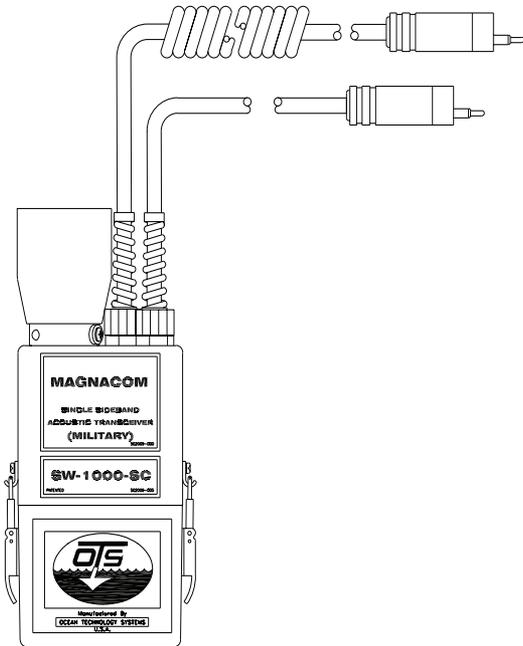




# MAGNACOM<sup>®</sup>

# SW-1000-SC

**SINGLE SIDEBAND  
ACOUSTIC TRANSCIVER  
(MILITARY)**



*“TECHNOLOGY IN DEPTH”*

*Undersea Systems International, Inc.*

*dba*

***Ocean Technology Systems***

- NOTICE -

This manual and the information contained herein are provided for use as a maintenance and operation guide. No license or rights to manufacture, produce, and/or sell either the manual or articles described herein are given. Undersea Systems International, Inc., *dba* Ocean Technology Systems hereinafter referred to as OTS, reserves the right to change specifications without notice. It is recommended that all users read and fully understand this manual before using the SW-1000-SC.

All statements, technical information, and recommendations herein are based on tests we believe to be reliable, but the accuracy or completeness thereof is not guaranteed; and the following is made in lieu of all warranties, expressed or implied, including the implied warranties of merchantability and fitness for purpose: Seller's and Manufacturer's only obligation shall be to replace such quantity of the product proved to be defective. Before using, the user shall determine the suitability of the product for intended use, and the user assumes all risk and liability whatsoever in connection therewith. Neither Seller nor Manufacturer shall be liable either in tort or in contract for any loss or damage—direct, incidental, or consequential—arising from the use of or the inability to use the product. No statement or recommendation not contained herein shall have any force or effect unless it is in an agreement signed by officers of the Seller and Manufacturer.

- IMPORTANT SAFETY NOTICE -

*(Please read before using product.)*

**It is absolutely essential that all operators are properly trained and equipped and fully understand this user's manual before attempting to use the SW-1000-SC.**

**While the SW-1000-SC provides good underwater communications, it does not change or eliminate the potential hazards of diving!**

Refer to the Library page of our website, [www.otscmm.com](http://www.otscmm.com), for a list of any changes made to this manual since its publication.

© Copyright 2003, 2011 by Undersea Systems International, Inc., *dba*

***Ocean Technology Systems***. All rights reserved.

*Specifications are subject to change without prior notice.*

506079-000 (L)

# TABLE OF CONTENTS

<b>Section 1: Introduction</b> .....	1
1.1 General.....	1
1.2 Specifications .....	2
<b>Section 2: Equipment Description</b> .....	3
2.1 General Description .....	3
2.2 Package Design.....	3
2.3 Transceiver Adjustments.....	4
2.4 Voice-Operated Transmitter (VOX).....	4
2.5 Push-to-Talk Switch (PTT).....	4
2.6 Squelch (SQ).....	4
2.7 Side Audio Volume (ST).....	4
2.8 Intercom Audio (IV) .....	5
2.9 Receiver Volume (RV).....	5
2.10 Dual Channel Selection.....	5
2.11 Earphone-Microphone (EM) Assemblies .....	5
2.11.1 EMA-SW-1SM (910274-001).....	5
2.11.2 EMA-MK24SM (910279-001) .....	5
2.11.3 EM-KMS-48 (910280-002).....	5
2.11.4 HM-1SW (910281-000).....	6
2.11.5 HM-1SW-SM (910281-001) .....	6
2.11.6 LAR5-SW Adapter (900282-006).....	6
2.11.7 EM-OTS-2 (910369-000).....	6
2.11.8 EM-OTS-2FM (910379-000).....	6
2.12 Microphones .....	6
2.12.1 ME-16R Hot-Mic® (912086-000) .....	6
2.12.2 Super Mic® Depth Master.....	7
2.13 Compatible Surface/Diver Transceivers .....	7
<b>Section 3: Adjustment and Operating Instructions</b> .....	8
3.1 General.....	8
3.2 Inspection of Equipment.....	8
3.3 Operating Procedures.....	8
3.4 Adjustments .....	9
3.4.1 Push-to-Talk (PTT) Button.....	9
3.4.2 Transmit VOX or PTT.....	10
3.4.2.1 VOX Adjustment .....	10

3.4.3	Channels .....	10
3.4.4	Squelch Adjustment .....	10
3.4.5	Volume Adjustment .....	10
3.5	Rebreather Installation .....	10
3.5.1	System Setup .....	10
3.5.2	Transceiver Installation .....	11
3.5.3	LAR V Adapter .....	11
3.6	Pre-Dive Checklist .....	11
3.7	Sleep Mode .....	12
3.8	Receiving a Message .....	12
3.9	Doffing the Diver Units .....	12
3.10	Examples of Underwater Communication .....	13
3.10.1	Calls Between Surface, Subs, or Divers .....	13
3.10.2	Calls Between Divers and Surface, Subs, or Bells .....	13
3.10.3	Calls Between Surface Units, Subs, and Bells .....	13
<b>Section 4:</b>	<b>Batteries and Charging .....</b>	<b>14</b>
4.1	Battery Installation or Replacement .....	14
4.2	Battery Charging .....	15
<b>Section 5:</b>	<b>Maintenance and Helpful Hints .....</b>	<b>16</b>
5.1	General .....	16
5.2	Periodic Maintenance .....	16
5.3	Helpful Hints .....	16
<b>Section 6:</b>	<b>Advanced User Information .....</b>	<b>18</b>
6.1	General .....	18
6.2	VOX .....	18
6.3	Squelch .....	19
<b>Section 7:</b>	<b>Basics of Sound in Water .....</b>	<b>21</b>
7.1	Background .....	21
7.2	Factors that Affect Sound in Water .....	21
7.2.1	Distance .....	21
7.2.2	Water Density .....	21
7.2.3	Water Temperature .....	21
7.2.4	Background Noise .....	22
7.2.5	Zones of Silence .....	22
<b>OTS Limited Warranty .....</b>		<b>24</b>

## SECTION 1

### INTRODUCTION

Congratulations! You have just purchased the finest, state-of-the-art, patented underwater communication system available. The Magnacom® SW-1000-SC is a 70-watt, ultrasonic, single sideband transceiver designed to allow diver-to-diver and/or diver-to-surface (and vice versa) through-water voice communications. It also allows secure hardwired intercom communications between two divers. With the optional Buddyline communication rope, up to six divers can plug in and communicate in secure hardwire mode (if secure communication is needed among more divers, custom Buddyline ropes can be made, although the result will be increased diver breathing noise). Any one of the six divers using the Buddyline can disconnect without interrupting communications. The SW-1000-SC employs advanced Digital Signal Processing (DSP) techniques, which ensure the highest quality intelligibility possible. Standard features include automatic electronic switching between VOX and PTT, dual earphones with holders<sup>1</sup>, voice-operated transmission (VOX) or Push-to-Talk (PTT) mode, dual channels, heavy-duty housing, 70 watts of power, and more! In all, the SW-1000-SC is second to none!

The SW-1000-SC is designed for use with virtually all full-face masks and rebreathers with appropriate earphone-microphone assemblies. The interface used for the earphone-microphone assembly can be designed to fit virtually any style of rebreather and/or full-face mask. See Section 2.11 for information on available earphone-microphone assemblies.

#### 1.1 GENERAL

This manual contains information about the Magnacom® SW-1000-SC underwater communication system, including most earphone-microphone assemblies and support equipment. Section 1 discusses the functions of the SW-1000-SC and provides a table of specifications. The SW-1000-SC with the EMA-SW-1SM earphone-microphone assembly is illustrated in Figure 1.

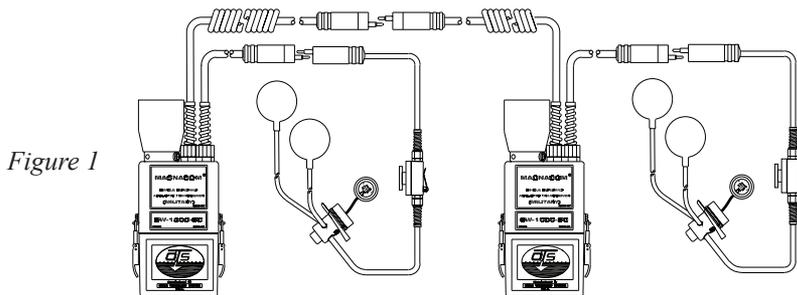


Figure 1

<sup>1</sup>Note: Some configurations employ only a single earphone.

## 1.2 SPECIFICATIONS

Nominal Range:	200 m to 3000 m
	<i>Note: Environmental variability such as that caused by biological noise and interference, thermoclines, etc., can reduce range.</i>
Acoustic Output Power:	70 watts PEP (peak envelope power) on Channel B
Audio Frequency Response:	300–4000 Hz
Receiver Sensitivity:	–110 dBv
Automatic Gain Control:	120 dB dynamic range
Adjustment Controls:	2-turn level controls located on the upper housing (must remove lower battery compartment)
Adjustment Tool:	Small jeweler-type, flathead screwdriver used to adjust 2-turn level controls
Transmitter Activation:	Voice-operated transmitter (VOX) or manual activation (PTT)
Frequencies:	Channel A: 25 KHz upper sideband (USB) Channel B: F2 (special frequency)
Battery Life:	Assuming 10% transmit time: 4 hours on high-power channel (B, the F2 frequency) or 8 hours on low-power channel (A)
Battery Type:	RB-14 NiMH battery pack, 12 V at 2 amp-hours. Includes spring contact pad
Low-Battery Indication:	Blinking red LED on upper housing and beep in earphone
Transducer:	Piezoelectric Broadband Helmholtz Resonator
Earphone:	Ceramic type (standard on most FFMs)
Maximum Depth:	300 FSW (transceiver); ear-mic assemblies may affect operating depth
Operating Temperature:	0° celsius to 60° celsius (32° F to 140° F)
Storage Temperature:	–10° celsius to 60° celsius (14° F to 140° F)
Connector Type:	Hi-Use®
Housing:	Injection-molded, high-impact, glass-filled ABS plastic
Housing Dimensions:	Height: 8.63”, Width: 3.55”, Depth: 1.80”
RCS-3U-HIU Battery Charger:	90–264 VAC, 50–60 Hz input; 14.7 VDC output; charging current 800 mA

## SECTION 2

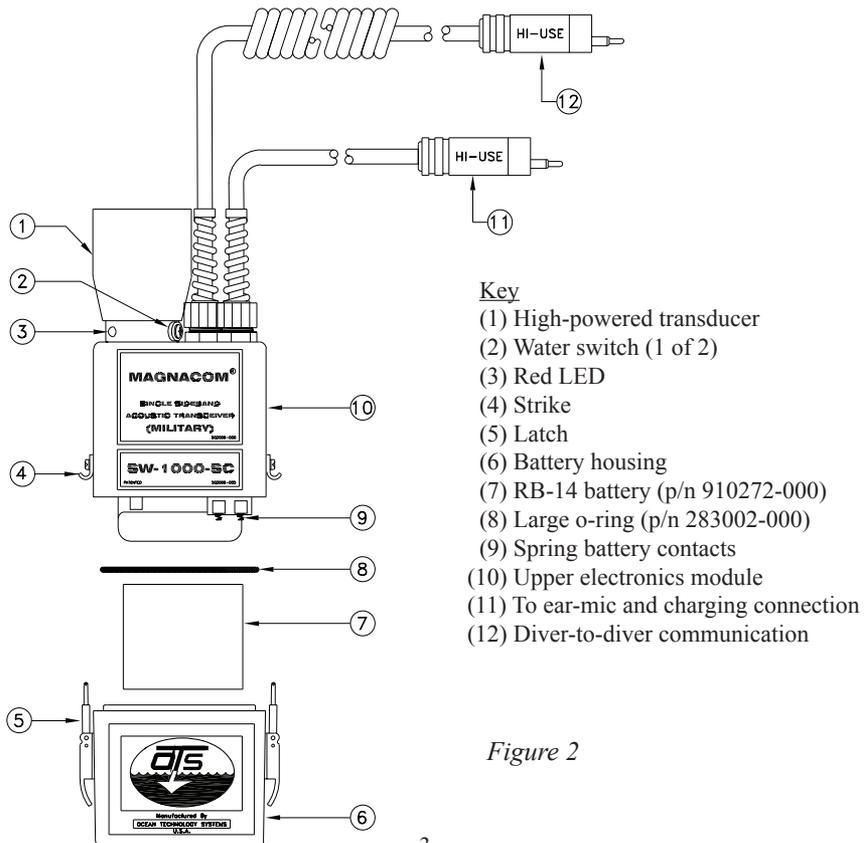
### EQUIPMENT DESCRIPTION

#### 2.1 GENERAL DESCRIPTION

The Magnacom® SW-1000-SC is housed in a watertight enclosure designed for easy belt or tank mounting. (For surface operation, our Magnacom® MAG-1001S surface station and SW-100-CD portable surface unit are fully compatible with the SW-1000-SC and offer long-range performance. *Note: Be sure to obtain a MAG-1001S or SW-100-CD programmed for the same channels as the SW-1000-SC.*)

#### 2.2 PACKAGE DESIGN

The SW-1000-SC housing is constructed of high-impact, glass-reinforced ABS plastic, which will not corrode if scratched. The housing is divided into two major parts (Fig. 2): the upper electronics and lower battery sections. An o-ring between the sections sustains the housing's watertight integrity. Stainless steel latches maintain a constant pressure that pre-loads the o-ring and prevents leakage within specified depths. (*Note: Upper and lower housings are a matched set; do not mix them up with those of other transceivers.*)



## **2.3 TRANSCEIVER ADJUSTMENTS**

The SW-1000-SC provides adjustment controls for squelch (SQ), voice-operated transmitter (VOX) sensitivity, receive volume (RV), side audio (ST), intercom volume (IV), and channel selection. Most adjustments are made on the surface, not while diving. There are two options for transmission: VOX (voice activation) and push-to-talk (PTT). The sensitivity control for the VOX is a two-turn level control located on the lower half of the upper electronics housing (Fig. 6 in Section 6). This adjustment must be made in a dry environment. To switch from VOX to PTT or vice versa, you simply depress the PTT button three times within 2 seconds. You will hear a long tone indicating VOX and a short tone indicating the PTT mode.

The switch for channel selection and all two-turn adjustments for squelch sensitivity, side audio, intercom, and VOX are located on the lower side of the upper electronics module. To access these adjustments, remove and set aside the lower battery housing and locate the controls on the electronics module's lower side. Adjustments will be discussed fully in Section 6, Advanced User Information.

## **2.4 VOICE-OPERATED TRANSMITTER (VOX)**

VOX operation provides hands-free communications. The user simply talks for the unit to transmit automatically. The VOX sensitivity needs to be set according to the diver's voice. Improper VOX adjustment may result in false transmission or inability to transmit. VOX mode can be overridden with the PTT control. Overriding the VOX mode via the PTT switch automatically switches the transceiver to the PTT mode. Tests have shown most divers favor the PTT mode over the VOX mode.

## **2.5 PUSH-TO-TALK SWITCH (PTT)**

A unique feature of the SW-1000-SC is electronic switching between the VOX and PTT modes while underwater, not only on the surface. The location of the PTT button varies among earphone-microphone assemblies, because of the many configurations of full-face masks and rebreather mouthpieces. In the PTT mode the button is simply pressed to transmit. Upon release of the PTT button, the system automatically returns to the receive mode. The PTT function overrides the VOX function. The PTT button is used also to switch the transceiver from VOX to PTT or vice versa. See Section 3.4.1, Push-to-Talk (PTT) Button, for further instructions.

## **2.6 SQUELCH (SQ)**

The squelch provides a means to limit the background noise heard by the diver. The setting will depend on the specific requirements of the dive. If long range is desired, minimal or no squelch should be used. If working close-range to other divers and/or the surface station, an increased setting can be used. (Note: An increased setting is appropriate for most SDV training operations.) For most operations a setting of one-half turn counterclockwise from fully clockwise is optimum.

## **2.7 SIDE AUDIO VOLUME (ST)**

When you transmit, you will hear yourself via your earphone. This is called "*Side Audio*" ("*Sidetone*," *ST*). It is useful for verifying that you are transmitting. Some full-face masks or helmets may have a configuration that causes feedback between the microphone and

earphones. If this occurs, a lower setting is desired. Refer to Section 3 (Adjustment and Operating Instructions) for more information.

## 2.8 INTERCOM AUDIO (IV)

Your intercom volume is on all the time. You will hear yourself or any other diver that plugs in his coiled cord as “*Intercom Audio*.” The two-turn level control allows adjustment of secure diver-to-diver intercom audio volume. A clockwise turn will increase the volume. This volume is typically set a little lower than the rest.

## 2.9 RECEIVER VOLUME (RV)

All wireless received audio is called “*Receiver Volume*” (*RV*). Each diver hears a little differently and may prefer a loud or soft listening volume. A clockwise turn of the “*RV*” volume control increases the volume.

## 2.10 DUAL CHANNEL SELECTION

The SW-1000-SC offers two different frequencies, called channels. The ability to select between channels is useful for dive teams with more than one group. The diver can select channels only on the surface, not while diving. The slide switch, on the bottom of the upper electronics housing, is labeled *A* and *B* (the two channels). See Section 3 (Adjustment and Operating Instructions) for more information.

The more efficient channel is B (F2 frequency), because transducers have a peak output over a narrow band of frequencies. The transducer output has been optimized for the special F2 frequency. F2 provides the longer range. **IMPORTANT NOTE:** Ensure all the transceivers are on the *same* channel before beginning a dive.

## 2.11 EARPHONE-MICROPHONE (EM) ASSEMBLIES

Because each full-face mask manufacturer has designed a different communication port for its masks, we have provided different earphone-microphone (EM) assemblies. Table 1 is a compatibility chart showing many of the EM assemblies available for the SW-1000-SC. *Note: If you need an EM assembly for a mask or rebreather not listed here, contact OTS or your local OTS dealer.*

**2.11.1 EMA-SW-1SM (910274-001):** The EMA-SW-1SM EM assembly is designed for all MKII AGA FFM. It consists of dual ceramic earphones, two earphone holders, an all-depth Super Mic<sup>®</sup>, a Hi-Use<sup>®</sup> connector, and a chest-mount PTT button. It is installed into the MKII AGA FFM communication port.

**2.11.2 EMA-MK24-SM (910279-001):** The EMA-MK24-SM EM assembly is designed for the MK-24 FFM. It consists of dual ceramic earphones, two earphone holders, an all-depth Super Mic<sup>®</sup>, a Hi-Use<sup>®</sup> connector, and a chest-mount PTT button. The assembly is installed into the MK-24 FFM communication port.

**2.11.3 EM-KMS-48SM (910280-002):** The EM-KMS-48SM EM assembly, for all M-48 SuperMask<sup>®</sup> FFMs, consists of dual ceramic earphones, two earphone holders, an all-depth Super Mic<sup>®</sup>, a Hi-Use<sup>®</sup> connector, and a chest-mount PTT button. The assembly is installed into the M-48 FFM communication port.

**2.11.4 HM-1SW (910281-000):** The HM-1SW consists of an HM-1 mouth mask, a head strap, a ceramic earphone, an ME-500 dynamic microphone, a Hi-Use® connector, and a chest-mount PTT button.

**2.11.5 HM-1SW-SM (910281-001):** The HM-1SW-SM consists of an HM-1 mouth mask, a head strap, a ceramic earphone, an all-depth Super Mic®, a Hi-Use® connector, and a chest-mount PTT button.

**2.11.6 LAR5-SWADAPTER (900282-006):** The LAR5-SW adapter is placed between the inhalation hose and LAR V bite-mouth DSV assembly. It is designed to allow basic words to be transmitted without the need for a full-face or mouth mask. The assembly also is fitted with a high-quality ceramic earphone.

**2.11.7 EM-OTS-2 (910369-000):** The EM-OTS-2 EM assembly is designed for all Guardian (GFFM) FFMs. It has dual ceramic earphones w/ earphone holders, an ME-16 Hot-Mic, a Hi-Use® connector, and a PTT button. The assembly is installed into the Guardian FFM communications port.

**2.11.8 EM-OTS-2SM (910379-000):** The EM-OTS-2SM EM assembly is designed for all Guardian (GFFM) FFMs. It has dual ceramic earphones w/ earphone holders, the Super-Mic (all depth, floodable, noise-cancelling microphone), a Hi-Use® connector, and a PTT button. The assembly is installed into the Guardian FFM communications port.

## **2.12 MICROPHONES**

**2.12.1 ME-16R HOT-MIC® (912086-000):** The ME-16R Hot-Mic® has a state-of-the-art 150-ohm, water-resistant, noise-cancelling microphone element designed to give you long, trouble-free use and the highest intelligibility possible. Although the Hot-Mic is trouble free, it should be maintained. Rinse it with freshwater after each use to get all dirt, debris, and salt water from the grill. Dry it with a clean, soft towel. If the element ever needs to be replaced, it is easily removed by unscrewing the two small Phillips-head screws located on its base.

Wetting the microphone does not harm it. However, the microphone element can only withstand an 8- to 10-foot depth/pressure differential. Removing your diving FFM at the back of the boat and wetting the microphone would cause no problem; but if the FFM with element dropped more than 8 to 10 feet into the water, the pressure change probably would damage the element. In tests we have taken off and replaced the FFM at 30 feet without any problem; but the pressure difference from doffing the FFM at 30 feet and descending to 40 feet may damage the microphone.

Do not allow the microphone to be submerged for more than five minutes. The hydrophobic membrane may saturate and be squeezed on the next dive, causing damage to the element. If a more robust microphone is necessary, we have other, all-depth, floodable microphone elements. However, they are not noise canceling, and their intelligibility is about 20% lower. The ME-16R Hot-Mic should be replaced yearly or sooner if it becomes damaged.

**2.12.2 SUPER MIC® DEPTH MASTER:** The Super Mic® offers patented technology\* that overcomes a limitation of other microphones. It can be used at any

**Table 1: EM Assemblies for the SW-1000-SC**

Model Number	Microphone	Earphones	Mask Type
EMA-SW-1SM (910274-001)	Super Mic	2	Divator MK II FFM
EMA-MK24-SM (910279-001)	Super Mic	2	MK24 FFM
EM-KMS-48SM (910280-002)	Super Mic	2	M-48 SuperMask®
LAR5-SW (900282-006)	Dynamic	2	N/A (rebreather)
HM-1SW (910281-000)	Dynamic	1	HM-1 mouth mask
HM-1SW-SM (910281-001)	Super Mic	1	HM-1 mouth mask
EM-OTS-2 (910369-000)	Hot-Mic	2	Guardian FFM
EM-OTS-2SM (910379-000)	Super Mic	2	Guardian FFM

depth and—unlike the Hot-Mic or many other microphones—can withstand changes in depth while submerged, remaining undamaged when a diver descends with the mask flooded (for example, on removal and stowage of the mask when switching to another air system). Its design is compact and lightweight, and—like the Hot-Mic—it has noise-cancelling properties, reducing background noises to provide clear communications. When only the highest quality of intelligibility is required, the Hot-Mic® is the preferred choice; but the Super Mic’s intelligibility is sufficient for most diving situations.

To assure clear communications when using the Super Mic, it should be no more than 1/4 inch from the corner of the diver’s mouth.

After each dive, clean the Super Mic by rinsing it with freshwater and drying it with a clean, soft towel. No other maintenance is required.

*Note: Do not press on the microphone diaphragm. Doing so may cause damage.*

It is possible for the MAG-1003D or MAG-1004HS to transmit sporadically when used with the Super Mic, especially in combination with the KMDSI M-48 SuperMask®. If this problem occurs, see Section 5.3, Helpful Hint #13.

## **2.13 COMPATIBLE SURFACE/DIVER TRANSCIEVERS**

The SW-1000-SC can transmit to and receive from other SW-1000-SC transceivers as well as the Magnacom® MAG-1001S surface unit when on the same frequency and within range. Our SW-100-CD (900369-000) is an SW-1000-SC that has been converted to a portable surface station. The small portable surface station is great for confined conditions or for working out of small boats.

\*U.S. Patent no. 7,170,822; EU patent nos. 000458351-0001, -0002, -0003, -0004, -0005, -0006.

## SECTION 3

### ADJUSTMENT AND OPERATING INSTRUCTIONS

#### 3.1 GENERAL

This section contains information for operating the Magnacom® SW-1000-SC through-water transceiver.

#### 3.2 INSPECTION OF EQUIPMENT

Upon arrival of the equipment, inspect the shipping container for dents, gouges, or any other evidence of rough handling.

The Magnacom® transceiver should be visually inspected upon removal from the shipping container. If any damage is evident, immediately file a claim with the carrier. Forward a copy of the damage claim to OTS, Santa Ana, CA. Arrangements for repair or replacement will then be made.

***NOTE: Although the Magnacom is rugged in design, care should be exercised to ensure that problems are not caused by improper handling. Store the unit in a safe, secure area after unpacking.***

#### 3.3 OPERATING PROCEDURES

STEP 1: Ensure the batteries are charged and all o-rings are free of debris and in good condition.

STEP 2: Ensure all internal settings are properly adjusted (squelch, VOX, channel, etc.). See Section 3.4 (Adjustments).

STEP 3: Connect the standard (non-coiled cord) Hi-Use® connector from the SW-1000-SC to the Hi-Use® connector on the FFM or LAR V Adapter. Standard EMA-2 earphone-microphone assemblies will not work with the SW-1000-SC transceiver. Only the assemblies designed for the transceiver will operate.

STEP 4: Immerse the diver unit in a pail of water (if testing 2 units, place each in a separate pail of water). Separate the pails to a distance of approx. 6 feet. When immersed, verify the red LED is illuminated—indicating power is activated. To activate the unit, use a paper clip, bent over and in contact w/ both water activation screws.

***WARNING: Minimal operation through-air is possible, but not recommended. Conditions may arise where transmitter amplification can occur and cause permanent damage to the unit(s).***

STEP 5: Ensuring they are on the same channel and while using the FFM microphone while the unit is still activated, press the PTT button and talk into the microphone. You should hear yourself through the other diver unit or the surface station. If using the system in the voice operation mode (VOX), speak loudly with a vowel sound such as “AH” or say the number “FOUR” to trigger the VOX. (Note: The SW-1000-SC, when first initiated, will *always* begin in the PTT mode, even if you had it in the VOX mode when it powered down.)

STEP 6: Verify your transceiver is on the same channel everyone else will be using, earphone levels are to your liking, the VOX setting is proper (unless you plan on using only PTT), and the squelch setting is appropriate for the environment and range you require. (Refer to Section 3.4, Adjustments, for assistance if necessary.)  
Note: The factory squelch default setting should be appropriate for most operations. .

STEP 7: Repeat the above procedures with any other transceiver and verify that it is operational and on the same channel.

STEP 8: After the above verification and all settings are to the diver’s liking, the batteries are fully charged, and the o-ring is installed properly and clean of debris, you are ready to dive.

**NOTE:**

- (1) The units will not sound as clear during these tests as they will in open water.**
- (2) The units will always start in PTT mode after powering down or up.**
- (3) The VOX setting typically increases in sensitivity when the mask is under pressure.**

### **3.4 ADJUSTMENTS**

The SW-1000-SC has a unique feature that allows you to adjust the VOX/PTT functions electronically, either out of the water or in the water. If you depress the PTT button three times within two seconds, you will hear in your earphones either a two-tone beep sequence or a short beep. A double two-tone beep sequence indicates the unit is going into VOX mode. A single tone indicates the system is going into PTT mode. (Note: The system requires three *distinct* presses. If the three presses are done too quickly, i.e., three times within *1* second or less, then the system may not switch modes.)

**3.4.1 PUSH-TO-TALK (PTT) BUTTON:** The PTT button serves two purposes: (1) When pressed and held, you activate the transmitter. As long as you hold the PTT button, you will be transmitting. When you release the button, your transceiver will automatically return to the receive mode. If you are in the VOX mode, you can still depress the PTT to override the VOX. This is useful if your VOX is not adjusted properly and you have trouble activating the VOX. However, if you override the VOX, then when you release the PTT button, you will still have the VOX delay

(see Section 3.4.2.1, VOX Adjustment). (2) When you click it three times within two seconds, the unit switches from VOX to PTT mode.

**3.4.2 TRANSMIT VOX OR PTT:** When power is first applied, the system defaults to PTT mode. By pressing the PTT button three times within two seconds, the system toggles between VOX and PTT modes and emits a verification tone. A two-tone sequence indicates VOX mode, and a short tone indicates PTT mode.

**3.4.2.1 VOX Adjustment:** A two-turn level control is located inside the electronics housing for adjusting the VOX sensitivity. The factory default is a one half to middle setting, which is one full clockwise rotation. The control is a two-turn device that puts its mid setting at one full revolution from fully counterclockwise or clockwise. Rotating *clockwise increases* VOX sensitivity. A rotation of one eighth is recommended for fine adjustments of either more or less sensitivity. The factory setting is usually sufficient for most voices. Remember to speak close to the microphone (less than 1/4") at higher than normal volume.

**3.4.3 CHANNELS:** To change between channels A and B, open the housing, find the slide switch located on the electronics module, and place the switch in the desired position. *Note: Channel B (the F2 frequency) is more efficient for long-range communication.*

**3.4.4 SQUELCH ADJUSTMENT:** Open the housing and locate the squelch control. A fully *counterclockwise* position *disables* the squelch. This setting is recommended when it is critical that all communications are received. This ensures reception of all signals, even those buried in background noise. Signals so weak that they are marginally detectable will never un-squelch a unit. For very long-range communication, the squelch control must be set fully counterclockwise.

If the system is operated at close range and this range will never be increased, a setting of one-and-a-half turns clockwise is good for close-quarter environments (SDV training operations).

**3.4.5 VOLUME ADJUSTMENT:** Receive (RV), side audio (ST), and intercom (IV) volume adjustments are made inside the electronics module. See Figure 6 (in Section 6).

## **3.5 REBREATHING INSTALLATION**

This section provides instructions for installation of the SW-1000-SC into a rebreather system. These instructions apply specifically to the LAR V but can be adapted for a different rebreather. Refer to Figure 3 throughout this section.

**3.5.1 SYSTEM SETUP:** Figure 3 illustrates the correct position of all components.

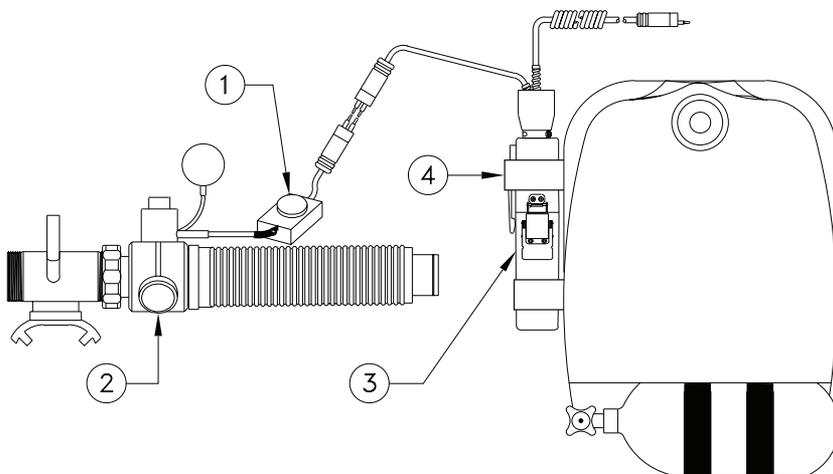
**3.5.2 TRANSCIEVER INSTALLATION:** Mount the transceiver to the LAR

V housing with straps (not supplied). Figure 3 shows the transceiver mounted to the LAR V fiberglass shell.

**3.5.3 LAR V ADAPTER:** If a LAR V Adapter is used instead of a full-face or mouth mask, install the adapter between the dive surface valve (DSV)/T-bit assembly and the inhalation hose. See the instruction sheet provided with the LAR V Adapter for more information.

### 3.6 PRE-DIVE CHECKLIST

1. Fully charged RB-14 NiMH battery pack installed (Section 4).
2. O-rings in place, clamps secure.
3. Diver unit in place with transducer free of diving equipment.
4. Earphone(s) adjusted and in position.
5. Hi-Use® connector lightly greased and properly mated.
6. Microphone is tightly secured by screws to the bushings on the nickel wires.
7. Diver is dressed out so wires will not snag and transducer is not covered by any type of diving equipment.
8. In-water surface check:
  - a. Recheck the location of the earphone.
  - b. Submerge the transducer (diver with waterline at chest level).
  - c. Establish communication.
  - d. Ensure your dive partner's equipment is properly adjusted and wires are dressed so as not to snag.
9. Connect the coiled intercom cord to your dive partner's coiled cord and verify intercom (secure) communications.



*Figure 3: Setup of SW-1000-SC system with a LAR V rebreather*

### 3.7 SLEEP MODE

Disconnecting the e/m harness (cable) from the transceiver, with the transceiver remaining under water, results in the transceiver entering “Sleep Mode.” During this mode of operation, battery consumption is dramatically reduced—allowing the swimmer to exit the water or perform other operations not requiring through-water communications. The transceiver “wakes up” upon re-connection of the e/m cable and returns to normal operation. The remaining amount of operational time depends on the state of charge before the Sleep Mode was activated and the length of time the transceiver had been in Sleep Mode before re-activation.

#### **NOTE:**

*Your speech should be considerably slower than normal, and each word should be pronounced clearly and distinctly. Speak one word at a time instead of in flowing sentences. Do not shout, but use slightly loud conversation volume. Minimize exhalation while speaking. Your communication will be more easily understood if you are relaxed, since speech is less intelligible when a diver is anxious.*

*You should conduct a pool checkout and have more pool practice before using the system in open water. While Magnacom® transceivers provide divers with good underwater communications, they do not change or eliminate the potential hazards of diving!*

**CAUTION:** *Use any standard safe entry into the water, but be aware of the additional equipment you are wearing. The transceiver and cables should be positioned so they do not snag or hit against anything during entry. Keep a copy of this checklist handy for reference before entering the water.*

### 3.8 RECEIVING A MESSAGE

- Relax
- Concentrate on hearing.
- Try different earphone positions until the best one is found.
- Minimize exhalation bubble noise, but do not hold your breath. Most divers find that an inhalation cycle is the best time to receive a message. While off-gassing, the bubble noise makes hearing difficult (with open-circuit scuba).

### 3.9 DOFFING THE DIVER UNITS

1. Disconnect the Hi-Use® connector from the full-face mask, HM-2 mouth mask, or LAR V Adapter. Doff the rebreather.
2. As soon as possible after each dive, rinse the unit in freshwater to remove salt and other mineral deposits.
3. Although the SW-1000-SC is ruggedly constructed for long life in the marine environment, we strongly recommend that you place it in a protective carrying

case between dives and take special care to avoid damaging the transducer.

### **3.10 EXAMPLES OF UNDERWATER COMMUNICATION**

**3.10.1 CALLS BETWEEN SURFACE, SUBS, OR DIVERS:** Listen for a break in conversation if others are communicating in the area. Identify whom you are calling and then identify yourself. Continue speaking until the message is complete. At the end of each message, say “OVER” if a response is required and “OUT” if no response is required.

*Note: If using the LAR V Adapter, a limited lexicon should be used and practiced among all team members. Speech intelligibility among trained talkers averages around 40%, as verified through word list tests.*

EXAMPLE (not using limited lexicon):

DIVER A: Red Diver this is Blue Diver, do you see the wreck yet?...  
OVER.

DIVER B: Blue Diver this is Red Diver, yes I see the wreck, it’s ten yards  
to your right....OUT.

### **3.10.2 CALLS BETWEEN DIVERS AND SURFACE, SUBS, OR BELLS:**

EXAMPLES:

DIVER A: Topside this is Blue Diver, how far am I from the dive boat?...  
OVER.

SURFACE: Blue Diver this is Topside, I see your bubbles 50 feet off my port  
bow....OUT.

DIVER A: Sub, this is Blue Diver, How long before I must lock in?...  
OVER.

SUB B: Blue Diver, this is Sub, we expect you in seven minutes....  
OUT.

### **3.10.3 CALLS BETWEEN SURFACE UNITS, SUBS, AND BELLS:**

Surface units within range can communicate in open water or harbors, thereby avoiding the sometimes crowded and less private channels. Crews of submarines or bells can communicate with one another or with surface units in much the same way. We recommend that standard radio/telephone procedures be used in all communications.

### **- IMPORTANT SAFETY NOTES -**

***It is absolutely essential for all divers to be properly trained and equipped before responding to distress, emergency, and safety calls.***

***WARNING: Under no circumstances should a diver begin an ascent while holding his breath (air embolism may occur).***

## SECTION 4

### BATTERIES AND CHARGING

With the SW-1000-SC are provided one RB-14 nickel-metal hydride (NiMH) rechargeable battery pack and an RCS-3U-HIU smart charger (Fig. 4). OTS offers an optional charger, the RC-SW-6 (Fig. 5), that charges up to six RB-14 batteries at a time.

***Note: Due to the self-discharge characteristics of Nickel Metal Hydride (NiMH) batteries, they should be charged upon receipt of the unit and at least once a month to maintain service life.***

The RB-14 nickel-metal hydride battery pack has greater capacity than NiCad batteries and does not suffer from “memory effect” as does a NiCad battery pack.

*Note: The battery you receive may have specifications upgraded from what is stated in this manual. Due to advancing battery technologies, we continually upgrade our batteries and chargers. Contact OTS or your OTS dealer to find out the latest available battery and charger.*

#### 4.1 BATTERY INSTALLATION OR REPLACEMENT

To install or replace the batteries, follow these steps (refer to Figure 2 with the indicated item numbers):

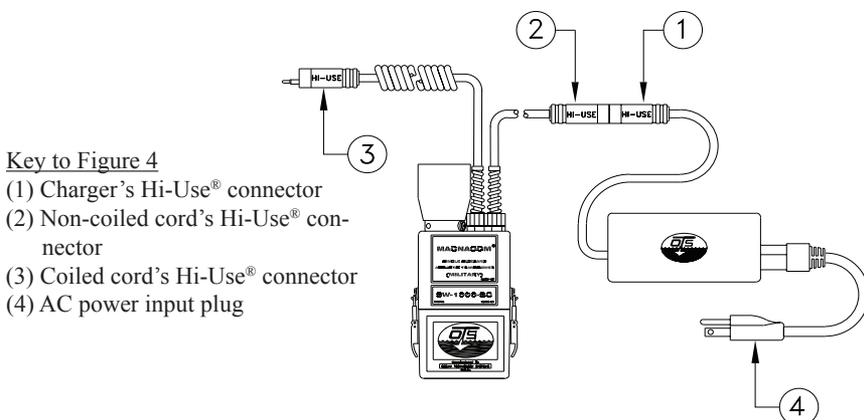
1. Locate the latches on the sides of the SW-1000-SC's lower housing (#5). Pull up on the latches simultaneously.
2. Separate the upper and lower modules while being careful not to damage the o-ring (#10 & #6).
3. If you are replacing a currently installed RB-14 battery, remove the old RB-14 from the lower housing (#7).
4. Install the RB-14 by inserting it into the lower housing of the diver unit with the contacts oriented so they connect to the springs located in the upper electronics housing (#9).
5. Verify that the o-ring (#8) is in place, lightly lubricated with a high-grade silicone grease, and free of debris.
6. Carefully mate the upper and lower housings together. Ensure that they line up evenly and that nothing is on the o-ring or mating surface.
7. Connect the latches from the lower housing (#5) to the upper strikes (#4). Pull down the latches simultaneously until fully down. Doing so will spring-load the upper and lower assemblies.
8. Look on all sides of the SW-1000-SC to verify the upper and lower assemblies appear evenly matched with no high spots. *Note: If the housing is not completely sealed, water will enter during the dive and may damage the battery and EM type selection switch.*

## 4.2 BATTERY CHARGING

To recharge the RB-14 battery pack using the RCS-3U-HIU smart charger (provided with the SW-1000-SC), connect the charger (Fig. 4, #1) to the diver unit's EM Hi-Use<sup>®</sup> connector (Fig. 4, #2) and the power input cord (Fig. 4, #4) to the AC power source (90–264 VAC, 50–60 Hz). Refer to the instruction sheet provided with the RCS-3U-HIU charger for complete charging instructions.

If using the RC-SW-6 multi-battery smart charger, connect it (Fig. 5, #2) to the diver unit's EM Hi-Use<sup>®</sup> connector, and plug the power input cord (Fig. 5, #1) into the AC power source. Refer to the RC-SW-6 user's manual for more information.

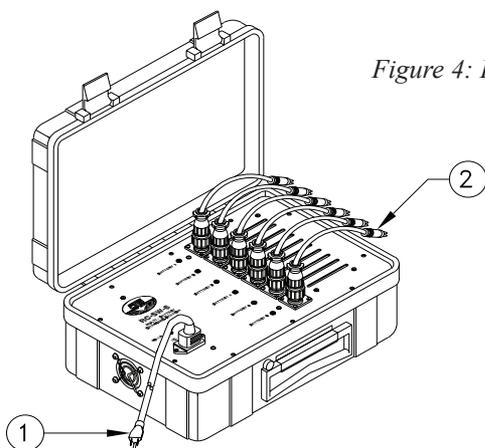
*IMPORTANT NOTE, MAG-1004HS only: Be sure to connect the charger's Hi-Use<sup>®</sup> connector (Fig. 4, #1 or Fig. 5, #2) to the SW-1000-SC's EM cable (Fig. 4, #2), not to its intercom coiled cord (Fig. 4, #3). Electrical current applied through the coiled cord will not charge the batteries.*



### Key to Figure 4

- (1) Charger's Hi-Use<sup>®</sup> connector
- (2) Non-coiled cord's Hi-Use<sup>®</sup> connector
- (3) Coiled cord's Hi-Use<sup>®</sup> connector
- (4) AC power input plug

Figure 4: RCS-3U-HIU smart battery charger



### Key to Figure 5

- (1) AC power input cord
- (2) Charger's Hi-Use<sup>®</sup> connector

Figure 5: RC-SW-6 multibattery charging station

## SECTION 5

### MAINTENANCE AND HELPFUL HINTS

#### 5.1 GENERAL

The SW-1000-SC is virtually maintenance-free and should give you many years of service. The following should be done after each day of diving:

1. Freshwater-rinse the unit to remove debris. A mild soap solution can be used, but after cleansing, rinse with freshwater.
2. Dry the transceiver with a clean towel, especially around the area of the power activation screws. Doing so will ensure the unit will shut off. Also ensure you dry the mask microphone. Note: It may take a few minutes for the unit to turn off; this is normal.
3. Store in a dry, safe area.

#### 5.2 PERIODIC MAINTENANCE

The transceivers should have the following service performed periodically:

1. Clean and lightly grease the main housing o-ring. Check the o-ring for cracks or damage. If there is any evidence, replace it. PMS: Replace yearly.
2. Keep the transducer clean, especially from grease. (Grease decreases performance.)
3. Verify the battery springs are in good order and making good contact with the battery pack.
4. If an ME-16R Hot-Mic® is being used, it should be replaced yearly or if it becomes damaged.

#### 5.3 HELPFUL HINTS

Underwater communication is a useful tool and can save lives when used properly. Training is important and a must for new users. The following are a few helpful hints. Please review and consider them when writing your training plan.

1. Conduct initial underwater training in a controlled area, such as a swimming pool.
2. Speak slowly and pronounce each word clearly.
3. If working in a pool, make sure the pool does not have a bad or noisy pump, which would release numerous tiny bubbles, reducing the range. If after a few minutes you see tiny bubbles (like carbonation) gathering on your hands or dive gear, move to a new location. If the pump is noisy, secure it during the test.

4. Make sure the microphone element is less than 1/4" from the diver's lips (unless using the LAR V Adapter or other rebreather adapter).
5. Ensure all batteries are charged before starting the dive operation.
6. Before the divers enter the water, check to make sure they have not covered the transducer with any type of dive gear.
7. Make sure all wires are dressed to avoid snags while diving.
8. Designate one diver as the lead communication diver so both divers will not be trying to answer questions.
9. Brief divers that after entering the water, especially if making a jump, they should make eye contact with the dive supervisor and establish communications (assuming you have a surface station).
10. In initial training, talk to only one diver at a time until he establishes clear communications. After the divers are comfortable, have the divers talk to each other (assuming you have a surface station).
11. It is a good idea for everyone to agree on Channel A or B before the dive starts and to ensure everyone is on that channel.
12. If you feel a thermocline, report the depth to other divers and topside. Topside should adjust the transducer depth accordingly.
13. If you are using an SW-1000-SC (or related transceiver) with a Super Mic<sup>®</sup> microphone, and especially if your mask is a KMDSI M-48 SuperMask<sup>®</sup>, you may experience intermittent transmission, resulting in broken speech communication. If this problem occurs, do the following:
  - *Intercom volume:* If the transceiver is a MAG-1004HS and will be used in through-water mode only, turn down the intercom volume to reduce or eliminate the diver breathing noise. However, if intercom communications are needed, the intercom volume will need to be adjusted appropriately.
  - *Squelch settings:* The factory setting for the squelch is based on the Hot-Mic's frequency response, which differs from the Super Mic's response in the M-48 mask. Adjusting the squelch to a higher sensitivity level will most likely maintain activation of the receiver squelch during diver speech (although more ambient noise may be heard through the receiver).
  - *Microphone position:* To ensure loud and consistent speech, grab the push-to-talk (PTT) assembly and bend it so you feel the microphone against the corner of your mouth. A rebreather does not have enough room to accommodate both the Super Mic<sup>®</sup> and the bite mouthpiece inside the M-48's mask cavity. To allow the maximum amount of speech to enter the microphone, resulting in the loudest and clearest speech possible through the intercom or through-water system, reposition the microphone against the corner of your mouth every time you spit out the bite mouthpiece. When reinserting the bite mouthpiece, gently move the PTT assembly toward your neck such that the microphone is positioned at the corner of your mouth.

## SECTION 6

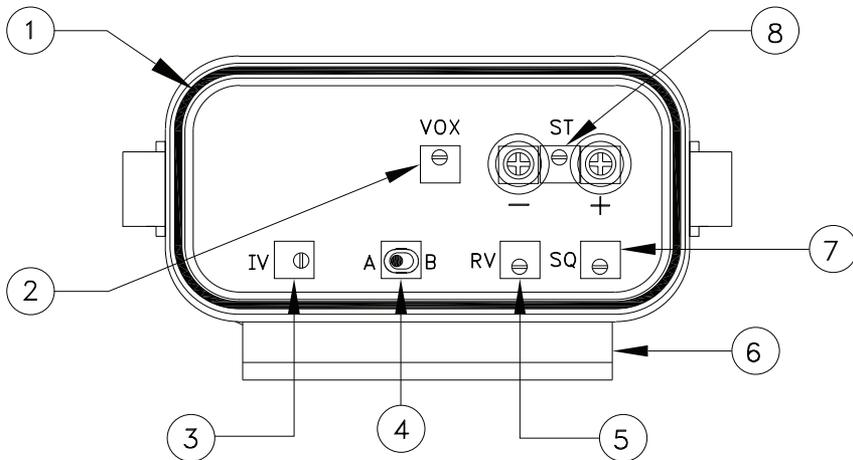
### ADVANCED USER INFORMATION

**6.1 GENERAL:** Although the SW-1000-SC is designed so that minimal manual adjustments are necessary, custom user adjustments are available. These adjustments allow the user to define sensitivities of the VOX and squelch systems, adjust listening volumes, and change channels. Because no standards for design of full-face masks have been established, virtually all full-face masks have different internal designs. Some designs have little room for microphone installation, thereby requiring a more sensitive setting. These advanced adjustments offer the user more options.

When VOX is selected, your transceiver will give you a setting that is either the factory preset or the custom user setting. If you find that you need more or less sensitivity, you can easily change the settings.

The adjustment controls are located on the inside bottom of the upper electronics module. The controls include level controls (VOX, side audio volume, etc.) and a slide switch for changing channels (Fig. 6).

**6.2 VOX:** The VOX sensitivity control is labeled “VOX” on the bottom of of



#### Key

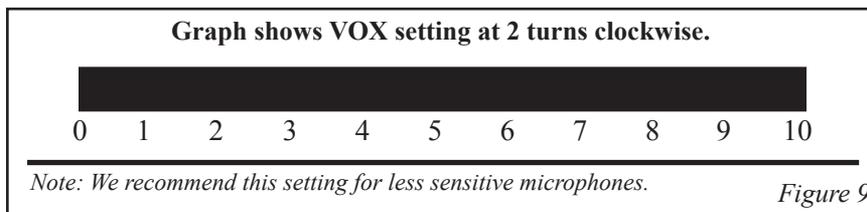
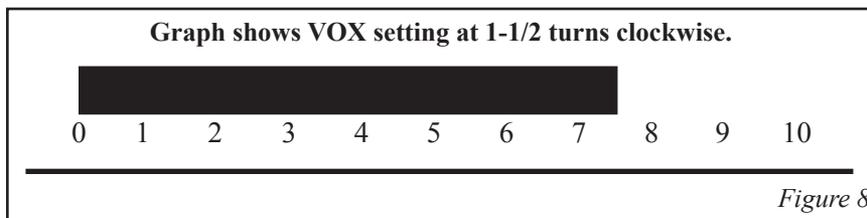
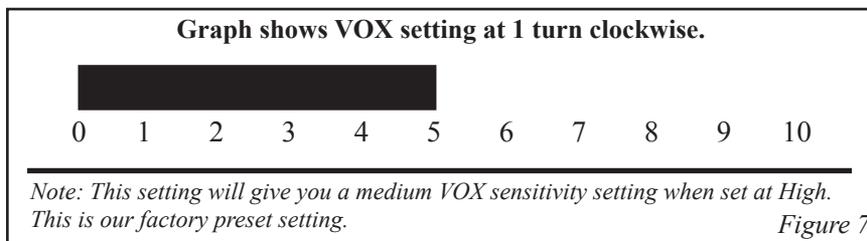
- |                               |                                |
|-------------------------------|--------------------------------|
| (1) O-ring groove             | (5) Receive volume adjustment  |
| (2) VOX adjustment            | (6) Belt clip                  |
| (3) Intercom volume selection | (7) Squelch adjustment         |
| (4) Channel selection         | (8) Sidetone volume adjustment |

*Figure 6*

the electronics compartment and can be observed after removing the lower battery compartment. The VOX control (Fig. 6, #1) will rotate two times and then stop. Rotation in the **clockwise** direction **increases** the sensitivity. If a VOX high setting is too sensitive causing false triggering, rotate counterclockwise until a good setting is found (see Figures 7–9 for a graphic look at the effect of rotating the adjustment control). Divers should use a low VOX setting when using an ME-16R Hot-Mic®. A higher setting should be used if the microphone-mask combination causes the microphone to be further than a quarter inch from the diver’s lips. Figures 7–9 illustrate the relationship between the number of turns and sensitivity. **CAUTION:** *Do not force the control past the stop point, or damage will occur!*

**6.3 SQUELCH:** The squelch control (labeled “SQ” in Figure 6) allows the squelch level to be varied. When the squelch is on, the control acts like the squelch control on a CB radio. The squelch adjustment control is a two-turn type. **Clockwise** turns from the beginning point (full counterclockwise rotation) will make the unit apply **more** squelch. The more you apply squelch, the quieter the unit becomes; however, the range is reduced (Figures 10–12). The factory preset “ON”

*Note for Figures 7–9: The graphs show the variance in VOX sensitivity with turns of the VOX control. A fully counterclockwise rotation is indicated by 0, and a fully clockwise rotation (two turns) by 10.*



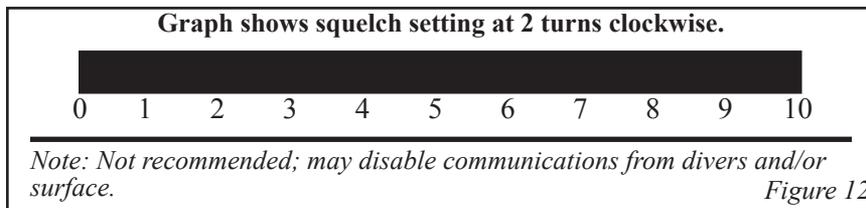
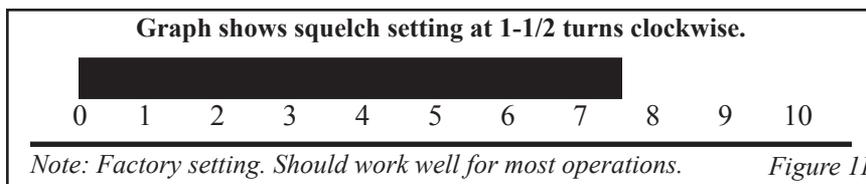
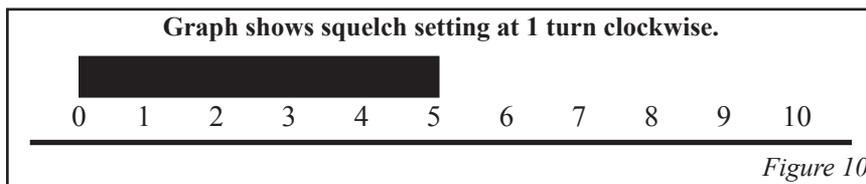
adjustment is set between 1 and 1-3/4 turns clockwise (Fig. 12). When in the “ON” setting mode, the background noise should be suppressed. If you turn the control two turns clockwise, you will decrease your receive range dramatically (Fig. 12). The divers will have to stay within a few feet of each other. If the mission requires long-range communication, the squelch should remain off. Squelch is turned off by a full counterclockwise rotation (where the squelch control cannot be turned any further). ***CAUTION:*** *Do not force the control past the stop point, or damage will occur!*

Remember, the more squelch you apply, the less range you can expect. When possible, use the transceiver in the squelch “OFF” position. The following graphs will give you a visual of the squelch settings.

If you are using a Super Mic® in combination with a KMDSI M-48 SuperMask®, your transmissions may be sporadic (see Section 5.3, Helpful Hint #13). If you experience this problem, adjust the squelch level to a higher sensitivity. Although more ambient noise may be heard through the receiver, the speech signal will be more likely to activate the receiver squelch consistently, resulting in unbroken speech. If you absolutely need unbroken communication, disable the squelch (fully counterclockwise rotation of the squelch control).

---

*Note for Figures 10–12: The graphs show the variance in squelch sensitivity with turns of the Squelch control. A fully counterclockwise rotation is indicated by 0, and a fully clockwise (two turns) rotation by 10.*



## SECTION 7

### BASICS OF SOUND IN WATER

#### 7.1 BACKGROUND

If a diaphragm submerged in water is caused to vibrate by electrical means, it has mechanical energy of motion communicated to the water. If another diaphragm is submerged in the water near the vibrating diaphragm, the acoustic energy in the water will excite mechanical vibrations in the second diaphragm. These vibrations may be detected electrically to complete a flow of mechanical energy from the first diaphragm to the second. The first diaphragm is called the *source* or *transducer*, and the second is called a *receiver* or *hydrophone*. With the Magnacom<sup>®</sup>, the transducer and hydrophone are one and the same.

#### 7.2 FACTORS THAT AFFECT SOUND IN WATER

Many factors affect the propagation of sound in water, depending upon location, depth, and time of day. As a net result, communication in water can be affected by local conditions and the dive's type and depth. Fluctuations in range and intelligibility can be expected.

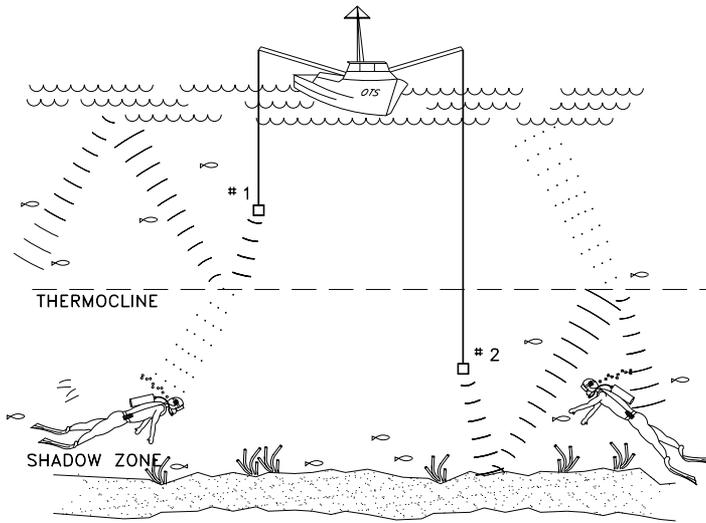
**7.2.1 Distance:** The sound intensity from a source varies inversely with the square of the distance from the source. This sort of variation is referred to as *spherical spreading*. Other factors also influence the variation of sound intensity with distance. As the sound passes through the water, some of the energy is absorbed and converted to heat (*attenuation*) and some of the energy is scattered by fish, pilings, seaweed, bubbles, etc. (*diffraction*). In addition, both the surface and bottom may affect the sound intensity by reflecting sound back into the water. The sound reflected by the surface and bottom may raise the intensity above normal levels (*reinforcement*) or may introduce *destructive interference*. The bending of the sound waves by temperature variations also has a great effect on the sound intensity at points remote from the source.

If the source of the sound is near the surface, there is some point beyond which sound is not received from the source. This point is said to be in a *shadow zone*. The distance from the source to the shadow zone is determined by the rate of change of temperature with depth, the depth of the source, and the depth at which the reception is made (Fig. 13).

**7.2.2 Water Density:** In addition to these factors, water density is also important. Because the density of sea water varies with the temperature, the salt content, and the static pressure, the effect on sound of each of these three factors is usually considered separately.

**7.2.3 Water Temperature:** Variations in water temperature affect sound transmission most. In some areas of the ocean, the temperature changes at a fixed rate over large ranges of depth. If the temperature increases with depth at a fixed rate, the velocity of sound increases at a rate constant with depth and sound waves are refracted toward the surface. If, however, the temperature *decreases* with the depth (as is frequently the case), the velocity of sound decreases with depth and the waves of sound are bent downward.

There are also areas in the sea where, at some depth, temperature changes rapidly over a small depth range. Such a layer is referred to as a *thermocline* or *thermal layer*. Such layers, in addition to producing rather sharp bending of the sound waves by refraction effects, can serve as reflecting surfaces.



*Figure 13: Thermoclines affect the ultrasonic signal. Divers must report thermocline depth(s) so the surface transceiver and/or other divers can be as close to the same depth as possible.*

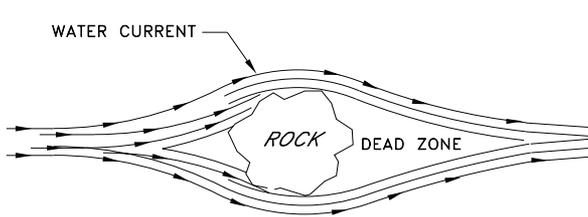
The velocity of sound transmission changes only about one percent for a temperature change of 10°F. However, the resultant bending of the sound path has great effect over a distance of several hundred yards.

If the temperature of the water decreases with depth at the rate of 1°F for each 30 feet (starting at the surface), most of the sound energy originating at the source near the surface will travel along paths that are bent rather sharply downward. Therefore, the sound energy may not reach a shallow detector positioned 1000 yards from the source but may reach a deeper detector position further from the source. Greater temperature variations can cause these paths to bend more sharply.

The best method to deal with thermoclines is to bring the divers and/or transducers as close to each other as possible. If a diver enters a thermocline, he should report it to everyone (surface and divers) so they know the depth of the thermocline. All divers should stay within that depth, and the surface station should try to position the surface transducer below or above, whichever is the case (Fig. 13).

**7.2.4 Background Noise:** Marine organisms play an important role in underwater acoustics. They are important primarily because of the effect they have on sound transmission, but they often serve as sources of underwater noise as well. High background noise—whether man-made, animal, or environmental (waves or rain)—can interfere with good communications. Such background noise can be suppressed through the use of the squelch function and thermoclines.

**7.2.5 Zones of Silence:** Large natural or man-made objects can block acoustical transmission under certain conditions, in much the same way as a rock blocks a fast-moving current of water. Close to the back side of the rock, in this example, the current is absent and



the water seems still. A short distance away, the current is flowing again (Fig. 14).

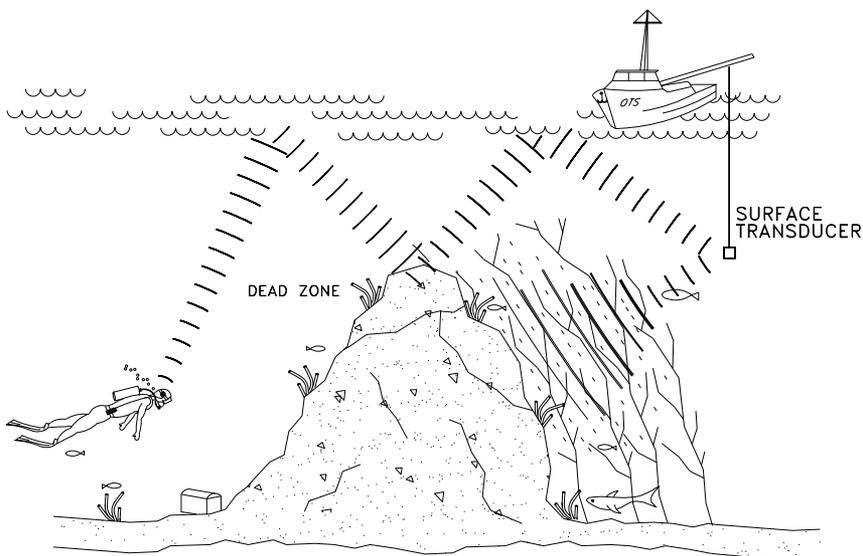
Similarly, acoustic energy in the water can be blocked if the transmitting source is

*Figure 14* close to a large object. Behind the blocking object is a “zone of silence” in which reception of the transmitted signal is not possible. Divers can reduce zones of silence by moving away from, around, or above the blocking object until communication is reestablished (Fig. 15).

Most single-sideband signals are efficient enough to permit communications around blocking objects. Reception is mainly through surface and bottom reflections. Man-made noise may be present underwater in busy harbors, shipping lanes, and many coastal locations, particularly at lower frequencies. The outstanding characteristic of this coastal ambient noise is its great variability from place to place in the same harbor and from time to time at the same place.

Under some conditions, when your diving suit is directly between the transmitting source and your Magnacom<sup>®</sup>, a small zone of silence may be created that prevents reception. This effect becomes greater at longer ranges. Turning approximately 45 degrees in any direction eliminates this zone of silence.

Since most divers are in constant motion, more than a momentary signal loss would be unlikely when acoustic energy is blocked by air inside a dry suit, by gas bubbles within neoprene wetsuit material, or when both are present—such as with a partially inflated dry suit.



*Figure 15: Communication through indirect and direct paths. Note kelp scattering sound. Without surface and bottom bounce, the diver would lose communications.*

## LIMITED WARRANTY

Ocean Technology Systems' Magnacom® SW-1000-SC is fully warranted against defects in materials and workmanship for a period of one year from the time of purchase. Our obligation under this warranty is limited to the replacement of any part or parts that prove to our satisfaction to have been defective and that have not been misused or carelessly handled. Labor is warranted for one year from time of purchase. The complete unit and/or part must be returned to our factory, transportation charges prepaid. We reserve the right to decline responsibility where repairs have been made or attempted by other than an Ocean Technology Systems factory-trained service center or properly trained personnel. In no event shall Ocean Technology Systems be liable for consequential damages.

You can now register your product online at the OTS Web site. Just visit <http://www.otscmm.com/register1.html>.

Undersea Systems International, Inc.

*dba*

### **Ocean Technology Systems**

3133 West Harvard Street, Santa Ana, CA 92704 USA

Telephone (714) 754-7848 • Toll-free (800) 550-1984 • Fax (714) 966-1639

[ots@otscmm.com](mailto:ots@otscmm.com) • [www.otscmm.com](http://www.otscmm.com)

© Copyright 2003,2011 by Undersea Systems International, Inc., *dba*  
**Ocean Technology Systems**. All rights reserved.