INSTALLATION AND MAINTENANCE GUIDE

for

SAFEmine COLLISION AVOIDANCE SYSTEMS

Firmware Version 2.61
SMTool version 2.0.7

July 31-, 2014

Topic:	This document is the reference manual for the installation, configuration and operation of SAFEmine units and tools.		
Document Nr:	PRO_CAS_QC2_130207		
Date:	May 23, 2016		
Disclaimer	This document and the use of any information contained therein, is subject to the acceptance of the SAFEmine terms and conditions. They can be downloaded from www.SAFE-mine.com SAFEmine makes no warranties based on the accuracy or completeness of the contents of this document and reserves the right to make changes to specifications and product descriptions at any time without notice. SAFEmine reserves all rights to this document and the information contained herein. Reproduction, use or disclosure to third parties without express permission is strictly prohibited. Copyright © 2012, SAFEmine. SAFEmine ® is a registered trademark		

Version Control

Version	Modifications
PRO_CAS_QC2_101010 August 29th 2011	• Original document
PRO_CAS_QC2_130207	• Removed Appendix: Troubleshooting guide. Created a separate document • Added : the main unit enclosure and the metal shrouds of all connectors need to be electrically isolated from the vehicle • Added 'To assist during installation the 'Mode' LED will turn Red to indicate that the digital output has gone high' to Test Station and Boom gate chapters • SMTool manual was removed. A separate document was added • All features and changes introduced by FW 2.61 were added • Added QC250 specifications (no Wifi configuration)

SECTION A Introduction

1 SAFEmine device presentation

1.1 Objective

The main task for SAFEmine QC250 series products is to support the operator while he scans the space ahead and around the vehicle with his own eyes, cameras and other aids. SAFEmine products are simple to use and are designed not to distract the operator from operating the vehicle.

1.2 Technology

The SAFEmine system – based on technology widely used in aviation – consists of a main unit, an operator's interface (both output and input) and a dual antenna (one for GPS, one for radio communication). Depending on the product selected, the operator's interface is either integrated into the main unit or mounted as a separate display unit. The main unit contains all main sensors (GPS engine, radio transceiver, micro-controller, memory, data interfaces and a series of sensors), The operator interface provides both a directional display of nearby traffic and danger, the beeper/loudspeaker for acoustical warnings and one button for input.

SAFEmine QC250 series products receive position and movement information from an internal high-sensitivity 50 channel GPS receiver with an external antenna. Additional sensors and logic further enhance the accuracy of position measurements. The predicted driving path of the vehicle, in which a SAFEmine QC250 series product is installed, is calculated by the main unit 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 SAFEmine QC250 series products. 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. At the same time, SAFEmine QC250 series products optionally compare the predicted driving path with known static obstacle data, e.g. electric power lines.

If a SAFEmine QC250 series product determines the risk of dangerous proximity to another vehicle or to an obstacle equipped with a SAFEmine QC250 series product, the unit gives the operator a warning of the greatest danger at that moment. This warning is given by a buzzing sound (beep) and bright light emitting diodes (LED). The display also gives indication of the threat level, plus the horizontal bearing to the threat.

The operating range is very dependent upon the antenna installation in or outside the vehicle. The normal range is about 500m for line-of-sight operations, but up to 2 km may be achieved in individual cases.

For their radio communication, SAFEmine QC250 series products use a proprietary patent- and copyright-protected protocol. Any non-licensed use, dissemination, copying, implementation or reverse engineering of the SAFEmine QC250 series radio communication protocol, their hardware and software or parts of it is forbidden by law and will be prosecuted. SAFEmine is a registered trademark and may not be used without license.

1.3 Limitations

SAFEmine is **not** designed for use

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

SAFEmine units are only to be used with other SAFEmine units, otherwise inconsistent function may occur. SAFEmine Ltd. cannot assume any liability from correct or incorrect use

of above specified products other than regular warranty according to SAFEmine Ltd. General Terms and Conditions.

2 Safety

2.1 Operating precautions

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 SAFEmine QC250 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 Operating Manual and the Installation Manual.

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

The SAFEmine System will provide no warning for some hazards, such as vehicles, obstacles, and other objects not equipped with properly operating SAFEmine devices.

SAFEmine products are intended as an additional tool in determining potential traffic threats, supporting an alert and conscientious driver. SAFEmine 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.

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

SAFEmine products may not be used in the USA and Canada unless the operator or customer has been authorized to do so in writing by SAFEmine Ltd.

Customers agree to indemnify and hold harmless SAFEmine Ltd., 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 SAFEmine Ltd. with respect to any of the SAFEmine products.

2.2 Installation precautions

All work done to install the SAFEmine Collision Avoidance System shall be done in accordance with safe work standards and shall comply with the latest Health, Safety, and Reclamation Code for mines in the local jurisdiction.

SECTION B Hardware and Installation

3 Hardware

3.1 Main units

3.1.1 **Main unit overview**

The main unit houses the GPS receiver, radio transceiver, processor, interface logic and additional sensors. The housing is made of aluminum with plastic end-bezels. All connectors are on the backside of the unit.

	QC250 WiFi integrated for AVL / IVMS
CAS	•
Integrated display	
Digital IO	6
Analog Input	2
GSM tracking	
WiFi tracking	•
Comment	

The QC250 model has an WiFi connector and has no integrated display. The QC250 model supports Vehicle tracking via WiFi.

In addition to the vehicle's position, the following status information can be tracked and or recorded:

- Vehicle-ID, Serial number, Firmware version and Build number (sent once after system reset)
- Supply Voltage
- Digital inputs (e.g. seatbelt, handbrake, idling)
- Analog inputs (e.g. connected to fuel gauge)

The digital IOs of the device can be used to monitor and record vehicle parameters such as: door open, seatbelt clicked, handbrake set, etc.

Another use of this functionality is the switching of cameras based on movement direction or surrounding vehicles and obstacles.

Please contact SAFEmine if you plan to use this option.

The QC250 have two analog inputs. They can be used to monitor fuel gauges, tire gauges or other analog data.

3.2 GPS & RF Antenna

The antenna provided by SAFEmine is a customized GPS and RF combined antenna especially designed for harsh environments like mines.

The antenna must be professionally installed by trained personnel only and only the antenna supplied with the equipment by SAFEmine may be used!

3.2.1 **Through Hole Mount Antenna (QF036)**

The screw mount antenna comes with 10/15cm of cable.

The advantage of using short cables on the antenna and then connecting and running extension cables is that in case of damage to either the antenna or the cables the defective part can be replaced separately. Furthermore, testing of the cable and antenna independently is possible with an SWR meter (Contact SAFEmine for SWR recommendations). The Through Hole Mount Antenna is ideal for cars with high vibrations (Haul Trucks) where the antenna and cable must be attached firmly.

Through Hole Mount Antenna (QF036) ***Magnetic Mount Antenna (QF037)***

3.2.2 **Magnetic Mount Antenna (QF037)**

The magnetic mount antenna comes with 3.5m of cable for GPS & RF & WIFI. It can be magnetically attached to any roof top. It allows an easy installation. It is ideal for light vehicles or other vehicles with little vibration.

3.3 Technical specifications and interfaces

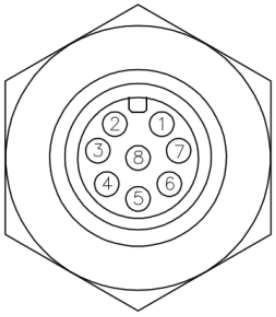
3.3.1 **QC250 main unit specifications**

See Appendix B : Specifications (QC250)

3.3.2 **Main unit interfaces and connectors**

3.3.2.1 Power / Interface connector (All devices)

The connector is type M12 male, with 8 contacts.



QC250

This interface is connected to the vehicle or add-on modules.

Power / Interface connector (All devices)		**QC250**	**Cable color**
Pin function	**Pin type**	**Pin #**	
Ground	Power	2	brown
Power (+9 to +28VDC) overvoltage and polarity protected	Power in	1	white
Digital I/O (IO1 in chapter 3.4 I/O Connections)	Input / Output	7	blue
Audio (voice) out (may be left NC)	Output	8	red
RS485 (may be left NC) for GPS augmentation input, Modbus for IO modules Allows interfacing to a wide range of commercially available input / output modules, such as switches to control cameras on haul trucks	Input (RX) Output (TX)	- -	grey pink
RS 232 (data to display and for updates) Firmware can be updated through this interface.	Input (RX) Output (TX)	5 6	grey pink
CAN listener (may be left NC) (typically J1939, ISO 11898)	IO H L	3 4	green yellow

3.3.2.2 GPS antenna connector

SAFEmine devices use a 50 channel GPS L1 receiver with SBAS (WAAS, EGNOS) capability, integrated RAIM (Receiver Autonomous Integrity Monitoring) and active multipath detection and elimination algorithms. The receiver is GALILEO ready.

The connector is a SMA female for 3.3V active GPS antenna.

Only antennas supplied by SAFEmine may be used.

3.3.2.3 RF antenna connector

SAFEmine devices use an RF transceiver with typically less than 1% Duty Cycle, Peak Pulse Power below 15 mW (ERP).

The license free ISM / SRD bands are software selectable depending on country of use

- Europe, Africa: 868.2 and 868.4 MHz, others
- Australia: 921MHz
- North America: Frequency hopping around 920MHz
- South America: Frequency hopping around 920 to 951MHz
- Asia: various

The country of Origin is Switzerland (Harmonized System Customs Code 852610). The connector for the RF transceiver is a SMA female for 50 Ohm RF antenna

Only antennas supplied by SAFEmine may be used.

3.3.2.4 Wifi antenna connector (QC250)

The QC250 SAFEmine devices include a self-contained WLAN module. The module is a complete IEE 802.11 b/g/n based wireless device.

The module supports WPA2-PSK, WEP (64 and 128 bit) TKIP security.

The connector is a SMA Reverse Polarity female.

Only antennas supplied by SAFEmine may be used.

3.3.3 GPS/RF Antenna Specifications

Parameter	QF036	QF037
Mounting type	Through Hole	Magnetic
Weight	480g	620g
Dimensions	ø107 x 91 mm	
Power Supply	from main unit	
Connector	3 * SMA	
Operating temperature	-40°C to +85°C	
Storage temperature	-40°C to +85°C	
Protection rating	IP 67	
Cable	3 * 20cm, coaxial	3 * 3.5m, coaxial
WIFI gain	5 dBi	5 dBi
RF gain	3 dBi	3 dBi

3.4 I/O Connections

3.4.1 **Hardware capabilities**

SAFEmine devices all have extended GPIO (General purpose Input/Output) functionalities.

An IO is available on pin 7 of the Power/Interface connector. It is the blue wire on the Power Connector (see pictures below).

Power connector on QC250

On the QC250s up to 7 additional IOs can be configured as Input/Output. 7 are available on the I/O connector (see picture below). The I/O connector is type M12 male, with 8 contacts.

I/O connector on QC250

The I/O connector can be used to monitor vehicle statuses such as seatbelt, emergency break, and voltages like the fuel gauge.

The following table lists the GPIO capabilities of each device type.

Name	Connector	Pin #
IO0	n/a	n/a
IO1	Power	7
IO2	I/O	1
IO3	I/O	2
IO4	I/O	3
IO5	I/O	4
IO6	I/O	5
IO7	I/O	6
IO8	I/O	8

3.4.2 I/O Specifications

3.4.2.1 Digital inputs

A digital input transforms a voltage level into a logical “1” (or “on” state) or “0” (off state).

- SAFEmine interprets a voltage of less than 2.2 volts as logical 0,
- SAFEmine interprets a voltage of more than 8.7 volts as logical 1.
- Each digital input must be configured to incorporate either the 4.7kOhm pull-up or a pull-down resistor in the SAFEmine device:

Care must be taken to select the correct input configuration, depending on the characteristics of the vehicle! Wrong settings can influence or even incapacitate the vehicle! Always ensure that after installation the voltage levels are correct

3.4.2.2 Digital outputs

The digital output is designed to drive modest consumers, such as relays and lamps. Most units support source and sink driver configuration:

Digital Input / Output

- FW configurable as digital input
- FW configurable "High Side Switch" or “Low Side Switch”
- Maximum continuous load current: 0.4A
- Can switch capacitive, inductive and resistive loads
- On-state resistance: 350mOhm
- Short circuit protected
- ESD protection: 5kV

3.4.2.3 Analog Input

- Input voltage range: 0..24V
- Input Resistance: 300k Ohm

4 Installation and operation

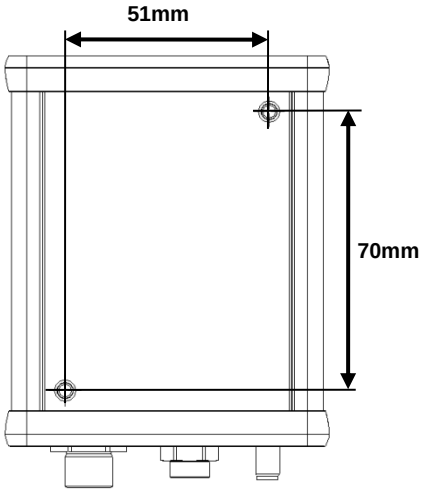
4.1 General advice

Unless certified, installation and operation must be on the basis of non-interference with and no hazard to the existing equipment installed for safe operation. When certified, installation and operation must be done according to certification procedures in order to comply with official regulations and requirements.

After installation, an appropriate entry should be made in the vehicle's technical logs and a check is to be made that the installation is in no way detrimental to the mechanical or electrical performance of other vehicle's systems (e.g. radio). The unit serial number and software version is to be recorded in the vehicle's technical log.

SAFEmine highly recommends establishing a "Radio Map", containing all intentional transmitters on the mine and their operating frequencies. This map will help to minimize radio interference.

4.2 Main unit



Main unit bottom view

4.2.1 General recommendations

The main unit must be secured in such a position that:

- The operator has the front panel display with the LEDs in direct view, can hear the acoustic warning tone and can operate the control button.
- The front panel display may not be obstructed at any time.
- It must not impede the operation of the vehicle (incl. emergency procedures) and in particular it must not reduce the operator's field of view.
- **The connectors at the back of the main unit must remain accessible to allow the upload of firmware and maintenance from a PC with an extension cable.**
- The connectors are tied with a spanner and can't be removed by hand.

4.2.2 Power supply

The power supply must be installed such that

- The voltage is above 9.6 V at all times. At voltages below 9V the operation of the SAFEmine unit is no longer guaranteed.
- **The main unit must be connected directly to battery power** to ensure continued operation in case of vehicle stopping or breakdown
- A 2A fuse must be installed near the vehicles battery on **both** power and ground.

If supply voltage is below 9.6V at startup, a 'low supply power' error is displayed and the device will not power up.

If voltages below 9.6V are observed at any time during operation, the 'Power' LED will turn red. If the voice option is enabled 'Error Power' is announced every 30 seconds on the voice output as long as there is sufficient voltage to do so.

A sealable fuse holder is highly recommended. Furthermore, the fuse should be secured with a cable tie to make any tampering obvious

4.3 Antennas

The external combined GPS & RF antenna supplied with the main unit must be connected.

- The main unit will not operate without the antennas.
- Follow the recommendations regarding antenna cables in chapter ‘4.4 Antenna cables’

The GPS/RF antennas must be mounted such that:

- **It is mounted on the highest point of the vehicle, with 360° unobstructed view of the sky** and at least 100cm away from any other transmitting antenna.
- The position of the antenna is the same for all the vehicles of the same model. As an example all the Toyota Hilux Single Cabs must have the antenna at the same position.
- The antennas are connected to the correct inputs.
- **On tracked type vehicles, the antenna must be mounted as close as possible to the axis of rotation**, unless the two-antenna (SAFEmine devices) setup is used.
- On haul trucks it may not be possible to install the antenna at the height of the bucket. In such a case place the antenna in one of the front corners of the vehicle i.e not in the center front.

Other information regarding antenna installation

- Improper installation of the antenna and its cables is the prominent cause for malfunction.
- The antenna must be professionally installed by trained personal only.
- Only antennas supplied by SAFEmine may be attached to the antenna connectors!
- Mounting brackets for various vehicles (Haul Trucks etc.) are available from your local SAFEmine distributor.
- Snow and ice buildup reduce the performance of the antenna and must be removed prior to operation**.**

4.3.1 **Through Hole Mount QF036**

The screw mount antenna comes with 10/15cm of cable.

To mount the antenna:

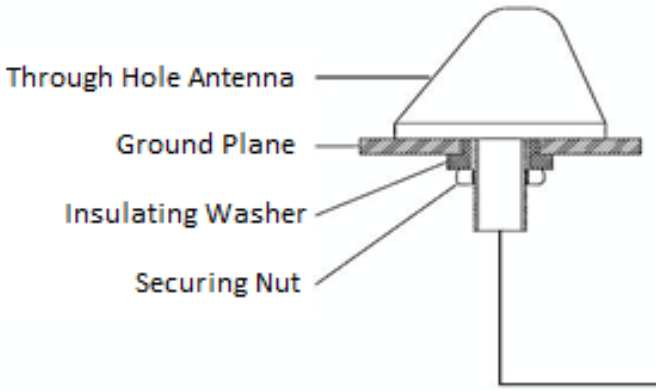
- The antenna must be mounted on a horizontal metal surface of diameter 1-2cm larger than the diameter of the antenna. For smaller vehicles the diameter can be larger.
- A hole must be drilled or punched into the surface. The diameter of the hole must be at least 22mm (0.866") for the antenna and the compulsory insulating washer. (Without the washer at least 19mm (3/4"))
- The surface should also not be thicker than 12mm (1/2")
- In order to secure the antenna mounting it is necessary to have access to the underside of the hole.

To attach the antenna:

- After removing the nut feed the cables through the hole seat the antenna on the surface
- Add the insulating washer
- Attach the nut. The nut should be tight (Torque: 5 ft-lb, ~6.8 nm) in order to properly seal the gasket. Tighten the nut with a wrench.
- Finally, feed the cables to the receiver thru additional jumper cables.

The mounting screw of the antenna must be isolated from the vehicle to avoid ground loops. Suitable insulating washers are available from SAFEmine.

The attached gasket provides a sealant to prevent moisture from entering.



Vertical cut of a QF036 after installation

4.3.2 **Magnetic Mount QF037**

The magnetic mount antenna comes with 3.5m of cables, both GPS & RF. It can be quickly mounted on vehicles such as light vehicles. For vehicles with a lot of vibration like Haul Trucks it is recommended to use the through hole mount antenna.

The GPS/RF antenna (QF037) must be mounted such that**:**

- The antenna should not have any electrically conducting surfaces (e.g. metal, carbon fiber) above or immediately alongside.
- If the roof is made out of non-metallic material, a ground plane of minimum 18cm diameter must be mounted underneath the antenna.

4.3.3 **Wifi Antenna (QC250 only)**

The Wifi antenna length must not exceed 5 meters. For further information contact SAFEmine.

4.4 Antenna cables

The choice of antenna cables and installers must be done carefully. SAFEmine recommends to source cables with SMA connectors already installed:

- **It is recommended to source cables from a professional local supplier.**
- Any work on radio RF cabling must be done professionally by trained personnel according to SAFEmine specifications.
- Coaxial low loss cables as well as connectors of proper length and high quality must be used.
- Respect the maximum cable length (see below)

The RF and GPS cables must follow the following rules:

- The maximum acceptable attenuation rate for the RF cable is 3dB at 900MHz at 10 meters.
- Inner conductor must be solid core

Below is the typical maximum cable length between antenna and main unit per cable type recommended by SAFEmine.

These values are indications and vary between manufacturers. **Please see the datasheet and send it to SAFEmine prior to the installation.**

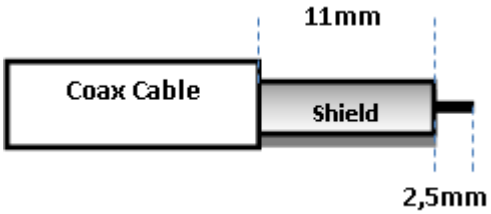
Use of other coaxial cable types must be approved in writing by SAFEmine!

Coaxial cable type	Max. length RF	Max. length GPS
RG174 / RG58	Do not use	5m
HDF-195/CFD-195 LMR -195/ RF 195 LMR-200	8m	15m
LMR 400	15m	15m

To calculate the attenuation rate, sum up the attenuation of all segments as specified by the cable manufacturer. Add 0.3dB for any connection

If the SMA connectors need to be attached, strictly follow the recommendations of the manufacturer as well as the following rules:

- Use 3 blade coax strippers (no knife)
- Adjust the coax stripper blades as recommended by the SMA connector manufacturer. See below for an example :



- Always solder the center pin (or crimp when not possible)
- Only use appropriate crimping tool
- Protect the connection with insulating tape.

Contact SAFEmine with the datasheets of the cables and SMA connectors prior to installation

SECTION C Software and Programming

The SAFEmine devices are controlled by a configurable firmware. The firmware as well as its configuration will be explained in the following chapters.

Configuration is not only compulsory for the firmware to run but it will also allow the best usage of the device. The SAFEmine device **needs** a unique configuration file created and/or modified by the installer.

Please contact SAFEmine for any question relative to configuration files.

The following chapters will present

- The software and its features
- How to configure the software and the special features

Vehicles requiring special configurations as well as additional functionalities of the device are also presented.

5 SAFEmine programming tool (SMTool)

5.1 Installation

For the installation and configuration of the Collision Avoidance System firmware the following is needed:

Hardware:

1) PC or Laptop running Windows 2000 or later.
2) M8 to USB Cable (QL019)

   or M8 to serial port cable (QL014) and RS232 to USB converter if PC has no serial port.

   (A QM109 Y cable must be added for QC250)
3) Power Supply or Battery (12 or 24 volts)

Software:

4) SMTool (SAFEmine Software Utility)
5) Microsoft Office
6) Latest Firmware
7) Configuration File generated by a vehicle register
8) USB Driver (if USB port used).
9) Net 3.0 or higher

Notes:

- All necessary programs and files referred to above can be obtained on-line through www.safe-mine.com/support/partners. Enter your user name and password and then select the corresponding directory. Contact SAFEmine if you don't have a username and password.
- The SMTool guide (SMTool 2.0User_Manual(PRO_SMT_120601).pdf) is available upon request or on www.safe-mine.com/support/partners.

5.2 Firmware and Configuration File upload

Both the firmware and configuration file need to be uploaded to the SAFEmine device for the system to function properly**.**

Firmware is periodically updated by SAFEmine. Many features and improvements are available by uploading the latest released version. As a helpful feature, the firmware version is displayed during start-up. Three green LEDs are lit sequentially for one second, according to the firmware revision ("2", "6", "1"), where "2" is 2 o'clock, and numbers increment clockwise.

6 Configuration parameter specifications

6.1 Site specific parameters:

Site specific parameters must be set on all units

6.1.1 Radio Channel

Keyword	Description	Unit	Range	Default	Example
CHANNEL	RF Radio Channel	-	117 - 381	-	117

Sets the frequency of the radio transmission
117: for Europe / Africa
287: North / South America
301: North America countries under FCC regulation
122: New Zealand
381: Australia
357: Israel

6.1.2 Channel Hopping

Keyword	Description	Unit	Range	Default	Example
HOPPING	Number of channels to use for hopping	-	1 - 50	1	1

50: North America countries under FCC regulation
1: All other areas

6.1.3 Transmit Power

Keyword	Description	Unit	Range	Default	Example
RFPOWER	Transmit Power Setting.	-	0 - 3	3	3

Sets the transmit power of the radio. A setting of 3 results in maximum power and range of the radio
2: North America countries under FCC regulation (lower power setting required to comply with FCC)
3: All other areas

Keyword	Description	Unit	Range	Default	Example
WIFIPOWER	Transmit Power Setting.	-	0 - 2	2	2

Sets the transmit power of the wifi. A setting of 2 results in maximum power and range of the wifi
0: North America countries under FCC regulation (lower power setting required to comply with FCC)
2: All other areas

6.2 Vehicle parameters

6.2.1 Required vehicle parameters

Vehicle ID

Parameter	Description	Unit	Range	Default	Example
VEHID	Vehicle ID, e.g. mine plant number	-	max 6 char	-	LV007

Must be unique within the site

Vehicle Type

Parameter	Description	Unit	Range	Default	Example
VEHTYPE	Vehicle Type	-	10 - 100	-	31

Description	VEHTYPE value	Examples/ Remarks
Light Vehicle	10	Ford F150,F250
Small Tractor	11	
Haul Truck	21	Komatsu 730E,
Dump Truck	22	Caterpillar 789C
Water Tanker	23	CAT 777
ADT (Articulated Dump Truck)	31	Volvo A25E
Fuel Bowser	32	
Service Truck	33	Mitsubushi Canter; Volvo Fm12
Mobile Crane	34	Franna AT 20
Low Bed Truck	35	
Rear Tip Truck	36	
Excavator	41	CAT 385C
Shovel	42	Liebherr 3994, Bucyrus 495HR2
PC	43	Komatsu PC 4000
Dozer	44	Cat D9T
Dragline	45	
Drill	46	Atlas Copco PV271
Large Front End Loader	51	Le Tourneau L1850
Small Front End Loader	52	CAT 988H
Tyre Handler	53	
Cable Handler	54	
Grader	55	Cat 24H , Cart 16M
TLB, JCB	56	John Deere 110 TLB, (Back Hoe)
Large Tractor	57	CAT 992C
Train	61	
Stockpile Stacker	71	
Test Station	72	
Stockpile Dozer	73	
Lighting Plant	74	Alight 22KVa , Multiflo ??
Stockpile Reclaimer	75	
Boomgate	76	
Beacon	100	

Vehicle Dimensions

Parameter	Description	Unit	Range	Default	Example
VEHLENGTH	Vehicle length, overall	meter	0 - 655	10	12.8
VEHWIDTH	Vehicle width, overall	meter	0 - 655	4	3.4
VEHHEIGHT	Vehicle height, overall	meter	0 - 50	3	2.34

6.2.2 **Highly recommended vehicle parameters**

Vehicle Weight

Parameter	Description	Unit	Range	Default	Example
VEHWEIGHT	Maximum vehicle weight (with no load)	Ton	0 -1500	50	430

LED notification distances

Parameter	Description	Unit	Range	Default	Example
DISTFAR	Green LED indicates vehicle closer than distfar meters	meter	0 - 500	150	180
DISTNEAR	Steady Red LED indicates vehicle closer than disnear meters	meter	0 - 250	40	40
DISTCLOSE	Flashing Red LED indicates vehicle closer than disclose meters	meter	0 - 250	5	5

For best situation awareness it is recommended to keep the DISTFAR value larger than the maximum breaking distance of any vehicle in the mine, typically about 110m.

Additional safety distances

Parameter	Description	Unit	Range	Default	Example
SAFETYLENGTH	Extends the alarm region in percent of vehicle length.	% of length	0 - 100	10	20
SAFETYWIDTH	Extends the alarm region in percent of vehicle width.	% of width	1 - 100	10	0

Example: A vehicle with length 5m sets `SAFETYLENGTH = 30` thus will have an additional safety area of 1.5m ahead AND behind the vehicle.

6.2.3 **Optional vehicle parameters**

Parameter	Description	Unit	Range	Default	Example
VEHMANU	Vehicle Manufacturer	-	max. 31 characters	-	KOMATSU
VEHMOD	Manufacturers model name	-	max. 31 characters	-	785

Parameter	Description	Unit	Default	Example
MINTURNRAD	This value must be set to 1.	Meter	1	1
DRIVERAFT	Distance between front of vehicle and driver	Meter		1.5
DRIVERRIGHT	Distance between left side of vehicle and driver	Meter		1.5
DRIVERUP	Elevation of driver above ground	Meter		4
MAXSPEED	Maximum speed before alert.	Km/h	0 (disabled)	70

SECTION D Software maintenance

7 Advanced Troubleshooting

A complete troubleshooting guide (Troubleshooting_Guide(PRO_CAS_QC2_111025).pdf) is available upon request.

7.1 Error codes

The unit performs a self-test upon power up. Errors are indicated by all 4 status LEDs (left side of the display) glowing red, while the circular display shows the error code(s). More detailed error messages are sent to the serial port.

Debugging of error codes is best done with a PC running a terminal program (e.g. HTerm) connected to the serial port.

On first restart after updating a "non-fatal" error may be displayed for 30 seconds due to the additional configuration options (green flashing status lights and one green light on the compass display). Troubleshooting guide explains how to react to an error code.

Error code	LED #	Subsystem	Severity	Cause/Comment
01	1	Flash Memory	(Fatal)	Flash memory failure; non-fatal if operational, but data lost. Fatal if operation is not possible.
02	2	Serial	Fatal	Serial number invalid, contact support
03	2&1	Dataport error	Alert	Sending of Dataport Heartbeat message failed.
04	3	GPS receiver	Fatal	Unable to communicate with or configure GPS module
05	1 & 3	GPS Antenna	Fatal	GPS antenna defective or bad connection
08	4	Power	Fatal	Power supply defective or low/high voltage
16	5	User Interface	Fatal	No user interface connected.
32	6	Config	(Fatal)	Configuration file contains errors, or is not present.
64	7	Firmware	Fatal	Firmware corrupt, upload new firmware
128	8	Generic	Various	Generic error, currently not used
256	9	GPIO error	Fatal	GPIO configuration or hardware problem. See Terminal output for details.
4095	All	Unknown	Various	Not used.

Appendix A Declaration of conformity

SAFEmine Ltd., CH-6340 Baar, Switzerland, declares that in typical configuration the Hardware Version 1 meets the requirements of the CE Mark.

The radio conforms with the requirements of EN 300 220-3:2000 (Power Class 9). The EMC conforms with EN 301 489-3:2002-08 for a Class 3 SRD Device (equipment type I). It is a Class 1 item of radio equipment as defined by R&TTE Directive. The necessary tests and certification were undertaken by TRAC-KTL, Unit E, South Orbital Trading Park, Hedon Road, Hull, HU9 1NJ, UK.

These documents may be inspected at the premises of SAFEmine Ltd. by arrangement through: info@safe-mine.com

Schwyz, September 2008

CE

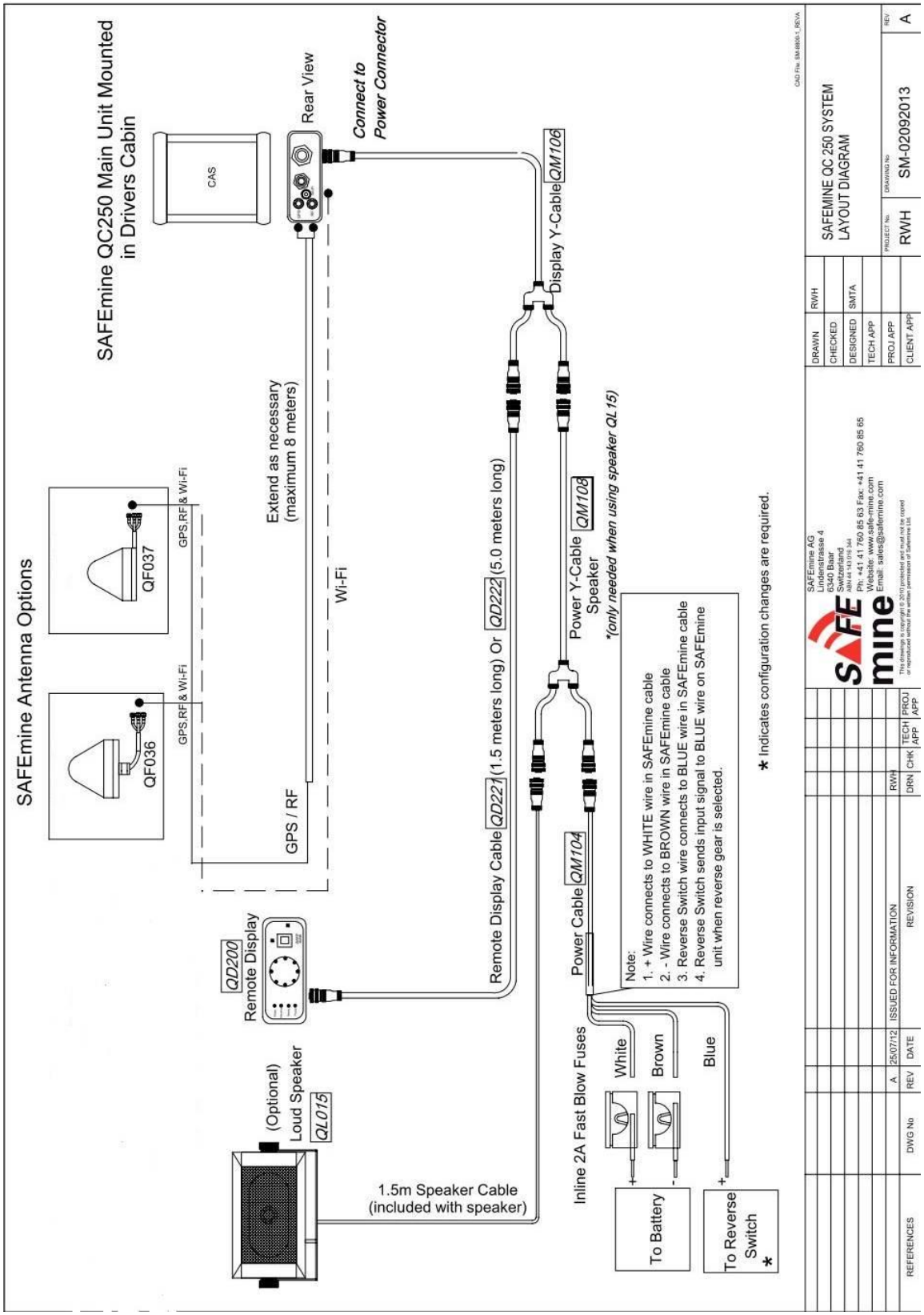
Appendix B Specifications (QC250)

Parameter	**Conditions**[1]	
Dimensions	excl. connectors	81 x 30 x 126 mm^3 (3.2 x 1.2 x 5.0 in^3)
Weight	excl cables	260 g (0.57lb)
Power Supply	Nominal	12 to 28 VDC
Power Consumption (@ 12 V)	typical	< 80 mA
	Max peak	< 150 mA
	Max standby	< 40 mA
Input/Output	Digital	3x, configurable
Input	Digital	2x, low < 2.2V, high > 8.7V
Input	Analog	2x, 0 to 24V
GPS		50 channel GPS L1, ISO/TS 16949 qualified, GALILEO ready
WiFi	Network standard	IEEE 802.11 b/g/n
	Frequency band	2.412 GHz – 2.484 GHz
	Security	802.11i (AES, TKIP, WPA, WPA 2)
	Typ. Transmit power	10 dBm (Europe) 7 dBm (North America)
	Sensitivity	-97dBm @ 1 Mbps to -71 dBm @ 65 Mbps
	Data rates	802.11n: 65 Mbps; OFDM: 6,9,12,18,24,36,48,54 Mbps
Traffic alert range	Typical	500m (1/3 mile)
Refresh Rate	Typical	4 Hz
Traffic alert range	Typical	500m
Operating temperature		-40°C to +60°C[2]
Humidity		95%, non condensing
Protection rating	IEC 60529	IP54

[1] All specification are at an ambient temperature of 25°C.

[2] SAFEmine devices are designed to run at 85°C. For operator safety reasons the device must not be run at temperatures above 60°C

Appendix C Additional figures and drawings



Typical installation

Appendix D Maintenance Checklist

To be performed before vehicle is released

Item			
Date checked			
Responsible			
Configuration technician			
SAFEmine serial number			
Firmware version loaded			
Configuration file loaded			
Vehicle Plant number			
		Initial	**Comment**
Check cables, abrasion, UV damage			
Visual inspection of housing for damage			
Firmware updated to latest version			
Buzzer (speaker if installed) unobstructed and working			
Ready LED green after <3 minutes (if vehicle is outside)			
Press button (> 5 seconds) for reset -> light, beep, self test			
Driven by test station			

Appendix E FCC compliance

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.

Per FCC Rules, changes or modifications not expressly approved by SAFEmine could void your authority to operate this equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.

—Increase the separation between the equipment and receiver.

—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

—Consult the dealer or an experienced radio/TV technician for help.

Appendix F RF radiation

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.

Appendix G IC compliance

Industry Canada Notice and Marking

This radio transmitter 9849A-QC250B has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.

Antennatype	**QF036**	**QF037**
Mounting type	Through Hole	Magnetic
Weight	480g	620g
Impedance	50 Ohm Nominal	
WIFI gain	5 dBi	
RF gain	3 dBi	
GPS gain	5 dBi	

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

This device complies with Industry Canada licence-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'Industrie 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'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Appendix H Legal statement

WARNING OF PERSONAL INJURY

As with all traffic awareness and collision avoidance devices, SAFEmine products may not detect all threats within the detection window. SAFEmine products are intended as an additional tool in determining potential traffic threats, supporting an alert and conscientious driver. SAFEmine 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. SAFEmine products only warn the operator of the presence of other vehicles that are also fitted with SAFEmine products or warn of obstacles that are stored in the internal database. SAFEmine products do not give any guidance on avoiding action. The operator of the vehicle remains fully responsible for operating the vehicle and ensuring the safety of passengers, pedestrians and other traffic. Never use SAFEmine products for applications other than their intended and authorized use. Never use SAFEmine products as emergency stop device or in any other application where failure of the products could result in personal injury. Before installing, handling, using or servicing SAFEmine 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.

LIMITED WARRANTY

EXCEPT FOR THE WARRANTIES EXPRESSLY SET FORTH HEREIN, SAFEMINE MAKES NO WARRANTIES, EITHER EXPRESS OR IMPLIED, WITH RESPECT TO THE PRODUCT. ANY AND ALL WARRANTIES, INCLUDING WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE EXPRESSLY EXCLUDED AND DECLINED. SAFEMINE is only liable for defects of this product arising under the conditions of operation provided for in the data sheet and proper use of the goods. SAFEMINE explicitly disclaims all warranties, express or implied, for any period during which the goods are operated or stored not in accordance with the data sheet. The warranty voids in the case of the following cases: any opening of the housing, inappropriate operations or installation (see the restrictions in the respective manuals) and intellectual property violations.

SAFEmine Ltd.’s entire liability and customer’s exclusive remedy for SAFEmine products that fail to conform to SAFEmine Ltd.’s limited warranty, shall be, at SAFEmine Ltd.’s sole option, either repair or replacement of the nonconforming products, or, if neither is practicable, a refund of the fees paid by customer to SAFEmine Ltd. for such products. The warranty for the repaired or replaced product is limited to the scope and remaining duration of the original warranty for the nonconforming product.

LIMITED LIABILITY

SAFEmine Ltd. does not accept any liability arising out of any application or use of any product or circuit and specifically disclaims any and all liability, including without limitation consequential or incidental damages. All operating parameters, including without limitation recommended parameters, must be validated for each customer’s applications by customer’s technical experts. Recommended parameters can and do vary in different applications. SAFEMINE LTD.’S LIABILITY TO CUSTOMER ARISING OUT OF OR RELATING TO ANY SAFEMINE PRODUCTS SHALL NOT EXCEED THE AGGREGATE AMOUNTS PAID BY CUSTOMER TO SAFEMINE FOR SUCH SAFEMINE PRODUCTS. IN NO EVENT WILL SAFEMINE LTD. BE LIABLE FOR LOST USE, PROFITS, REVENUE, COST OF PROCUREMENT OF SUBSTITUTE GOODS, OR ANY OTHER SPECIAL, INDIRECT, RELIANCE, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED AND UNDER ANY THEORY OF LIABILITY RELATING HERETO. Radio band frequency allocation and licensing conditions may vary from country to country. The operator is solely responsible for ensuring that SAFEmine products are operated in

conformity with the applicable telecommunication laws.
If the customers uses SAFEmine products for any unintended or unauthorized application, the customer shall defend, indemnify and hold harmless SAFEmine Ltd. and its officers, employees, subsidiaries, affiliates and distributors against all claims, costs, damages and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if SAFEmine Ltd. shall be allegedly negligent with respect to the design or the manufacture of the product.

INDEMNIFICATION
Customers agree to indemnify and hold harmless SAFEmine Ltd., 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, including without limitation, reasonable counsel fees, arising from or by reason of any actual or claimed damages, and/or injuries, or any litigation based thereon, which may be incurred by SAFEmine Ltd. with respect to any of the SAFEmine products covered by the order, including use, and such obligation shall survive acceptance of the SAFEmine products and payment therefore by the customer.

INFRINGEMENT
SAFEmine Ltd. does not warrant that products and its use will not infringe any patent, copyright or trademark. No specification shall constitute a warranty, express or implied, against any claims for infringement of patents, copyrights or trademarks. Customer shall indemnify and hold SAFEmine Ltd., its subsidiaries and affiliates, and their respective successors and assigns, and its customers harmless from any and all third party liability for such infringement, including without limitation damages, costs, expenses (including reasonable counsel fees), and lost profits arising from any claim that the use of any goods supplied under the invoice infringe any patent, copyright or trademark rights.