IMAGENEX TECHNOLOGY CORP.

DT360Xi

360° Multibeam Sonar System

User Manual

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Acronyms and Abbreviations

Acronym	Definition
GB	Gigabyte
IP	Internet Protocol
LAN	Local Area Network
MBES	Multibeam Echosounder
PC	Personal Computer
RAM	Random Access Memory
TCP	Transport Control Protocol
UDP	User Datagram Protocol
USB	Universal Serial Bus
VDC	Volts Direct Current

1. INTRODUCTION

The DT360Xi is an advanced high-speed, high-resolution multibeam echosounder system (MBES) that has the capability to scan in a 360° arc with an along-track transducer beamwidth of 0.7°. Its primary use is for applications that require all-round profile points for example internal bores, pipelines, flooded structures and caves and caverns.

The system consists of an underwater sonar head connected by an Ethernet cable to a surface personal computer (PC). A top-side power supply supplies operational power via the same cable.

The effective beamwidth is selectable at 0.75°, 1.5° and 3° and the number of beams are selectable at 360, 720 and 1440 beams. Data is acquired at full resolution every shot but processing the data for screen display on a PC can slow the system at highest number of beams. 360 Beam mode is therefore recommended for real time data acquisition and data can then be played back at the high-resolution of 1440 beams.

The general features are:

Frequency	2.25 MHz
Transducer Beam Width (Nominal)	360° x 0.7°
Effective Beam Widths	Narrow: 0.75° Medium: 1.5° Wide: 3°
Minimum Range	0.25m
Maximum Range	10 m
Maximum Frame (Ping) Rate	20 Hz
Maximum Operating Depth	1000 m

Table 1 General Features

2. GETTING STARTED

The DT360Xi was designed to be user friendly and simple to set up. The following paragraphs detail the recommended considerations and set-up:

2.1. HARDWARE INSTALLATION

- It is recommended that the 4 X mounting holes be used to secure the sonar to a retaining frame (highlighted in red below). The transmitter and receiving transducers should be clear of any obstruction and have a clear view of any targets:

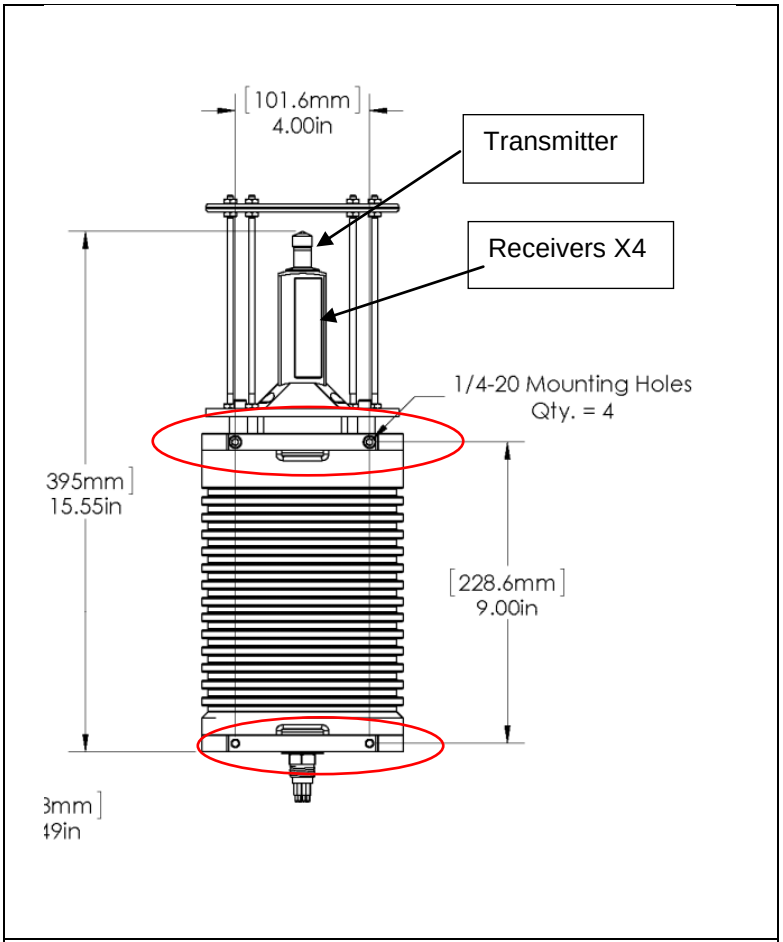


Figure 1 Mounting Arrangement

- The sonar is designed to be mounted in the horizontal plane with the sonar scanning vertically, but may be mounted vertically with horizontal scanning.

- Ensure 24 (22 – 32) VDC @ 1 A minimum power supply is connected but remains off.
- Connect the RJ45 connector to the PC's network port or USB to Ethernet adapter.
- Connect the underwater connector to the sonar.
- Power up the DT360Xi.
- Configure the IP address in Windows™ see 2.2 Software Setup.
- Launch the DT360Xi_vxxxx.exe program.

The minimum requirements for the user supplied PC are:

- Intel i5 or equivalent.
- Windows™ 7.
- 8 GB RAM.
- Available discreet Gigabit Ethernet port, supported by a Realtek PCIE GBE family chipset (not an FE family chipset). If an external Ethernet to USB adapter is used, a high specification USB 3.0 Gigabit Ethernet Adapter is recommended. The TP-LINK Model UE300 appears to work well.
- Minimum software screen resolution is 1024 x 768.
- 1 TB Hard drive.

2.2. SOFTWARE SETUP

The sonar head needs to run with a static IP (Internet Protocol) address for both head and PC. The IP Address of the PC must be set to **192.168.0.X** where X is any number between 3 and 254. The subnet mask is set to **255.255.255.0**. These settings can be found in the 'Network Connections' item in the 'Control Panel'.

The IP Address of the sonar head is fixed at **192.168.0.2**.

See APPENDIX B Ethernet Setup Guide.

The software runs on a PC via an executable file DT360Xi_vxxxx.exe where xxxx is the version number. The latest version is available on the Imagenex Technology Corp. website (https://imagenex.com/interior-page/software-download). Associated with the executable file is an INI file, which is automatically created upon start-up if not present in the folder used to run the executable. This file holds the settings of the program and reloads them subsequently.

Figure 2 Software User Interface shows the interface with associated information. Most are self explanatory. Some items report software parameters whilst others allow control of the sonar.

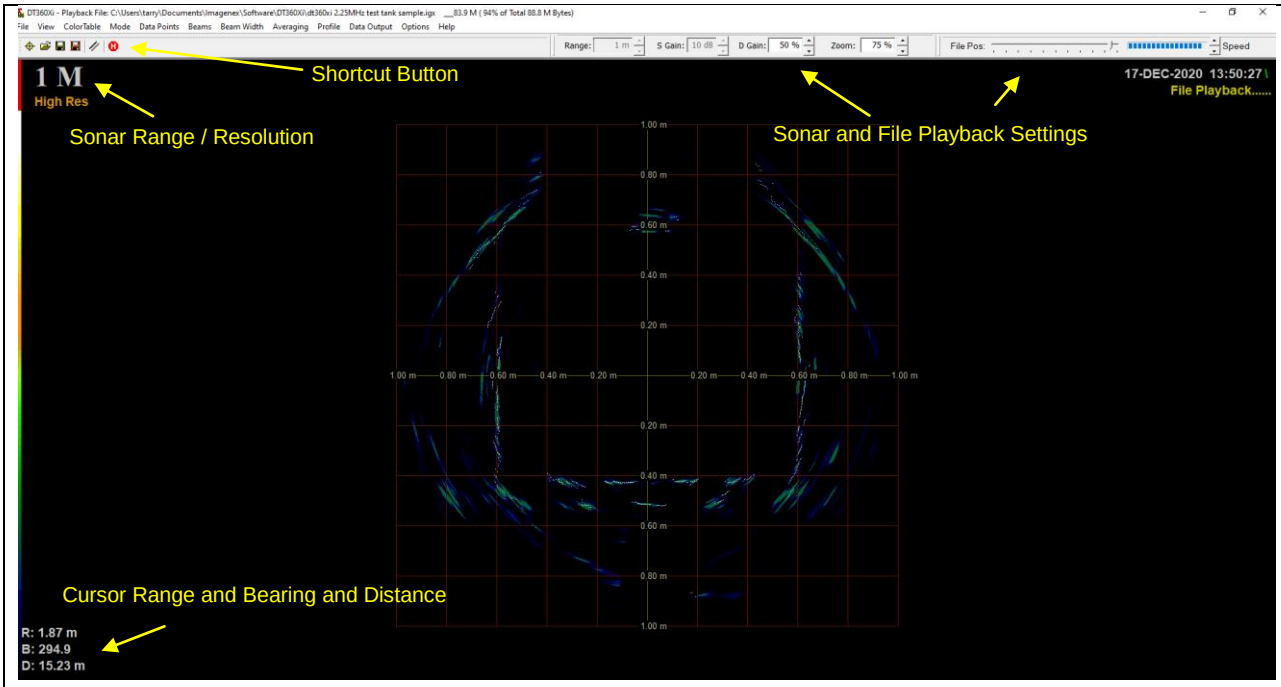


Figure 2 Software User Interface

2.2.1. Shortcut Buttons

	Realtime connection to sonar
	Open file for data playback
	Record real time data
	Stop recording real-time data
	Take distance measurement between points on the screen
	Hold display

Table 2 Shortcut Buttons

2.2.2. Controls:

Range (Real-time only). Range is adjustable between 0.5m and 10m and sets the expected maximum range to target. It should be monitored and adjusted according to the expected target distance from the sonar.

S Gain (Real-time only): Gain can be set between 0dB and 20dB. Sets the gain value of the sonar. It should be monitored and adjusted according to propagation conditions, range to target, ambient noise and other such factors. Adjustment should be made when the sonar is in High Mix mode (see section 3.9.1 Profile > Profile Mode), as this mode displays intensity and gives a better indication of the saturation levels of the internal receivers.

Recommended value: Start at 5 dB and adjust up or down. Optimum when sufficient returns but not saturated

D Gain: Adjust the display threshold so that sufficient data is displayed and no saturation of the display occurs. Adjustment of Display Gain does not impact the recorded data nor the sonar return performance. It is only used to optimise the display saturation.

Recommended value: 50% during data acquisition

Zoom: Zooms the display in and out between 50% (zoomed out) and 300% (zoomed in). This allows the user to zoom in to features of interest.

2.2.3. Displays

Range and resolution (top left): Displays the range and resolution set.

Date, time and recording status are displayed (top right).

R: Displays the cursor distance in metres from the sonar transmitter.

B: Displays the bearing between the cursor and the zero angle plain. Zero angle is the vertical +Y axis of the display.

D: Displays the sonar distance along track (sometimes called chainage). Comes from the Cable Counter input value. (see 3.11.2 Options > Cable Counter Input….). Note that this value may also pertain to Depth if the sonar is being deployed vertically for example into a borehole.

3. SOFTWARE MENUS

3.1. FILE

3.1.1. File > Real Time

Connects to the sonar head.

3.1.2. File > File Playback

Data can be replayed from a previously recorded file from the Open File Dialog.

3.1.3. File > Record (.IGX Format)

Records an IGX format file to the path and filename specified in the Save Dialog. A default file name is generated based on date and time, but this may be changed. It is recommended that during operations, IGX files are logged throughout. This will be beneficial during support if required.

3.1.4. File > Record (B96 Format)

Not implemented

3.1.5. File > Record (P96 Format)

Not implemented

3.1.6. File > Stop Recording

Stops the recording process.

3.1.7. File > Auto File Size

If enabled, Sets the maximum file size to 1,2,3,4 GBytes.

3.1.8. File > Convert .IGX to .xyz

The user specifies a previously logged .IGX file and a points cloud file is created with each point having an X, Y and Z coordinate. The X and Y points are derived from a simple polar to rectangular conversion using the scan angle and range data, and the Z is incremented by the cable counter input.

The generated XYZ file is a (tab delimited text file) with format as follows:

PC Date<tab>PC Time<tab>X<tab>Y<tab>Z.

3.1.9. File > Save Screen

Makes a bitmap (BMP) of the current screen and allows the user to specify a save location for it.

3.1.10. File > Exit

Writes the current settings to the .INI file then closes the program

3.2. VIEW

3.2.1. View > Hold

Pauses the current view to allow for inspection of areas of interest. It performs the same function as the  icon

3.2.2. View > Clear Screen

Clears the sonar image display

3.2.3. View > Units

Select metres or feet for range data

3.2.4. View > Grid

Select no grid, a polar (circular) grid or a rectangular grid.

3.2.5. View > Display Range Mark

Enable display of range marks of axis of display.

3.3. COLOUR TABLE

Allows various colour combinations (background and scan) to be selected.

Used to change the sonar data colour palettes for the sonar images. DT360Xi uses a colour table to represent echo data strength (amplitude). For example, the Normal High intensity colour table maps the echo data amplitude to 256 colours ranging from black (low strength level) through blue, green, orange, yellow, white, and red (highest strength level).

The Colour Table menu offers the following options:

Normal High	Standard colour table used for mapping the echo data amplitude to 256 colours ranging from Black (low level), through blue, green, orange, yellow, white, and red (highest level)
Normal Low	Same colours as Norm Hi, but uses a lower colour intensity
Green	256 shades of green
Grey	256 shades of grey (white on black)
Reverse Grey	256 shades of Grey (black on white)
Brown/Yellow	256 mixed shades of brown and yellow
Green/Blue	256 mixed shades of green and blue
Green/Yellow	256 mixed shades of green and yellow
Blue	256 shades of blue

Table 3 Colour Table

3.4. MODE

3.4.1. Mode > Polar

Displays a polar plot with targets and return intensities.

3.4.2. Mode > Beam Test

Displays the beam test widow showing return from all channels. Not used in normal operations.

3.5. DATA POINTS

Select 500 or 1000 data points.

3.6. BEAMS

Select 360, 720 or 1440 beams for display. Data is acquired at full resolution every shot but processing the data for screen display on a PC can slow the system at highest number of beams. 360 beam mode is therefore recommended for real time data acquisition. The data can then be played back at highest resolution (1440 beam).

3.7. BEAM WIDTH

Select:

- Processed 1 – 3°
- Processed 2 – 1.5°
- Processed 3 – 0.75°

3.8. AVERAGING

This selection is useful in the elimination of spurious returns. Depending on selection (Off, 3 shots, 5 shots, 7 shots or 9 shots) returns are averaged and the average value plotted. Spurious outliers are thus removed. The value selected will affect the speed of plotting as the sonar will be required to wait for for example 3, 5, 7 or 9 shots (dependent on selection) to be returned before plotting, which will adversely affect speed.

3.9. PROFILE

3.9.1. Profile > Profile Mode

One of the following can be selected:

- High Mix: Image data is displayed at the normal intensity along with the generated profile points.
- Med Mix: Image data is displayed at the half intensity along with the generated profile points.
- Low Mix: Image data is displayed at the quarter intensity along with the generated profile points.
- Points Only: Image data is not displayed. The generated profile points are displayed.

3.9.2. Profile > Profile Point Filter

One of the following filters can be used:

- First Return: Displays the first return received. This may include return from items in the water column and may not represent a true target.
- Maximum Return: Displays the target with the maximum intensity received during the receive window. This is the recommended setting.
- Bottom Following: Displayed points are based on neighbouring points in order to generate a smooth contour. Objects in the water column which generate weaker returns will not generate profile points.

3.9.3. Profile > Profile Min Range …

Allows the user to set a gate where any returns with a range less than the gate set, are not plotted nor logged. This is useful in eliminating spurious returns if the target's approximate range is known, but should be used with caution.

3.10. DATA OUTPUT

It is possible to output point and beam data on a UDP port for use with additional software. The format (P96 - Point Data or B96 - Beam Data) and the UDP Output IP are selected. Note that if the same PC is used to run both DT360Xi and the third party software, a loopback IP (127.0.0.1) should be used. Port =4040

3.11. OPTIONS

3.11.1. Options > Sonar IP Address…

Realtime only. The Sonar has a default factory setting of 192.168.0.2. If during the ordering of the sonar, a different IP address was requested, the non-default address may be set here.

3.11.2. Options > Cable Counter Input…

Realtime only. A cable counter may be integrated to allow for computation of the distance or depth value. The cable counter must be interfaced via a COM port and the port and baud rate are set. The expected format of the cable counter string is $xx.x,meter<CR><LF>, where xx.x is decimal meters.

3.11.3. Options > Diagnostics…

This opens the diagnostics window that displays data from the sonar head. This includes Format, Operations, Speed and Environmental data.

3.11.4. Options > Sonar Information…

This opens the sonar information window that displays additional data from the sonar head.

3.11.5. Options > Sonar Orientation

Realtime only. This allows the user to specify the orientation of the transducer relative to the direction of travel. If the transducer array is forward with respect to the direction of travel, 'Transducer Fwd' is selected and if aft with respect to direction of travel, 'Transducer Aft' is selected.

A mounting angle can also be set (between -180° and +180°). This is used to the rotate the sonar image by the mounting angle set in the case that the sonar body is not mounted horizontally.

3.11.6. Options > Sound Velocity…

If sound velocity is known, it can be entered here and the ranges will be adjusted accordingly. If unknown, the default of 1500m/s should be used.

3.12. HELP

Displays a dialog with the version number which should be quoted during support requests.

4. ADDITIONAL DOCUMENTATION

The following table details additional documentation that should be referenced when using the DT360Xi system, available on Imagenex Technology Corp. website (https://imagenex.com/support):

No	Document Title
430-046	DT100 Ethernet Troubleshooting Guide
425-043	P96 format

Table 4 Additional Documentation

DT100 Ethernet troubleshooting guide

P96 format

APPENDIX A **DT360XI SPEC SHEETS**

DT360Xi
445-116 JANUARY 2021

IMAGENEX MODEL DT360Xi
2.25 MHz MULTIBEAM PROFILING SONAR

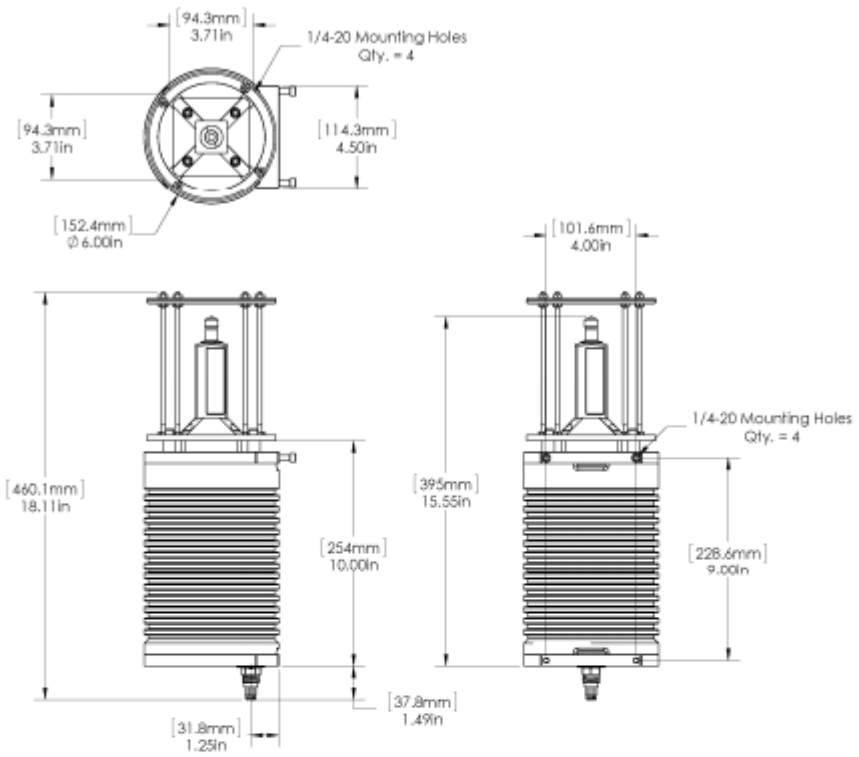
Specifications subject to change without notice

www.imagenex.com

HARDWARE SPECIFICATIONS:	
FREQUENCY	2.25 MHz
TRANSDUCER BEAM WIDTH (nominal)	Horizontal: 360° Vertical: 0.7°
EFFECTIVE BEAM WIDTHS	Narrow: 0.75° Medium: 1.5° Wide: 3°
NUMBER OF BEAMS*	360, 720, 1440
DATA POINTS	500 or 1000
RANGE RESOLUTION	1/500 or 1/1000 of range
MIN. DETECTABLE RANGE	0.25 m
MAX. OPERATING DEPTH	1000 m
FRAME RATE	Up to 20 fps
INTERFACE TO PC	Ethernet (100 Mbps) using TCP/IP
MAX. CABLE LENGTH	100 m on CAT5e (Longer cable runs possible with additional hardware)
CONNECTOR	End mounted, 8 conductor, wet mateable (Subconn MCBH8M-SS)
POWER SUPPLY	24 V Nominal, (22 – 32 VDC) at less than 25 Watts
DIMENSIONS	See drawing
WEIGHT: In Air In Water	~12 lbs (~5.4 kg) TBA
MATERIALS	6061-T6 Aluminum, PVC, Epoxy, Stainless Steel connector
FINISH	Hard Anodize

*Data is acquired at full resolution every shot: processing the data for screen display on a PC can slow the system at highest number of beams. 360 beam mode is recommended for real time data acquisition. The data can then be played back at highest resolution (1440 beam).

SOFTWARE SPECIFICATIONS:	DT360Xi.exe
WINDOWS™ OPERATING SYSTEM	Windows™ XP, Vista, 7, 8, 10
DISPLAY MODES	Polar, Beam Test
RANGE SCALES	0.5 m, 1 m, 2 m, 3 m, 4 m, 5 m, 6 m, 8 m, 10 m
PULSE WIDTH	Automatic with manual multiplier
MANUAL GAIN CONTROL	0 to 20 dB
FILE FORMAT: RAW DATA BEAM POINT	 (filename).IGX (filename).B96 (filename).P96
RECOMMENDED MINIMUM COMPUTER REQUIREMENTS:	2 GHz Pentium 4 256 MB RAM 20 GB Hard Disk 1024 x 768 screen resolution



ORDERING INFORMATION:		
1000 m UNIT	Standard	965-000-301
225 MHz	Option (included)	-003
Xi	Option (included)	-055

APPENDIX B **ETHERNET SETUP GUIDE**

1. INTRODUCTION

The DT360Xi consists of an underwater sonar head connected via Ethernet to a PC running the application software on a PC.

This document covers the setup procedures to enable a Windows™ 10 based PC to communicate with the surface interface processor via Ethernet. Legacy versions of Windows™ (7, XP etc.) have a similar set-up procedure.

1.1. ETHERNET ADAPTER

It is important that the onboard Ethernet port has an adequate specification to accommodate the high data flow rate. The Fast Ethernet (FE) chipset used in some computers does not allow for the required data flow rate and should be avoided. Instead, a chipset supporting Gigabit Ethernet (GBE) should be used.

The details of the onboard Ethernet port are found as follows in Widows 10:

Control Panel > System > Device Manager > Network adapters. (Other versions of Windows may differ)

In the list there may be an FE Family Controller which is **inadequate** or **adequate**:

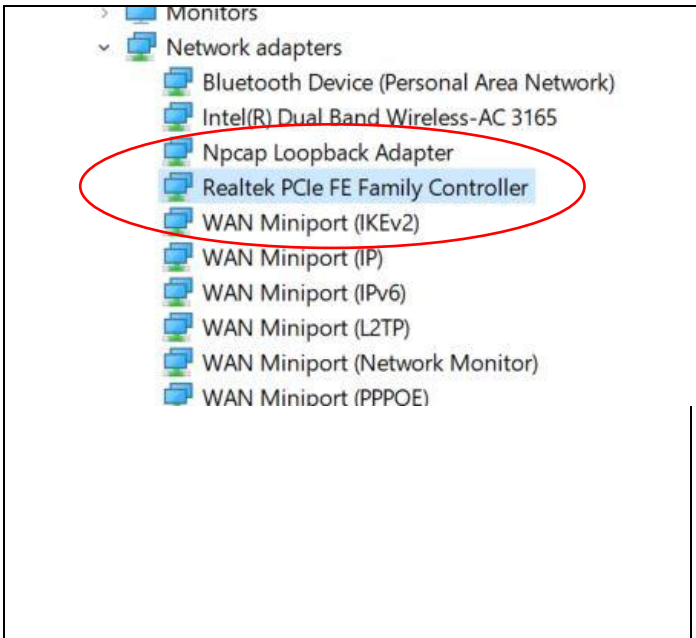


Figure 3 Network Adapters (Inadequate)

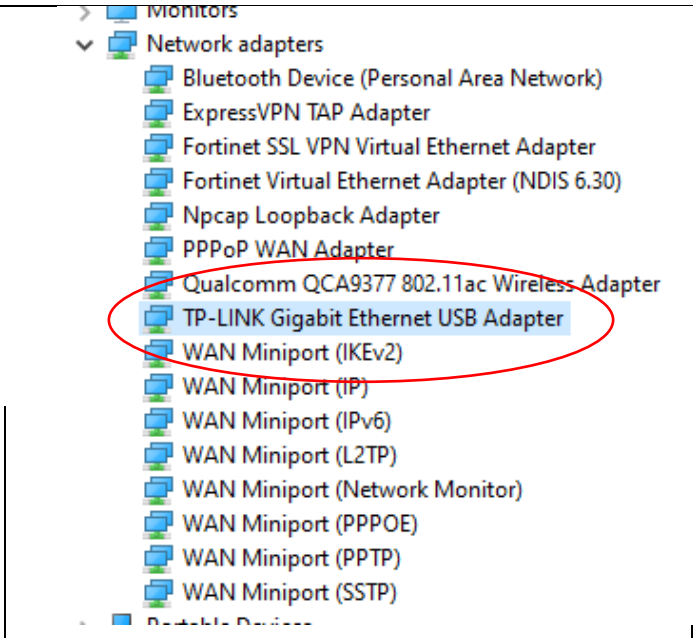


Figure 4 Network Adapters (Adequate)

If the internal Ethernet port supports FE as opposed to GBE, an external USB3.0 to GBE Ethernet adaptor should be used to ensure data flow rates are supported. See 1.5 Connection through a USB – Ethernet Adaptor.

1.2. ETHERNET CABLE

The included Ethernet cable specifications are:

- Cat 5E (or higher).
- RJ-45.
- 568B wiring scheme.

1.2.1. RJ45 568W Wiring

Figure 5 Ethernet Cable below shows the recommended wiring for the standard Ethernet cable:

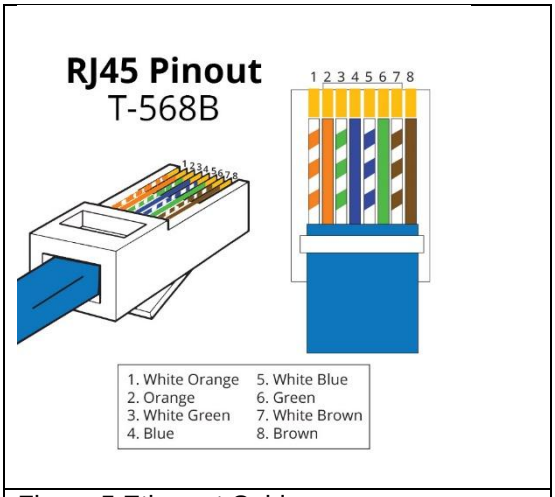


Figure 5 Ethernet Cable

If this cable needs to be replaced, ensure that the above specifications are met.

1.3. DIRECT CONNECTION

Once the correct Ethernet adapter is being used, a standard Cat 5E Ethernet (or higher) cable should be connected between the PC Ethernet port and the surface interface processor (see 1.2 Ethernet Cable). This cable should not exceed 100m in length.

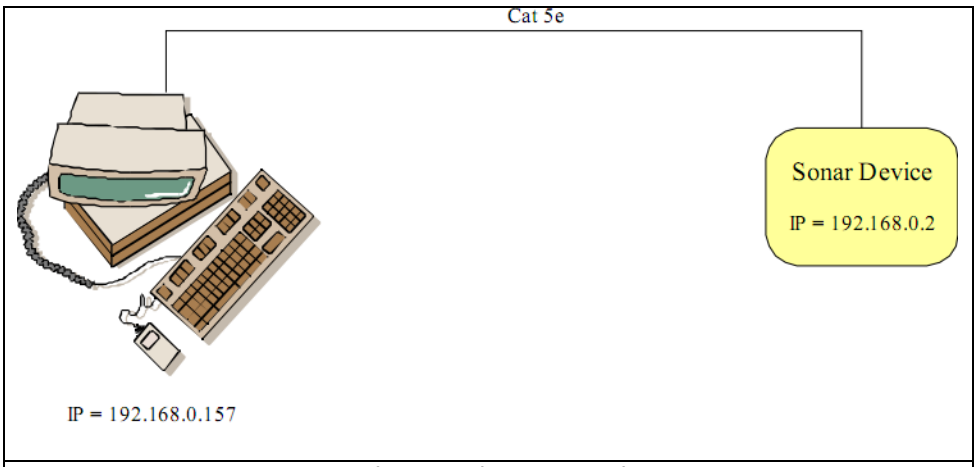


Figure 6 Direct Connection

Where 'X' is a decimal number between 3 and 254 (excluding 1,2 and 10), so the PC's network adaptor IP address could be set to **192.168.0.157,** subnet mask **255.255.255.0.**

1.4. CONNECTION THROUGH A SWITCH OR LOCAL AREA NETWORK

If an Ethernet switch is used, the same considerations as described above should be made, and a Gigabit Switch should be used between the surface interface processor and the PC. All devices can share the 192 domain if they are on the same LAN (see Figure 7 Connection Through a LAN). If a Multi-LAN exists, a router must be used that can separate the domains. In the example below (Figure 8 Connection Through a Multi-LAN) a router is used to separate the 172 and 192 domains.

Again, Cat 5E (or higher) cables should be used and the length per cable should not exceed 100m in length.

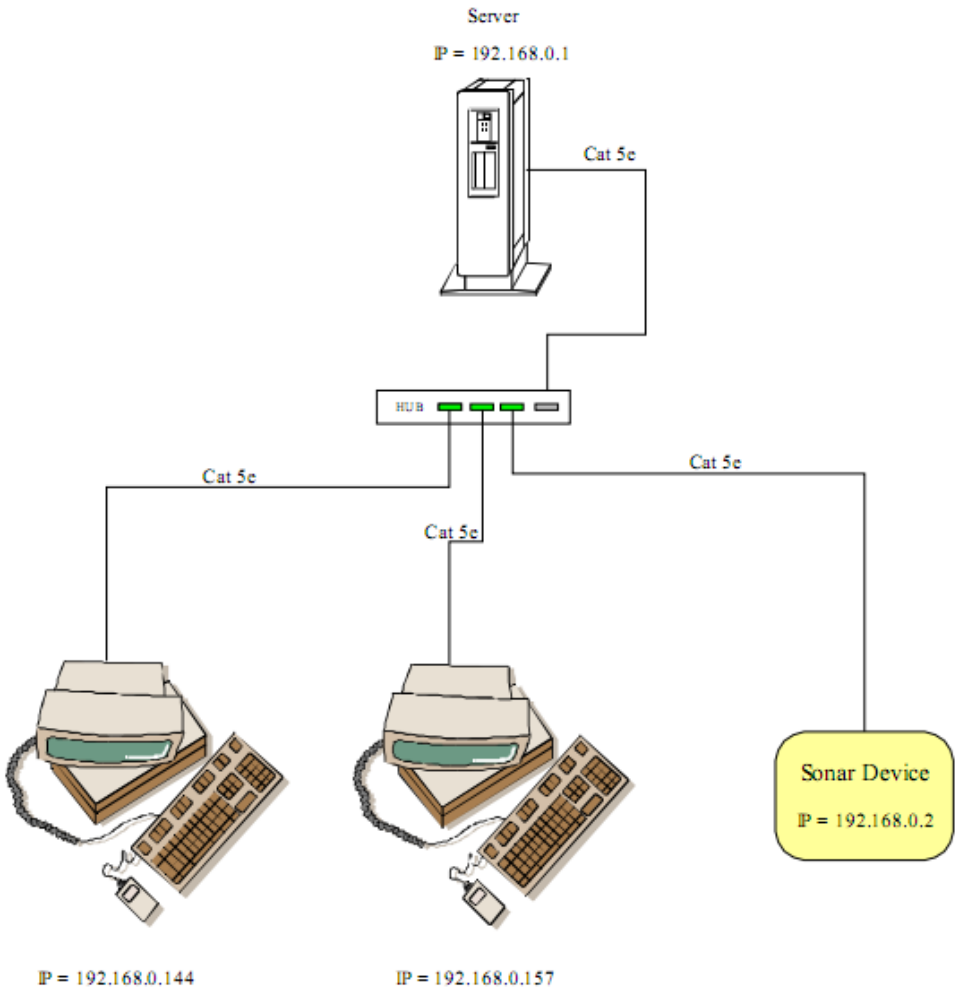


Figure 7 Connection Through a LAN

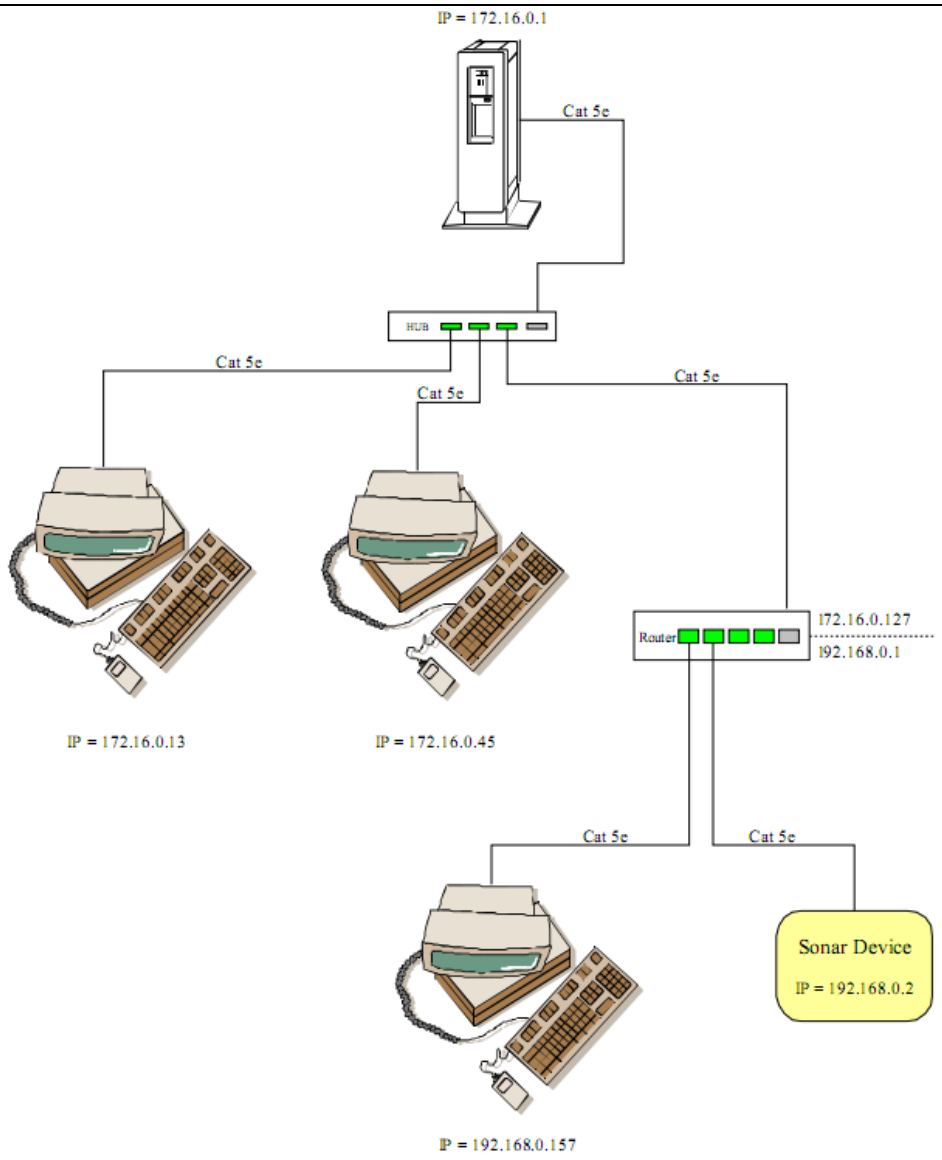


Figure 8 Connection Through a Multi-LAN

1.5. CONNECTION THROUGH A USB – ETHERNET ADAPTOR

The specification of an external USB3.0 to GBE Ethernet adaptor should be used to ensure data flow rates are supported. The adaptor should support Gigabit Ethernet (GBE) and a TP-LINK Model UE300 appears to work well. A USB 3.0 port is recommended as it can transfer 5 GB/s. These ports are normally (but not always) coloured blue.

The PC can be connected to the surface interface processor, either directly or through a Gigabit switch. Again, Cat 5E or higher cables should be used and the cable length should not exceed 100m in length.

2. OPERATING SYSTEM

The connection between PC and surface interface processor is made via Ethernet using the TCP/IP protocols. In order for connection to occur, the TCP/IP parameters must be set-up in Windows™. The following details the set-up process:

2.1. CONFIGURING OF THE WINDOWS™ 10 ETHERNET CONNECTION

The following IP addresses may be set in for the PC's network adaptor:

	IP Address
IP Address	192.168.0.X
Subnet mask	255.255.255.0

Table 5 IP Addresses

Where 'X' is a decimal number between 3 and 254 (i.e. excluding 1, 2 and 255), so the PC's network adaptor IP address could be set to **192.168.0.157,** subnet mask **255.255.255.0.**

Note: The number 192.168.0.1 is reserved for a network server, 192.168.0.255 is reserved for a network broadcast message, and 192.168.0.2 is reserved for the DT360Xi (by default).

This is done as follows (Windows™ 10):

- Navigate to the Control Panel and double click ‘Network and Sharing Centre’.
- Click ‘Change adapter settings’.
- Right click on the Ethernet adaptor you wish to connect with and select ‘Properties’.
- Select ‘Internet Protocol Version 4 (TCP/IPv4)’.
- Click Properties.
- Configure as follows and click OK:

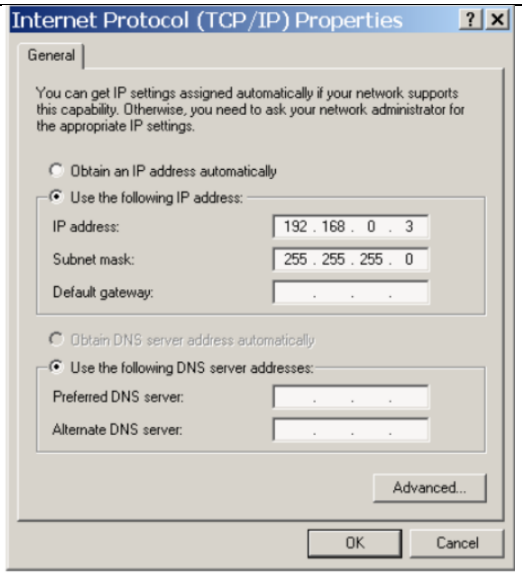


Figure 9 TCP/IP Settings

Note that the IP address need not be identical but the **192.168.0.** part must remain in place. The last digit(s) can be changed, but may **NOT** be 0, 1, 2 nor 255.

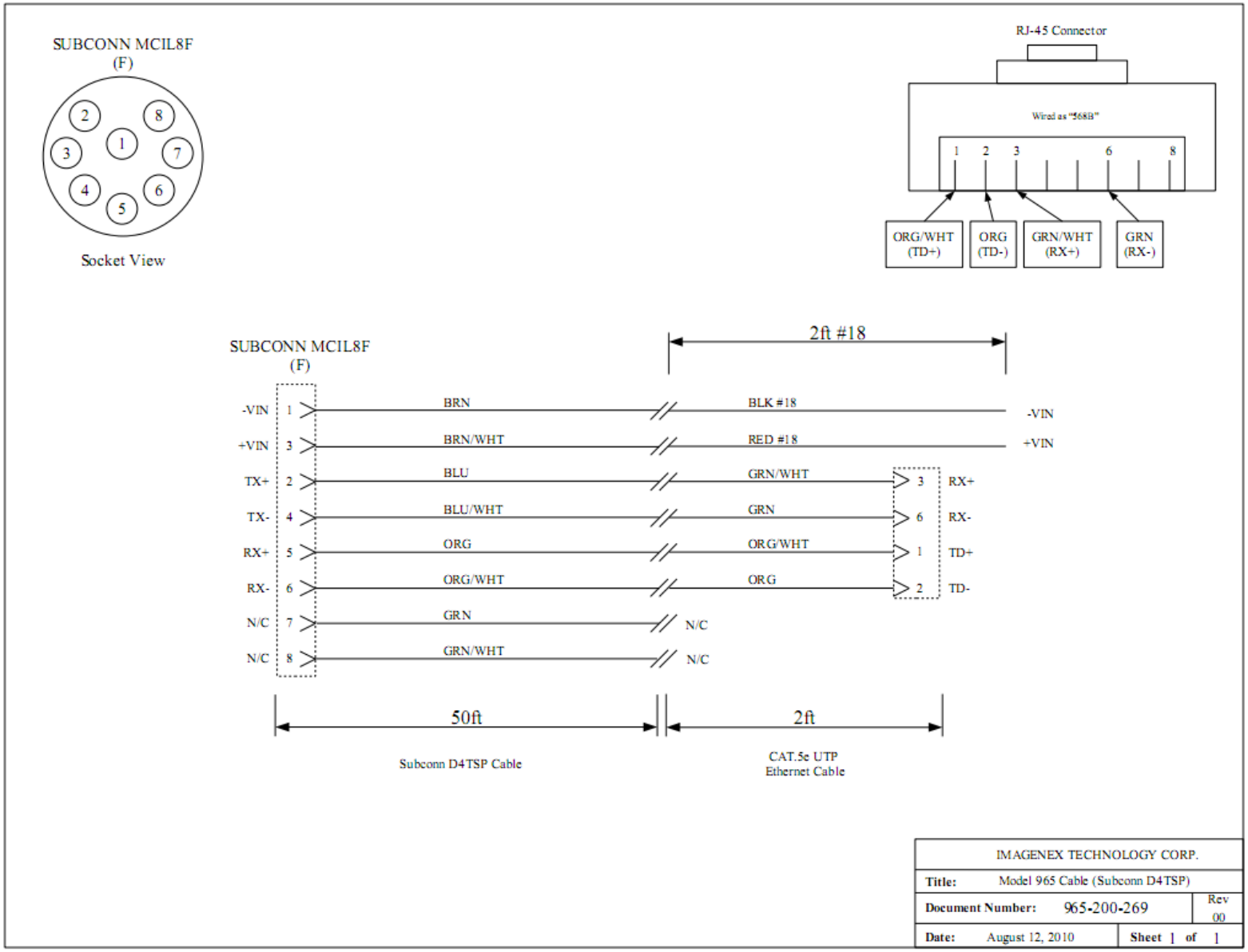
The sonar head should function correctly, however if communication does not occur properly, the suggestions listed in the points below may help:

- Ping the surface interface processor. Successful packet receipt will show that there is hardware connection and that the processor Ethernet is functional. In Widows Start type Run > cmd > type ping 192.168.0.2. If functioning correctly, the ‘out’ packets should be equal to the ‘In’ packets.
- Disable any network bridges that are present. A network bridge allows a separate port, such as “USB”, or “Firewire” to piggyback the Ethernet connection. Under Control Panel > Network and Internet > Network Connections, disable any network bridges.

- Disable any other network devices that are present on the computer. Often, if there are multiple network cards present, Windows™ may communicate incorrectly. Right-click on each invalid connection and select “Disable”.
- Clear unnecessary network protocols. De-select all services except for Internet Protocol Version 4 (TCP/IPv4).
- Remove any firewalls present. For the network adapter used, right click and select Properties. Click Configure > Advanced and de-select the Firewall option (if present).
- In the Configure > Advanced (as above) tab, click Speed and Duplex and set Auto Negotiate.
- Select Configure > Power Management (as above). Disable any power saving that shuts down the Ethernet card.
- Windows 10™ is using the Connected Devices Platform Service (or CDPSvc) for multicast streaming and in the event of a port clash, this service needs to be stopped. Press Shift-Ctrl-Esc to invoke the Task Manager and select the Services tab. Right-click on the service "CDPSvc" and select "Stop". Restart the computer. If the CDPSvc service continues to restart on its own, right-click on "CDPSvc" and select Open Services. In the list of Services, locate "Connected Devices Platform Service", right-click then select Properties. In "Startup type:" select "Disabled" then press OK. Restart the computer.

It is advisable to try these options one by one, and see if communication with the surface interface processor unit is initiated.

APPENDIX C **WIRING DIAGRAM**


SUBCONN MCIL8F
(F)
2
8
1
3
7
4
6
5
Socket View
RJ-45 Connector
Wired as "568B"
1
2
3
6
8
ORG/WHT
(TD+)
ORG
(TD-)
GRN/WHT
(RX+)
GRN
(RX-)
SUBCONN MCIL8F
(F)
2ft #18
-VIN 1 BRN BLK #18 -VIN
+VIN 3 BRN/WHT RED #18 +VIN
TX+ 2 BLU GRN/WHT 3 RX+
TX- 4 BLU/WHT GRN 6 RX-
RX+ 5 ORG ORG/WHT 1 TD+
RX- 6 ORG/WHT ORG 2 TD-
N/C 7 GRN N/C
N/C 8 GRN/WHT N/C
50ft
2ft
Subconn D4TSP Cable
CAT.5e UTP
Ethernet Cable
IMAGENEX TECHNOLOGY CORP.
Title: Model 965 Cable (Subconn D4TSP)
Document Number: 965-200-269
Rev 00
Date: August 12, 2010
Sheet 1 of 1