ADVANCED MINING TECHNOLOGIES PTY. LTD.

COLLISION AVOIDANCE SYSTEM CAS-CAM/RF®
Operating Instructions

18 June 2010

Issue E

Dear Customer

Thank-you for purchasing the CAS-CAM/RF® system.

We strongly suggest that you note the listed Precautions and carefully study the Operating Instructions before attempting to operate the CAS-CAM/RF® system.

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1 PRECAUTIONS

Please read these precautions carefully before you operate the CAS-CAM/RF® system.

1.1 Certifications

This equipment has been independently tested and found to comply with the following standards:

- AS/NZS3548 'Electro-magnetic Compatibility for Information technology Equipment' (CISPR22, EN55022), Class A, C-tick Mark Supplier Code Number N11443
- AS/NZS 4268.2 'Low Interference Potential Devices Class License'
- ACMA Radio Communications (Short Range Devices) Standard 2004
- ES60950-1: 2001 'Information Technology Equipment – Safety – Part 1: General Requirements'
- ETSI EN 301 489-1 V1.8.1 (sections 9.2 and 9.6) 'Electromagnetic compatibility and Radio spectrum Matters (ERM); Electromagnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.'
- ETSI EN 301 489-1 V1.8.1 (2008-04) and ETSI EN 301 489-3 V1.4.1 (2002-08)
- ETSI EN 300 220-1 v2.1.1 (2006-04)

1.2 Operation

- Warning – this product is not to be operated within 20 cm of people (FCC requirement)
- Warning – this product is not to be modified from the Manufacturer's standard design as this will void manufacturer's warranty and could impact Certifications.
- Warning – This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
- The CAS-CAM/RF® System is a safety aid in providing the drivers of Heavy Vehicles, Light Vehicles and Personnel Tag users with additional information to make informed decisions in order to reduce the incidence of collisions. The system is not designed to be a stand-alone safety interlocking system that can give a false sense of protection and security, but still requires that all vehicle drivers and personnel still take every manual precaution to avoid the incidence of collisions. The system is designed as an aid to supplement and enhance existing safe work practices and procedures.
- In the event of equipment malfunction, check the Troubleshooting section for remedial action. If not covered by this section, consult the AMT Service Agent.
- To prevent fire or shock hazard, do not expose the Heavy Vehicle Display Unit to rain or moisture.
- To avoid electrical shock, do not open the electrical equipment enclosures. There are no user serviceable parts located inside the equipment items. Refer servicing to the AMT Service Agent.
- To maintain clear camera vision on the Heavy Vehicle Display Unit, the user is recommended to regularly clean the build up of foreign material from the camera unit window. Cleaning can best be conducted with a window cleaning spray and cloth. Approved access methods must be used when cleaning cameras located at heights.
- The audible alarms contained within the Heavy Vehicle Display Unit, Light Vehicle Dash Alarm Unit and Mobile Plant & Equipment Dash Alarm Unit must not be blocked with foreign objects in order to reduce alarm sound levels as this is the

primary means of notifying drivers of potential collisions. Consult the AMT Service Agent if you wish to adjust the alarm sound levels to suit the ambient noise levels of the particular installation. Additionally for the above reason, the Light Vehicle Dash Alarm Unit and Mobile Plant & Equipment Dash Alarm Unit must not be disconnected during normal operation.

- The visual alarms contained on the Heavy Vehicle Display Unit Screen, Light Vehicle Dash Alarm Unit and Mobile Plant & Equipment Dash Alarm Unit should not be covered over with foreign objects in order to reduce night vision glare, as this is the secondary means of notifying drivers of potential collisions (the primary means being the audible alarms). The brightness level can be switched to a low setting on the Heavy Vehicle Display Unit Screen by activating 'DIM' mode (refer to section 10.1.8). The intensity of the Power On LED indicators on both equipment items and the Light Vehicle Dash Alarm Unit and Mobile Plant & Equipment Dash Alarm Unit 'alarm' LED indicators have been set at low intensity levels suited for both day and night visibility.
- This equipment generates random low power radio frequency emissions (license exempt) for automatic object detection using RF tagging (CAS-RF®) and could interfere with existing radio communication devices even though classified as a 'Low Interference Potential Device' (LIPD). If this is the case, contact the AMT Service Agent for further investigation. Operating frequencies may need to be changed to cater for existing radio communication spectrum usage for the particular application. Similarly, the CAS-RF® equipment may not be immune to interference by other higher power radio communication devices present on site.

1.3 Installation

- Only AMT Service Agents are to carry out installations. Non-approved installations will automatically void the warranty conditions.

1.4 Repairs

- Only AMT Service Agents are to carry out repairs. Non-approved repairs will automatically void the warranty conditions.
- Do not remove equipment item covers. There are no user serviceable parts located inside the equipment items.

2 SYSTEM OVERVIEW

2.1 Introduction

Since the advent of large mining trucks there has been an ongoing problem with collisions resulting from poor external vision and limited maneuverability. This has resulted in a very high incidence of accidents where large mining trucks collide with other vehicles, items of plant and occasionally people. Over the last 10 years in Australian open cut coal mines in the states of New South Wales and Queensland, 147 collisions have been reported involving large mining equipment. Of these, a large proportion has been the result of poor visibility (see Figure 1). Remarkably there have been few fatalities but property damage and lost productivity has been significant.

The only protection against collisions in the blind areas of a truck at the moment are procedural or "soft" barriers, such as no-go zones for Light Vehicles, standard parking and start-up procedures, and audible reversing alarms. Even with these procedural controls and noisy reversing alarms in place, the problem of Heavy Vehicle collisions has not been eliminated. In addition to the requirement for an improved collision avoidance system, the noise from these smart reversing alarms have recently come under review in mines operating in close proximity to residential areas.

Even if the Heavy Vehicle driver could be provided with 360 degree unlimited vision around the Heavy Vehicle, this would still not be adequate because of the vehicle size. The driver would only be able to ‘look’ in a limited number of directions at once with the potential for also creating distractions from safe driving.

An improved approach is to provide enhanced driver vision supplemented by an automatic detection system that looks in all high risk directions at once, identifies potential problems and attracts the driver’s attention to those areas where potential collisions could occur. In addition, a further level of effectiveness is to provide warning information to both the Heavy Vehicle driver and the objects/personnel at risk, as any hazardous situation involving two parties, in which one party does not have the ability to take action, is inherently unsafe.

As part of the ongoing commitment to improving safety and productivity through the application of innovative technology, Advanced Mining Technologies (AMT) in conjunction with CSIRO Exploration and Mining has developed such a Collision Avoidance System (CAS) aimed at greatly improving Heavy Vehicle safety and eliminating the need for audible reversing alarms.

The CAS technology utilises state of the art colour video cameras with an LCD video Display Unit as a vision aid (CAS-CAM®) and Radio Frequency (RF) transmitters and receivers for automatic object proximity detection and classification (CAS-RF®). The combined video camera and RF technologies form the CAS-CAM/RF® System.

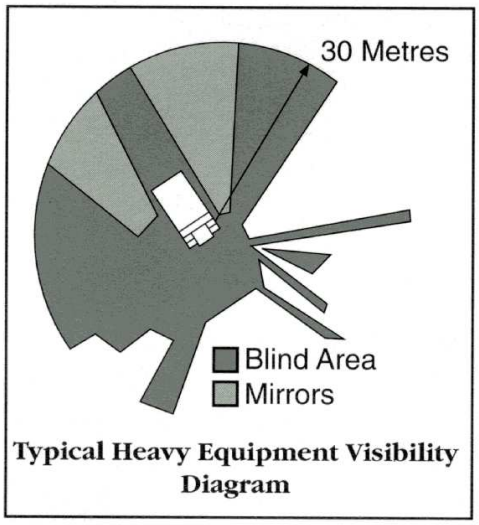


Figure 1: Typical Visibility Map for a Large Haul Truck (QMITAB 1998)

2.2 Performance Capabilities

The key performance capabilities of the CAS-CAM/RF® System are as follows:

- Warning to the driver of the Heavy Vehicle when a vehicle, personnel or stationary object is in the Heavy Vehicle's path (visual and audible warning when an object is detected within a programmed detection range)
- Warning to the "AT-RISK" personnel / vehicles / equipment in the case of an imminent collision when the Heavy Vehicle is detected within a programmed detection range (visual and / or audible warning)
- Programmable detection ranges for different object types from 0 – 80 m (accuracy of +/-20%). Option for long range operation (typically 200-300m) for haul road crossing warning light activation by approaching Heavy Vehicle or Heavy Vehicle to Heavy Vehicle haul road fatigue management 'wake-up' alarms.
- Improved vision for the driver (i.e. video cameras)
- Mechanism for driver acknowledgment of alarms
- Reversing Alarm activated when personnel / objects are within the programmed detection range of the Heavy Vehicle when in the reverse direction (optional)
- Default to existing warning system by notifying the driver of the Heavy Vehicle when the system is not working and automatically activates the traditional reversing alarm
- Rugged construction for reliability in mining environments
- Reliable operation in adverse environmental conditions (e.g. dust, fog, smoke, hot, cold and darkness)
- System aids and doesn't inhibit current mine operations
- Coded identification of objects within programmed detection range displayed at all times (i.e. Heavy Vehicle (HV), Light Vehicle (LV), Stationary Object (SO) / Fixed Plant, Personnel Tag (PT), Test Station (TS))
- Data logging capability on all Heavy Vehicles and Light Vehicles for monitoring / recording system operational performance & logging all anti-collision detections as a safety audit trail (optional).
- Easy integration with existing Mine Fleet Management Systems (e.g. Modular Mining, Tritronics, WENCO etc) either via the Display Unit serial interface using MODBUS protocol or via the Expansion Unit RS-485 or CAN interface. This allows the transfer of

vehicle detection data in ‘real-time’ back to the mine central monitoring station / Dispatch as a safety-audit-trail for operator compliance monitoring.

2.3 Features and Benefits

Features	Benefits
• Combined vision system (CAS-CAM®) & automatic object detection (CAS-RF®) technologies (CAS-CAM/RF®)	• Comprehensive Heavy Vehicle safety package utilising both vision aids (cameras) and automated object proximity detection (using active RF tags) for safe interactions between Heavy Vehicles, Light Vehicles, Personnel and Stationary Objects. • Single compact video display / alarm unit alerts Heavy Vehicle operator when objects are in the vehicle's path. • Automatic alarming alleviates need to monitor video display whilst driving thus reducing distractions. Alarms attract the driver's attention to areas of potential collisions. • Improved driver vision using high-resolution colour video cameras. • Multiple levels of collision detection redundancy (i.e. two-way RF tagging, Video Cameras, reversing alarms and side mirrors). • Seamless integration of CAS-CAM® and CAS-RF® components into CAS-CAM/RF®.
• Two-way alarming	• Heavy Vehicle driver receives alarm when another Heavy Vehicle, Light Vehicle, Personnel, Mobile and / or Stationary Objects are in the vehicle's path and can take appropriate action. Driver can also confirm presence of 'AT-RISK' objects using unique object Identification Codes for specific radio confirmation and can also check location using video cameras. • Individual warning to the "AT-RISK" personnel and / or mobile object of the approaching Heavy Vehicle so that appropriate action can be taken. • Avoids the hazardous situation involving two parties, in which one party does not have the ability to take action, as this is inherently unsafe.

Features	Benefits
• Coded object classes and unique ID codes (i.e. Heavy Vehicle (HV), Light Vehicle (LV), Stationary Object (SO) Personnel Tag (PT), Test Station (TS))	• Heavy Vehicle driver receives real time indication of the number of objects in each class and object identification codes and can confirm the location of the object(s) using video cameras. • Alarms generated when object status changes within the programmed detection range(s). • Multi-RF tag operation. • RF tag could also be used for access control purposes when integrated with a security access control system.
• Programmable multiple detection ranges from 0 – 80 m (accuracy of +/- 20%). • Option for long range operation (typically 200-300m) for haul road crossing warning light activation by approaching Heavy Vehicle or Heavy Vehicle to Heavy Vehicle 'wake-up alarm' for managing driver fatigue on long haul roads.	• Flexibility to adjust detection ranges to suit specific applications. • Programmable detection ranges available on Heavy Vehicle for different object types (e.g. HV, LV, SO, PT, TS), HV detection location (i.e. front or rear or sides), HV direction of travel (forward or reverse) and speed. • Single detection range on Personnel, Light Vehicle, Stationary Object & Test Station tags. • Heavy Vehicle detection ranges can be dynamically changed according to vehicle speed for high speed and low speed collision warning ranges.
• Cameras can be programmed to automatically switch to front or rear or side cameras either on gear changes and / or automatic object detections	• Provides driver with visual confirmation of the presence of new object (s) without having to manually switch to the front or rear camera.
• High performance Heavy Vehicle & RF communications backbone	• Allows flexibility for custom operation and future expansion. • Easy integration with other Heavy Vehicle collision sensing technologies (e.g. radar, ultra-sonics). • Easy integration with existing mine data telemetry networks (e.g. fleet management systems).
• Heavy Vehicle and Light Vehicle data logging capability for all detections (optional)	• Able to monitor system performance and all collision detections as a safety audit trail. • Data recoverable via laptop PC or in real-time using Fleet Management System.

Features	Benefits
• Heavy Vehicle RF Unit eliminates the need for noisy reversing sirens when other 'AT RISK' objects are protected with RF tags.	• Reduced noise emissions in particular when operating near residential areas (i.e. improves license to operate and compliance with environmental noise emission regulations). • Reversing alarms can be activated when either objects are detected within the programmed detection zone (optional) or when a system malfunction is detected.
• Localised System compared with Distributed Wide Area Network	• Not reliant on existing mine infrastructure for reliable operation (i.e. good risk management practice). • High level of redundancy. • Fast detection response time (typically under 300 msec for 10 units operating within the detection range).

3 BASIC SYSTEM OPERATION

The CAS technology offers significant benefits in the safety and productivity of both surface and underground mining operations by eliminating Heavy Vehicle blind spots using a combination of high-resolution colour cameras and automatic object detection using active Radio Frequency (RF) tagging of ‘AT RISK’ objects / personnel. Objects types that can be fitted with RF tags include Heavy Vehicles, Light Vehicles, Stationary Objects, Mobile Plant & Equipment and Personnel (currently under development). Object detection zones ('safety bubbles') can be programmed from 0 - 80m range (long range option for 200 - 300m range). Heavy Vehicles fitted with camera only systems can be seamlessly upgraded to include the RF tagging capability. The colour video display in the Heavy Vehicle also functions as an alarm panel which automatically alerts the driver to the presence of the type and number of objects detected in either the front or rear or side detection zones. Cameras can be programmed to automatically switch to front or rear cameras either on gear changes and / or automatic object detections. Heavy Vehicle reversing sirens can also be switched off when Heavy Vehicles and other 'AT RISK' objects / personnel are protected with the RF tags. The system also provides 2-way alarming between the Heavy Vehicle and the ‘AT RISK’ objects / personnel, as any hazardous situation involving two parties, in which one party does not the ability to action, is inherently unsafe. Only objects tagged as Heavy Vehicles generate alarms as they create the greatest risk of collision with other objects due to size and blind spots.

4 SYSTEM DESCRIPTION

4.1 Overview

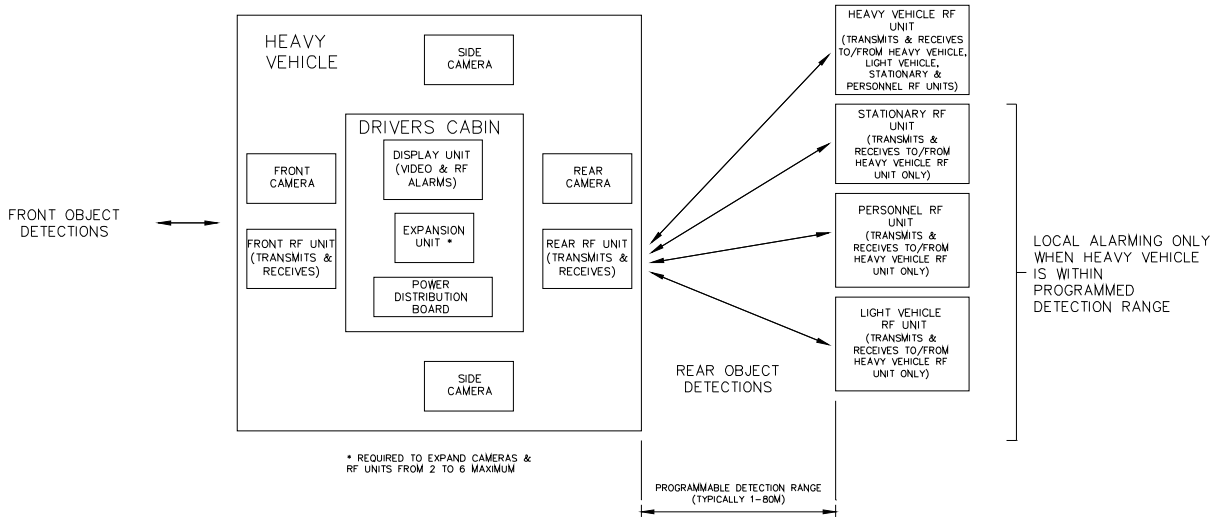


Figure 2: System Function Diagram

The CAS-CAM/RF® system consists of Radio Frequency (RF) Tags for each person, Light Vehicle, Heavy Vehicle and other items of value. The Heavy Vehicle also has high quality colour video cameras and a high definition colour LCD video Display Unit. The camera video images and RF tagging alarms, in text format, are simultaneously displayed on the Display Unit inside the Heavy Vehicle driver's cabin.

The video camera is housed in a ruggedised enclosure and produces full colour vision down to 0.03 lux illumination. Camera settings such as brightness and colour can be set for each individual camera at the time of installation. Up to six (6) cameras can be attached to the Display Unit (2 directly, 4 via an Expansion Unit). User programmable camera functions include: DIM (brightness settings) and manual camera switching. Additional programmable camera settings fixed at the time of installation include: Camera titles (8 characters maximum), mirror / normal mode, auto switching to reverse / forward camera when vehicle either engages reverse / forward gear or when RF detections are recorded at the rear / front, camera cycling at variable rates. All settings are saved during power down.

The Radio Frequency system transmits digitally coded data such as tag identification number, tag type, vehicle status and tag status. This is crucial to the system's ability to discriminate when multiple tags are detected of various object classes.

A high quality, license exempt, digital RF link is used with full error control.

Personnel Tags (under development) are mounted on a safety vest and operate on rechargeable batteries.

The system can be purchased with the following options:

- Video Only system for enhanced vision applications: CAS-CAM®
- RF Only system for automatic object detection: CAS-RF®
- Video & RF systems (vision & object detection): CAS-CAM/RF®

A Video only system (CAS-CAM®) or RF only system (CAS-RF®) can be easily upgraded for full Collision Avoidance System capability (CAS-CAM/RF®) as both technologies can be seamlessly integrated with each other.

4.2 Heavy Vehicle System

The Heavy Vehicle System comprises of the following components:

- Camera Unit (up to 6 units)
- Display Unit
- Expansion Unit
- Front and / or Rear RF Unit and / or Side RF Units

Details on these components are as follows:

4.2.1 Camera Unit (PROD0118)

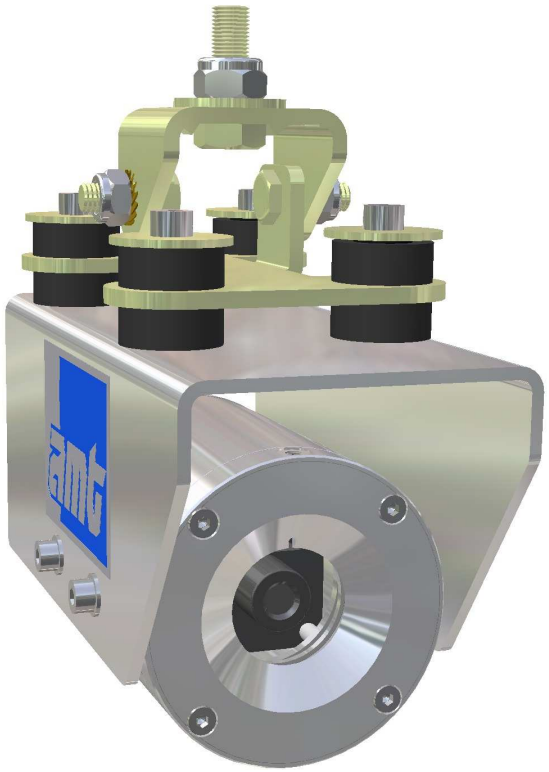


Figure 3: Camera Unit (PROD0118)

The Camera Units are water and dust resistant and designed to withstand the high-pressure water sprays commonly used to clean Heavy Vehicles.

Features:

- IP 66 rated enclosure
- High resolution colour 1/3" CCD image sensor

- Resolution: 380 TV lines
- Viewing angle: 123 degrees horizontal and 91 degrees vertical (153 degrees diagonal) (narrower viewing angles are available on request)
- Minimum illumination: 0.03 lux / F1.2 using day/night camera
- Waterproof connection system
- Small contemporary design
- Solid aluminium construction
- Highly adjustable mounting hardware
- Optional attachment for compressed air/water lens cleaning system (end user to arrange)

4.2.2 Display Unit (PROD0119)

Figure 4: Heavy Vehicle Display Unit (PROD0119)

The Heavy Vehicle Display Unit consists of an active matrix 6.4” colour LCD screen. It displays images from the cameras, text information received from the RF system, and driver controls for camera selection adjustment and alarm acknowledgement. The Display Unit also contains an RS-232 interface for system configuration and recovering logged detection data via a laptop PC.

Features:

- IP 32 rated enclosure
- Full colour display (6.4” colour TFT LCD)
- High resolution (960W x 234H) anti-glare screen

- User programmable camera functions include: DIM (brightness)
- Installer mode functions programmable via a Laptop PC using RS-232 interface include: Channel Settings (6 camera channels maximum), Camera Titles (8 characters maximum), Camera Brightness (1-5), Camera Colour (1-5), Camera Mirror (on/off), Camera enabled (yes/no), Camera Auto Cycling (off, 2s, 4s, 6s, 8s, 10s), Keypad Tone (yes/no), Auto Switch to Reverse / Forward Camera on Reverse / Forward Gear Selection and / or Rear / Front RF Unit detections, Display power down settings (sleep time: off, 5mins, 10mins, 15mins, 20mins, 25mins, 30mins), Camera Wake Settings (on forward gear and / or reverse gear), RF Detection Settings (programmable range, visual & audible alarms for various object types and direction of travel), Clock Settings.
- Wide operating power supply range (10–30 VDC, 25W max)
  (Note: The Display Unit, Expansion Unit, Camera Units and RF Units can be permanently powered from the Heavy Vehicle battery with the Display Unit screen powering down after a preset timeout period when the vehicle is not in forward or reverse gear (if enabled). This function conserves battery life and enables the RF tagging to still be active when the vehicle is unattended for the benefit of other vehicles. Camera only installations (CAS-CAM®) are powered from the vehicle auxiliary / ignition circuit.
- 4 function membrane keypad
- On-screen display function (text overlaid on video)
- Real time clock
- Audible alarm
- Menu settings saved during power down
- Two camera inputs (expandable up to 6 cameras using Expansion Unit) - can connect RF Units to Camera inputs for upgrade to RF tagging capability (CAS-CAM/RF®)
- Video output – PAL (for connection to VCR)
- RS-232 & RS-485 interfaces
- Rugged aluminum construction
- Optional sun visor (PROD0164)

4.2.3 Expansion Unit (PROD0161)

Figure 5: Heavy Vehicle Expansion Unit (PROD0161)

The Heavy Vehicle Expansion Unit provides the ability to easily expand the number of cameras and RF Units from the standard 2 channels supported by the Display Unit up to a maximum of 6 channels.

Features:

- IP 54 rated enclosure
- Provides Camera Unit & RF Unit expansion up to 6 units maximum with the Display Unit
- 4 local camera inputs (in addition to 2 camera inputs on Display Unit) – can connect RF Units to Camera inputs for upgrade to RF tagging capability (CAS-CAM/RF®)
- 4 auxiliary inputs (opto isolated) (e.g. reverse & forward signals)
- 2 switched contact outputs (voltage free) (e.g. reverse alarm circuit)
- RS-232, RS-485 & CAN interfaces
- Wide operating power supply range (10–30 VDC, 50W max) – also powers Display Unit
  (Note: The Display Unit, Expansion Unit, Camera Units and RF Units can be permanently powered from the Heavy Vehicle battery with the Display Unit screen powering down after a preset timeout period when the vehicle is not in forward or reverse gear (if enabled). This function conserves battery life and enables the RF tagging to still be active when the vehicle is unattended for the benefit of other vehicles. Camera only installations (CAS-CAM®) are powered from the vehicle auxiliary / ignition circuit.
- Input power provided from vehicle electrical distribution board (10–30 VDC, 50W max)
- Rugged aluminum construction
- Typically located within 10 metres of Display Unit

4.2.4 Front / Rear RF Unit (PROD0239 / PROD0169)

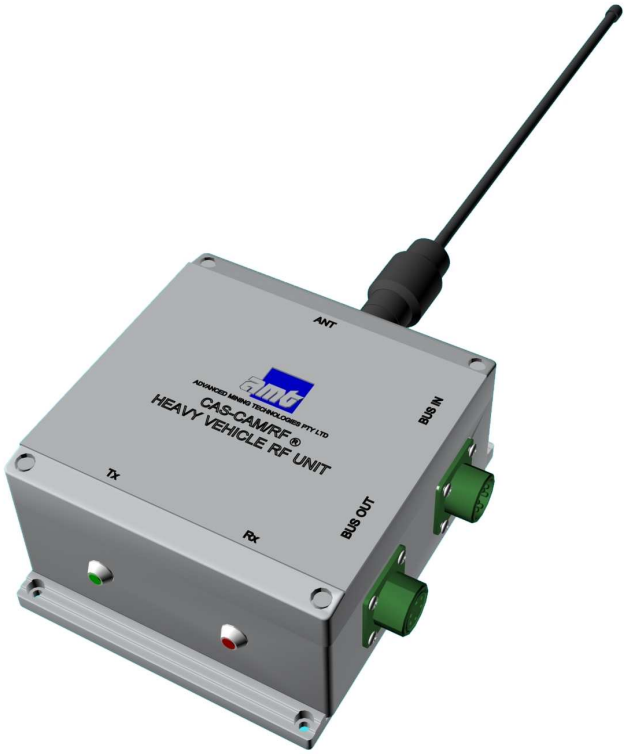


Figure 6: Heavy Vehicle (HV) RF Unit (Front – PROD0239 / Rear – PROD0169)

The Heavy Vehicle (HV) RF Unit is available in both Front and Rear models for mounting at the front and rear of the vehicle respectively. Rear mounted versions are typically located above the rear axle of large rear dump trucks; front mounted versions are typically located in front of the grill on the driver access ladder. The unit receives the transmitted signal from the other RF units and also continuously transmits a signal for triggering alarms on the remote tags when located within the programmed detection range.

Optional Side RF Units (Left RF Unit, Right RF Unit) are available for effective 360 degree close-range start-up object detection, whereas Front & Rear RF Units only provide partial blind-spot object detection at the expense of long range detection directly in front or behind.

Features:

- IP 56 rated enclosure
- Low power RF transceiver operates in LIPD class license for unlicensed bands
- Digital RF data transmission with full error control
- Detection angles typically in range 90 – 120 degrees at rear (including detection in rear tyre path) and 180 degrees at front.
- Power supply 12VDC, 100mA maximum
  (Note: The Display Unit, Expansion Unit, Camera Units and RF Units can be permanently powered from the Heavy Vehicle battery with the Display Unit screen powering down after a preset timeout period when the vehicle is not in forward or reverse gear (if enabled). This function conserves battery life and enables the RF tagging to still be active when the vehicle is unattended for the benefit of other vehicles.

- Input power provided from Display Unit or Expansion Unit
- Up to two units can be connected directly to Display Unit camera channels or additional 4 units connected via the Expansion Unit. Can multi-drop RF Units with camera connected directly to RF Unit (e.g. Front + Left Side RF Units, Rear + Right Side RF Units).
- External Tx and Rx activity indicators
- Rugged aluminum construction

4.3 Light Vehicle (LV) System (with integral beacon) (PROD0246)

The Light Vehicle (LV) System (with integral beacon) comprises of an RF unit integrated into a Light Vehicle Unit (Rotating Beacon) (Figure 7) as commonly used at open cut mine sites, which is normally fitted to the roof of a Light Vehicle. A driver dash-mounted Alarm Unit (Figure 8) is situated inside the vehicle cabin to provide both an audible and visual warning to the driver when a Heavy Vehicle (HV) or Test Station (TS) is detected within the programmed detection range. The Alarm Unit also contains a RS-232 interface for system configuration and recovering logged detection data via a Laptop PC.

Features:

- IP 54 rated enclosure
- RF transceiver integrated into Rotating Beacon (12V, 55W)
- Dash mounted Alarm Unit containing audible alarm buzzer, flashing alarm indicator, power indicator and RS-232 interface
- Rotating Beacon & dash mounted Alarm Unit activated when Heavy Vehicle (HV) (in gear) or Test Station (TS) is detected within the pre-programmed range
- Low power RF transceiver operates in LIPD class license for unlicensed bands
- Digital RF data transmission with full error control
- Object detection angle of 360 degree
- Operating power supply: nominal 12VDC, 5A maximum
- Input power provided from vehicle electrical distribution board (via battery) for permanent installation.
  (Note: The Light Vehicle Unit is normally permanently powered from the vehicle battery which enables the RF tagging to still be active when the vehicle is unattended for the benefit of other vehicles. The Rotating Beacon on the roof will only be activated when either a Heavy Vehicle (HV) (in gear) is detected or a Test Station (TS) is detected within the programmed range.)
- Rugged construction

Figure 7: Light Vehicle (LV) System – Light Vehicle Unit (PROD0209)

Figure 8: Light Vehicle (LV) System – Dash Alarm Unit (PROD0211)

4.4 Light Vehicle (LV) System (with external beacon option) (PROD0294)

The Light Vehicle (LV) System (with external beacon option) comprises of an RF unit (Figure 9**Figure 7**) which is normally fitted to the roof of a Light Vehicle. A driver dash-mounted Alarm Unit (Figure 10) is situated inside the vehicle cabin to provide both an audible and visual warning to the driver when a Heavy Vehicle (HV) or Test Station (TS) is detected within the programmed detection range. The Alarm Unit also contains a RS-232 interface for system configuration and recovering logged detection data via a Laptop PC.

Features:

- IP 54 rated enclosure
- RF transceiver
- Optional external beacon interface (12VDC@5A maximum)
- Dash mounted Alarm Unit containing audible alarm buzzer, flashing alarm indicator, power indicator and RS-232 interface
- Optional External Beacon & dash mounted Alarm Unit activated when Heavy Vehicle (HV) (in gear) or Test Station (TS) is detected within the pre-programmed range
- Low power RF transceiver operates in LIPD class license for unlicensed bands
- Digital RF data transmission with full error control
- Object detection angle of 360 degree
- Operating power supply: nominal 12VDC, 5A maximum (0.1A without external beacon)
- Input power provided from vehicle electrical distribution board (via battery) for permanent installation.
  (Note: The Light Vehicle Unit is normally permanently powered from the vehicle battery which enables the RF tagging to still be active when the vehicle is unattended for the benefit of other vehicles. The Rotating Beacon on the roof will only be activated when either a Heavy Vehicle (HV) (in gear) is detected or a Test Station (TS) is detected within the programmed range.)
- Rugged construction

Figure 9: Light Vehicle (LV) System – Light Vehicle RF Unit (with external beacon option) (PROD0295)

Figure 10: Light Vehicle (LV) System – Dash Alarm Unit (PROD0211)

4.5 Stationary Object (SO) System (PROD0210)

The Stationary Object (SO) System is an identical design to the Light Vehicle (LV) System (Figure 7), however, is coded as a Stationary Object (SO). The unit would normally be mounted on fixed plant / equipment / obstacles that are prone to being damaged by Heavy Vehicles. The unit can be powered by either battery packs with solar panel charging capability or powered directly from mains powered 12VDC supply.

4.6 Mobile Plant & Equipment (HV) System (PROD0225)

The Mobile Plant & Equipment (MPE) System is an identical design to the Light Vehicle (LV) System (Figure 7), however, is coded as a Heavy Vehicle (HV). The unit would normally be mounted on Mobile Plant & Equipment that doesn't require a Display and Camera Unit(s).

The Mobile Plant & Equipment System comprises of an RF unit integrated into a Mobile Plant & Equipment Unit (Rotating Beacon) (Figure 7) as commonly used at open cut mine sites, which is fitted to the roof of mobile plant & equipment. A driver dash-mounted Alarm Unit (Figure 8) is situated inside the vehicle cabin to provide both an audible and visual warning to the driver when another Heavy Vehicle (HV), Light Vehicle (LV), Stationary Object (SO) or Test Station (TS) is detected within the programmed detection range. The Alarm Unit also contains a RS-232 interface for system configuration and recovering logged detection data via a Laptop PC.

4.7 Personnel Tag (PT) Unit

Figure 11 – Personnel Tag (PT) Unit (prototype version)

Personnel Tag (PT) Units (under development) can be provided in a safety vest version and provides a warning to the user via a combination of audible and vibrating battery alarms. The units operate on rechargeable batteries.

Features:

- RF Transceiver integrated into small, lightweight sealed enclosure
- Mounts onto safety vest and can be removed for battery charging
- audible alarm and vibration alarm when within the programmed detection range of either a Heavy Vehicle (HV) (in-gear) or Test Station (TS)
- Powered from rechargeable batteries
- Low power RF transceiver operating in LIPD class license for unlicensed bands
- Digital RF data transmission with full error control
- Object detection angle of 360 degrees
- RF tag operational check performed during battery charging
- RF tag could also be used for access control purposes when integrated with security access control system

4.8 Test Station (TS) System (PROD0241)

A Stationary Object (SO) Unit can be configured internally as a Test Station object type (TS) for in-field testing of all mobile CAS tagged object types (e.g. Heavy Vehicle, Light Vehicle, Stationary Object, Personnel Tags). Test Stations are designed to be alarmed by and trigger alarms on all object types.

Test Stations would normally be installed in locations frequently passed by CAS RF tagged objects (e.g. maintenance workshop, GO-LINE, refueling station etc) and serve to provide regular functional two-way testing of all RF tagged objects. Solar power versions are available for remote locations.

Test Stations (TS) are detected in the following manner by each CAS tagged object type:

- Heavy Vehicle (HV)
  - TS object text displayed on Display Unit for front and rear detections
  - Normal object detection audible and visual alarms generated with 'CONFIRM' button operation
  - TS beacon activated when HV detected inside programmed detection zone. TS beacon switches OFF 3 seconds after HV moves outside programmed detection zone.

- Light Vehicle (LV)
  - Distinct pulsed alarm (warble) on dash-mount Alarm Unit and Rotating Beacon switched ON when TS detected inside programmed LV detection zone. LV audible and visual alarms switch OFF 3 seconds after LV moves outside TS programmed detection zone.
  - TS beacon activated when LV detected inside programmed detection zone. TS beacon switches OFF 3 seconds after LV moves outside programmed detection zone.

- Mobile Plant & Equipment System (HV)
  - Distinct pulsed alarm (warble) on dash-mount Alarm Unit and Rotating Beacon switched ON when TS detected inside programmed HV detection zone. HV audible and visual alarms switch OFF 3 seconds after HV moves outside TS programmed detection zone.
  - TS beacon activated when HV detected inside programmed detection zone. TS beacon switches OFF 3 seconds after HV moves outside programmed detection zone.

- Personnel Tag (PT)
  - PT alarms when TS detected inside programmed PT detection zone. PT alarm switches OFF 3 seconds after PT moves outside TS programmed detection zone.
  - TS beacon activated when PT detected inside programmed detection zone. TS beacon switches off 3 seconds after LV moves outside programmed detection zone.

5 SYSTEM OPERATION

5.1 General

The Heavy Vehicle will detect any tagged object within a pre-designated Detection Zone that can be programmed at the time of installation. The RF tags transmit an identification code that is deciphered by the Heavy Vehicle RF unit(s) and is classified into various object classes, i.e. Light Vehicle (LV), Personnel Tag (PT), Stationary Object (SO), other Heavy Vehicle (HV) or Test Station (TS).

The number of RF tags detected in each object class is displayed on the video monitor for both front and rear detections (refer to Figure 35 for the screen layout). The Heavy Vehicle unit also conducts initial and continuous self-checks to detect equipment malfunctions, which are reported to the driver on the Display Unit. The reversing siren circuit can be enabled as a fail-safe backup in the event of equipment failure or when an object is detected at the rear within the programmed detection zone.

The Heavy Vehicle is continually receiving and transmitting signals that are detected by the Personal Tags (PT), Light Vehicle (LV), Heavy Vehicle (HV), Stationary Object (SO) or Test Station (TS) RF tags. When in the Heavy Vehicle Detection Zone (and HV in gear), the Light Vehicle tags flash lights and sound an audible alarm in the cab. Tagged Stationary Objects and Test Stations flash lights for driver identification.

The driver is provided with the number of each class of obstacle within the Heavy Vehicle's Detection Zone, on the Display Unit. Only when the Heavy Vehicle is in gear will the audible alarm in the Display Unit sound when any objects have been detected within the Heavy Vehicle Detection Zone. Heavy Vehicle visual and audible alarms are fully programmable in the Display Unit for each object class (HV, LV, SO, PT, TS), based on range, HV detection location (front / rear / sides), direction of travel (forward / park / reverse) and speed.

All RF tags have a unique ID code that is logged when detected by either a Heavy Vehicle, Light Vehicle, Stationary Object, Mobile Plant & Equipment, Test Station or Personnel units. Collision detection data can be retrieved by either a Fleet Management System or Laptop PC for safety audit trail purposes.

The system has been designed to enable the installation of the CAS in it's entirety (CAS-CAM/RF®) or the high-resolution colour video system (CAS-CAM®) as a stand-alone product, with the necessary in-built smarts to install the RF interface (CAS-RF®) at a later stage, should the user so desire.

5.2 Programmable Detection Zones

Each RF tagged object has programmable Detection Zones as follows:

5.2.1 Heavy Vehicle Detection Zones

Fully programmable detection zones and audible alarms for different object types (e.g. HV, LV, SO, PT, TS) based on range (0-80m), vehicle gear status (i.e. forward, reverse, park), detection location (i.e. front or rear or sides) and vehicle speed.

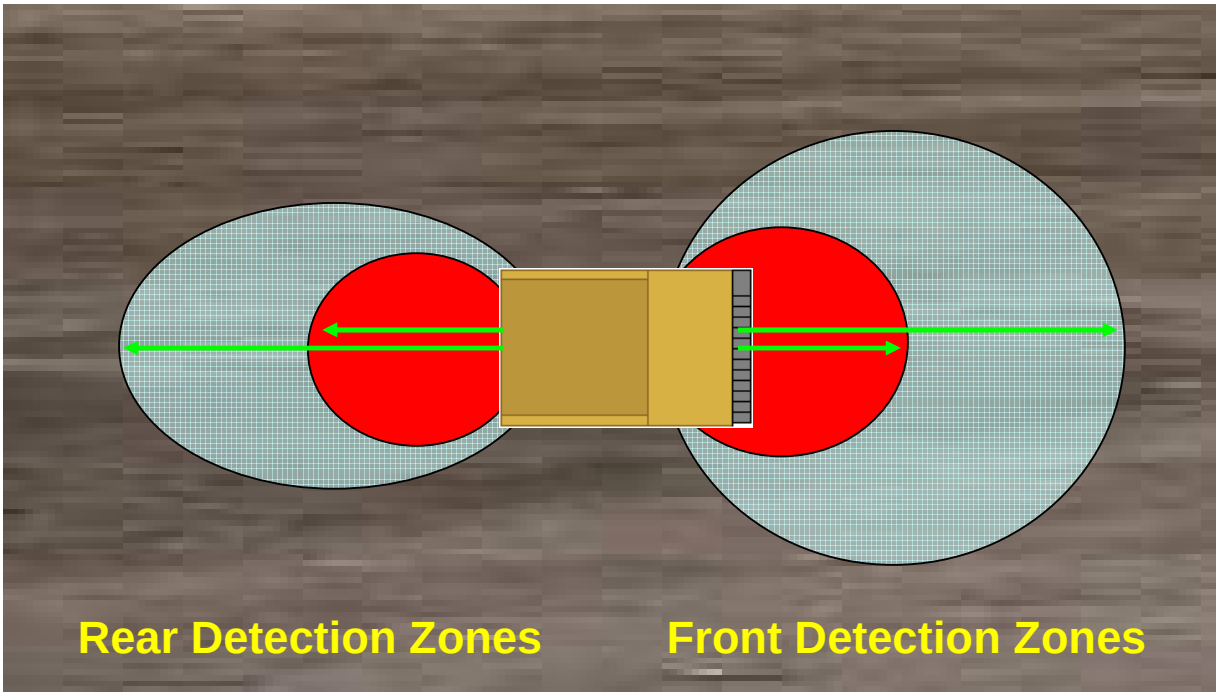


Figure 12 – Heavy Vehicle Front and Rear Detection Zones

5.2.2 Light Vehicle Detection Zone

Single Programmable Detection Zone
Radius programmable from 0- 80 m

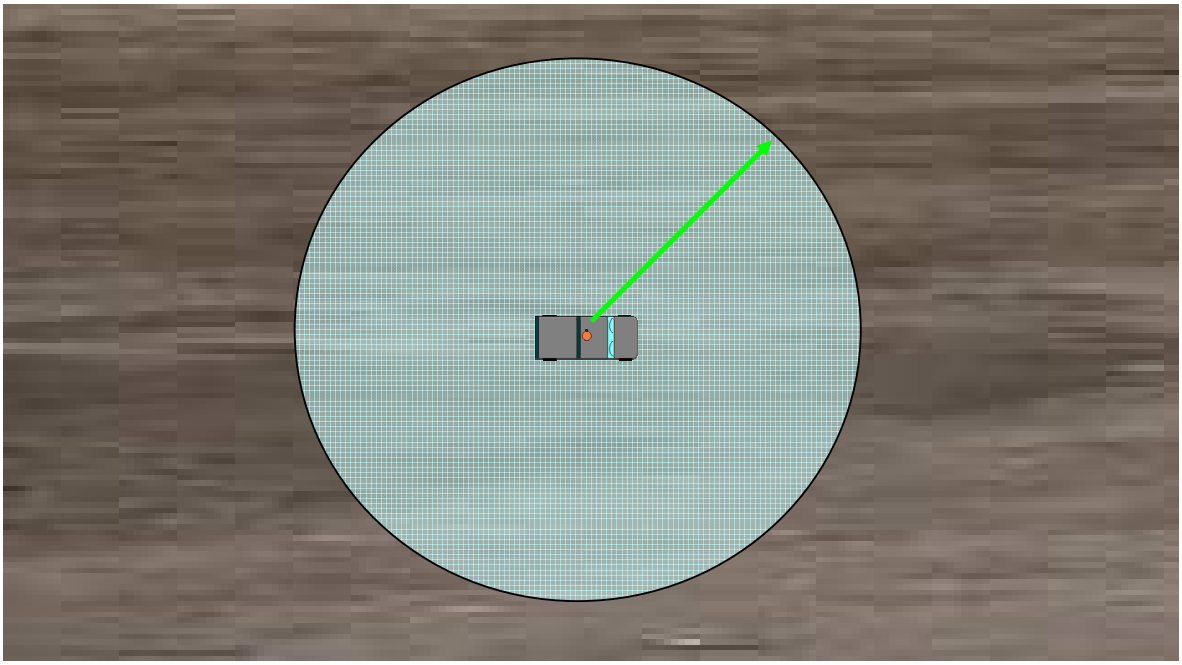


Figure 13 – Light Vehicle Object Detection Zone

5.2.3 Stationary Object / Mobile Plant & Equipment / Test Station Detection Zone

Single Programmable Detection Zone
Radius programmable from 0- 80 m

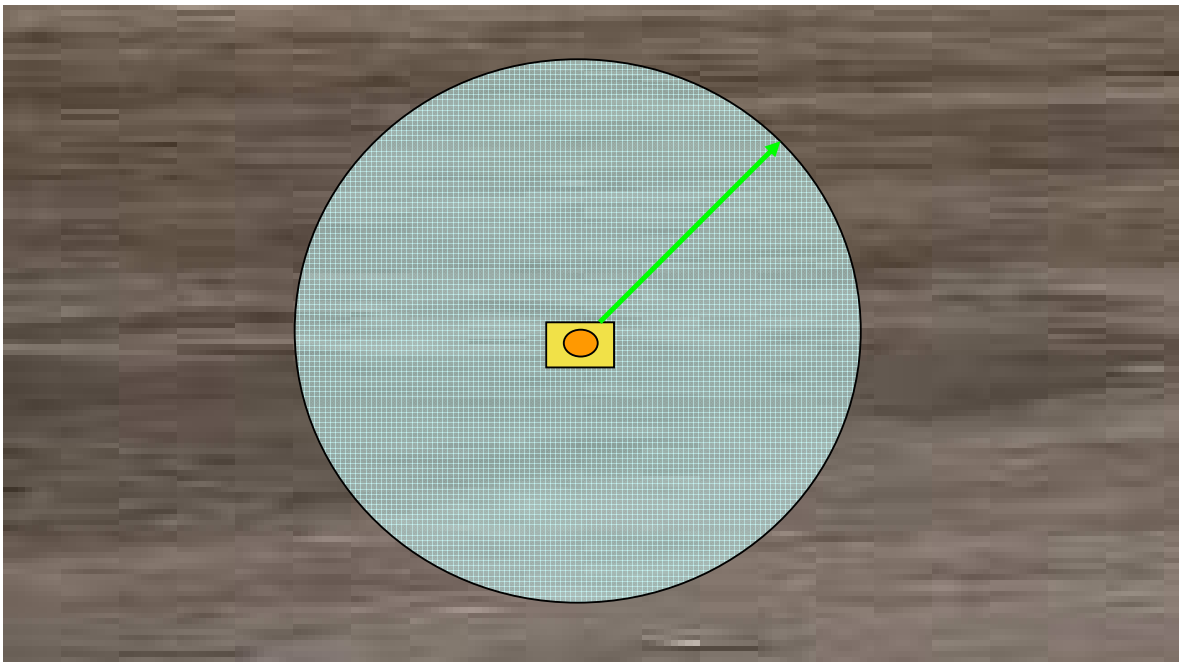


Figure 14 – Stationary Object / Mobile Plant & Equipment / Test Station Detection Zone

6 COLLISION AVOIDANCE APPLICATIONS

Mine site collision avoidance applications for the CAS-CAM/RF® system are unlimited and would typically cover:

6.1 Heavy Vehicle (HV) to Heavy Vehicle (HV) collision avoidance

(e.g. Rear Dump Trucks, Loaders, Dozers, Graders, Shovels, Draglines, Excavators, Water Trucks etc - covers forward, reverse and queuing scenarios)

HV to HV haul road queuing scenario: HV drives into rear of other HV either due to fatigue or poor visibility. The AMT CAS-CAM/RF® system alerts both HV drivers to the presence of both vehicles (within a programmed detection range) using both audible & visual alarms. The front HV Display Unit also switches to the REAR camera for visual confirmation and the rear HV Display Unit switches to the FRONT camera.

Heavy Vehicle (HV) to Heavy Vehicle (HV): stationary to reverse operation where the reversing HV drives into the other HV due to blind spots. The AMT CAS-CAM/RF® system alerts both HV drivers' to the presence of both vehicles (within a programmed detection range) using both audible & visual alarms. The Display Unit on the reversing HV also switches to the REAR camera for visual confirmation.

6.2 Heavy Vehicle (HV) to Light Vehicle (LV) collision avoidance

(covers forward, reverse and overtaking scenarios)

Heavy Vehicle (HV) to Light Vehicle (LV): stationary to forward operation where the HV drives over the LV due to blind spots. The AMT CAS-CAM/RF® system alerts both the HV driver and LV driver to the presence of both vehicles (within a programmed detection range) using both audible & visual alarms. The HV Display Unit also switches to the FRONT camera for visual confirmation.

Heavy Vehicle (HV) to Light Vehicle (LV): stationary to reverse operation where the HV drives over the LV due to blind spots. The AMT CAS-CAM/RF® system alerts both the HV driver and LV driver to the presence of both vehicles (within a programmed detection range) using both audible & visual alarms. The HV Display Unit also switches to the REAR camera for visual confirmation.

LV to HV overtaking scenario: LV overtakes HV without radio call-up and the HV turns right driving over the LV with fatal consequences. The AMT CAS-CAM/RF® system alerts both the HV driver and LV driver to the presence of both vehicles (within a programmed detection range) using both audible & visual alarms. The HV Display Unit also switches to the REAR / FRONT camera for visual confirmation as the LV moves from the HV Rear to HV Front detection zone.

6.3 Dragline / Shovel to Cleanup Dozer / Trailing Cable Handling Vehicle / Dump Truck collision avoidance

Vehicles remote to the Dragline / Shovel are damaged during swing cycles due to vehicles being located in blind spots within the swing radius. The AMT CAS-CAM/RF® system alerts all vehicle drivers to each other's presence (within a programmed detection range = swing radius + safety margin) using both audible & visual alarms. The Dragline / Shovel operator should not commence a swing cycle if another vehicle is detected within the programmed detection zone.

6.4 Heavy Vehicle (HV) to Stationary Object (SO) collision avoidance (e.g. fixed plant & equipment)

e.g. Dozer reversing or traming forward drives into Stationary Object (e.g. lighting tower) due to blind spots. The AMT CAS-CAM/RF® system alerts the HV driver to the presence of the RF tagged light tower (within a programmed detection range) using both audible & visual alarms. SO beacons are also activated when the Dozer is within the programmed detection range for visual confirmation using the rear camera.

6.5 Heavy Vehicle to Haul Road Crossing / Merging Collision Scenario

Haul Road Crossing / Merging Alarms activated by approaching Heavy Vehicles fitted with RF tags.

HV to LV haul road crossing / merging scenario: HV approaching road crossing / merger and collides with LV due to LV not being aware of approaching HV. The AMT CAS-CAM/RF® system alerts both the HV driver and LV driver to the presence of both vehicles (within a programmed detection range) using both audible & visual alarms. The HV unit activates at longer range (200-300m) a set of road crossing lights warning LV's of an approaching HV.

HV to HV haul road crossing / merging scenario: HV approaching road crossing / merger and collides with other HV due to HV not being aware of other approaching HV. The AMT CAS-CAM/RF® system alerts both HV drivers to each others presence (within a programmed detection range) using both audible & visual alarms. The HV units activate at longer range (200-300m) a set of road crossing lights warning other HV's / LV's of an approaching HV.

6.6 Heavy Vehicle to other RF tagged Vehicles Collision Avoidance Due to Driver Fatigue

General fatigue management: the Heavy Vehicle Display Unit can be programmed as a fatigue-monitoring unit where periodic alarms need to be actioned within a specified response time. All fatigue alarms and operator reactions are data logged (along with RF tag detections) for compliance monitoring & provides a safety audit trail in the event of an incident (drivers are less likely to breach procedures knowing that vigilance methods are being monitored). The CAS system RF tag audible alarms also act to combat fatigue.

HV to HV haul road collision due to driver fatigue: HV approaching another HV traveling on opposite side of haul road collides with the oncoming HV due to driver fatigue and driver not being aware of approaching HV and / or not maintaining adequate clearance. The AMT CAS-CAM/RF® system alerts both HV drivers to each other's presence (within a programmed detection range up to 200-300m with long-range RF option) using both audible & visual alarms.

A new extension to the CAS-CAM/RF® technology is a Guidance Laser System (CAS-GLS®). The CAS-GLS® is a new remote sensing technology fitted to surface mining road haulage equipment (e.g. Haul Trucks) that will automatically detect the presence of the edge of the road (windrow), calculate the distance from the side of the Haul Truck to the start of the windrow and report to the driver when the vehicle is operating within nominated corridors (too close to edge – normal – warning - danger) using both visual and audible indicators. Visual indication of whether an approaching Haul Truck is within or outside of the nominated corridors is also provided for the benefit of oncoming Haul Trucks.

The GLS assists in managing driver fatigue by alerting both the vehicle driver and oncoming vehicle when the vehicle is not operating within specified safe corridors for both passing and normal driving operations. This is particularly important when mines upgrade to larger payload capacity vehicles resulting in wider vehicles operating within reduced safe operating corridors on existing haul roads.

The GLS can be operated either stand-alone or integrated with the CAS-CAM/RF® Display Unit in the driver's cabin to provide a fully integrated Collision Avoidance System using a combination of high quality colour cameras and active RFID tags with programmable detection zones for automatic object detection.

6.7 Other Applications

There are numerous other Collision Avoidance Applications involving Heavy Vehicles (with blind spots) interacting with other Heavy Vehicles, Light Vehicles, Stationary Objects, Personnel and other Mobile Plant & Equipment.

Refer to Section 7.6 for typical surface mining Collision Scenarios and CAS Solutions.

6.8 Additional Benefits from Camera Only installations (CAS-CAM®)

Heavy Vehicle Reversing Operations – side view cameras provide a wider field of view than existing side view mirrors, offering greatly improved visibility and awareness of surroundings. Rear View camera eliminates known rear blind spots that have directly attributed to fatalities in the surface mining industry.

Heavy Vehicle Forward Operations – front view camera eliminates known front blind spots (typically out to 5-10m on larger rear dump trucks) that have directly attributed to fatalities in the surface mining industry.

Dozer reversing operations – operator experiences neck & back strain due to repetitive turning / twisting during reversing operations. Can be alleviated using rear view camera system.

Load Placement - Rear Dump Truck leading tyre breaks through berm during reversing operations for load dumping, placing vehicle at risk of flipping over edge when bed is raised during dumping. Can be prevented using wide angle rear camera showing the location of the rear tyres in relation to the berm in order to square the truck. The rear & blind-side cameras are also helpful in lining up the truck with a Shovel during loading operations.

Backing to Berms - Rear Dump Truck reverses over rock causing tyre and / or vehicle damage. Can be prevented by using rear and blind side-view cameras to detect the presence of rocks before reversing.

Confirming Load Completion – rear camera can be used to determine when the bed is empty during dumping as the driver can see when the material stops falling from the bed so they can determine when they can start off again. Without a rear view camera, drivers would allow the bed to stay raised longer because they could not tell if the bed was completely empty. Confirming Load Completion reduces turn-around time and increases productivity as well as reducing the time the truck is backed up.

Keeping the Berm Intact – using the rear camera, the truck driver can partially raise the bed of the truck during dumping so the bed doesn't damage the berm.

Automatic Switching of Cameras on gearing – system automatically switches to front or rear camera on gearing assisting the operator in assessing objects 'at-risk' before vehicle motion. The system can also automatically switch to front or rear camera on RF tagged object detections at either the front or rear of the vehicle. Where objects are detected at both the front and rear, the camera switches to the direction of vehicle travel.

Note:

- Elimination of Heavy Vehicle blind spots using camera systems (CAS-CAM®) significantly reduces the risk of collision with other vehicles, mobile and fixed plant & equipment, personnel and objects. However, the Heavy Vehicle operator cannot always be watching the camera Display Unit whilst focusing on the task of machine

operation. Hence, the risk of collision is further reduced using the Automatic Object Detection capability of the RF tagging (CAS-RF®), thereby offering a high level of protection and redundancy in a complete standalone package.

- The CAS-CAM/RF® System is a safety aid in providing the drivers of Heavy Vehicles, Light Vehicles and Personnel Tag users with additional information to make informed decisions in order to reduce the incidence of collisions. The system is not designed to be a stand-alone safety interlocking system that can give a false sense of protection and security, but still requires that all vehicle drivers and personnel still take every manual precaution to avoid the incidence of collisions and to comply with existing work place procedures. The system is designed as an aid to supplement and enhance existing safe work practices and procedures.

7 TYPICAL COLLISION AVOIDANCE SCENARIOS

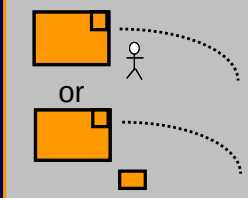
7.1 General

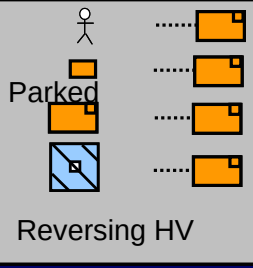
Typical collision avoidance scenarios for an open-cut mine site include operation between moving vehicles on haul roads, loading and dump sites, around high-wall and various bench levels and around other mine site obstacles such as buildings, plant and equipment etc.

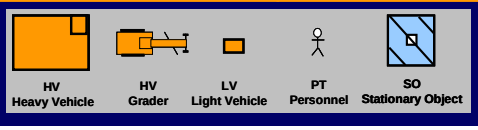
A typical CAS-CAM/RF® system would be configured for front and rear and optional left & right detection zones on all Heavy Vehicles, with fully programmable alarming for each object type (based on distance, detection location, direction of travel and speed), and a single detection zone on all Light Vehicles, Stationary Objects, Personnel Tags, Test Stations and Mobile Plant & Equipment.

The system operation covers the following Heavy Vehicle – Light Vehicle and Heavy Vehicle – Heavy Vehicle interaction scenarios (ranked from highest to lowest risk):

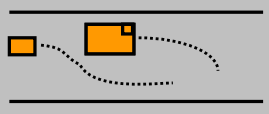
7.2 Collision Scenarios and Solutions

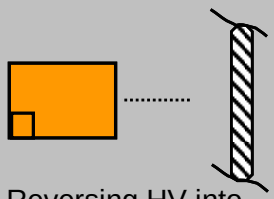
Scenario 1	AMT CAS Solutions	Comments
	HV driving forward receives audible & visual alarm when within 'AT-RISK' object programmed detection range. HV automatically switches to Front Camera for blind spot vision on both forward gear or when 'AT-RISK' objects are detected at the front. 'AT-RISK' objects also receive audible and visual alarms when the HV is in gear.	HV to 'AT-RISK' objects alarming is two-way. Different alarm ranges for different 'AT-RISK' object types (e.g. HV front, HV rear, LV, SO, TS, PT) and HV speed. HV RF units located on front / rear / right & left sides for close range start-up object detection. Personnel Tag (PT) proto-typed only and subject to customer requirements.

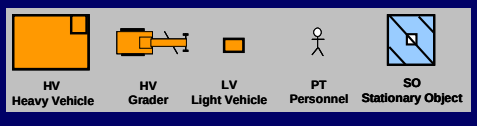
Scenario 2	AMT CAS Solutions	Comments
	Reversing HV receives audible & visual alarm when within 'AT-RISK' object programmed detection range. HV automatically switches to Rear Camera for blind spot vision on both reverse gear or when 'AT-RISK' objects are detected at the rear. 'AT-RISK' objects also receive audible and visual alarms (no audible alarm on parked HV).	HV to 'AT-RISK' objects alarming is two-way. Different HV alarm ranges possible for different 'AT-RISK' object types (e.g. HV front, HV rear, LV, SO, TS, PT) and HV speed.



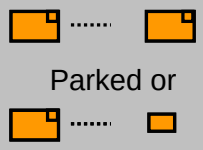
CAS Scenario Solutions 2005

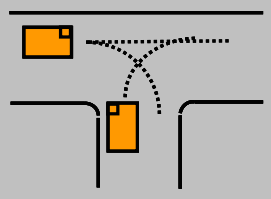
Scenario 3	AMT CAS Solutions	Comments
 LV Overtaking HV	Procedure for LV to call HV on radio for permission to overtake. HV receives LV Identification Code on Display Unit for positive confirmation before granting approval for LV to overtake.	Provides Positive Identification (ID) for radio confirmation.

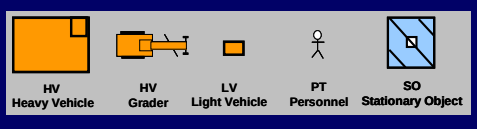
Scenario 4	AMT CAS Solutions	Comments
 Reversing HV into dump	Rear camera assists HV operator in: 1) reversing square to berm, 2) avoid sharp rocks that could result in tyre damage, 3) verification of tray empty before driving forward.	



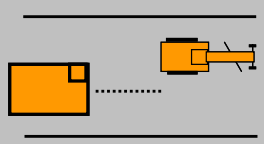
CAS Scenario Solutions 2005

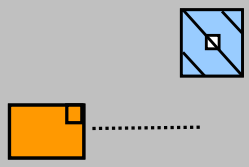
Scenario 5	AMT CAS Solutions	Comments
 Parked or Approaching parked vehicle	Approaching HV receives audible & visual alarm when within programmed range of another HV rear or approaching a LV when in gear. LV only alarms when HV is in gear and within programmed range. No alarming on parked HV.	HV to LV alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT) and HV speed.

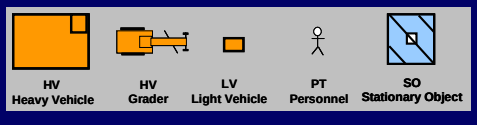
Scenario 6	AMT CAS Solutions	Comments
 Intersection	HV on straight haul road approaching road junction would trigger Haul Road Crossing Warning lights at 200-300m distance prior to road intersection. No HV - HV front audible alarms enabled. Assume stop sign is in place at entry to 'T' junction.	HV to HV alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT), HV location (front/rear/sides) and HV speed.



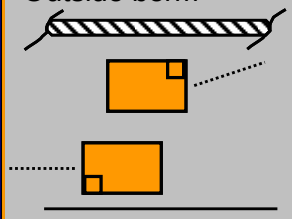
CAS Scenario Solutions 2005

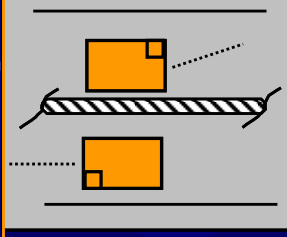
Scenario 7	AMT CAS Solutions	Comments
 HV approaching roadwork	Approaching HV receives audible & visual alarm when within programmed range of Grader in gear. Grader would receive audible and visual alarm when approaching HV in gear is detected within the programmed detection range. Grader automatically switches to Rear Camera for blind spot vision when 'AT-RISK' objects are detected within the programmed detection range.	HV to HV alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT), HV location (front/rear/sides) and HV speed.

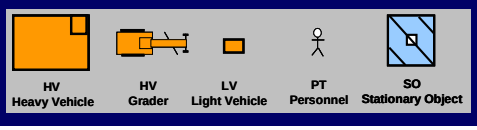
Scenario 8	AMT CAS Solutions	Comments
 HV Approaching / passing structure	Approaching HV receives audible & visual alarm when within programmed range of a RF tagged Stationary Object (SO). SO can provide visual alarm when HV is in gear and within programmed range. No alarming on parked HV.	HV to SO alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT), HV location (front/rear/sides) and HV speed.



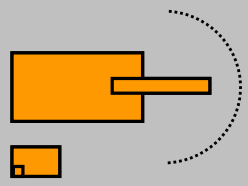
CAS Scenario Solutions 2005

Scenario 9	AMT CAS Solutions	Comments
Outside berm 	Guidance Laser System (GLS) used to ensure HV's remain in programmed corridors on haul road. Typical corridors include: 1) Close to Edge, 2) Safe, 3) Warning, 4) Danger. Voice & Visual Alarms generated in Operator's Cabin when moving outside 'Safe' corridor. Green (safe) and Red (danger) Lights on front of HV for visual warning to approaching HV.	GLS doesn't require regular road side guidance markers for operation, but uses the road-edge feature for guidance (e.g. windrow, drain). GLS system operation automatically controlled using Signaling Barriers placed at: 1) Start of Haul Road, 2) End of Haul Road, 3) Road Junction.

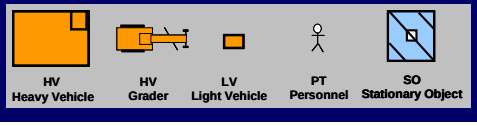
Scenario 10	AMT CAS Solutions	Comments
Centre berm 	Guidance Laser System (GLS) used to ensure HV's remain in programmed corridors on haul road. Typical corridors include: 1) Close to Edge, 2) Safe, 3) Warning, 4) Danger. Voice & Visual Alarms generated in Operator's Cabin when moving outside 'Safe' corridor. Green (safe) and Red (danger) Lights on front of HV for visual warning to approaching HV.	GLS doesn't require regular road side guidance markers for operation, but uses the road-edge feature for guidance (e.g. windrow, drain). GLS system operation automatically controlled using Signaling Barriers placed at: 1) Start of Haul Road, 2) End of Haul Road, 3) Road Junction.



CAS Scenario Solutions 2005

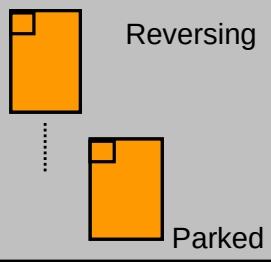
Scenario 11	AMT CAS Solutions	Comments
 Shovel rotating / swinging	HV blind side camera used to assist operator in aligning with Shovel bucket. Shovel blind spot cameras fitted with automatic switching on swing direction.	Side RF units can be fitted to Shovel for alarming HV when within swing radius of Shovel Housing. HV's normally programmed to receive audible alarms from Shovel typically include Clean-up Dozer and Cable Handling Vehicle as Rear Dump Trucks may receive a high level of nuisance alarms when reversing to Shovel at different approach angles.

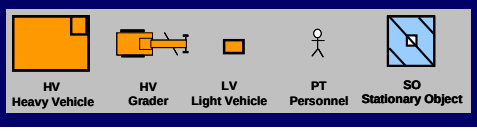
Scenario 12	AMT CAS Solutions	Comments
 Oncoming Correct Lanes	Guidance Laser System (GLS) used to ensure HV's remain in programmed corridors on haul road. Typical corridors include: 1) Close to Edge, 2) Safe, 3) Warning, 4) Danger. Voice & Visual Alarms generated in Operator's Cabin when HV moves outside 'Safe' corridor. Green (safe) and Red (danger) Lights on front of HV for visual warning to approaching HV.	GLS doesn't require regular road side guidance markers for operation, but uses the road-edge feature for guidance (e.g. windrow, drain). GLS system operation automatically controlled using Signaling Barriers placed at: 1) Start of Haul Road, 2) End of Haul Road, 3) Road Junction.



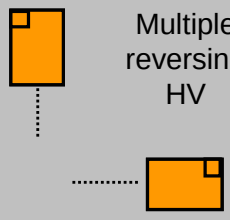
CAS Scenario Solutions 2005

Scenario 13	AMT CAS Solutions	Comments
 Following Same lanes	HV getting too close to HV in front would receive an audible & visual alarm based on distance and speed differential. Different Alarms can be programmed based on speed & distance to cover both the 'Queuing' and 'Haul Road At Speed' scenarios.	HV to HV alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT), HV location (front/rear/sides) and HV speed.

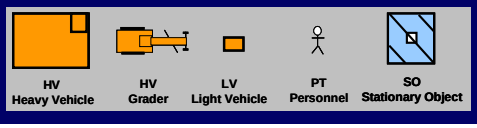
Scenario 14	AMT CAS Solutions	Comments
 Reversing Parked	Reversing HV receives audible & visual alarm when within programmed detection range of another HV. HV automatically switches to Rear Camera for blind spot vision on both reverse gear or when 'AT-RISK' objects are detected at the rear. No alarming on parked HV.	HV to HV alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT), HV location (front/rear/sides) and HV speed.



CAS Scenario Solutions 2005

Scenario 15	AMT CAS Solutions	Comments
 Multiple reversing HV	Reversing HV's receive audible & visual alarm when within programmed detection range of another reversing or stationary HV. HV's automatically switch to Rear Camera for blind spot vision on both reverse gear or when 'AT-RISK' objects are detected at the rear.	HV to HV alarming is two-way. Different HV alarm ranges possible for different object types (e.g. HV front, HV rear, LV, SO, TS, PT), HV location (front/rear/sides) and HV speed.

CAS settings shown are AMT suggested settings only. All settings are fully programmable and final settings are best decided upon completion of site Risk Assessment.



CAS Scenario Solutions 2005

8 APPLICATIONS

The superior quality video imaging, RF tagging capability and rugged construction make the CAS-CAM/RF® system an ideal package in assisting the prevention of collisions with plant, equipment or personnel for a variety of Heavy Vehicles.

Typical application areas include:

- Quarry, Mining and Construction Industry
- Refuse Industry
- Transport Industry (Road Haulage and Buses)
- Forklift / Handling / Storage
- Fire Fighting / Emergency Services Industry
- Agricultural Industry
- Recreational Vehicles
- Any other poor visibility application in hostile environments

9 NAME AND FUNCTION OF PARTS

9.1 Heavy Vehicle (HV) System

9.1.1 Display Unit (PROD0119)

Front Panel Items

1. Keypad – controls screen power, switches camera channels and operator functions
2. Display - 6.4” colour TFT LCD monitor for displaying camera images, RF tagging alarms and function text
3. Power Indicator – active when power is applied

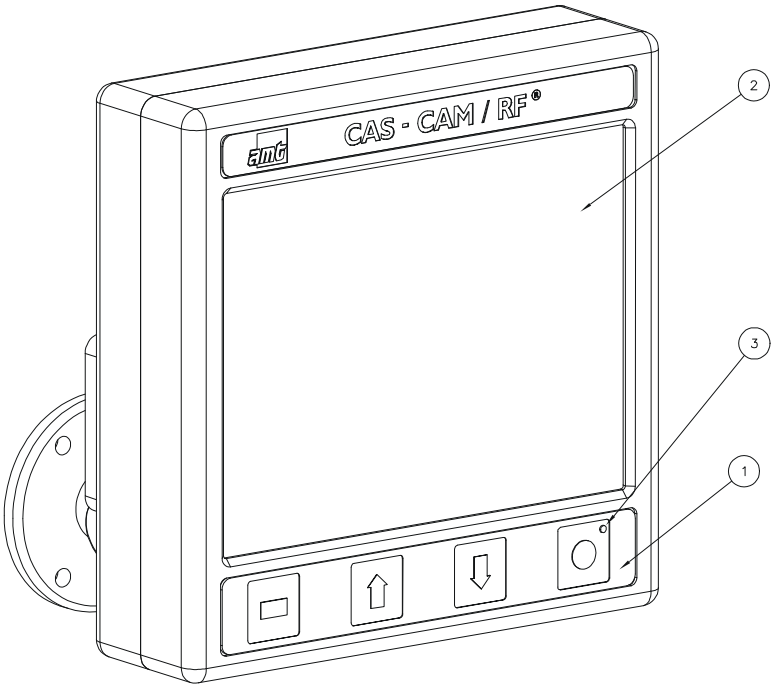


Figure 15: Display Unit - Front Panel Layout

Rear Panel Items

1. EXT I/O – External Input/Output connector, including Power Input (12-way panel plug) and Fuse (2A, 20mm x 5mm slow blow)
2. CH1 – Channel 1 connector (6-way panel socket) and Fuse (0.5A, 20mm x 5mm slow blow)
3. CH2 – Channel 2 connector (6-way panel socket) and Fuse (0.5A, 20mm x 5mm slow blow)
4. RS232 – serial communications port connector (DB-9 panel socket)
5. VIDEO OUT – Video output (PAL) connector (RCA panel socket)
6. Adjustable mounting bracket
7. Mounting base
8. Ventilation slots

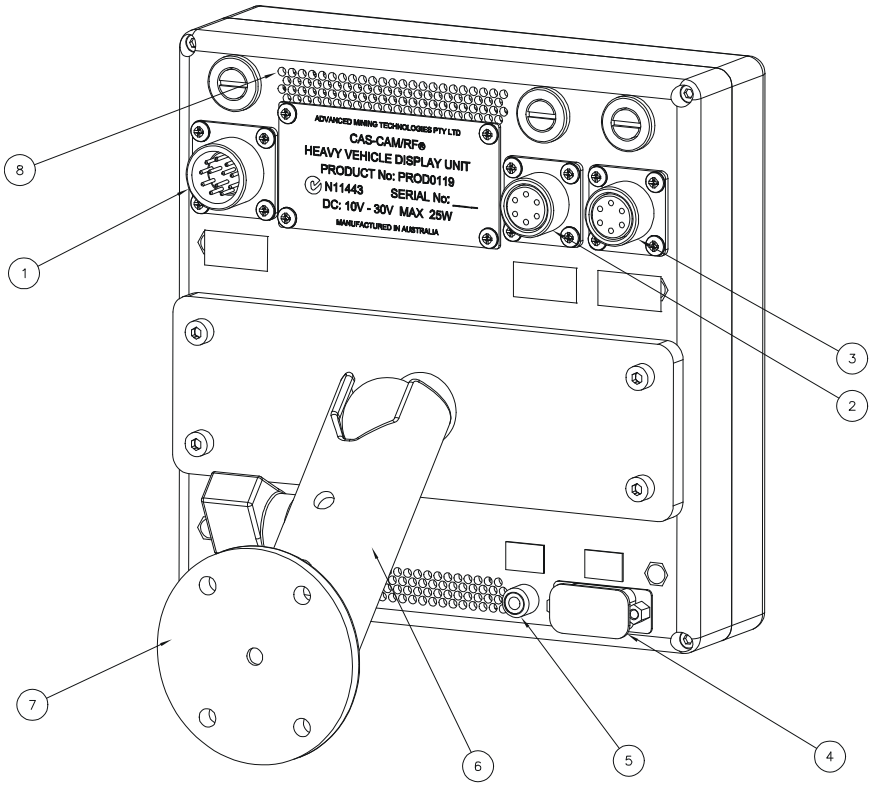


Figure 16: Display Unit - Rear Panel Layout

9.1.2 Camera Unit (PROD0118)

1. Weatherproof camera housing
2. Camera Window – requires manual cleaning for quality vision
3. Adjustable mounting bracket
4. Window air purge inlet (client option)
5. Electrical connector (6-way panel plug)

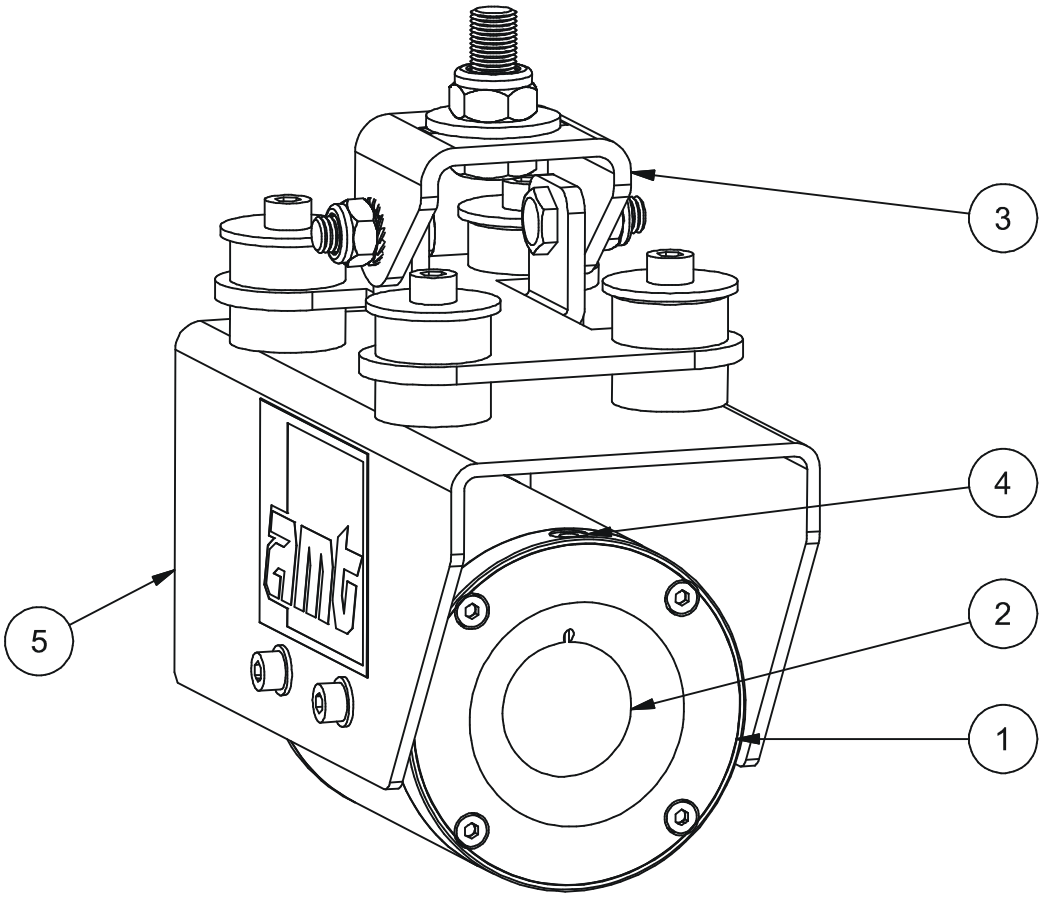


Figure 17: Camera Unit - Layout

9.1.3 Expansion Unit (PROD0161)

1. POWER – Power Input (10-30VDC, 50W max.)
2. INPUT POWER FUSE (5A, 20mm x 5mm slow blow)
3. RS232 – serial communications port connector (DB-9 panel socket)
4. CAN – CAN Bus Interface (DB-9 panel socket)
5. CH3 – Channel 3 connector (6-way panel socket)
6. CH4 – Channel 4 connector (6-way panel socket)
7. CH5 – Channel 5 connector (6-way panel socket)
8. CH6 – Channel 6 connector (6-way panel socket)
9. Channel 3 – 6 Fuses (0.8A, 20mm x 5mm slow blow)
10. DISPLAY – Display Unit connector (12-way panel socket)
11. TX BUS – Communications Bus 'Transmit' Activity Indicator
12. RX BUS – Communications Bus 'Receive' Activity Indicator
13. Mounting base

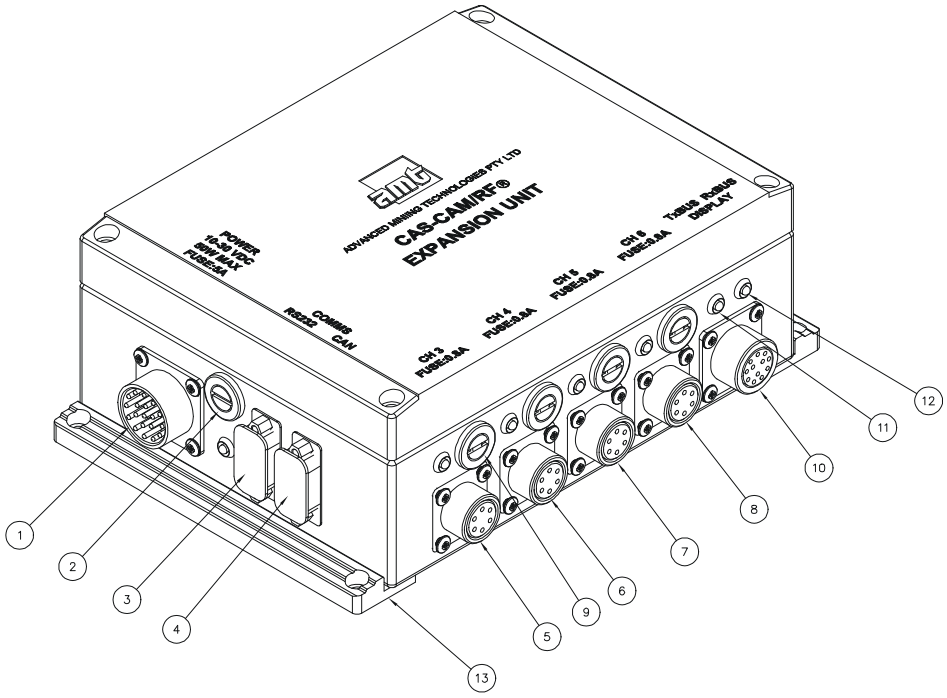


Figure 18: Expansion Unit - Layout

9.1.4 RF Unit – Front (PROD0239) or Rear (PROD0169)

1. BUS IN – Communications Bus Input (6-way panel plug)
2. BUS OUT – Communications Bus Input (6-way panel socket)
3. TX – Communications Bus 'Transmit' Activity Indicator (red)
4. RX – Communications Bus 'Receive' Activity Indicator (green)
5. Mounting base
6. ANT – Antenna connector

Note: optional Side RF Units (Left Side RF Unit, Right Side RF Unit) are identical in design to the Front RF Unit and Rear RF Unit, however, are coded differently internally.

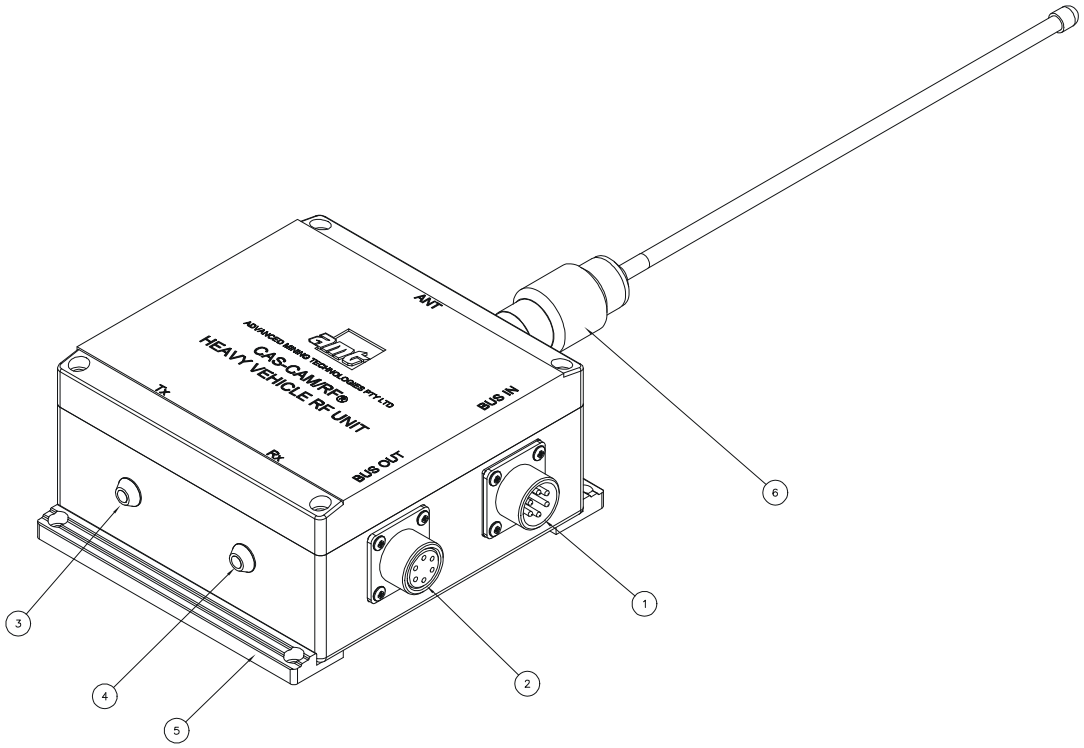


Figure 19: RF Unit - Layout

9.2 Light Vehicle (LV) System (with integral beacon) (PROD0246)

9.2.1 Light Vehicle Unit (PROD0209)

1. Rotating Beacon
2. Beacon lens cover (optional colours)
3. External Input/Output connector, including Power Input (12-way panel plug)
4. Antenna
5. Mounting Base

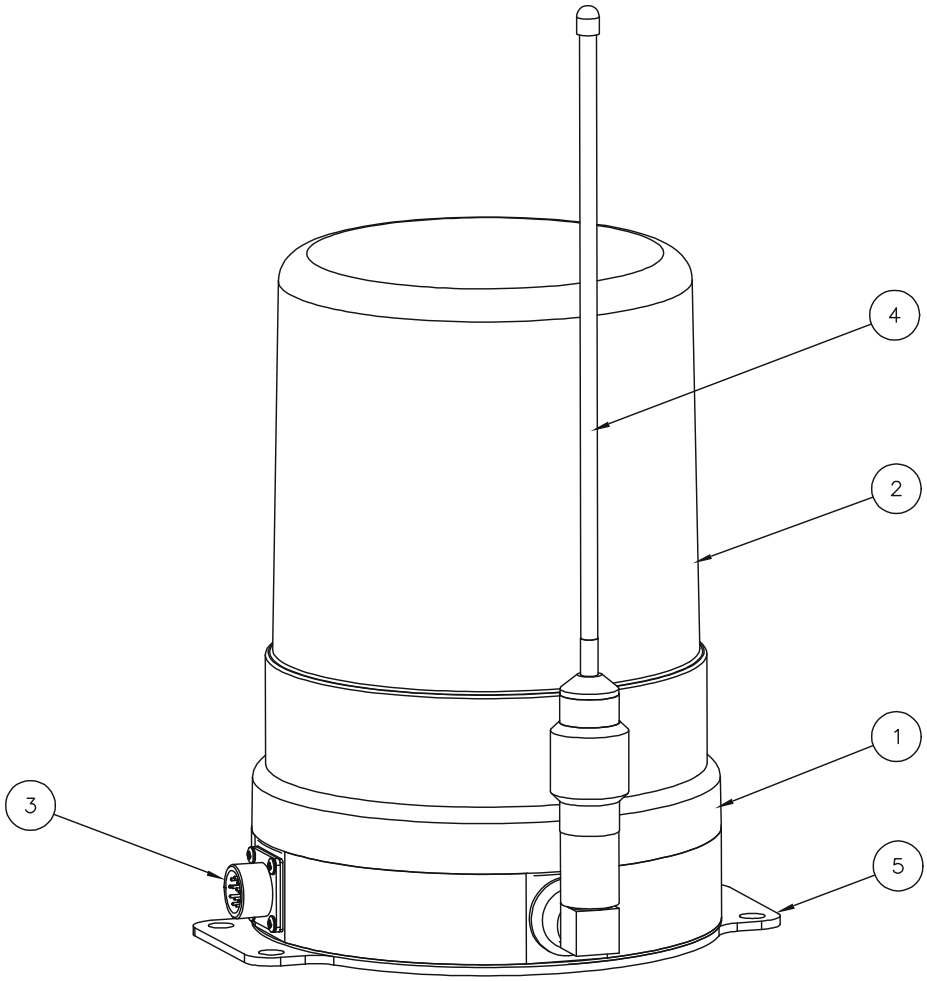


Figure 20: Light Vehicle Unit – Layout

9.2.2 Dash Alarm Unit (PROD0211)

Front Panel Items

1. Power Indicator (green)
2. Alarm Indicator (red)
3. Audible Alarm

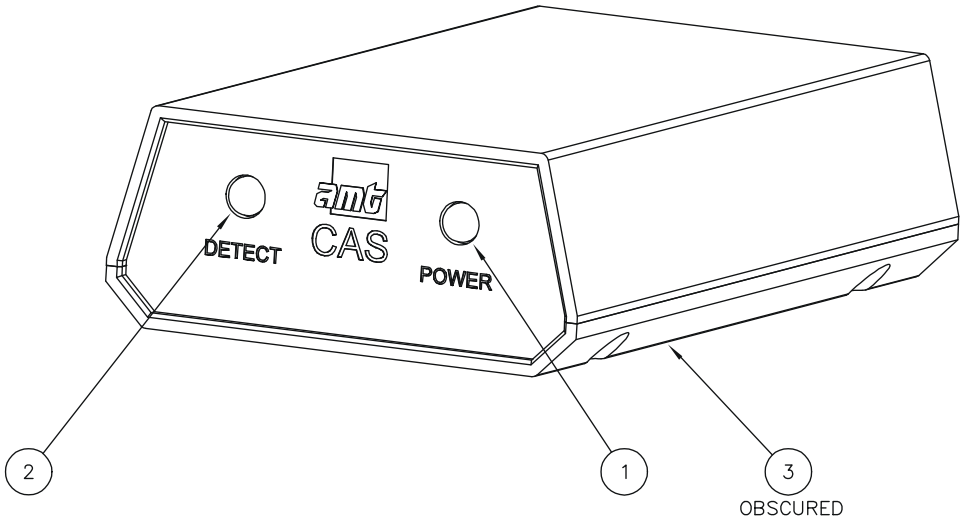


Figure 21: Dash Alarm Unit – Front Panel Layout

Rear Panel Items

4. External Input/Output connector, including Power Input (5-way panel subminiature DIN socket)
5. RS-232 - serial communications port connector (DB-9 panel socket)

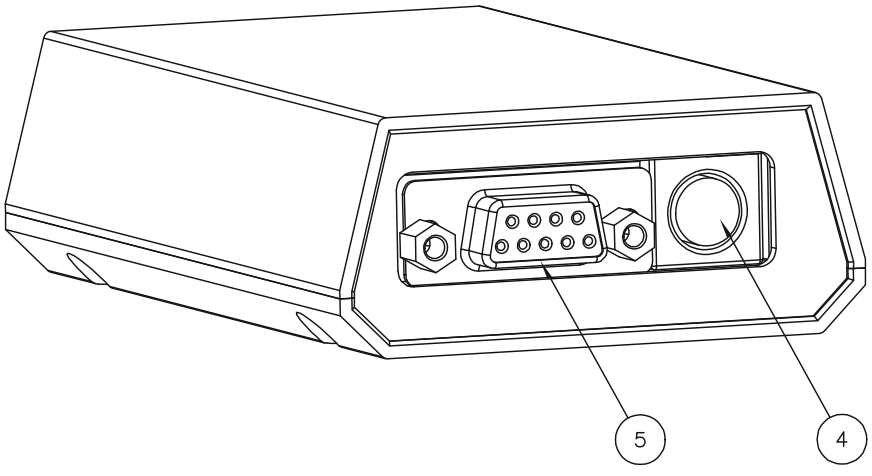


Figure 22: Dash Alarm Unit – Rear Panel Layout

9.3 Light Vehicle (LV) System (with external beacon option) (PROD0294)

9.3.1 Light Vehicle RF Unit (with external beacon option) (PROD0295)

1. BEACON – External Beacon Interface (2-way panel plug)
2. PWR/COMMS – Input Power & Communications (6-way panel socket)
3. TX – Communications Bus 'Transmit' Activity Indicator (red)
4. RX – Communications Bus 'Receive' Activity Indicator (green)
5. Mounting base
6. ANT – Antenna connector

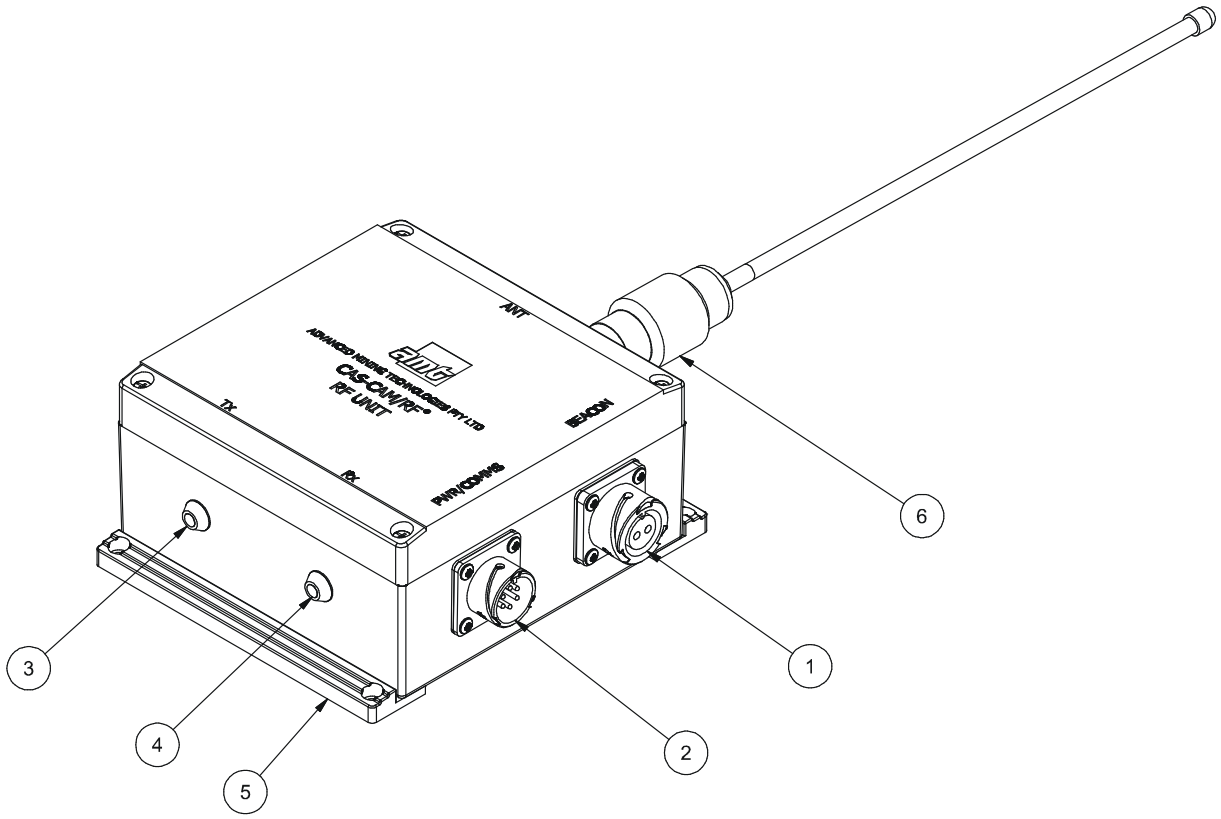


Figure 23: Light Vehicle Unit – Layout

9.3.2 Dash Alarm Unit (PROD0211)

Front Panel Items

1. Power Indicator (green)
2. Alarm Indicator (red)
3. Audible Alarm

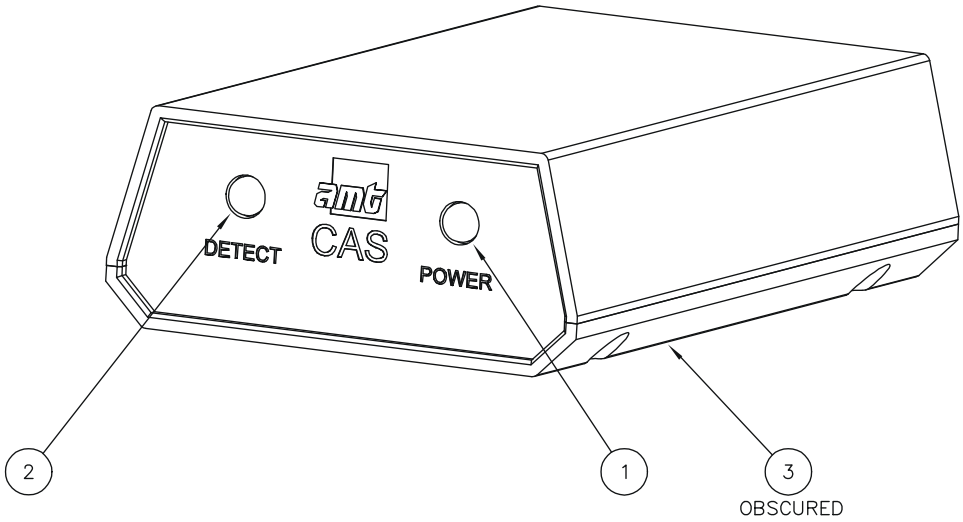


Figure 24: Dash Alarm Unit – Front Panel Layout

Rear Panel Items

4. External Input/Output connector, including Power Input (5-way panel subminiature DIN socket)
5. RS-232 - serial communications port connector (DB-9 panel socket)

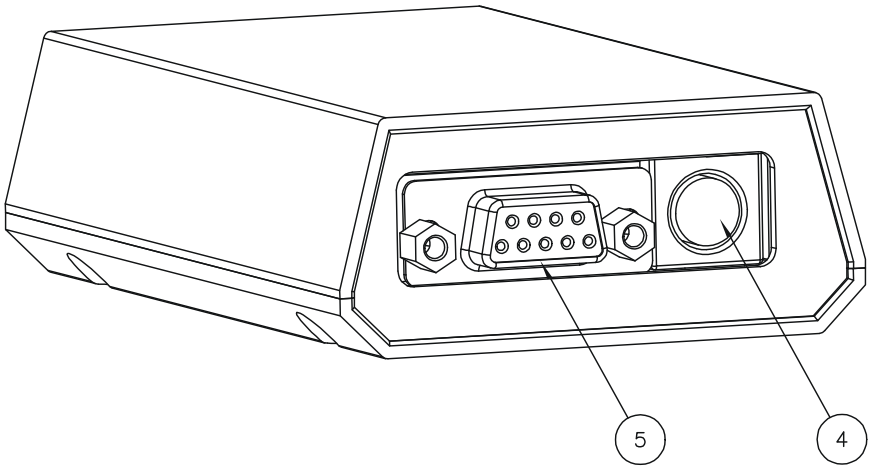


Figure 25: Dash Alarm Unit – Rear Panel Layout

9.4 Stationary Object (SO) System (PROD0210)

9.4.1 Stationary Object Unit (PROD0212)

1. Rotating Beacon
2. Beacon lens cover (optional colours)
3. External Input/Output connector, including Power Input (12-way panel plug)
4. Antenna
5. Mounting Base

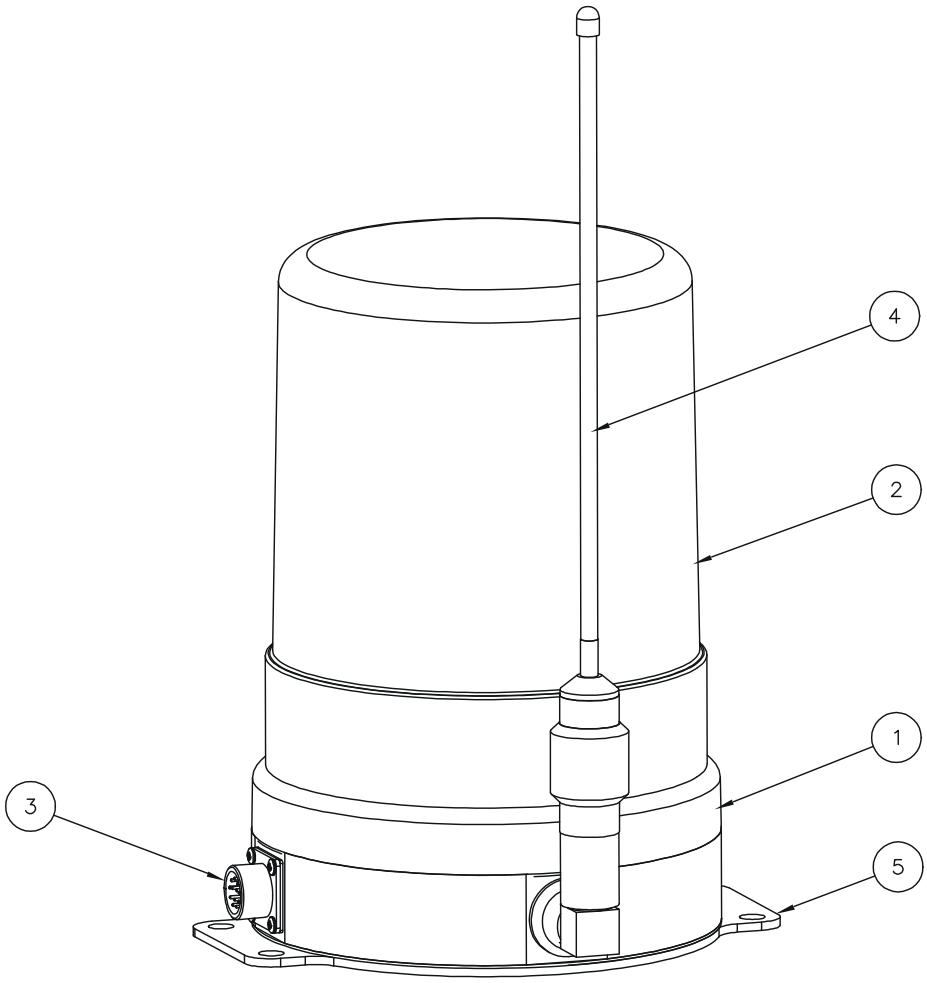


Figure 26: Stationary Object Unit – Layout

9.4.2 Dash Alarm Unit (PROD0211)

Front Panel Items

1. Power Indicator (green)
2. Alarm Indicator (red)
3. Audible Alarm

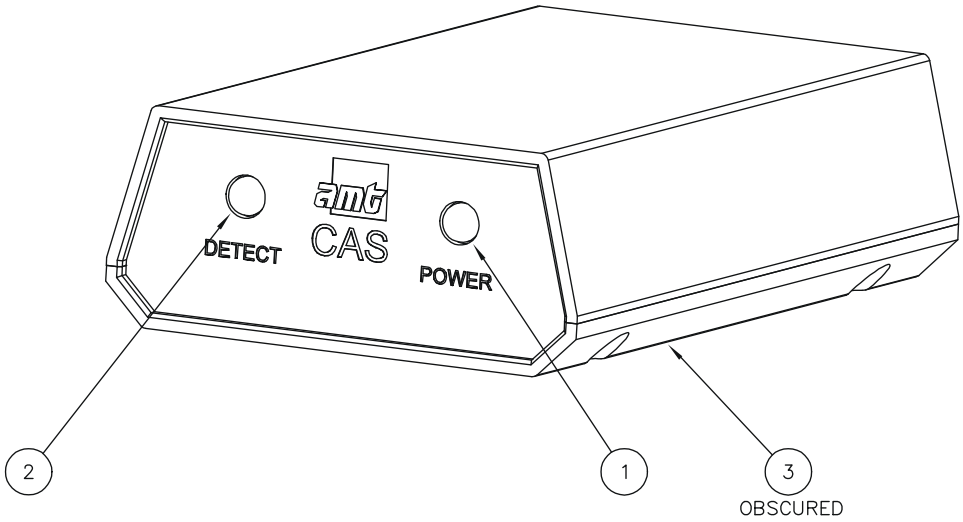


Figure 27: Dash Alarm Unit – Front Panel Layout

Rear Panel Items

4. External Input/Output connector, including Power Input (5-way panel subminiature DIN socket)
5. RS-232 - serial communications port connector (DB-9 panel socket)

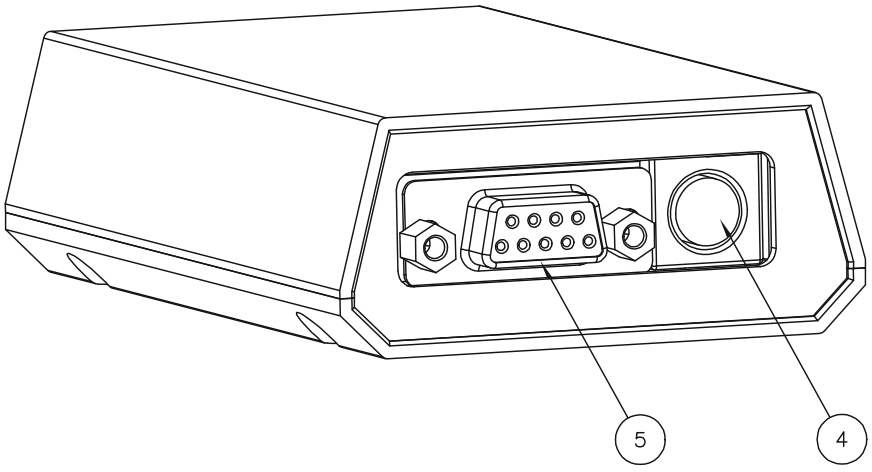


Figure 28: Dash Alarm Unit – Rear Panel Layout

9.5 Mobile Plant & Equipment (HV) System (PROD0225)

9.5.1 Mobile Plant & Equipment Unit (PROD0250)

1. Rotating Beacon
2. Beacon lens cover (optional colours)
3. External Input/Output connector, including Power Input (12-way panel plug)
4. Antenna
5. Mounting Base

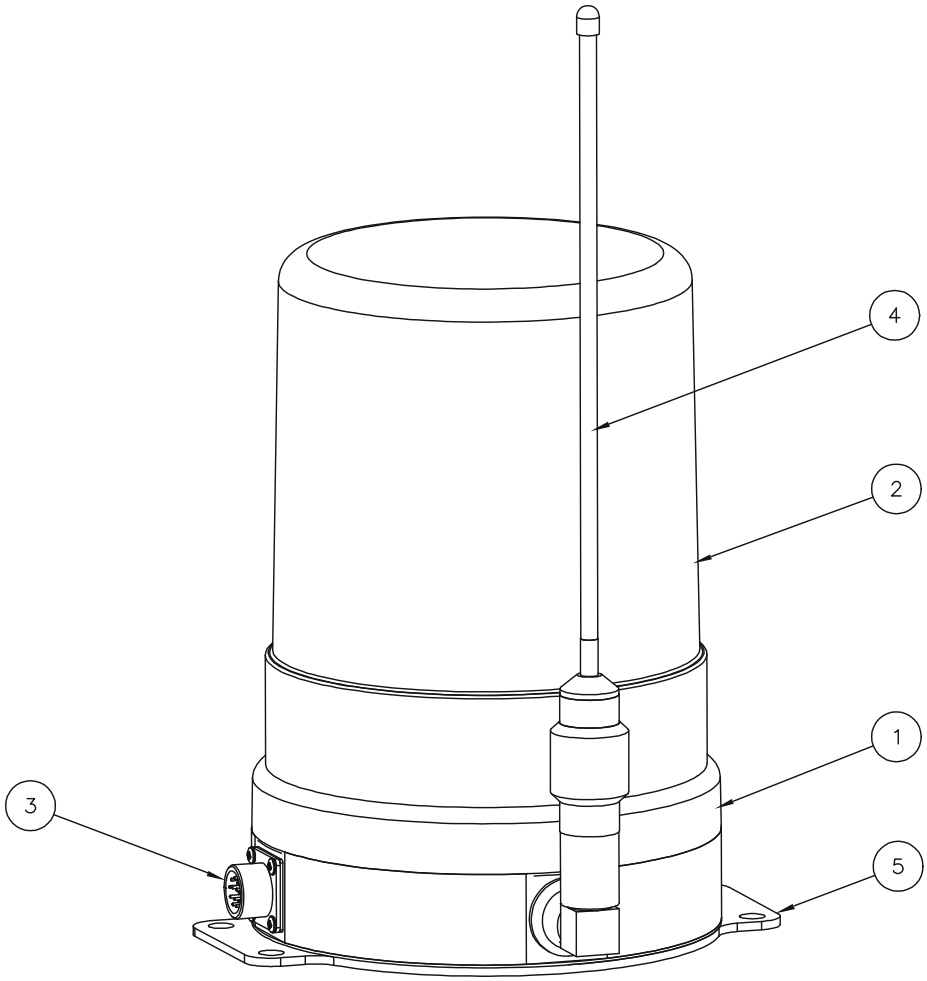


Figure 29: Mobile Plant & Equipment Unit – Layout

9.5.2 Dash Alarm Unit (PROD0211)

Front Panel Items

1. Power Indicator (green)
2. Alarm Indicator (red)
3. Audible Alarm

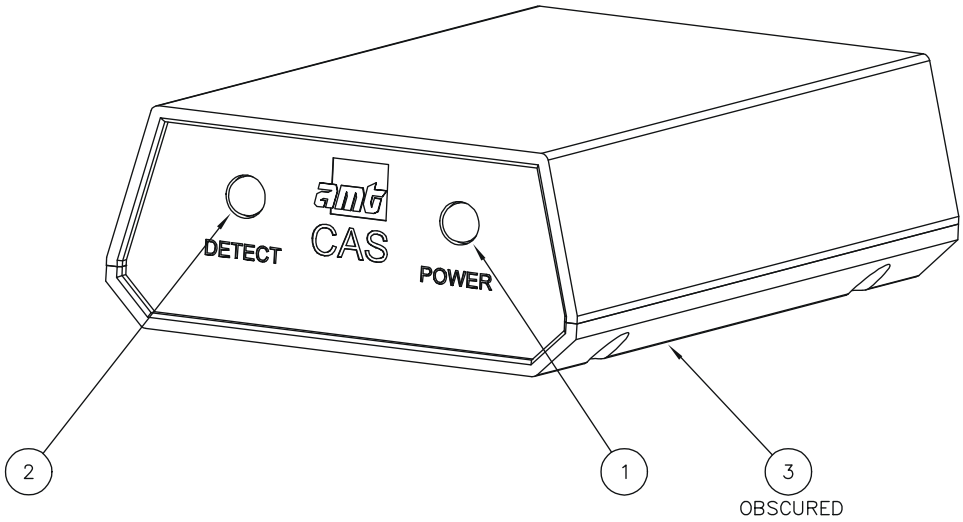


Figure 30: Dash Alarm Unit – Front Panel Layout

Rear Panel Items

4. External Input/Output connector, including Power Input (5-way panel subminiature DIN socket)
5. RS-232 - serial communications port connector (DB-9 panel socket)

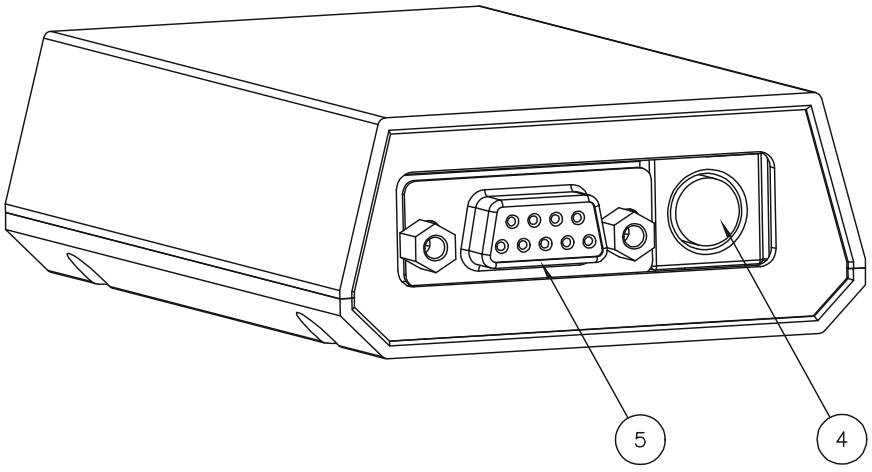


Figure 31: Dash Alarm Unit – Rear Panel Layout

9.6 Test Station (TS) System (PROD0241)

9.6.1 Test Station Unit (PROD0251)

1. Rotating Beacon
2. Beacon lens cover (optional colours)
3. External Input/Output connector, including Power Input (12-way panel plug)
4. Antenna
5. Mounting Base

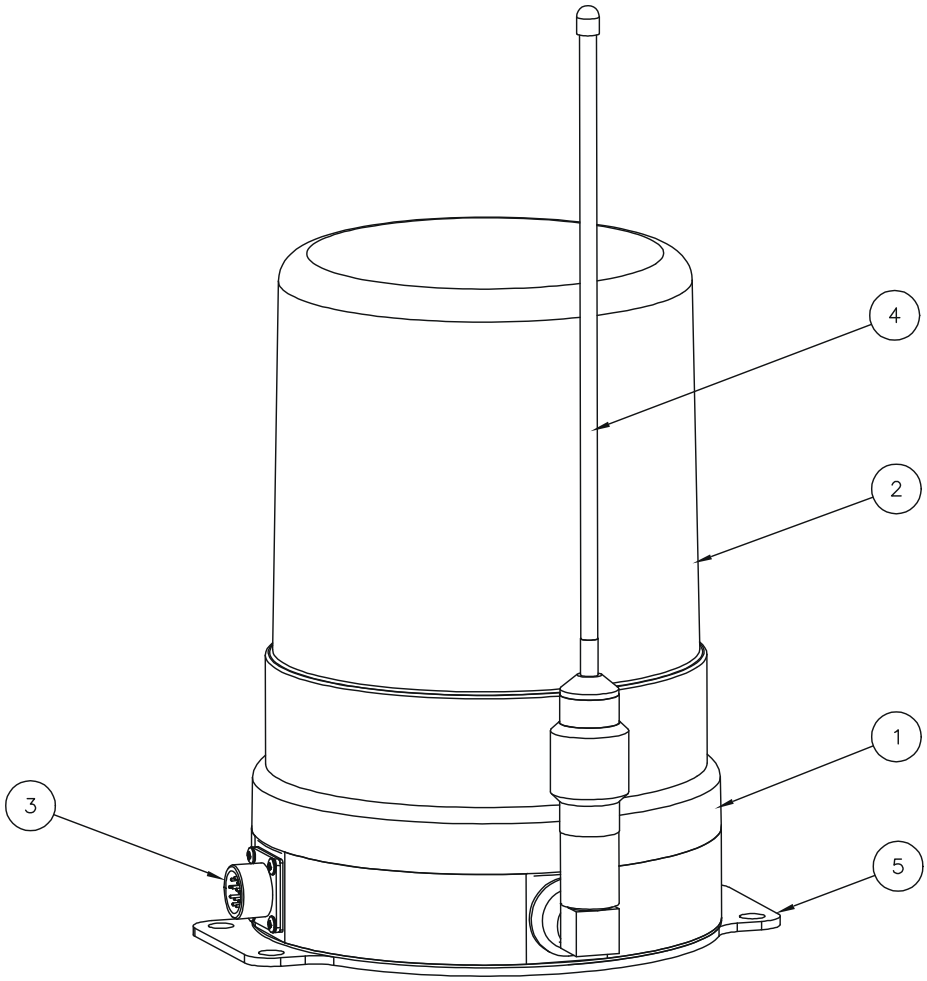


Figure 32: Test Station Unit – Layout

9.6.2 Dash Alarm Unit (PROD0211)

Front Panel Items

1. Power Indicator (green)
2. Alarm Indicator (red)
3. Audible Alarm

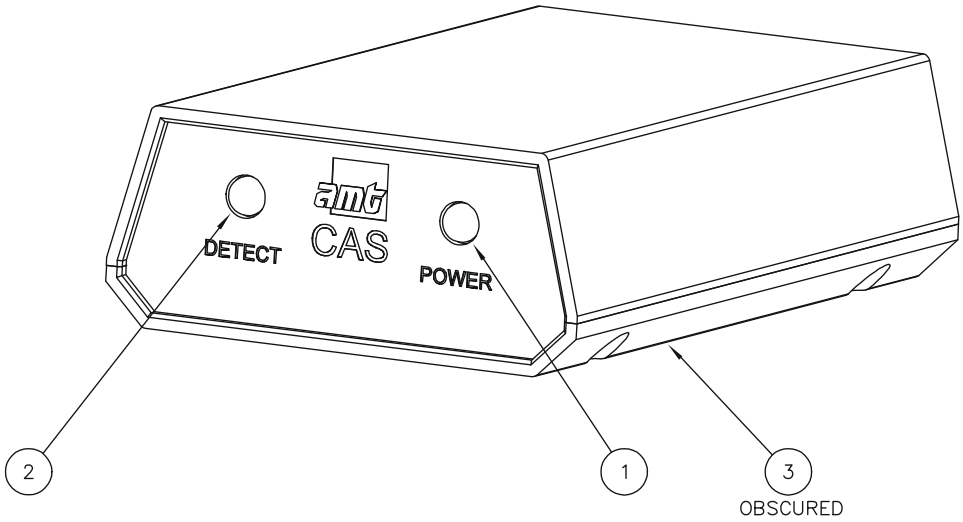


Figure 33: Dash Alarm Unit – Front Panel Layout

Rear Panel Items

4. External Input/Output connector, including Power Input (5-way panel subminiature DIN socket)
5. RS-232 - serial communications port connector (DB-9 panel socket)

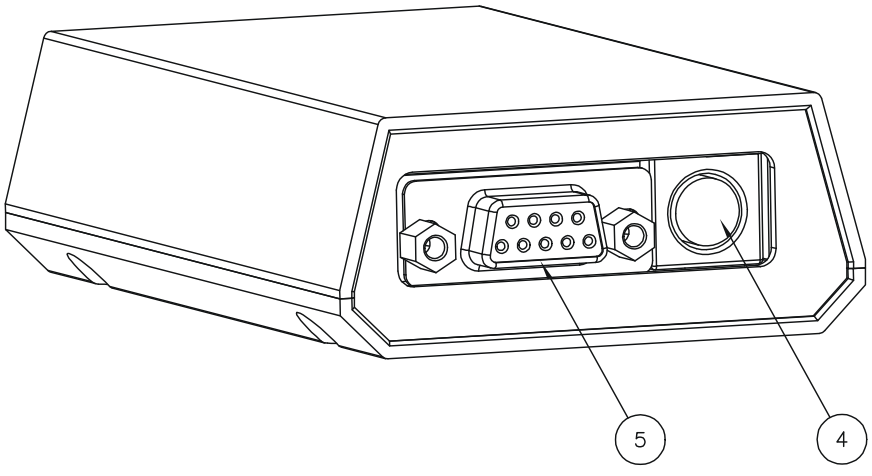


Figure 34: Dash Alarm Unit – Rear Panel Layout

9.7 Personnel Tag (PT) Unit

(under development)

Refer to section 4.7 for overview.

10 BASIC FUNCTIONS

10.1 Heavy Vehicle Display Unit

8.1.1 Screen Layout

The Default Screen layout is as follows:

Figure 35: Display Unit – Default Screen Layout

1. Video Display of current camera selected (6 cameras maximum)
2. Type and Number of FRONT Objects detected using RF tagging option (CAS-RF®) (HV = Heavy Vehicle, LV = Light Vehicle, SO = Stationary Object, PT = Personnel Tag, TS = Test Station)
3. Type and Number of REAR Objects detected using RF tagging option (CAS-RF®) (HV = Heavy Vehicle, LV = Light Vehicle, SO = Stationary Object, PT = Personnel Tag, TS = Test Station)
4. DIM key 5 levels of Brightness adjustment. Becomes the CONFIRM key when RF alarming is enabled. Press the CONFIRM key to cancel the audible alarm.
5. CAMERA channel selected (custom title – 8 characters maximum)
6. OFF – switches video display OFF/ON (also functions as BACK and CYCLE continue key)
7. Keys to manually select camera
8. 1 x 4 user keypad

10.1.1 Power On/Off

To switch ON the video screen, press the '●' key. The Default screen will then appear.

To switch OFF the video screen, press the '●' key again (OFF).

When CAS-CAM/RF® is fitted to a Heavy Vehicle, the power to the video screen can be programmed to automatically switch OFF after a predetermined time period when the vehicle is neither in forward or reverse gear (i.e. park / neutral) – this option is programmed at the time of installation using Installer mode software and conserves vehicle battery life when unattended as all equipment is permanently powered. Camera only installations (CAS-CAM®) are powered from the vehicle auxiliary / ignition circuit.

The Display screen will switch ON again and sleep timer will reset under the following conditions:

- On any key press
- On Forward or Reverse gearing
- Receiving PC commands from the Installer Mode software

10.1.2 Keypad Functions

A summary of the Keypad functions is as follows:

KEY	SCREEN TEXT (above keypad)	KEY FUNCTIONS
■	DIM	• 5 levels of Brightness adjustment
	CONFIRM	• Confirms new object detection and cancels alarm (CAS-RF® option)
⇧	CAMERA TITLE	Switch up to next camera channel
⇩		Switch down to next camera channel
●	OFF	• Switch display OFF • Switch display ON
	CYCLE	Cycles cameras when 'CYCLE' mode selected in SYSTEM menu

Note: Display Reset function - press keys □ and ● simultaneously

Figure 36: Display Unit – Summary of Keypad Functions

10.1.3 Switching Camera Channels

Use the ⇧, ⇩ arrow keys to scroll through the Camera Channels. The camera channel title (8 characters maximum) will be displayed above the arrow keys for the currently selected channel.

Camera channels can be changed at any time except when RF detections have not been confirmed by pressing the 'CONFIRM' key. Refer to section 10.1.11.7 'Operator Confirmation of Alarms' for details.

10.1.4 Changing Camera Settings

Programmable camera settings for each individual camera include: Colour, Mirror mode and Camera Enable. These settings are not accessible by the operator and are programmed at the time of installation using a laptop PC. These settings are saved during power down and are automatically restored at power on.

10.1.5 Switching Cameras on Gearing

To configure the Display Unit to automatically switch to the FRONT or REAR camera when engaging FORWARD or REVERSE gear, refer to section 13 as this function is only programmable at the time of installation using a laptop PC.

At any time, other camera channels can be selected using the ⇧, ⇩ arrow keys except when RF detections have not been confirmed by pressing the “CONFIRM” key. Refer to section 10.1.11.7 ‘Operator Confirmation of Alarms’ for details.

The Auto Cycle function is paused when camera switching is enabled on gear changes. Press the ‘CYCLE’ key to resume Auto Cycling.

10.1.6 Switching Cameras on RF Detections

To configure the Display Unit to automatically switch to the FRONT or REAR camera on FRONT or REAR RF detections, refer to section 13 as this function is only programmable at the time of installation using a laptop PC.

At any time, other camera channels can be selected using the ⇧, ⇩ arrow keys except when RF detections have not been confirmed by pressing the “CONFIRM” key. Refer to section 10.1.11.7 ‘Operator Confirmation of Alarms’ for details.

The Auto Cycle function is paused when camera switching is enabled on RF front / rear detections. Press the ‘CYCLE’ key to resume Auto Cycling.

10.1.7 Auto Cycling Camera Channels

Enabling Auto Cycling

Camera Channels that are enabled can be cycled automatically at a nominated cycle time (2s, 4s, 6s, 8s, 10s). This function is not programmable by the operator and is only programmable at the time of installation using a laptop PC. This function setting is saved during power down and is automatically restored at power on.

Pausing Auto Cycling to Study Camera View

1. When Auto Cycle is enabled and the active cameras are switching at the selected cycle time, the Auto Cycle function can be paused at the current camera view by pressing either of the ⇧, ⇩ arrow keys.
2. Use the ⇧, ⇩ arrow keys to switch between camera channels

Resuming Auto Cycling after Pausing

Auto Cycling is paused when either the operator manually selects a camera or automatic camera switching is activated on gear changes or with RF front / rear detections. Press the 'CYCLE' key to resume Auto Cycling.

Disabling Auto Cycling
Disabling the Auto Cycle function is only programmable at the time of installation using a laptop PC. This function setting is saved during power down and is automatically restored at power on.

10.1.8 DIM Function

The DIM function provides 5 levels of global Brightness settings for all cameras.

Press the 'DIM' key to scroll thru 5 levels of Brightness settings from minimum to maximum and then back to minimum.

10.1.9 Display Reset Function

Pressing simultaneously the keys ■ and ● will generate a Display Reset which causes the Display to Reboot. When reset, the message RESETTING' will be displayed on the screen before switching to the Boot-Up screen (refer to section 11.1). This function should only be used in the event of a screen or keypad lockup and should be reported to the AMT Service Agent.

10.1.10 Recording Video Signals (PAL format)

A VCR unit with PAL format can be connected to the 'VIDEO OUT' connector on the rear panel of the Display Unit for recording the video images along with text alarms and messages.

The video signal can also be displayed on an external monitor if desired using the same 'VIDEO OUT' connector.

NOTE: for camera channels in mirror mode (horizontal flip), the text will appear mirrored (i.e. backwards) on the 'VIDEO OUT' signal.

10.1.11 RF Detections and Alarms

10.1.11.1 Alarm Display

The top two lines of the Heavy Vehicle Display Unit are reserved as the alarm display for both FRONT and REAR RF detections (refer to Figure 35). This relies on the Heavy Vehicle being fitted with the CAS-RF® option where RF Units are fitted to either the REAR only or FRONT and REAR of the vehicle for automatic object detection.

The objects detected are sorted into the following classes:

- Heavy Vehicle (HV) or Mobile Plant & Equipment (HV)
- Light Vehicle (LV)
- Stationary Object (SO)
- Personnel Tag (PT)
- Test Station (TS)

The number of objects detected in each class is also displayed.

A sample of the object detection alarm display for both a FRONT and REAR detection CAS-RF system is as follows (refer to Figure 35 for screen layout):

FRONT: HV 1 LV 1 SO 1 PT 2 TS
REAR: HV2

The above alarm display indicates that the following object types and numbers were detected within the Heavy Vehicle Front and Rear Detection Zones:

FRONT: detected 1 x Heavy Vehicle (HV), 1 x Light Vehicle (LV), 1 x Stationary Object (SO), 2 x Personnel Tags (PT) and 1 x Test Station (TS)

REAR: detected 2 x Heavy Vehicles

10.1.11.2 RF Detection Ranges

The Heavy Vehicle FRONT and REAR RF Units can be field programmed for adjustable RF Detection Ranges (typically 0 – 80 m +/- 20% accuracy). Front and Rear RF Detection Ranges and alarm conditions based on direction of travel can be different for each object types (e.g. HV, LV, SO, PT, TS) in order to suit the particular application.

The audible alarm (if enabled) is a pulsed alarm (typically 0.5Hz).

Refer to sections 5 & 7 for more details on Detection Zones and Alarm Scenarios.

10.1.11.3 Alarm Process

- new objects detected within the programmed RF Detection Range(s) can generate alarms or existing objects previously detected will re-trigger alarms on a gear change
- object detections generate an audible alarm if programmed
- The number and class of objects detected are displayed on the top two lines of the Display Unit screen for both FRONT and REAR RF units (where fitted)

- A new object detected is highlighted by blinking the text and enabling the audible alarm (if programmed)
- The audible alarm will only silence when either the Operator presses the 'CONFIRM' key or when the object originally detected moves out of the Detection Range
- Only active detections are shown on the Display Unit screen (i.e. blank Display when there are no detections)
- Alarms are generated on high risk changes only (i.e. new object moves into detection zone or Heavy Vehicle changes gear)
- No alarm is generated when the object moves out of the Detection Range

10.1.11.4 Heavy Vehicle Reverse Mode

- Fully programmable detection ranges and audible alarms for different object types (e.g. HV, LV, SO, PT, TS) based on vehicle gear status (i.e. forward, reverse, park) and detection location (i.e. front or rear)

Refer to section 7 for more details on HV Alarm Scenarios.

10.1.11.5 Heavy Vehicle Forward Mode

- Fully programmable detection ranges and audible alarms for different object types (e.g. HV, LV, SO, PT, TS) based on vehicle gear status (i.e. forward, reverse, park) and detection location (i.e. front or rear)

Refer to section 7 for more details on HV Alarm Scenarios.

10.1.11.6 Heavy Vehicle Stationary (neutral) Mode

- Fully programmable detection ranges and audible alarms for different object types (e.g. HV, LV, SO, PT, TS) based on vehicle gear status (i.e. forward, reverse, park) and detection location (i.e. front or rear)

Refer to section 7 for more details on HV Alarm Scenarios.

10.1.11.7 Operator Confirmation of Alarms

The Heavy Vehicle Operator is encouraged to acknowledge the presence of new objects detected by visually confirming the object presence in the appropriate camera view and then pressing the 'CONFIRM' key. This action cancels the audible alarm and is logged along with all detections with time and date stamped into non-volatile memory.

To assist the Operator in the visual confirmation of new CAS-RF® alarms, the Display Unit can be programmed at the time of installation to automatically switch to either the FRONT or REAR camera depending on the source of the CAS-RF® alarm (e.g. REAR RF detections will cause the Display Unit to automatically switch to the REAR camera and similarly FRONT RF detections will cause the Display Unit to automatically switch to the FRONT camera).

Camera switching is disabled until alarms are confirmed by pressing the 'CONFIRM' key.

10.1.11.8 Alarm Specifications

Alarm Conditions:	1. New object(s) move into HV Detection Zone(s) 2. Object(s) in HV Detection Zone when HV re-engages gear
Alarm Modes:	1. Reverse Gear • Fully programmable Front & Rear & Side detection ranges & audible alarms for different object types (e.g. HV, LV, SO, PT, TS), location (front or rear or side) and direction of travel with flashing object text 2. Forward Gear • Fully programmable Front & Rear detection & Side ranges & audible alarms for different object types (e.g. HV, LV, SO, PT, TS), location (front or rear or side) and direction of travel with flashing object text 3. Park / Neutral Gear • Fully programmable Front & Rear & Side detection ranges & audible alarms for different object types (e.g. HV, LV, SO, PT, TS), location (front or rear or side) and direction of travel with flashing object text
Alarm Zones:	Programmable detection zones for different object types (e.g. HV, LV, SO, PT, TS) with programmable ranges (0-80m).
Alarm Output:	Audible alarm and flashing object text (detections) on Display for both FRONT and REAR and SIDES. Fully programmable alarms based on object type, range, location (front or rear or sides), direction of travel and speed.
Alarm Tones:	Pulsed audible alarm @ 0.5Hz
Alarm Cancellation:	Driver presses ‘CONFIRM’ key or object moves out of Detection Zone(s).

Table 37: Heavy Vehicle Alarm Specifications

10.2 Light Vehicle (LV) System

10.2.1 RF Detections and Alarms

10.2.1.1 Alarm Components

The Light Vehicle Unit comprises of the following alarm components:

Rotating Beacon Unit (optional)

- Mounted on roof of LV
- Activated (flashing) when HV detected (in gear) within the LV Detection Zone
- Provides HV driver with visual confirmation

Light Vehicle RF Unit (with external beacon option) (in lieu of Rotating Beacon Unit above)

- Mounted on roof of LV
- Optional external beacon / strobe activated (flashing) when HV detected (in gear) within the LV Detection Zone
- Provides HV driver with visual confirmation

Light Vehicle Alarm Unit

- Dash mounted alarm unit
- Audible and visual alarms on HV detections
- Power indicator

10.2.1.2 RF Detection Zones and Ranges

The Light Vehicle Unit can be field programmed for a single Detection Zone with programmable range / radius typically 0 – 80 m (+/- 20% accuracy).

Refer to sections 5 & 7 for more details on Detection Zones and Alarm Scenarios.

10.2.1.3 Alarm Process

1. Alarms are generated only when a HV (in gear) or TS is detected within the programmed LV Detection Zone.
2. Only HV(s) (in gear) and TS(s) can generate LV alarms.
3. Alarm automatically cancels when the HV(s) or TS(s) move outside the LV Detection Zone or HV out of gear.

10.2.1.4 Alarm Specifications

Alarm Conditions:	HV (in gear) or TS detected within LV programmed Detection Zone
Alarm Zones:	Single programmable Detection Zone
Alarm Output:	Flashing beacon on roof (optional), dash-mount audible alarm and flashing alarm indicator
Alarm Tones:	High rate pulsed tone on initial HV (in gear) or TS detection, changes after 3 seconds to low rate pulsed tone upon continuous HV or TS detection. Reverts back to high rate pulsed tone when either HV changes gear or another HV or TS is detected.
Alarm Cancellation:	HV or TS outside of LV Detection Zone (or HV out of gear)

Table 38: Light Vehicle Alarm Specifications

10.2.2 Power On/Off

The Light Vehicle Unit is permanently powered ON and will only generate alarms when a HV (in gear) or TS is detected within the LV Detection Zone.

10.3 Stationary Object (SO) Unit

10.3.1 RF Detections and Alarms

10.3.1.1 Alarm Components

The Stationary Object Unit comprises of the following alarm components:

Rotating Beacon Unit

- Identical to LV Rotating Beacon Unit
- Mounted on Stationary Object requiring protection from Heavy Vehicles
- Activated (flashing) when HV (in gear) or TS is detected within the SO Detection Zone
- Provides HV driver with visual confirmation

10.3.1.2 RF Detection Zones and Ranges

The Stationary Object Unit can be field programmed for a single detection zone with programmable range / radius typically 0 – 80 m (+/- 20% accuracy).

Refer to sections 5 & 7 for more details on Detection Zones and Alarm Scenarios.

10.3.1.3 Alarm Process

1. Visual alarm is generated only when a HV (in gear) or TS is detected within the programmed SO Detection Zone. Alarms can be programmed for HV(s) either in or out of gear.
2. Only HV(s) (in gear) and TS(s) can generate SO alarms.
3. Alarm automatically cancels when the HV(s) move outside the SO Detection Zone or HV out of gear.

10.3.1.4 Alarm Specifications

Alarm Conditions:	HV (in gear) or TS detected within SO programmed Detection Zone
Alarm Zones:	Single programmable Detection Zone
Alarm Output:	Flashing beacon
Alarm Tones:	Not Applicable
Alarm Cancellation:	HV or TS moves outside of SO Detection Zone (or HV out of gear)

Table 39: Stationary Object Alarm Specifications

10.3.2 Power On/Off

The Stationary Object is permanently powered ON and will only generate visual alarms when a HV (in gear) or TS is detected within the SO Detection Zone.

12VDC, 60W power can be supplied either from a permanent mains powered supply, battery pack, or solar energy power supply for remote locations.

10.4 Mobile Plant & Equipment (HV) Unit

10.4.1 RF Detections and Alarms

10.4.1.1 Alarm Components

The Mobile Plant & Equipment Unit comprises of the following alarm components:

Rotating Beacon Unit

- Identical to LV Rotating Beacon Unit
- Mounted on Mobile Plant & Equipment Unit
- Activated (flashing) when either HV (in gear), LV or TS is detected within the programmed Detection Zone
- Provides HV driver with visual confirmation

10.4.1.2 RF Detection Zones and Ranges

The Mobile Plant & Equipment Unit can be field programmed for a single detection zone with programmable range / radius typically 0 – 80 m (+/- 20% accuracy).

Refer to sections 5 & 7 for more details on Detection Zones and Alarm Scenarios.

10.4.1.3 Alarm Process

1. Visual alarm is generated only when either a HV (in gear), LV or TS is detected within the programmed Detection Zone.
2. Alarm automatically cancels when the HV, LV or TS moves outside the Detection Zone or HV out of gear.

10.4.1.4 Alarm Specifications

Alarm Conditions:	HV (in gear), LV or TS detected within programmed Detection Zone
Alarm Zones:	Single programmable Detection Zone
Alarm Output:	Flashing beacon
Alarm Tones:	Not Applicable
Alarm Cancellation:	HV, LV or TS moves outside of Detection Zone (or HV out of gear)

Table 40: Mobile Plant & Equipment Alarm Specifications

10.4.2 Power On/Off

The Mobile Plant & Equipment Unit is normally powered from the machine ignition and will only generate visual alarms when either a HV (in gear) or TS is detected within the Detection Zone.

12VDC, 60W power can be supplied from the machine battery via the ignition switch.

10.5 Test Station (TS) Unit

10.5.1 RF Detections and Alarms

10.5.1.1 Alarm Components

The Test Station Unit comprises of the following alarm components:

Rotating Beacon Unit

- Identical to LV Rotating Beacon Unit
- Mounted near vehicle traffic areas (e.g. maintenance workshop, GO-LINE, refueling station etc) for regular functional testing of all RF tagged objects
- Activated (flashing) when either HV (in gear) , LV, SO or TS is detected within the programmed Detection Zone
- Alarms all RF tagged objects within the programmed Detection Zone
- Is alarmed by all other RF tagged objects within the programmed Detection Zone
- Provides HV & LV driver with visual confirmation

10.5.1.2 RF Detection Zones and Ranges

The Test Station Unit can be field programmed for a single detection zone with programmable range / radius typically 0 – 80 m (+/- 20% accuracy).

Refer to sections 5 & 7 for more details on Detection Zones and Alarm Scenarios.

10.5.1.3 Alarm Process

1. Visual alarm is generated only when either a HV (in gear), LV, SO or TS is detected within the programmed Detection Zone.
2. Alarm automatically cancels when the HV, LV, SO or TS moves outside the Detection Zone or HV out of gear.

10.5.1.4 Alarm Specifications

Alarm Conditions:	HV (in gear), LV, SO or TS detected within programmed Detection Zone
Alarm Zones:	Single programmable Detection Zone
Alarm Output:	Flashing beacon
Alarm Tones:	Not Applicable
Alarm Cancellation:	HV, LV, SO or TS moves outside of Detection Zone (or HV out of gear)

Table 41: Test Station Alarm Specifications

10.5.2 Power On/Off

The Test Station is permanently powered ON and will only generate visual alarms when either a HV (in gear), LV, SO or TS is detected within the TS Detection Zone.

12VDC, 60W power can be supplied either from a permanent mains powered supply, battery pack, or solar energy power supply for remote locations.

10.6 Personnel Tag (PT) Unit

10.6.1 RF Detections and Alarms

10.6.1.1 Alarm Components

Note: The Personnel Tag Unit is under development and the following information is preliminary only and subject to change.

The Personnel Tag Unit comprises of the following alarm components:

Safety Vest Version

- Audible & Vibrating battery alarm
- Alarm activated when HV (in gear) or TS detected within the PT Detection Zone

10.6.1.2 RF Detection Zones and Ranges

The Personnel Tag Unit can be field programmed for a single detection zone with programmable range/radius typically 0 – 80 m (+/- 20% accuracy).

Refer to sections 5 & 7 for more details on Detection Zones and Alarm Scenarios.

10.6.1.3 Alarm Process

1. Alarm is generated only when a HV (in gear) or TS is detected within the programmed PT Detection Zone.
2. Only HV(s) (in gear) or TS(s) can generate PT alarms.
3. Alarm automatically cancels when the HV(s) or TS(s) move outside the PT Detection Zone or HV out of gear.

10.6.1.4 Alarm Specifications

Alarm Conditions:	HV (in gear) or TS detected within PT programmed Detection Zone
Alarm Zones:	Single programmable Detection Zone
Alarm Output:	Audible / Vibrating Battery Alarm (Belt Version)
Alarm Tones:	Not Applicable
Alarm Cancellation:	HV or TS moves outside of PT Detection Zone (or HV out of gear)

Table 42: Personnel Tag Alarm Specifications

10.6.2 Power On/Off

The Personnel Tag is permanently powered ON and will only generate alarms when a HV (in gear) or TS is detected within the PT Detection Zone.

Power is supplied by rechargeable batteries.

10.6.3 Battery Low

The battery voltage is monitored and when it falls to a ‘battery low’ condition, a battery low alarm is generated warning the user to recharge the battery pack.

The battery low alarm is distinct to the CAS detection alarm and continues until the battery reaches a flat condition or is recharged.

10.6.4 Battery Charging

Personnel Tag batteries are recharged using a smart charger unit designed to automatically charge multiple battery packs. The charger provides status indication on each battery being charged and provides a functional check when initiated by the user.

11 HEAVY VEHICLE DISPLAY UNIT - MENU FUNCTIONS

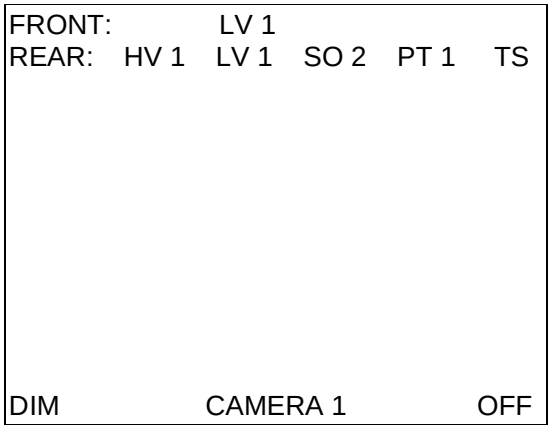
11.1 Boot-Up Screen

The following boot-up screen will appear for approximately 5 seconds after initial power ON or after performing a Display Reset function (refer to section 10.1.9):

SOFTXXXX-Y = Software Part Number - Issue
ID = Display Unit Identification (ID) Number (5 digits)

11.2 Default Screen

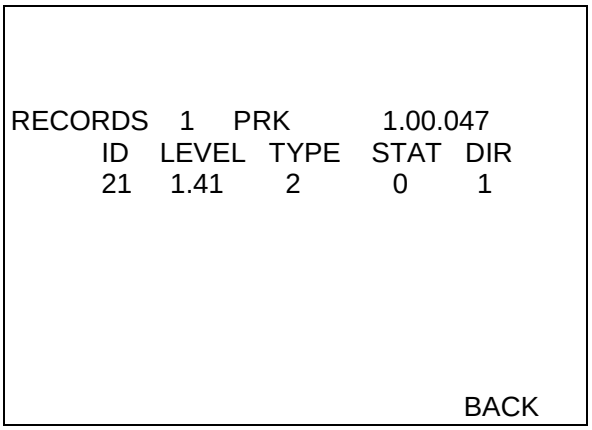
After initial power ON, the above boot-up screen will appear for approximately 5 seconds after which the following DEFAULT screen will appear:



The RF Detection Status for the FRONT and REAR RF units will only appear if either of these units are fitted to the Heavy Vehicle (CAS-RF® option) and there are valid detections within the programmed Detection Zone(s). Otherwise, the top two lines of the screen will remain blank to maximise the video display area.

11.3 Heavy Vehicle Display Unit – Diagnostic Menu

The following basic Diagnostic Menu is available to the User for in-field monitoring of the CAS-RF® tags under the direction of the AMT Service Agent:



To enter the DIAGNOSTICS MENU, press the ■ and ⇩ keys simultaneously.
To exit the DIAGNOSTICS MENU, press the 'BACK' key to return to the 'Default' Menu.

The top line (3rd row) fields and descriptions are as follows:
RECORDS 1 PRK 1.00.047

RECORDS = Number of CAS-RF tags detected (details listed on remaining rows)
PRK = Gear Direction
- PRK = Park
- REV = Reverse
- FWD = Forward

1.00.047 = Display Unit Bus I.D.

The second line (4th row) fields and descriptions are as follows:

ID = Object Identification Number (factory programmed & unique)
LEVEL = Detection Level (0.8 – 1.9 V)
TYPE = Object Type
- 0 = PT
- 1 = LV
- 2 = HV Front RF
- 3 = HV Rear RF
- 4 = SO
- 5 = TS
- 6,7 = Test Codes

STAT = Object Status
- 0 = RF O.K.
- 1 = low battery
- 2 = No RF Receive
- 3 = Fault

DIR = Gear Direction
- 0 = Reverse
- 1 = Forward
- 2 = Park / Neutral

12 OTHER FUNCTIONS

The following Functions are not accessible by the operator and need to be programmed by the installer using a PC connected to the Display Unit RS-232 communications interface. Refer to section 13 “Installer Mode Settings” for function settings and refer to the CAS-CAM/RF® Installation Manual for detailed function descriptions and programming details.

Changes to installer Mode Settings only to be conducted by an AMT Service Agent.

12.1 Camera Titles (8 chars max)

12.2 Camera Brightness Settings

12.3 Camera Colour Settings

12.4 Camera Mirror / Normal Mode

12.5 Camera Enable

12.6 Switching Settings

12.6.1 Forward Gear Switching
12.6.2 Forward Channel Selection
12.6.3 Reverse Gear Switching
12.6.4 Reverse Channel Selection
12.6.5 Sleep Time
12.6.6 RF Switching
12.6.7 Wake on Forward Gear
12.6.8 Wake on Reverse Gear
12.6.9 Central RF
12.6.10 Keypad Tone
12.6.11 Auto Cycle

12.7 Front RF Unit Settings

12.8 Rear RF Unit Settings

12.9 Reversing Siren Disable on Heavy Vehicle

12.10 Heavy Vehicle Maintenance Mode

In order to disable alarms on all object types in the proximity of a Heavy Vehicle during maintenance work, the Heavy Vehicle can be set to 'Maintenance Mode'. This mode disables all detections and alarms on both the Heavy Vehicle and all tagged objects within the Heavy Vehicle Detection Zone(s). This mode is suited to a maintenance workshop environment where normal CAS-RF® alarms may generate a high annoyance factor.

Refer to the CAS-CAM/RF® Installation Manual for programming details.

12.11 Heavy Vehicle Display Unit – Screen Power Down

12.11.1 Manual Mode

Refer to section 10.1.1 for details.

12.11.2 Automatic Mode

Refer to section 10.1.1 for details.

12.12 Real Time Clocks

The following CAS Units contain battery backed real time clocks, which can be used to time & date stamp all RF detections and HV driver confirmation of alarms. This information would be useful as a safety audit trail and is an optional feature.

- Heavy Vehicle Display Unit
- Light Vehicle Unit
- Stationary Object Unit
- Mobile Plant & Equipment Unit
- Test Station Unit

The programming of real-time clocks in all units is conducted at the time of installation using laptop PC programming software. Refer to the CAS-CAM/RF® Installation Manual for programming details.

12.13 Data Logging of Detections

All RF detections received by object types HV, LV, SO and TS can be logged to non-volatile memory and are time and date stamped. This information would be useful as a safety audit trail and is an optional feature.

Data is recovered via the RS-232 interface on the above mentioned objects using the laptop Installer mode software. Refer to the CAS-CAM/RF® Installation Manual for programming details.

13 INSTALLER MODE SETTINGS

The CAS-CAM/RF® equipment contains programmable system settings that can only be configured at either the factory at the time of order or by an AMT Service Agent. These system settings are not accessible by the user. Software setting changes require the use of a laptop PC with RS-232 interface running the CAS-CAM/RF® Installer Mode Software. Hardware setting changes require opening instrument enclosures and changing internally configured jumper link settings.

The following settings are programmable by the Installer or can be factory preset at the time of order:

Heavy Vehicle Display Unit Settings

CHANNEL Settings (6 camera channels)

- Channel Title (8 character title maximum)
- Brightness (1-5)
- Colour (1-5)
- Mirror (on, off)
- Enabled (yes, no)

SWITCHING Settings

- Forward Switching (yes, no)
- Forward Channel (1-6)
- Reverse Switching (yes, no)
- Reverse Channel (1–6)
- Sleep Time (off, 5, 10, 15, 20, 25, 30 mins)
- RF Switching (yes, no)
- Wake on Forward (yes, no)
- Wake on Reverse (yes, no)
- Central RF (yes, no)
- Keypad Tone (yes, no)
- Auto Cycle (off, 2s, 4s, 6s, 8s, 10s)

FRONT RF UNIT settings

- RF Unit Enable (yes, no)

- HVR (Reverse Gear) – audible (on, off), range (0-80m)
- HVF (Reverse Gear) – audible (on, off), range (0-80m)
- LV (Reverse Gear) – audible (on, off), range (0-80m)
- SO (Reverse Gear) – audible (on, off), range (0-80m)
- PT (Reverse Gear) – audible (on, off), range (0-80m)
- TS (Reverse Gear) – audible (on, off), range (0-80m)

- HVR (Park Gear) – audible (on, off), range (0-80m)
- HVF (Park Gear) – audible (on, off), range (0-80m)
- LV (Park Gear) – audible (on, off), range (0-80m)
- SO (Park Gear) – audible (on, off), range (0-80m)
- PT (Park Gear) – audible (on, off), range (0-80m)
- TS (Park Gear) – audible (on, off), range (0-80m)

- HVR (Forward Gear) – audible (on, off), range (0-80m)
- HVF (Forward Gear) – audible (on, off), range (0-80m)
- LV (Forward Gear) – audible (on, off), range (0-80m)
- SO (Forward Gear) – audible (on, off), range (0-80m)
- PT (Forward Gear) – audible (on, off), range (0-80m)
- TS (Forward Gear) – audible (on, off), range (0-80m)

REAR RF UNIT settings

- RF Unit Enable (yes, no)

- HVR (Reverse Gear) – audible (on, off), range (0-80m)
- HVF (Reverse Gear) – audible (on, off), range (0-80m)
- LV (Reverse Gear) – audible (on, off), range (0-80m)
- SO (Reverse Gear) – audible (on, off), range (0-80m)
- PT (Reverse Gear) – audible (on, off), range (0-80m)
- TS (Reverse Gear) – audible (on, off), range (0-80m)

- HVR (Park Gear) – audible (on, off), range (0-80m)
- HVF (Park Gear) – audible (on, off), range (0-80m)
- LV (Park Gear) – audible (on, off), range (0-80m)
- SO (Park Gear) – audible (on, off), range (0-80m)
- PT (Park Gear) – audible (on, off), range (0-80m)
- TS (Park Gear) – audible (on, off), range (0-80m)

- HVR (Forward Gear) – audible (on, off), range (0-80m)
- HVF (Forward Gear) – audible (on, off), range (0-80m)
- LV (Forward Gear) – audible (on, off), range (0-80m)
- SO (Forward Gear) – audible (on, off), range (0-80m)
- PT (Forward Gear) – audible (on, off), range (0-80m)
- TS (Forward Gear) – audible (on, off), range (0-80m)

- Reverse Alarm Relay (closed, RF closed, open)

MAINTENANCE MODE

- On / Off

Light Vehicle (LV) Settings

- Range (0 – 80m)

Stationary Object (SO) Settings

- Range (0 – 80m)

Mobile Plant & Equipment (HV) Settings

- Range (0 – 80m)

Personnel Tag (PT) Settings

- Range (0 – 80m)

Test Station (TS) Settings

- Range (0 – 80m)

Details on performing changes to installer Mode Settings are contained within the CAS-CAM/RF® Installation Manual and are only to be conducted by an AMT Service Agent.

14 SYSTEM CALIBRATION & TESTING

The following equipment is required for the initial calibration and ongoing in-service testing of the CAS-CAM/RF® Equipment. A brief overview is only given for general understanding by the user.

14.1 Calibration System (PROD0260)

The CAS-CAM/RF® Calibration System (PROD0260) comprises of a Heavy Vehicle (HV) RF Unit enclosure configured as a Calibration Unit (PROD0193) which is in effect a mobile Test Station (TS) Unit. The unit is mounted on a portable tripod, battery powered and interfaces via a RS-232 interface to a Portable Computer (laptop or Pocket PC / Palm PDA) running the CAS-CAM/RF® Installer Mode software.

The Calibration System allows for programming the Detection Zones of all RF tagged objects (i.e. Heavy Vehicle (HV), Light Vehicle (LV), Stationary Object (SO), Personnel Tag (PT), Test Station (TS)).

An approved CAS-CAM/RF® System Installer can only conduct the Calibration Process using the Installer Mode software. Refer to the CAS-CAM/RF® Installation Manual for details.

14.2 Test Station System (TS) (PROD0251)

All CAS-CAM/RF® Equipment functionality can be tested on site using a Test Station (TS) System (PROD0251).

Test Stations would normally be installed in locations frequently passed by CAS RF tagged objects (e.g. maintenance workshop, GO-LINE, refueling station etc) and serve to provide regular functional two-way testing of all RF tagged objects. Solar power versions are available for remote locations.

Refer to section 4.8 for more details.

15 CARE AND MAINTENANCE

The following care and maintenance activities should be conducted to ensure the reliable and safe operation of the CAS-CAM/RF® equipment. Note that there are no serviceable parts located inside the equipment enclosures. Refer servicing to an AMT Service Agent.

15.1 Heavy Vehicle (HV) System

15.1.1 Operational Care

- To prevent fire or shock hazard, do not expose the Heavy Vehicle Display Unit to rain or moisture.
- To avoid electrical shock, do not open the electrical equipment enclosures. There are no user serviceable parts located inside the equipment items.
- Ensure that the Heavy Vehicle Display Unit rear panel ventilation holes are not obstructed for efficient natural convection cooling.
- The audible alarm contained within the Heavy Vehicle Display Unit must not be blocked with foreign objects in order to reduce alarm sound levels as this is the primary means of notifying drivers of potential collisions. Consult the AMT Service Agent if you wish to adjust the alarm sound levels to suit the ambient noise levels of the particular installation.
- The visual alarms contained on the Heavy Vehicle Display Unit Screen should not be covered over with foreign objects in order to reduce night vision glare as this is the secondary means of notifying drivers of potential collisions (the primary means being the audible alarms). The brightness level can be switched to the lowest setting on the Heavy Vehicle Display Unit Screen by using the DIM function (refer to section 10.1.8 for details). The intensity of the LED power indicators on both equipment items and the Light Vehicle alarm LED indicator have been set at low intensity levels suited for both day and night visibility.

15.1.2 Pre-Operation Inspection

External Checks

- Visually check that all cameras are clean and are orientated correctly. Clean and adjust if necessary.
- Visually check that all equipment items and wiring harnesses are secure.

15.1.3 Startup Inspection

- Check the clarity of the Display Unit screen and where visibility is affected, clean with a window cleaning spray and soft cloth. Ensure that the cleaning process doesn't scratch the screen cover or result in cleaning fluid entering the rear ventilation holes.
- Inspect the clarity of vision from each camera on the Heavy Vehicle Display Unit and where affected by the build up of foreign material, clean the camera unit window with a window cleaning spray and cloth. Approved access methods must only be used when cleaning cameras located at heights.
- Scroll thru all active camera channels to check operation
- Check that no error messages are displayed (refer to section 16.2 'System Error Messages' for details).
- When operating at daytime, check that DIM function has been set for maximum brightness (refer to section 10.1.8 for details).

- When operating at night-time, check that the DIM function has set to minimum brightness (refer to section 10.1.8 for details).
- Check automatic camera switching operation on gear selection (if programmed at time of installation).

15.1.4 Operational Checks

- Drive past the Test Station (TS) and verify detection on the Heavy Vehicle Display Unit (TS code) and the activation of the Test Station rotating beacon.

15.1.5 Shutdown Inspection

- Switch OFF the Heavy Vehicle Display Unit screen by pressing the ● key when unattended. This applies only when the RF tagging option has been fitted (CAS-RF®) where all equipment is permanently powered from the vehicle battery. If however this operation is not conducted, the Display Unit screen will automatically switch OFF after a preset time period (if programmed during Installation - refer to the CAS Installation manual for details) thereby conserving battery life. Camera only installations (CAS-CAM®) are powered from the vehicle auxiliary circuit and the equipment will automatically shutdown when the ignition is switched OFF.

15.1.6 Maintenance Requirements

Routine Checks

- Inspect the clarity of vision from each camera on the Heavy Vehicle Display Unit and where affected by the build up of foreign material, clean the camera unit window with a window cleaning spray and cloth. Approved access methods must only be used when cleaning cameras located at heights.
- Where camera lenses have been scratched severely affecting image quality, arrange for repair with the approved AMT Service Agent.
- Check that the antenna is securely screwed onto the RF Unit enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).
- Check all equipment and cabling is secure. Re-secure if necessary.

Notes:

1. Damage to cables effecting signal connectivity will automatically be detected by the Display Unit and reported as errors (refer to section 16.2 ‘System Error Messages’ for details).
2. To disable Heavy Vehicle & other tagged object alarms during workshop Maintenance, refer to section 12.10 ‘Heavy Vehicle Maintenance Mode’.

15.2 Light Vehicle (LV) System

15.2.1 Operational Care

- To prevent fire or shock hazard, do not expose the Dash Alarm Unit to rain or moisture.
- To avoid electrical shock, do not open the electrical equipment enclosures. There are no user serviceable parts located inside the equipment items.
- The audible alarm contained within the Dash Alarm Unit must not be blocked with foreign objects in order to reduce alarm sound levels as this is the primary means of notifying drivers of potential collisions. Consult the AMT Service Agent if you wish to adjust the alarm sound levels to suit the ambient noise levels of the particular installation.
- The visual alarm contained on the Dash Alarm Unit should not be covered over with foreign objects in order to reduce night vision glare as this is the secondary means of notifying drivers of potential collisions (the primary means being the audible alarms). The intensity of the led indicators (alarm and power) have been set at low intensity levels suited for both day and night visibility.

15.2.2 Pre-Operation Inspection

External Checks

- Visually check that the roof mounted Rotating Beacon (if fitted) or RF Unit and wiring harness are secure.
- Check that the antenna is securely screwed onto the Rotating Beacon enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).

15.2.3 Startup Inspection

- Check that the dash alarm power indicator is ON

15.2.4 Operational Checks

- Drive past the Test Station (TS) and verify detection on the Light Vehicle dash alarm unit (warble tone) and roof mounted Rotating Beacon (if fitted - verify beacon operation using Test Station mirror). The Test Station rotating beacon should also switch on when the Light Vehicle enters the programmed Detection Zone.

15.2.5 Maintenance Requirements

Routine Checks

- Check that the antenna is securely screwed onto the Rotating Beacon Unit enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).
- Check the operation of rotating beacon (if fitted) and dash alarm at the Test Station (TS).
- Check all equipment and cabling is secure. Re-secure if necessary.

15.3 Stationary Object (SO) Unit

15.3.1 Operational Care

- To avoid electrical shock, do not open the electrical equipment enclosures. There are no user serviceable parts located inside the equipment items.

15.3.2 Maintenance Requirements

Monthly Checks

- Check that the antenna is securely screwed onto the Rotating Beacon Unit enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).
- Check the operation of the Rotating Beacon by triggering a detection using a Heavy Vehicle (in gear) or the Test Station (TS).
- Check all equipment and cabling is secure. Re-secure if necessary.

15.4 Mobile Plant & Equipment (HV) System

15.4.1 Operational Care

- To prevent fire or shock hazard, do not expose the Dash Alarm Unit to rain or moisture.
- To avoid electrical shock, do not open the electrical equipment enclosures. There are no user serviceable parts located inside the equipment items.
- The audible alarm contained within the Dash Alarm Unit must not be blocked with foreign objects in order to reduce alarm sound levels as this is the primary means of notifying drivers of potential collisions. Consult the AMT Service Agent if you wish to adjust the alarm sound levels to suit the ambient noise levels of the particular installation.
- The visual alarm contained on the Dash Alarm Unit should not be covered over with foreign objects in order to reduce night vision glare as this is the secondary means of notifying drivers of potential collisions (the primary means being the audible alarms). The intensity of the led indicators (alarm and power) have been set at low intensity levels suited for both day and night visibility.

15.4.2 Pre-Operation Inspection

External Checks

- Visually check that the roof mounted Rotating Beacon (if fitted) or RF Unit and wiring harness are secure.
- Check that the antenna is securely screwed onto the Rotating Beacon enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).

15.4.3 Startup Inspection

- Check that the dash alarm power indicator is ON

15.4.4 Operational Checks

- Drive past the Test Station (TS) and verify detection on the Dash Alarm unit (warble tone) and roof mounted Rotating Beacon (if fitted - verify beacon operation using Test Station mirror). The Test Station rotating beacon should also switch on when the Mobile Plant & Equipment Unit enters the programmed Detection Zone.

15.4.5 Maintenance Requirements

Routine Checks

- Check that the antenna is securely screwed onto the Rotating Beacon Unit enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).
- Check the operation of rotating beacon and dash alarm at the Test Station (TS).
- Check all equipment and cabling is secure. Re-secure if necessary.

15.5 Personnel Tag (PT) Unit

15.5.1 Operational Care

- The visual / audible alarm contained within the Personnel Tag Unit must not be obstructed with foreign objects in order to reduce alarm output levels as this is the primary means of notifying personnel of potential collisions with Heavy Vehicles.
- Charge or replace battery pack when 'battery low' alarm is ON.

15.5.2 Pre-Operation Inspection

- Check that the PT unit is correctly fitted with fully charged battery

15.5.3 Startup Inspection

- Check that the power indicator is ON
- Check that the 'battery low' alarm is OFF

15.5.4 Operational Checks

- Drive past the Test Station (TS) and verify detection. The Test Station rotating beacon should also switch on when the Personnel Tag enters the programmed Detection Zone.

15.5.5 Maintenance Requirements

Routine Checks

- Check PT unit operation at the Test Station (TS).
- Check operation of battery charger unit.

15.6 Test Station (TS) Unit

15.6.1 Operational Care

- To avoid electrical shock, do not open the electrical equipment enclosures. There are no user serviceable parts located inside the equipment items.

15.6.2 Maintenance Requirements

Monthly Checks

- Check that the antenna is securely screwed onto the Rotating Beacon Unit enclosure and located in the upright position. Tighten and straighten by hand if necessary (secure using Loctite 243).
- Check the operation of the Rotating Beacon by triggering a detection using any other tagged object. The tagged object should also alarm when within the TS Detection Zone.
- Check all equipment and cabling is secure. Re-secure if necessary.
- For remote sites without permanent power, check the operation of the Solar Energy system (where fitted).

16 TROUBLESHOOTING

16.1 Overview

If you have any questions or problems not covered below, please consult your nearest AMT approved Installer or Service Agent.

16.2 Heavy Vehicle Display Unit Error Messages

Error Message	Possible Cause	Corrective Action
NO SIGNAL accompanied by Blue Screen)	No camera connected	Connect camera connection
	Faulty camera	Check camera operation Replace with Spare Unit Contact Service Agent for repair
	Faulty cabling	Check cabling
	Faulty Expansion Unit	Check equipment operation Replace with Spare Unit Contact Service Agent
	Blown fuse on Display Unit / Expansion Unit channel	Check & replace fuse Investigate source of fuse failure – Contact Service Agent
HV Front Unit Not Detected	No Front RF Unit connected	Connect Front RF Unit Check connectors
	Faulty Front RF Unit	Check equipment operation Replace with Spare Unit Contact Service Agent
	Blown fuse on Display Unit / Expansion Unit channel	Check & replace fuse Investigate source of fuse failure – Contact Service Agent
	Faulty cabling	Check cabling
HV Rear Unit Not Detected	No Rear RF Unit connected	Connect Front RF Unit Check connectors
	Faulty Rear RF Unit	Check equipment operation Replace with Spare Unit Contact Service Agent
	Blown fuse on Display Unit / Expansion Unit channel	Check & replace fuse Investigate source of fuse failure – Contact Service Agent
	Faulty cabling	Check cabling
Expansion Unit Not Detected	No Expansion Unit connected	Connect Expansion Unit
	Faulty Expansion Unit	Check equipment operation Replace with Spare Unit Contact Service Agent
	Faulty cabling	Check cabling
	Blown fuse on Expansion Unit input power (note: Display Unit won't operate either)	Check power indicator. If OFF check fuse & replace if necessary. Investigate source of fuse failure – Contact Service Agent

Error Message	Possible Cause	Corrective Action
Hardware Defaults Restored	Flash memory problem – User settings replaced with hardware defaults	Replace with Spare Unit Contact Service Agent
Saving Settings, Verify Failure	Flash memory problem	Replace with Spare Unit Contact Service Agent
User System Settings – Restoring Backup Defaults	Flash memory problem – User System Settings restored with Backup Defaults	Replace with Spare Unit Contact Service Agent (unit still operational with same settings)
Backup System Settings – Restoring Emergency Defaults	Flash memory problem – Backup System Settings restored with Emergency Defaults	Replace with Spare Unit Contact Service Agent (unit still operational but may have different settings)
User Switching Settings – Restoring Backup Defaults	Flash memory problem – User Switching Settings restored with Backup Defaults	Replace with Spare Unit Contact Service Agent (unit still operational with same settings)
Backup Switching Settings – Restoring Emergency Defaults	Flash memory problem – Backup Switching Settings restored with Emergency Defaults	Replace with Spare Unit Contact Service Agent (unit still operational but may have different settings)
User Front RF Settings – Restoring Backup Defaults	Flash memory problem – User Front RF Settings restored with Backup Defaults	Replace with Spare Unit Contact Service Agent (unit still operational with same settings)
Backup Front RF Settings – Restoring Emergency Defaults	Flash memory problem – Backup Front RF Settings restored with Emergency Defaults	Replace with Spare Unit Contact Service Agent (unit still operational but may have different settings)
User Rear RF Settings – Restoring Backup Defaults	Flash memory problem – User Rear RF Settings restored with Backup Defaults	Replace with Spare Unit Contact Service Agent (unit still operational with same settings)
Backup Rear RF Settings – Restoring Emergency Defaults	Flash memory problem – Backup Rear RF Settings restored with Emergency Defaults	Replace with Spare Unit Contact Service Agent (unit still operational but may have different settings)
User Channel Settings – Restoring Backup Defaults	Flash memory problem – User Channel Settings restored with Backup Defaults	Replace with Spare Unit Contact Service Agent (unit still operational with same settings)
Backup Channel Settings – Restoring Emergency Defaults	Flash memory problem – Backup Channel Settings restored with Emergency Defaults	Replace with Spare Unit Contact Service Agent (unit still operational but may have different settings)
Resetting	User has pressed ■ and ● keys simultaneously to activate Display Reset function.	No action required

16.3 Diagnostic Tables

16.3.1 Heavy Vehicle (HV) Diagnostic Table

Symptom	Possible Cause	Corrective Action
HEAVY VEHICLE (HV) Unit		
Poor quality video image	Dirty camera lens	Clean lens
	Camera lens scratched	Replace camera Contact Service Agent for repair
	Dirty Display Unit screen	Clean screen
	Cable damaged	Check cable
	Poor connection	Check connections
	Internal Problem	Replace with spare unit Contact Service Agent
Camera Not Working	Loss of camera signal (NO SIGNAL message with Blue Screen)	Check connections & cables at Camera and Display Unit / Expansion Unit
	Camera not enabled	Enable with Installer Mode software – contact Service Agent
	Faulty camera	Replace camera Contact Service Agent for repair
	Blown fuse on Display Unit / Expansion Unit channel	Check & replace fuse Investigate source of fuse failure – contact Service Agent
No text or video image on screen	No power	Check power LED indicator - should be ON Check fuse Check power connector is attached Check battery condition
	Display Shutdown or in Sleep Mode	Press any key to switch ON
Low Level of Camera Brightness	Low brightness settings	Increase brightness setting (refer to section 10.1.4)
	Direct sun glare	Fit sun visor option (PROD0164)
Black & White camera image	Colour settings set too low	Increase Colour setting (refer to section 10.1.4)

Symptom	Possible Cause	Corrective Action
HEAVY VEHICLE (HV) Unit		
No automatic camera switching on gearing	Function not programmed	Enable with Installer Mode software – contact Service Agent
	Faulty Gear Detection	Check gearing signal detection on Display Unit diagnostics screen (refer to section 11.3). Check gearing signal pickup at electrical distribution board and cable path to Display Unit. Contact Service Agent
Poor quality camera image at night	Lighting level too low (<= 0.03 lux illumination)	Camera limited to 0.03 lux operation
No CAS-RF® Detections when HV is within the Detection Zone of other tagged objects (i.e. HV, LV, SO, PT, TS)	No RF unit(s) fitted	Check installation configuration with Service Agent
	RF units fitted but not enabled	Enable with Installer Mode software – contact Service Agent
	Loss of communications with RF unit (s) – Display should show error messages 'HV Front Unit Not Detected' or 'HV Rear Unit Not Detected' or both (refer to section 16.2 for Troubleshooting details)	Refer to section 16.2 for corrective actions
	Loss of Detection Zone settings	Unit should still work with factory default Detection Zone settings (30 m range) Contact Service Agent
	Poor Antenna Connection	Check antenna is firmly attached & orientated upright. Check for antenna damage & replace if necessary – contact Service Agent.
	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
No automatic camera switching on Front / Rear RF Detections & Alarms	Function not programmed	Enable with Installer Mode software – contact Service Agent

Symptom	Possible Cause	Corrective Action
HEAVY VEHICLE (HV) Unit		
Pulsed Audible Alarm	Normal operation – indicates that a new object has moved into the programmed Detection Zone (Front / Rear). Object type text and location (Front or Rear) flashes on Display Unit until the user presses the 'CONFIRM' key to verify that the new object has been visually confirmed using the cameras and cancels the alarm.	Normal operation
Audible alarm re-triggers after pressing 'CONFIRM' key	Tagged object has moved out of Detection Zone and re-entered (e.g. LV approaching from rear moving in & out HV Detection Zone)	Normal Operation
	New tagged object has entered the HV Detection Zone(s).	Normal Operation
	HV has changed gear and all previously confirmed objects are now 'unconfirmed'.	Normal Operation
HV Alarms when in Maintenance Workshop	Detected other objects within programmed Detection Zone(s) – Front & Rear.	Press 'CONFIRM' key to cancel alarm. Will re-alarm on new detections or HV gear changes. Note: the HV is always active for RF detections independent of gearing status. To disable HV alarm for Maintenance work refer to section 12.10 'Heavy Vehicle Maintenance Mode'

16.3.2 Light Vehicle (LV) Diagnostic Table

Symptom	Possible Cause	Corrective Action
LIGHT VEHICLE (LV) Unit		
Power indicator OFF	Dash Alarm not connected	Check rear panel connection
	Rotating Beacon / RF Unit not connected	Check roof connection
	Loss of power	Check in-line fuse Check under-dash wiring / connections Check battery condition
No Dash Alarms when within HV (in gear) or TS Detection Zone	Dash Alarm not connected	Check rear panel connection
	Rotating Beacon / RF Unit not connected	Check roof mounted unit connection
	Loss of power	Check in-line fuse Check under-dash wiring / connections Check battery condition
	HV not in gear	Check HV gear status
	Poor Antenna Connection	Check antenna is firmly attached & orientated upright. Check for antenna damage & replace if necessary – contact Service Agent.
	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
No external Rotating Beacon Alarm when within HV (in gear) or TS Detection Zone	"All of above"	"All of above"
	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when a Heavy Vehicle is within the Light Vehicle Detection Zone.
	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
External Beacon not rotating but lamp is ON	Faulty internal drive	Replace with Spare Unit Contact Service Agent for repair

Symptom	Possible Cause	Corrective Action
LIGHT VEHICLE (LV) Unit		
External Beacon rotating but lamp is OFF	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when a Heavy Vehicle is within the Light Vehicle Detection Zone.
Pulsed Dash Alarm (high rate) when inside HV Detection Zone	Normal operation on initial HV detection (in gear) - reverts to low rate alarm after 3 seconds	Normal operation
Pulsed Dash Alarm (low rate) when inside HV Detection Zone	Normal operation after detecting HV (in gear) for longer than 3 seconds	Normal operation
Pulsed Dash Alarm (low rate warble) when inside TS Detection Zone	Normal operation	Normal operation
Rotating Beacon always ON when outside of HV or TS Detection Zone	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
LV Alarms when in Maintenance Workshop	Detected HV or TS within programmed Detection Zone(s).	To disable LV alarm for Maintenance work refer to section 12.10 ‘Heavy Vehicle Maintenance Mode’

16.3.3 Stationary Object (SO) Diagnostic Table

Symptom	Possible Cause	Corrective Action
STATIONARY OBJECT (SO) Unit		
No external Rotating Beacon Alarm when within HV (in gear) or TS Detection Zone.	Rotating Beacon not connected	Check connections
	Loss of power	Check power supply (permanent, battery, solar etc)
	Loss of Detection Zone settings	Unit should still work with factory default Detection Zone settings (30 m range) Contact Service Agent
	HV not in gear	Check HV gear status
	Poor Antenna Connection	Check antenna is firmly attached & orientated upright. Check for antenna damage & replace if necessary – contact Service Agent.
	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when a Heavy Vehicle is within the SO Detection Zone.
	Faulty internal drive	Replace with Spare Unit Contact Service Agent for repair
No SO Detections by HV (in gear) or TS when within the SO Detection Zone	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
External Beacon not rotating but lamp is ON	“All of above”	“All of above”
External Beacon rotating but lamp is OFF	Faulty internal drive	Replace with Spare Unit Contact Service Agent for repair
	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when a Heavy Vehicle is within the SO Detection Zone.

16.3.4 Mobile Plant & Equipment (MPE) Diagnostic Table

Symptom	Possible Cause	Corrective Action
Mobile Plant & Equipment (MPE) Unit		
Power indicator OFF	Dash Alarm not connected	Check rear panel connection
	Rotating Beacon not connected	Check roof connection
	Loss of power	Check in-line fuse Check under-dash wiring / connections Check battery condition
No Dash Alarms when within HV (in gear), LV or TS Detection Zone	Dash Alarm not connected	Check rear panel connection
	Rotating Beacon not connected	Check roof mounted unit connection
	Loss of power	Check in-line fuse Check under-dash wiring / connections Check battery condition
	HV not in gear	Check HV gear status
	Poor Antenna Connection	Check antenna is firmly attached & orientated upright. Check for antenna damage & replace if necessary – contact Service Agent.
	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
No external Rotating Beacon Alarm when within HV (In gear), LV or TS Detection Zone	"All of above"	"All of above"
	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when a Heavy Vehicle is within the Light Vehicle Detection Zone.
	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
External Beacon not rotating but lamp is ON	Faulty internal drive	Replace with Spare Unit Contact Service Agent for repair

Symptom	Possible Cause	Corrective Action
Mobile Plant & Equipment (MPE) Unit		
External Beacon rotating but lamp is OFF	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when a Heavy Vehicle is within the Light Vehicle Detection Zone.
Pulsed Dash Alarm (high rate) when inside HV (in gear), LV or TS Detection Zone	Normal operation on initial HV (in gear), LV or TS detection - reverts to low rate alarm after 3 seconds	Normal operation
Pulsed Dash Alarm (low rate) when inside HV (in gear) or LV Detection Zone	Normal operation after detecting HV (in gear) or LV for longer than 3 seconds	Normal operation
Pulsed Dash Alarm (low rate warble) when inside TS Detection Zone	Normal operation	Normal operation
Rotating Beacon always ON when outside of HV, LV or TS Detection Zone	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
MPE Alarms when in Maintenance Workshop	Detected HV (in gear), LV or TS within programmed Detection Zone(s).	To disable MPE alarm for Maintenance work refer to section 12.10 ‘Heavy Vehicle Maintenance Mode’

16.3.5 Personnel Tag (PT) Diagnostic Table

Symptom	Possible Cause	Corrective Action
PERSONNEL TAG (PT) Unit		
No PT Alarm when within HV (in gear) or TS Detection Zone	Battery Flat	Charge or replace battery pack
	Loss of Detection Zone settings	Unit should still work with factory default Detection Zone settings (30 m range) Contact Service Agent
	HV not in gear	Check HV gear status
	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
No PT Detections by HV (in gear) or TS when within the PT Detection Zone	Faulty HV or TS tagged object	• HV (refer to Troubleshooting section 16.3.1) • TS (refer to Troubleshooting section 16.3.6)
Pulsed alarm (high rate) when inside HV (in gear) Detection Zone	"All of above"	"All of above"
Pulsed alarm (low rate) when inside TS Detection Zone	Normal operation	Normal operation
Continuous alarm (pulsed) outside of HV or TS Detection Zone	Normal operation	Normal operation
	Battery Low	Charge or replace battery pack

16.3.6 Test Station (TS) Diagnostic Table

Symptom	Possible Cause	Corrective Action
TEST STATION (TS) Unit		
No TS Rotating Beacon Alarm when within the Detection Zone of other tagged objects (i.e. HV, LV, SO, PT)	Rotating Beacon not connected	Check connections
	Loss of power	Check power supply (permanent, battery, solar etc)
	HV Not in Gear	Check HV gear status
	Loss of Detection Zone settings	Unit should still work with factory default Detection Zone settings (30 m range) Contact Service Agent
	Poor Antenna Connection	Check antenna is firmly attached & orientated upright. Check for antenna damage & replace if necessary – contact Service Agent.
	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when any tagged object is within the TS Detection Zone.
	Faulty internal drive	Replace with Spare Unit Contact Service Agent for repair
	Faulty Tagged Object	• HV (refer to Troubleshooting section 16.3.1) • LV (refer to Troubleshooting section 16.3.2) • SO (refer to Troubleshooting section 16.3.3) • PT (refer to Troubleshooting section 16.3.5)
No TS Detections by tagged objects when within the TS Detection Zone	Faulty Unit	Replace with Spare Unit Contact Service Agent for repair
External Beacon not rotating but lamp is ON	"All of above"	"All of above"
External Beacon rotating but lamp is OFF	Faulty internal drive	Replace with Spare Unit Contact Service Agent for repair
	Blown lamp	Replace lamp (12V, 55W) Warning: isolate power from the beacon by disconnecting the external connector before removing the lamp cover in order to replace a globe, as the beacon may start revolving without warning when any tagged object is within the TS Detection Zone.

17 FAULT REPORTING

On all occasions where a fault is observed on the equipment, the details and corrective action taken should be reported on the “Fault Report Sheet” as detailed in Appendix 1.

The following details the recommended procedure for reporting faults:

1. For an observed fault, record the details on the Fault Report Sheet.
2. Attempt to rectify the fault as per the instructions in section 16 ‘Troubleshooting’ and send a copy to AMT. If the fault cannot be rectified contact the approved AMT Service Agent and give them a copy of the Fault Report Sheet.
3. Arrange with the AMT Service Agent to repair the fault and detail the cause and remedy on the Fault Report Sheet.
4. The AMT Service Agent will then return the Fault Report Sheet to the originator of the report and will send a copy to AMT.

18 ACCESSORIES

18.1 Heavy Vehicle Display Unit – Sun Visor (PROD0164)

An option exists to attach a Sun Visor over the Display Unit in order to reduce the level of glare from the sun on the video display screen. This option is recommended as standard for Display Units mounted at dashboard level.

19 CONFIGURATION OPTIONS

Option	Benefits
Vehicle Identification	• Positive confirmation of 'AT-RISK' objects being detected. HV operator can make specific radio call for confirmation before moving from start-up or approving LV to overtake.
CAS Data Logging / Safety Audit Trail	• Time & date stamped safety audit trail • Track & manage HV-HV & HV-LV non-compliance • Data could be sent to Dispatch in real-time using existing Fleet Management Systems
Non-Beacon Light Vehicle RF Unit	• Eliminates night vision glare from beacon (originally required for positive confirmation of LV by HV operator. No longer required with Vehicle I.D. being displayed on camera monitor) • Option to add external beacon of clients selection (12VDC @ 5A maximum)
Blind Side RF Units (LHS & RHS)	• Close range detection and full coverage of 'AT-RISK' objects at HV sides (Front & Rear RF Units only provide partial blind-side detection at the expense of long range detection directly in front or behind). • Required for effective 360 degree close-range 'start-up' object detection
Alarming based on Vehicle Speed	• Eliminates HV-LV & HV-HV nuisance alarms above preset speed on haul roads • Fully programmable alarming based on object type, range, location (front/rear/sides), HV direction of travel (forward/reverse) and now speed.
Road Junction Warning System	• Long range RF unit (300m) used to detect HV approaching road junction / intersection for triggering warning lights for other vehicles.

Table 43: CAS-CAM/RF® Configuration Options

20 PART NUMBERS

Refer to the AMT CAS-CAM/RF® System Supply Brochure and Spare Parts Catalogue.

21 SPECIFICATIONS

Note: All dimensions in mm

21.1 Display Unit (PROD0119)

Display	6.4” Colour TFT LCD	
Resolution	960(W) x 234(H)	
Active Area	129.6 mm (W) x 97.34 mm (H)	
Dot Pitch	0.135 mm (W) x 0.416 mm(H)	
Back Light	CCFT	
Video Signal	Composite video signal 1 Vp-p / 75 ohm	
	F_H	15.625 KHZ
	F_V	50 Hz
	F_C	4.43 MHz
Power Source	DC 10V – 30V (ripple 0.5 Vp-p max.)	
Power Consumption	25 W max.	
Response Time	Tr = 25ms (max. 50ms) Tf = 30ms (max. 60ms)	
Contrast Ratio	Typ. 150 At optimal viewing angle	
Brightness	Typ. 300 cd/m^2	
LCD Lamp Life	10,000 hr min (at Tamb = 25°C)	
Viewing Angle	Top Bottom Left / Right	40 deg 55 deg 60 deg
Operating Temperature	0°C - 60°C	
Storage Temperature	-30°C - 80°C	
Operating Humidity	85 % RH max.	
Storage Humidity	85 % RH max.	
Protection Rating	IP 32 rated enclosure	
Overall Dimension	165 mm (W) x 165 mm (H) x 49 mm (D)	
Weight	1.6 kg	
Connectors	• EXT. I/O (12-way MILSPEC panel plug) • CH 1 (6-way MILSPEC panel socket) (1xCamera + 1xRF Unit max) • CH 2 (6-way MILSPEC panel socket) (1xCamera + 1xRF Unit max) • Video Out (RCA panel socket) • RS-232 (DB-9 panel socket)	
Sun Visor	Optional (PROD0164)	
Keypad Functions	• ■ (DIM / Confirm) • ⇧ (Channel scrolling) • ⇩ (Channel scrolling) • ● (Power On-Off / Back / Cycle)	

Menu Functions
(settings saved during power down)
 	
Note:
* Installation Functions – configured at time of installation using laptop PC programming software. Not User programmable.
	• Channel settings (1-6):
	  • Camera Select (using ↑, ↓ keys)
	  • Channel Title (8 char max) *
	  • Brightness (5 settings) *
	  • Colour (5 settings) *
	  • Mirror (Off/On) *
	  • Enable (Yes/No) *
	  • Status (Detected / Not-Detected)
	• Switching settings:
	  • Forward Switching (yes/no) *
	  • Forward Channel (1-6) *
	  • Reverse Switching (yes/no) *
	  • Reverse Channel (1-6) *
	  • Sleep Time (Off, 5, 10, 15, 20, 25, 30 mins) *
	  • RF Switching (yes/no) *
	  • Wake on Forward (yes/no) *
	  • Wake on Reverse (yes/no) *
	  • Central RF (yes/no)
	  • Keypad Tone (yes/no) *
	  • Auto Cycle (off, 2s, 4s, 6s, 8s, 10s) *
	• Front RF Unit settings:
	  • Enabled (Yes, No) *
	  • Reverse Gear - alarm ranges & audible (on/off) for all object types (HV, LV, SO, PT, TS) *
	  • Park Gear - alarm ranges & audible (on/off) for all object types (HV, LV, SO, PT, TS) *
	  • Forward Gear - alarm ranges & audible (on/off) for all object types (HV, LV, SO, PT, TS) *
	• Rear RF Unit settings:
	  • Enabled (Yes, No) *
	  • Reverse Gear - alarm ranges & audible (on/off) for all object types (HV, LV, SO, PT, TS) *
	  • Park Gear - alarm ranges & audible (on/off) for all object types (HV, LV, SO, PT, TS) *
	  • Forward Gear - alarm ranges & audible (on/off) for all object types (HV, LV, SO, PT, TS) *
	  • Reverse Alarm Relay (closed, RF closed, open) *

Input Signals	• Vehicle Main Power (10-30 VDC, 25W max.) • Vehicle Reverse sense signal (10-30 VDC, 20 mA max, opto-isolated 3KV) • Vehicle Forward sense signal (10-30 VDC, 20 mA max, opto-isolated 3kV) • Camera Unit video signal (differential 1Vp-p) – CH 1-2 • Expansion Unit Video Mux Output (differential 1Vp-p) – CH 3-6

Output Signals	• Camera Unit power (12 VDC, 200mA ea.) – CH 1-2 • RS-485 comms bus (for connection to Expansion Unit & Camera / RF Units) • Vehicle Reverse Alarm circuit switched contact (voltage free contact, N.O., 2A rating) • Video Output (PAL, 1Vp-p / 75 ohm) – video + text • RS-232 interface • Audible Alarm
Fuses	• Input Power (2A, 20 mm x 5 mm slow blow) • 2 x Camera / RF Unit Power (500 mA, 20 mm x 5 mm slow blow)

21.2 Camera Unit (PROD0118)

Image Sensor	1/3” CCD Image Sensor
Chip Size	6.0 mm (W) x 4.96 mm (H)
CCD Total Pixels	500 (W) x 582 (H)
Scanning System	625 Lines (PAL) 50 fields/sec
Sync System	Internal
Minimum Illumination	0.03 Lux at F1.2
Resolution	380 TV Lines
Field of View	123 degrees Horizontal & 91 degrees Vertical (153 degrees Diagonal). Narrower field of views available on request.
Signal to Noise Ratio	Better than 48dB (AGC OFF)
White Balance	Auto
Auto Iris	AES
Electronic Shutter	Auto: Up to 1/100,000 sec continual
Video Output Signal	1.0V p-p composite video at 75 ohm & Y/C output
Gamma Correction	0.45
Operating Temperature	-10°C to 50°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	IP 66 rated enclosure
Overall Dimension	130 mm (W) x 200 mm (H) x 180 mm (D)
Weight	1.3kg
Power Supply	DC 12V (+/- 10%) @ 100mA (powered from Display Unit for 2 camera system or from Expansion Unit for 6 camera system maximum)
Lens Mount	On board Lens (f2.27mm)
Connector	Input Power / Video / RS-485 comms (6-way MILSPEC panel plug)
Input Signals	• Camera Unit power (12 VDC, 800 mA max)
Output Signals	• Camera Unit Video Signal (differential 1Vp-p / 75 ohm) • RS-485 comms bus (connected to Display Unit & all Camera / RF Units)

21.3 Expansion Unit (PROD0161)

Power Source	DC 10V – 30V (ripple 0.5 Vp-p max.)
Power Consumption	50 W max.
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	IP 54 rated enclosure
Overall Dimension	204 mm (W) x 70 mm (H) x 150 mm (D)
Weight	1.2 kg
Connectors	• POWER & I/O (19-way MILSPEC panel socket) • DISPLAY (12-way MILSPEC panel socket) • CH 3-6: Camera / RF Unit channels (6-way MILSPEC panel sockets) • RS-232 Interface (DB-9 panel socket) • CAN Interface (DB-9 panel socket)
Input Signals	• Vehicle Main Power (10-30 VDC, 50W max.) • Vehicle Reverse sense signal (10-30 VDC, 20 mA max, opto-isolated 3KV) • Vehicle Forward sense signal (10-30 VDC, 20 mA max, opto-isolated 3KV) • 2 x spare input signals (10-30VDC, 20 mA max, opto isolated 3KV) • Camera Unit Video Signal (differential 1Vp-p)
Output Signals	• CH3-CH6: 4 x Camera / RF Unit channels (12VDC, 0.8A max) • Display Unit power (10-30 VDC, 25W max) • Vehicle Reverse Alarm circuit switched contact (voltage free contact, N.O., 2A rating) • Spare switched contacts (voltage free contact, N.O.+N.C., 2A rating) • Video Mux Output (differential 1Vp-p) • RS-485 comms bus (connected to Display Unit & Camera / RF Units) • RS-232 interface • CAN interface
Fuses	• Input Power (5A, 20 mm x 5 mm slow blow) • CH3-CH6 (Camera / RF Unit Channels) (800 mA, 20 mm x 5 mm slow blow)

21.4 Heavy Vehicle Front RF Unit (PROD0239) & Rear RF Unit (PROD0169)

Power Source	DC 12V +/- 10% (powered from either the Heavy Vehicle Display Unit or Expansion Unit)
Power Consumption	3W maximum
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	IP 56 rated enclosure
Overall Dimension	76 mm (W) x 65 mm (H) x 56 mm (D) – excluding antenna (490 mm (H) with antenna connected)
Weight	1.2 kg (excluding antenna backing plate) 2.6 kg (including antenna backing plate)
Connectors	• BUS IN (6-way MILSPEC panel plug) • BUS OUT (6-way MILSPEC panel socket) • Antenna (UHF panel socket)
Input / Output Signals	CAS BUS (6 way interface) • Input Power (12 VDC, 1.2W max.) – pins A(+ve), B (gnd) • Video Signal Out (differential 1Vp-p) – pins C(+), D(-) • RS-485 data communications – pins E(+), F(-)

21.5 Light Vehicle System (with integral beacon) (PROD0246)

Power Source	DC 12V +/- 10% (powered from Light Vehicle electrical distribution board (via battery) with inline 7.5A fused circuit)
Power Consumption	57W maximum
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	• Light Vehicle Unit - IP 54 rated enclosure • Dash Alarm Unit – IP 32 rated enclosure
Overall Dimension	• Light Vehicle Unit – 200mm (W) x 250mm(H) x 165mm (D) (excluding magnetic base) • Dash Alarm Unit – 64 mm (W) x 25 mm (H) x 108 mm (D)
Weight	• Light Vehicle Unit – 1.9 kg (excluding magnetic base option) • Dash Alarm Unit – 82 g
Connectors	Light Vehicle Unit (PROD0209) • Power & I/O (12-way MILSPEC panel plug) • Antenna (UHF panel socket) Dash Alarm Unit (PROD0211) • Power & Inputs (5-way subminiature DIN) • RS-232 Interface (DB-9 panel socket)
Input Signals	Light Vehicle Unit • Input Power (12 VDC, 55W max.) • Antenna Dash Alarm Unit • Power (12VDC, 0.6W typical) • RS-232 data communications • Alarm signal
Output Signals	Light Vehicle Unit • Rotating Beacon Lamp (12V, 55W) • RS-232 data communications • Alarm Unit Power • Alarm signal Dash Alarm Unit • Power indicator (POWER) • Alarm indicator (DETECT) & buzzer (volume set by internal jumper links) • RS-232 data communications
Fuse	Fuse to be installed in-line with vehicle power circuit (7.5A, 20 mm x 5 mm slow blow)

21.6 Light Vehicle System (with external beacon option) (PROD0294)

Power Source	DC 12V +/- 10% (powered from Light Vehicle electrical distribution board (via battery) with inline 7.5A fused circuit)
Power Consumption	57W maximum
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	• Light Vehicle RF Unit - IP 56 rated enclosure • Dash Alarm Unit – IP 32 rated enclosure
Overall Dimension	• Light Vehicle Unit – 76 mm (W) x 65 mm (H) x 56 mm (D) – excluding antenna (490 mm (H) with antenna connected) • Dash Alarm Unit – 64 mm (W) x 25 mm (H) x 108 mm (D)
Weight	• Light Vehicle Unit – 1.2 kg • Dash Alarm Unit – 82 g
Connectors	Light Vehicle RF Unit (PROD0295) • Power & Comms (6-way MILSPEC panel plug) • External Beacon (2-way MILSPEC panel plug) • Antenna (UHF panel socket) Dash Alarm Unit (PROD0211) • Power & Inputs (5-way subminiature DIN) • RS-232 Interface (DB-9 panel socket)
Input Signals	Light Vehicle Unit • Input Power (12 VDC@ 55W max. with external beacon, 12VDC@ 1.2W without external beacon) • Antenna Dash Alarm Unit • Power (12VDC, 0.6W typical) • RS-232 data communications • Alarm signal
Output Signals	Light Vehicle RF Unit • External Beacon (12V, 55W max.) (optional) • RS-232 data communications • Alarm Unit Power • Alarm signal Dash Alarm Unit • Power indicator (POWER) • Alarm indicator (DETECT) & buzzer (volume set by internal jumper links) • RS-232 data communications
Fuse	Fuse to be installed in-line with vehicle power circuit (7.5A, 20 mm x 5 mm slow blow)

21.7 Stationary Object System (PROD0210)

Power Source	DC 12V +/- 10% (powered from suitable external 12VDC power source via fused circuit – e.g. permanent power supply, battery power supply, solar power supply with battery backing)
Power Consumption	57W maximum
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	• Stationary Object Unit - IP 54 rated enclosure • Dash Alarm Unit – IP 32 rated enclosure
Overall Dimension	• Stationary Object Unit – 200mm (W) x 250mm(H) x 165mm (D) (excluding magnetic base) • Dash Alarm Unit – 64 mm (W) x 25 mm (H) x 108 mm (D)
Weight	• Stationary Object Unit – 1.9 kg (excluding magnetic base option) • Dash Alarm Unit – 82 g
Connectors	Stationary Object Unit (PROD0212) • Power & I/O (12-way MILSPEC panel plug) • Antenna (UHF panel socket) Dash Alarm Unit (PROD0211) • Power & Inputs (5-way subminiature DIN) • RS-232 Interface (DB-9 panel socket)
Input Signals	Stationary Object Unit • Input Power (12 VDC, 55W max.) • Antenna Dash Alarm Unit • Power (12VDC, 0.6W typical) • RS-232 data communications • Alarm signal
Output Signals	Stationary Object Unit • Rotating Beacon Lamp (12V, 55W) • RS-232 data communications • Alarm Unit Power • Alarm signal Dash Alarm Unit • Power indicator (POWER) • Alarm indicator (DETECT) & buzzer (volume set by internal jumper links) • RS-232 data communications
Fuse	Fuse to be installed in-line with power supply circuit (7.5A, 20 mm x 5 mm slow blow)
Mounting Options	• Generic Mounting Base (standard) • Magnetic base • Solar System Pole Mount

21.8 Test Station System (PROD0241)

Power Source	DC 12V +/- 10% (powered from suitable external 12VDC power source via fused circuit – e.g. permanent power supply, battery power supply, solar power supply with battery backing)
Power Consumption	57W maximum
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	• Test Station Unit - IP 54 rated enclosure • Dash Alarm Unit – IP 32 rated enclosure
Overall Dimension	• Test Station Unit – 200mm (W) x 250mm(H) x 165mm (D) (excluding magnetic base) • Dash Alarm Unit – 64 mm (W) x 25 mm (H) x 108 mm (D)
Weight	• Test Station Unit – 1.9 kg (excluding magnetic base option) • Dash Alarm Unit – 82 g
Connectors	Test Station Unit (PROD0251) • Power & I/O (12-way MILSPEC panel plug) • Antenna (UHF panel socket) Dash Alarm Unit (PROD0211) • Power & Inputs (5-way subminiature DIN) • RS-232 Interface (DB-9 panel socket)
Input Signals	Test Station Unit • Input Power (12 VDC, 55W max.) • Antenna Dash Alarm Unit • Power (12VDC, 0.6W typical) • RS-232 data communications • Alarm signal
Output Signals	Test Station Unit • Rotating Beacon Lamp (12V, 55W) • RS-232 data communications • Alarm Unit Power • Alarm signal Dash Alarm Unit • Power indicator (POWER) • Alarm indicator (DETECT) & buzzer (volume set by internal jumper links) • RS-232 data communications
Fuse	Fuse to be installed in-line with power supply circuit (7.5A, 20 mm x 5 mm slow blow)
Mounting Options	• Generic Mounting Base (standard) • Magnetic base • Solar System Pole Mount

21.9 Mobile Plant & Equipment System (PROD0225)

Power Source	DC 12V +/- 10% (powered from suitable external 12VDC power source via fused circuit – e.g. permanent power supply, battery power supply, solar power supply with battery backing)
Power Consumption	57W maximum
Operating Temperature	0°C - 60°C
Storage Temperature	-20°C - 60°C
Operating Humidity	85 % RH max.
Storage Humidity	85 % RH max.
Protection Rating	• Mobile Plant & Equipment Unit - IP 54 rated enclosure • Dash Alarm Unit – IP 32 rated enclosure
Overall Dimension	• Mobile Plant & Equipment Unit – 200mm (W) x 250mm(H) x 165mm (D) (excluding magnetic base) • Dash Alarm Unit – 64 mm (W) x 25 mm (H) x 108 mm (D)
Weight	• Mobile Plant & Equipment Unit – 1.9 kg (excluding magnetic base option) • Dash Alarm Unit – 82 g
Connectors	Mobile Plant & Equipment Unit (PROD0250) • Power & I/O (12-way MILSPEC panel plug) • Antenna (UHF panel socket) Dash Alarm Unit (PROD0211) • Power & Inputs (5-way subminiature DIN) • RS-232 Interface (DB-9 panel socket)
Input Signals	Mobile Plant & Equipment Unit • Input Power (12 VDC, 55W max.) • Antenna Dash Alarm Unit • Power (12VDC, 0.6W typical) • RS-232 data communications • Alarm signal
Output Signals	Mobile Plant & Equipment Unit • Rotating Beacon Lamp (12V, 55W) • RS-232 data communications • Alarm Unit Power • Alarm signal Dash Alarm Unit • Power indicator (POWER) • Alarm indicator (DETECT) & buzzer (volume set by internal jumper links) • RS-232 data communications
Fuse	Fuse to be installed in-line with power supply circuit (7.5A, 20 mm x 5 mm slow blow)

21.10 Personnel Tag

Under development.

Refer to section 4.7 for overview.

22 WARRANTY INFORMATION

22.1 Warranty

Subject to the AMT General Terms and Conditions, all new equipment supplied and commissioned by AMT (or approved Service Agent) is warranted against defects for a period of twelve (12) months from completion of commissioning.

The obligation of AMT is limited to the cost of making good the defect in the equipment only and specifically excludes any consequential malfunction or loss, including loss of profits or turnover.

This warranty does not apply to defects incurred through improper field installation, expiry of consumable items, abnormal operating conditions, accidental damage, improper handling, abuse or neglect or non-compliance with instructions provided by AMT.

The warranty is valid for the customer only and does not extend to third parties.

AMT will, at no charge to the customer, provide a replacement for any defective component in the equipment supplied by AMT during the warranty period. However, labour charges for dismantling and re-assembly shall be to the customer's account.

AMT takes no responsibility for defects in the equipment, or part of the equipment, caused in connection with the above-mentioned replacement work if performed by other than AMT or their accredited representative(s).

Normal system testing and calibration may only be carried out by trained customer technical personnel or accredited Service Agent(s) using the techniques provided by AMT.

22.2 Maintenance and Repairs

AMT will provide warranty coverage against equipment defects for a period of twelve (12) months from completion of commissioning as outlined above.

If the customer is purchasing spares of each major equipment item, trained customer technical personnel or accredited Service Agent(s) could replace defective equipment items with working spare equipment items to immediately restore full equipment operation. The defective equipment items would be returned via courier to AMT for immediate repair and subsequent return to the customer. Refer to section 17 for the preferred 'Fault Reporting' procedure.

23 GLOSSARY OF TERMS

Alarm	The means of alerting the User to a new Object Detection. Comprises of either an audible alarm or visual alarm or both.
AMT	Acronym for 'Advanced Mining Technologies', the designers and manufacturers of the CAS-CAM/RF® system.
Audible Alarm	Refers to sound emitting devices used as alarm indicators (e.g. HV Display Unit & LV Dash Alarm Unit sounds a buzzer for alarms).
Calibration	The procedure by which the Detection Range of all CAS-RF® tagged objects is programmed.
Calibration Unit	Equipment used to conduct a calibration procedure.
Camera	Apparatus used for taking real time photographs. Used to provide high-resolution colour video images of blind spots on the Heavy Vehicle Display Unit.
CAN	Acronym for 'Car Area Network'. International standard for automotive vehicle networking. Used widely on current model Heavy Vehicles for sensing and actuating functions (e.g. brake and turning indicators, lighting control, engine management etc).
CAS-CAM®	Collision Avoidance System Camera only system. Registered trademark of AMT.
CAS-CAM/RF®	Integrated Collision Avoidance System with Camera & RF tagging technologies. Registered trademark of AMT.
CAS-RF®	Collision Avoidance System RF tagging only system. Registered trademark of AMT.
Code	Describes a software program as stored and run in a

	computer.
Collision Avoidance System (CAS)	The classification of sensing technologies used to prevent collisions between objects.
Command	A user selectable task to be run by a computer.
Communications	The system used to transfer data between computers and other computers or hardware.
Confirm	The operation of acknowledging the presence of a new object detection on the Heavy Vehicle Display Unit. Involves the User visually confirming the presence of a new object using cameras and pressing the 'CONFIRM' key to cancel the alarm.
Day / Night Camera	Low light level camera technology where the camera automatically switches from Colour to Black & White at a preset low light level enabling images to be viewed in near dark conditions.
Detection	The term used to describe the sensing of the presence of an object.
Detection Range	Refers to the distance over which an object can be detected by the CAS-CAM/RF® system.
Detection Zone	Refers to the area around which an object can be detected by the CAS-CAM/RF® system.
Diagnostic	A command or procedure used to find out about the behaviour of a system, usually if a problem has occurred.
Flash Memory	A storage medium that retains data when power is removed. Used on all CAS-CAM/RF® equipment for saving User or Installer programmed settings.
Hardware	Electrical equipment used to perform functions the nature of which are determined by the combination of the

	hardware and software.

Heavy Vehicle (HV)	Refers to the class of vehicle objects that poses the greatest risk of collision with other objects due to their physical size and poor visibility (blind spots). Heavy Vehicles typically include: haulage truck, excavator, shovel, truck, loader, dozer, grader, water truck, forklift, semi-trailer, bus. HV's can be fitted with camera only (CAS-CAM®), RF tag only (CAS-RF®) or combined camera and RF tagging (CAS-CAM/RF®).
Installer	The person(s) approved by AMT and the client to install, calibrate, service and repair the CAS-CAM/RF® equipment.
Keypad	A device used to input data into a computer or instrument. The Heavy Vehicle Display Unit contains a 1 x 4 keypad for User Operation.
LCD	Acronym for 'Liquid Crystal Display'. A low power display used on many portable PC's and instruments. Used on the Heavy Vehicle Display Unit for displaying video images and text.
LED	Acronym for Light Emitting Diode. A semiconductor light source that emits visible light or infra-red radiation. Used as power, status and alarm indicators on the CAS-CAM/RF® equipment.
Light Vehicle (LV)	Refers to the class of mobile vehicle objects fitted with CAS-RF tags that are under threat of collision from Heavy Vehicles. Light Vehicles typically include: 4WD, sedan, wagon.
Lux	Standard unit of illumination (brightness) equal to one lumen per square metre.
Memory	The part of a computer in which code and data are stored.
Menu	A list of command functions and settings.

Mobile Plant & Equipment (MPE)	Refers to the class of Heavy Vehicle fitted with CAS-RF® tag and Dash Alarm unit in lieu of Display Unit and Cameras. Identical hardware to Light Vehicle System, except RF tag coded as Heavy Vehicle (HV). MPE typically includes: Dozer, Grader, Loader vehicle types if no blind spot cameras are required.
Object Type	Refers to the classification of objects fitted with CAS-RF® tags. Object Types include: Heavy Vehicle (HV), Light Vehicle (LV), Stationary Object (SO), Personnel Tag (PT), Test Station (TS).
PAL	Acronym for Phase Alternating Lines. This is the television standard used in Europe and Australia. The PAL standard is 25 frames per second within 625 lines.
Personnel Tag (PT)	Refers to the CAS-RF tags worn by personnel for protection from collision with Heavy Vehicles.
RF	Acronym for 'Radio Frequency'.
RF Tagged Object	An object protected by a CAS-RF® tag.
RS-232	Interface between Data Terminal Equipment and Data Communications Equipment, employing serial binary data exchange. Available on the Heavy Vehicle Display Unit, Expansion Unit and Light Vehicle Unit for in-field programming of system settings using a PC.
RS-485	Interface standard used for multipoint digital communications using drivers and receivers. Used on the Heavy Vehicle for communications between Display Unit, Expansion Unit and RF Units.
Service Agent	The Company approved by AMT and the client to install, calibrate, service and repair the CAS-CAM/RF® equipment.

Software	The set of instructions that are to be run on a computer.
Specification	A detailed description of the requirements, features and performance capabilities of an instrument.
Stationary Object (SO)	Refers to the class of fixed (stationary) objects fitted with CAS-RF® tags that are under threat of collision from Heavy Vehicles. Stationary Objects typically include: fixed plant and equipment, buildings and structures.
Tag	Refers to the physical placement of CAS-RF® units on remote objects for collision avoidance detection and alarming. Tags can be coded as different object types (e.g. HV, LV, SO, PT, TS) with fully programmable alarming configurations based on range. HV tags with Display Unit can be coded with additional alarming configurations based on HV gearing, detection location (i.e. front or rear) and object type.
Test Station (TS)	Refers to the class of Stationary Object fitted with CAS-RF® tag that is programmed to Test the operational functionality of all other tagged objects (e.g. HV, LV, SO, PT). TS unit is alarmed by all other object types and in turn alarms all object types. Used for 2-way functional testing of CAS-RF® tags.
Troubleshooting	The process of trying to locate the source of a problem.
User	The person operating the CAS-CAM/RF® system.
Video	Electronic signals for producing television images.
Visual Alarm	Refers to light emitting devices used as alarm indicators (e.g. HV Display Unit flashes video text for alarms, LV Unit flashes the roof mounted rotating beacon and Dash Alarm Unit LED indicator).

24 APPENDIX 1: AMT CAS-CAM/RF® FAULT REPORT RECORD

AMT: CAS-CAM/RF® Fault Report Record

No: FRR-

Equipment:		Site:	Dept.
Serial No.:			
Reported By:		To:	Date & Time:

Fault Report:

Equipment & Vehicle Conditions relative to Fault Report:

Actions Taken to Rectify Fault:

Service by:		Date & Time:
Arrive Time:	Depart Time:	Duration:

Recommendations/Comments:

Comment by:	Date & Time:

Follow Up Action:

Comment by:	Date & Time:

Fax to AMT on +61 2 4389 2355

25 APPENDIX 2: AMT CONTACT DETAILS

For Information or Technical Support on AMT's Collision Avoidance System (CAS-CAM/RF®), contact: sales@advminingtech.com.au

or visit our web site at: www.advminingtech.com.au

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