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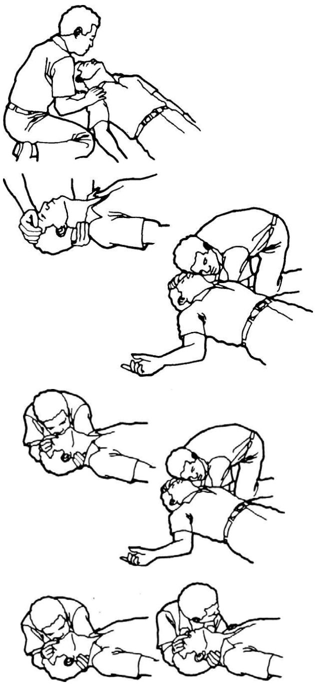
First Aid

Equipment manufactured by Stealth Telecom Ltd. meets stringent quality and safety standards. However, high voltages are present in many radio products, and only a skilled technician should attempt to remove outer covers and make adjustments and repairs. All personnel who operate and maintain the equipment should be familiar with this page as a safety preparedness measure. Although this assumes no liability regarding any injuries incurred during the operation and repair of such equipment, or administration of this suggested procedure.

ELECTRICAL SHOCK: EMERGENCY PROCEDURE

The victim will appear unconscious and may not be breathing. If the victim is still in contact with the voltage source, disconnect the power source in a manner safe to you, or remove the victim from the source with an insulated aid (dry wooden pole or rope). Next, determine if the victim is breathing and has a pulse. If there is a pulse but no breathing, administer artificial respiration. If there is no breathing and no pulse, perform CPR (if you have been trained to do so). If you have not been trained to perform CPR, administer artificial respiration anyway. Never give fluids to an unconscious person.

WHEN BREATHING STOPS



FIRST, send someone to get a **DOCTOR.**

THEN, administer first aid to restore breathing artificial respiration):

IF A VICTIM APPEARS TO BE UNCONSCIOUS

TAP VICTIM ON THE SHOULDER AND SHOUT; "ARE YOU OKAY?"

IF THERE IS NO RESPONSE

TILT THE VICTIM'S HEAD, CHIN POINTING UP. Place one hand under the victim's neck and gently lift. At the same time, push with the other hand on the victim's forehead. This will move the tongue away from the back of the throat to open the airway. IMMEDIATELY LOOK, LISTEN, AND FEEL FOR AIR. While maintaining the backward head tilt position, place your cheek and ear close – to the victim's mouth and nose. Look for the chest to rise and fall while you listen and feel for the return of air. Check for about five seconds.

IF THE VICTIM IS NOT BREATHING

GIVE FOUR QUICK BREATHS.

Maintain the backward head tilt, pinch the victim's nose with the hand that is on the victim's forehead to prevent leakage of air, open your mouth wide, take a deep breath, seal your mouth around the victim's mouth, and blow into the victim's mouth with four quick but full breaths just as fast as you can. When blowing, use only enough time between breaths to lift your head slightly for better inhalation. If you do not get an air exchange when you blow, it may help to reposition the head and try again. LOOK, LISTEN, AND FEEL FOR AIR EXCHANGE

IF THERE IS STILL NO BREATHING

CHANGE RATE TO ONE BREATH EVERY FIVE SECONDS.

Table of Contents

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List of figures

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List of charts and tables

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1. How to use this manual

This manual describes the installation, operation and technical details of the type ST940B automatic tuning NVIS HF antenna system. It is intended for:

- users of the antenna
- agents and dealers

The manual contains 8 sections. Before you start to use the antenna, read Section 2- Safety Rules; Section 3 – Introduction; Section 4 – Overview; Section 5 – Installation and Section 6 – Operating the antenna.

Section 7 – Technical Description and Section 8 – Appendices containing circuit diagrams and Parts list are for authorized Stealth Telecom agents and dealers rather than users.

We recommend that only Stealth-approved service agents perform any maintenance on the antenna.

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Glossary

A	Ampere
ADC	Analog-to-Digital Converter
ALC	Automatic Load Control
ALE	Automatic Link Establishment
AM	Amplitude Modulation
ATU	Antenna Tuning Unit
CW	Continuous Wave
DC	Direct Current
EMGL	Electro Magnetic Groundplane Loop
foF2	Critical frequency of F2 layer
FPC	Flexible Printed Cable
HF	High Frequency
I/O	Input/Output
JU	Junction Unit
LSB	Lower Side Band
MLA	Magnetic Loop Antenna
MUF	Maximum Usable Frequency
MU	Main Unit
NEC	Numeric Electromagnetic Code
NVIS	Nearly Vertical Incidence Skywave
OLED	Organic Light Emitting Diode
PA	Power Amplifier
PC	Personal Computer
PCB	Printed Circuit Board
PEP	Peak Envelope Power
PTT	Push To Talk
RAM	Random Access Memory
RCU	Remote Control Unit
RF	Radio Frequency
RMR	Rack Mounted Radiator
ROM	Read Only Memory
RX	Receive
SMD	Surface Mounted Device
SMT	Surface Mount Technology
SSB	Single Side Band
TX	Transmit
USB	Upper Side band
V	Volt
VSWR	Voltage Standing Wave Ratio
VVC	Vacuum Variable Capacitor
W	Watt

Units

Measurement	Unit	Abbreviation
Distance	meter	m
Frequency	Hertz	Hz
Voltage	Volt	V
Current	Ampere	A
Power	Watt	W

Units multipliers

Unit	Name	Multiplier
M	mega	1.000.000
k	kilo	1.000
d	deci	0.1
m	milli	0.001
u	micro	0.000001

2. Safety rules

Following information is written to help for safe installation and operation of the ST-940B Mobile HF Loop Antenna.

Although this product is powered from vehicular battery and requires no mains power connection for operation, it still presents a potential hazard to end user and technical personnel who perform installation, maintenance and repair of mobile radio communications equipment. Electrical shock may occur from test equipment or power tools used during installation and alignment. Temporal mains line brought to the vehicle must be of high quality cable with grounding wire and three pole grounding sockets and plugs. ***Never use occasional wires with frayed insulation or naked contacts.*** Always watch for the power cables as they may get cut or damaged when closing vehicle doors.

Never touch the antenna loop when antenna is in vertical position. This means that antenna circuit is energized and connected to a transceiver. ***Always remember that transceiver, driven by a network request, can start transmit/tune automatically, not only by accidental pressing of PTT knob.*** Up to 7000 Volts is present across the loop and under ATU cover when antenna radiates! Despite this tension is of RF nature and cannot kill instantly, it still can cause strong shock, burns and inadequate muscular reaction that may lead in falling from the roof rack.

To ensure optimal performance and to avoid exposure to excessive electromagnetic fields, the antenna system must be installed according to the instructions provided. ***A very high intense RF energy is radiated by the antenna when transmitting.*** Because of normal position of the antenna at the top of the vehicle it guaranties safe environment for operator and passengers located beneath. However, should it be found necessary to perform any tests or maintenance of the antenna installed on the ground or bench, you should not transmit/tune if people are standing within 2 m of the antenna.

The ST940B is designed in a form of automotive accessory, therefore it presents a potential hazard of loosing the antenna or luggage on the move that **can cause death** or injury of traffic participants. Providing of reliable mounting of the antenna to the vehicle as well as securing cargo on the roof rack is the imperative requirement. Installation instructions and safety tips given below describe typical installation procedure. However, some vehicle types may require certain modifications or alterations to mounting hardware.

It is impossible to highlight all mounting variations and, in these cases, safety of installation will depend totally on skill of installer.

As a general advice we recommend to use only high quality accessories approved by your vehicle manufacturer rather than to fabricate clamps or fixtures.

Always remember that ***your vehicle with mounted antenna at the top is now taller*** and may not pass under certain obstacles, such as underground parking, garage gates, etc. To avoid accidents it is now necessary to pay special attention to height limiting traffic signs and especially when entering low arches or

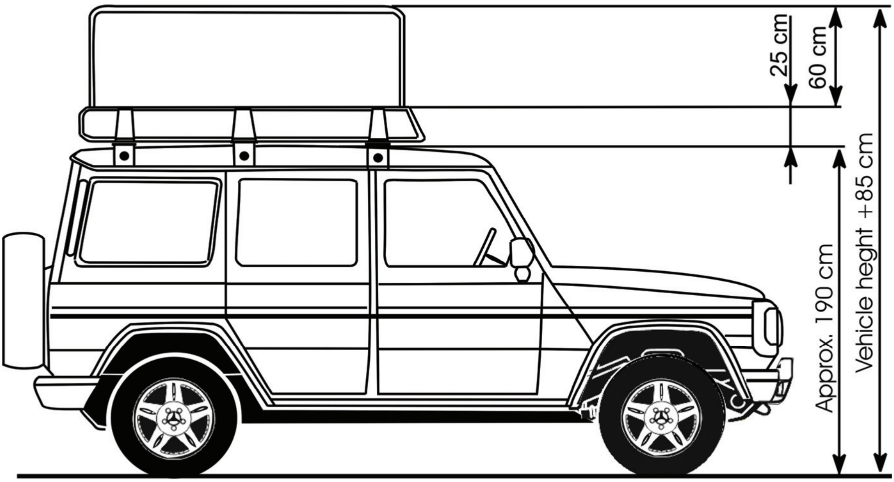

Fig.1

gates that are not provided with warning boards. Fig.1 illustrates typical vehicular installation which helps to conclude that approximately **90 cm of added height** must be taken in to consideration. However, depending on the vehicle brand, dimensions may vary and it is advisable to measure your vehicle height after antenna is installed. The heights of vehicle with **Loop UP** and **Loop Down** positions must be measured and remembered or noted. It is also advisable to put a small sticker inside cabin with measured figures as the antenna on the top is not visible and may be forgotten.

Special precautions shall also be considered prior to attempt folding the loop upright when parked inside the garage or low height parking as sufficient height clearance for the folded down loop may now have no room for folded up position.

When driving in scrub or undergrowth, try to avoid overhanging branches which could damage the antenna loop. When the antenna is not being used, bring the loop in down position.

When climbing onto roof rack, always remember that occasional naked electrical wires or power lines can now be accessible and accidental contact may occur. Always watch for overhead wires and obstacles when climbing up for loading of luggage.

As the ST940B antenna system has moving loop, a special attention must be paid when loading and securing cargoes.

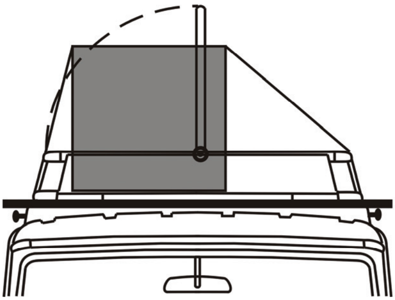

Fig. 2

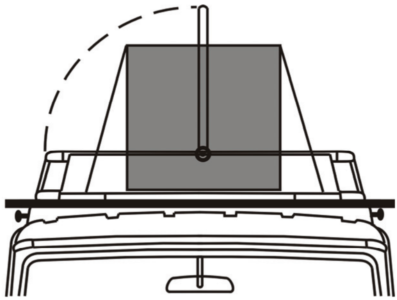

Fig. 3

The motorized loop is capable to produce significant torque, therefore it can throw untied cargo away from roof rack. In order to avoiding accidents it is important to tie cargo correctly. Fig. 2 illustrates incorrect way of loading and securing a box onto roof rack.

Firstly, it should be evaluated whether box size will not obstruct loop movement.

Secondly, cargo must always be positioned in the center of the roof rack or at left side. In any case it shall be placed as far as possible from right side of upper parapet as it may cause loop jamming.

Thirdly, never use upper parapet frame for tying ropes as it will block loop mechanics and can cause damage of the jack. Use only roof rack floor grill for tying as shown on Figure 3.

Strictly observe following instructions:

Never load roof rack with highly flammable fuels, such as petrol, gasoline, butane, propane, etc. RF fields radiated by the antenna can cause tiny sparks between adjacent metal cans that can lead in fire or explosion!

Never transmit from your vehicle being parked at petrol filling stations and fuel storage facilities.

Never load roof rack with explosive, especially electronically controlled devices and materials as induced RF currents may cause triggering of the circuits! Transporting of weapons loaded with live ammunition is not recommended.

Do not use roof rack for transporting live birds, animals and plants!

Do not load roof rack with electronics items such as video and digital photo cameras, computers, etc., as they circuitry can be damaged or stored data erased by induced RF currents and intensive magnetic field.

3. Introduction

This section briefly describes the type ST940B automatic tuning NVIS HF antenna system.

The ST940B Antenna System is a highly efficient mobile autotune HF NVIS antenna designed for applications where reliable and concealed operation within medium communications range is required. It can be installed on any 4WD vehicle, sedans, minivans or trucks. Antenna can work along with any 50-125 Watt output multichannel HF transceiver and provides excellent performance at distances up to 2000 km even in regions with poor soil conductivity. This is not obtainable with use of any other kind of HF mobile antenna systems.

The ST940B is shaped as a vehicular luggage roof rack that provides almost undetectable concealed appearance when installed on a vehicle. The luggage rack is a carefully modeled integral part of the entire system that works as antenna radiating structure. It has a motorized loop that can be remotely folded upright and down by an operator during ride without stopping the vehicle. Loop is tuned to operation frequency by microprocessor controlled ATU automatically. This ensures the best communications possible.

Four microcontrollers utilized in the antenna circuit to support automatic tuning, scanning, loop position control, flexible interfacing, parameter measurements, programming, readings displaying and diagnostics functions.

With observing limits and precautions described in Section 2 of this manual, antenna can be used as fully functional luggage roof rack.

The ST940B antenna system is recommended for medium range HF mobile voice and data communications within corporative organizations and groups such as police, state security, emergency, ambulance, forestry, special agencies, etc.

On receipt of your antenna package, check the contents against packing list. Ensure all items are available before commencing the installation.

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3.1. Specifications

Table 1

General Specifications	ST-940B
Frequency Range	**3.5 – 15.0 MHz, ±2%**
Power Rating	125 W PEP
Input Impedance	50 ohms
VSWR	Not greater than 1.3:1 at resonance peak
Pattern Radiation	Omni directional, HRP offsets are less than 1 dB at two opposite minimas, Vertical Elevation – NVIS lobe @ 70-90º
Bandwidth (Measured at VSWR 2:1)	20 kHz at 3.5 MHz Carrier 260 kHz at 15.0 MHz Carrier
Gain (compared to ideal 1/4λ Ground Plane*)	-0.32dB @ 15 MHz; -1.27dB @ 7 MHz; -2.17dB @ 3.5 MHz;
Power Supply Voltage	12-14VDC/ 4 A (peak current)
Tuning Method	Continuously Variable Tuning
Tuning Time	3 seconds average, 8 seconds max.
Tuning Accuracy	± 1.8º step
Tune Signal	10-30 W PEP CW followed by logic consequence via 4 I/O programmable interface
Tuned Point Instability vs. Wind/Vibration	Not detected at speeds up to 150 km/h asphalt and up to 90 km/h off-road
Tuned Point Thermal Instability (measured within 3 minutes under 100 W PEP CW)	Less than 500Hz negative drift @ frequencies below 4 MHz Less than 10Hz negative drift @ frequencies above 4 MHz
Feeding method	Shunt fed
System Serial Bus	RS-485, differential
Programming Port	RS-232
Dimensions H x W x L, (without mounting brackets)	Folded Up: 740** x 1254 x 1852 mm Folded Down: 175 x 1254 x 1852 mm
Weight (without mounting brackets)	60 kg
Sealing	IP64 outdoor enclosures, IP54 indoor enclosures
Shock/Vibration	Complies with MIL STD 810 C/D/E test procedures
Dust and Humidity	Protection provided via environmental resistant housing to MIL STD 810 C/D/E and connections to MIL C26482.

NOTES:
Data is specified for +25Cº unless otherwise stated. All specifications listed are typical.
Specifications are subject to change without notice and are issued for guidance purpose only.

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4. Overview

This section describes principles involved in design of the type ST940B NVIS antenna system and provides useful information on HF communications techniques.

4.1. Theory of operation

In general ST940B antenna utilizes principle of a Very Small Closed Tuned Loop with aperture dimensions less than 0.1λ compared to wavelength and also referred to as a Magnetic Loop Antenna.

The loop radiator is effectively a single turn inductor continuously tuned by a variable capacitor. The radiation impedance and efficiency of the loop mainly depends on its surface conductivity in order to minimize resistance to quasi constant current, which creates a magnetic flux in the near field and an electromagnetic field in the far field. This type of antenna differs from open antennas (like whips, dipoles, log periodics, etc.) by its impedance, which is reactive and can be compensated by capacitor only. It has low, typically <10mΩ radiating resistance, which drops with frequency and, at the lowest frequency of the range, it can be less than 1.0mΩ. As the radiation efficiency is given by the ratio:

$$E=Rr/Rt \quad (1)$$

where Rr - radiating resistance, Rt - total resistance of the tuned circuit, it is necessary to minimize the radiating element resistance using a highly conductive conductor and low loss capacitor. If these conditions are fulfilled, the loop will deliver a high current and will have high selectivity with quality factor (Q-factor) typically 10 to 20 times higher that Q-factor of the traditional antennas. The RF currents and voltages present in such a loop must also be multiplied by Q-factor and, if fed by 100 watt radioset, can reach 30-50 Amperes and 5000-7000 Volts. The resulting intensity of magnetic field radiated by the loop in the near filed is thus nearly equal to 10000-20000 Watts. This requires involving of very high voltage low loss variable vacuum capacitor driven by precision stepper motor as tuning to resonance of high Q circuit is very sharp.

Once the mechanical issues are overcome, the narrow bandwidth of the tuned circuit turns to be advantageous feature as it helps to minimize unwanted harmonics in the emitted signal and, what is most important, to significantly increase a signal/noise ratio of the antenna when working on reception.

The tuned loop antenna, due to its low impedance closed circuit is almost insensitive to static and industrial noise.

In fact, compared with any other antenna type, loops provide excellent and comfortable reception when reception with other antennas is noisy or completely impossible.

4.2. Antenna Modelization

The ST940B Antenna System is a version of a Magnetic Loop Antenna (MLA) known as an Electro Magnetic Ground Plane Loop (EMGL) and sometimes called half loop antenna, because part of its loop is electrically included into a large ground plane. Simplified diagram of a full loop shown on the Figure 4.

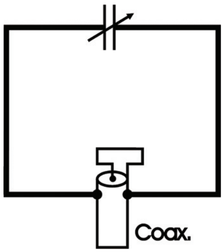

Fig. 4

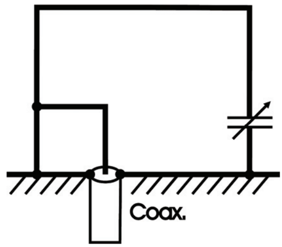

Fig. 5

Practically, the half loop is nearly the half size of a full loop that makes installation of such antenna possible on a small vehicle. Full loop equivalence is achieved by connecting the half loop ends with a highly conductive ground plane as shown on Fig. 5. The ground plane helps to form a special radiation pattern diagram in order to optimize overall antenna performance.

The full loop shown is excited by an inductively coupled smaller loop. The half loop on Fig. 5 is shunt fed by a wire connected to the loop at a specific point (so called γ-match - gamma match) that provides better and uniform impedance matching between radioset output and antenna input across frequency range as well as minimizes constructive difficulties.

The modellization utilizing wire method of moments allows for precise definition of currents and voltages in the circuit and obtaining of required radiation pattern diagrams. The Figure 6 illustrates 3-D model of actual ST940B antenna built with aid of EZNEC 4 CAD calculation engine.

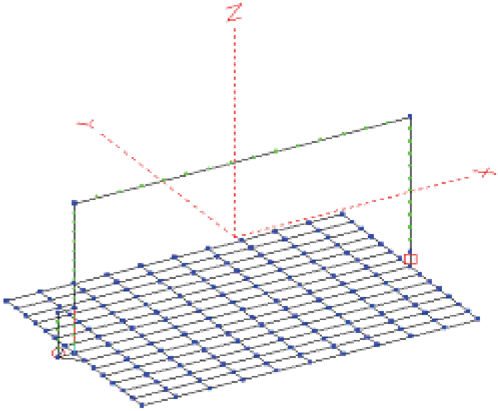

Fig. 6

The Fig. 7 illustrates resulting 3-D radiation pattern. It has shape of pseudo torroid with slight (less than 1 dB) minimas in horizontal plane and with only one slope directed upward in vertical plane that makes it possible to describe it as a quasi sphere. In horizontal plane such antenna will radiate almost equally in all directions which is most important factor for HF communications on the move. In the vertical plane maximum of radiation of this antenna is concentrated in the area that perpendicular to horizon and lies within 60-90 degrees.

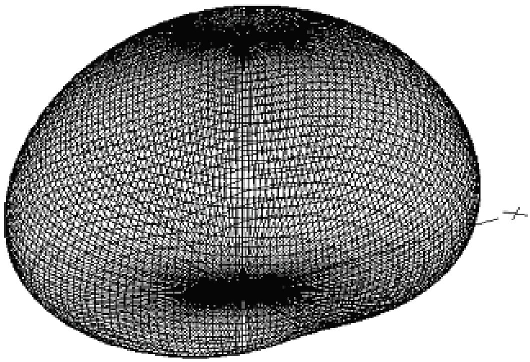

Fig. 7

This combination of horizontal omnidirectionality and high elevation angle makes this antenna most suitable for mobile NVIS operation.

4.3. HF Propagation

HF radio waves propagate in two paths simultaneously:

- ground wave
- sky wave

Ground wave

The ground wave travels near the ground for short distances, typically up to 70 km over land and 300 km over sea. The distance covered depends upon the operating frequency, transmission power and type of terrain. The lower soil conductivity, the less distance the ground wave will cover. Lossy soil, mountainous terrain or forests significantly reduce range of the ground wave communications.

Sky wave

The sky wave is the most important form of HF propagation. The radio wave is transmitted toward the sky and is reflected by the ionosphere layers to a distant receiver on earth. The reflective properties of the ionosphere layers change throughout the day, from season to season and yearly.

4.4. Frequency, distance and time of day

The extent to which a radio wave is reflected *depends on the frequency* that is used. If the frequency is too low the signal is absorbed by the ionosphere. If the frequency is too high the signal passes straight through the ionosphere. Within the HF band, low frequencies are generally considered to be in the range of 2 to 10 MHz. High frequencies are above 10 MHz.

A frequency chosen for daytime transmission may not necessarily be suitable for night time use. During the day the layers of the ionosphere are thick and absorb lower frequencies and reflect higher frequencies. At night, the ionosphere becomes very thin. The low frequencies that were absorbed during the day are reflected and the high frequencies that were reflected during the day pass straight through to the space. The height of the reflective layers is varies during the day that causes change of reflection angle and therefore distance at which the reflected wave is returned to earth is also varies. *Sometimes sky wave can be reflected to the area where* *ground wave is also present*. In this case the sky wave will travel longer distance and may arrive to earth in different phase resulting in interference effect known as fading, e.g. consequent lowering and increasing of the resulting signal strength.

Summer HF communications usually operate on higher frequencies than those used in winter over the same distance.

Solar activity varies over an 11 year cycle. Higher frequencies need to be used during periods of peak activity.

It is important to remember that you may need to change the frequency you are using to achieve the best communication. The general rules for HF communications are:

- the higher the sun, the higher the frequency
- the longer the distance, the higher the frequency

4.5. Skip Zone

The Chart 1 on the page 4-7 illustrates typical mobile 5 m tuned vertical whip performance at distances up to 1500 km versus used frequency. The ground wave emitted by such antenna propagates in accordance with the principle highlighted in the chapter 4.3 and is getting inaudible at approximately 70-80 km distance. The sky wave emitted by the whip is reflected back to the earth at approximately 300 km. Due to low, typical 30º take off angle of radiation maxima in the elevation plane of this antenna there are no waves that strike the ionosphere at angles required to reflect them at distances below 300 km. The skip zone is the region consisting of areas of the earth's surface which are outside the radius the ground wave will reach, and yet not far enough away to receive reflections of sky waves. Therefore, the gap in coverage between 80 and 300km will occur. This effect is also known as silent or dead zone. ***Within typical distances of 80 to 300 km reliable HF communications is impossible without use of special antenna types.***

4.6. NVIS propagation and antennas

To eliminate the skip zone the transmitted sky waves must strike the ionosphere at high, typically 60-90° angles to be returned back to earth at similar angles in order to fill 0-300 km distance of skip zone. *It is like taking hose and spray water into a ceiling. At high angles of hose water will cover spot under it. Once the angle is lowered and jet strikes the ceiling at shallow angle, the water will fall quite far away leaving dry floor.* The Nearly Vertical Incidence Skywave (NVIS) antennas have been developed for fixed HF radio stations such as dipoles installed at lowered, typically 0.25λ height, Inverted Vees or dipoles with additional grounded reflector wire installed beneath it. The main purpose of those modifications is to maximize the upward radiation towards the vertical (or zenith) and minimize low-angle sky and ground waves.

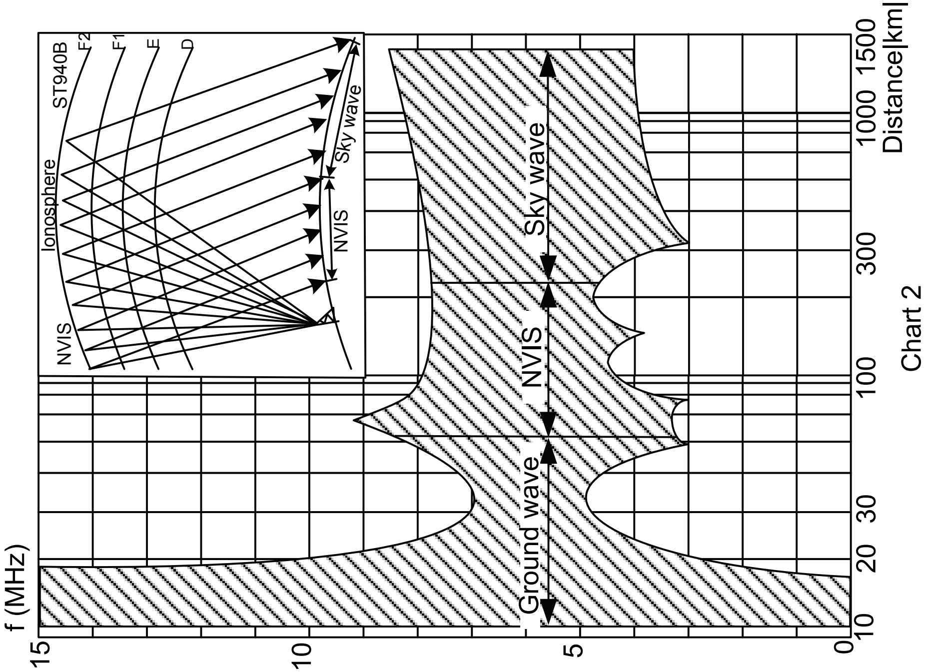

Chart 2

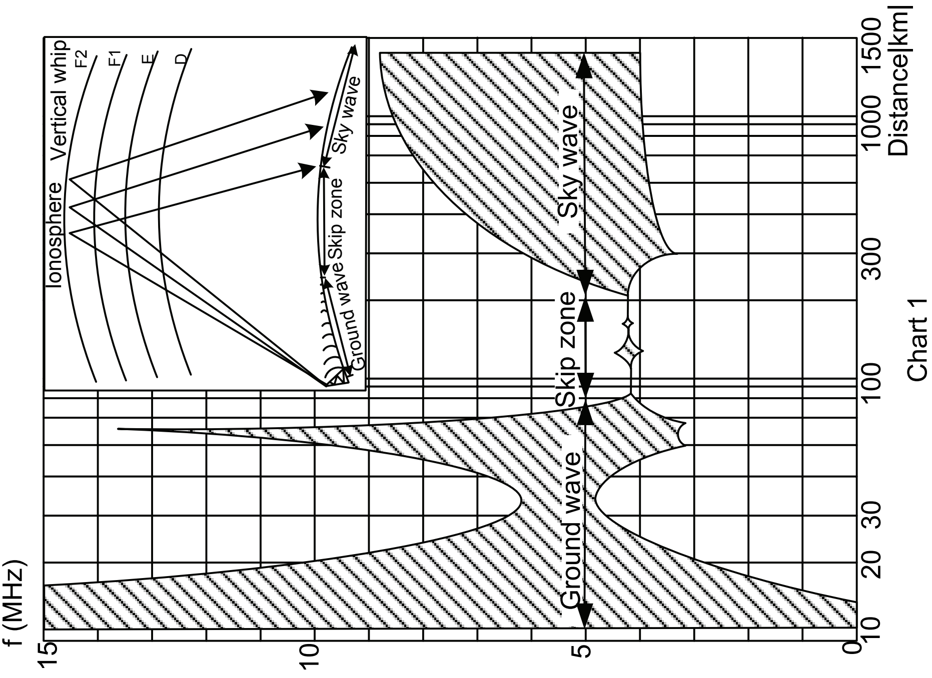

Chart 1

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However, the NVIS turns to be a difficult task for mobile applications. Due to lack of space there are no NVIS antennas were possible for mobile HF communications. *The bent whip, frequently called NVIS whip cannot change situation effectively as its radiation effectiveness very much depends on the soil conductivity while usually lossy soil is a bad reflector*. The half loop and conductive reflector combination is the only real NVIS antenna available for mobile HF communications.

4.7. NVIS networks and frequency planning

NVIS is the mode of operation that is most suitable for small to medium range of communications, where all radiosets in the network are located within 1000-1500 km radius. This is the range that can be covered by a vehicle and is well within a typical range for any mobile communications requirement. This is a local range. Despite the same equipment is sufficient for intercontinental or even worldwide communications, those are more exclusions than practice. Once your network is considered local it must provide reliable communications between all fixed and mobile stations registered in your local network.

To achieve maximum benefits from NVIS propagation it is important that all radiosets in the network, either mobile or fixed, are equipped with NVIS antennas. Falling to do with so will result in poor communications where two way conversation becomes one way, which is little better than no way, as it would be with all non-NVIS radiosets in the network.

General rules for proper frequency planning for sky wave operation as highlighted in chapter 4.4 are valid for the NVIS mode. However, when NVIS propagation becomes a target mode, a better study of ionosphere properties is essential.

The ionosphere is a high altitude region of the earth's atmosphere composed of gaseous atoms which have broken into ions. The sun is the source of the ionizing energy, so the condition of the ionosphere varies with time of the day, season of the year, the 11-year sunspot cycle, and the 27-day rotation of the sun. Ionosphere continuously fluctuates in height and thickness. The layers of the atmosphere that effect radio propagation are the D, E, F1 and F2 layers (refer Chart 1, 2). In a nutshell, it is the F2 layer which is usually involved in reflecting sky wave back to earth, while the D layer absorbs signals. The E-layer can either help, or hinder.

It is established that all frequencies which can be reflected by the F2 layer lie within 2-14 MHz range. It must be noted that higher frequencies of the range emitted and reflected at regular shallow angle sky wave frequently tend to penetrate the F2 layer if were transmitted at higher angles. Therefore, NVIS mode requires more accurate real time knowledge of ionosphere condition when choosing frequency. The critical frequency foF2 is the frequency up to which a return can be obtained from a sky wave directed vertically at the F2 layer of the ionosphere is the most important parameter to know. *A good "working" frequency for NVIS will often be between 10 - 15% below, i.e. 85% of the foF2.*

4.8. NVIS critical frequency prediction, ionospheric maps

A very rough guide is to take the higher frequencies (say 7-12 MHz) for daytime communications, with the lower (say 2-4 MHz) for nighttime use. ***In practice, to maintain NVIS communications over a 24 hours period, effectively 3 different frequencies are required***;

- a day frequency (the highest of the 3)
- a night frequency (lowest of the 3)
- a transition frequency, somewhere between the other two.

A more accurate method is to follow weekly propagation bulletins or use propagation-prediction programs available (Miniprop, for example) on the Internet. There is access to various propagation information sites, which either provide real-time indications or detailed recent history records of the critical frequency presented in form of ionosperic maps at no cost.

Those map help to determine the frequencies that will always be returned to the earth. Transmitted frequencies higher than the indicated contours (which are given in MHz) may penetrate the ionosphere, resulting in lost power to space. Frequencies lower than the indicated contours will never penetrate the ionosphere. Lower foF2 values indicate a weaker ionosphere and correspond to regions with lower Maximum Usable Frequencies (MUF). Higher foF2 values indicate a stronger ionosphere and correspond to regions with higher MUFs.

Below are some useful links to websites that offer regularly updated maps online:

http://www.wdc.rl.ac.uk/ionosondes/view_latest.html
http://www.ips.gov.au/HF_Systems/4/3
http://www.hfpack.com/

4.9. NVIS and ALE

NVIS can be viewed more as a "Systems Concept" and not just what antenna to use. The concept of NVIS is to have reliable communications anywhere within a 1000 km radius through use of special antenna systems in conjunction with such techniques as frequency planning and network management. A great help in achieving of benefits from NVIS concept in recent times is ALE - Automatic Link Establishment.

In the commercial and military world, the problems of changing propagation conditions, plus the fact that skilled radio operators are getting lesser in number, led to the development of ALE.

ALE scans and tests authorized frequencies or channels for a particular path until it finds a frequency that will support communications over a path. Each radioset in an ALE network constantly broadcasts a sounding signal and listens for other sounding signals generated by other network members. A quality analysis of these signals by an on-board processor determines the best frequency for communications and this frequency is then selected automatically for operations. This has dramatically increased the efficiency of HF Communications and is obviously highly useful for NVIS mode.

Many NVIS antennas are designed to work only within NVIS frequency ranges, which usually limited by 2.0-14.0 MHz range, while most HF radiosets can cover full HF band (1.6 – 30.0 MHz). *For correct functioning of NVIS in conjunction with ALE featured radiosets, all channels or frequencies programmed in your radioset must correspond with these limits.*

4.10. Tests and conclusions

The Chart 2 illustrates overall performance of the ST940B NVIS antenna system. Both the charts are drawn upon results derived from field tests of two ST940B NVIS antennas in comparison with two 5m autotune whip antennas being installed at the same vehicles. **The comparison is self-explanatory**. Tests were held on the move trough desert dunes, humid forests, under rain, at day and night, measuring S/N ratio in highly industrialized towns, under high voltage lines.

Based on those data, it was established that two 100 W radiosets equipped with two ST-940B half loops having -11 to +5dBi typical gain figure from 3 to 12 MHz would insure reliable voice and data communications at any distance from 0 to 1000 km at least.

This mission cannot be fulfilled by any 3 to 10 m vertical or bent whip antenna on a poor or medium soil even in association with a 1kW radio set as it does not transmit and receive enough energy to cover the typical 70-300 km skip zone.

4.11. Etiquette for the use of HF radio

There is standard procedure for communicating over HF radio. Before you begin transmitting, listen to the channel that you are going to use and ensure that there is no voice or data communication taking place. You may need to wait until the channel is clear or select another channel. Even the channel is seemed to be clear, it is always good to ask several times: ***Is the frequency in use?***

When you first establish communication with another station, it is customary to state their ***call sign*** and then your own using the phonetic alphabet.

Always maintain polite and friendly style of conversations. Swearing or foul language should not be used – heavy penalties can apply. Keep communication as short as possible.

5. Installation

This section contains the following topics:

This document summarizes the FCC requirements that are met by the ST940B antenna system.

Statement for FCC compliance

Any modifications made to the ST940B antenna that are not approved by the party responsible for compliance may void your equipment's compliance under Part 15 of the FCC rules.

The ST940B antenna system has been tested and found to comply with the limits for a Class B device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in residential installations. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by switching the equipment off and on, the user is encouraged to try to correct the interference by one or the following measures:

- reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver
- Consult the dealer or an experienced radio/TV technician for help

CE compliance

Unused connectors on the Junction Unit must be covered with the protective caps supplied to prevent electrostatic discharge passing through your mobile station equipment.

5.1. ST940B Roof Rack Installation

When ordering antenna proper clamping hardware should be selected and specified. Two standard mounting hardware systems can be supplied with the antenna. The first system (Fig. 8) is designed for direct mounting of the antenna to Toyota Land Cruiser vehicle and can also be adopted for installations on the some other vehicles that have two slots stamped in the roof. The mounting set, as shown on Figure 9, is designed for installation on the roofs that instead of slots have rain channels. If neither of standard packages is suitable, a custom set can be fabricated on request. Alternatively, user can adopt one of standard or aftermarket accessory available locally.

Fig. 8

Fig. 9

For achieving of specified performance it is recommended that installation shall be carried by a technician familiar to HF communications installation techniques. In most cases vehicle, being equipped with an antenna system, is simultaneously being equipped with a transceiver that converts the vehicle into the Mobile HF Radio Station. Therefore, entire installation procedure requires certain skills and experience in mechanical works, electrical wiring and system integration. Shown below is the installation procedure on the Toyota Land Cruiser vehicle.

1. Prepare vehicle’s roof by removing two decoration strips snapped into the two slots, as shown on Figure 10. Unscrew standard mounting M8x30 bolts from the holes and install six cast standoffs from the installation set observing markings: LF – Left Front, RF - Right Front, LM, RM, RR, LR. Use new M8x80 bolts, rubber pads and insulating gaskets included.

    NOTE It is preferred that antenna rack metalwork will have no galvanic contact with vehicle body metalwork at six mounting points, as it may lead in slight degrading of system performance such as increase of standing wave ratio. Make sure to use insulating bushings and washers included when mounting standoffs to the vehicle.

2. Cut or file down aligning pins available on the right and left middle standoffs.

3. Unpack antenna and check whether one coaxial and one control cables have already been connected to antenna Main Unit.

Fig. 10

NOTE: If these cables are not factory connected, install them now. It will be required to place antenna rack bottom up, use carton box as a table in order do not scratch paintwork. First determine ends of both cables that need to be connected to the Main Unit mating connectors. On the RG-58 coaxial cable (ST94060.55) this is the end terminated with Mini-UHF angle connector and on the control cable (ST94060.57) this is Amfenol angle connector. Feed both the ends into the gap formed by lower frame tube and plastic guard plate and attach them to appropriate connectors. Lay both the cables into the Pi-shaped channel and tie with plastic straps included. This will drive both cables towards the Rear Right standoff mounting plate. Put the free ends of cables on the rack so that they will not be accidentally torn during antenna placing. Antenna now is ready for installation to the vehicle roof. You will need three helpers at the next stage.

4. Held at corners by four men, as shown on Fig. 11, bring antenna to required height and, moving from behind of the vehicle, place it over the roof observing that six bottom plates of the antenna align with the six installed standoffs. With aid of a free standing ladder insert six M8x30 bolts to coinciding holes and tighten them with nuts securely. Make sure to install self-locking washers to prevent nuts loosening.

5. Now take both cables from the roof rack and drive them into the slot in the vehicle roof and then alongside the rear lid frame to inside the cabin as shown on Fig. 12. Use cable ties or adhesives in order to make this operation nicely as possible. In ideal case no wires should be visible. Make sure that rear lid will not damage cables when closing.

6. Remove protecting adhesive film from entire antenna metalwork; check that nothing can obstruct loop movement. The mechanical part of the antenna installation is now completed. Antenna installed on the vehicle with rain channel type roof is shown on the Fig. 13 for a reference.

Fig. 11

Fig. 12

Fig. 13

Fig. 14

5.2. ST940B HF Antenna System Interfacing

Typical ST940B Antenna System consists of:

- a rack mounted radiator unit (RMR)
- an antenna tuning unit (ATU)*
- a main unit (MU)*
- a linear actuator*
- a junction unit (JU)
- a remote control unit (RCU)

NOTE Star marked units are environmentally sealed devices that constructively installed on the RMR. The JU and RCU units must be installed inside the vehicle cabin.

The ST940B Antenna System can be interfaced with any HF transceiver with RF output not exceeding 125 Watts PEP.

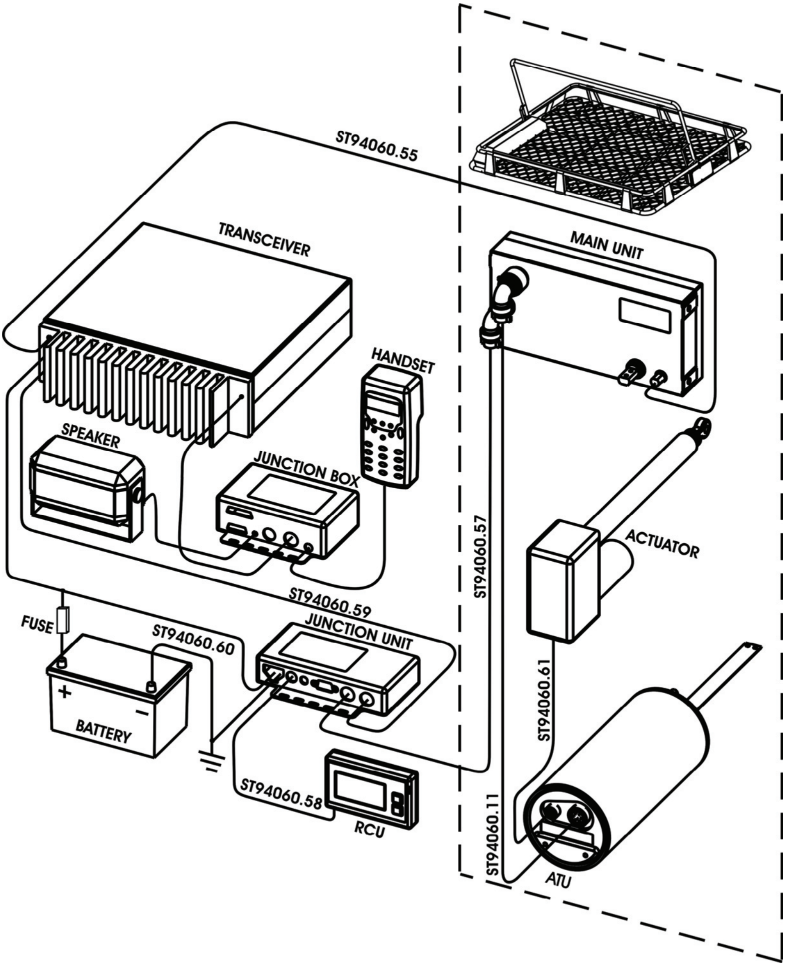
Following versions of interfacing software and adaptor kits have been developed to support integration of the antenna into different mobile stations:

1. Codan NGTseries of transceivers (ver.9407.20)
2. Barret 900 series of transceivers (ver.9407.30)

NOTE Interfacing aid with other types of transceivers available on request.

Figure 15 on the page 5-7 shows the ST-940B Antenna System interfaced with Codan NGT transceiver.

Typical HF Mobile Station



Fig, 15

Notes:

1. Devices in the dotted area are located on the roof rack.
2. Cabling scheme shown corresponds only to ST940B and Codan NGT interconnections.

Cables

Table 1: Cables for interfacing of ST940B antenna and NGT mobile transceiver

Cable	Part Number	Remark
Coaxial cable between NGT RF Unit and Main Unit of ST940B	ST94060.55	*
Control cable between Main Unit and Junction Unit	ST94060.57	*
Control cable between NGT RF Unit and Junction Unit of ST940B	ST94060.59	Optional **
Cable between MU and ATU	ST94060.11	Preinstalled
Cable between ATU and Actuator	ST94060.61	Preinstalled
Power cord	ST94060.60	***
Cable between RCU and JU	ST94060.58	Tail cable

* The part number for this cable corresponds to a standard 6 m length.

** This 2 m long cable is required only in case of distant mounting of NGT RF unit and Junction Unit of ST940B.

*** This 1 m long power cord is terminated at one end with a plug mating with power socket installed in the Junction Unit. The other end is not terminated and must be connected to NGT power inlet tail cord close to its cable receptacle by means of two splice taps included.

Mounting the Junction Unit

Best location to mount Junction Unit is the next to the NGT RF Unit so that it's short control cable can be plugged into the appropriate socket of the JU. Use cable ties or screws to secure the Junction Unit in suitable location. Ensure there is sufficient space at the rear for cables and connectors. Make sure that the Junction Unit, the NGT RF Unit and the NGT Junction Box have reliable grounding contact with the vehicle chassis, preferably in a single point.

Mounting the Remote Control Unit

Correct Location of RCU is very important as it is only the aid to control antenna loop position. The RCU must be mounted in visible, preferably on direct line of sight and easy to access place in the vehicle so that its controls can be approached swiftly by both driver and front passenger.

The best location of RCU is the middle part of a vehicle dashboard. Protect the cables, as far as possible, by routing them within the body of the vehicle. Where they pass through bulkheads use grommets to protect the cable insulation from being damaged. Hide any cables excess under carpet and decorative plastic trims of the vehicle to minimize probability of accidental damage.

Connecting the System

Make sure that your vehicle is of 12 V battery voltage, not 24 V. For the 24 Volt battery vehicles, a special powerful low noise voltage converter is a necessity.

For cabling devices belonged to NGT transceiver please refer NGT Transceiver Getting Started Guide (Codan part number 15-04127-EN), section 1. Also refer Fig. 15 of this manual for cabling scheme of entire system.

All cables of ST940B antenna are marked and terminated so that wrong mating with the transceiver devices is not possible.

If the NGT equipments have already been installed, temporarily disconnect PLUS wire (red) of Codan power cord from the vehicle battery for duration of installation procedure.

If the NGT equipments have already been installed and close mounting of the Junction Unit to NGT RF Unit is not possible, use optional ST940060.59 elongation cable.

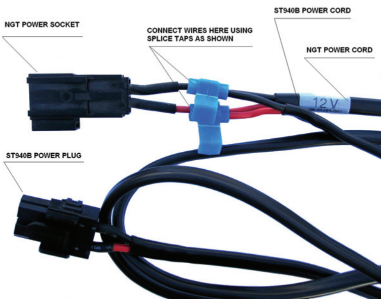


Fig. 16

To connect antenna power cord with the NGT power inlet cord use two blue splice taps included. Alternatively, remove 20mm of PVC insulation on both cords and get them soldered and insulated with PVC tape. Make sure to observe correct polarity. Red (+) and black (-) wires of the antenna cord must be connected with red and black wire of the NGT respectively, as shown on Figure 16.

If the vehicle has a battery installed in a compartment that located in the rear, cut excess of the Codan power cord and connect ST940B power cord directly to the battery. This will minimize wiring resistance and voltage drop under load. Always use original Codan power cord or replacement cords of wire cross section sufficient to carry 50 Amperes DC. Adopting of occasional thin wires is dangerous as they can get hot and cause short connection or fire.

Installation of insufficient size of power cord is the most obvious cause of malfunctioning or downgrading of the entire HF system performance.

5.3. Weatherproofing

The coaxial and control cables connections on the roof rack are considered to be weatherproof when inserted in their mating sockets. However, for added protection against dust or moisture entering the connections it is recommended to wrap the mating connectors in Telcohesive Polymerizing Tape or 3M Splicing Tape.

6. Operating the antenna

The type ST940B antenna can be used in two positions:

- Loop is Up
- Loop is Down

When loop is folded down, the antenna can be used in scan mode only. In this loop position reception is provided through a special RX antenna integrated into the roof rack in order to support fully concealed monitoring of channels. Antenna operates as an ”active antenna”, that is, a Low Noise Amplifier (LNA) is switched into the into the RX antenna circuit making it sensitive enough to receive signals. Antenna cannot be tuned in this position.

When loop is folded upright, the antenna can transmit and receive RF signals. The integrated RX antenna is disconnected and three modes of operation modes now performed through the loop itself:

- scan mode
- tuned mode
- stay tuned mode

6.1. Frequency range

The ST940B antenna system is designed to operate within frequency range that covers lower half of HF band and includes all NVIS-usable frequencies. The upper half of the HF band is mostly used for radio amateur DX-ing experiments and long range broadcasting. These frequencies are usually considered impractical for commercial fixed and mobile HF communications.

Typical ST940B antenna can be tuned to any frequency within 2.7-15.0 MHz range.

For correct functioning of your mobile station make sure that all channels or frequencies programmed to you transceiver are within the specified antenna frequency range.

6.2. Scan mode

In scan mode with loop folded upright, the LNA is disconnected from the integrated RX antenna and switched into the loop circuit, making it sensitive enough to receive signals – any mismatch is disregarded. This removes the need to retune at each frequency.

To start the scan mode, press the **Scan** button on the transceiver.

6.3. Tuned mode

With the loop positioned upright and in the tuned mode, the transceiver operates as a normal radioset. That is, it can transmit and receive signals as required.

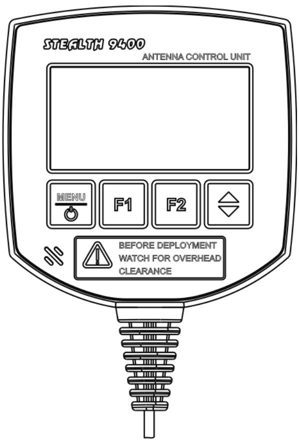
To tune the antenna, press the **Tune** button on the transceiver.

6.4. Stay tuned mode

This mode is used when all parties operate in a common single channel. Once loop is tuned, it can then be folded down for concealed monitoring the channel or waiting for a call.

If received call needs to be answered, push knob on the RCU to fold the loop upright. Upon completing loop movement you can transmit immediately by pressing **PTT** knob on the transceiver. Retuning is not required. Do not press **Tune** knob.

6.5. RCU controls



The RCU is a small rugged unit that must be mounted on the vehicle's dashboard and intended for controlling and changing position of the antenna loop. All system messages and readings are displayed on the OLED screen of the RCU. The warning sounds are coming from small openings located on the right edge of the front panel. These openings shall never be closed. The RCU has two buttons on the panel:

⬍ - to change direction of loop movement
Ctrl - reserved button (I)

The ST940B antenna has no ON/OFF switch. The loop servo motor and loop tuning circuits are separated intentionally for security reasons. If installed in accordance with given instructions, antenna will be switched ON or OFF automatically by a power switch of the radioset.

Switching the radioset OFF either intentionally or due to failure of the transceiver will result in automatic folding the loop down.

6.6. Switching ON

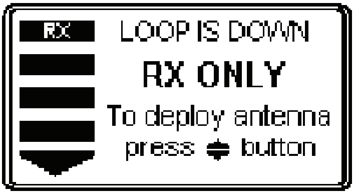
By switching your radioset ON, antenna is energized. Following information will appear on display:

(I)

During first 3 seconds a spinning motor sound can be heard, which is normal. During this time all subsystems of the antenna are being tested and prepared for operation. Antenna loop will remain in initial “parked” position. In this position you can operate you radioset on receiving (scanning) only, transmitting is blocked.

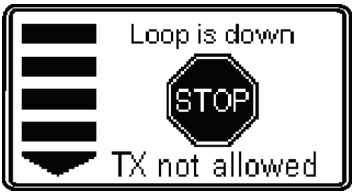
When initializing is completed, the following screen shot will be displayed:

(II)



If **PTT** button is pressed, an attracting continuous sound signal will be given and new screen shot will be displayed for 3 seconds:

(III)

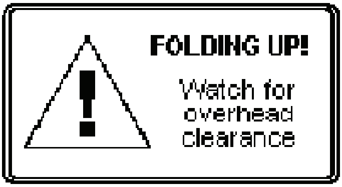


6.7. Folding loop upright

ATTENTION: Always aware there is enough space overhead the antenna when entering low arches. Make sure that there is enough space for the loop movement. Check luggage on the roof rack to ensure that nothing can obstruct loop movement! To fold the loop upright press ⬍ button on the RCU unit momentarily.

An attracting continuous sound signal will be given and following screen shot will appear:

(IV)



Upon passing 3 seconds the screen will turn to display an animated arrow that moves upward for approximately 15 seconds accompanied by short pips until the loop is arrived in the vertical position.

During this time no operating the antenna is possible. Accidental pressing of the **PTT** knob when loop moves in either up or down position will result in giving of warning sound signal and following screen shot will appear for 3 seconds:

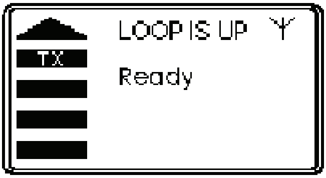
(V)

If, during loop repositioning in either direction the ⬍ knob has been unintentionally pressed, the direction can be immediately changed to opposite at any time by repeated momentarily pressing the ⬍ knob, the animated arrow will change its direction accordingly.

This feature helps to prevent damage to the antenna loop or to bring the antenna in to the concealed parked position promptly.

When the loop is arrived in the vertical position the "completing" three short pips will be given and following screen shot will be displayed:

(VI)



6.8. Tuning antenna to a frequency

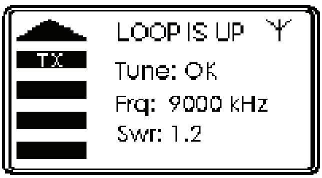
(This chapter is written for NGT, series transceivers only.)

To tune the antenna, select desired channel or frequency and press PTT knob on the transceiver.

NOTE: If the transceiver is in SCAN mode, pressing the **PTT** knob will interrupt Scan mode, however will not result in tuning the antenna.

To tune the antenna, press **TUNE** knob followed by pressing **PTT** knob on the transceiver. The repetitive double pips will be heard and line **"Tuning…"** will be displayed for approximately 3-5 seconds. When tuning is complete a short pip will be given and tuning status message will appear:

(VII)



Now you can operate your transceiver as a normal radioset: Press **PTT** to talk, release for listening. Repetitive depressing of **PTT** knob will not result in retuning the antenna.

IF tuning is not successful or high SWR (more than 2:1) is measured, press **TUNE** knob momentarily followed by pressing **PTT** knob again. If measured SWR is still high you may need to change your vehicle position.

The typical SWR ratio measured within 1.05-1.5 limits is considered as very good matching. The SWR values up to 3.0:1 are considered satisfactory and will almost not affect performance of the system. SWR values more than 3.0:1 may lead in activation of the transceiver’s ALC or PA protection system that usually causes automatic reducing of RF output power.

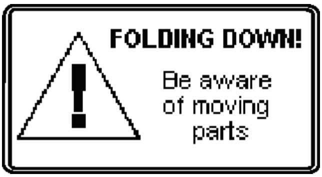
If new channel or frequency is selected, press **PTT** knob for tuning. Antenna will tune to new frequency, operate radioset as usual. It will remain to stay tuned to this frequency until new frequency is selected.

If driven by your network settings, transceiver switches to SCAN mode automatically, depress **PTT** knob to interrupt SCAN mode. Press **PTT** knob again to transmit. Antenna will be retuned.

6.9. Switching OFF

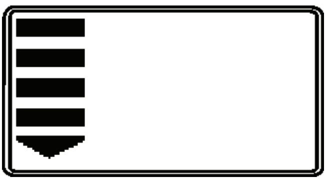
Antenna is switched OFF by an ON/OFF switch of the transceiver. The OLED screen of the RCU goes blank and loop starts to move into parking position automatically. However, it is recommended to use alternative way: prior the switching transceiver OFF, park the antenna by pressing knob . This allows controlling movement of the loop visually. The screen will turn to display message;

(VIII)



Followed by animated arrow;

(IX)

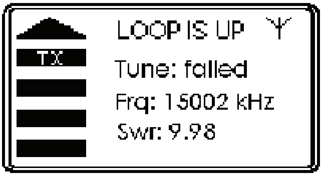


That will end up with the screen shot (II).

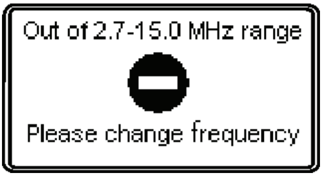
Transceiver can now be switched OFF.

6.10. Diagnostic messages and troubleshooting

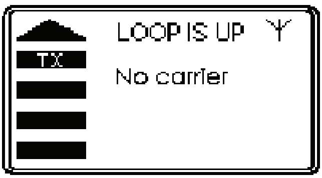
If one of following message is displayed antenna will not tune:



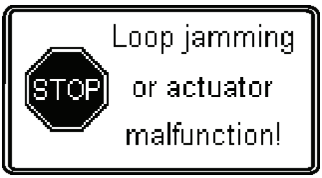
Typical causes are:
- Excessively large conductive luggage loaded onto roof rack. Remove luggage and retune the antenna.
- Accidental contact of the loop with a large metal object. Remove the object and retune the antenna.
- Damage to one of three flexible low loss strip cables that connect the loop, Two cables are located under plastic guard plate at rear loop axle, the third cable is located under high voltage cover at the front. Change damaged cables.
- Damage to RF coaxial cable, change if required.
- Battery voltage is too low. The line voltage should never drop below 11.5 Volts. Excessively long or insufficient power cord size, bad or no contact between radioset grounding post and the vehicle chassis.



Antenna will not tune when transmitted frequency from your transceiver is out of antenna frequency limits. Change frequency. Please refer Chapter 6.1 Frequency range.



This message will appear in case of RF coaxial cable cut off or damage to your transceiver circuit. Check the cable and the transceiver. Replace if required.



The typical time required for the loop to change its position is 15 seconds. In case the loop is not arrived in either UP or DOWN position within 30 seconds, the warning sound and screen shot as shown will appear. This situation can be caused by wrongly tied luggage or accident obstacle and may lead in damage to the loop or misalignment of the servomotor assembly. Explore antenna carefully.

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7. Technical description

This section describes the functions of the ST940B antenna system;

- RMR assembly
- ATU assembly
- MU assembly circuits on Printed Circuit Boards (PCB) P/N 9403.01-00 rev 2 and P/N 94030.10 rev 1
- JU assembly circuit on PCB P/N 940040.10 rev 1
- RCU assembly circuit on PCB P/N 94050.10 rev 1

Please refer Section 8 - Appendices at the end of this section containing wiring and schematic diagrams that can be looked while reading the technical description.

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7.1. Rack mounted radiator assembly

(Refer Drawing 940BAX01.10 when reading)

The RMR is a welded aluminium alloy construction that consists of two parts:

- ground plane platform 11, 13
- foldable loop 1

The ground plane 11 is an integral part of the RMR that involved in forming of required radiation pattern diagram and work as mounting frame for the loop, ATU and MU.

The folding loop 1 is mounted to the ground plane 11 by two axle joints with insulating bushings made of Erthacetal. This prevents uncontrolled electrical contact between loop ends and ground plane at mechanic joint points that can lead in random change of loop circumference and tuning point instability.

The electrical continuity of the loop equivalence is achieved through use the low loss flexible jumper cable jointed with loop conductor and the ground plane at rear side and through similar cable that is being an integral part of ATU assembly at front side. The “cold” end of the ATU circuit is then jointed with spring strip welded to ground plane, making entire circuit closed.

At the rear side the loop is shunt fed by a third flexible cable jointed with loop at feeding point 4 and the MU output.

The loop front shoulder is provided with mechanically rigid high voltage insulator 3, which is terminated by the front axle integrated with a lever, which is driven by a linear actuator 7 (servo motor) via push link. This makes possible motorized movement of the loop within 0-90° segment.

The ATU 6 is mounted on the bottom plate 12 through four aircraft type shock absorbers. The linear actuator is mounted to the front bracings welded to the platform. Both the devices are protected by the cover 5, which in conjunction with the bottom plate and the wind deflector 8 forms protective compartment.

The Main Unit 9 is installed between two vertically welded bracings in the centre of rear panel of the platform.

The signal cable between MU and ATU is routed inside the tubular frame profile.

The protective guard plate 10 is inserted into the slot channel in the ground plane and secured with the rear axle nut. It protects all connections located at the back side of the MU.

7.2. Linear Actuator

This device consists of a DC motor that jointed with a backlash-free ball screw through a geared reduction box. When rotating, the ball screw transfers circular motion into linear motion. The gear box reduces speed and increases torque at the end of the push rod. The push rod is then connected with the loop lever via push link.

The DC motor is electrically connected with the inbuilt end switch plate unit, featuring a self locking circuit. The adjustable cam rotor activates two end switches causing disconnection of power at linear movement extremes, so the new movement is possible in opposite direction only, by changing power polarity. The cam rotor can be adjusted so that the loop will move and automatically stop at required positions.

7.3. Antenna tuning unit

The ATU assembly can be considered as a distantly controlled condenser that is connected in series with the loop inductor and tunes it to resonance.

The assembly is hermetically sealed device, which is located under high voltage cover and mounted to bottom plate through four shock absorbers.

It has a very rugged tubular construction terminated by two plates pulled together with three silver clad studs and nuts.

Inside the tube a hi-Q high voltage ceramic envelope variable vacuum capacitor (VVC) and precision stepper motor assembly is installed. The VVC “cold” terminal is connected to the ground through silver plated mounting plate and three studs. The “hot” terminal tip is connected with the impact compensating subassembly (tip) that hermetically projects the feed through Teflon insulator installed in the front plate.

The tip is then connected with the loop through a flexible silver clad Litzendrath cable making the VVC introduced into the loop in series.

In order to increase tuning range at the lower end, one or two fixed high voltage multilayer capacitors can be added in parallel to VVC by means of two high voltage vacuum relays mounted near the VVC.

All internal connections are wired to hermetically sealed I/O connector installed on the back plate.

7.4. Main unit assembly

The Main Unit is microcontroller operated device that measures input frequency, VSWR, optimizes matching conditions and tunes the loop to resonance by driving the motorized VVC in accordance with the Tuning Sequence programmed. For better protection from high intensity RF fields, it communicates with other microcontroller operated devices in the system via differential RS-485 bus.

The MU is a rugged self contained hermetically sealed device mounted at the rear of the RMR. It contains two PCB units installed in two screened compartments.

The RF PCB P/N 9403.01-00 accommodates all circuits involved in RF path, e.g. impedance matching circuit, LNA and the VSWR-meter. The RF input of the MU is terminated by 50 Ohms coaxial Mini-UHF female connector. The RF output of MU is terminated by the special binding post installed at the back side of the MU.

RF path

The transmitter output is coupled by a 50Ω coaxial cable to connector X4. From here, this output is applied through current transformer T1 to the first of three impedance matching inductors L5, L6 and L7 connected in series.

From last inductor L7, the transmitted signal is fed through relay contacts K5/B, K5/C, K6/B and K6/C to the antenna loop feed point.

Current transformer T1, sampling capacitor C8 and associated components form the VSWR bridge circuit. Detected forward and reflected wave voltages provide the microcontroller with information on the tuning of the antenna.

The RF sample passed through capacitor C9 is applied to the RF swing limiting circuit associated with IC DD1/A and DD1/B, that acts as a square wave former and first frequency divider 1:64. From its output the signal is provided to the microcontroller, which executes measurement of the frequency.

The impedance matching circuit consisting inductors L5, L6, L7 shortened by relays K1/B, K2/B and K3/B forms inductive reactance bank able to introduce 8 different positive (inductive) reactance values into the gamma match input in order to compensate negative (capacitive) impedance of the feed point.

When the loop is in upright position, the receive signal follows the reverse path to that taken by the transmit path.

Scan

When manual or automatic scan mode is selected, the antenna is normally required to receive signals over a broad band of frequencies.

To achieve this, the antenna loop is coupled through switched relay contacts K5/C and K5/B to the input of two-stage Low Noise Amplifier (LNA) consisting of transistors Q1, Q2 and associated components. The Field Effect transistor Q2 provides a high input impedance and bipolar transistor Q1 provides 50Ω output impedance to match the receive input of the radioset. When terminated by the receiver, the amplifier has a nominal 6 dB voltage gain.

If scan mode selected and loop is in parked position, the loop is disconnected and replaced with the special integrated scan antenna, e.g. LNA input is switched between antennas by relay contacts K6/B and K6/C.

MU microcontroller

The PCB P/N 94030.10 accommodates main microcontroller circuit, stepper motor driver circuit and RS-485 bus controller circuit. All control signals between both the PCBs and to two sealed signal connectors are made through vibration resistant FPC cables.

The microcontroller DD1 consists of EEPROM, RAM, three timers, 8-channel ADC and four 8-bit I/O ports and is clocked at 8 MHz rate.

There a number of components connected to IC DD1 which enable it carry out the tuning process:

DD3 — This IC converts data from the microcontroller into RS-485 data protocol.

DA1 — 5VDC voltage stabilizer

DA3 — This IC provides the 2-phase current to drive a bipolar stepper motor. The motor is driven in WPM mode under software control.

Q8-Q9 — These transistors, controlled by the microcontroller, energize the relays K1 and K2 installed in the ATU assembly to connect additional high voltage capacitors in parallel to VVC.

Q3 — This transistor energizes relay K1, whose contacts change polarity applied to the linear actuator motor to change direction of loop movement.

Q2 — This transistor provides information to the microcontroller on whether or not the loop has arrived to one of its two possible positions.

MU tuning sequence

1. When transceiver is switched on, the ST-940B antenna circuits are energized.
2. The MU microcontroller, under software control stored in the ROM, generates a command,

consisting of burst of steps sent to DA3 and to the stepper motor, which drives the VVC in position of maximum capacity. This makes the VVC initialized to the controller; VVC position data is then recorded in the RAM and stored until next change of VVC position. At the same time MU microcontroller sets LOW on pin 26 and, through Q3 and contacts of relay K1/B and K1/C brings the loop in folded down position and informs through the RS-485 bus the RCU microcontroller, which generates appropriate information displayed on the RCU screen. Before operating the antenna, the loop must be folded up by pressing knob ⬍ by the operator.

3. When command TUNE START is received from the JU microcontroller, the MU microcontroller checks whether or not the loop is in vertical position and whether or not the RF power is applied to the RF path is exceeds 4 Watts PEP.
4. If information from those two sources is positive, the MU microcontroller initiates tuning cycle. If either of sources is silent or negative, the TUNE START request is rejected and a data is sent to the JU and RCU microcontrollers. The JU microcontroller informs transceiver with TUNE FAIL and JU microcontroller generates appropriate message or symbol to be displayed.
5. The microcontroller measures input RF frequency applied to pin 40 from the first divider on RF PCB by comparing it with the 8 MHz clock.
6. The measured value is now being checked whether it is within or out the default limits of the antenna tuning range and whether or not additional fixed capacitors are required. At the same time, the measured value is also compared with the default lookup table stored in the EEPROM and selects one of eight default matching inductance values through transistors Q3-Q5 and relays K1-K3.
7. If measured frequency is out of the antenna tuning range, the tune cycle is aborted and RCU microcontroller generates appropriate message displayed on the screen.
8. Microcontroller generates command to stepper motor to spin towards minimum capacity and searches for a best attainable tuning point measuring FWD and REF power and calculating VSWR values before ending the tuning sequence

with a “TUNE PASS” signal.

9. Stored data obtained from last 16 tuning cycles is then compared with new frequency in order to determine the direction in which to start driving the tuning assembly. If next measured frequency is concurs with one of the stored 16 frequencies, the “fast tuning” is then executed without making new measurements through entire range but just measurements in the 10 step positions preceding the previously memorized position.
10. The “TUNE PASS” and “TUNE FAIL” are indicated to the transceiver by the logic levels of the **Ind** at the release of the **Tune** line. The “TUNE PASS”, “TUNE FAIL”, measured frequency and VSWR values data is sent via RS-485 bus to RCU unit where they indicated on the OLED display in usual form.

7.5. Junction unit

The Junction Unit is a microcontroller operated device that provides flexible interfacing of the entire system with variety of radiosets through loading of different interfacing software versions developed to supporting different radiosets protocols. The JU communicates with other ST940B electronic devices via differential RS-485 bus and provides interconnection with a radioset’s external device port.

The JU is a self contained unit that mounted close to a radioset inside a vehicle cabin.

It accommodates the PCB assembly P/N 940040.10 that contains power inlet circuit and following ICs; DD1 – microcontroller; DD3 -differential RS-485 bus transceiver and DD2 - RS-232 controller that used for reprogramming the interface and diagnostics via a PC based service software.

The connector X5 consists four programmable signal ports that link microcontroller I/O ports on pins 1,2, 9, 10, 12-15 and transceiver control signals through bidirectional buffers consisting transistors Q1-Q4 and Q6-Q9.

When transceiver is switched ON, the positive 5-12VDC is applied to pins 8 and 9 of connector X5 that opens transistor Q5 and 12VDC battery line voltage from pin 1 of connector X4 through switched contacts of relay K1 is applied to energize all circuits of the system. The IC DA1 and associated components form a 5VDC stabilizer.

The microcontroller DD1 consists of EEPROM, RAM, three timers, 8-channel ADC, two 8-bit and one 7-bit I/O ports and is clocked at 8 MHz rate.

JU logic sequence

Note: This is programmable interfacing function to support different radiosets. Below's 9407.20 sequence is written to support Codan NGT series transceivers.

1. When tuning is initiated by the transceiver, the Tune line goes LOW. Transistor Q7 conducts and sets the pin 10 of the microcontroller at LOW.
2. In response, the microcontroller immediately sets HIGH on pins 9 and 1 switching on Q6 to continue to hold Tune line LOW.
3. At the same time Q8 is also switched on and sets Ind line to LOW.
4. Microcontroller verifies above conditions and sends command TUNE START to Main Unit microcontroller trough differential RS-485 bus consisting DD3 and associated components.
5. Main unit controller executes its own tuning sequence.
6. When tuning sequence is completed, the MU microcontroller informs the JU microcontroller about results through the RS-485 bus.
7. Upon the completing the tuning cycle, the JU microcontroller trough Q6 and Q8 informs transceiver with one of two results:

   TUNE PASS - If line Ind goes HIGH advancing by 60 ms the line Tune goes HIGH.

   TUNE FAIL - If line Tune goes HIGH advancing by 100ms line Ind goes HIGH.

8. If scan mode is selected by the operator or automatically by the transceiver, the line Scan goes LOW and trough transistor Q4 applies LOW to pin 12.
9. The JU microcontroller forms command SCAN and informs the MU microcontroller through RS-485 bus.

Note: In the Scan mode, the NGT transceivers first tune antenna to a frequency calculated in accordance with their own

"Scan Tune" sequence and then set line Scan at LOW. During "Scan Tune" there is no tune pips, tune pass is not indicated, but a tune fail is. Refer to Codan 9350 Automatic Tuning Whip Antenna manual.

7.6. Remote control unit

The RCU is a microcontroller operated device that controls antenna loop position and generates all system sound signals, messages and symbols displayed on the OLED screen.

It accommodates OLED PCB and PCB P/N 94050.10 that contains microcontroller and RS-485 circuits.

There a number of components connected to IC DD1 which enable it carry out control functions:

DD3	This IC converts data from the microcontroller into RS-485 protocol
DA1	5VDC voltage stabilizer
DD2	Display module
DA2	Audio Frequency Amplifier
BUZ	Buzzer
SB1	Ctrl Knob (reserved)*
SB2	⬍ Knob

When knob ⬍ is depressed, the RCU microcontroller generates and sends command to MU microcontroller through RS-485 bus to change the loop position.

The all system information addressed by MU microcontroller to RCU microcontroller is then translated to sound signals and symbols displayed on the screen.

* By pressing this knob, the Interfacing software version and antenna tuning limits are displayed for reference.

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8. Appendices

NOTES:

All repair works on the ST940B antenna system must be carried out by authorized and trained personnel only.

In case of necessity to conduct any repair works on the ATU assembly, it is strongly recommended to replace all rubber rings and Celica Gel cartridge each time of reassembling the Unit., in order of ensuring impermeability of the ATU housing. We do not recommend disassembling of this device without evident necessity and by not trained personnel as it may lead in damage of fragile and extremely expensive components.

All spares and special repair kit, containing necessary rubber rings and special grease are available on request.

A CD containing configuration and diagnostic software is available for authorized dealers.

Custom mounting brackets, adaptor cables, replacement strip cables and custom length cables are available on request.

Custom interfacing software for transceivers other than mentioned in this manual is available on request.

ATU - PARTS LIST

Assembly P/N 94020
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
K1, K2	SPST Vacuum Relay	RF6C-12S		TC40.030
X5	12 Pin ATU - CPU Connector	62IN-57A-12-12S-624		
X7	4 Pin ATU - Actuator Connector	62IN-57A-8-4S-624		
C2-C6	Multilayer Ceramic Capacitor 5KV 200 pF +/-5% Strip Leads	1031/2000J/JEO TYPE103		Ref TC40.014
C1	Variable Vacuum Capacitor 5-500 pF +/-10%, 8kV	CVBA-500BC2004152/8		HV tested
M1	Linear Actuator Motor	E57H46-27-002ENGEA	ST23.002EN	
M2	Linear Actuator	DARL3606	ST3606/12	TC40.089

Main Unit - PARTS LIST

Assembly P/N 94030
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
X18	12 Pin MU-ATU Connector	Amphenol 62IN-57A-12-12S-219-624	Custom	TC
X9	6 Pin MU-JU Connector	Amphenol 62IN-57A-10-6S-219-624	Custom	N/A

Main Unit - PARTS LIST (continued)

PCB Assembly P/N 9403.01-00 rev 2
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
K5, K6	DPDT Relay 2A 6GA	6GA-2X4P-ST(40)-US		
K1, K2, K3, K4	SPDT Relay 3A 6GE	6GE-1X4P-US		
X3	FFC Connector	52610-1290		
X4	Mini UHF Female Custom Connector	M-B215-3	ST215-3	TC40.04
X2	Conn. Recept Coax. FL2 Series SMD	S.FL2-R-SMT(C) (10)		
D4, D7, D8, D9, D11	SMD Diode, Si High speed 75V	BAS16		
D3, D5, D6	Double Diode	BAV99		
D1, D2	Diode	BAT54		
Q1	RF Transistor SOT-23(BEC)	PMBT3904		
Q8	Unipolar Transistor PNP SMD SOT-23	BC807		
Q3, Q4, Q5, Q7, Q9	Transistor 45V NPN SMD SOT-23	BC817		
Q2	Transistor	BF51X		
C5, C6	Ceramic Capacitor 33n C1206			
C9	Ceramic Capacitor 4.7p C1210	501S41C4R7CV4E		
C1, C2, C7	Ceramic Capacitor 120p C0805	GRM2165C2A121JA01D		
C14	Ceramic Capacitor 470p C0805	GRM2165C1H471JA01D		

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
C18	Ceramic Capacitor 10n C0805	C0805KRX7R9BB103		
C3, C4, C11, C12, C13	Ceramic Capacitor 33n C0805	GRM219R71H333KA01D		
C10, C16	Ceramic Capacitor 100n C0805	GRM21BR71H104KA01L		
C15, C17	Bi-Polar Capacitor 10u 16V T491(sizeB) TAJB	T491B106M016AS		
C8	CAP 3.0-10PF 4X4.5MM TOPADJ WHT	TZB4Z100BA10R		
L3, L4	Power Inductor 150mH CM322522	CM322522-101K		
L1, L2	Power Inductor 1mH CM453232	CM453232-102K		
L5	Inductor 1uHn		9403.1-00.10	
L6	Inductor 0,5uHn		9403.1-00.20	
L7	Inductor 0,25uHn		9403.1-00.30	
R6, R13	Resistor 47 1/8, +/-5% R0805	9C08052A47R0JLHFT		
R10	Resistor 100 1/8, +/-5% R0805	9C08052A1000JLHFT		
R8	Resistor 330 1/8, +/-5% R0805	9C08052A3300JLHFT		
R7	Resistor 390 1/8, +/-5% R0805	9C08052A3900JLHFT		
R1, R2	Resistor 100 1W, +/-5% R2512	ERJ-1TYF101U		
R9	Resistor 1k 1/8, +/-5%R0805	9C08052A1001JLHFT		
R5, R44	Resistor 5k6 1/8, +/-5%R0805	9C08052A5601JLHFT		
R41	Resistor 10k 1/8, +/-5% R0805	9C08052A1002JLHFT		

R3, R4	Resistor 100k 1/8, +/-5%R0805	9C08052A1003JLHFT		
R11, R12	Resistor 39k 1/8, +/-5%R0805	9C08052A3902JLHFT		
DD1	Dual 4-Bit Binary Counter	SN74HC393D		
T1	TRANSFORMER		9403.1-00.40	TC40.10

Main Unit - PARTS LIST (continued)

PCB Assembly P/N 94030.10 rev 1
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
D5	Schottky Rectifier DSO-C2/X3.3	30BQ060		
D4, D7, D13	Diode SOT-23	BAS16		
D1, D2, D3, D8, D9, D11, D12	Double Diode SOT-23	BAV99		
D10	Light Emitting Diode	LED3		
Q4, Q6	General Purpose Transistor SOT-23(BEC)	BC807		
Q1, Q2, Q3, Q5, Q7	General Purpose Transistor SOT-23(BEC)	BC817		
C5, C6	Ceramic Capacitor 1n C0805	0805CG102J9B200		
C30, C32	Ceramic Capacitor 4,7n C0805	08052R472K9B20D		
C7	Ceramic Capacitor 5.6 n C0805	08052R562K9B20D		
C3	Ceramic Capacitor 10n C0805	C0805KRX7R9BB103		

C8, C9, C28, C29, C20, C33	Ceramic Capacitor 33n C0805	GRM219R71H333KA01D		
C4	Ceramic Capacitor 68n C0805	GRM21BR71H683KA01L		
Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
C10, C11, C13, C15, C16, C17, C22, C23, C24, C25, C26, C27	Ceramic Capacitor 100n C0805	GRM21BR71H104KA01L		
C2	Ceramic Capacitor 220n C0805	GRM21BR71H224KA01L		
C31	Bi-Polar Capacitor 10u 16V T491(sizeB) TAJB	T491B106M016AS		
C14, C18, C21	Bi-Polar Capacitor 100u 6,3V T491(sizeB) TAJB	T495B107M006AS		
C1, C12	Bi-Polar Capacitor 100u 16V T491(sizeD) TAJD	T491D107K016AS		
L1, L6, L7	Power Inductor 100uH CM453232	CM453232-101K		
L2	Power Inductor 4,7mH B82793	B82793C0475N265		
L3	Power Inductor 10uH	DQ1280-100M		
L4, L5	EMI Filter SQD508505	SQD508505-202		
K1	Relay 6GEA	6GA-2X4P-ST(40)-US		
DD1	ATmega TQFP44	16L-8AI		TC40.90
DD2	SOIC16DW	IL485		

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
DA1	Precision 500mA Regulator SIP-G3/C7.4	L78M05ABDT		
DA3	POWER SO-36	L6208PD		
DA2	DC/DC converter TYL	TYL 05-05S30		
R10	Resistor 560 1/8, +/-5% R0805	9C08052A5600JLHFT		
R11	Resistor 390 1/8, +/-5% R0805	9C08052A3900JLHFT		
R16, R25, R48	Resistor 0R 1/8, +/-5% R0805	9C08052A0R00JLHFT		
R46	Resistor 120 1/8, +/-5% R0805	9C08052A1200JLHFT		
R38	Resistor 620 1/8, +/-5% R0805	9C08052A6200JLHFT		
R18, R19, R50, R51, R52	Resistor 1K 1/8, +/-5% R0805	9C08052A1001JLHFT		
R45, R47	Resistor 1,5k 1/8, +/-5% R0805	9C08052A1501JLHFT		
R12	Resistor 4k7 1/8, +/-5% R0805	RC0805FR-074K7L		
R23, R26, R27, R31, R32, R33, R34, R35, R39, R40, R41, R44	Resistor 5k6 1/8, +/-5% R0805	9C08052A5601JLHFT		
R20, R21, R22, R24, R28, R29, R42, R43, R49	Resistor 10k 1/8, +/-5% R0805	9C08052A1002JLHFT		
R13, R14	Resistor 39k 1/8, +/-5% R0805	9C08052A3902JLHFT		
R9, R25, R48	Resistor 100 1/8, +/-5% R0805	9C08052A1000JLHFT		

R15, R36, R37	Resistor 100k 1/8, +/-5% R0805	9C08052A1003JLHFT
R1, R2, R3, R5, R6, R7, R53, R54, R55, R57, R58, R59	Resistor 1R2 1/4W, +/-5%R1206	9C12063A1R20FGHFT
X1	FFC Connector 52610-1690	52610-1690
X2	FFC Connector 52610-2290	52610-2290
X3	FFC Connector 52610-1290	52610-1290
X4	Prog. Connector 53398-0690	53398-0690
X1	FFC Connector 52610-1690	52610-1690
X2	FFC Connector 52610-2290	52610-2290
X4	Connector WM1768-ND	WM1768-ND
XTAL1	Clock Oscillator 8.000 MHz SG-8002JF	CB3-3C-8.0000-T

Junction Unit – PARTS LIST

Assembly P/N 94040
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
X11	MR7 JU-MU			
X22	MR6 JU-Transceiver			
X16	JU-RC Connector	SR30-10R-6S		
	FPC(JU-7pin)		ST94060.13	JIG-112
	FPC(JU-6pin)		ST94060.14	JIG-114

Junction Unit – PARTS LIST (continued)

PCB Assembly P/N 94040.10 rev 1
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
D1	Diode SOT-23	BAS16		
D5, D6	Double Diode SOT-23	BAV99		
D2, D3	Double Diode SOT-23	BAV74		
D4	Diode Schottky Rectifier DSO-C2/X3.3	30BQ060		
Q1, Q4, Q7, Q9	Transistor SOT-23(BEC)	BC807		
Q2, Q3, Q5, Q6, Q8	Transistor SOT-23(BEC)	BC817		
C30, C32	Capacitor 4,7nF C0805	08052R472K9B20D		
C7, C8, C16, C17, C18, C19, C20, C21, C24, C25, C26	Capacitor 100n C0805	GRM21BR71H104KA01L		
C6, C22, C23	Electrolytic Capacitor 100u	CAP100X25		
C1, C2, C3, C13	Bi-Polar Capacitor 1u 35V T491(sizeB) TAJB	T491B105K035AS		
C14, C15	Bi-Polar Capacitor 10u 16V T491(sizeB) TAJB	T491B106M016AS		
L1	Power Inductor 15uH B82477G4	B82477G4		
L2	Power Inductor 4,7mH	B82793C0475N265		

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
L3	EMI Filter SQD508505	SQD508505-202		
DD1	RISC Microcontroller TQFP32	ATmega8L-8AI		TC40.90
DD2	Driver RS-232 SO-G18/X.6	MAX222EWN		
DD3	Driver RS-485 SOIC16DW	IL485		
DA1	Precision 500mA Regulator SIP-G3/C7.4	L78M05ABDT		
DA2	DC/DC converter TYL	TYL 05-05S30		CNL
R25, R48	Resistor 0 1/8, +/-5% R0805	9C08052A0R00JLHFT		
R12	Resistor 100 1/8, +/-5% R0805	9C08052A1000JLHFT		
R46	Resistor 120 1/8, +/-5% R0805	9C08052A1200JLHFT		
R16, R22, R28, R32	Resistor 200 1/8, +/-5% R0805	9C08052A2000JLHFT		
R26	Resistor 1k 1/8, +/-5% R0805	9C08052A1001JLHFT		
R45, R47	Resistor 1,5k 1/8, +/-5% R0805	9C08052A1501JLHFT		
R17, R20, R21, R24, R27, R30, R31, R34	Resistor 5k6 1/8, +/-5% R0805	9C08052A5601JLHFT		

R3, R4, R10, R11, R13, R15, R18, R19, R23, R29, R33	Resistor 10k 1/8, +/-5% R0805	9C08052A1002JLHFT	
X1, X5	FFC Connector 52610-1490	52610-1490	
X2	FFC Connector 52610-0890	52610-0890	
X3	Board mount Pin Connector DB9M	DB9M	SS
X4	Power Connector Header 2POS 10MM R/A GOLD 42820-2213	42820-2213	
X6	Prog. Connector 53398-0690	53398-0690	
XTAL1	Clock Oscillator 8.000 MHz SG-8002JF	CB3-3C-8.0000-T	
K1	Relay G2R-1-E	G2R-1-E-DC12	
F1, F2	Fuse MF-R090	MF-R090	
F3	FUSEHOLDER_5X20	03450121H	
	FUSE 5A FAST ACTING 5x20	0217005.H	

Remote Control Unit – PARTS LIST

PCB Assembly P/N 94050.10 rev1
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Issue 1

Part/Dwg Number	Description	Manufacturer's P/N	Stealth P/N	Remarks
SP1	Speaker GT-0950RP3	GT-0950RP3		
SB1, SB2	Button TP1103	TP1103	CO	JIG090
D5	Diode Schottky Rectifier DSO-C2/X2.3	10BQ060		
D11, D12	Double Diode SOT-23	BAV99		
C30, C32	Ceramic Capacitor 4.7n C0805	08052R472K9B20D		
C13, C16	Ceramic Capacitor 39n C0805	ECJ-2VB1H393K		
C1, C2, C3, C5, C7, C9, C12, C15	Ceramic Capacitor 100n C0805	GRM21BR71H104KA01L		
C14	Bi-Polar Capacitor 4.7ux16V T491(sizeB) TAJB	T491B475K016AS		
C10	Bi-Polar Capacitor 47ux6,3V T491(sizeB) TAJB	TAJB476K006R		

C6, C11	Bi-Polar Capacitor 100ux6,3V T491(sizeB) TAJB	T495B107M006AS	
C4, C8	Bi-Polar Capacitor 100ux16V T491(sizeD) TAJD	T491D107K016AS	
L1	Power Inductor 10uH B82477G4	DQ1280-100M	
L2	Power Inductor 4,7mH B82793	B82793C0475N265	
L3	EMI Filter SQD508505	SQD508505-202	
DD1	RISC Microcontroller TQFP64	ATmega 128L-8AI	TC40.60
DD2	OLED Display BL12864C	BL12864C	JIG117
DD2	Driver RS-485 SOIC16DW	IL485	
DA1	Precision 500mA Regulator SIP-G3/C7.4	L78M05ABDT	
DA2	Audio Amplifier	TPA741DGNR	
R10, R13	Resistor 100 1/8, +/-5% R0805	9C08052A1000JLHFT	
R46	Resistor 120 1/8, +/-5% R0805	9C08052A1200JLHFT	
R45, R47	Resistor 1,5k 1/8, +/-5% R0805	9C08052A1501JLHFT	
R18	Resistor 3k9 1/8, +/-5% R0805	9C08052A3901JLHFT	
R11, R12, R14, R16, R19	Resistor 5k6 1/8, +/-5% R0805	9C08052A5601JLHFT	
R2, R2, R17, R20	Resistor 10k 1/8, +/-5% R0805	9C08052A1002JLHFT	
R15	Resistor 39k 1/8, +/-5% R0805	9C08052A3902JLHFT	
25	Resistor 0 1/8, +/-5% R0805	9C08052A0R00JLHFT	

	20 pin OLED to PCB (RC) Connector PZC20SZAN	PZC20SZAN	SA-RUB-ST
X2	Prog. Connector 6POS 1.25MM VERT SMD	53398-0690	
X13	Connector RC to JU 6POS 1.25MM R/A SMD	53261-0690	
XTAL1	Clock Oscillator SG-8002JF 8.000 MHz	CB3-3C-8.0000-T	