



INSTALLATION AND MAINTENANCE GUIDE

FOR

SAFEMINE COLLISION AVOIDANCE SYSTEMS

**FIRMWARE VERSION 2.20
SMT00L VERSION 1.30**

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SWITZERLAND**



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Preliminary

Section 1 – Hardware

Preliminary

Safety

System

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 QC200 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.

In addition, SAFEmine Ltd.'s current "General Terms and Conditions of Sale" apply.

Installation

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.

Introduction

Objective

The main task for SAFEMine QC200 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.

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 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 QC200 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 enhances the accuracy of position measurements. The predicted driving path of the vehicle in which a SAFEMine QC200 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 QC200 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 QC200 series products optionally compare the predicted driving path with known static obstacle data, e.g. electric power lines.

Implementation

If a SAFEMine QC200 series product determines the risk of dangerous proximity to another vehicle or to an obstacle equipped with a SAFEMine QC200 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 QC200 series products use a proprietary patent- and copyright-protected protocol. Any non-licensed use, dissemination, copying, implementation or reverse engineering of the SAFEMine QC200 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.



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.

Preliminary

Components

Main units

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



The Main Unit is produced in two versions: Model QC235, with an integrated operator display, as shown above, and the Model QC 230, which utilizes a separate remote display connected by means of the Remote Display Cable, part number QD221.

GPS

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

Radio Frequency (RF) communication

Less than 1 % Duty Cycle, Peak Pulse Power 10 mW (ERP).

License free ISM / SRD bands, software selectable depending on country of use

Europe, Africa:	868.2 and 868.4 MHz, others
Australia:	921MHz
North America:	around 951MHz
South America:	around 951MHz
Asia:	various

Country of Origin: Switzerland, Harmonized System Customs Code 852610

Low power behavior

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 and 'Error Power' is announced every 30 seconds on the voice output as long as there is sufficient voltage to do so. At voltages below 9V the operation of the SAFE mine unit is no longer guaranteed.

⇒ Installing the Main Unit

It must be assured that only one SAFEmine QC200 series product is operated per vehicle.

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.

The main unit must not impede the operation of the vehicle (incl. emergency procedures) and in particular it must not reduce the operators 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.

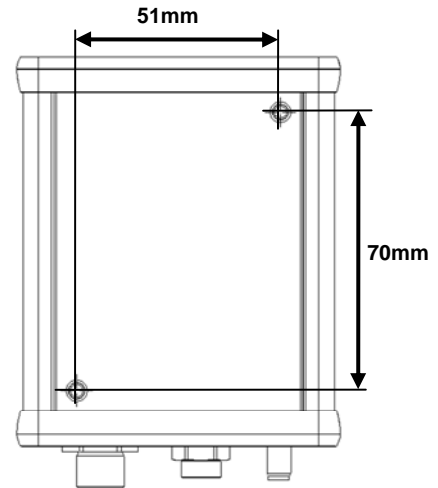


Figure 3 Main unit bottom view

Cables must not be bent or attached under stress. The installation must allow adequate space for cable connectors and antennae cables.

The lower face of the main units' aluminum housing includes two blind threads, so that the housing can easily be secured by two M4 screws. Forcing longer than 8 mm screws into the nuts may cause damage! The unit should be installed on a flat surface so that the housing is not subject to any mechanical stress. 3D Models (Solidworks) of the housing and all connectors are available on request.

Care should be taken not to allow the devices to be exposed to liquids. Should the unit become humid, it must be thoroughly dried prior to use. Wet devices can sustain permanent damage. Sudden massive cooling should be avoided, as condensation may occur inside the unit.

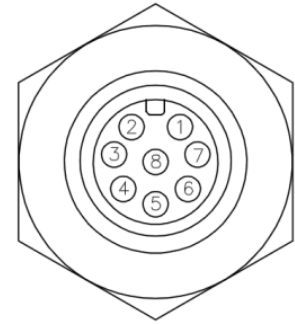
The main unit should be connected directly to battery power to ensure continued operation in case of vehicle stopping or breakdown. A 3A fuse should be installed near the vehicles battery on **both** power and ground. A sealable fuse holder is highly recommended. Furthermore the fuse should be secured with a cable tie to make any tampering obvious.

If vehicle is equipped with a "breaker" the housing should not be connected to vehicle ground as otherwise a ground loop occurs.

The housing is black to minimize glare and is specified for temperatures from -40°C to +85°C.

It is recommended to attach the cables to the vehicle in a semi permanent way (e.g. cable ties), so they can easily be (re)moved for service and maintenance.

Connector Details – Main Unit



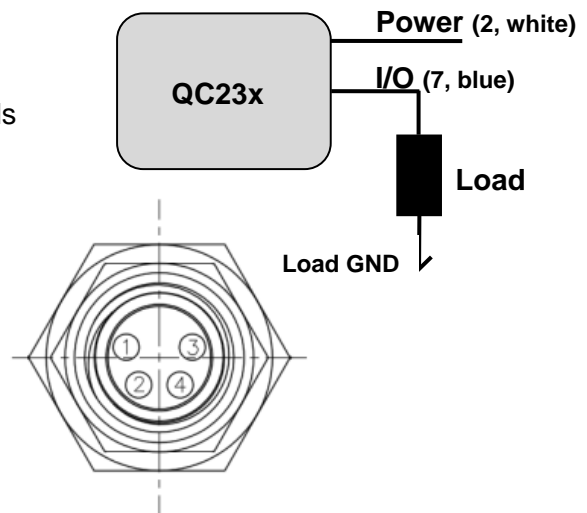
Power / Interface connector

To vehicle or add-on modules
Type M12 male, 8 contacts

Pin function	# of pins	Pin type	Pin #	Cable color
Ground	1	Power	2	brown
Power (+9 to +28VDC) overvoltage and polarity protected	1	Power in	1	white
Digital I/O (optional) use to control power down modes e.g. connect to ignition May also be used to switch a load (see below) (0-28V, 0.4A)	1	Input / Output	7	blue
RS485 (optional) 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	2	Input (RX) Output (TX)	5 6	gray pink
CAN listener (optional) (typically J1939, ISO 11898)	2	IO H L	3 4	green yellow
Audio (voice) out (optional)	1	Output	8	red

Digital Output (pin 7):

- "High Side Switch"
- maximum continuous load current: 0.4A
- may switch capacitive, inductive and resistive loads
- On-state resistance: 350mOhm
- short circuit protected
- ESD protection: 5kV
- Pulled up with 4.7kOhm



Display / Update connector

Data and power to remote display and other periphera
Type M8 female, 4 contacts

Pin function	# of pins	Pin type	Pin #	Cable color
Ground	1	Power	3	blue
12V out (sanitized)	1	Power	1	brown
RS 232 (data to display and for updates) Firmware can be updated through this interface.	2	Input (RX) Output (TX)	2 4	white black

GPS connector

SMA female for 3.3V active GPS antenna
 Only antenna supplied by SAFEMine may be used.

RF connector

SMA female for 50 Ohm RF antenna
 Only antenna supplied by SAFEMine may be used.



Specifications for QC230/235:

Parameter	Conditions ¹	
Dimensions	excl. connectors	81 x 30 x 98 mm ³
	overall	81 x 30 x 108 mm ³
Weight	without cables	210 g
Power Supply	nominal	12 - 28 VDC
Power Supply Range	min / max	9.5 / 31 VDC
Power Consumption	typical @12 V	< 55 mA
	peak @12 V	< 180 mA
	standby @12 V	< 35 mA
Processor		ARM7, 32bit @ 60 MHz
GPS		50 channel GPS L1, ISO/TS 16949 qualified, GALILEO ready
Time to operation after power-up	typical	50 s
Time to operation from "hot" standby	max	2 s
Traffic alert range	typical	500m
Maximum number of moving units in range	typical	50
Direction of Targets Updated	typical	4 Hz
Average Latency	typical	250 ms
Operating Conditions . ²		
Operating temperature		-40°C to +85°C
Storage temperature		-40°C to +85°C
Humidity		85%, non condensing

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

² Operation beyond the "Operating Conditions" is not recommended and exposure beyond the "Operating Conditions" may affect device reliability.

Vibration		IEC 68-2-6 10-500 Hz; 2 hours/axis; 5g
Shock	no function	IEC 68-2-27 30g/11ms (halfsine); 3 Shock/axis
Protection rating	IEC 60529	IP54
Connectors		
Power		M12, male, 8 contacts (IP67)
GPS		SMA Female, color coded
RF		SMA Female, color coded
Remote Display		M8, female, 4 contacts (IP67)

Preliminary

GPS & RF Antenna



The external combined GPS & RF antenna supplied with the main unit must be connected; the main unit will not operate without the antennas.



Always verify that the antennas are connected to the correct inputs. The connectors are identical for both antenna types.

Improper installation of the antenna and its cables is the prominent cause for malfunction.



Magnet Mount Version

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

Antenna Models

- **Through Hole Mount QF021**

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

The advantage of using short cables on the antenna and then connect and run 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 (available through SAFEmine)

To mount the antenna a hole must be drilled or punched into the surface. The diameter of the hole must be 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. For optimal performance, it is recommended that the antennas be mounted on a horizontal metal surface. This will provide the best acquisition for GPS satellites and will also optimize the RF antenna element.

To attach the antenna, first remove the nut. The attached gasket provides a sealant to prevent moisture from entering. Feed the cables through the hole, seat the antenna on the surface, and then reattach the nut. The nut should be tight 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 inside of the mounting screw of this antenna is NOT sealed. If it is exposed to the outside additional sealing is required before installation.



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

- **Magnetic Mount QF024**

The magnetic mount antenna comes with 3.5m of cables, both GPS & RF.

Specifications for the GPS / RF Antenna

Parameter	Conditions	QF012	QF024
Mounting type		Through Hole	Magnetic
Weight		480g	620g

Dimensions		ø107 x 91 mm	
Power Supply		from main unit	
Connector		2 * SMA Male	
Operating temperature		-40°C to +85°C	
Storage temperature		-40°C to +85°C	
Protection rating		IP 67	
Cable		2 * 20cm, coaxial	2 * 3.5m, coaxial

⇒ **Installing the Antenna**



The antenna must be mounted on the highest point of the vehicle, with 360° unobstructed view of the sky and at least 50cm away from any other transmitting antenna. 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.

Mounting brackets for various vehicles (Haul Trucks etc.) are available from your local SAFEmine distributor.



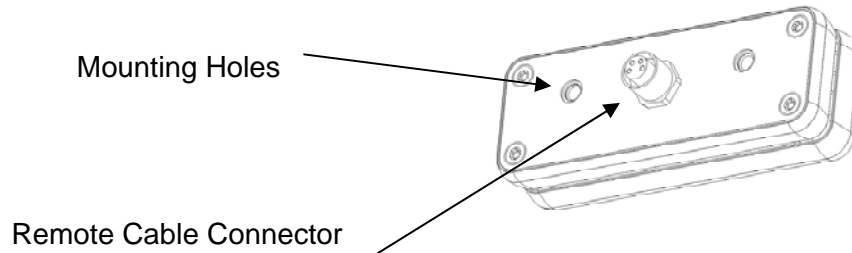
On tracked vehicles, the antenna must be mounted as close as possible to the axis of rotation!

Snow and ice buildup reduces the performance of the antenna and must be removed prior to operation.

Preliminary

Remote Display unit

The back side of the aluminum housing includes two blind threads, so that the housing can easily be secured by two M4 screws (no longer). Forcing longer than 8 mm screws into the nuts may cause damage! 3D Models (Solidworks) of the housing and all connectors are available on request. Alternatively the remote display can be fixed with 3M dual lock (see Appendix A: Recommended parts), This is ideal for installation, where the owner of the vehicle does not want to drill holes in his dashboard



The Remote Display QD200 can also be used with the Main Unit with internal Display QC235. This configuration is not described in further detail here.

Connections – Remote Display

Data and power from main unit

Connector type M8 male, 4 contacts

Specification for Remote Display

Parameter	Conditions	
Dimensions	excl. connectors	80 x 30 x 20 mm ³
	overall	80 x 30 x 30 mm ³
Weight	without cables	60 g
Power Supply		from Transceiver CG1-S
Connector		M8, male, 4 contacts (IP67)
Operating temperature		-40°C to +85°C
Storage temperature		-40°C to +85°C
Vibration		IEC 68-2-6 10-500 Hz; 2 hours/axis; 5g
Shock		IEC 68-2-27 30g/11ms (halfsine) 3 Shock/axis; no function
Protection rating		IP54
Construction		Anodized aluminum with plastic end-bezels, all connectors on the back side.



Figure 1 Front view of remote display



Figure 2 Rear view of remote display

Each User Interface has

- 12 red / green LED in a circle, diameter 20mm
- 1 red / green status LED each for Mode / Reverse / Ready /Power / "Ready" / Mode
- 1 multifunctional button

LED brightness is automatically controlled based on ambient light, with backlight for night operation.

Buzzer with max. 85dB sound level (@10cm) volume can be automatically controlled based on ambient noise.

Preliminary

Connectors and Cabling

Antenna Cables

It is recommended to source coaxial low loss cables including connectors of proper length and high quality from a professional local supplier. Any work on radio RF cabling must be done professionally by trained personnel according to Safemine specifications. Manufacturing of coaxial cables to custom length on site requires specialist tools (strip and crimp tools, soldering iron, SWR meter) and know-how / experience and may result in reduced reliability.

Contact SAFEmine if on site cable confectioning is necessary.

Recommended maximum cable length between antenna and main unit:

Coaxial cable type	Max. length RF	Max. length GPS
RG174	DO NOT USE	5m
HDF-195/CFD-195 LMR -195	5m	10m
LMR 400	15m	15m

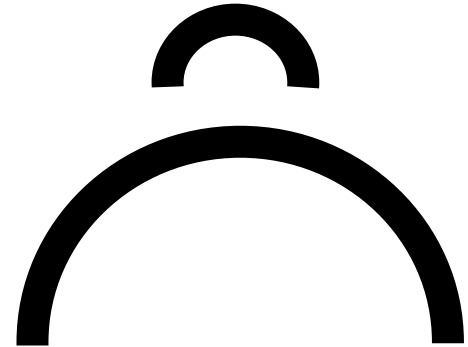


Figure 6 Minimum bend radius of RF195 coaxial cable for one-time (above) and repeated bends (below).

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



The maximum acceptable attenuation rate for the RF cable is 3dB at 900MHz. The maximum acceptable attenuation rate for the GPS cable is 10dB. To calculate the attenuation rate, sum up the attenuation of all segments as specified by the cable manufacturer. Add 0.3dB for any connection.



The minimum bend radius of the coaxial cables must be strictly observed!

Typical minimum bend radius for RF195 type cables is 18mm (3/4 in.) on installation, 60mm (2 1/3 in.) for repeated bending.

It is highly recommended to add a braided sleeve around the cables for further UV and abrasion protection. Wear and damage to the RF and GPS antenna cables is not covered under warranty.



Connections in the antenna cable must be sealed over the whole assembly with **heat shrink tubing (glue type)**. In addition, outside connections must be sealed with **silicone tape** to ensure a reliable, weatherproof operation. Never use 'electrical tape' or to weatherproof RF connections!

No installation may have more than one (1) connection.

No PVC tape (black 'electrical tape') may be used for sealing connectors!



All antenna cables must be carefully tied to the vehicle. Loosely vibrating cable will fatigue and the central conductor will break over time!

Make cables removable to prevent them from being cut when the vehicle is being serviced.

Section 2 – Software and Programming

Preliminary

Programs and Files

Required Components

For the installation of the Collision Avoidance System you will need the following hardware:

- PC or Laptop running Windows 2000 or later.
- M8 to USB Cable (QLxxx)
or M8 to serial port cable (QL014) and RS232 to USB converter if PC has no serial port.
- Power Supply or Battery (12 or 24 volts)

and the following software:

- SM Tool (SAFEmine Software Utility)
- H-Term
- Latest Firmware (v.2.24)
- Configuration File (see configtemplate.ini)
- USB Driver (for use with cables above that connect to USB port on computer)

Note: 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 info@safe-mine.com if you don't have a username and password.

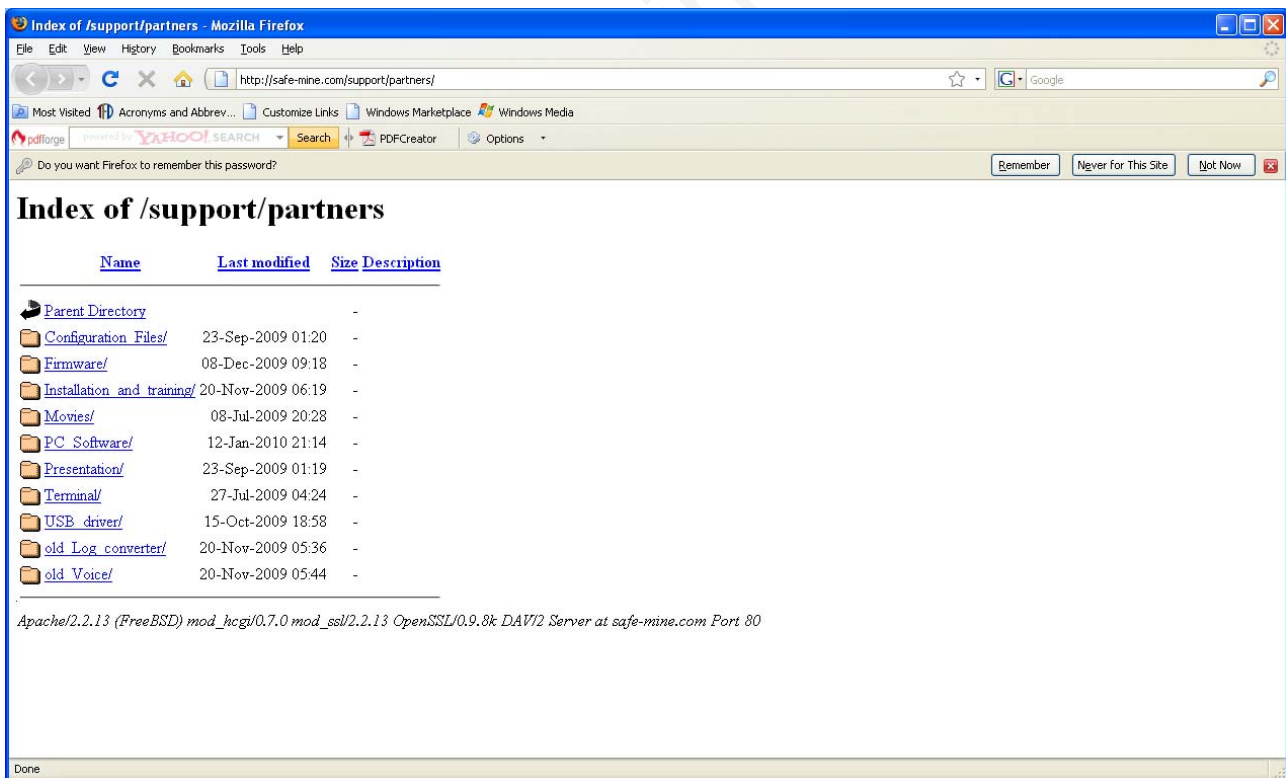


Figure 1 SAFEmine support file repository

Firmware and the Configuration File

The QC230/235 is controlled by firmware, basically a small, embedded program that is stored permanently in read-only memory. The firmware reads a unique configuration file (refer to "Configuration file" for programming details) that is created and/or modified by the installer which customizes the behavior of the device for the particular vehicle on which it is installed.

Both the firmware and configuration file need to be uploaded to the QC230/235 for the system to function properly.

Firmware is periodically updated by SAFEMine software engineers. Many features and improvements are available by uploading the latest released version. As a helpful feature, the firmware version is display during start-up. Three green LEDs are lit sequentially for one second, according to the firmware revision ("2", "0", "0"), where "0" is 12 o'clock, and numbers increment clockwise.

⇒ **Setting up the SM Tool File Utility -**

1. If not already done, obtain and install a copy of SM Tools on your PC or Laptop.
2. Connect power (12 volts to 28 volts) to the SAFEMine QC230/235.
3. Connect either the QLxxx or QL014 to the M8 connector of the QC230/235, depending on the type of port you have available.
4. Click on the SM Tools icon and start the program.
5. The window as shown in Figure x below appears.
6. Choose the correct COM port at the lower left-hand corner.

⇒ **Uploading Firmware**

1. Choose the correct firmware file
2. Disconnect power from the unit
3. Press "Start Update"
4. Apply power. Four red status LED should stay lit after 5 seconds. If device powers up normally, retry, select different serial port.
5. Wait 45 seconds, or until the message box appears
6. **Do not cut power until SAFEMine device has restarted completely (another 20 seconds)!**
7. Watch for Errors on restart on the SAFEMine device display
8. In case you have a SAFEMine unit with remote display, you must check for Errors on the PC screen (not yet implemented) or by connecting the display after the update.

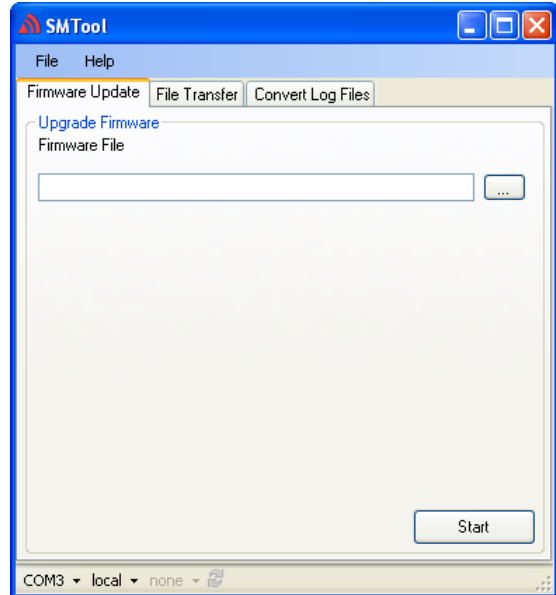


Figure 2 The first tab of SM Tool permits the uploading of a new version of firmware to the QC230/235.

⇒ **Uploading a configuration file**

1. Browse using the button to the right [...] and choose the desired configuration file. Please refer to page X for details on modifying a configuration file.
2. Click the [Upload] button.

3. Wait 15 seconds, or until a message box appears.
4. Disconnect and reconnect power to the SAFEmine QC230/235.
5. Watch for Errors on startup on the SAFEmine QC230/235.
6. In the case where you are using a QC230 (the unit without an integrated display), check for errors by connecting the display after the update.

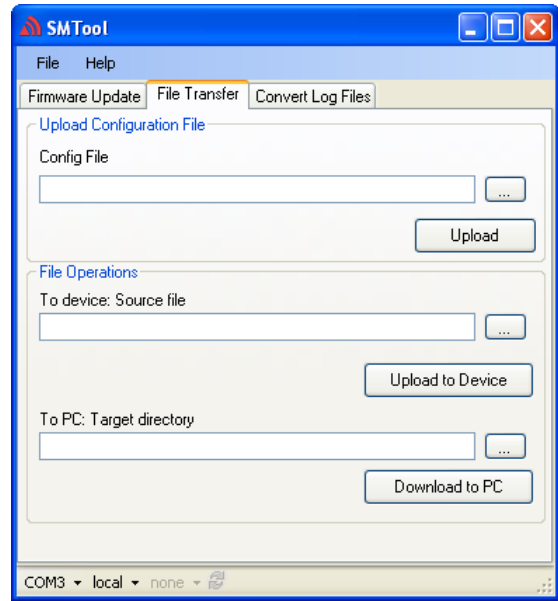


Figure 3 The File Transfer Tab permits up- and downloading of files to and from the unit

⇒ **Converting a raw log file**

1. Choose the file to convert.
2. Press the button corresponding to the type of desired output file
3. Find the converted file in the same directory as the original file.

“Analyze” will analyze the recorded file and print the results into a text file.

“Convert GE” will convert the log file into a Google Earth compatible .kml format file.

“Convert CSV” will convert the raw data into CSV (Comma Separated Value) format for further analysis.

Remote Management

Most operations can be performed on nearby devices using the RF link. Note that the remote device has to be operational and GPS has been locked.

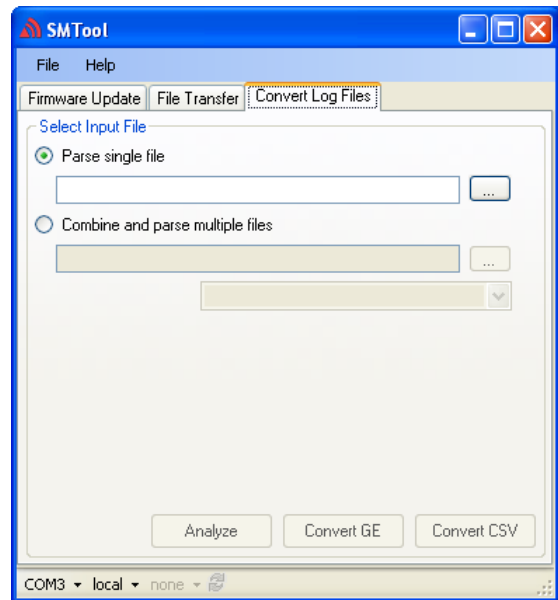


Figure 4 The File Conversion Tab permits the conversion of raw log files to other formats

File up- download over RF

Certain maintenance operations can be performed over the air.

Requirements:

- PC with latest SM Tools installed, .NET > 3.0 recommended
- Local device connected to PC and powered up. Preferably, the device also has GPS reception. This will add direction and distance information in the host selection dialogue.
- Peer device with firmware >= 2.00

In SM Tools select “Remote Connection”, “Enable”. The list of available peer devices will be populated automatically. Select a device, proceed as usual to download/upload files, and configuration file.

Very carefully check that you are connected to the unit you want to program on!

Limitations:

- The peer device must have GPS reception; otherwise it will not show up in the list.
- Transmit speed is about 1500 bytes per second in good conditions, but will degrade with increasing data traffic (i.e. other nearby vehicles).

SAFEmine Configuration Tool (discontinued)

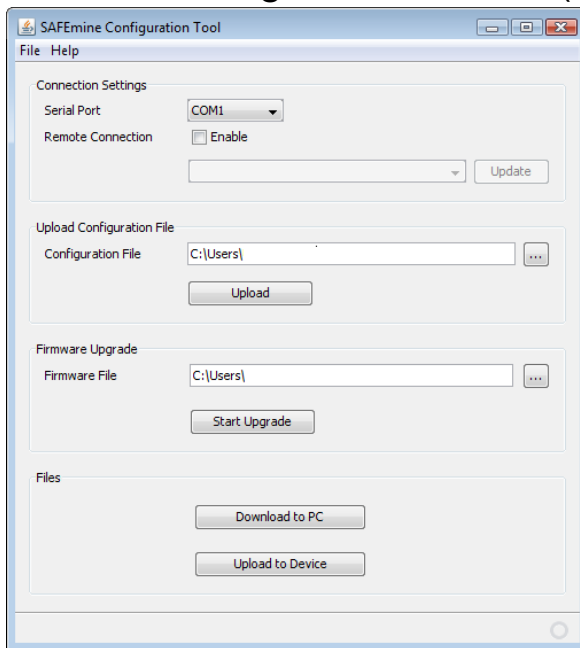


Figure 5 Discontinued SAFEmine Configuration Tool (do not use)

Configuration file



A unique configuration file must be compiled and uploaded for each vehicle.

The file name should consist of the individual "Plant Number" of the vehicle and end with .cfg

Example: HT10.cfg

Maintaining a repository of all files allows for easy configuration of replacement units.

Syntax:

- Parameter = value
- The "#" character at the beginning of a line indicates a comment. Comments are ignored and have no effect on the function of the configuration file.

Sample configuration files for various vehicles are available from SAFEmine. We strongly recommend that you submit your configuration files for review to info@safe-mine.com.

NOTE: Values not set in a configuration file are automatically treated as default value. For instance, if there is no "volume = xxx" entry in the configuration file, it will be set to "100".

Mandatory parameters which must be present in every configuration file are marked in red.

Sample configuration file

```
# Sample SAFEmine configuration for Loader
#####

# do not modify!
#####
channel          = 287
hopping          = 1

# site specific configurations
#####

# all alarm exceptions activated
alarmexceptions  = 0xffffffff

# vehicle specific configuration below, please adapt
#####

# speaker volume
volume          = 20

distfar         = 80
distnear        = 40
distclose       = 10

vehtype         = 52
vehmanu         = CAT
vehmod          = 988H Loader
vehid           = 741
vehlength       = 6
safetylength    = 0
vehwidth        = 3
safetywidth     = 0
vehheight       = 4
antennaaft      = 3
antennaright    = 1
antennaup       = 3.3
minturnrad      = 0
```

Site Specific Parameters

Site specific parameters are the same and must be set on all units.

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

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

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

Minimum required parameters

Vehicle ID

Keyword	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

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

Vehicle Type	VEHTYPE	Examples
Light Vehicle	10	Fort F150,F250
Small Tractor	11	
Small Service Truck	13	Ford 750
Bus	15	
Haul Truck	21	Komatsu 730E,
Dump Truck	22	
Water Tanker	23	CAT 777
Lomak Trucks	24	Lomak, Freightliner
ADT	31	
Fuel Bowser	32	
Service Truck	33	
Low Bed Truck	35	
Mobile Crane	34	
Rear Tip Truck	36	
Excavator	41	CAT 385C, PC4000
Shovel	42	
PC	43	
Dozer	44	
Dragline	45	
Drill	46	Atlas Copco PV271
Large Front End Loader	51	
Small Front End Loader	52	CAT 988H
Tire Handler	53	
Cable Handler	54	
Grader	55	
TLB, JCB	56	
Large Tractor	57	
Train	61	
Stockpile Stacker	71	
Test Station	72	
Stockpile Dozer	73	
Lighting Plant	74	
Beacon	100	

Vehicle Dimensions

Keyword	Description	Unit	Range	Default	Example
VEHLENGTH	Vehicle length, overall	meter	1 - 655	-	12.8
VEHWIDTH	Vehicle width, overall	meter	1 - 655	-	3.4
VEHHIGHT		meter	0 -		

Antenna position

Keyword	Description	Unit	Range	Default	Example
ANTENNAAFT	Distance between front of vehicle and antenna.	meter	0 - 655	-	3.4
ANTENNARIGHT	Distance between left side of vehicle and antenna.	meter	0 - 655		1.2
ANTENNAUP	Elevation of antenna above ground	meter	0 -		2.1

Figure 6 Vehicle dimension and antenna position parameter

Optional parameters

LED Notification Distances

Keyword	Description	Unit	Range	Default	Example
DISTFAR	Green LED indicates vehicle closer than disfar meters; taken from outer boundary of "alarm area"	meter	1 - 500	150	180
DISTNEAR	Steady Red LED indicates vehicle closer than disnear meters; taken from outer boundary of "alarm area"	meter	1 - 250	40	40
DISCLOSE	Flashing Red LED indicates vehicle closer than disclose meters; taken from outer boundary of "alarm area"	meter	1 - 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.

Safety Length

Keyword	Description	Unit	Range	Default	Example
SAFETYLENGTH	Extends the alarm region in percent of vehicle dimension.	% of length	0 - 100	0	20
SAFETYWIDTH		% of width	1 - 100	0	5

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

Setting above values too high (typically > 30) may result in unwanted "nuisance alarms" as alerts will sound even though there is no danger of collision. Recommended values are 30 for haul trucks and 10 for light vehicles

Vehicle data

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

Buzzer volume

Keyword	Description	Unit	Range	Default	Example
VOLUME	Volume of the buzzer of the display in percent of full volume -1: automatic (not yet implemented)	%	0 - 100	100	60

User Interface Mask

Individual user interface components can be deactivated (e.g. buzzer, LED circle)

Keyword	Description	Unit	Range	Default	Example
UIMASK	Deactivates selected user interface components, e.g. buzzer, LED circle. Individual user interface components can be deactivated (e.g. buzzer, LED circle).	Flags	0 – 0xFF	0xFF	0xE2

Refer to the UIMASK Utility in order to enter the correct parameter.

0x01	Buzzer
0x02	Warning LED (Compass rose)
0x04	Voice
0x08	GPS status (buzzer and voice only)
0x10	Infobeep (inverted logic, clear to enable)
0x20	All LED

Reducing nuisance alarms

Infobeep



All Infobeep functions are still in a 'BETA' state and may only be used for testing!

"Infobeep" instead of DM Alarm on passing vehicles

To enable the new "Infobeep", clear UIMASK bit number 5 e.g. with UIMASK = 0xEF

Conditions for triggering an Infobeep:

- The other vehicle could .
- I can see the other vehicle at +- 30 degrees from my direction of travel
- The other vehicle has a heading that is opposed to mine with a max deviation of +- 30 degrees
- The other vehicle is within DISTFAR (otherwise it is not shown on the display and should not be announced)



A vehicle that has been announced through "Infobeep" will never generate a DM alarm (beeping) on approaching, as it is assumed that the operator is aware of the approaching vehicle and will avoid it.

AlarmSuppressions

Keyword	Description	Unit	Range	Default	Example
ALARMSUPPRESSION		-	0-0xFFFFFFFF	0	0FFFFFFF

To avoid unnecessary 'nuisance alarms' several alarm exceptions detailed below have been implemented which suppress alerting for certain DM (dangerous movement) alarms. To allow flexibility, they can be switched on or off by setting `ALARMSUPPRESSIONS` in the configuration file accordingly. If `ALARMSUPPRESSIONS` is not set, **by default all suppressions are switched off** (there will be an alarm in the described situations). To edit the settings, sum up the listed **codes** (hex) and set `ALARMSUPPRESSIONS` (hex) to the total result.



Use of this parameter will permanently disable some alarms when vehicles approach each other.

My vehicle	My vehicle is moving	Type of other vehicle I am approaching	Direction where I come from	code	
				off	on
Light Vehicle	forward	Light Vehicle	anywhere	0	0x1
		Small Tractor		0	0x2
	backwards	Light Vehicle	anywhere	0	0x4
		Small Tractor		0	0x8
Small Tractor	forward	Light Vehicle	anywhere	0	0x10
		Small Tractor		0	0x20
	backwards	Light Vehicle	anywhere	0	0x40
		Small Tractor		0	0x80
ADT	forward	PC	anywhere	0	0x100
Small Front End Loader	forward	ADT	side	0	0x200
		Dump Truck	side	0	0x400
		Rear Tip Truck	side	0	0x800
Large Front End	forward	Haul Truck	side	0	0x1000

Loader		Dump Truck	side	0	0x2000
Tire Handler	forward	Grader	side	0	0x4000
		Service Truck	side	0	0x8000
		Fuel Bowser	side	0	0x10000
		Small Front End Loader	side	0	0x20000
		Large Front End Loader	side	0	0x40000
		Tyre Handler	side	0	0x80000
		Haul Truck	side	0	0x100000
		Water Tanker	side	0	0x200000
		Dump Truck	side	0	0x400000
Haul Truck	all	Excavator	anywhere	0	0x800000
		PC	side	0	0x1000000
Dump Truck	all	PC	anywhere	0	0x2000000
Rear Tip Truck	all	PC	anywhere	0	0x4000000
Excavator	all	Haul Truck	anywhere	0	0x8000000
PC	all	ADT	anywhere	0	0x10000000
		Dump Truck	anywhere	0	0x20000000
		Rear Tip Truck	anywhere	0	0x40000000
Dozer	all	Dozer	anywhere	0	0x80000000

Example:

Following suppressions turned **on**:

My vehicle	I am moving	Other vehicle I am approaching	Direction where I come from	code for switching on:
Light Vehicle	forward	Light Vehicle	anywhere	0x1
		Small Tractor		0x2
Small Tractor	forward	Light Vehicle	anywhere	0x10
		Small Tractor		0x20
Large Front End Loader	forward	Haul Truck	side	0x1000
		Dump Truck	side	0x2000
Tyre Handler	forward	Service Truck	side	0x8000

All other exceptions turned **off**

- ⇒ sum of all codes = 0x4 + 0x8 + 0x40 + 0x80 + 0x1000 + 0x2000 + 0x8000 = 0xB033
- ⇒ the following line has to be added into the configuration file:
ALARMSUPPRESSIONS = 0xB033

Note that the number entered for the parameter ALARMSUPPRESSIONS is hexadecimal. A single digital hex number can range from 0 to 15, so letters are used to represent numbers greater than

9, i.e., 10=A, 11=B, 12=C, 13=D, 14=E, and 15=F. Hence when numbers are added they are done one column at a time. If the total for a column is greater than 9 letters between A and F are used to represent the hex number.

To eliminate some of the work, if only some few exceptions have to be turned **off**, the associated **on**-codes can be subtracted from the value 0xFFFFFFFF.

Maximum exception speed

Keyword	Description	Unit	Range	Default	Example
MAXEXSPEED	Limit of alarm suppression	km/h	0 - xx	0	10

If MAXEXSPEED [km/h] is set in the configuration file, all active suppressions are only suppressing beeping if *my vehicle* is moving below that speed. If MAXEXSPEED is not set, there will be no limiting speed for alarm suppressions.

Use 0 to disable this feature (default).

Put another way, Suppressions only have an effect when vehicle speed > MAXEXPTSPEED.

Example:

On a Large Front End Loader, MAXEXSPEED = 5 and ALARMEXCEPTIONS = 0xB033 are set in the configuration file. Therefore there will be no DM (beeping) alarms if the Large Front End Loader approaches a Dump- or Haultruck from the side, except if the Large Front End Loader is going faster than 5km/h.

Preliminary

Parameter	Description	Unit	Example	Keyword
Weight	Maximum vehicle weight (including load)	Ton	350	VEHWEIGHT
Max Speed Rev	Maximum speed in reverse. Alarm will sound on speeding (optional. Requires Option QP117) 0: disabled	km / h	5	MAXSPEEDREV
Turning radius	Turning radius SAE (set to 0 for rotating, e.g. tracked vehicles). See additional instructions below	Meter	28	MINTURNRAD
Driver Pos Aft	Distance between front of vehicle and driver	Meter	1.5	DRIVERAFT
Driver Pos Right	Distance between left side of vehicle and driver	Meter	1.5	DRIVERRIGHT
Driver Pos Up	Elevation of driver above ground	Meter	4	DRIVERUP

Preliminary

Optional Features

Speeding Alert

Alerts are issued through the LED display and the voice output if the vehicle goes faster than MAXSPEED.

Rollover alert

Keyword	Description	Unit	Range	Default	Example
ROLLOVER	Maximum roll angle. Alarm will sound on higher angle Requires Option QP 0: disabled	° degree s	0 - 90	0	40

Rollover alarm is currently deactivated on very bumpy roads to avoid nuisance alarms.

Voice output

All voice output functions are still in a 'BETA' state and may only be used for testing!

[intro]

Voice is currently available in English and Spanish. More languages can be ordered through your SAFEmine dealer.

The 'announce all on button press' works again, however the vehicle must meet the conditions described below to get re-announced.

Keyword	Description	Unit	Range	Default	Example
VOICEFILE	File name of voice audio file			0	sm_EN_M_1 .1.voc
DISTVOICE					
AUDIOVOLUME	Controls speaker volume independent of the buzzer volume	%	0 - 100		80

Voice plays for the first time if its predicted trajectories come within DISTVOICE.

0 suppresses all vehicle alarms

The distance to the other vehicle is no longer announced, as the announcement took too long.

Conditions for Clustering:

I see the vehicles within +-40 degrees and between them there is less than DISTFAR/2 distance.

Clustered vehicles are announced as "n Vehicles".

Data Recording

Log interval

Keyword	Description	Unit	Range	Default	Example
LOGINTERVAL	Log interval for track and data recording.	seconds	1 - 255	1	2

The internal flash memory will overwrite the oldest logs after about 80h of vehicle movement (if 1 second interval is chosen). Log interval is multiplied by 60 when vehicle is stationary to save memory.

Each position record also contains information on the accumulated RMS (Root Mean Square) vibration since the last log entry.

It also contains the movement mode (for easier data analysis)

Note: Analysis of vibration data is not yet supported by the PC software.

Fatal errors that lead to a device reset are now recorded.

Note: Analysis of this data is not yet supported by the PC software.

Vehicles are only recorded if they trigger a sound alarm, or if a sound alarm was suppressed by an alarm exceptions setting.

Obstacles

Fixed obstacles can be defined. If a vehicle approaches these obstacles the operator will be warned.

Obstacle data must be placed in a separate file named "obst.ini". It may be updated through the Sync Station

The syntax of an obstacle entry is:

OBST = <type> , <geometry type> , <geometry>

You may also use ";" as delimiting characters. The fields are:

<type>	A number, where: 0 -> Generic Obstacle (announced as 'Obstacle') 10 -> Building 21 -> Power line 22 -> 'Stop' sign 23 -> reduced speed area 71 -> Coal valve 72 -> Stockpile edge
<geometry type>	one of the following 1d: circular obstacle 2d: line obstacle (i.e. conduit, cable)
<geometry>	depends on geometry type. For 1d: <lat>,<lon>,<radius> For 2d: <lat><lon>,<lat>,<lon> (designating the start and endpoint of the conduit)
<lat>	latitude, decimal notation (decimal sign is the period "."), followed by "N" or "S" character. E.g.: 48.1234N (trailing zeros may be omitted) coordinates must be in WGS84 system
<lon>	same as lat, but using "E" or "W" character. E.g.: 167.987552W.
<radius>	radius in meters, decimal notation.

Examples:

```
# This is a "line" obstacle, issuing "power line" voice alerts
OBST = 21;2d;37.845N,122.243W;37.847N,122.243W
```

```
# This is a circular obstacle, issuing "obstacle" voice alerts
OBST = 0;1d;37.841343N,122.248W;5.3
```

The maximum number of obstacles is 25.

The maximum numbers of characters in a line is to 80.



Distance to obstacles is calculated from the GPS antenna of the vehicle, no vehicle dimensions and antenna locations are considered! This will be improved in future releases.

Areas

Areas allow to automatically change parameters based on the location of the vehicle, e.g. to have different maximum speed limits on site and on the highway.

See separate documentation for details on how to program areas.

Stockpile Collision Avoidance

Special modes are available to support stockpile collision avoidance system application. This includes warnings for stackers, reclaimers, coal valves and vehicles operating on the stockpile. Please contact SAFEmine for additional information.

Preliminary

Special configurations

Test Station

[Intro]

A Test Station may be in command of an electric boom gate for automated access control.

Any SAFEmine equipped vehicle within the range of the Test Station will cause the digital output to go high. The output will remain high until the vehicle is again out of range. The approaching vehicle will have its LED flash red along with a buzzer alarm when it is within its DISTNEAR setting.

To use the Test Station mode, set vehicle type VEHTYPE to 72 and DISTCLOSE to the range in meters where it is desired to be activated. The unit must be purchased as option QP141 per price list.



Setting DISTCLOSE to 0 will make the unit behave as if it was approached by a vehicle, this is the test mode to test the digital output.

Test stations do not trigger on any vehicle in the vicinity but look at the location and direction of travel. **Only vehicles that drive 'IN' will be detected and shown by the test station.**

Add the keyword 'moving' to the VEHMOD parameter to limit detection to forward moving vehicles

Keyword	Description	Unit	Range	Default	Example
VEHTYPE	Set to 72		72	0	72
VEHMOD	Determines behavior		'from left' or 'from right' 'moving'	-	FROM LEFT MOVING
FIXHEADING	Orientation	° degree s	0 - 360	-	53
DISTCLOSE	Range	m	0 - 255	5	40

Examples

Right hand traffic

(traffic keeps to the right side of the road)

The example below uses the following parameters:

VEHMOD = from left

FIXHEADING = 330

DISTCLOSE = 50

Left hand traffic

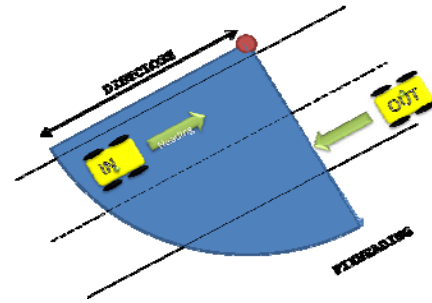
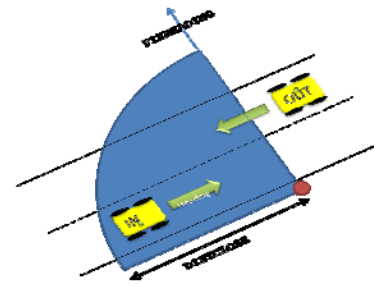
(traffic keeps to the left side of the road)

The example below uses the following parameters:

VEHMOD = from right

FIXHEADING = 150

DISTCLOSE = 50



Preliminary

Rotating Vehicles (Patent Pending)

Minimum Turn Radius

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

The parameter `minturnrad` should be set to zero for tracked vehicles and other vehicles where the orientation of the driver may differ from the direction of travel. Setting `minturnrad = 0` will result in the motion filter discarding heading information once the vehicle enters standstill. Setting a value greater than 0 will disable this behavior.

To determine the heading of rotating vehicles (e.g. tracked dozers etc), two units must be mounted. The main unit can be mounted as normal, except that its antenna should be mounted towards a corner of the vehicle.

The minimum distance between the antennas of the units is 5 meters for vehicles operating on the surface of the mine and 15 meters for vehicles active in regions with more than 30% obstruction of the sky. Contact SAFEmine if these restrictions cannot be met.

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).

⇒ *Configuring the main unit*

Set `BEACON = XXXXXXXXXXXX`

Where `XXXXXXXXXX` is the serial number of the beacon unit, e.g. "70011855000".

Also, accurately enter the position of the slave (beacon) antenna:

`BCNANTENNAAFT = XX.X` meters

`BCNANTENNARIGHT = XX.X` meters

`BCNANTENNAAUP = X.X` meters

⇒ *Configuring the beacon unit*

Set `VEHICLETYPE = 100` (required!)

It is essential that both the main and the beacon unit have their antenna positions programmed accurately.

- Usage

The main unit's "Reverse" LED is flashing red if no valid beacon signal is received.

The LED of the beacon unit will flash green at 1Hz and 50% duty cycle and the "reverse" LED is always off".

- Limitations

The center of rotation is assumed to be in the middle of the vehicle for the rotation prediction.

Rotating vehicles

Some vehicles can turn or rotate and hence change their heading without any forward or backward movement, such as in the case of track dozers and shovels. In effect, these vehicles have a turning radius of zero. In such cases, it is recommended that a second antenna be added so that the direction of movement of the vehicle is always defined.

Installing Hardware

The principal antenna should be installed as close to the center of rotation of the vehicle as possible and the second antenna, referred to as a beacon, should be installed in a corner location such that

the distance between the principal and beacon antennas is as large as possible. Both antennas require their own SAFEmine main unit. The principal main unit can be either a QC230 with a remote display or a QC235; the beacon main unit does not require a display and often a QC230 without a remote display is used here. For convenience, both main units are often mounted close together in the cab of the vehicle, in a piggy-back or side-by-side fashion.

It is recommended that the distance between the two antennas be at least 5 meters. For vehicles that operate in regions of the mine where more than 30% of the view of the sky is obstructed, this distance is increased to 15 meters. Contact SAFEmine if these restrictions cannot be met.

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).

Software Configuration

For the system to operate properly, the principal main unit needs to recognize the beacon main unit. This is accomplished by means of the main unit serial number. By including the beacon main unit serial number in the configuration file of the principal main unit, the two antennas can be linked.



It is also critical that the relative position of the two antennas be known. This is also done by means of special parameters in the principal main unit configuration file, such that the relative position of the beacon antenna is stored in the principal main unit. By knowing the position of the principal and beacon antennas and the distance and angle between the two, the heading of the vehicle can easily and accurately be determined.

To do this, add the following to the standard configuration file of the *principal main unit*:

`Minturnrad = 1`

(Rotating vehicles using only a single antenna are vehicles of unknown headings and are calculated as circular objects. No threat heading can be displayed to the operator. In such cases of rotating vehicles, where only a single antenna is used, `minturnrad` is set to 0).

`BEACON = XXXXXXXXXXXX`

where XXXXXXXXXXXX is the serial number of the beacon unit, e.g. "70011855000".

`BCNANTENNAAFT = XX.X`

`BCNANTENNARIGHT = XX.X`

`BCNANTENNAAUP = XX.X`

where XX.X is the distance measured in meters. These configuration file parameters are defined as follows:

`BCNANTENNAAFT` – distance measured from the front of the vehicle to the beacon antenna

`BCNANTENNARIGHT` – distance measured from the left side of the vehicle to the beacon antenna

`BCNANTENNAAUP` – distance measured from the ground level to the beacon antenna.

It is essential that both the main and the beacon unit have their antenna positions programmed accurately for proper operation!

Now add the following to the configuration file of the *beacon main unit* to set its vehicle type to 100:
VEHICLETYPE = 100

Performance

The LED of the beacon unit will flash green at 1Hz, 50% duty cycle, and the "reverse" LED is always off.

However, the main unit's "Reverse" LED will flash red if no valid beacon signal is received.

Limitations

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.

Dual Zone vehicles

Keyword	Description	Unit	Range	Default	Example
VEHBASELENGTH	Length of the vehicles body	m	0 - 655	0	20

Some Vehicle types can be configured to have a base-length (configuration value "vehbaselength"). This allows Haul-Trucks and Dump-Trucks to reverse towards the loading boom of an excavator or shovel without causing an alarm. Also no alarm will be given to the operator of the excavator or shovel when swinging the boom over the haul truck.

This behavior only occurs in interactions between shovels/excavators (VEHTYPE = xx / xx) and haul- and dump trucks (VEHTYPE = 21 / 22)

Vehicles with configured vehbaselength are currently exempt from collision de-escalation.

Digital I/O

The digital IO module can be used to monitor and record vehicle parameters such as: door open, seatbelt, handbrake, etc.

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


This option requires additional hardware, contact SAFEmine for evaluation.

Visual Displays and Alarms


The visualization of rollover alarm, obstacle alarm and over speed alarm are as follows:

Obstacles, Powerlines



Rollover 



Rollover 



Overspeed



These special alarms are not shown with other alarms together. Therefore they only appear if no other more important alarm was found.

Alarm "Hysteresis"

All alarms are shown for a minimum of 1.5 seconds to allow the operator to see and react to it. Changes to higher alarm levels are immediate, lower levels only after showing higher level for 1.5 seconds.

Inside detection

The unit automatically detects when the vehicle is inside (e.g. a garage) and goes into standby mode. This prevents nuisance alarms due to bad GPS coverage and also prevents spurious GPS ok/not ok signals while being parked inside.

When the unit detects that it is inside, the 'Ready' LED changes to red.

Button press recording

Short button presses are being recorded and are visible in the CSV file as 'BUTTON' Entry.

This can be used to flag special situations, e.g. incidents or situations where the user believes the SAFEmine device does not perform as expected.

Error codes

The unit performs a self-test upon power up. Errors are indicated by flashing of all status LED in red while showing the error code(s) on the circular display and also sending it to the serial port.

Debugging of error codes is best done with a PC running a terminal program (e.g. Hyperterm) 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)

Error code	LED #	Subsystem	Severity	Cause
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
04	3	GPS receiver	Fatal	
05	1 & 3	GPS Antenna	Fatal	GPS antenna defective or bad connection
08	3	Power	Fatal	Power supply defective or low/high voltage
		RF transceiver	Fatal	
		Microphone		
		Buzzer	Fatal	
		Ambient Light Sensor		
		Acceleration Sensors	Fatal	
		Flash Memory		
		Flash File System		
16	4	User Interface	Fatal	
32	5	Config	(Fatal)	Configuration file contains errors, or loading default configuration
64	6	Firmware	Fatal	Firmware corrupt, upload new firmware
128	7	Generic		Generic error
		Speaker		Only when configured for Speaker use
255	8	Unknown		

Limitations

- Distance to obstacles is calculated from the GPS antenna of the vehicle, no vehicle dimensions and antenna locations are considered!
- Only the following obstacle types are implemented in the voice output: "Power Line", "Obstacle".
- Vehicles with unknown heading (e.g. non-moving, tracked vehicles) are not calculated with their exact dimensions / behavior. Will be resolved in next revision.

Preliminary

Section 3 – Installation and Maintenance

Preliminary

Installation

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.

We highly recommend establishing a "Radio Map", containing all intentional transmitters and their operating frequencies. This map will help to minimize radio interference.

Recommended installation procedure

Create list of all vehicles, with properties as required, for the configuration files.

Create one configuration file for each vehicle. These files must remain readily available to maintenance so they can be used anytime a unit needs to be replaced.

See Appendix C: Installation Checklist for mandatory installation checklist to be filled out and kept on file for each vehicle.

Maintaining the System

Contact your local dealer to find out about available maintenance services.

See Appendix D: Maintenance Checklist for a sample maintenance checklist to be filled out and kept on file for each vehicle.

The housing should only be cleaned with a slightly moist non-abrasive cloth without any cleaning agents. All electrical connection and cables should be controlled regularly and the GPS antenna should not be covered by snow or a thick mud layer.

If new firmware is available, it should be uploaded to the device at earliest convenience.

It is highly recommended to install a "Test Station", available through SAFEmine on site (e.g. in the brake test area and at site access), where all vehicles and their units can be tested for proper operation before use.

Solar panels on Test stations must be inspected every week. Any dust, snow or ice buildup must be removed immediately.



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.

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



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

Appendix A: Recommended parts

These parts have been tested by SAFEmine and allow an installation with highest reliability.

Please consult with SAFEmine before substituting with non listed parts

3M "Dual Lock"

Type 3550 / 51 / 52

Heat shrink tubing

HellermannTyton HISA-9/3-PEX-BK

Self-Fusing Silicone Rubber Electrical Tape

3M Scotch® 70

Braided Sleeving

Polyamide

HellermannTyton TMEGA10MM

Clean Cut PET Expandable Sleeving

Techflex CCP0.50

Low loss 50Ohm coaxial cable

RF-195 / LMR-195 / HDF195 / LMR 400

SMA connectors

SMA connectors, crimp and strip tools are specific to the cable type. Information below is for the HDF195 cable.

Male: Wellshow P/N C01AA31058A04A

Female: Wellshow P/N C02AA31058A12

Crimp tool: .213 Hex

Strip tool: Paladin CST Vario 3-Stage Coax Cable Stripper

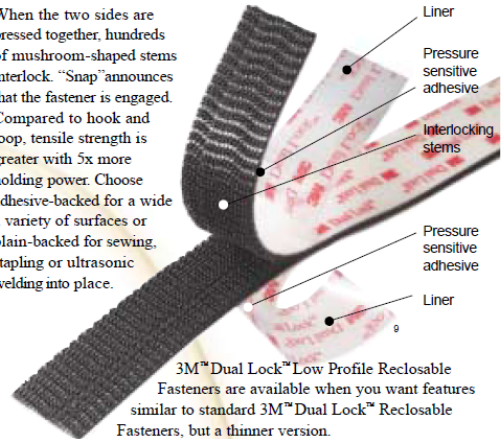
Solder - .5mm or 23 gauge 60/40 Rosin Core

Small Torch

for shrink tubing

3M™ Dual Lock™ Reclosable Fasteners family for hundreds of closures with greater holding power

When the two sides are pressed together, hundreds of mushroom-shaped stems interlock. "Snap" announces that the fastener is engaged. Compared to hook and loop, tensile strength is greater with 5x more holding power. Choose adhesive-backed for a wide variety of surfaces or plain-backed for sewing, stapling or ultrasonic welding into place.



Appendix B: Additional Figures and Drawings

Antenna Cable

TBA

Battery Cable

TBA

Preliminary

Appendix C: Installation Checklist

Item		
Date installed		
Installation technician		
Configuration technician		
SAFEmine serial number		
Firmware version loaded		
Configuration file loaded		
Vehicle ID (Plant number)		
Vehicle type		
	Initial	Comment
GPS antenna is at highest point of vehicle		
Antenna bolt and main housing are insulated from vehicle frame		
Main unit secured to vehicle		
Maximum one connection in RF cable		
All coaxial (RF/GPS) cable connections well covered by adhesive lined heat shrink or silicone tape		
Maximum total RF cable lengths 8m		
RF cables sleeved if outside or where chafing is possible		
Unit powered up with no error messages after installation		
Ready LED green after <3 minutes (if vehicle is outside)		
3A fuse on Power and GND if it is not connected to chassis		
Buzzer (speaker if installed) unobstructed		
Driven by test station		
Signoff vehicle owner		

Appendix D: Maintenance Checklist

To be performed before vehicle is released after a regular PM

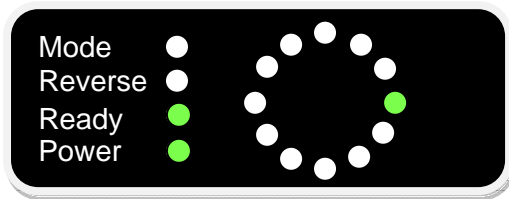
Item		
Date checked		
Responsible		
Configuration technician		
SAFEmine serial number		
Firmware version loaded		
Configuration file loaded		
Vehicle Plant number		
	Initial	Comment
Check cables, abrasion, UV damage		
Visual inspection of housing for damage		
Firmware updated to latest version		
Buzzer (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		

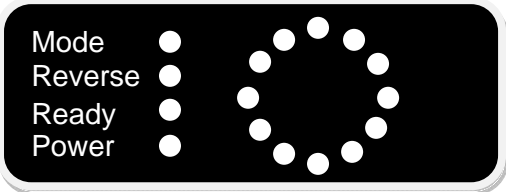
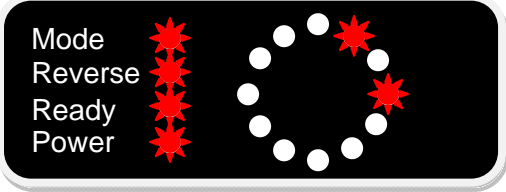
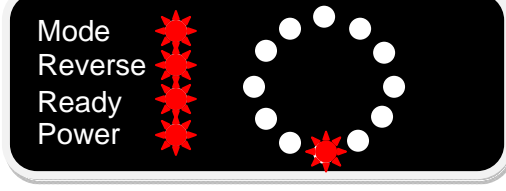
Appendix E: Troubleshooting guide

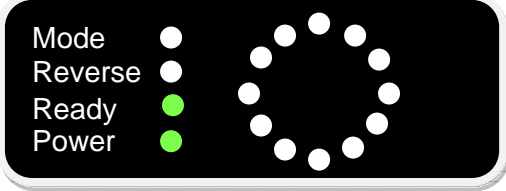
Find the failure case in the table below. Click on the links in the “Troubleshooting Instructions” column for more detailed instructions on how to resolve failure. Consult Installation Manual for further information.

LED OFF	○
LED ON green	●
LED flashing green	★
LED ON red	●
LED flashing red	★

Normal working system moving forward reporting one distant vehicle to the right:



Symptom	Failure Description	Troubleshooting Instructions
<p>All LED OFF</p> 	<p>No power indication main unit</p> <p>No power indication remote display</p>	<ul style="list-style-type: none"> - Check vehicle has power - Ensure main unit is connected to power cable, power connector fully engaged, no bent pins. - Check fuse - Check power cable properly attached to battery - Replace main unit with known good unit <p>Check all items above. If problem persists:</p> <ul style="list-style-type: none"> - Check main unit is connected to remote display by cable - Check for bent pins on remote display, cable, and main unit - Replace remote display with known good unit
	<p>No GPS</p>	<ul style="list-style-type: none"> - Ensure Antenna has unobstructed view of sky - Check Antenna connected to main unit - Check Antenna cable intact - Check Antenna cable crimp contacts - Check Antenna for damage - Replace Antenna with known good unit - Replace main unit with known good unit
	<p>Bad configuration file</p>	<ul style="list-style-type: none"> - Check configuration file for errors - Upload known good configuration file

<p>No indication of nearby vehicles</p> 	<p>No radio communication</p>	<ul style="list-style-type: none"> - Check Antenna connected to main unit - Check Antenna cable intact - Check Antenna cable crimp contacts - Replace Antenna with known good unit - Replace main unit with known good unit
<p>Indication of vehicles where no vehicles are</p>	<p>Bad GPS</p>	<ul style="list-style-type: none"> - Vehicles inside buildings or next to walls may obtain an inaccurate GPS position. If such an inaccurate position is reported to another vehicle it may indicate a vehicle where none is.

Main Unit Power

Power Cable



Check for bent pins on the main unit power connector. Screw power cable onto connector until fully engaged.

Fuse

Fuse holder is usually placed in line with the power cable close where power cable is attached to vehicle power (i.e. battery).

Open fuse holder. Remove fuse and check if intact.

Remote Display Connection



Check for bent pins on the main unit remote display connector and on the remote display as well as the cable. Carefully connect remote display cable. Note that there are no locking pins. The contacts prevent the connector from rotating when it is screwed on and can bend.

Antenna and Cable Connection



Ensure antenna cable is connected to main unit and antenna. Two cables exit the antenna, one carrying the GPS signal, the other carrying the RF signal. Both cables need to be connected and fully engaged.

The main unit has a port labeled GPS and a port labeled RF. If not sure which cable connects to which port try both combinations until main unit lights ready LED.

Crimp Contacts

Check the crimp contacts of the RF and GPS cable for any damage. Re-crimp if needed or use new cable.