

NORBIT

- explore more -



Technical Note

ROV, AUV and USV Mounting

Doc. revision	1	2	3	4				
Date	2019.03.05	2019.05.23	2020.02.19	2020.10.09				
Prepared by	T.Vaule	T.Vaule	T.Vaule	T.V / A.J				
Checked by	JM/PAP	EL	EL					
Approved by	PKE	PAP	TV					

1 Revision History

Rev. 1:

- New document.

Rev. 2:

- Added trigger delay chapter 8.
- Added IP change description chapter 7.

Rev. 3:

- Added installation example picture.
- Fixed error on transceiver type under trigger and timing chapter.
- Added table about trigger connection.

Rev. 4:

- Clarified timing requirements.
- Added WINGHEAD to all relevant chapters.

2 References to Other Documents

2.1 Administrative Documents

#	Doc ref.	Title
[A1]		

2.2 Technical Documents

#	Doc ref.	Title
[T1]	TN-180196	WBMS DFD External
[T2]	TN-140075	Sonar User Manual
[T3]		

3 Terms and Abbreviations

WBMS Wideband Multibeam Sonar
SIU Sonar Interface Unit

4 Preface

This document is a guide for users on how to install a NORBIT sonar on ROV, USV and AUV platforms.

5 Disclaimer

All measurements for power consumption (Chapter 6) and timing accuracy (Chapter 8) given in this document are guiding numbers. Some deviations may be seen across models and hardware revisions. For specific models and applications please contact subsea_support@norbit.com for further detail.

6 Confidentiality

This document is not to be shared without approval from NORBIT Subsea.

Table of Contents

1	Revision History.....	2
2	References to Other Documents.....	2
2.1	Administrative Documents	2
2.2	Technical Documents	2
3	Terms and Abbreviations	2
4	Preface	2
5	Disclaimer.....	2
6	Confidentiality	2
7	Preface	5
8	WINGHEAD Series	5
8.1	General Guidelines.....	5
8.2	Pinout WINGHEAD	5
8.3	Power	6
8.3.1	Input voltage	6
8.3.2	Power consumption	6
8.3.3	Power Inrush.....	6
8.3.4	Sonar Grounding.....	6
8.3.5	Common Mode Choke	7
8.4	Ethernet.....	7
8.4.1	General	7
8.4.2	Change Sonar IP	7
8.4.3	Change Ethernet Speed	7
8.5	Trigger.....	8
8.5.1	General	8
8.5.2	IO Configuration.....	8
8.5.3	Trigger Delays.....	8
8.6	Timing.....	8
8.6.1	General	8
8.6.2	IO configuration.....	9
8.6.3	IRIG-B.....	9
8.6.4	NTP+PPS.....	9
8.6.5	NTP	9
8.7	Cable Options.....	9
8.7.1	USV.....	9
8.7.2	ROV/AUV	9
9	WBMS Series.....	10
9.1	General Guidelines.....	10
9.2	Pinout WBMS	10
9.3	Power	10
9.3.1	Input voltage	10
9.3.2	Power consumption	10
9.3.3	Power Inrush.....	11
9.3.4	Sonar Grounding.....	11
9.3.5	Common Mode Choke	11
9.4	Ethernet.....	12
9.4.1	General	12
9.4.2	Change Sonar IP	12
9.5	Trigger	12
9.5.1	General	12
9.5.2	Trigger Delays.....	12
9.6	Timing.....	12
9.6.1	General	12
9.6.2	IRIG-B.....	13
9.6.3	NTP+PPS.....	13
9.6.4	NTP	13
9.7	Cable Options.....	13
9.7.1	USV.....	13
9.7.2	ROV/AUV	13
10	ROV Configurations	14
10.1	Single head	14

10.2	Dual Head	15
10.2.1	Trigger Connection.....	15
11	AUV Configurations	16
11.1	Single Head.....	16
12	Mounting	17
12.1	General.....	17
12.1.1	Weight and Dimensions	17
12.1.2	Acoustic Clearance Zones	17
12.1.3	Isolation.....	17
12.2	ROV Mounting.....	18
12.2.1	WINGHEAD Mounting With Bracket.....	18
12.2.2	WBMS Mounting With Bracket	19
12.2.3	WBMS Mounting Without Bracket	20
12.2.4	Mounting Examples	21
13	Appendix	24
13.1	Appendix A: RTS Gen5 QuickStart	24
13.2	Appendix B: RTS Gen5 NORBIT MOD	28
13.3	Appendix C: NORBIT ROV-WBMS-ROVINS Integration Example.....	29

7 Preface

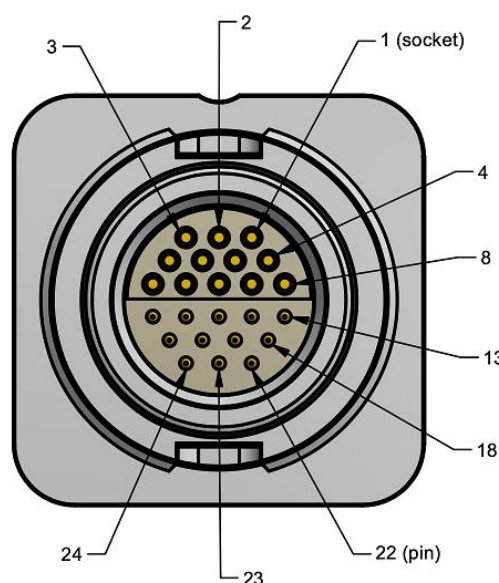
This document describes the special considerations when mounting NORBIT sonars on different types of AUVs, ROVs, ASVs and RSVs. The focus is on the electronic and technical side of the installation and should be used in conjunction with the NORBIT Sonar User Manual.

8 WINGHEAD Series

8.1 General Guidelines

NORBIT does not advise the use of the SIU topside unit with ROV and AUV configurations.

8.2 Pinout WINGHEAD



WINGHEAD Bulkhead Connector

Connector type :	NORBIT 33227
Material :	Titanium Grade 5
Insert :	Lemo 24 pin
Endurance :	> 5000 cycles IEC 60512-5 test 9a (ref: Lemo, O-ring maintenance)
Pressure rating :	600 Bar (mated)

Figure 1. WINGHEAD Bulkhead Connector

Pin	WINGHEAD Function	Electrical Spec	Comment
1	TIME+	RS422	Selectable TTL/RS422 0-60V. (RS232 is supported -10-60V with a 220Ohm series resistor)
2	TIME-	RS422	
3	TIME_GND	RS422 GND	
4	PWR-	Power GND	Main Power GND
5	ETH_B-	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
6	ETH_B+	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
7	PWR-	Power GND	Main Power GND
8	ETH_A+	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
9	IMU_A+	RS422	RS422
10	IMU_B-	RS422	RS422
11	IMU_C+	RS422	RS422
12	ETH_C-	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
13	ETH_A-	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
14	IMU_A-	RS422	RS422
15	IMU_B+	RS422	RS422
16	IMU_C-	RS422	RS422
17	ETH_C+	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
18	PWR+	24-48VDC	24-48VDC Main power input
19	ETH_D+	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
20	ETH_D-	1000BASE-T	Selectable 1000BASE-T and 100BASE-T
21	PWR+	24-48VDC	24-48VDC Main power input
22	TRIG_GND	RS422 GND	Selectable TTL/RS422 0-60V. (RS232 is supported -10-60V with a 220Ohm series resistor)
23	TRIG-	RS422	
24	TRIG+	RS422	

Table 1. WINGHEAD Bulkhead Pinout

8.3 Power

8.3.1 Input voltage

All WINGHEAD sonars have the same input voltage specification when not using the SIU.

Minimum input is 24V (Cut-off voltage = 20V, WARNING: If the PSU and power lines create voltage drops that go under 20V, unexpected behavior may be encountered with sudden system reboots.)

Maximum input is 48V (Shut off voltage = 52V)

8.3.2 Power consumption

Sonar power consumption may vary according to model number and TX settings applied during operation. See Table 2 for some guiding numbers. The numbers in the table are measured with an 8-meter cable and a 48V PSU. Please note these do not cover all models and hardware versions, so differences may occur. If you are on a very tight power budget please contact support for further guidelines. NORBIT recommends minimum 150W PSU for all WINGHEAD models.

Model	Description	Idle	10Hz 1000uS Peak	10Hz 1000uS Mean
B41, B43	WINGHEAD Non-Integrated	44W	90W	76W
i67, i77h, i69, i79h	WINGHEAD Integrated	47W	93W	79W

Table 2. Power Consumption

8.3.3 Power Inrush

Power inrush are determined by several factors. Cable length (impedance between PSU and sonar), input capacitor bank and PSU output capacitor bank are the most important factors. Below is a list of most common NORBIT sonars and some data on inrush:

8.3.3.1 B41, i67 and i77h

PSU Capacitor bank : ~70uF
TX PSU : ~25mF

8.3.3.2 B43, i67 and i79h

PSU Capacitor bank : ~70uF
TX PSU : ~90uF

The WINGHEAD B41, i67 and i77h bathy sonars have a power input capacitance of around 25 000uF. Most PSUs will handle this, but if you have other equipment in parallel with the sonar and are experiencing power issues when the sonar is powered on, NORBIT recommends adding at least 30 000uF (63V rated) output capacitance to the PSU.

8.3.4 Sonar Grounding

The sonar has multiple ground nodes detailed below.

8.3.4.1 Chassis Ground

Coupled to Internal Isolated Ground.

8.3.4.2 Power Ground

External power ground. Connected to Pin 4 and 7 (ref Table 1)

8.3.4.3 Time Ground

The WINGHEAD timing input has a separate signal ground. It is galvanically isolated from all other ground nodes. See Table 1 Pin 1-3. Check cable documentation to see how GND is connected.

8.3.4.4 Trigger Ground

The WINGHEAD trigger input has a separate signal ground. It is galvanically isolated from all other ground nodes. See Table 1 Pin 22-24. Check cable documentation to see how GND is connected.

8.3.5 Common Mode Choke

If a NORBIT sonar is mounted without the SIU, NORBIT advise the use of a common mode choke on the power lines to limit noise to the sonar through the power lines. A suitable choke is suggested below:

Manufacturer : Bourns Inc.
Part : 7124-RC
Description : Common Mode, CMC 2.55MH 10A 2LN TroughHole

8.4 Ethernet

8.4.1 General

NORBIT WINGHEAD sonars uses a 4/8 wire 100BASE-T/1000BASE-T with HP Auto-MDIX Support. It can also be reconfigured through the WebUI.

8.4.2 Change Sonar IP

To change to sonar static IP or change the IP mode please use an Internet browser and go to <http://<sonar-ip>:8080> (for example: <http://192.168.53.51:8080>). Use the mode selection to change between static and DHCP. Use the IP address, Netmask and Gateway to change the static settings.

Figure 2. Sonar WebUI - Network Settings

8.4.3 Change Ethernet Speed

The default Ethernet link speed is 100Mbit. To change it, select 1Gbps in the WebUI as shown in Figure 2. This might be needed for some ROV MUX units to work without modifications.

8.5 Trigger

8.5.1 General

Many installations require synchronization of sensors to prevent interference. NORBIT sonars come with separate trigger lines for input and output of sync pulse. To run NORBIT sonars in dual head mode, the trigger lines are required.

Description	:	Transceiver RS422, Isolated, Configurable
Ground	:	Trig_GND
Maximum ratings	:	See Table 1

The trigger input is RS422 (default), TTL 5V and 3V3.

8.5.2 IO Configuration

Figure 3. IO Line Configuration

The IO line configuration menu selects the mode of operation for the data port.

TTL

For TTL select single-ended. Connect TTL+ To Trig+ and TTL GND To Trig_GND.

RS422

For RS422 select balanced. Connect as standard RS422. We do in general not recommend using the GND.

RS232

RS232 is currently not supported. Contact NORBIT Support for further details on this topic.

8.5.3 Trigger Delays

Trigger IN:

The Trigger In signal will initiate the TX. An adjustable trigger delay is possible in millisecond resolution.

Trigger OUT:

The Trigger Out signal is adjustable. Contact Support for further details.

8.6 Timing

8.6.1 General

Description	:	Transceiver RS422, Isolated, Configurable
Ground	:	Time_GND
Maximum ratings	:	See Table 1

The timing input is RS422 (default), TTL 5V and 3V3.

8.6.2 IO configuration

See Chapter 8.5.2

8.6.3 IRIG-B

Most common method when using the NORBIT SIU topside unit. The SIU timing processor uses ZDA + 1PPS to generate the IRIG-B signal. The timing signal is then connected from the SIU via the ROV tether to the sonar.

Accuracy	:	Good, <0.1ms
USV	:	Recommended
ROV/AUV	:	Not recommended

8.6.4 NTP+PPS

Most common method when not using the NORBIT SIU topside. The sonar takes 1PPS + SigGND on pins 7 and 8 and connects to an NTP server through Ethernet. NTP can be run on the topside where the data acquisition software is installed, and there are many NTP services available, e.g. Qinsy NTP and Meinberg NTP(free).

Accuracy	:	Good, <0.1ms
USV	:	Not recommended
ROV/AUV	:	Recommended

8.6.5 NTP

When there is no 1PPS available, the last method is NTP only, but NORBIT strongly advises against this unless there is no alternative. The sonar connects to an NTP server through Ethernet. For platforms with lots of motion and dynamics this method is not recommended. For steady slow-moving platforms, this is an adequate solution if 1PPS is not available. NTP can be run on the topside where the data acquisition software is installed, and there are many free NTP services available, e.g. Qinsy NTP and Meinberg NTP (free). Windows built-in NTP is not recommended.

Accuracy	:	Medium, <2ms
USV	:	Not recommended
ROV/AUV	:	Optional

8.7 Cable Options

NORBIT Subsea can supply customized cables if required. Please contact support to get more information.

8.7.1 USV

NORBIT can offer a USV mounting cable kit. Contact support for more information.

8.7.2 ROV/AUV

For ROV mounting, NORBIT offers the following cables:

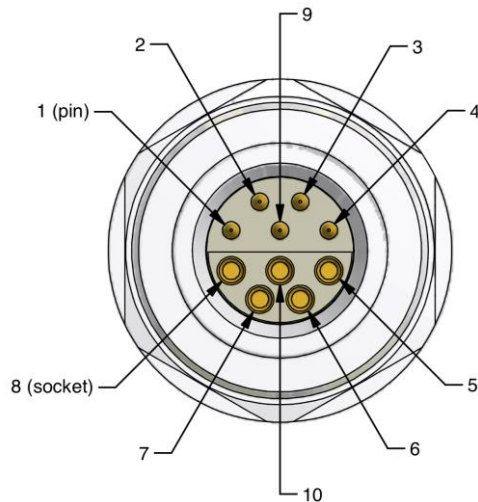
33256 WINGHEAD Interface Pigtail

9 WBMS Series

9.1 General Guidelines

NORBIT does not advise the use of the SIU topside unit with ROV and AUV configurations.

9.2 Pinout WBMS



WBMS Bulkhead Connector

Connector type :	NORBIT 33049
Material :	Titanium Grade 5
Insert :	Lemo 10 pin
Endurance :	> 5000 cycles IEC 60512-5 test 9a (ref: Lemo, O-ring maintenance)
Pressure rating :	600 Bar (mated)

Figure 4. WBMS Bulkhead Connector

Pin	WBMS function	Electrical spec	Maximum Rating	Comment
1	LAN, TX+	100Base-T	1500 Vrms	Twisted Pair
2	LAN, TX-	100Base-T	1500 Vrms	
3	LAN, RX+	100Base-T	1500 Vrms	
4	LAN, RX-	100Base-T	1500 Vrms	
5	Trig OUT	RS232	-15V to +15V	Debug/trigger. $V_{low}=-6.1V$ $V_{high}=6.6V$
6	Trig IN	RS232 (TTL comp.)	-25V to +25V	Debug/trigger. Trigger threshold $1.7\pm0.5V$
7	PPS/IRIG-B	TTL 5V	-9V to +14V	Timing input. 3.3V and 5V TTL
8	Signal GND	GND	-	Shared ground for Pin 5, 6 and 7.
9	GND	GND	-	Power ground
10	24VDC	24VDC	28V	Power input

Table 3. WBMS Bulkhead Pinout

9.3 Power

9.3.1 Input voltage

All NORBIT sonars have the same input voltage specification when not using the SIU.

Minimum input is 24V (Cut-off voltage = 20V, WARNING: If the PSU and power lines create voltage drops that go under 20V, unexpected behavior may be encountered with sudden system reboots.)

Maximum input is 28V (Break down voltage = 31.4V, WARNING: Getting close to this voltage will burn the input on the sonar and require service.)

9.3.2 Power consumption

Sonar power consumption may vary according to model number and TX settings applied during operation.

See Table 2 for some guiding numbers. The numbers in the table are measured with an 8-meter cable and a 24V PSU with no drop. Please note these do not cover all models and hardware versions, so differences may occur. If you are on a very tight power budget please contact support for further guidelines.

Model	Description	Idle	20Hz 500uS Peak	20Hz 500uS Mean
24002, 24009,	WBMS FLS Wide, all materials	0.6 A	2.4 A	1.4 A
24003, 24007, 24010	WBMS Bathy (2x1 deg), all materials	0.6 A	2.7 A	1.5 A
24016, 24017	WBMS STX (1x1 deg), all materials	0.8 A	2.5 A	2.0 A

Table 4. Power Consumption

9.3.3 Power Inrush

Power inrush are determined by several factors. Cable length (impedance between PSU and sonar), input capacitor bank and PSU output capacitor bank are the most important factors. Below is a list of most common NORBIT sonars and some data on inrush:

9.3.3.1 FLS (24002/24009)

PSU Capacitor bank : 70uF
TX PSU : No TX inrush

9.3.3.2 Bathy (24003/24007/24010)

PSU Capacitor bank : 70uF
TX PSU : ~10mF

The NORBIT bathy sonars have a power input capacitance of around 10000uF. Most PSUs will handle this, but if you have other equipment in parallel with the sonar, and are experiencing power issues when the sonar is powered on, NORBIT recommends adding at least 10 000uF (35V rated) output capacitance to the PSU.

9.3.3.3 STX (24016/24017)

PSU Capacitor bank : 170uF
TX PSU : No TX inrush

9.3.4 Sonar Grounding

The sonar has three different ground nodes detailed below.

9.3.4.1 Chassis Ground

Capacitively coupled to Power Ground with high voltage capacitors.
All models : 110-130nF 500V

9.3.4.2 Power Ground

Internal power ground. Connected to PIN 9 (ref Chapter 5)

9.3.4.3 Signal Ground

Signal ground is galvanically isolated from all other ground nodes. See Chapters 8 and 8.

9.3.5 Common Mode Choke

If a NORBIT sonar is mounted without the SIU, NORBIT advise the use of a common mode choke on the power lines to limit noise to the sonar through the power lines. A suitable choke is suggested below:

Manufacturer : WURTH ELEKTRONIK
Part : 744834433
Description : Common Mode, Power Line, Horizontal, 3.3 mH, 5 A, WE-CMBH Series

9.4 Ethernet

9.4.1 General

- NORBIT WBMS sonars uses a 4 wire 10BASE-T/100BASE-TX with HP Auto-MDIX Support, and it cannot be reconfigured.
- NORBIT WINGHEAD sonars can be configured between 100 and 1000BASE-T.

Common data rates for different WBMS settings are listed in Table 3. Note these are guiding numbers. Ask NORBIT Support if you require exact numbers for a specified setting.

	Bathy	POS	WC	SS	SN	SNS	Data rate
Ping 50Hz	✓	✓	✗	✗	✗	✗	5Mbps
Ping 50Hz	✓	✓	✓	✓	✗	✗	13Mbps
Ping 50Hz	✓	✓	✓	✓	✓	✗	13Mbps
Ping 50Hz	✓	✓	✗	✗	✗	✓	11Mbps

Table 5. WBMS Data Rates

9.4.2 Change Sonar IP

Please refer to the user manual [T2] for instructions.

9.5 Trigger

9.5.1 General

Many installations require synchronization of sensors to prevent interference. NORBIT sonars come with separate trigger lines for input and output of sync pulse. Note that some of the oldest systems might not have this capability. To run NORBIT sonars in dual head mode, the trigger lines are required.

Description : Transceiver RS232, Isolated
 Ground : SigGND
 Maximum ratings : See Table 1

The trigger input is TTL 5V and 3V3 compatible and the SigGND is isolated from power ground.

9.5.2 Trigger Delays

Trigger IN:

The default delay from the Trigger In signal to the center of the transmit pulse is 3300μs (half the transmit pulse buffer plus additional). An adjustable trigger delay is possible in millisecond resolution.

Trigger OUT:

The Trigger Out signal is sent out at 3300μs (half the transmit pulse buffer plus additional) before the center of the following transmit pulse. An adjustable trigger delay is possible in millisecond resolution.

The command `set_trigger_mode` and `set_trigger_delay` ref [T1] will control the trigger and adjust the trigger delay in both Trigger In and Out.

9.6 Timing

9.6.1 General

Description : Transceiver RS485, Isolated
 Ground : SigGND
 Maximum ratings : See Table 1

The timing input is TTL 5V and 3V3 compatible and the SigGND is isolated from power ground. There are

several ways of time synchronizing a NORBIT sonar. The timing pins are Pin 7 and 8 (ref Chapter 5). Time synchronization methods are detailed below.

9.6.2 IRIG-B

Most common method when using the NORBIT SIU topside unit. The SIU timing processor uses ZDA + 1PPS to generate the IRIG-B signal. The timing signal is then connected from the SIU via the ROV tether to the sonar.

Accuracy	:	Good, <0.1ms
USV	:	Recommended
ROV/AUV	:	Not recommended

9.6.3 NTP+PPS

Most common method when not using the NORBIT SIU topside. The sonar takes 1PPS + SigGND on pins 7 and 8 and connects to an NTP server through Ethernet. NTP can be run on the topside where the data acquisition software is installed, and there are many free NTP services available, e.g. Qinsy NTP and Meinberg NTP.

Accuracy	:	Good, <0.1ms
USV	:	Not recommended
ROV/AUV	:	Recommended

9.6.4 NTP

When there is no 1PPS available, the last method is NTP only, but NORBIT strongly advises against this unless there is no alternative. The sonar connects to an NTP server through Ethernet. For platforms with lots of motion and dynamics this method is not recommended. For steady slow-moving platforms, this is an adequate solution if 1PPS is not available. NTP can be run on the topside where the data acquisition software is installed, and there are many free NTP services available, e.g. Qinsy NTP and Meinberg NTP.

Accuracy	:	Medium, <2ms
USV	:	Not recommended
ROV/AUV	:	Optional

9.7 Cable Options

NORBIT Subsea can supply customized cables if required. Please contact support to get more information.

9.7.1 USV

NORBIT can offer a USV mounting cable kit. Contact support for more information.

9.7.2 ROV/AUV

For ROV mounting, NORBIT offers the following cables:

33095 WBMS Interface Pigtail
33205 WBMS Interface Pigtail Angled (longer lead times should be expected)

10 ROV Configurations

The following configurations are valid with Bathy, FLS, STX, Deep Sea and Full Ocean NORBIT sonars.

10.1 Single head

The recommended setup for single head is shown in Figure 2.

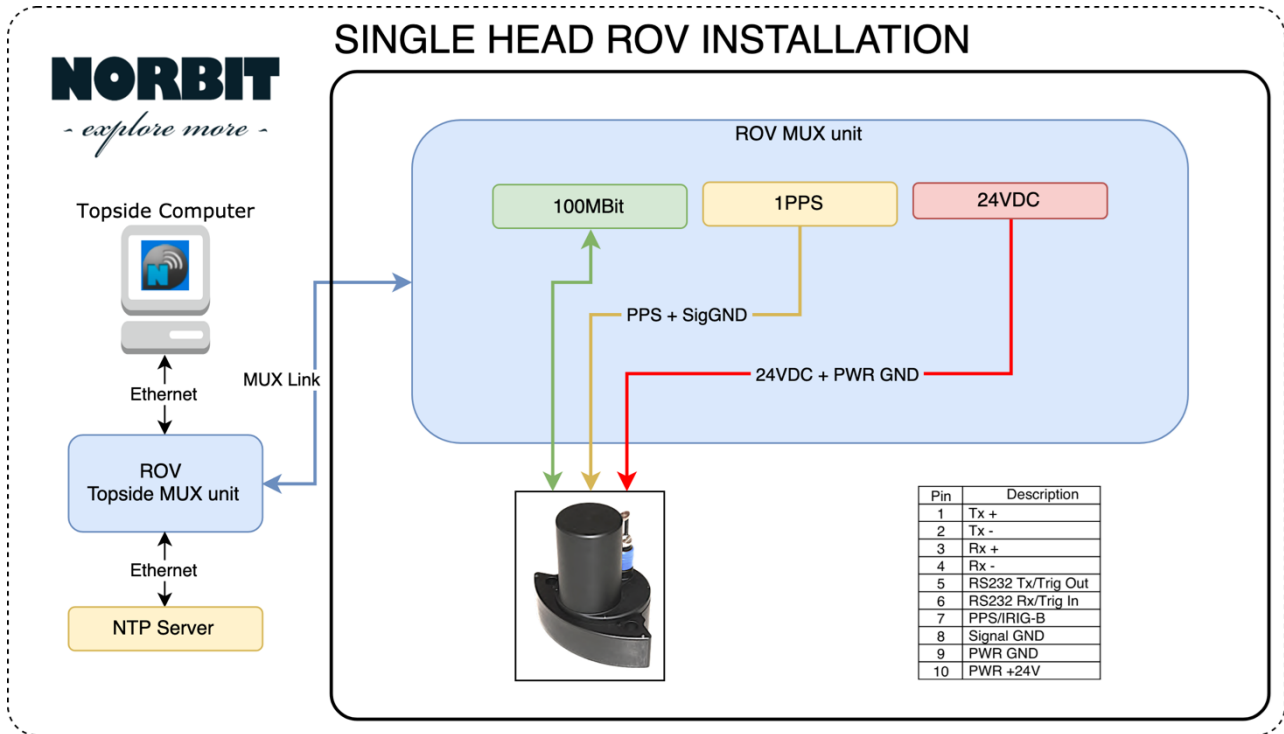


Figure 5. Typical WBMS Single Head on ROV

10.2 Dual Head

The recommended setup for dual head is shown in Figure 3.

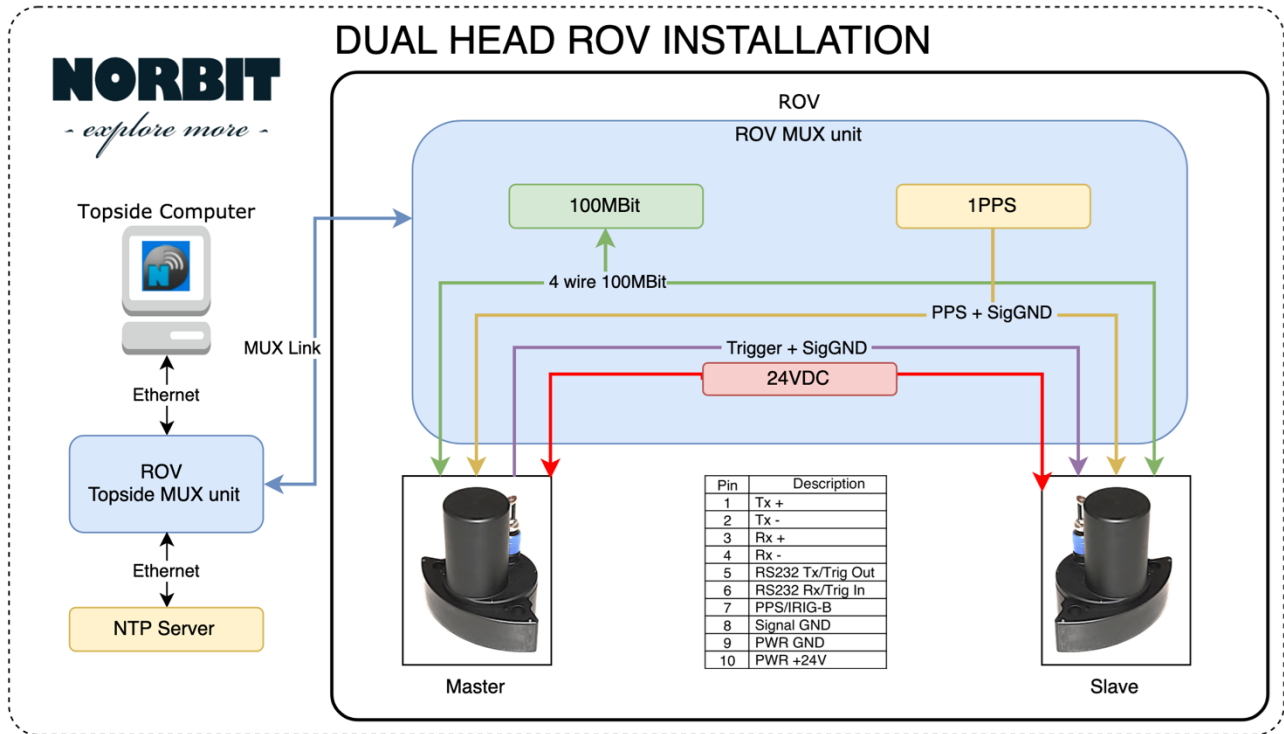


Figure 6. Typical WBMS Dual head on ROV

10.2.1 Trigger Connection

To connect the trigger between the two heads, the trigger signal must be crossed over.

Signal	Sonar 1	Sonar 2	Comment
TX+	1	1	To switch/MUX
TX-	2	2	To switch/MUX
RX+	3	3	To switch/MUX
RX-	4	4	To switch/MUX
RS232 TX/Trig Out	5	6	Trigger between heads
RS232 TX/Trig In	6	5	Trigger between heads
PPS/IRIG-B	7	7	To MUX/timing output
Signal GND	8	8	Shared signal GND
PWR GND	9	9	PSU
PWR 24V	10	10	PSU

Table 6. Trigger Connection

11 AUV Configurations

11.1 Single Head

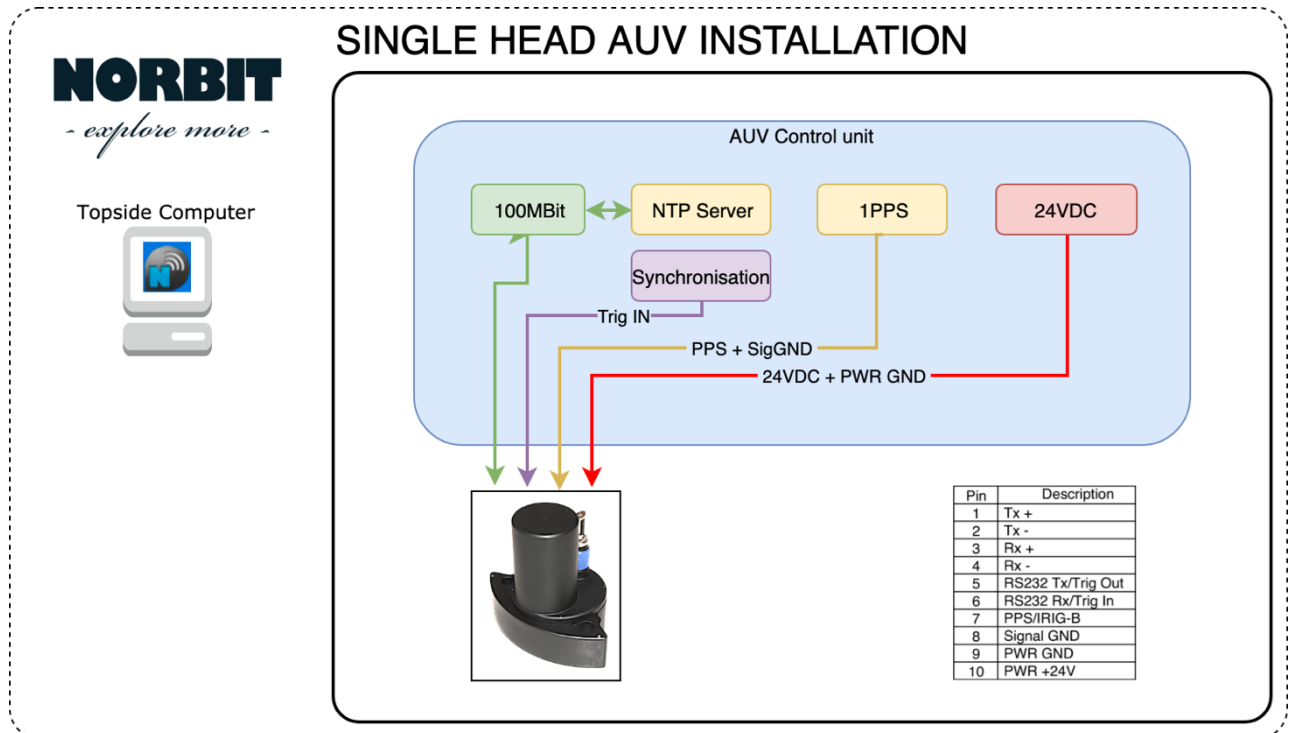


Figure 7. Typical WBMS Single Head on AUV

12 Mounting

12.1 General

12.1.1 Weight and Dimensions

Refer to the online data sheets: <https://norbit.com/subsea/products/>

12.1.2 Acoustic Clearance Zones

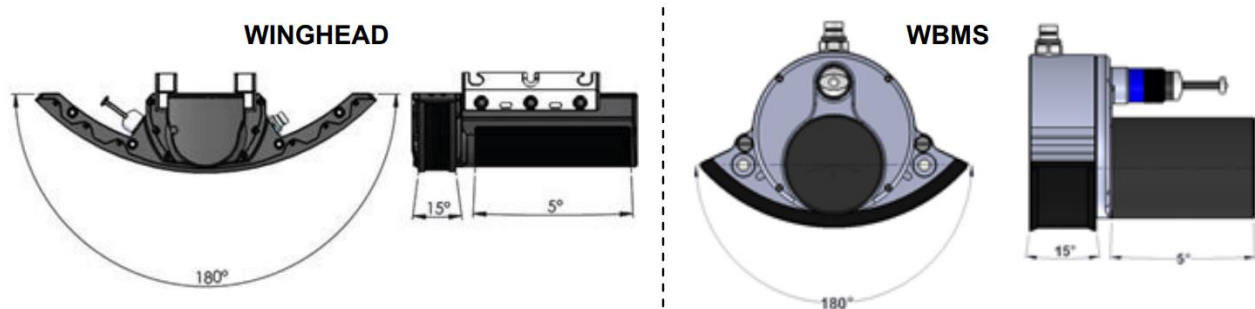


Figure 8. Acoustic Clearance Zones

12.1.3 Isolation

It is important to always keep the NORBIT sonar isolated from other metal such as brackets, poles and the vessel hull. This can cause severe corrosion because of ground currents and potential differences.

Use the NORBIT protection plate if mounted directly on metal (part: 45459) and the correct plastic spacers for the screws fastening the sonar.

12.2 ROV Mounting

12.2.1 WINGHEAD Mounting With Bracket

Bracket part number : 451214, 451215
 Bracket material : PETP Plastic
 Bracket flange : Figure 9

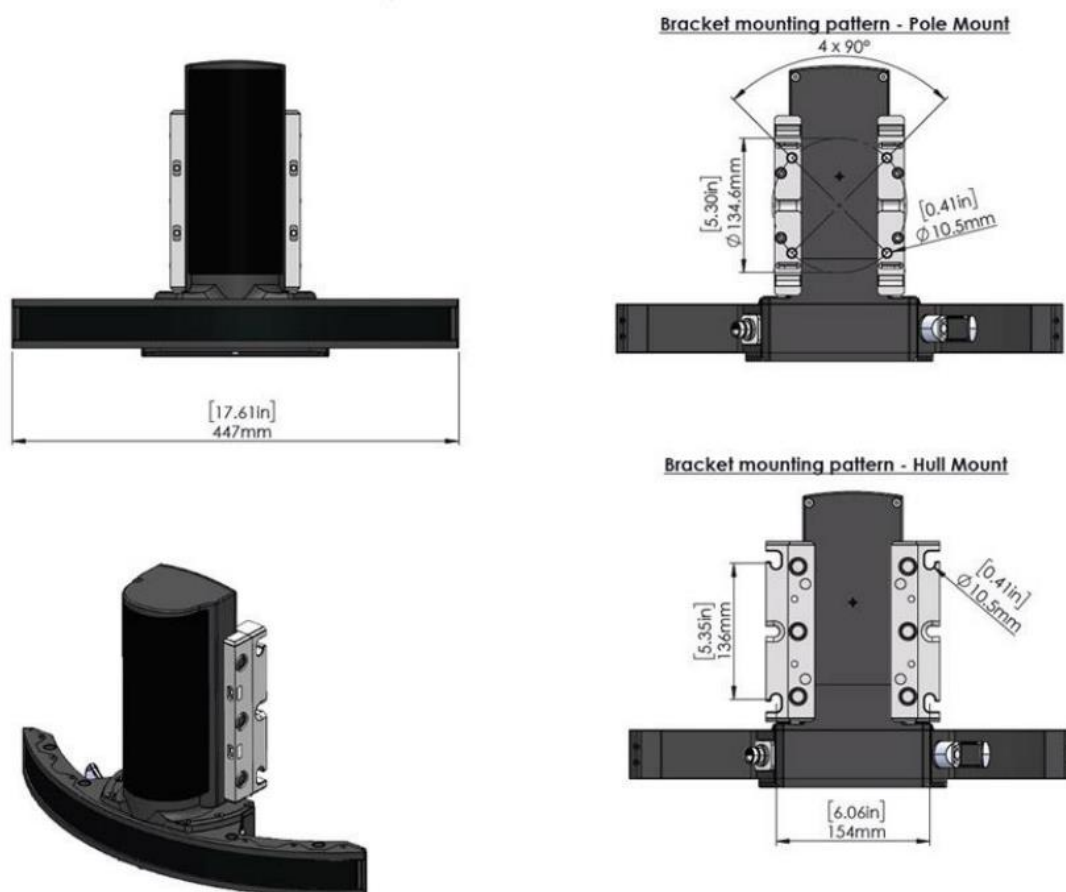


Figure 9. WINGHEAD with Standard Bracket

The WINGHEAD bracket can be reconfigured as required (see Figure 10). The “hull mount” configuration is typically used for ROV/AUV installations.

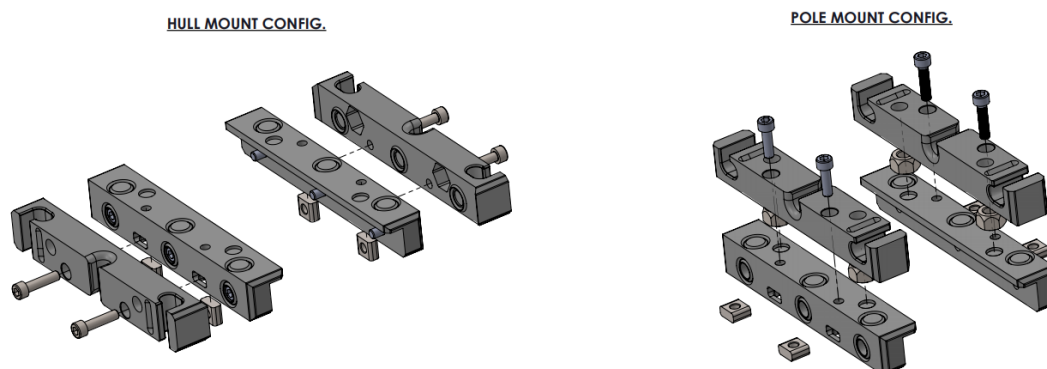


Figure 10. Reconfiguring the Bracket

12.2.2 WBMS Mounting With Bracket

Bracket part number : 35047
 Bracket spacers : 45466
 Bracket material : POM Plastic
 Bracket flange : Figure 11

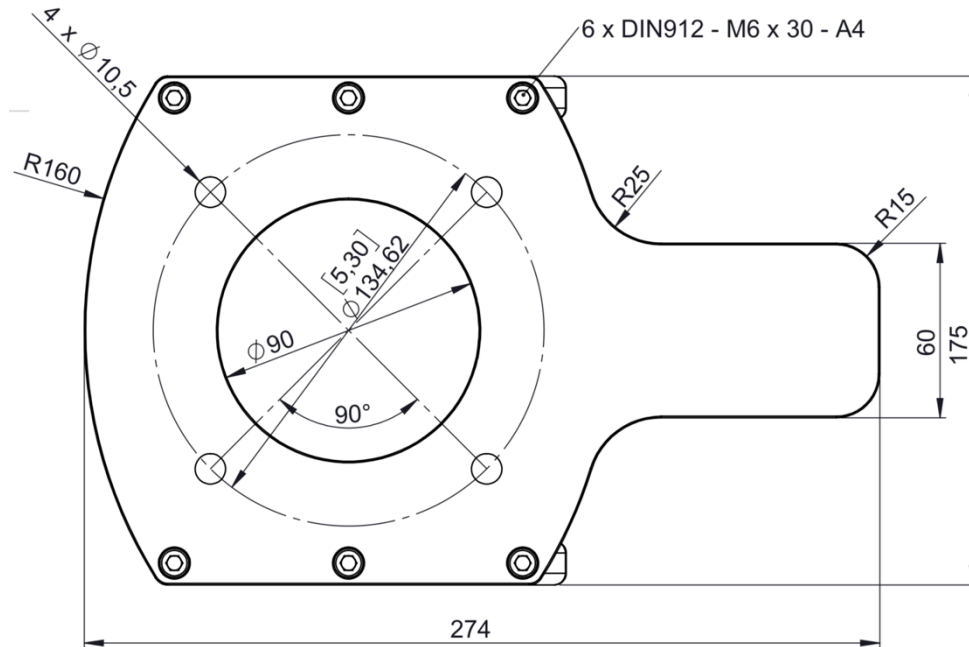


Figure 11. WBMS standard bracket 35047 flange

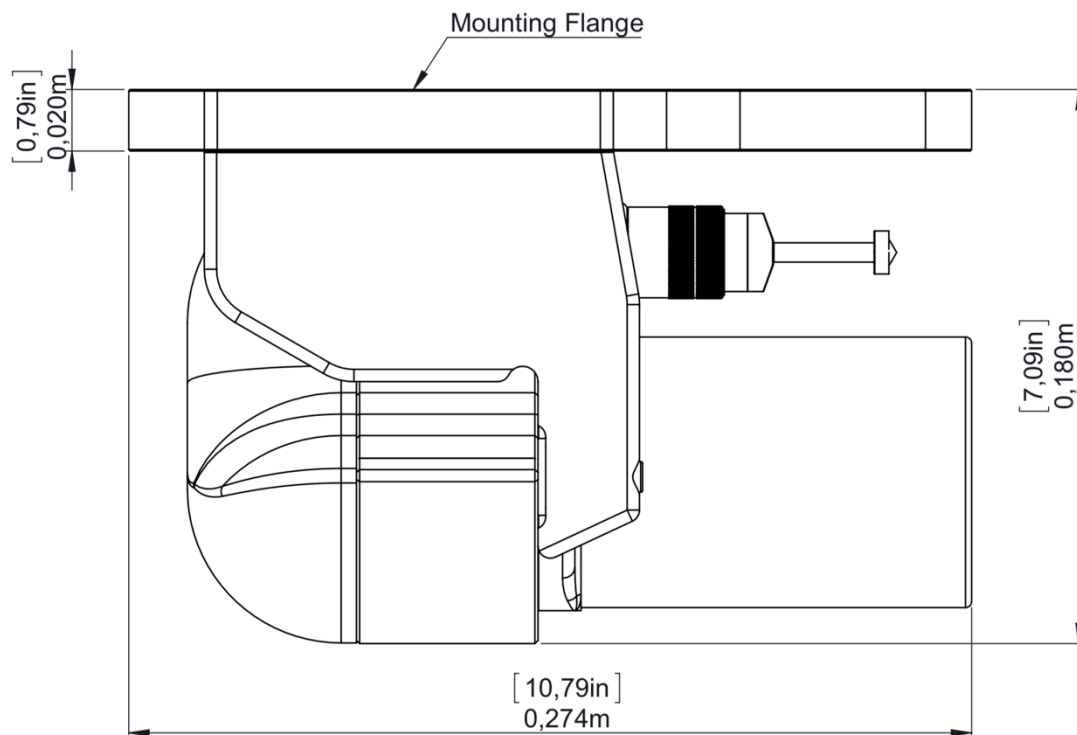


Figure 12. WBMS mounted on standard bracket

12.2.3 WBMS Mounting Without Bracket

Protection plate	:	1 x 45449
WBMS spacer	:	2 x 45466
Screws	:	M6 x 70-100mm
Hole spacing	:	160mm



Figure 13. WBMS mounted without bracket

12.2.4 Mounting Examples

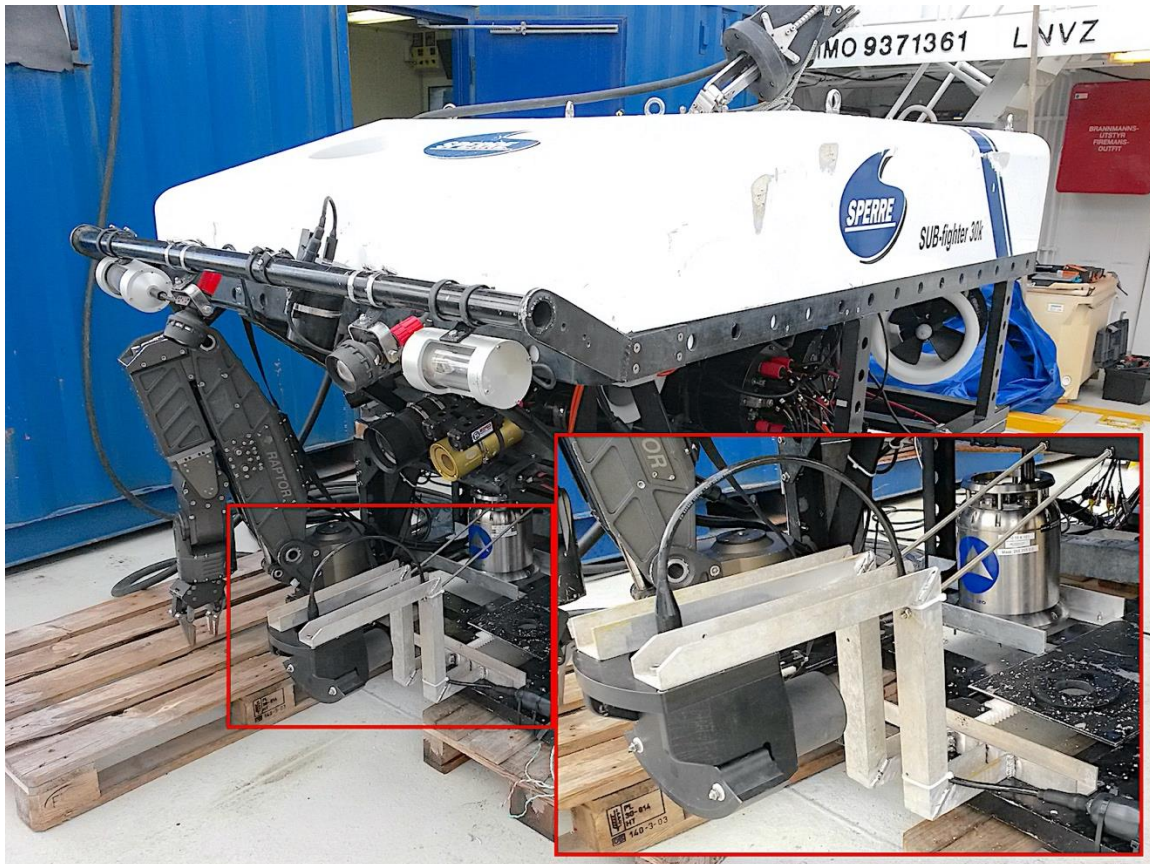


Figure 14. WBMS Basic on Sperre SUB-fighter 30k with IXBLUE PHINS



Figure 15. Dual WBMS Basic on a STD Quasar ROV with IXBLUE ROVINS



Figure 16. Up looking WBMS Bathy on Seatronics

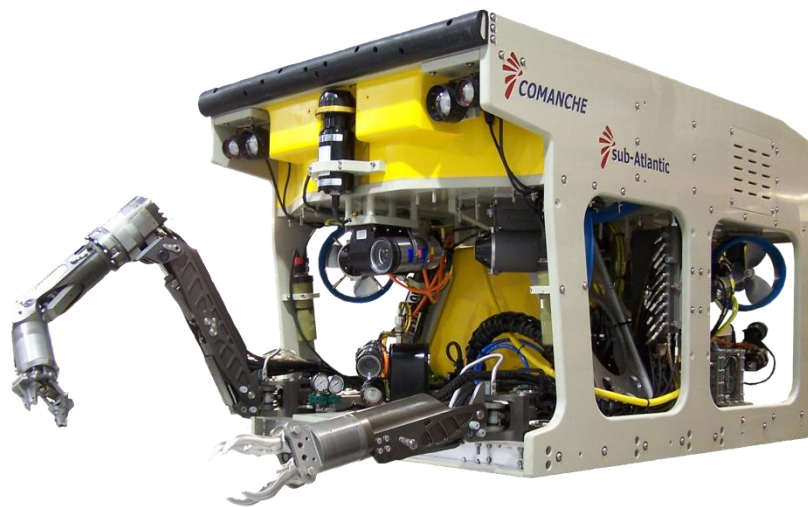


Figure 17. Sub-Atlantic Comanche ROV

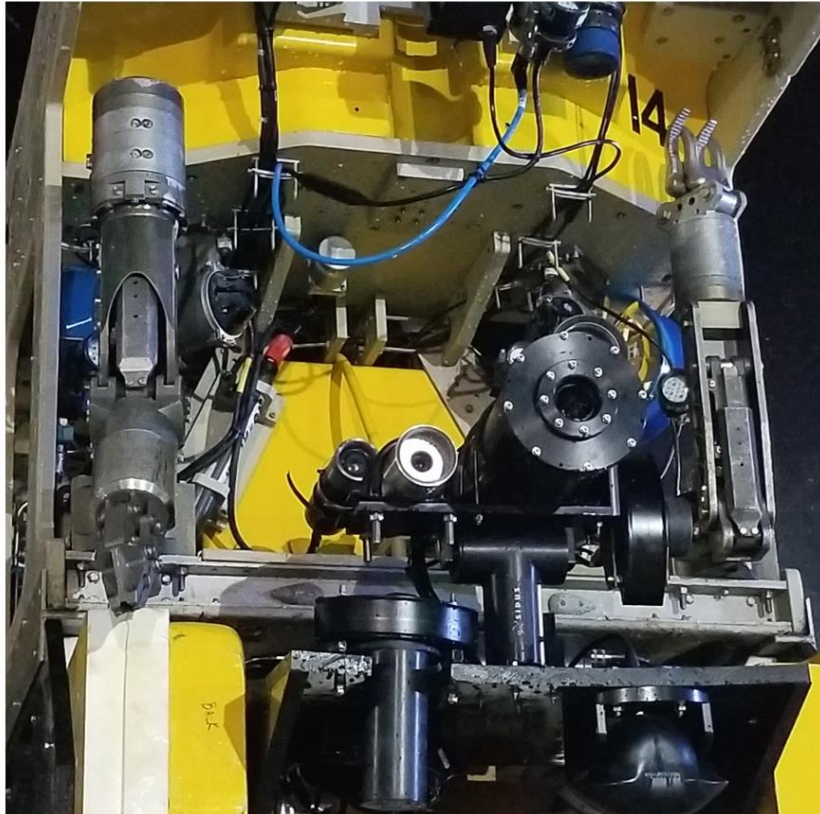


Figure 18. Mounted on Comanche

13 Appendix

13.1 Appendix A: RTS Gen5 QuickStart



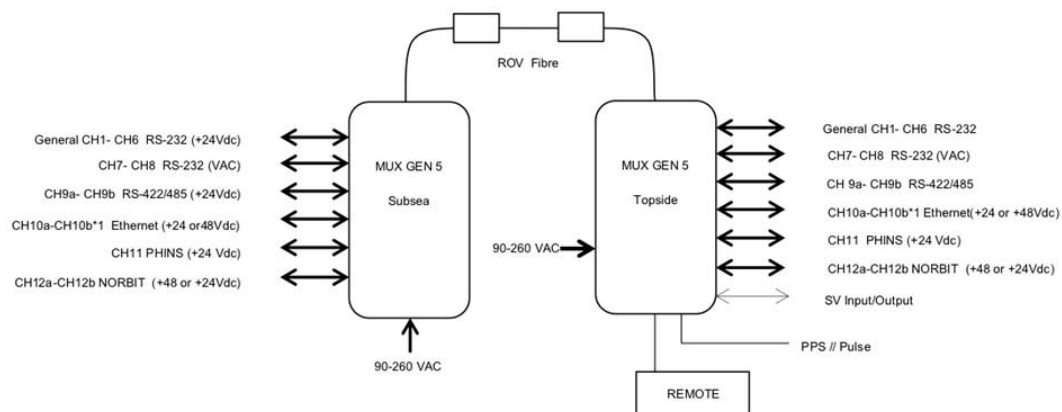
Rental Technology & Services AS
Devoted to Solutions

RTS GEN 5 MUX MkII

Quick Reference Guide 3000TI-Norbit

- Depth rating: 3000 meter - Optical fiber range 10km, optional 70km for single mode fiber 16 channel C-WDM, 1271nm-1611nm 8 channels RS-232 fully isolated - One channel RS-422 fully isolated - One channel RS-485 fully isolated - Four channel 10/100Mbit Ethernet	- PPS Timing pulse available subsea for CH6 and INS Ethernet - PPS Timing pulse available subsea for CH12a and CH12b - HD/SD video (optional) 14 configurable Relay outputs (24Vdc/48vdc) - Two channel AC relay output 110VAC - Small size, and a highly flexible modular system
--	--

RTS MUX GEN 5 Topside Unit	RTS MUX GEN 5 Subsea Unit
	
Power Requirement Topside unit: 100W max Voltage requirement: 90-264VAC or 120-370VDC Operating ambient Temperature: -15°C to +45°C Weight: 8.5kg ± 1.0kg Size: 134mm x 374mm x 483mm [HxDxW] 19" panel and 3U height	Power requirement Subsea unit: 800W max. (AC output relays OFF) Voltage requirement: 90-264VAC or 120-370VDC Operating ambient temperature: -2°C to +35°C Weight in air: 32 kg ± 2.0 kg Weight in water: 15 kg ± 2.0 kg Size: 435mm x Ø 230mm

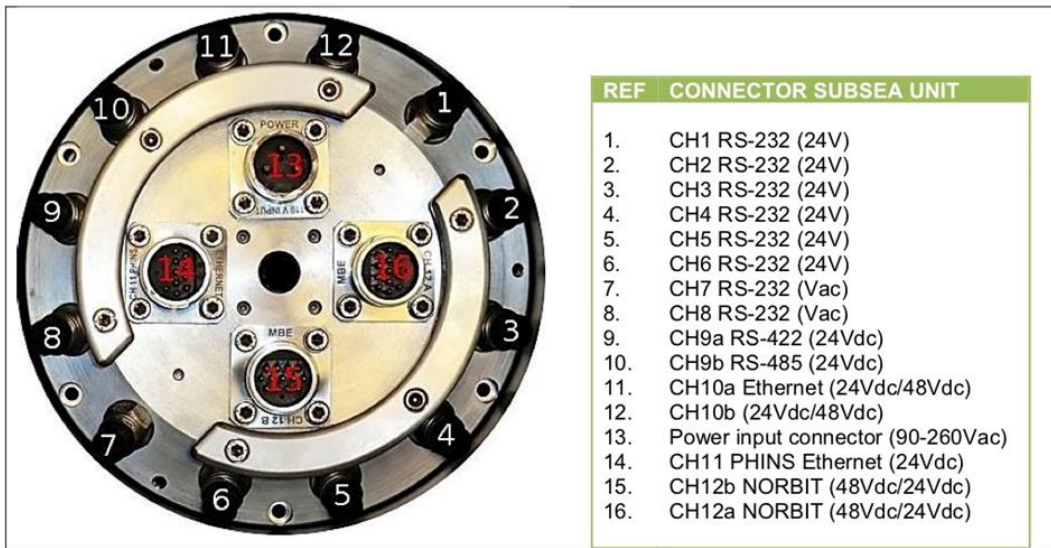


Block schematic RTS MUX GEN 5 system.

Rental Technology & Services AS
tel: +47 52 81 47 60
e-mail: sales@rts.as

Aakrehamn Teknologisenter
Sjøenveien 52
NO-4270 Åkrehamn NORWAY





Connections on subsea bottle cap



Back panel RTS MUX GEN 5 Topside unit.

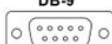
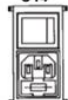
NOTES:

1. CH10b in the GEN 5 MUX equipped with INS Ethernet is fitted only with Power function.
2. Video 1-4 currently not in use. (Optional SDI or Composite Video)
3. OPT1/OPT2 currently not in use.
4. USB is currently not in use.
5. Remote option is currently not in use.

Specifications subject to change without further notice.

RTS GEN 5 MUX: TOPSIDE CONNECTORS

MUX GEN5 INS_ETH REV 1.79 Norbit
Date 08.02.2019

LABEL	FUNCTION	BULKHEAD	PINOUT																												
CH1 CH2 CH3 CH4 CH5 CH6 CH7 CH8	GENERAL PORT RS232		<table><thead><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>NC</td><td>7</td><td>NC</td></tr><tr><td>2</td><td>RX Data Down</td><td>8</td><td>NC</td></tr><tr><td>3</td><td>TX Data Up</td><td>9</td><td>NC</td></tr><tr><td>4</td><td>NC</td><td></td><td></td></tr><tr><td>5</td><td>SerGND</td><td></td><td></td></tr><tr><td>6</td><td>NC</td><td></td><td></td></tr></tbody></table>	PIN	Function	PIN	Function	1	NC	7	NC	2	RX Data Down	8	NC	3	TX Data Up	9	NC	4	NC			5	SerGND			6	NC		
PIN	Function	PIN	Function																												
1	NC	7	NC																												
2	RX Data Down	8	NC																												
3	TX Data Up	9	NC																												
4	NC																														
5	SerGND																														
6	NC																														
CH9a	GENERAL PORT RS422		<table><thead><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>NC</td><td>7</td><td>RX+ Data Down</td></tr><tr><td>2</td><td>NC</td><td>8</td><td>TX+ Data Up</td></tr><tr><td>3</td><td>NC</td><td>9</td><td>TX- Data Up</td></tr><tr><td>4</td><td>NC</td><td></td><td></td></tr><tr><td>5</td><td>Signal GND</td><td></td><td></td></tr><tr><td>6</td><td>RX- Data Down</td><td></td><td></td></tr></tbody></table>	PIN	Function	PIN	Function	1	NC	7	RX+ Data Down	2	NC	8	TX+ Data Up	3	NC	9	TX- Data Up	4	NC			5	Signal GND			6	RX- Data Down		
PIN	Function	PIN	Function																												
1	NC	7	RX+ Data Down																												
2	NC	8	TX+ Data Up																												
3	NC	9	TX- Data Up																												
4	NC																														
5	Signal GND																														
6	RX- Data Down																														
CH9b	GENERAL PORT RS485		<table><thead><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>NC</td><td>7</td><td>Data +</td></tr><tr><td>2</td><td>NC</td><td>8</td><td>NC</td></tr><tr><td>3</td><td>NC</td><td>9</td><td>NC</td></tr><tr><td>4</td><td>NC</td><td></td><td></td></tr><tr><td>5</td><td>Signal GND</td><td></td><td></td></tr><tr><td>6</td><td>Data -</td><td></td><td></td></tr></tbody></table>	PIN	Function	PIN	Function	1	NC	7	Data +	2	NC	8	NC	3	NC	9	NC	4	NC			5	Signal GND			6	Data -		
PIN	Function	PIN	Function																												
1	NC	7	Data +																												
2	NC	8	NC																												
3	NC	9	NC																												
4	NC																														
5	Signal GND																														
6	Data -																														
CH10a CH11	GENERAL PORT ETHERNET		<table><thead><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>TXD+ WHITE/ORANGE</td><td>7</td><td>NC</td></tr><tr><td>2</td><td>TXD- ORANGE</td><td>8</td><td>NC</td></tr><tr><td>3</td><td>RXD+ WHITE/GREEN</td><td></td><td></td></tr><tr><td>4</td><td>NC</td><td></td><td></td></tr><tr><td>5</td><td>NC</td><td></td><td></td></tr><tr><td>6</td><td>RXD- GREEN</td><td></td><td></td></tr></tbody></table>	PIN	Function	PIN	Function	1	TXD+ WHITE/ORANGE	7	NC	2	TXD- ORANGE	8	NC	3	RXD+ WHITE/GREEN			4	NC			5	NC			6	RXD- GREEN		
PIN	Function	PIN	Function																												
1	TXD+ WHITE/ORANGE	7	NC																												
2	TXD- ORANGE	8	NC																												
3	RXD+ WHITE/GREEN																														
4	NC																														
5	NC																														
6	RXD- GREEN																														
CH11 (Repeater)	GENERAL PORT RS232		<table><thead><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>NC</td><td>7</td><td>NC</td></tr><tr><td>2</td><td>RX Data Down</td><td>8</td><td>NC</td></tr><tr><td>3</td><td>TX Data Up</td><td>9</td><td>NC</td></tr><tr><td>4</td><td>NC</td><td></td><td></td></tr><tr><td>5</td><td>SerGND</td><td></td><td></td></tr><tr><td>6</td><td>NC</td><td></td><td></td></tr></tbody></table>	PIN	Function	PIN	Function	1	NC	7	NC	2	RX Data Down	8	NC	3	TX Data Up	9	NC	4	NC			5	SerGND			6	NC		
PIN	Function	PIN	Function																												
1	NC	7	NC																												
2	RX Data Down	8	NC																												
3	TX Data Up	9	NC																												
4	NC																														
5	SerGND																														
6	NC																														
CH12a CH12b	NORBIT		<table><thead><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>BIDIA+ WHITE/GREEN</td><td>7</td><td>BIDID+ WHITE/BROWN</td></tr><tr><td>2</td><td>BIDIA- GREEN</td><td>8</td><td>BIDID- BROWN</td></tr><tr><td>3</td><td>BIDIB+ WHITE/ORANGE</td><td></td><td></td></tr><tr><td>4</td><td>BIDIC+ BLUE</td><td></td><td></td></tr><tr><td>5</td><td>BIDIC- WHITE/BLUE</td><td></td><td></td></tr><tr><td>6</td><td>BIDIB- ORANGE</td><td></td><td></td></tr></tbody></table>	PIN	Function	PIN	Function	1	BIDIA+ WHITE/GREEN	7	BIDID+ WHITE/BROWN	2	BIDIA- GREEN	8	BIDID- BROWN	3	BIDIB+ WHITE/ORANGE			4	BIDIC+ BLUE			5	BIDIC- WHITE/BLUE			6	BIDIB- ORANGE		
PIN	Function	PIN	Function																												
1	BIDIA+ WHITE/GREEN	7	BIDID+ WHITE/BROWN																												
2	BIDIA- GREEN	8	BIDID- BROWN																												
3	BIDIB+ WHITE/ORANGE																														
4	BIDIC+ BLUE																														
5	BIDIC- WHITE/BLUE																														
6	BIDIB- ORANGE																														
PULSE INPUT PPS INPUT	PULSE		<table><thead><tr><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>GND</td></tr><tr><td>2</td><td>+5V</td></tr></tbody></table>	PIN	Function	1	GND	2	+5V																						
PIN	Function																														
1	GND																														
2	+5V																														
POWER	POWER 110VAC		<table><thead><tr><th>PIN</th><th>Function</th></tr></thead><tbody><tr><td>1</td><td>VAC 110V L</td></tr><tr><td>2</td><td>VAC 110V H</td></tr><tr><td>3</td><td>GND</td></tr></tbody></table>	PIN	Function	1	VAC 110V L	2	VAC 110V H	3	GND																				
PIN	Function																														
1	VAC 110V L																														
2	VAC 110V H																														
3	GND																														

RTS GEN 5 MUX: SUBSEA CONNECTORS

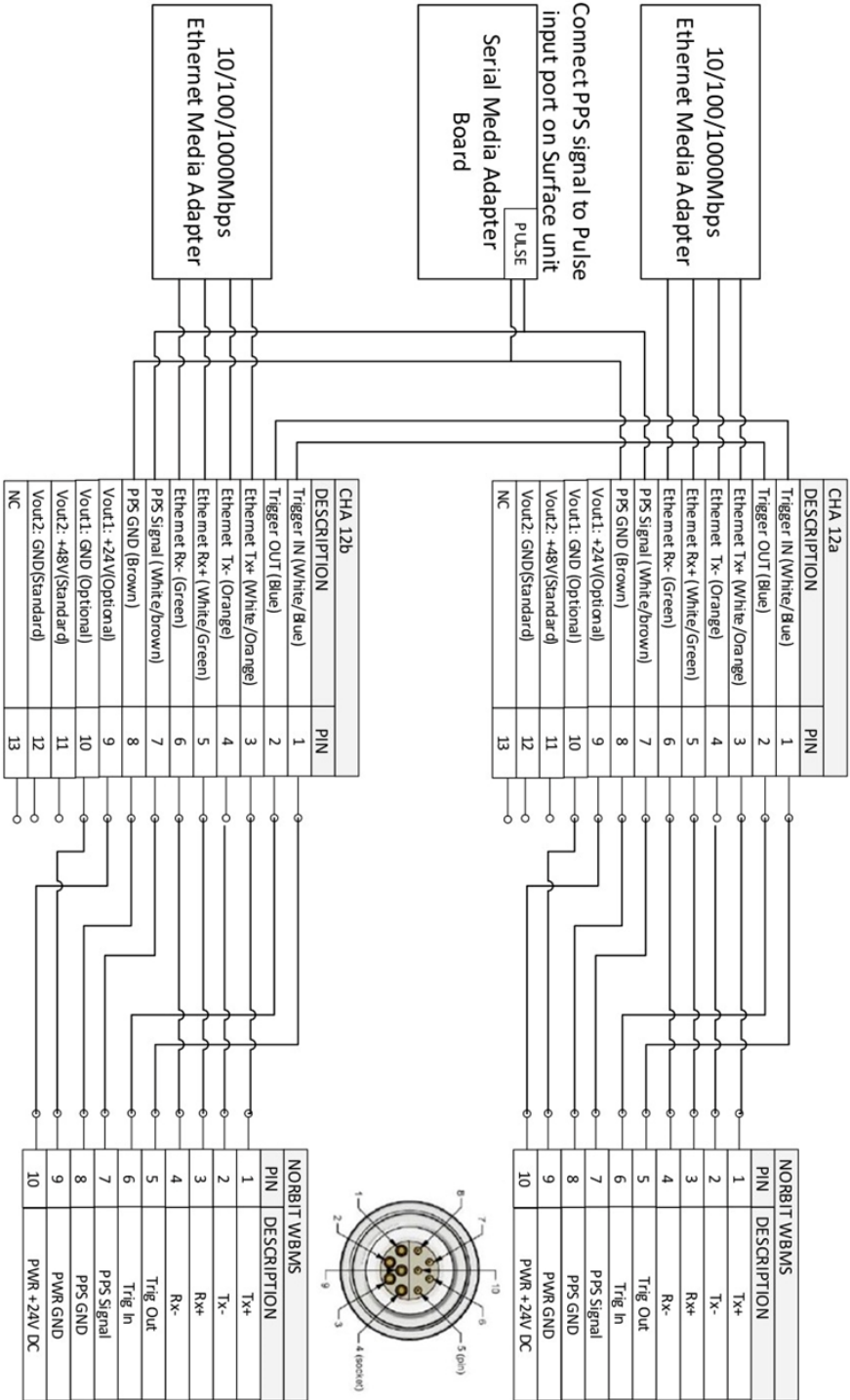


LABEL	FUNCTION	BULKHEAD	PINOUT																																
CH1 CH2 CH3 CH4	GENERAL PORT RS232	MCBH-6-F 	<table><tr><th>PIN</th><th>Function</th><th></th><th></th></tr><tr><td>1</td><td>+24V</td><td></td><td></td></tr><tr><td>2</td><td>GND</td><td></td><td></td></tr><tr><td>3</td><td>TX Data Down</td><td></td><td></td></tr><tr><td>4</td><td>RX Data Up</td><td></td><td></td></tr><tr><td>5</td><td>SerGND</td><td></td><td></td></tr><tr><td>6</td><td>NC</td><td></td><td></td></tr></table>	PIN	Function			1	+24V			2	GND			3	TX Data Down			4	RX Data Up			5	SerGND			6	NC						
PIN	Function																																		
1	+24V																																		
2	GND																																		
3	TX Data Down																																		
4	RX Data Up																																		
5	SerGND																																		
6	NC																																		
CH5 CH6	GENERAL PORT RS232	MCBH-6-F 	<table><tr><th>PIN</th><th>Function</th><th></th><th></th></tr><tr><td>1</td><td>+24V</td><td></td><td></td></tr><tr><td>2</td><td>GND</td><td></td><td></td></tr><tr><td>3</td><td>TX Data Down</td><td></td><td></td></tr><tr><td>4</td><td>RX Data Up</td><td></td><td></td></tr><tr><td>5</td><td>SerGND</td><td></td><td></td></tr><tr><td>6</td><td>NC</td><td></td><td></td></tr></table>	PIN	Function			1	+24V			2	GND			3	TX Data Down			4	RX Data Up			5	SerGND			6	NC						
PIN	Function																																		
1	+24V																																		
2	GND																																		
3	TX Data Down																																		
4	RX Data Up																																		
5	SerGND																																		
6	NC																																		
CH7 CH8	AC SUPPLY PORT RS232	MCBH-6-F SPECIAL 	<table><tr><th>PIN</th><th>Function</th><th></th><th></th></tr><tr><td>1</td><td>Mech GND</td><td></td><td></td></tr><tr><td>2</td><td>AC 110/240V L</td><td></td><td></td></tr><tr><td>3</td><td>TX Data Down</td><td></td><td></td></tr><tr><td>4</td><td>RX Data Up</td><td></td><td></td></tr><tr><td>5</td><td>SerGND</td><td></td><td></td></tr><tr><td>6</td><td>AC 110/240V N</td><td></td><td></td></tr></table>	PIN	Function			1	Mech GND			2	AC 110/240V L			3	TX Data Down			4	RX Data Up			5	SerGND			6	AC 110/240V N						
PIN	Function																																		
1	Mech GND																																		
2	AC 110/240V L																																		
3	TX Data Down																																		
4	RX Data Up																																		
5	SerGND																																		
6	AC 110/240V N																																		
Note: Special Modified Seacon MCBH-6-F Modified Penetrator AC power output voltage is depending on AC main supply (power input)																																			
CH9a CH9b	GENERAL PORT RS422 RS485	MCBH-6-F 	<table><tr><th>PIN</th><th>Function Channel 9a RS422</th><th>PIN</th><th>Function Channel 9b RS485</th></tr><tr><td>1</td><td>+24V</td><td>1</td><td>+24V</td></tr><tr><td>2</td><td>GND</td><td>2</td><td>GND</td></tr><tr><td>3</td><td>RX- Data Up</td><td>3</td><td>Data +</td></tr><tr><td>4</td><td>RX+ Data Up</td><td>4</td><td>Data -</td></tr><tr><td>5</td><td>TX+ Data Down</td><td>5</td><td>NC</td></tr><tr><td>6</td><td>TX- Data Down</td><td>6</td><td>NC</td></tr></table>	PIN	Function Channel 9a RS422	PIN	Function Channel 9b RS485	1	+24V	1	+24V	2	GND	2	GND	3	RX- Data Up	3	Data +	4	RX+ Data Up	4	Data -	5	TX+ Data Down	5	NC	6	TX- Data Down	6	NC				
PIN	Function Channel 9a RS422	PIN	Function Channel 9b RS485																																
1	+24V	1	+24V																																
2	GND	2	GND																																
3	RX- Data Up	3	Data +																																
4	RX+ Data Up	4	Data -																																
5	TX+ Data Down	5	NC																																
6	TX- Data Down	6	NC																																
CH10a	GENERAL PORT ETHERNET	MCBH-8-F 	<table><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr><tr><td>1</td><td>+24V</td><td>7</td><td>GND</td></tr><tr><td>2</td><td>GND</td><td>8</td><td>+48V</td></tr><tr><td>3</td><td>TXD+ WHITE/ORANGE</td><td></td><td></td></tr><tr><td>4</td><td>TXD- ORANGE</td><td></td><td></td></tr><tr><td>5</td><td>RXD+ WHITE/GREEN</td><td></td><td></td></tr><tr><td>6</td><td>RXD- GREEN</td><td></td><td></td></tr></table>	PIN	Function	PIN	Function	1	+24V	7	GND	2	GND	8	+48V	3	TXD+ WHITE/ORANGE			4	TXD- ORANGE			5	RXD+ WHITE/GREEN			6	RXD- GREEN						
PIN	Function	PIN	Function																																
1	+24V	7	GND																																
2	GND	8	+48V																																
3	TXD+ WHITE/ORANGE																																		
4	TXD- ORANGE																																		
5	RXD+ WHITE/GREEN																																		
6	RXD- GREEN																																		
CH11	PHINS Ethernet	5506-2013 	<table><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr><tr><td>1</td><td>GND PPS & SerGND</td><td>8</td><td>RS232 Repeater RX</td></tr><tr><td>2</td><td>PPS OUT, TTL 5V</td><td>9</td><td>Vout INS: +24VDC</td></tr><tr><td>3</td><td>Eth TXD+ WHITE/ORANGE</td><td>10</td><td>Vout INS: GND</td></tr><tr><td>4</td><td>Eth TXD- ORANGE</td><td>11</td><td>NC</td></tr><tr><td>5</td><td>Eth RXD+ WHITE/GREEN</td><td>12</td><td>Vout EXTSENS: GND</td></tr><tr><td>6</td><td>Eth RXD- GREEN</td><td>13</td><td>Vout EXTSENS: +24VDC</td></tr><tr><td>7</td><td>RS232 Repeater TX</td><td></td><td></td></tr></table>	PIN	Function	PIN	Function	1	GND PPS & SerGND	8	RS232 Repeater RX	2	PPS OUT, TTL 5V	9	Vout INS: +24VDC	3	Eth TXD+ WHITE/ORANGE	10	Vout INS: GND	4	Eth TXD- ORANGE	11	NC	5	Eth RXD+ WHITE/GREEN	12	Vout EXTSENS: GND	6	Eth RXD- GREEN	13	Vout EXTSENS: +24VDC	7	RS232 Repeater TX		
PIN	Function	PIN	Function																																
1	GND PPS & SerGND	8	RS232 Repeater RX																																
2	PPS OUT, TTL 5V	9	Vout INS: +24VDC																																
3	Eth TXD+ WHITE/ORANGE	10	Vout INS: GND																																
4	Eth TXD- ORANGE	11	NC																																
5	Eth RXD+ WHITE/GREEN	12	Vout EXTSENS: GND																																
6	Eth RXD- GREEN	13	Vout EXTSENS: +24VDC																																
7	RS232 Repeater TX																																		
CH12a CH12b	NORBIT	5506-2013 	<table><tr><th>PIN</th><th>Function</th><th>PIN</th><th>Function</th></tr><tr><td>1</td><td>Trigger IN</td><td>8</td><td>Pulse(PPS) GND</td></tr><tr><td>2</td><td>Trigger OUT</td><td>9</td><td>Vout 1: +24VDC(Optional)</td></tr><tr><td>3</td><td>Ethernet Tx+ (White/Orange)</td><td>10</td><td>Vout 1: GND(Optional)</td></tr><tr><td>4</td><td>Ethernet Tx- (Orange)</td><td>11</td><td>Vout 2: +48VDC(Standard)</td></tr><tr><td>5</td><td>Ethernet Rx+ (White/Green)</td><td>12</td><td>Vout 2: GND(Standard)</td></tr><tr><td>6</td><td>Ethernet Rx- (Green)</td><td>13</td><td>NC</td></tr><tr><td>7</td><td>Pulse(PPS) Signal</td><td></td><td></td></tr></table>	PIN	Function	PIN	Function	1	Trigger IN	8	Pulse(PPS) GND	2	Trigger OUT	9	Vout 1: +24VDC(Optional)	3	Ethernet Tx+ (White/Orange)	10	Vout 1: GND(Optional)	4	Ethernet Tx- (Orange)	11	Vout 2: +48VDC(Standard)	5	Ethernet Rx+ (White/Green)	12	Vout 2: GND(Standard)	6	Ethernet Rx- (Green)	13	NC	7	Pulse(PPS) Signal		
PIN	Function	PIN	Function																																
1	Trigger IN	8	Pulse(PPS) GND																																
2	Trigger OUT	9	Vout 1: +24VDC(Optional)																																
3	Ethernet Tx+ (White/Orange)	10	Vout 1: GND(Optional)																																
4	Ethernet Tx- (Orange)	11	Vout 2: +48VDC(Standard)																																
5	Ethernet Rx+ (White/Green)	12	Vout 2: GND(Standard)																																
6	Ethernet Rx- (Green)	13	NC																																
7	Pulse(PPS) Signal																																		
POWER	POWER 110VAC	5506-2003 	<table><tr><th>PIN</th><th>Function</th><th></th><th></th></tr><tr><td>1</td><td>VAC 110V L</td><td></td><td></td></tr><tr><td>2</td><td>VAC 110V H</td><td></td><td></td></tr><tr><td>3</td><td>Mech GND</td><td></td><td></td></tr></table>	PIN	Function			1	VAC 110V L			2	VAC 110V H			3	Mech GND																		
PIN	Function																																		
1	VAC 110V L																																		
2	VAC 110V H																																		
3	Mech GND																																		

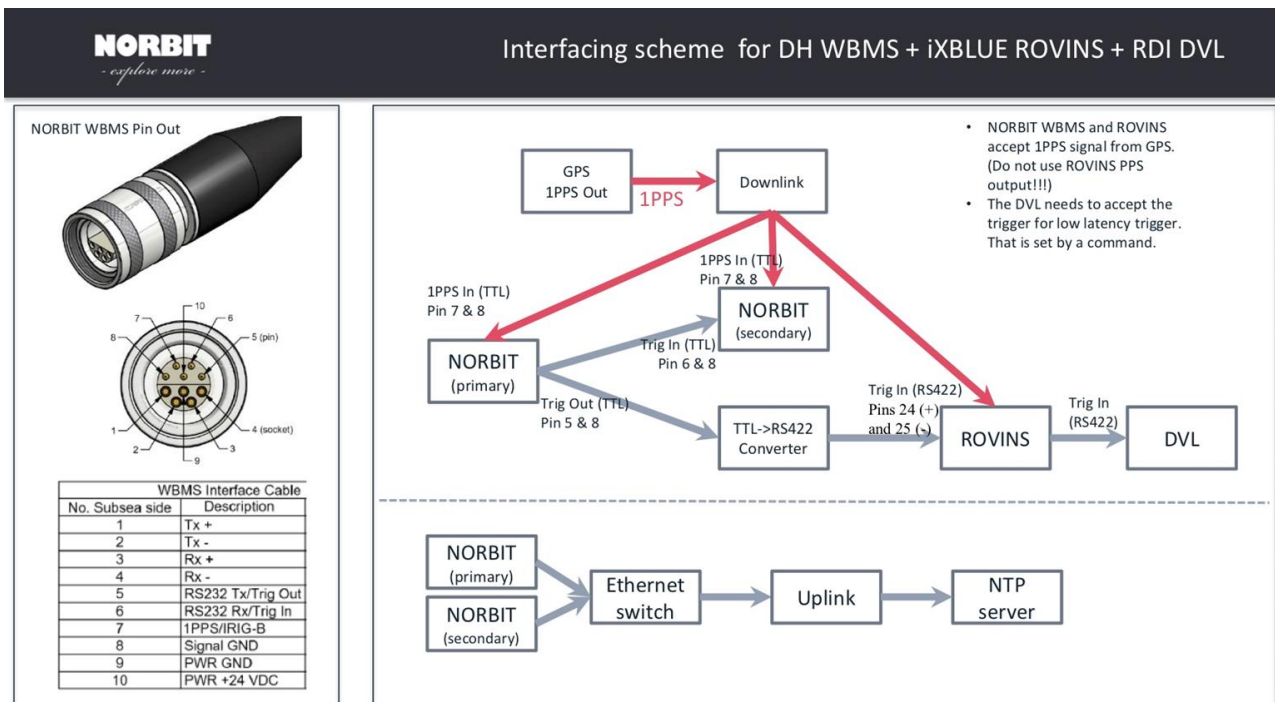
Note: Special Modified
Seacon MCBH-6-F
Modified Penetrator

AC power output
voltage is depending
on AC main supply
(power input)

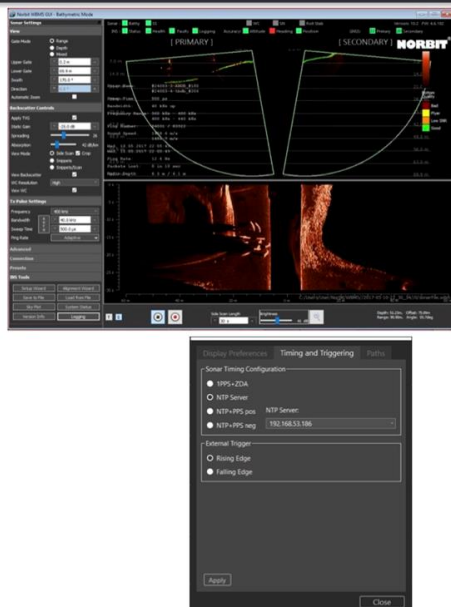
13.2 Appendix B: RTS Gen5 NORBIT MOD



13.3 Appendix C: NORBIT ROV-WBMS-ROVINS Integration Example



Configuring NORBIT WBMS



Synchronization:

In Dual head mode the secondary head WBMS is configured **automatically** by the GUI to use external trigger from primary head which allows for a proper synchronization. However, user needs to ensure the proper electrical connection.

Timing:

For ROV the 1PPS+NTS scheme needs to be used to achieve the best accuracy. If the 1PPS is not available, the NTP alone can be used with the limited accuracy on timing. The timing is set in GUI and populated to both heads.

Please refer to user manual for further details.

To slave the DVL to the multi beam, the best would be to supply a Pulse in on Pins 24 (+) and 25 (-) of the central connector on the ROVINS:

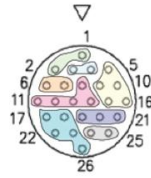


Figure 4 - Central connector

The full pin assignment for the central connector is described in Table 2.

PIN	Signal	PIN	Signal
1	System Power In (+24 V)	14	Port A: RS422 RX(+)(B)
2	System Power In GND (0/24 V) (*)	15	Repeater: RS422 RX(-)(A)/RS232 RX(+)
3	Ext sensor 1 In (+V1)	16	Repeater: RS422 RX(+)(B)
4	Ext sensor 1 In GND (0/+V1 V) (*)	17	Port B: RS422 TX(+)(B)/RS232 TX(+)
5	Repeater: GND, B (**)	18	Port B: RS422 TX(-)(A)
6	Ext sensor 2 In (+V2)	19	Pulse A: OUT TTL
7	Ext sensor 2 In GND (0/+V2 V) (*)	20	Pulse A: IN TTL
8	Port A: GND, A (**)	21	Pulse A: GND, A (**)
9	Repeater: RS422 TX(+)(B)/RS232 TX(+)	22	Port B: RS422 RX(-)(A)/RS232 RX(+)
10	Repeater: RS422 TX(-)(A)	23	Port B: RS422 RX(+)(B)
11	Port A: RS422 TX(+)(B)/RS232 TX(+)	24	Ext Pulse IN + (***)
12	Port A: RS422 TX(-)(A)	25	Ext Pulse IN -
13	Port A: RS422 RX(-)(A)/RS232 RX(+)	26	Port B: GND, B (**)

Then on the connector which goes to the DVL (port C, D or E) on the ROVINS the pulse will be available on PIN 9 (+) and 10 (-):

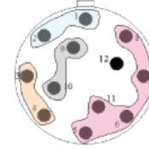


Figure 5 - Diagram of Port X [X being C, D or E] connector

The full pin assignment for Port X connector is described in Table 3.

Table 3 - Port X connector pin definitions

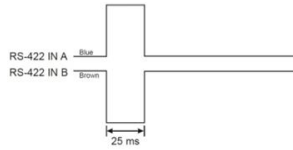
PIN	Signal
1	Ext sensor 1 Out (+V1)
2	Ext sensor 1 Out GND (0/+V1 V) (*)
3	Ext sensor 2 Out (+V2)
4	Ext sensor 2 Out GND (0/+V2 V) (*)
5	Port X: RS422 TX(+)(B)/RS232 TX(+)
6	Port X: RS422 TX(-)(A)
7	Port X: RS422 RX(-)(A)/RS232 RX(+)
8	Port X: RS422 RX(+)(B)
9	Ext Pulse OUT + (***)
10	Ext Pulse OUT -
11	Port X: GND, X (**)
12	Reserved except if X=C: Pulse C: IN TTL (****)

Excerpt from RDI's DVL user manual.

Using Low-Latency Triggering:

To configure the DVL for low latency triggering, set the CX command to enable trigger input by sending CX1. Start the DVL pinging with the CS command. The DVL will then wait for a trigger before each ping. Setting the RS-485 lines to a break state for not less than 10 microseconds sends the trigger. The DVL will then ping within 250 microseconds of the leading edge of the break pulse (See also FSA-018 - Triggering a DVL with a TTL Signal).

Please refer to user manual for further details.



ORDER DATE
Aug 11, 2017

1 item sold by memorabiliacollectiblesandmore



B & B Electronics RS-422 to TTL 25 Pin Converter - Model #422TTL
(322338762636)

Estimated delivery Tue, Aug 15 - Tue, Aug 22

ORDER TOTAL
US \$7.99

Free shipping

ITEM PRICE:
US \$7.99

