

becker
MINING SYSTEMS

Becker Mining Systems



Collision Avoidance Systems

in

Surface & Underground Mining





The Nature of Mining Accidents...



- ❖ Mechanised equipment and vehicle collisions with each other.
- ❖ Mechanised equipment colliding with pedestrians or crushing them against walls and other equipment.
- ❖ Underground roof falls & miner entrapment accidents, resulting in slow persecution.
- ❖ Personnel inadvertently entering unsupported roof & other unsafe areas, resulting in injury or death.
- ❖ Underground methane gas as well as planned excavation explosions & fire events causing loss of life.
- ❖ Underground flooding causing drowning & loss of life.
- ❖ Environmental parameters (oxygen, gas, temperature etc) becoming incapable of supporting life, resulting in suffocation or medical conditions such as Meningitis.
- ❖ Injuries or death resulting from dangerous working conditions or reluctance to loose production time fetching proper equipment.



BEKERCAS Principle

FUNCTIONAL FEATURES

- ❖ RFI Vehicle & Personnel Detection
- ❖ Integrated High Intensity Audio Alarm
- ❖ 2 x 7 Segment LCD (Vehicle & Personnel)
- ❖ System Self Test
- ❖ Multiple Antenna Types (DPOD Ready)
- ❖ Modular Design





Collision Avoidance Unit

The 'Becker Electronics Collision Avoidance System', was borne out of the desire to prevent injury and possible loss of life during the operation of mining vehicles in close proximity to mining personnel. The Collision Avoidance System provides an early warning indication that brings to his / her attention the presence and the number of personnel and/or vehicles in his vicinity.





Specific Functionality Touch Tags

Learn Personnel Mode

The CAS will learn all of the Personnel Tags in its vicinity, and not alert the user of these tags while they stay in range of the unit.



Alarm Mode Control

This Dallas iButton is used to activate and deactivate the audio alarm of the CAS unit.





Active Vehicle Tag

The 'Becker Electronics Active Vehicle Tag' is specifically designed to transmit a unique Tag Identification number using an active radio frequency carrier from the metallic body of a vehicle, locomotive, carriage or hopper. The unit is completely self contained and utilizes high reliability lithium cells for its power source. It is capable of reliable performance within the harsh operating environment typically found on underground mining vehicles. The unit is typically bolted to the chassis of the vehicle, preferably in the centre of the vehicle roof, although it has been proven to perform, even when mounted underneath the chassis of a typical underground hopper.





Active Personality Control Tag

The 'Becker Electronics Control Tag' is designed to transmit a unique Tag Identification number using an active radio frequency carrier. The unit is completely self contained and utilizes high reliability Lithium cells for its power source. Two groups of Control Tags are available, the one group of tags are used to control the Collision Avoidance System, and the other to control the Personnel Avoidance System. The unit is intended to be mounted at a fixed position, transmitting a signal that is recognized by CAS units or PAS units, depending on the unique ID that is transmitted.





Active Personnel Tag (Self Powered)

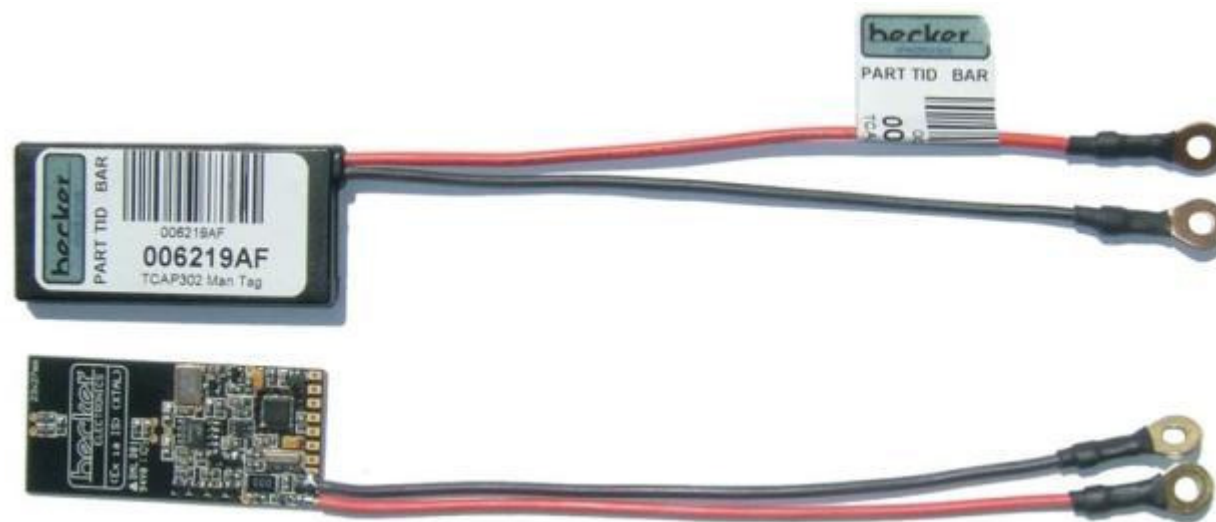
The 'Becker Electronics Personnel Tag' is designed to transmit a unique Tag Identification number using an active radio frequency carrier. The unit is completely self contained and utilizes a high reliability Lithium cell for its power source. It has a "Motion Detect" feature built in, that senses if the tag is moving or not. This information is used to reduce the period of Active Tag ID retransmission in order to save battery life. The unit also includes a "Battery Status Reporting" feature that allows the user to monitor the battery life. This reporting tool indicates the battery life in steps of 200mV, allowing the user to accurately predict and schedule a service of the Lithium battery cell. The custom re-enterable enclosure allows on-site service of the battery.





Active Personnel Tag (Powered by Cap Lamp)

The 'Becker Electronics Cap Lamp Battery Tag' is designed to transmit a unique Tag Identification number using an active radio frequency carrier. The unit is intended to be installed inside the cover of the Cap-Lamp Battery, utilizing the battery as its power source. An advanced quadratic loop antenna ensures a consistent and omnidirectional radiation pattern. The electronic components are sealed using conformal coating and a custom ultra sonically sealed enclosure. The unit is compatible with the Becker Electronics ATR-200/300/400/500 series active tag readers, as well as PAS and CAS readers.





Personnel Avoidance Unit (Powered by Cap Lamp)

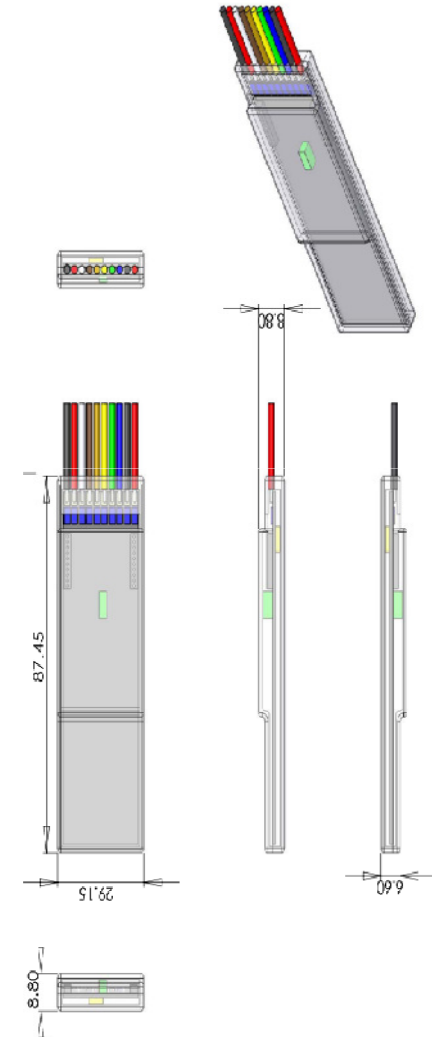
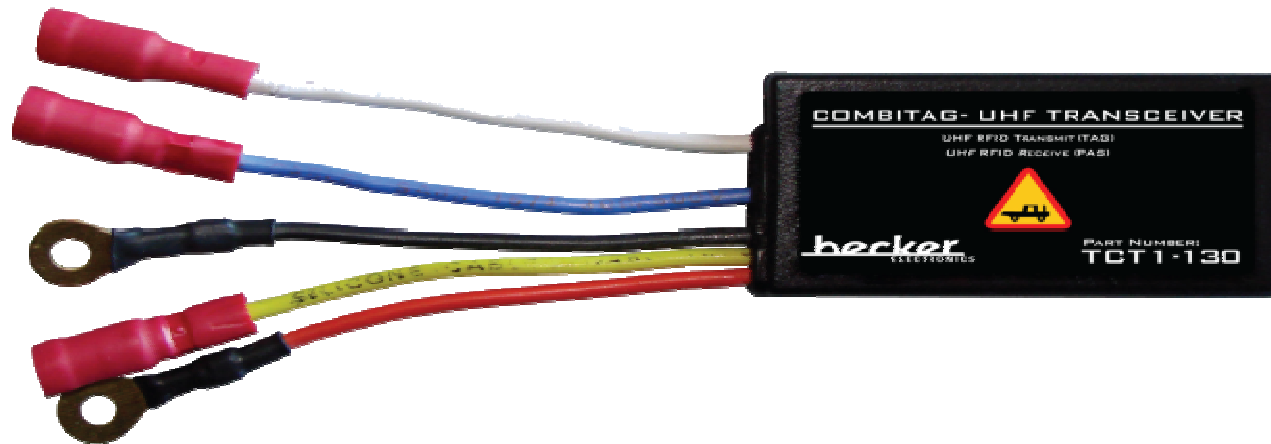
The ‘Becker Electronics PAS Reader’ is specifically designed to receive unique “Tag Identification Numbers” radiated from their range of Vehicle Tags (TVEH 204/205/206). This system was designed to improve the safety of personnel, by alerting them of dangerous vehicles approaching, and thus avoiding possible injury or even death. The PAS alerts the wearer by means of dipping the user’s Cap Lamp light. The cap lamp will dip briefly for every vehicle detected, during each 2 second cycle.





NEW Combination Tag / PAS – TCT1

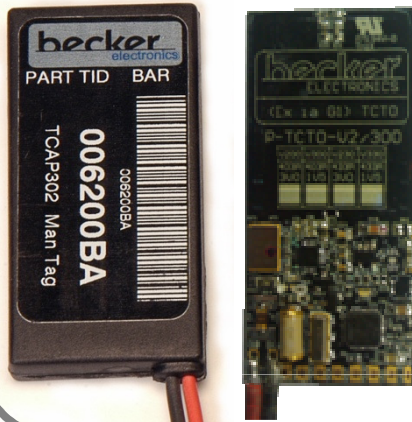
The ‘Becker Electronics Combination Tag Transponder / PAS Reader’ is specifically designed to transmit and receive unique “Tag Identification Numbers” radiated from their range of Collision Avoidance product range. This system was designed to improve the safety, by alerting vehicle operators and personnel simultaneously of dangerous possible collision circumstances, and thus avoiding possible injury or even death.



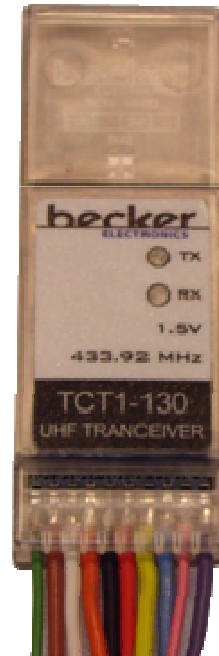


Transceiver – TCT1

TCT0 - Transmitter



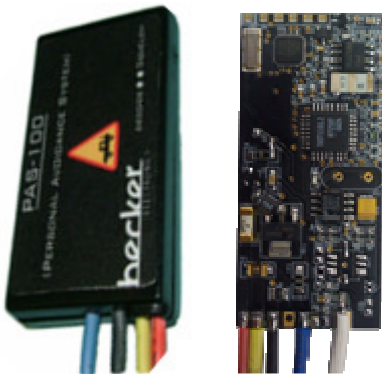
**TCT1 -
Transceiver**



❖ The TCT1 Transceiver combines the standard TCT0 Transmitter with the UPAS Receiver to create a UHF transceiver capable of both TX and RX.

❖ The TCT1 unit utilises an “Agile Active Microstrip Antenna” which can be tuned from 400MHz to 500MHz digitally: thereby covering the UHF RFID range + UHF Leaky Feeder range.

UPAS - Receiver





Checklist

The combination of Vehicle Tags, Control Tags and the new TCT1 Tag address the majority of Tag specific requirements that have been identified.

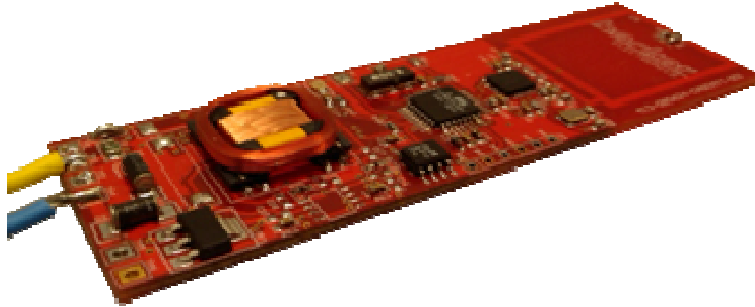
The checklist has been updated to highlight those needs which are met through the various Becker Tag options.

CHECKLIST

- ❖ Vehicle to Vehicle awareness.
- ❖ Miner to Vehicle awareness.
- ❖ Vehicle to Miner awareness.
- ❖ Hazardous Zone awareness.
- ❖ Accident Investigation support.
- ❖ Multi-mode operation (near and far fields)
- ❖ Control over alarm and methodology of warning provision.
- ❖ Configurable and reliable detection zone(s)
- ❖ Integration with Tagging Systems and Communications Networks.
- ❖ Ability to locate “tags” or equipment, or a Resource Locator capability.
- ❖ Self testing with multi-level notifications of error or failure.
- ❖ Learning capability for miner’ and vehicles working constantly together.
- ❖ Simple messaging capability to Miner’ tags.
- ❖ Intrinsically Safe design and Certification.



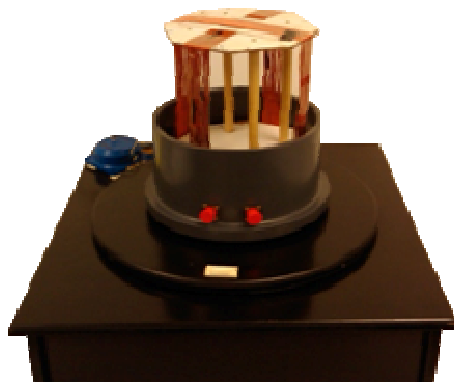
Electromagnetic Active Tag – TCT3



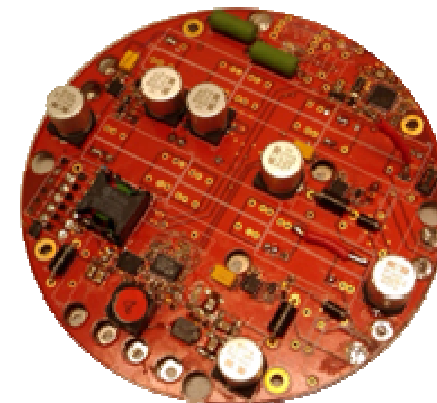
EM Tag Prototype



EM TX DRIVER MODULE



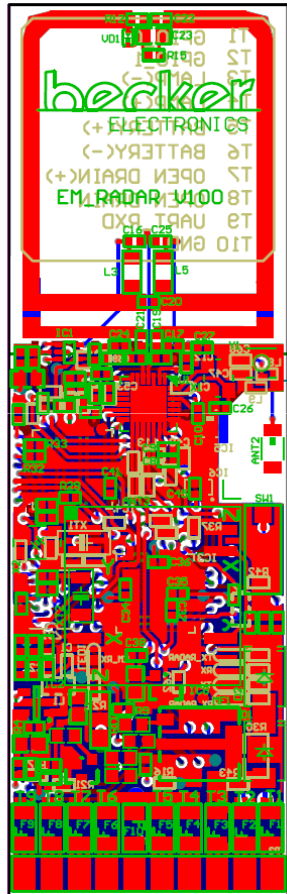
EM TX COIL – 360 Rotator



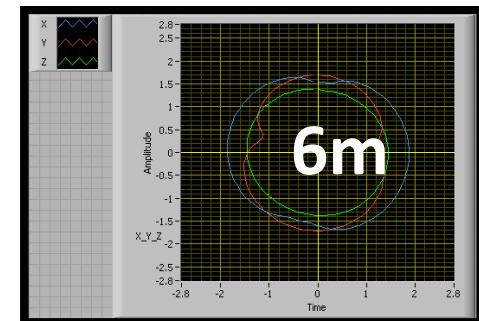
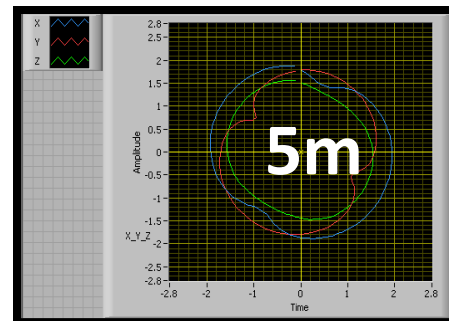
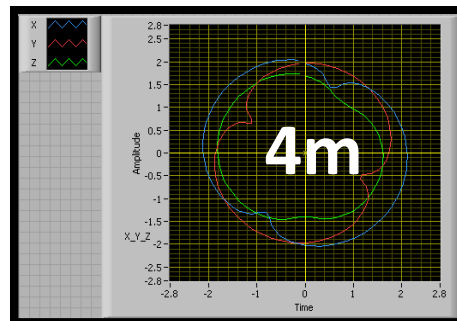
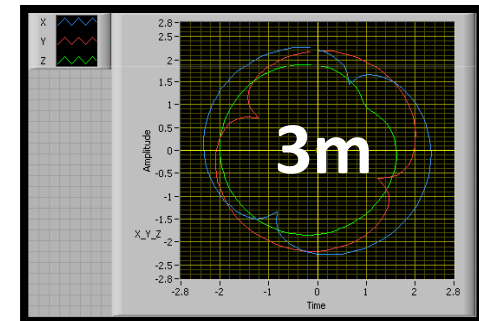
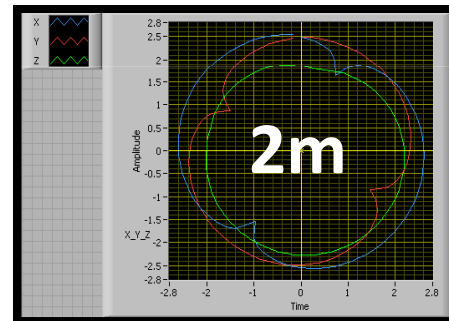
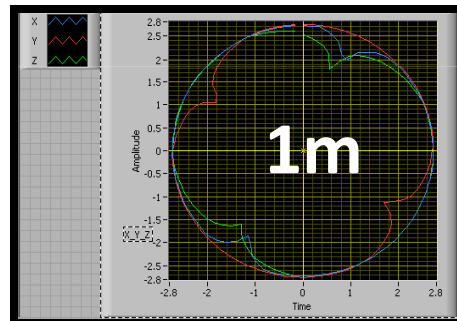
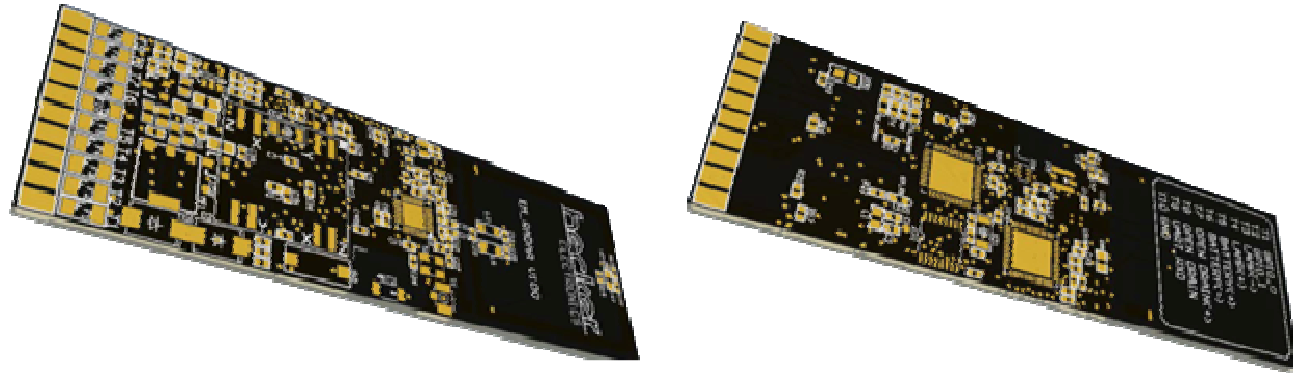
EM TX PCB



Electromagnetic Active Tag – TCT3



EM TAG - PPU





TCT3 Features & Applications

The Tag Cap Lamp Type 3 (TCT3) tightly integrates 5 RF features in a single unit:

- a. Acts as an RFID Active Tag Transmitter for CAS & T&T Applications. (TX high speed ASK)
- b. Acts as an RFID Active Tag Receiver for CAS Applications. (Like UPAS Cap Lamp Receiver)
- c. Acts as a UHF Leaky Feeder Transceiver for RESS Applications. (TX & RX NBFM GFSK)
- d. Acts as an Electromagnetic Field Strength Detector in 3 Axis : X Y and Z.
- e. Acts as a RFID-RADAR 2.4GHz ranging node for time-of-flight distance measurement.

This tight integration facilitates underground mining safety applications such as :

- a. UHF G-ASK Based Long Range Active Tagging & Tracking
- b. UHF RSSI Based Long Range Collision Warning to Vehicle Drivers
- c. UHF RSSI Based Long Range Vehicle-In-Proximity warning to Miner
- d. 3 Axis X, Y and Z EM Field Strength Based VERY CLOSE warning to Vehicle Driver (5m range)
- e. SHF Time-of-Flight Based Line-of-sight PROXIMITY warning to Vehicle Driver (30m range)



Tag Comparison Matrix

	TCT0 – Capclamp or Standalone	TCT 1 UHF Transceiver	TCT 3 Electromagnetic	Vehicle UHF Transmitter
Unique ID, Name programmable	Yes, but not name programmable	Yes, Yes Detection of name depends on Tag Reader being used	Yes, Yes Detection of name depends on Tag Reader being used	Yes, but not name programmable
Battery Status	Yes 13 step voltages	Yes 13 step voltages	Yes 13 step voltages	Yes 13 step voltages
Detection Range	0-100m with 10dBi RX Ant. 0-30m with 2dBi RX Ant. Accuracy : ±5m res 0-10m ±10m res 10-30m ±30m res 30-100m	0-100m with 10dBi RX Ant. 0-30m with 2dBi RX Ant. Accuracy : ±5m res 0-10m ±10m res 10-30m ±30m res 30-100m	Accuracy : 0-5m EM (<1.0m res) 5-20m 2.4GHz (<2.0m res) thereafter same as TCT1	0-100m with 10dBi RX Ant. 0-30m with 2dBi RX Ant. Accuracy : ±5m res 0-10m ±10m res 10-30m ±30m res 30-100m
Message Receiving (Basic)	No	Yes, via UHF Leaky Feeder	Yes, via UHF Leaky Feeder	No
PAS (Personal Avoidance)	N/A, a separate UPAS is required.	Yes, Included in T1	Yes, Included in T3	Not Applicable.
Digital & Analog Input capable	Yes Against Customer Requirement Specification	Yes Against Customer Requirement Specification	Yes Against Customer Requirement Specification	Yes Against Customer Requirement Specification



Checklist

The TCT3 Electromagnetic Tag in addition to having all functionality of the TCT1 Tag, overcomes the issues of detecting in both near and far fields. That is, in the immediate vicinity of a vehicle less than 5-10metres and at distances up to 100m. The accuracy is high up to about 20m from the vehicle then shifts to +/-5m increments thereafter.

The checklist has been updated to highlight those needs which are met through the various Becker Tag options.

CHECKLIST

- ❖ Vehicle to Vehicle awareness.
- ❖ Miner to Vehicle awareness.
- ❖ Vehicle to Miner awareness.
- ❖ Hazardous Zone awareness.
- ❖ Accident Investigation support.
- ❖ **Multi-mode operation (near and far fields)**
- ❖ Control over alarm and methodology of warning provision.
- ❖ Configurable and reliable detection zone(s)
- ❖ Integration with Tagging Systems and Communications Networks.
- ❖ Ability to locate “tags” or equipment, or a Resource Locator capability.
- ❖ Self testing with multi-level notifications of error or failure.
- ❖ Learning capability for miner’ and vehicles working constantly together.
- ❖ Simple messaging capability to Miner’ tags.
- ❖ Intrinsically Safe design and Certification.



UCAS300 Series vs. UCAS500 Series



CAS500 Series

CAS 300 Series (Current Model) features:

- ❖ Vehicle/Miner identification
- ❖ Self Testing
- ❖ Learning Functionality
- ❖ Alarm control
- ❖ Remote Digital Antenna and RSSI
- ❖ Variety of Antenna to suit different vehicle types.

CAS 500 Series (Next Generation) features:

- ❖ All key functions of CAS330 plus
- ❖ Larger separate display with input capability (buttons or touch screen)
- ❖ Voice Annunciation of warnings with volume adjustment pending proximity.
- ❖ Multiple storage methods including Flash memory for historical monitoring.
- ❖ Network and UHF Leaky Feeder connectivity.
- ❖ Tag Resource Locator functionality.



UCAS500 Series Features

CAS 500 Series (Next Generation) features:

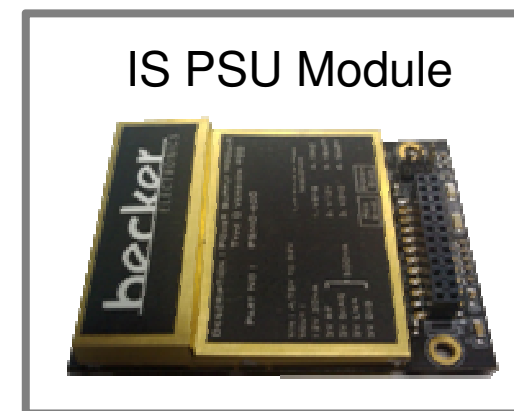
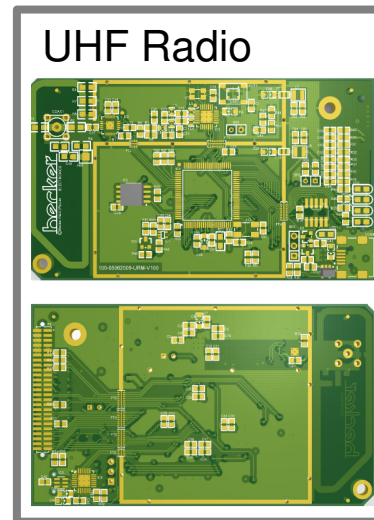
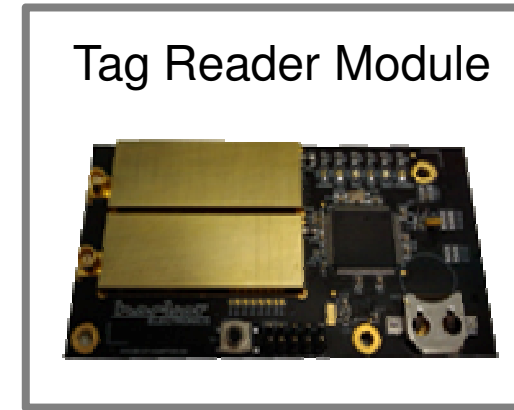
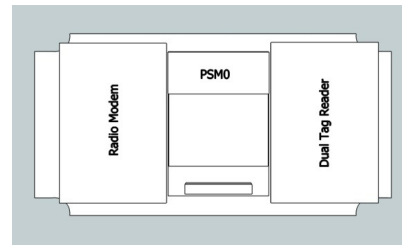
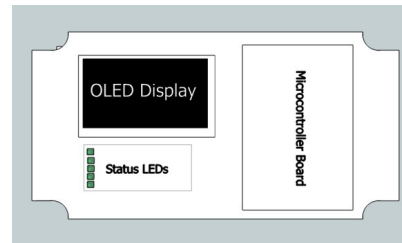
- ❖ All key functions of CAS300 series including self testing (enhanced), digital antenna input capability and RSSI, IS design, power supply filtering etc plus
- ❖ Larger separate display with input capability (buttons or touch screen). This will provide the operator with much more feedback including the name of the vehicle/miner assigned to a detected tag, ability to see which tags/miners are passengers on a vehicle, easier reading of information.
- ❖ Voice Annunciation of warnings with volume adjustment pending proximity. The major complaint about all CAS solutions is the warning buzzer becoming annoying to an operator. Becker propose to make use of voice annunciation, not unlike a GPS in a vehicle. The voice can be customised for local accents etc.
- ❖ Multiple storage methods including Flash memory for historical monitoring. The CAS500 series could be considered the equivalent of a “black-box” storing critical proximity information indefinitely. This would be uploaded via the network to a database and stored locally on a flash memory card.
- ❖ Network and UHF Leaky Feeder connectivity. Integrating with all of Becker’ communications solutions to provide maximum benefits such as storage and analysis of data, updating of tag name databases and interaction with the Tracking system
- ❖ Tag Resource Locator functionality. Through the interaction with the Tracking System the CAS500 series could be simply setup to locate a specific tag – vehicle, or person.



UCAS500 Series Development

CAS500 Series Development

The CAS500 series makes use of modular design, which is consistent with all Becker Electronics products. This reduces development time as commonly used modules are already developed such as the IS Power Supply and IS Tag Reader modules. The CAS500 series will feature a separate large screen and input functionality to provide the operator with a simple but efficient means of determining the type and level of potential interaction occurring.





Checklist

The UCAS 500 series next-generation CAS receiver addresses the majority of the needs identified. The CAS500 series offers new functionality and enhanced capabilities over the existing CAS300 series. The majority are already well developed or in prototype stage. The additional network interface while being a new requirement is simply an integration of existing Becker technologies.

The checklist has been updated to highlight those needs which are met through the UCAS500 series system.

CHECKLIST

- ❖ Vehicle to Vehicle awareness.
- ❖ Miner to Vehicle awareness.
- ❖ Vehicle to Miner awareness.
- ❖ Hazardous Zone awareness.
- ❖ [Accident Investigation support.](#)
- ❖ Multi-mode operation (near and far fields)
- ❖ [Control over alarm and methodology of warning provision.](#)
- ❖ Configurable and reliable detection zone(s)
- ❖ [Integration with Tagging Systems and Communications Networks.](#)
- ❖ [Ability to locate “tags” or equipment, or a Resource Locator capability.](#)
- ❖ [Self testing with multi-level notifications of error or failure.](#)
- ❖ [Learning capability for miner’ and vehicles working constantly together.](#)
- ❖ Simple messaging capability to Miner’ tags.
- ❖ Intrinsically Safe design and Certification.



Ladder Antenna

The 'Becker Electronics Ladder Antenna' has been designed specifically for the Becker Collision Avoidance product range pertaining to underground installation where an omnidirectional radiation pattern is more suited. It is capable of reliable performance within the intended harsh operating environment typically found in underground mining conditions.





Digital POD Antenna

The 'Becker Electronics Digital POD Antenna' is an active tag receiver with a RS485 interface, a single on-board relay and a small internal tag buffer capable of storing up to 20 tag events. The DPOD can be used in any application where tags need to be received at multiple points, but without the need for a complete Active Tag Reader. Applications of the DPOD antenna include complementing the CAS (Collision Avoidance System), to maximize the CAS's coverage of the vehicle by installing DPOD antennas where extra coverage is needed.





Personnel Remote Cluster Alarm (DPOD use only)

The 'Becker Electronics Remote Cluster Alarm Personnel - RCAP' series is a visualization complement to the Becker Electronics Collision Avoidance System. The RCAP acts as a proximity indicator. It provides a visual interpretation of how close a Personnel Tag(s) is to a CAS system and its antennas. On installation the antennas will be spatially programmed to the CAS system, enabling a CAS system to identify the direction of this Personnel Tag relative to the CAS unit. The CAS unit will then send this relative direction information via a RS485 bus to the RCAP. The RCAP responds by illuminating (with higher intensity to indicate proximity to it) on its 4 directional LEDs.





Vehicle Remote Cluster Alarm (DPOD use only)

The 'Becker Electronics Remote Cluster Alarm Vehicle – RCAV' series is a visualization complement to the Becker Electronics Collision Avoidance System. The RCAV acts as a proximity indicator. It provides a visual interpretation of how close a vehicle is to a CAS system and its antennas. On installation the antennas will be spatially programmed to the CAS system, enabling a CAS system to identify the direction of this vehicle relative to the CAS unit. The CAS unit will then send this relative direction information via a RS485 bus to the RCAV. The RCAV responds by illuminating (with higher intensity to indicate proximity to it) on its 4 directional LEDs.





Video Collision Avoidance

The Becker Electronics VCAS system relies on two separate technologies to aid the safe operation of mining vehicles. The first technology utilizes RF tags placed on personal and other vehicles, from which the system can identify and report to the operator the direction and an approximation of the distance of the nearest RF tag. This technology is mainly used to avoid high speed collisions. The second technology utilizes cameras situated around the vehicle and a LCD screen placed within the cabin, allowing the operator to quickly and easily identify hazards that were previously hidden within their blind spots.





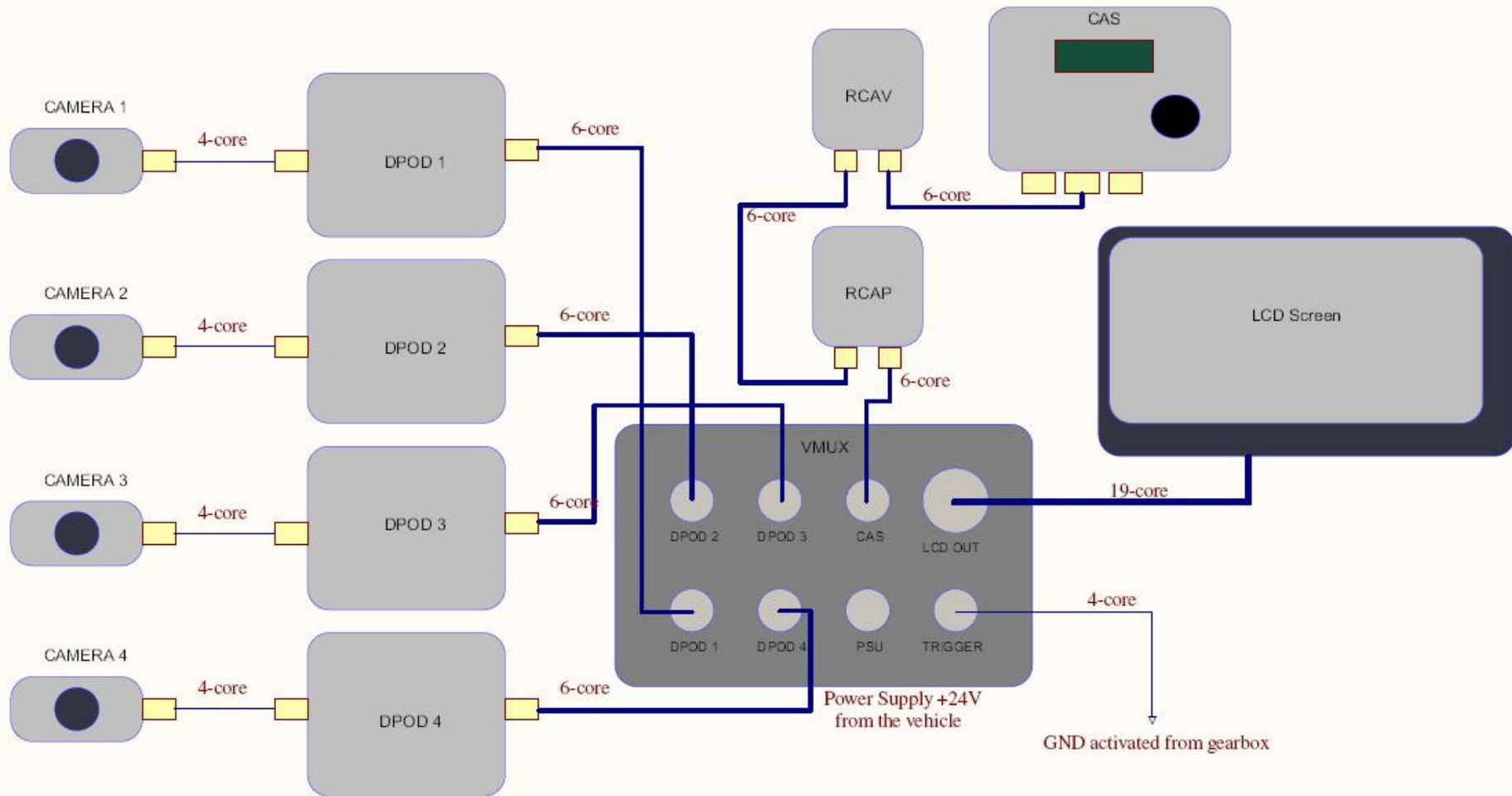
Video Collision Avoidance Equipment



- ❖ The Video camera's transfer their images to the CCAS FPGA based video multiplexor via the BNET bus.
- ❖ These digitized images are tiled on the operators LCD screen based on the information available from the CAS sensors.
- ❖ Up to 8 camera's may be multiplexed depending on vehicle requirements. Typically 4 day/night camera's and 1 forward looking infrared FIR camera are deployed.
- ❖ Video Over IP utilizing WiFi MESH networks may be used to overlay oncoming driver views to the other drivers screen, allowing him to see what the other driver sees.



Video Collision Avoidance Wiring Diagram





Thank You For Your Attention!