**H5 - Accurate Positioning System**

EDT’s home developed accurate positioning system consists of high accuracy dGPS transponders wirelessly networked to a dGPS (RTK) base station and an operator control station.

The Transponders are situated at planned intervals along the pipeline and special transponders are situated on the main tug-boats supplying visual information to the tug master.

All Transponders transmit their corrected location to the operator’s onshore control station. At the control station, real-time accurate position of the pipeline is displayed and overlaid on background of planned pipeline rout.

Control station operator easily maneuvers the tug-boats and workboats to position the pipeline in place.

**Pipe Accurate Positioning System Working Plan**

![Diagram](image)

Transponders are place along the pipeline and the tugboat.

Locations are displayed in control station

Pipeline precisely positioned by workboats and by controlling the position of the main tugboat.

**Technical Specifications**

Thales DG 14 Real-Time Kinematic navigation sensor incorporated in our unique navigation transponders Including TDMA UHF radio modules

<table>
<thead>
<tr>
<th>System Accuracy</th>
<th>dGPS - +/- 25 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RTK - +/- 5 cm</td>
</tr>
<tr>
<td>Power Consumption</td>
<td>Battery – 18 hours</td>
</tr>
<tr>
<td></td>
<td>AC In - Continuous</td>
</tr>
<tr>
<td>Environmental</td>
<td>IP 68</td>
</tr>
<tr>
<td>Range</td>
<td>40 km</td>
</tr>
</tbody>
</table>
All transponders are mashed and will relay information in case of need.

Tugboat Display will display both self position and attitude and all other pipeline transponders. Control station will create targets and run lines that will display on tugboat units.
Tracs-TDMA is an intelligent radio data network which integrates advanced UHF and VHF communications with GPS technology. Offering outstanding configuration flexibility, and the advantages of unique automatic repeater capabilities, Tracs-TDMA is ideal for complex tracking and communications tasks including:

- Vessel tracking
- Fleet management
- Vehicle tracking
- Port vessel monitoring
- Personnel tracking
- Geophysical field operations management

**Key user benefits of Tracs-TDMA**

- Real time mobile tracking with either Real Time Kinematic or standard DGPS accuracy
- System provides continuous location of all mobile units ‘at a glance’
- Auto adaptive repeater mode extends operating range in areas where direct communications is obstructed
- Advanced technology permits reliable signal transmission in difficult conditions without operator intervention
- Use of messaging facility for the broadcast of navigational instructions such as waypoints and guard zones reduces voice radio traffic and speeds communications
- Advanced error correction as standard
- Emergency alarm for vehicle/operator security
**Tracs-TDMA advanced features**

Tracs-TDMA is an intelligent data network system which operates at UHF and VHF frequencies permitting continuous real-time messaging from a wide variety of applications. Operating on a Time Division Multiple Access principle the system is extremely flexible in configuration, giving the mobile data system integrator complete control over messaging rates and content.

Each mobile unit within the Tracs-TDMA system is allocated a unique identity code and transmits its position or other data in a time slot assigned to it. Transmission timing is synchronised by GPS and revised by the control centre as required. All transmitted data carries a tag identifying its origin and destination and this enables other mobile units in the operating area to monitor the data network and automatically forward messages if direct transmission is blocked. This unique technology enhances communication reliability and can significantly extend the operational range of the Tracs system beyond the normal line of sight restrictions.

Tracs-TDMA is ideal for real-time tracking applications allowing the reporting of GPS position of mobile units back to a control centre display system. At the same time, Differential GPS corrections can be broadcast through the network for precise positioning applications. The system operates on a single UHF or VHF frequency and can handle up to 250 mobile reports per radio channel although this capacity can be expanded by the use of additional channels in a cellular configuration.

**Technical capabilities**

**Data communication between units**

As well as position reporting to a control centre and the distribution of RTCM data, messages can be routed from one mobile to another. Selective or group messaging is possible from the control centre as is the facility for units to be configured dynamically. Voice radio traffic can be reduced and communications in crowded frequencies made faster as a result.

**Auto adaptive repeater mode**

Any Tracs-TDMA unit in a system can operate intelligently as a repeater. Each mobile unit monitors the communications status of all other units in its local area, and should the path between 2 units be obscured, the unit will automatically deduce which path is blocked and undertake to pass on the message during the next time slot allocated to the originator of the message. In this way messages can be re-broadcast to circumvent radio line of sight limitations or to relay messages made from beyond the network's normal radio range.

**System capacity**

Transmission of data within a ‘cell’ is via a single radio channel. Each unit's access to the network is configured during initial set-up. A typical mobile reporting interval would be 10 seconds, depending on priority, which would allow spare capacity to be allocated to fast mobiles and any dedicated repeaters. The frequency of position reports from mobile units can be changed by the control centre enabling it to focus on units involved in critical activities.

**Accessories and options**

**GPS modules and configurations**

Tracs-TDMA is available with either standard (2-4 metre) or precision (better than 1 metre) accuracy.
Display systems
A range of mapping and display systems is available depending on the application and on the functionality required. Alternatively, assistance can be provided for the integration of Tracs-TDMA data into existing display systems.

Emergency alarm facility
Mobile units can be fitted with an alarm button which causes the system to transmit an emergency position and status report with minimum delay. Emergency transmissions can be detected and acknowledged by adjacent mobiles as well as the control centre.

System software and user interfaces
Several packages are available for planning, configuring and operating the network depending on the client's requirements.

Network planning software
This is used to assign transmission slots to mobiles to meet their perceived requirements for data capacity. The configuration file is then passed to the configuration software.

Configuration software
Enables the units to be set up as required in the network planning software via a serial cable from a PC. Units retain the configuration in memory until reprogrammed.

Tracs communications controller (Tracs-CC)
Data can either be extracted directly from a Tracs-TDMA unit by the application software or Tracs-CC software can be used to manage the Tracs-TDMA data. This software is of particular benefit when larger systems are being used which include several base stations.

Control centre software
PC software to manage a database of the position reports and a graphical display of mobile locations is available. In addition, the software can provide message scheduling, co-ordinate conversion, system monitoring and network control functions for inclusion in either simple, single base station systems or multiple base/frequency systems.

GeoPod - pod unit
The Tracs-GeoPod unit is a variant of the system designed for extremely hostile environments or conditions. The unit is designed for the rough handling that can be experienced in high shock environments and is waterproof to 10 metres.
### Technical Specification

<table>
<thead>
<tr>
<th>Channelisation format:</th>
<th>TDMA (Time Division Multiple Access)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range:</td>
<td>Line of sight operating ranges with integrated power output options of up to 10W</td>
</tr>
</tbody>
</table>
| Frequency bands:     | VHF 136 - 174MHz  
                       | UHF 440 - 512MHz |
| Number of channels:  | The transceivers are configured to use any 10 channels in the band with the system configuration software |
| Transmitter power output: | 10mW, 500mW or 2W software selectable, optional 10W integral PA |
| CCIR emission designator: | 25KOF1D/12K5F1D |
| Error correction:    | Byte level Hamming (12,8) code, correcting 1 bit per byte, interleaved into blocks of 20 bytes |
| Antennae             | Integrated GPS and VHF/UHF with single cable, max power 10W  
                       | L1(1.575GHz), Gain 40dB, 5V DC, Azimuth 360 deg, Zenith 0 deg to 90 deg |
|                       | VHF: 136MHz to 174MHz, -0.3dBd with optional radials, -3dBd surface mounted  
                       | UHF: 440 – 512 MHz  
                       | Optional: Separate GPS and VHF/UHF antennae |
| GPS receiver         | Standard: 8 channel receiver  
                       | High accuracy: 12 channel receiver  
                       | Precision: Real Time Kinematic |
| Power supply:        | 9V to 36V DC. Load dump protection to 250V |
| Power consumption    | Maximum: Transmit (2W PA. 100% duty cycle) 12W  
                       | Transmit (10W PA. 100% duty cycle) 40W  
                       | Receive 4W |
|                       | Typical: Transmit (2W PA. 1 report/sec) 5W  
                       | Transmit (10W PA. 1 report/sec) 7W |
| Temperature:         | Operating -30 °C to + 60 °C  
                       | Storage -45 °C to + 70 °C |
| Waterproofing:       | Tracs-TDMA and antenna IP 67 compliant. Dust proof with short term immersion to 1 metre  
                       | GeoPod IP 68 compliant. Dust proof with immersion to 10 metres |
| Dimensions and weight: | TDMA: L 246mm W 140mm H 95mm, 3kg  
                       | GeoPod: L 603mm Diam 90mm, 4.5kg  
                       | Excluding connectors with cables |
| Type Approval:       | TDMA: Meets ETS 300-113, CE approved  
                       | GeoPod: Meets UK MPT 1329 band 458.5 to 458.8 MHz, CE approved |
DG14™ Receiver

Advanced, High-Precision GPS Technology for Highly Demanding Applications

The DG14 from Magellan is a cost-effective, sub-meter GPS+Beacon+SBAS receiver. It incorporates signals from Satellite Based Augmentation Systems (SBAS), such as WAAS, EGNOS & MSAS, or an embedded beacon receiver to provide sub-meter differential positioning.

The DG14 comes standard as a 14-channel receiver with 12 GPS L1 code and carrier channels and two SBAS channels. Two additional DGPS beacon channels are available as an optional feature. The two SBAS channels can be configured as two additional GPS channels offering a total of 14 GPS channels. DG14 can provide up to 20-Hz precise three-dimensional position and raw data for real-time guidance and navigation. DG14 can output SBAS ranging, ephemeris and differential corrections through the serial port. While DG14 offers three standard RS232 ports, it is capable of single port operation. In addition, DG14 comes standard with User Defined Messages (UDM) software, a feature that enables the user to create custom messages.

DG14 incorporates Receiver Autonomous Integrity Monitoring (RAIM) that allows the receiver to detect and correct errors in the satellite signals. In addition, the DG14 features Horizontal Protection Level (HPL) output for aviation applications such as Automatic Dependent Surveillance Broadcast (ADS-B) stations. It also features improved in-band and out-of-band interference rejection capabilities. For best performance, DG14 can be configured to use a Kalman filter with adaptive dynamic mode or user can select dynamic modes such as walking, ship, aircraft, etc. to match the operating conditions.

New RTK Engine
The DG14 receiver now supports RTK positioning with reliable decimeter to centimeter accuracy. The DG14 allows customers to choose from fixed centimeter solutions or fast decimeter (Flying RTK™) solutions with the new state-of-the-art Blade technology. In addition, the DG14 supports moving base operation and heading plus pitch or roll computation with auto-calibration for easy initialization. For best results, the DG14 rover can be configured to use SBAS signals in addition to GPS for RTK positioning with RTCM 3.0-compatible base station.

WADGPS Processing with (M) Option
The DG14 WADGPS algorithm has been developed by Magellan to provide a position solution using corrections coming from a network of up to 24 base stations. The DG14 WADGPS algorithm has been extensively tested in operational conditions in various environments: North-Sea, Equatorial region and Southern Hemisphere, and has shown excellent results over medium-spaced (1500 km) network, even during ionospherically active days.

Integrated Differential Optimization (IDO)
With the IDO, you can choose either a single or multiple sources of corrections from up to seven sources/channels of corrections (serial port, SBAS, and beacon). Sources are selected in order of preference through a Primary-Secondary scenario mode or combined using a Multi-Base processing, automatically or manually.

Multipath Mitigation
Multipath is the single largest cause of differential GPS position errors. The Strobe Correlator (patent pending) is a digital signal processing technique implemented in the hardware and software of the DG14 receiver that removes multipath errors almost entirely for reflected signals with delays of 37 m or more. This represents the best DGPS multipath mitigation available today in GPS receivers - and it is available standard with the DG14.
**DG14 Receiver Technical Specifications**

### Real-Time Position Accuracy
- **Autonomous**
  - CEP: 3.0 m (9.843 ft)
  - 95%: 5.0 m (16.4 ft)
- **Differential**
  - Local Base Station
    - CEP: 40 cm (1.31 ft)
    - 95%: 90 cm (2.95 ft)
  - Beacon
    - CEP: 70 cm (2.30 ft)
    - 95%: 1.6 m (5.25 ft)
  - SBAS
    - CEP: 1.0 m (3.28 ft)
    - 95%: 3.0 m (9.84 ft)
  - RTK
    - Fixed RTK (kinematic)
      - sigma: 1 cm + 1 ppm
    - Flying RTK (kinematic)
      - CEP: 5 cm + 1 ppm
      - CEP: 20 cm + 1 ppm
  - Heading, Pitch/Roll
    - Heading (sigma): 0.2 deg/baseline (m)
    - Pitch/roll (sigma): 0.4 deg/baseline (m)

### Velocity Accuracy (knots)
0.1 (95%)

### Time to First Fix
- Re-acquisition: 3 sec
- Hot start: 11 sec
- Warm start: 35 sec
- Cold start: 90 sec

### DG14 Features
- 14 Channels
- 12 GPS code and carrier
- 2 SBAS (WAAS/EGNOS/MSAS)
- Standard NMEA-0183 V3.0 output
- Selectable position and raw data rates up to 20 Hz (maximum 10 Hz with RTK)
- Position latency output: 20 - 40 ms
- Raw data output (code and carrier)
- 1 PPS (5V TTL)
- Precision: 200 ns (stand-alone)
- 50 ns (differential)
- Edge and Strobe Correlator
- Differential base RTCM V2.3, message types 1.2,3,6,9,16,18,19,22
- Differential rover RTCM V2.3 message types 1,2,3,6,9,16,18,19,22, RTCM V3.0 message types 1001-1006
- 20 G tracking capability
- Kalman filter
- Event marker
- Session programming
- Integrated Differential Optimization™
- Low-power sleep mode
- Wide array of coordinate transformation options
- 3 bi-directional RS-232 serial ports, up to 115,000 bps
- External LED drivers
- Multi-base Differential with WADGPS (optional)
- User-defined Messages (UDM)
- On-board 2-Channel Beacon Receiver (optional)
- Receiver Autonomous Integrity Monitoring (RAIM)
- Horizontal Protection Level (HPL) Output
- Speed (max): 514 m/sec (1,000 knots)
- Altitude (max): 18287 m (60,000 feet)

### RTK Base
- 5 Hz update rate
- RTCM-2.3: Types 3, 22, 18, 19
- Moving base operation

### RTK Rover
- **Blade**™ technology
- 5 Hz Synchronized RTK
- 10 Hz Fast RTK
- Compatible with RTCM 2.3, RTCM-3.0, DBEN (Magellan proprietary)
- Moving base operation
- Heading and pitch/roll determination with auto-calibration

### Environmental & Physical
- Operating Temp: -30°C to +70°C (-22°F to 158°F)
- Storage Temp: -40°C to +85°C (-40°F to 185°F)
- Power Consumption: 1.2 W (GPS only)
- 1.6 W (GPS + Beacon) 0.3 W (antenna)
- Input Voltage: 5 VDC ±5%
- 100 mV p-p ripple
- Size: 108 mm x 57 mm (4.25 in x 2.25 in)
- Connector: 30 pins
- Weight: 65.35 gr (2.3 ounces)
- Vibration: MIL SPEC 810E / Category 10
- Altitude (max): 514 m/sec (1,000 knots)
- Speed (max): 18287 m (60,000 feet)
- Humidity: 95% non-condensing
- Shock: ±40 g Operational
- ±75 g Non-Operational
- Acceleration: 20 G
- Temperature range: -40°C to +85°C
- Acceleration range: ±40 g
- Humidity range: 10 to 95% non-condensing
- Shock range: ±40 g
- Vibration range: MIL SPEC 810E / Category 10
- Altitude range: up to 514 m/sec (1,000 knots)
- Speed range: up to 18287 m (60,000 feet)
- Power consumption: 1.2 W (GPS only), 1.6 W (GPS + Beacon), 0.3 W (antenna)
- Input voltage: 5 VDC ±5% (±10%)
- Maximum current: 250 mA
- Power consumption in sleep mode: 90 mW
- Storage temperature: -40°C to +85°C
- Operating temperature: -30°C to +70°C
- Power connection: 5 VDC ±5%
- Power consumption: 1.2 W (GPS only), 1.6 W (GPS + Beacon), 0.3 W (antenna)
- Input voltage: 5 VDC ±5% (±10%)
- Maximum current: 250 mA
- Power consumption in sleep mode: 90 mW
- Storage temperature: -40°C to +85°C
- Operating temperature: -30°C to +70°C
- Power connection: 5 VDC ±5%
- Power consumption: 1.2 W (GPS only), 1.6 W (GPS + Beacon), 0.3 W (antenna)
- Input voltage: 5 VDC ±5% (±10%)
- Maximum current: 250 mA
- Power consumption in sleep mode: 90 mW
- Storage temperature: -40°C to +85°C
- Operating temperature: -30°C to +70°C
- Power connection: 5 VDC ±5%

### Edge and Strobe Correlator
1. Generic Standard Correlator Spacing, 1 chip
2. Generic Narrow Correlator Spacing, 0.1 chip

This figure shows the errors induced by a multipath signal half the strength of the direct signal.

The horizontal axis of the plot show the multi-path delay, this is the extra distance that the reflected signal travels compared to the direct signal. The vertical axis shows the induced range error caused by a multipath signal with the indicated delay.

From this plot you can see that typical narrow correlator performance and Edge Correlator performance is similar, while Strobe Correlator performance is much better, almost totally cancelling any multipath with a delay of more than 37 m.

---

1 Accuracy and TTFF specifications based on tests conducted in Santa Clara and Moscow. Tests at different locations under different conditions may produce different results. Beacon tests based on 40 km baseline. Position accuracy may degrade with longer baselines.
2 Options for altitude and/or velocity limits removed are available with proper authorization.
3 Values correspond to open sky conditions. Performance may degrade with limited visibility, multipath, and high ionosphere activity.
4 For baseline lengths <10 km.
5 Steady state value for baselines <50 km after sufficient convergence time.
6 Typical value after 3 minutes of convergence for baselines <50 km.
7 Typical value for properly installed antenna on vehicle body.

Contact Information:
- In USA: +1 408 615 3970  Fax +1 408 615 5200
- Toll Free (Sales in USA/Canada) 1 800 922 2401
- In South America: +56 2 273 3214  Fax +56 2 273 3187
- Email: professionalsales@magellangps.com
- www.pro.magellangps.com

Magellan follows a policy of continuous product improvement; specifications and descriptions are thus subject to change without notice. Please contact Magellan for the latest product information.

© 2007 Magellan Navigation Inc. All rights reserved. DG16, DG14, G12, Blade, Mission Planning, Edge, Z-Sensor, Strobe Correlator, Integrated Differential Optimization and Evaluate are trademarks of Magellan Navigation, Inc. All other trademarks are property of their respective holders. Rev (1Sep07) P/N XC20045G