1000 shall be increased to 15 meters.

It is essential that both antennas are not obstructed by any part of the vehicle and have a 360° view of the horizon (except for terrain obfuscation).

Limitation

The center of rotation is assumed to be in the middle of the vehicle for the rotation prediction. If there is a significant difference between the true axis of rotation and the center a slight positional error will result.

8.8   Pre-Configuration

After mechanical installation and correct cabling, QC1000 must be pre-configured to connect to the MPData Server. Once this pre-configuration is correctly done, QC1000 can be updated remotely via the server and network.

9   Boot-up Process

After connection of components and power up, the boot up process starts automatically.

1. QC1000 LED turns green, goes into green blink every 10s

    Power up process of QC1000 can take up to 90 seconds until all network capabilities are up and running.

2. In parallel, the QD1400 boots up

    a. Splash Screen with progress bar advancing

    b. Operator ID login (for testing purposes: type in any number)

    c. Traffic Awareness Screen

        i. Will show a connection error until QC1000 is booted up completely

        ii. When error disappears, system is ready to go

10 Troubleshooting

10.1 Error Codes on Display 5

Example: Error – Connection lost – Code: 100

Error Code	Title	Description
80	Error No GNSS Signal	Insufficient GNSS fix. No position of own vehicle can be determined in sufficient quality for Collision Avoidance and Traffic Awareness. Error should resolve when driving to area with open sky view.
100	Error Connection Lost	No connection between QD1400 and QC1000 could be established. When both QC1000 and QD1400 are powered up at the same time, QD1400 takes about 30-40 seconds to start up. It then waits for the QC1000 to start up and initialize the connection. This takes another 50-90s during which the Error Code 100 is shown. This is expected behaviour. If error is shown outside start-up or if persists, check correct connection of cables and power cycle whole system. Else, check network configurations in Configuration Register, in particular DHCP configuration. If error persists, please report to Hexagon.
101	Error Connection Lost	Special error: QC1000 did not send or QD1400 did not receive opponent vehicle list for more than 1 second. Error should resolve quickly. If it persists, please report to Hexagon.

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Appendix E: Legal statement

WARNING OF PERSONAL INJURY

As with all traffic awareness, collision avoidance and personal alert devices, Hexagon Mining products may not detect all threats within the detection window. Hexagon Mining products are intended as an additional tool in determining potential traffic threats, supporting an alert and conscientious driver. Hexagon Mining products are not designed as a substitute for proper safe driving and visual traffic scanning procedures; a vigilant effective lookout is required at all times. Hexagon Mining products only warn the operator of the presence of other vehicles and personnel that are also fitted with Hexagon Mining products or warn of obstacles that are stored in the internal database. Hexagon Mining products do not substituted for an experienced and alert operator. The operator of the vehicle remains fully responsible for operating the vehicle and ensuring the safety of passengers, pedestrians and other traffic. Never use Hexagon Mining products for applications other than their intended and authorized use. Before installing, handling, using or servicing Hexagon Mining products, consult the data sheet, manuals and application notes and make yourself thoroughly familiar with the operations and limitations. Failure to comply with these instructions could result in serious injury or death.

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11 Glossary

Term	Definition
AP	Access Point
CAS	Collision Avoidance System
FMS	Fleet Management System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HP	High Precision
IP	Internet Protocol
LP	Low Precision
MAC	Media Access Control
RTK	Real Time Kinematic
SOPs	Standard Operating Procedures

About Hexagon Mining

Hexagon is a global leader in sensor, software and autonomous solutions. We are putting data to work to boost efficiency, productivity, and quality across industrial, manufacturing, infrastructure, safety, and mobility applications.

Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous — ensuring a scalable, sustainable future.

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