Kongsberg Maritime

# Operator manual

KONGSBERG

## 1007D

Altimeter series

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# *1007D Altimeter Series*

Operators manual

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# About this document

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# 1 GENERAL DESCRIPTION

The 1007D digital altimeters are small, rugged, light-weight instruments for deep ocean applications, where dimensions and weight are key equipment selection factors. The 1007D is ideally suited for applications such as positioning, berthing, measurement of above-seabed altitude or depth below the water surface.

## 1.1 Features

- 200 kHz transmit frequency standard (120 kHz or 675 kHz optional)
- Configurable settings for operating parameters (range, resolution, firing rate, pulse width, etc.)
- Configurable settings for detection parameters (threshold, range, return pulse width, etc.)
- First or peak-level return based obstacle/bottom detection
- Adjustable threshold based range measurements
- User selectable range windowing control
- RS485 or RS232 serial interface standard
- 3 basic models available - standalone analog output, standalone digital serial output, and MS1000 mode (for use with MS1000 system)
- 808, 809, or NMEA output data formats
- Adjustable manual gain or automatic gain offset modes
- Compatible with Kongsberg Mesotech's MS1000 PC-based sonar imaging / data-logging software. Scope-graph and echo sounding available when operating with MS1000 software.

## 1.2 Options

- RS422 serial interface
- analog output
- electrical hold-off control
- multi-head ping synchronization
- second serial output for vehicle servo control
- connector options (contact factory)

## 1.3 Introduction

The Model 1007D acoustically measures underwater altitude at high resolution, producing a digital and/or analog output proportional to range.

It is primarily intended for remote operation where its output will be connected to a remote PC or MS1000 host, or to other instrumentation such as a data acquisition system or a telemetry system. Consequently, the 1007D does not have any operating controls nor does it have a display.

The 1007D's processing features, flexibility, and performance are designed to address the requirements of many applications and deployment scenarios. Many of its sonar acquisition and echo verification parameters such as pulse width, receiver gain offset, range limits, and sensitivity are all programmable. Altitude measurements can be output via a serial interface in a number of selectable formats for various interfacing requirements.

The 1007D is capable of measuring altitude at high resolution. A resolution of better than 2.5 millimetres can be achieved for distances up to 38 meters. The resolution is adjustable to allow the operator to optimize the balance between resolution and ping rate.

In its standard stand-alone configuration, the 1007D is connected to a remote PC or computer terminal via an RS485 or RS232 interface. Range measurements are up-linked directly to the host computer in a number of selectable ASCII formats and range units. Legacy Model 808 or 809 Altimeter output formats are also available. Range measurements can also be output to a DC voltmeter from an optional analog interface like that found in our Model 807 Altimeters. The voltage output is directly proportional to the range (10 volts corresponding to maximum range).

The 1007D's programmable gain receiver is controlled by a "Time Varying Gain" (TVG) function to compensate for acoustic return signal losses that increase with range. This process is microprocessor controlled and is applied during each ping, synchronized to the start of the transmit pulse. The TVG function is therefore very stable and accurate, and results in a very stable output signal.

The 1007D is compatible with Kongsberg Mesotech's MS1000 PC software and related accessories such as the MS1000 Power Supply Box. The MS1000 software can support up to 255 devices (sonar heads and/or 1007D Altimeters) over a single RS485 connection. The 1007D can also be used with the ROV Hub option on the MS1000 that allows several 1071/1171 scanning sonars and 1007D altimeters to be operated and synchronized with a single ethernet cable connection. The MS1000 software displays altitude measurements in a directly readable format in a moveable display window. An analog scope-graph window provides the operator with a visual indication of the aggregate acoustic signal received each ping, plotted as graph of signal-strength vs. range.

The Model 1007D is packaged in a small rugged housing rated for a maximum depth of 3000 meters. A single underwater connector provides a simple cable connection to an external DC power source, and either an external PC or a voltmeter.

# 2 THEORY OF OPERATION

The Model 1007D altimeter measures range as a function of the two-way acoustic travel time between its transducer and a reflecting target or sea bottom.

The 1007D range measurement cycle (or 'ping') begins by transmitting an acoustic tone burst from its transducer into a narrow conical-shaped beam. This beam pattern depends on the transducer element used, and defines the coverage of the targets which will be illuminated. The acoustic energy is reflected back to the transducer by each target at a delay time proportional to its distance, and at a strength related to its size and reflectivity.

The signal received by the transducer consists of a series of pulses or "returns" corresponding to each insonified target, and is amplified and conditioned by an adjustable gain receiver. The receiver output is sampled, digitized, and stored in internal memory over the duration of the ping, as determined by the altimeter's current maximum range setting. The sample data is then analyzed by a Digital Signal Processor (DSP) to determine time and distance to the most likely target.

The receiver gain is hardware-controlled by a Time-Varying-Gain (TVG) characteristic to compensate for acoustic energy losses that increase with range:

$$\text{Gain (dB)} = 20\,\text{Log}(R/Ro) + 2a(R - Ro)$$

where **R** = range, **Ro** = reference range (1m), and **a** = attenuation constant in dB/range units. The first term compensates for the natural spreading loss proportional to the inverse of the square of the distance, assuming a wide, flat, bottom. The second term compensates for losses due to energy absorption and is directly proportional to the distance, assuming uniform water salinity, temperature, and pressure.

The sampled data set of the received signal may contain numerous 'returns' of varying amplitudes due to noise or representing actual targets. The DSP identifies those 'returns' that meet the following adjustable criteria as potential candidates for the final range measurement:

a) *minimum amplitude (threshold)*
b) *minimum pulse width*
c) *minimum inter-pulse gap width*
d) *minimum range*
e) *maximum range*

Adjustments are made to these settings to reduce the detection of spurious and/or low reflectance targets. The minimum range setting can also be adjusted to eliminate nearby targets such as vessel hulls, cables, etc. near the altimeter.

The range of candidate 'returns' in the sample data set is estimated as the time the 'return' pulse first exceeds a minimum amplitude threshold.

After the candidate 'returns' have been identified from the sample data set, one is chosen by the DSP using a decision rule that selects the sea bottom return. The operator can select one of the following decision rules the 1007D uses to determine the sea bottom return:

a) *first return*: The selected return is the first return whose level is above the set threshold. This mode is recommended for obstacle avoidance applications

b) *peak return*: The selected return is the strongest return whose level is above the set threshold. This mode is recommended for long range applications in low multipath environments for detection of hard, flat sea bottom.

The acoustic travel time is calculated for the chosen return based on its position in the sample data set, then converted to a range estimate. This estimate is then filtered using an adjustable range window that considers the new range estimate valid only if it is within a range window of the previous estimate. This range window feature can be disabled if desired.

If after each ping a valid range estimate is determined, the range data is either up-linked as an ASCII string from the telemetry interface and/or optionally output as a scaled 0..10V analog output. However, if no return is detected, or if range windowing is enabled and the range estimate of the current ping is outside the range window of the previous ping, an over-range value is output. This over-range value is zero from the digital telemetry interface, and typically +10.24V from the optional analog interface.

## 2.1 Operating Mode

Immediately on power-up the 1007D Altimeter scans its RS232/485 telemetry interface for the first ten seconds in order to detect MS1000 telemetry. If successful, the altimeter sets itself up as an MS1000 device for control by an MS1000 PC host. If no MS1000 is detected within the allotted time, the 1007D goes into its factory-configured default mode. These modes are one of the following and are configured at the factory as per customer requirements:

a) *807 mode*: operates as a standalone instrument with an analog output interface, where range measurements are output continuously as a 0…10V signal only. All range, detection, and output scaling settings are configured at the factory as per customer requirements. The *807 mode* can only be entered as a power-up default. While operating in this mode, the telemetry type (RS232, RS485, or RS422) is fixed by a factory-configured setting, and cannot be changed.

b) *808 mode*: emulates a standalone Model 808 Altimeter, where range measurements are continuously output via a quasi-full-duplex telemetry interface (RS232, RS485, or RS422). In this mode the altimeter accepts XON/XOFF characters from a computer to pause/resume pinging. All range, detection, and output scaling settings are configured at the factory as per customer requirements. This mode can only be entered as a power-up default. During this mode, the telemetry type (RS232, RS485, RS422) is fixed by a factory-configured setting, and cannot be changed.

c) *809 mode*: operates as a standalone instrument, where range measurements are continuously output via a quasi-full-duplex telemetry interface (RS232, RS485, or RS422). Range, detection, and output scaling parameters are programmable via serial commands. This mode can only be entered as a power-up default.

During this mode, the telemetry type (RS232, RS485, RS422) is fixed by a factory-configured setting, and cannot be changed. This mode emulates the Model 809 Altimeter, providing a pin-compatible serial interface for output/control of altitude measurements via a computer.

d) *MS1000 mode*: operates as an MS1000 device over an RS232 or RS485 telemetry interface, and is controlled by MS1000 host software running on a PC. In this mode, the 1007D detects the telemetry type (RS232, RS485) used by the MS1000 host PC. RS-485 telemetry is the most flexible, allowing multiple 1007D altimeters and MS1000-compliant digital sector scanning sonar heads to be connected to a single cable.

The MS1000 mode can also entered from any of the standalone *807, 808,* or *809* modes if MS1000 telemetry is detected. However, this is possible only if the altimeter is configured for a telemetry type that agrees with that used by the MS1000 host PC. Further details regarding 1007D setup and control with the MS1000 software can be found in the MS1000's help utility or in the MS1000 Operator's Manual.

The *807, 808,* and *809* modes are collectively referred to as the **standalone *80x*** modes throughout this document.

## 2.2 Range Resolution

The 1007D altimeter is capable of resolving distance at very high resolution, limited only by the altimeter's maximum sampling rate (307.2kHz or 2.4mm) and sample memory size (16000 samples). This implies that distances can be measured down to 2.4mm resolution for maximum ranges up to 38 meters.

In *807 and 808 mode*s the resolution and maximum range are set to fixed factory-default settings. In *809 and MS1000 mode*s the maximum range is adjustable, and the resolution is automatically adjusted to achieve the best resolution that will maximize sample memory usage.

The resolution and maximum range determine the number of samples acquired during each ping. Increasing the number of samples increases the processing time required by the altimeter's DSP, therefore decreasing the overall ping rate. The maximum resolution is therefore programmable in *809* and *MS1000 mode*s to allow the operator to adjust the balance between ping rate and resolution as required. In *809 mode* this adjustment is performed by the '**Q**' command (section 4.2.2). In *MS1000 mode*, a slider adjustment in the MS1000 software controls the ping rate vs. resolution optimization when profiling without a displayed image.

## 2.3 Over-range Condition

An "over-range" condition exists if a distinct, valid return is not found within the altimeter's current range settings, where:

*i.* "*distinct*" implies that the distance between a return pulse and the next pulse exceeding the minimum threshold exceeds the minimum gap width setting.

*ii.* "*valid*" implies that a return pulse meets all of the following conditions:

- it is located within the minimum, maximum range settings.
- its amplitude exceeds the minimum threshold.
- its width exceeds the minimum width setting.
- its corresponding range is within the range window of the altitude measurement of the previous ping (if range windowing is enabled).

If a distinct, valid return is not detected, an over-range value will be output. For the digital telemetry interface, a zero range value will be output. For the optional analog interface, a factory configured over-range voltage will be output (default = 10.24V).

## 2.4 Receiver Gain Adjustment

A TVG offset adjustment is available to increase or decrease the receiver gain by adding or subtracting a DC offset. The adjustment can be increased to improve the detection of low-reflectance targets or muddy sea bottoms. Decreasing this adjustment reduces the sensitivity of detecting spurious mid-water targets (such as fish), thereby improving tracking of hard sea bottoms. In standalone 80x modes, the offset is a constant value over the entire ping. In MS1000 mode, a menu selection of several TVG types is available as well as a user-defined TVG configuration which allows custom settings for spreading loss, absorption and overall gain.

## 2.5 Auto-GAIN Adjustment

The 1007D's **Auto Gain Adjustment** function, available in standalone 80x modes only, automatically adjusts the receiver's gain level to compensate for changes in the bottom return signal strength, and to reduce the sensitivity of detecting low-strength, mid-water targets. If auto-adjustment is enabled, the altimeter will attempt to adjust the overall gain to normalize the bottom return signal level. The gain is adjusted after every ping by calculating a gain offset that increases or decreases the receiver gain.

Auto-adjustment is recommended only in bottom tracking applications where interfering mid-water targets are present, otherwise it should normally be disabled. Moreover, auto-gain-adjustment should only be enabled by operators with a complete understanding of the acoustics and the operating conditions in which the altimeter will be used. It should not be used in obstacle avoidance applications.

When controlled by an MS1000 PC, the auto-gain-adjustment is disabled.

# 3 INSTALLATION

The 1007D altimeter is normally mounted with clamps around its 3½" diameter housing. Two tapped mounting holes (1/4 - 20 UNC by ¾" deep) are provided on the side of the connector end-cap for orientation only and **SHOULD NOT BE USED FOR MOUNTING**. When designing the mounting bracket, be sure to allow enough room for installation and removal of the underwater connector.

## 3.1 Mounting Position

The 1007D altimeter is normally used to measure height above the sea floor and in this case must be mounted vertically with the transducer pointing down.

For special applications, the altimeter can be mounted in any desired orientation, in which case range will be measured to targets of sufficient size and reflectivity within its beam.

## 3.2 Electrical Connection

In its standard configuration, power supply and telemetry connections to the 1007D altimeter are made via a 4-pin underwater connector. Refer to the "1007 Altimeter Product Information" guide shipped the unit regarding connector pin-out details for your unit. **Make sure your power source and cable can deliver the specified start-up and continuous currents at the required supply voltage** (the peak current is only required at power-up). In particular, some power supplies may power-up too slowly to meet the start-up requirement. In this case, install an external switch between the power source and the +V connection. This switch can then be turned on after the power source is ON and stable.

The standard telemetry configuration supports both RS485 and RS232 interface type specifications and is configured by the altimeter software. In MS1000 mode, the altimeter automatically detects/configures the telemetry connection type to that used by the MS1000 host computer. In standalone 80x mode, the telemetry connection type will be set to a factory-programmed default setting if an MS1000 host is not detected during the altimeter's power-up sequence.

The standard telemetry configuration is compatible with the MS1000 Power Supply Box, which supplies power and provides telemetry conversions between RS232 and RS485 (RS232 to/from host computer, RS285 to/from altimeter).

Alternative telemetry configurations include RS422, analog output (section 5.4) or external SYNC are options that are available. These alternatives require special connector requirements and pin-out arrangements that can only be configured at the factory. Contact the factory for details.

In its simplest configurations the 1007D altimeter is either configured to:

- *power-up in 809 mode with digital telemetry* for communication with a PC running terminal emulation software or a third-party software package to process the altitude data. Altitude readings are uplinked in a number of selectable ASCII formats for direct display by the terminal emulation software.

- *power-up in 807 mode with analog-output only* for connection to a DC voltmeter. The output voltage will be scaled according the factory-configured settings for maximum range and maximum range output voltage specified when the altimeter is ordered. For instance, if the altimeter is configured to output 10V at 100m maximum range, the range scale will be 10m/volt.

In its most versatile configuration, the 1007D altimeter with digital telemetry is controlled by a PC running MS1000 software. The following figure shows a typical 1007D/MS1000 setup. A standard serial modem cable connects the MS1000 Power Supply box to a PC running MS1000 software. Refer to the appendix regarding head cable wiring. Further information regarding installation and usage can be found in the MS1000 PC software's built-in help menu and in the MS1000 Operator’s Manual.

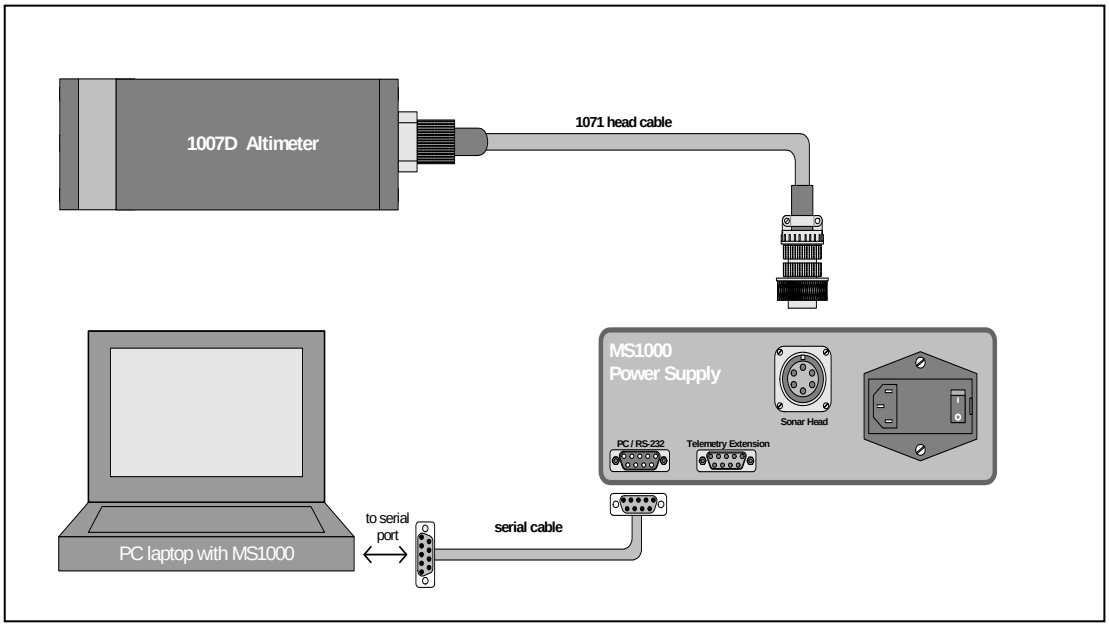



Figure 3.1 Typical 1007D Connection to MS1000 PC

## 3.3 System Checkout

After the system has been properly connected to a power supply and to an external PC (or DC voltmeter for analog only versions), it should be tested in 2 stages:

1. With the unit OUT of the water, turn on the power supply, and observe the following:
   – over-range output (time = 0.0usec or empty range field) received by the external PC. For analog output, the over-range output level +/- 0.05V should be measured by the DC voltmeter.
   – If possible, confirm that supply current is between 150 and 450 milliamps.
2. If all of the above appears normal, the system should be tested in water of known depth within the unit's minimum

and maximum range. With the system in the water and pointed toward the bottom, turn on the power and confirm the following:

- The output reading corresponds to the water depth.
- The output reading is steady.
- The output reading decreases as the unit is lowered.

*Note that the unit must be lowered by at least as much as the current resolution of the altimeter to see a change.*

## 3.4 Deployment

The Model 1007D altimeter is designed to operate in depths up to 3000 meters. To prevent improper operation and/or damage to the unit, protect the transducer face from contact with any surface or foreign object.

The 1007D's standard aluminum housing is anodized to prevent corrosion. However, for extended immersion in salt water, it may be necessary to use sacrificial zinc anodes.

## 3.5 Maintenance

The only routine maintenance required for the 1007D altimeter is to keep the transducer face clean using mild detergent.

The unit should only be opened by qualified personnel at the factory or authorized service center. Any attempt to do otherwise will void the warranty. Contact the factory for repair or replacement of faulty or damaged units.

# 4 TELEMETRY

The standard 1007D altimeter initially communicates with an RS232/485 asynchronous serial interface for compatibility with MS1000 systems. The power-up auto-detect feature attempts to detect the presence of an MS1000 host by switching between both interface types (RS232 or RS485) over the same cable wires. If the altimeter is configured for a standalone (80x) mode, the search for an MS1000 host ceases about 10 seconds after power-up, and the standalone mode is entered with the interface changing to the fixed interface type and baud rate specified by the factory default settings. Once the standalone mode is entered, the interface and baud rate remain fixed until the unit is powered down. If the altimeter is specifically configured in MS1000 mode only, the standalone mode is not entered, and the unit continues to search for an MS1000 host.

For special customer requirements, an RS422 interface is available, requiring the altimeter be fitted with a minimum 6-pin connector.

By definition, the 808 and 809 digital communications are full-duplex. This is the case when the telemetry interface is configured as RS232. However, the 1007D's RS485 telemetry interface configuration is optimized for half-duplex MS1000 solicited protocols and full-duplex RS422 is not directly supported. To use RS422, the 1007D should be configured as RS485 and the external computer should employ the following procedure to control pinging and issue commands in standalone modes:

a) Issue XOFF (Ctrl-S) character to the altimeter, immediately after the end of next altitude string output by the altimeter. This will pause pinging and data up-link.

b) Issue the desired command string to the altimeter, then wait for and process acknowledgment from the altimeter (if any).

c) Issue XON (Ctrl-Q) character to the altimeter to resume pinging and data up-link.

The serial communications settings for digital communications in all modes and protocols are 8 bits/character, 1 start bit, 1 stop bit, and no parity. A standard default baud rate of 9600 bits/second is programmed at the factory. Consult the factory if a different default rate is required.

## 4.1 808 Mode Messages

This section outlines the uplink and downlink messages recognized in 808 mode.

### 4.1.1 Uplink Messages

Range data is output from the altimeter after every ping, in the following ASCII format:

+*ddddd* CRLF

where "*ddddd*" is the two-way time of the acoustic echo of the first return. It is always 5 characters long, with leading zeros as required. This time is in units of 11.3932 μseconds and can be converted to depth by:

depth = *ddddd* * 11.3932 * sound velocity / 2000000

The leading '+' sign can be used to detect the start of the output data string. When no valid reply has been detected or the depth is greater than the maximum range, the value "*ddddd*" will be zero. The line of characters is terminated by a carriage-return, line-feed.

### 4.1.2 Downlink Messages

The following ASCII single-character commands are recognized by the altimeter configured for 808 mode operation:

| | |
|---|---|
| Ctrl-S (XOFF) | Pause |
| Ctrl-Q (XON) | Resume |

***NOTE:*** ***Because the telemetry is not true full duplex in RS485 mode, these messages must be sent immediately after uplink range messages are received. Downlink will be ignored while uplink is progress.***

## 4.2 809 Mode Messages

This section outlines the uplink and downlink messages recognized in 809 mode.

### 4.2.1 Uplink Messages

The 1007D altimeter outputs the following ASCII character strings in 809 mode:

| | |
|---|---|
| 'S'*frrrrlll*<CRLF> | range in 0.125m units |
| 'S'*fssssslll*<CRLF> | range in samples |
| 'S'*fttttttlll*<CRLF> | range in microseconds |
| '$SDDBT,*x.x*,'f',*x.x*,'M',*x.x*,'F*'*hh*<CRLF> | range in NMEA format ('*Depth Below Transducer*')<br>- only data for the current units selection will be output |
| 'P'<CRLF> | Power on reset completed, ready for command |
| 'I'<CRLF> | Illegal command or parameter error, command ignored |
| 'X'<CRLF> | serial RX transmission error, command ignored |

where:

*f* = 1…4 indicating current maximum range setting

*rrrr* = range in 0.125m units (0…1600); a "0000" indicates no return was received.

*sssss* = range in samples; a "00000" indicates no return was received.

*tttttt* = range in microseconds; a "000000" indicates no return was received.

| | |
|---|---|
| *lll* | = signal level (0…255), output only in fixed gain modes |
| *x.x* | = range in meters, feet, or fathoms (no leading or trailing zeros); blank field indicates no return was received. Only the range units currently selected will be filled. |
| *Hh* | = NMEA ASCII hex value of the 8-bit checksum of the exclusive OR of all characters after '$' and before '*'. |

### 4.2.2 Downlink Messages

The following table of ASCII strings are recognized in 809 mode. Those designated as "new" are not part of the original 809-telemetry specification and generate a CRLF-terminated echo in acknowledgment.

| ***Msg.*** | ***new*** | ***typical default*** | ***Description*** |
|---|---|---|---|
| 'C'*t* | | '1' | detection threshold:<br>*t* = '0'-auto, '1'…'8'-fixed, with threshold 10…80% of maximum |
| 'D'*d* | √ | '2' | detection method: *d* = '0'-first, '2'-peak |
| 'F'*f* | √ | '1' | output format: *f* = '0'-std., '1'-NMEA, '2'-samples, '3'-usec |
| 'G'*m* | √ | '1' | TVG Auto Gain Adjust Mode:<br>*m* = '0'-disabled, '1'-DC offset |
| 'K'*xxxxx* | √ | '00002' | minimum gap width in 1cm units: *xxxxx* = '00000'…'16000' cm |
| 'L'*xxxxx* | √ | '00002' | minimum valid return width in 1cm units: *xxxxx* = '00000'…'16000' cm |
| 'M'*xxxx* | √ | '3000' | custom 'R0' maximum range in 10cm units: *xxxx* = '0000'…'5000' |
| 'N'*xxxx* | √ | '0007' | custom 'R0' minimum range in 10cm units: *xxxx* = '0000'…'5000' |
| 'P'*x* | √ | '4' | xmit pulse width: *x* = '0'…'9', with pulse width = (*x* + 1) * 50µs. |
| 'Q'*xxxxx* | √ | '16000' | maximum resolution in samples: *xxxxx* = '00238'…'16000' |
| 'R'*x* | | '2' | maximum range: *x* = '1'-20m, '2'-50m, '3'-100m, '4'-200m, '0'-custom R0 |
| 'S'*x* | √ | '0' | NMEA o/p scale: *x* = '0'-meters, '1'-feet, '2'-fathoms |
| 'T'*x* | √ | '1' | xmit gate: *x* = '0'-listen only, '1'-XMIT1, '2'-XMIT2, '3'-XMIT1+XMIT2, '4'-FTX |
| 'U'*xx or* 'U'-*xx* | √ | '00' | TVG fixed gain offset: *xx* = '-99'..'99' offset in 0.5dB units |
| 'V'*xxxx* | √ | '1463' | assumed sound velocity: *xxxx* = '1400'…'1600' m/sec. |
| 'W'*xx* | √ | '01' | range window: *xx* = '01'…'99' percent of current max range setting; '00' = disabled |
| 'X'*x* | √ | '1' | transmit power select: *x* = '0' - low, '1' - high |
| 'Y'*xxxx* | √ | '0050' | minimum ping repetition period: *xxxx* = '0050'…'9999' msec |
| '-'*x* | √ | n/a | return current setting: *x* = 1st char of one of the command strings listed above |
| Ctrl-S | | n/a | pause |
| Ctrl-Q | | n/a | resume |

**NOTE: Because the telemetry is not true full duplex, these messages must be sent immediately after uplink range messages are received. Otherwise collisions with uplink telemetry may occur. Downlink will be ignored while uplink is in progress.**

These commands are detailed in the section below:

**'-'*x*** *– QUERY*

This command returns the current setting specified by ***x***, the first letter of one of the commands listed in the table above in 'C'…'Y'. For example, the acknowledgment to the command string '**-V**' is '**V*xxxx***' where ***xxxx*** is the current assumed sound velocity. In some cases, the current setting returned may be the *actual* setting used by the altimeter, instead of the setting last *issued* by the host. For instance, the acknowledgment to the command string is string '**-Q**' is '**Q*xxxxx***' where ***xxxxx*** is the *actual* resolution in samples currently used, as opposed to the *maximum* specified by issuing the '**Q*xxxxx***' command string. Note that if the altimeter is paused, that any new altimeter settings are not fully processed until the unit resumes pinging - always wait until the 1007D resumes pinging before issuing the QUERY command.

**'C'*t*** – Set Threshold

where ***t*** = '1'…'8', corresponding to a fixed threshold 10…80% of full-scale signal level, respectively. A value '0' enables the Auto-Gain-Adjust mode, where the gain is adjusted every shot according to the method selected by the *Set Auto-Gain Mode* command.

**'D'*d*** – Select Bottom Detection Method

where ***d*** is one of:

'0' *first return* (for obstacle avoidance applications)

'2' *strongest return* (for bottom detection applications)

**'F'*f*** – *Select Range Output Format*

This command selects the format of the range output string, where ***f*** is one of:

'0' legacy 809 format and scaling

'1' NMEA - "Depth Below Transducer"

'2' factory test mode (time in A/D samples)

'3' factory test mode (time in microseconds)

### **'G'*m*** – *Set Auto-Gain-Adjust Mode*

This command selects the TVG adjustment method used if auto-gain is enabled by the *Set Threshold* command. ***m*** is one of:

'0' Disabled (regardless of the *Set Threshold* command setting)

'1' Add or subtract a flat offset to shift the TVG curve up or down.

The performance and stability of the Auto-Gain-Adjustment is strongly dictated by:

- Settings that affect the ping rate (e.g. *Set Range* command)
- Bottom Detection Method used (*Set Detection Method* command)
- Deployment conditions (acoustic noise, multipath, turbulence, water column sediment, etc).

**'K'*xxxxx*** *– Set Minimum Gap Width*

***'L'xxxxx*** *– Set Minimum Return Width*

Sets the current profile return and gap widths where ***xxxxx*** is a five character ASCII value in the range from '00000' to '16000' (with leading zeros as required) representing the distance in 1 cm units. The altimeter performs profiling on ping data to determine candidates for bottom detection. An acoustic 'return' is said to be valid if it exceeds a minimum width and separated by at least a minimum gap between other 'return's at shorter range.

**'M'*xxxx*** *– Set Custom Maximum Range*

**'N'*xxxx*** *– Set Custom Minimum Range*

These commands set the range limits for the custom range setting 'R0' selected by the *Set Range* command, where ***xxxx*** is a four character ASCII value (with leading zeros as required) representing the range in 10cm units. The allowed minimum range setting is between '0003' and the current *Custom Maximum Range* setting. The allowed maximum range setting is between '5000' and the greater of the current *Custom Minimum Range* or '100'. A couple caveats apply here:

i.) The minimum range will be the greater of the *Custom Minimum Range* setting and the transmit pulse length.

ii.) The effective maximum range will be limited by the transmit pulse length, the operating frequency of the altimeter, as well as the deployment conditions.

**'P'*x*** – *Set Transmit Pulse Width*

where ***x*** = '0'…'9' corresponding to pulse lengths of (***x***+1)*50μs. The operator must be aware that a pulse width setting can be made to exceed the acoustic time corresponding to the current minimum range. Care should be taken when selecting pulse lengths near the minimum range setting since the actual transmit pulse may be detected as the altitude 'return' value. Make sure the minimum range value is set sufficiently larger than transmit pulse length.

**'Q'*xxxxx*** – *Set Maximum Resolution*

This command sets the maximum resolution in samples in acquiring maximum range, where ***xxxxx*** is a 5 ASCII digit (with leading zeros as required) value in '00238'…'16000'. The altimeter will then attempt to sample the received acoustic signal at a rate *Fs*:

*Fs* = Maximum Resolution in samples / maximum range acoustic time

At short ranges the actual resolution used may be less than ***xxxxx*** to limit *Fs* to the altimeter's maximum allowed sample rate (307.2 kHz). The actual value used can be determined using the QUERY command string '**-Q**', which returns '**Q*xxxxx***' where ***xxxxx*** is the *actual* resolution in samples currently used (instead of the *maximum* resolution). See the note under the '-x' command above regarding sending the query after the 1007D restarts pinging.

**'R'*x*** – *Set Operating Range*

where ***x*** is one of:

'1' 0.75-20m

'2' 0.75-50m

'3' 0.75-100m

'4' 0.75-200m

'0' Custom: range limits set by the Set Custom Minimum Range and Set Custom Maximum Range commands.

For all range settings, the altimeter attempts to assume the best resolution possible limited by the *Set Maximum Resolution* setting and hardware limits. The actual resolution used can be determined by the '**-Q**' QUERY command.

**'S'*x*** – *Select NMEA Units*

This command selects the units of the NMEA-format range data, where ***x*** is one of:

'0' meters

'1' feet

'2' fathoms

The NMEA string output contains fields for all three units but only the field corresponding to the selected units setting will contain altitude data.

**'T'*x*** – *Select Transmit Gate*

where ***x*** is one of:

| | |
|---|---|
| '0' | none (listen only) |
| '1' | XMIT1 (normal operation) |
| '2' | XMIT2 (for factory test only) |
| '3' | XMIT1 + XMIT2 (for factory test only) |
| '4' | FTX (for factory test only) |

This command is for factory testing and **must always be set to '1'** for normal operation**.**

**'U'*xx* *or* 'U'*-xx*** – *Set TVG Gain Offset*

where ***xx*** = '-99'…'99' is the offset in 0.5dB units. This command applies a fixed gain adjustment on the received signal to allow the operator to manually increase or decrease the gain. It is effective in both the manual and automatic gain modes. In automatic gain mode however, the 1007D may reduce the effects of the entered offset since it adds in additional offset determined by the actual acoustic signal level.

**'V'*xxxx*** – *Set Assumed Sound Velocity*

where ***xxxx*** = '1400'…'1600' is the velocity in meters per second.

**'W'*xx*** – *Set Range Window*

where ***xx*** = '01'..'99' is the range window size calculated as a percentage of the *Maximum Range* setting. Entering a value of '00' disables the range windowing feature.

**'X'*x*** – *Select Transmit Power*

where ***x*** is either '0' (low) or '1' (high).

**'Y'*xxxx*** – *Set Minimum Ping Repetition Period*

where ***xxxx*** is '0050'…'9999' milliseconds. The actual repetition rate will be a function of many of the other settings, but will be no less than the setting issued by this command. This setting is particularly useful to reduce the ping rate in conditions of significant multipath.

# 5 OPTIONS

## 5.1 Hardware Hold-off

An optional feature that allows hold-off of the 1007D pinging for ping rate control.

In the standalone 80x modes this is hold-off/trigger feature that functions the same as in older 80x sounders. It is available as a TTL compatible input signal. The altimeter samples this hold-off input signal before the start of each ping and will start the next ping if de-asserted (left floating or set to +5V). Pinging will be paused while the hold-off input is pulled down to zero volts. However, during this time the altimeter can still process incoming messages.

## 5.2 External Synchronization

In MS1000 mode, this is a signal compatible with the MS1000 system synchronization method and can be used to connect to one or more MS1000 altimeters or scanning sonar heads in order to synchronize the pinging of all of the units. It is a TTL compatible signal that can be configured as either input, output, or bidirectional in the MS1000 PC software application.

When this option is installed, it requires that a special connector also be installed that provides extra connections for this signal.

## 5.3 Auxiliary Serial Output

An optional second serial interface is available for 1007D altimeters configured with digital telemetry, to provide an additional output of altimeter data. This option provides a low-latency altitude digital data output for vehicle control from a 1007D altimeter operating in MS1000 mode.

The interface type (RS232 or RS485) and settings are normally configured at the factory to RS232, and 9600, 8 bits/character, no parity, 1 start bit, 1 stop bit. The data format is identical to the factory-configured default 809 format while operating in 807, 808, or MS1000 modes. In 809 mode, the current 809 format will be used. Consult the factory if a different interface type, default baud rate, or format is required.

This option also requires that a special connector be installed that provides extra connections for this interface.

## 5.4 Analog Output

An optional 807-type analog output is also available for 0…10V range data output to a DC voltmeter or a data acquisition system, and is active in all operating modes (807, 808, 809, MS1000). This output requires two connector pins that can either replace the two telemetry signals (for a 4-pin connector), or special ordered along with the digital telemetry as part of a special connector requirement (minimum 6 pins).

The default over-range output is 10.24V. Special analog output scaling and over-range voltage specifications can be factory ordered. On power-up or reset the output voltage is initially zero volts.

The analog output scaling (in volts/meter) is linear with 0V corresponding to zero range and 10V full scale analog output corresponding to the altimeter's maximum range setting, which can be fixed or adjustable depending on the altimeter's operating mode:

| | |
|---|---|
| 807, 808 mode: | maximum range is fixed to pre-programmed default |
| 809 mode: | maximum range is programmable |
| MS1000 mode: | maximum range depends on display scale selected - full scale output voltage corresponds to the selected range scale. |

The analog output of the altimeter is capable of supplying up to 10 mA at 10 volts. For maximum accuracy, the load on the output should be kept as low as possible. This is especially important when the altimeter is operated on a long cable.

## 5.5 Altimeter reconfiguration utility

ALTCONFIG is an optional Windows PC application for re-configuring numerous default settings in the Model 1007D Altimeter, such as:

operating mode (807, 809, MS1000)

digital telemetry interface type (RS232, RS485)

analog output scaling (if available)

807-mode fixed settings (e.g. range, pulse width, sound velocity, etc).

Reconfiguration of default settings is particularly useful for:

- Porting the 1007D among applications with different measurement and interfacing specifications.
- The evaluation/selection of various 807-mode configurations for standalone fixed range analog-output applications.

ALTCONFIG will only work on 1007D altimeters that have digital telemetry interfaces i.e. analog-output only configurations cannot be used with ALTCONFIG. Settings are either menu-selectable, or chosen from among a collection of default settings stored in configuration files.

Contact Kongsberg Mesotech or your local distributor for further details.

# 6 TIPS FOR SUCCESSFUL ALTIMETRY

The 1007D altimeter should normally output consistent, reliable altitude readings within the altimeter's usable range limits providing it has been properly installed, set-up, and deployed. However, under certain conditions operational and environmental factors can conspire to compromise measurement reliability, resulting in erratic and/or frequent over-range measurements. Reliability can therefore be improved by first examining the application's deployment geometry and water conditions, then applying judicious modifications to the deployment strategy, and/or to the altimeter settings.

While a diagnosis of all possible deployment scenarios is beyond the scope of this document, the following table describes some of the more common causes and possible solutions.

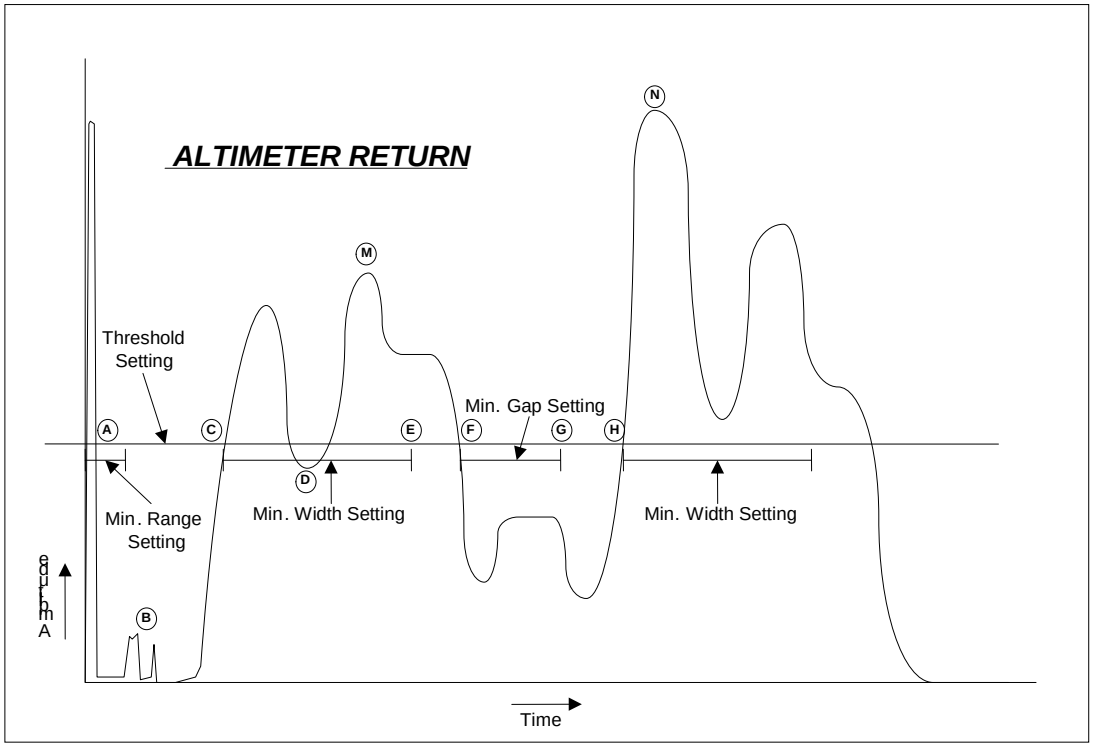
| ***Cause*** | ***Possible Solution*** |
|---|---|
| *The sea-bottom or target is outside the altimeter's beam or usable range.* | Re-orient the altimeter towards the target. The 1007D Altimeter's usable range will depend on its operating frequency. e.g. 300m at 200kHz. |
| *The sea-bottom or target is outside the minimum and maximum range settings.* | Adjust the *minimum*, *maximum range* settings accordingly. Note that when operating with an MS1000 PC, the *maximum range* will be the lesser of the *maximum range* setting and the display range setting. |

| ***Cause*** | ***Possible Solution*** |
|---|---|
| *The acoustic returns from the sea-bottom or target are too narrow or weak.* | Decrease the minimum threshold and/or the minimum return width and/or increase the TVG gain offset. For long ranges a longer transmit pulse length may be required. Target strength will depend on its shape, size, composition, & texture, as well as its location & orientation with respect to the altimeter's beam. If necessary, re-orient the altimeter to minimize the acoustic grazing angle to the target/bottom. |
| *Acoustic noise or spurious additional targets are being detected outside the range window.* | This may be seen as erratic altitude measurements due to noise, mid-water targets, or multipath interference. These can be filtered out by judicious adjustment of the *minimum, maximum range*, increasing *the minimum threshold*, and decreasing the *TVG gain offset*. Select the "*peak return*" decision method for bottom tracking applications.<br>If necessary, re-orient or relocate the altimeter away from nearby objects. |
| *Large discontinuities in the bottom.* | Increase the range window to accommodate anticipated gradients. |
| *Multipath interference* | Reduce the altimeter ping rate to reduce the effect of multipath. Select the "*first return*" decision method for bottom tracking applications. |
| *No echoes received due to air-bubbles on transducer face.* | Keep transducer face clean and free of air bubbles. If necessary, use a mild detergent. |

# 7 APPENDIX - 1007D ALTIMETER ALTITUDE DETECTION ALGORITHM

The 1007D is a digital altimeter used in several applications such as bottom profiling and forward-looking obstacle avoidance deployments. This appendix describes the methods used to determine the altitude/return values from the sampled sonar data.

The following figure shows a typical altimeter return signal:



The altitude extraction software starts processing the sonar data from range (time) 0. At the start of the ping, at point **A**, there is a large transmit pulse which will be ignored by the altitude detection software. The software starts looking for a target return starting after the end of the transmit pulse is over and also after a user-specified minimum range parameter. If the user specifies a minimum range less than the range corresponding to the transmit pulse length, then the pulse length value will be used as the minimum range. Otherwise the user value is employed. This parameter can also be used to eliminate unwanted returns from objects near to the altimeter (e.g. hulls, chains etc.) by setting the value beyond the range of these objects. However, care must be taken to not set the value too high so as to miss desirable returns.

A user-specified threshold parameter is used to set the level above which the sonar data will be detected as returns. This is usually set high enough so that small unwanted targets and noise (such as at **B**) do not become detected as returns.

Return samples are then evaluated proceeding to longer ranges. There may be low-level returns and noise that are ignored because they are below the threshold. At some point **C** the signal rises above the threshold at the start of a potential return value. This return is qualified to meet a minimum width as determined by a user-specified minimum width parameter. After point **C** is detected, the program evaluates the sample data in the width interval following the first sample over the threshold (over the interval **C** to **E**). Provision is included so that some samples may actually fall below (low) the threshold **D**, but the majority of samples over the width must be greater (high) than the threshold. If the majority is greater, then the return is flagged as a valid return and its peak value **M** is recorded as well as the range **C**. If the tested return is not valid, then the search for a return resumes at the first sample after **C**.

If the return is valid and the profiling algorithm parameter is set to FIRST RETURN then profile detection terminates and the value **C** is taken as the altitude and **M** is taken as the amplitude.

If the algorithm is set to PEAK RETURN, the return just validated is saved as a potential altitude and the search for further returns continues after **F**. In order to help distinguish between distinct returns, the software first looks for an 'absence' of return signal where the level solidly drops below the threshold level for a specified distance. This distance is controlled by the minimum gap parameter. The signal cannot be above the threshold anywhere in the gap. As shown in the figure, the gap will probably not be right after the width test - the program will continue to search for the gap until one is found **F** to **G**.

After the gap is found, the program resumes looking for another return after the point G, using the same threshold value and width checking as for the first return. A buffer of up to 30 potential altitudes can be built up in the PEAK RETURN mode.

Once all potential returns have been found to the end of the ping, the program then chooses the altitude value from the return that has the highest amplitude. Referring to the figure above, a second return was found at **H** with an amplitude **N** - the program would then use the altitude **H** with amplitude **N**.

Care must be used when employing the PEAK RETURN mode. This mode is not appropriate when the desired altitude is the first return and it has an amplitude less than later returns or when the gain is increased so that normal sonar background noise becomes a level higher than the threshold (especially near the end of the ping with the increase in TVG. This noise will probably can easily be detected and returned as altitude in the PEAK RETURN mode.

The additional maximum range parameter can be set to limit the maximum range at which the search for returns in the data will stop. When this value is less than the range setting, no sonar samples beyond that range will be evaluated as possible returns. This may be useful in some situations when there are unwanted targets (real targets or noise) at ranges much larger than the actual altitude being measured.

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