

STM-3

Surface Station



Technical Reference Manual

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CAUTION: Prior to using the Surface Station with a Desert Star System you must first install the Sealevel Drivers to the computer that the Surface Station will be working with. Without following this initial step the system WILL NOT work!

1. Introduction

The STM-3 is a surface station that is designed for use with the PILOT™ short baseline tracking system and the AquaMap™ long baseline precision sea floor survey. This surface station is used and tested with a Microsoft Windows XP machine. The DiveBase surface station software, a windows application, displays the target information. The STM-3 is available in four different setups: STM-3, STM-3V, STM-3H, and STM-3VH.

Prior to using the frame grabber you must install the drivers from the CoolGear website; if you do not then your pc may malfunction!

- The STM-3 is designed for open boat and 'vessel of opportunity' applications. It is housed in a rugged, splash proof carrying case. The STM-3 can be powered by its internal batteries or external line power. The STM-3 is most suitable for DiveBase PILOT or when you do not need the ability to capture video (still imagery) or need the high powered version.
- The STM-3V is the video capable version. It has a frame grabber for still imagery built in. You would connect your device via the RC jack on the STM-3V. Please refer to the DiveBase Seafloor manual for further instructions on how to obtain imagery.
- The STM-3H is the high powered version of the STM-3. This setup is in conjunction with the high powered versions of the PILOT or Aquamap systems.
- The STM-3VH is simply a high powered video capable version. It has the abilities of the STM-3V and STM-3H.



Figure 1: The STM-3V Surface Tracking Module For Permanent Installations

2. Unpacking The Surface Station

Please ensure that your STM-3 shipment contains these components.

STM-3 Component List

- 1 ea. model STM-3 surface station
- 1 ea. ACDC-U universal switching power supply
- 1 ea. USB to PC cable
- 3 ea. TDCR-S50-40 sonar transducers
- This manual

An STM-3 shipment should contain these components.

Both stations also require a personal computer running Microsoft Windows XP and the DiveBase software. These items are not a part of the station itself, and must be purchased separately. They are however included in a full system.

Please contact Desert Star Systems immediately if you are missing any components.

3. Surface Station Installation And Activation

The STM-3 surface station forms the surface station.

- Model STM-3 is our standard surface station. The STM-3 is housed in a splash proof carrying case. The station travels well, withstands considerable abuse and can run on its own battery power or external AC power.

To connect the surface station to the computer you need only to connect the USB cable between the two. The STM-3 will automatically run off of its internal batteries if a power cable (provided) has not been attached. CAUTION: Some ship A/C power systems are noisy. The electric noise of these systems can interfere with sonar operations. The DiveBase noise test functions let you check the noise levels seen by the sonar system. Use them if you suspect a problem.

*Prior to powering on, you must first install the sealevel drivers

3.1. Surface Station Sonar Transducer Installation

The STM-3 surface stations can be connected to up to three sonar transducers. These transducers serve as the reference for navigation and the antenna for communication. Proper mounting of the transducers is essential. If the transducers are allowed to swing about, survey accuracy is degraded. If transducers are blocked by obstacles, navigation data may not be available.

- For short baseline surveying, connect two or three ship-board mounted sonar transducers to the surface station. The surface station determines the location of the divers by measuring the distance from each surface station transducer to the diver. In general, you will connect three sonar transducers. However, the use of two sonar transducers is sufficient if dive operations are restricted to one side of the baseline. Always use connector SONAR #1 for the first transducer, SONAR #2 for the second transducer and SONAR #3 for the third transducer.
- For long baseline navigation, connect just one transducer to connector SONAR #1 of the surface station. Then, use anywhere from one to four baseline stations to complete the baseline configuration. The surface station will determine the diver position by measuring the diver's distance from both the surface station transducer and the baseline stations.

Short Baseline and Long Baseline Navigation

Figure 3 gives a birds eye view of the distribution of three sonar transducers on a vessel. These transducers form a 'short baseline'.

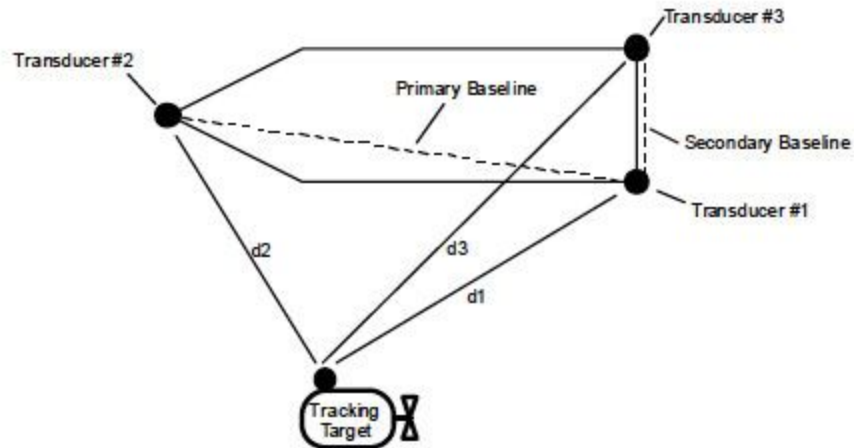


Figure 3: Distribution of Three Baseline Transducers aboard a Vessel

In this configuration: Transducer #1 is mounted at the stern port side, #2 is located forward and #3 sits at the stern, starboard side. Transducers #1 and #2 should have the greater separation and form the main baseline. Transducer #3 must always be to the right of the imaginary line starting at transducer #1 and extending towards transducer #2. The angle between the Transducer #1-#2 and Transducer #1-#3 baseline will ideally be close to 90 degrees. It should never approach either zero degrees or 180 degrees. If the three transducers are employed in something approximating a straight line, the system will not be able to determine if the diver is located to the left or the right of that line. The length of the baselines relates directly to the accuracy of the diver direction measurement. If the baseline is 3 meters long, the direction reading will be accurate to about +/- 5 degrees. If the transducer spacing is 30 meters, the direction accuracy will be about +/- 0.5 degrees. On most ship operations, the #1-#2 baseline will be longer than the #1-#3 baseline. In such cases, tracking accuracy will be better broadside to the #1-#2 baseline (broadside to the surface vessel). The accuracy of the diver distance and depth reading is independent of the surface station transducer separation distance. Distance accuracy is very precise, typically about +/- 0.15 meters. The depth accuracy depends on the sensitivity of the depth sensor in the diver station. It is about +/- 1% of the maximum depth rating of the diver station.

Short baseline tracking has the advantage that all baseline transducers are vessel mounted. Hence, there is no need to anchor the vessel in order to track - indeed the vessel could be underway. It is a great tracking method if the objective is simply to establish the position of the underwater stations relative to the vessel or if you are looking for some rough survey data. For precision sea floor survey tasks however, operate your system in 'long baseline' mode. Rather than establishing a two or three transducer baseline on your vessel, you will mount only a single transducer on the vessel. Supplement the transducer with anywhere from one to four model baseline stations. The baseline length - and hence accuracy - will no longer be limited by the size of your vessel.

NOTE: You do not need to position your transducers in this exact location; however, we do recommend that they create a right angle. Therefore, Transducer 1 can be in any of the three possible locations.

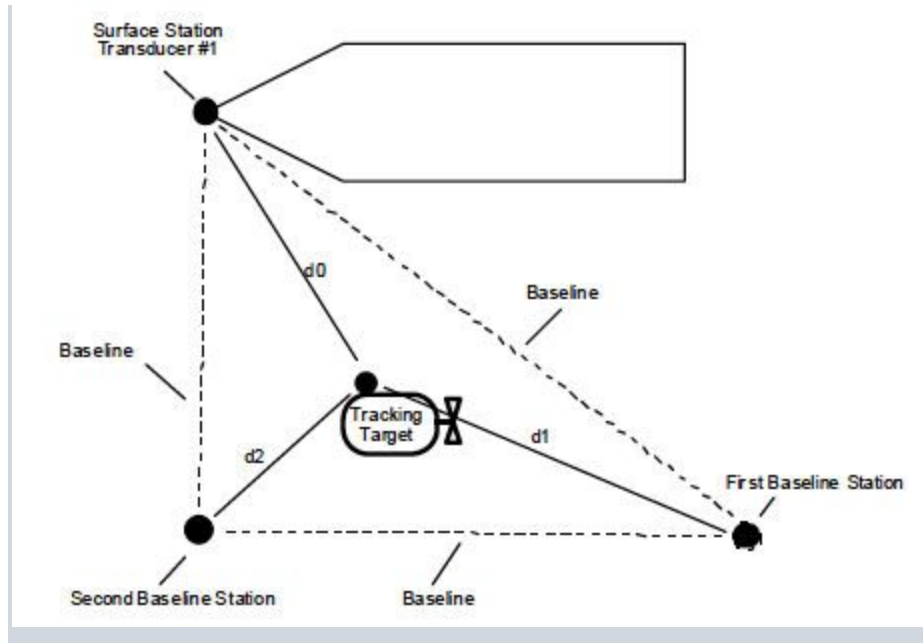


Figure 4: Bird's Eye View of a Long Baseline Configuration

Be mindful that movements of the surface station transducer relative to the baseline stations will degrade surveying accuracy. This is not a problem if the surface station transducer is mounted on a stable platform such as a dock. When using a boat, you can try mounting the transducer itself on a nearby buoy - with the cable running over to the boat. At the time of this writing, it was also planned to implement an option on the diver stations which would allow them to 'ignore' the surface station transducer position. An unstable surface station transducer would thus not reduce the accuracy of diver station position measurements.



Figure 5: A Sonar Transducer is lowered over the side of the Surface Vessel

The most common method of mounting the surface station sonar transducers is shown in figure 5. The cabled transducer is attached to a load carrying (strain relief) line and weighted down with a lead weight of about 5 kg (10 pounds). The line is attached to the top U-bolt of the transducer cage, the weight to the bottom U-bolt. The transducer is then lowered over the side of the vessel. This mounting method is fast and does not require any special engineering. The weighted transducer is kept in the proper 'cable up / transducer head down' orientation by the weight. The approach lends itself to anchored operations as well as live boat operations as long as the weight and line strength is dimensioned properly to keep the transducer down even at the highest conceivable vessel speed. Of course, caution must be taken to prevent the transducer from getting caught up in the ship's propeller.

Depending on circumstances, several other mounting techniques may be employed. A few methods are listed here.

- Lower the transducers over the side of the vessel. This technique allows you to easily adjust transducer depth to optimize performance. However, if surge or currents are present the transducers will sway and navigation accuracy will be limited.
- Mount the transducers on poles secured to the side of your vessel. Adjust the pole length to mount the transducers at the desired depth. The transducers should at least clear the keel of the vessel.
- Mount the transducers hard against the hull of your vessel. This is a very clean mounting technique that does not require disassembly when the vessel is in motion. Consider however that the hull will shield any sonar signals. Mount the transducers on the hull such as to obtain a good 'sonar view' of the environment.

- If you are operating from a small vessel such as an inflatable, your baseline may be too short to be useful. In this case, mount one transducer on the boat and the second transducer on a buoy anchored some distance away. You can run the transducer cable through the water. If necessary, attach small floatation devices to the transducer feed cable.
- Anchor your vessel properly to minimize movement of vessel based transducers.

Surface Station Transducer Mounting Techniques

To maximize performance, please also consider these guidelines:

- Many objects reflect sonar energy, especially if they contain air such as a ships hull, air tank or even kelp. A 'shadow' is thus created behind the body. A transducer located in that shadow may not pick up sonar energy. It is important to ensure that transducers are placed such that no path blockage will occur. The system can tolerate temporary shadowing, but a permanent blockage will result in loss of navigation and communication capabilities.
- There are many natural and man-made noise sources under water. All stations in a network must be able to 'hear' the other stations. This implies that the signal of the other stations must be 'louder' than the background noise. Thus, it is important to keep sonar transducers away from any interfering noise sources. Most problematic is high-frequency noise such as is generated by a boats propeller churning in the water, gas or fluids 'hissing' through a pipe, the banging of hammers and other tools etc. The system can tolerate momentary, sporadic noise. However a persistent noise source will raise a 'curtain' that the system may not be able to penetrate.
- Also consider the stability of your mounting technique. The baseline transducers are the reference for all measurements. Consequently, a shifting baseline will result in skewed position fixes.
- Practical limitations may not allow you to obtain an ideal setting for transducer mounting. However you should attempt to minimize the interfering factors.

3.2. Surface Station Activation And Operation

To use a surface station for tracking, first you must install the Sealevel Drivers to the PC that will be running the STM-3. After you have installed the drivers and deployed the system as described above, run the DiveBase software on the associated computer. Make sure to select the proper configuration file for your mission as the active configuration file (choose **Select Active Configuration File** on the **File** sub-menu), if you haven't done so already. Then select **Start Tracking NOW!** from the **Action** sub-menu.

The following tables explain the STM-3 switch and connector functions.

Connector	Function
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A/C Cable	A/C power inlet for STM-3 operation and charging. 95V - 250V / 47 Hz - 63 Hz. On the STM-3 it is labeled "95-250VAC".
Sonar #1, Sonar #2, Sonar #3	Connectors for the three cabled sonar transducers labeled as Sonar 1, Sonar 2, and Sonar 3 on the STM-3.
PC-DATA CONFIGURE	The STM-3 serial data port. Use the supplied data cable to connect to a USB port on the PC via the "COM" port on the STM-3.
GPS	The STM-3 has a "GPS" port built in. It's a USB compatible port that attaches directly to the GPS.
VIDEO DEVICE	The "video" rc jack on the STM-3V is for the video device. Please note that this rc jack is ONLY available on the STM-3V and STM-3VH.

Figure 6: The STM-3 Connectors

All versions of the STM-3 feature a status LED. The status LED is controlled by whatever application is currently running on the surface station or a transponder. Refer to the following tables to interpret the blink patterns for SmartDive. Note that the same blink patterns also apply to other AquaMap stations with a status LED, such as the baseline stations and the DS-3 diver station.

Status LED Pattern	Description
LED is OFF	The surface station is OFF, or it is not running any application software (no application software installed, surface station is connected to DiveTerm for maintenance functions)
LED is always ON	Not a valid blink pattern. A hardware problem may exist, the surface station supply voltage may be below 7 Volt.
Single short blink once per second	Surface station is running SmartDive and is operating fine.

Double blink once per second	A position fix has been received.
Triple blink once per second	Surface station self test failed. Run DiveTerm on the PC and start SmartDive from DiveTerm. Watch the error code. Look in next table to interpret the error code.
1/2 sec ON, 1/2 sec OFF	Surface station is running SmartDive, but SmartDive is not initialized yet - just start tracking. This signal may also indicate that a different application is running. Use DiveTerm to verify that SmartDive is running.
1 sec ON, 1 sec OFF	Charging of the surface station battery is under way (STM-3 only) 1 sec ON, 3 sec OFF Battery charging is complete (STM-3 only)
Other blink patterns	A different application is running on the surface station. Use DiveTerm to select SmartDive as the active application.

Figure 7: SmartDive Blink Patterns

3.3. Installing And Configuring Surface Station Software

Your surface station has standard configuration files already loaded onto it. Please do not attempt to modify these files.

The surface stations are designed to automatically start running the selected 'default application' shortly after they are turned on. Thus, during normal operation all you've got to do before deployment is to switch the station on.

4. Connectors, Indicators And Controls

The practical use of the surface station connectors, indicators and controls is explained earlier in this manual. Here is a summary of all controls for the two surface stations.

4.1. STM-3 Connectors, Indicators And Controls

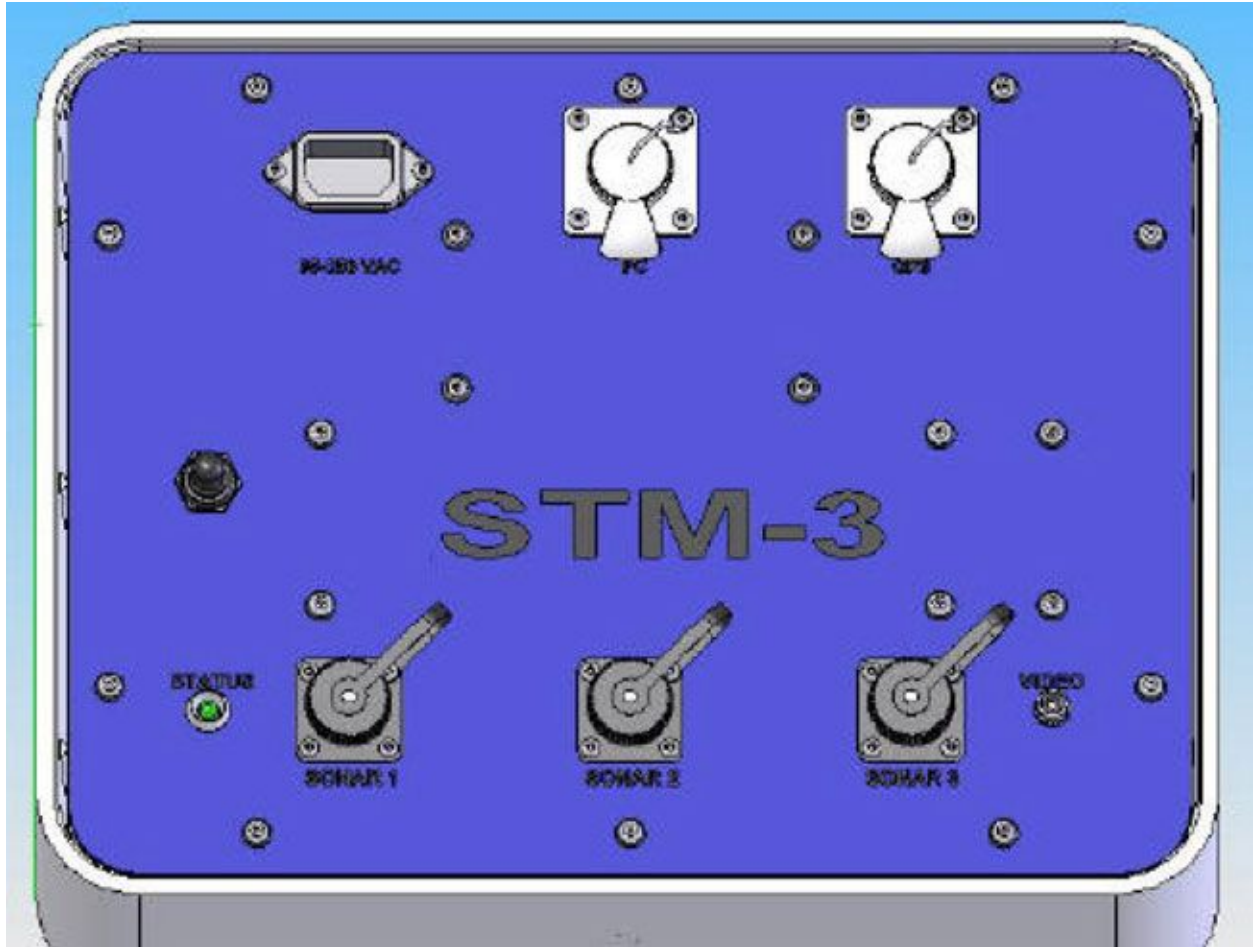


Figure 8: STM-3V Panel Layout

PC

Connect the supplied USB to PC cable from the PC port on the STM-3 to the USB port on the computer.

GPS

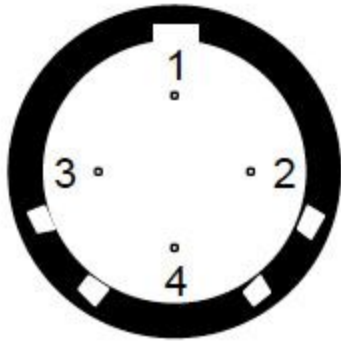
When using the GPS you attach the USB cable from the STM-3 to the GPS sensor (cable not supplied).

VIDEO

The STM-3V has the video port, an RC Jack, that works in conjunction with DiveBase software for image annotations. Connect to your video source via the RC Jack.

SONAR #1, SONAR #2, SONAR #3

Connect the three cabled sonar transducers here. If less than three transducers are used, start with Sonar #1. The connectors are four pin AMP circular connectors, reverse sex.



- 1: Ground
- 2: External Sonar Transducer
- 3: No Connect
- 4: No Connect

Figure 9: SONAR #1, SONAR #2, SONAR #3 Connectors

A/C Connector

The STM-3 uses a universal power supply and is compatible with line voltages from 95 to 250 VAC, 47 to 63 Hz. This is a universal A/C power connector. A power cable for United States standard outlets is provided. Use the appropriate cable for international use.

ON/OFF/CHARGE Switch

Use this toggle switches to select the operating mode of the STM-3.

STM-3 Mode	TRACK/OFF/CHARGE Switch
STM-3 OFF	OFF
Tracking	ON
STM-3 Battery Charge	CHARGE

Figure 10: STM-3 Switch Functions

STATUS LED

The status LED is controlled by whatever application is currently running on the surface station or a transponder. Refer to the following tables to interpret the blink patterns for SmartDive. Note that the same blink patterns also apply to other AquaMap stations with a status LED, such as the baseline stations and the DS-3 diver station. See **Figure 7: SmartDive Blink Patterns** for troubleshooting.

The status LED of the surface station or a transponder will triple blink if the self test failed. Connect the surface station or transponder to the PC and run DiveTerm. Reset the surface station or transponder. After a link is established, run SmartDive. After a few seconds, a TEST FAIL message will appear. Use the table below to interpret the error code(s) in [brackets] after the message.

Error Code	Description
1	Memory Error. The transponder memory is defective.
2	RTC Error. The real-time clock is not running. The clock battery may be low or the clock may be defective. Try setting the clock in DiveTerm.
3	VFO Error. The variable frequency oscillator, a part of the sonar transmitter and receiver, is not working.
4	ADC Error. The analog to digital converter is not working or is out of calibration. The transponder may still work, though depth sensing and battery charging may fail.
5	Depth sensing error. The depth sensor is not working or is out of calibration. The rest of the transponder may still work.
6	Sonar transmitter error. The sonar transmitter is not working, or the sonar transducer is not plugged in or is defective. CAUTION: In SmartDive V1.80X, this test may fail without a problem actually existing.
7	Sonar receiver error. The sonar receiver is not working, or the sonar transducer is not plugged in or is defective. CAUTION: In SmartDive V1.80X, this test may fail without a problem actually existing.

Figure 11: SmartDive Self Test Error Codes

5. Maintaining The Surface Station

The STM-3 requires virtually no maintenance. Make sure the connectors remain free of debris and use a dry or somewhat damp cloth to remove dust. Make sure all connectors are dry before connecting them to the station.

If the station should come in contact with significant quantities of salt water, you may have a slight chance of rescuing it by instantly removing it from the power source, rinsing it thoroughly with fresh water and shaking it dry.

The STM-3 is more resistant to water. All connectors and the panel are sealed. However, due to the open ports on the PC and GPS it is highly recommended to keep the unit out of reach of water.

6. Model STM-3 Specifications

Size:	356mm x 305mm x 152mm (L x W x H) Housed in a rugged, splash-proof carrying case
Weight:	4.08kg
Operating temperature:	0-50 degrees Celsius
Data I/O:	Controlled via USB Cable
Status Indicator:	Status LED on front panel
Microprocessor:	MC68HC11, 1 MHz
Frame Grabber:	COOLGEAR
Memory:	128 Kbyte of battery backed-up SRAM (for user data) 2.5 Kbyte of volatile SRAM (stack space) 512 Kbyte of permanent FLASH memory (for DiveCode) 24 Kbyte of EPROM (firmware storage)

Sonar transceiver:	<p>0-160 Watt RMS output in transmit mode</p> <p>RX sensitivity 7 microvolt RMS @ 6 dB S/N</p> <p>4th order continuous time bandpass filter</p> <p>Digital frequency synthesis, tunable in 0-100 kHz range, resolution 1.5 Hz</p>
Sonar transducers:	<p>Up to three external transducers. 34-41 kHz standard.</p> <p>Other frequencies available on request.</p>
Sonar range:	<p>100-1000 meters communication range, depending on sea conditions</p> <p>Extended range available on special request.</p>
Sonar modulation:	<p>Multi frequency-shift keying (MFSK)</p>
Sonar bitrate:	<p>15 - 150 bits/sec</p>
Sonar Navigation:	<p>Long baseline and short baseline principle supplemented by sensor derived depth information yields 3D position information for mobile stations Navigation range is 100-1000 meters, depending on sea conditions. Extended range available on special request. Distance measurements repeatability +/- 0.15 meters (system limit)</p>
Internal batteries:	<p>Nickel Cadmium re-chargeable cells, 12V 18Ah capacity</p> <p>Battery life about 120 hours per charge</p> <p>Battery charge time is about 24 hours</p>
External power:	<p>May be powered by external line power, 95 - 250 VAC / 47 - 63 Hz</p>

Note: all specifications are subject to change without notice