Introduction

The products listed in this data sheet are used specifically in covert radio tracking applications. They are all designed to operate together as a system.

The transmitters are normally placed on a vehicle or other object, the signal from the transmitter is then tracked by the radio direction finder fitted to the tracking vehicle(s).

List of Products

Direction Finder Installation

Beacon Transmitters

Direction Finder Installation.

Model DF4 - Tracker 1

A radio direction finding system designed for the most critical applications where total covertness is required without compromising sensitivity. The main part of Tracker is built into a "flight case" and is normally located in the vehicles luggage compartment. All display and control functions are carried out from a small hand-held terminal located at the operating position.

A major advantage of Tracker compared with other systems is its ability to use 2,3, or 4 very small (easy to hide) DF antennas. The loss of signal strength due to their small size is compensated by a patented processing method which uses the much stronger signal collected by a separate "reference" antenna to extract the weak signals from noise. The reference antenna can be the vehicles normal broadcast reception antenna.

Tracker gains further in sensitivity through using five identical receive channels, one for each antenna. In effect all antennas are able to collect signal simultaneously (unlike switched systems where a single receiver is shared between all antennas so that only one antenna can contribute at any one time).

Signal processing is carried out by an internal microprocessor using advanced real-time software. The system automatically adapts to pulsed or continuous transmissions. Transmitter pulse widths down to 11 milliseconds can be successfully handled.

Another major feature of Tracker is its ability to use a wide range of antennas. The antennas need not all have identical phase shifts. This allows smaller, more highly tuned, antennas to be used without sacrificing sensitivity.

The choice of antennas in a given installation depends mainly on the degree of covertness which is required. Tracker allows a car to be fitted out with tracking equipment yet without any external visible sign which would mark out the car as different to any other. This is done using the tuned disc antennas described in section 3. For less demanding applications the roof-rack antenna, described below, is equally effective and easier to install.

Brief performance information for Tracker is as follows:

Operating Frequency:	To order between 30 and 200 MHz. Up to 20 channels can be programmed into a single system provided they are within a bandwidth of 5% centred on the specified nominal frequency.
Signal into DF antennas for useful indication:	typically -146 dbm
Supply Voltage:	9 - 16 volts
Supply Current (max brightness):	2.8 Amps

Roofrack Antennas 2

A modified version of a roof-rack assembly which is widely available from car accessory shops in the UK. It can only be used with cars having rain gutters. The rack consists of two separate sections, similar to a ski-rack assembly. The four vertical parts of the rack are used as the antenna elements.

This antenna is suitable for use between about 30 and 90 MHz. Above this the separation (in wavelengths) between the elements becomes too great. No tuning adjustments are required to the antenna.

Since its introduction in 1986, Tracker has established an unrivalled reputation as the most effective covert tracking system available and is specified wherever ultimate performance is the deciding factor.

A car fitted with Tracker looks factory-fresh with no visible "extras" to mark it as different from any other car. This contrasts dramatically with conventional systems using external roof-mounted antennas. Even when disguised as innocent accessories these tend to draw unwanted attention and cause excessive noise and drag at high speed.

Even more impressive, despite its unrivalled covertness, Tracker typically gives a greater tracking range than competing systems which use exposed roof-mounted antennas.

Why Radio Tracking Stretches Technology

'Radio tracking' involves following a tiny low-power radio beacon from a distance without revealing the presence of the tracker and using radio direction finding techniques to 'point' in the direction of the beacon.

Conventional direction finders use large sensitive antennas and are intended to locate normal communications signals which by definition are strong enough to radiate for long distances. In contrast tracking beacons give much poorer signals and the tracker antennas have to be 'invisible'.

Compared therefore with normal direction finding practice the technical difficulties in tracking are very severe and highly advanced technology is essential for good results.

Purpose-Designed For Tracking

Tracker uses a proprietory DF technique (patented) which was invented specifically to solve these unique problems. At the same time the varied requirements of international law enforcement agencies were carefully considered throughout the design.

The resulting system is easy to use and the software-based modular design ensures that future enhancements or special requirements can be added as the need arises.

Major Operational Features

* Antennas can be totally concealed, need not be identical, and can be miniaturised.
* Compared with other equipment no range penalty results from antenna concealment and miniaturisation.
* Operates from hand-held controller/display unit with main unit hidden in car boot.
* Circular display with 36 radial lines shows the bearing in 10 degree steps. Radial length indicates bearing 'quality'.
* A novel three colour bar-graph displays 'relative signal strength' with high resolution and over 90 db dynamic range. The bar rises through all-green, then all-yellow, then all-red as the signal increases.
* Accepts continuous, pulsed, quasi-pulsed, or fast pulsed signals without operator adjustment, and holds steady readings between pulses. A single barely-audible 'confidence' pulse is enough to give a useful bearing.
* Exclusive signal processing software for 'fast pulses' gives multipath results similar to continuous mode yet with the transmitter power economy of conventional pulsed modes.
* Displays motion status of beacon transmitter.

Operating Principle

Three antennas (the 'DF antennas') arranged in a triangular array and connected to three identical receivers simultaneously pick up three versions of the beacon signal. At the same time a special 'reference' antenna which is more sensitive than the ones in the array also feeds a fourth identical receiver.

Note the key factor - the reference antenna can be quite efficient compared with the ones in the DF array because only the one is required. In contrast the four identical antennas in a conventional concealed DF antenna have to be relatively less sensitive if they are to remain hidden.

The reference antenna might for example be disguised as the normal car radio whip antenna, or in some other way. The important point is that its output can easily be made to be a relatively high quality version of the beacon signal.

Using a patented technique the reference signal and the three weaker signals are processed together so that almost the ultimate theoretical limit of detection sensitivity is achieved for the weak signals. The processing is done in both hardware and software and gives the relative phase shifts between the three signals from the DF antennas. Finally this data is used to calculate the bearing.

The overall result is that the sensitivity (and therefore tracking range) is determined mostly by the single large antenna, while the directional information is provided by the small antennas.

No Need for Identical Antennas

A unique feature of Tracker is that it can use non-identical antennas in the DF array. This helps to increase covertness in the following ways:

* 'Unlikely' antennas may be used in the DF array thereby improving 'disguisability'.
* Highly tuned antennas can be used to give high sensitivity in a small size.
* The reference antenna can form part of the DF array so that in favourable cases only three antennas in total are required, one large' and two 'small'. In this case the reference antenna must be mounted not further than 0.3 wavelengths from the other antennas.

These benefits stem from the fact that most of the signal processing is done in software. This makes it possible to add extra "trim" values to the measured phase differences to compensate for the lack of matching between the antennas.

Similar techniques allow the system to automatically compensate for lack of precise phase matching between the receivers. In fact all five receivers are automatically phase calibrated every thirty seconds under computer control. The software then corrects the "real" data before calculating the bearing. In this way errors due to long term drift are eliminated.

Compatibility With Existing Antenna Installations

Only three antennas are required in the DF array and the array is therefore easier to conceal than one with four antennas. However most earlier systems use arrays of four antennas so, to give compatibility with existing installations, Tracker is equipped with a total of five identical receivers.

A fully concealed three antenna array with Tracker usually gives more range than a less concealed four element array used with competing equipment. On the other hand if Tracker is used with the less concealed array an even further increase in range can be expected.

The Control Unit

The control unit is designed for easy operation and is small enough to be easily concealed when required. It carries all the displays and controls plus a small loudspeaker and connects to the main unit with a thin, flexible control cable. The rugged case is milled from solid aluminium. All functions are available from the controller and no access is needed to the main unit once the system has been connected up.

Apart from the volume control knob and the power on/off switch, all functions are controlled from eight calculator-type keys. A sixteen character alphanumeric display shows important control settings and allows easy setting up for different antenna arrays using a "menu" procedure. (Access to the setting-up routines can be easily restricted to technical personnel only).

The Main Displays

The directional display mimics an analogue compass display and allows very easy assimilation of changing data. It consists of thirty-six three-LED radial bargraphs and shows the bearing as a line "pointing" to the target. Thus if the target is straight ahead, the "12 oclock" line illuminates. The length of the line is a rough guide to the quality of the bearing.

The colour coded signal strength display combines high resolution with instant assessment of "too near", "OK", or "too distant" conditions. It consists of three eleven-LED bargraphs mounted side by side and coloured green, yellow, and red. As the signal strength rises from zero, the green bar extends like the mercury in a thermometer until when fully extended it is "pushed off-scale" by the yellow bar, which in turn is itself pushed up by the red one.

Setting Up

When the system is first installed it needs to be "told" about the antenna configuration. A series of questions are presented on the alphanumeric display and the installer simply has to answer the questions using the command keys. In effect the controller behaves as a "smart" terminal for the computer in the main unit.

All settings are stored in the memory of the main unit when the system is switched off and control units are fully interchangable between different Tracker main units.

Powerful Signal Processing Techniques

The computer inside Tracker uses special signal processing algorithms to extract maximum possible information from weak signals and to make the system easy to use. For example the system itself decides whether the incoming signal is continuous, pulsed, quasi-pulsed, or fast-pulsed and adjusts its processing method accordingly. It calculates its own pulse threshold levels which then adapt continuously to suit changing conditions.

Using optimum "matched filtering" techniques, the software is especially effective at giving usable bearings even on very weak isolated pulses such as confidence pulses, or those received when the target is at the limits of range and the signal is receivable only in bursts.

With quasi-pulsed transmissions (large pulses superimposed on a weak continuous background signal) the signal strength display always shows the **peak** signal strength so that it does not abruptly change scale when the background signal becomes detectable. However the direction is always calculated from the continuous part of the transmissions whenever it is detectable (i.e., at short range) because this gives best multipath suppression.

Bearing and signal strength are shown as a steady display at all times for both pulsed and continuous transmissions. With pulses the display holds the result of the previous pulse and updates when the next pulse arrives.

Multipath suppression is achieved by storing in memory at any one time all the bearing data received over the previous five seconds. The displayed bearing represents the average of as much of this data as required. The operator can easily choose between a "lively" fast responding display and the steadier display offered by longer averaging times.

Special Display Possibilities

If desired two control units can be connected to one Tracker using an optional interface box. This is especially useful when the system is airborne.

Communication between the main unit and the controller is via a serial data link based on the RS232 standard at 9600 baud and the controller contains its own microprocessor. If necessary the functions of the controller could be simulated by a remote computer or display systems could be developed for special applications without any changes being necessary to the main unit.

The Rest of the System

Tracker forms part of a complete system. Other components of the system have their own data sheets which are available on request. Almost every product in the range represents a significant advance on previous technology. They include: covert antennas, beacon transmitters, fully radio-commandable beacon transmitters.

Technical Information

Typical minimum signal from reference antenna for automatic detection of 80 msec pulses		-130 dbm
Typical minimum signals from DF antennas for useful directional indication		-146 dbm
Frequency range		any 5% bandwidth to order within the range 25 to 200 MHz.
Channels		up to 20 synthesised channels as standard with no restrictions on channel spacing.
Fine-tuning range		±2kHz (approx)
Maximum antenna spacings	*stub to stub*	0.5 wavelength in free space (typically 0.3 wavelength on-vehicle).
	stub to reference (reference not part of DF array)	no limit
	stub to reference (reference part of DF array)	same as stub to stub
Optimum width of conventional transmitter pulses		80 mS
Optimum width of transmitter pulses in fast-pulsed mode		11 mS
Maximum data averaging time		2.5 sec (operator adjustable)
Power supply voltage		9 - 16 volts DC (Negative connected to case)
Power supply current		2.8 Amps (Max display brightness)
Microprocessor	*Main Computer* *Control Unit Computer*	Z80 (6 MHz clock), 18K RAM, 32K ROM 8751
Dimensions of control unit		200x90x28 mm
Dimensions of main unit		Electronic section 270x175x275 mm, supplied in carrying case, 485x210x360 mm, with compartment for controller and for cables.

The information in this data sheet is subject to change without prior notice

DATONG
ELECTRONICS
LIMITED
Clayton Wood Close
West Park, Leeds,
England. LS16 6QE
Tel: 0532 744822
Fax: 0532 742872