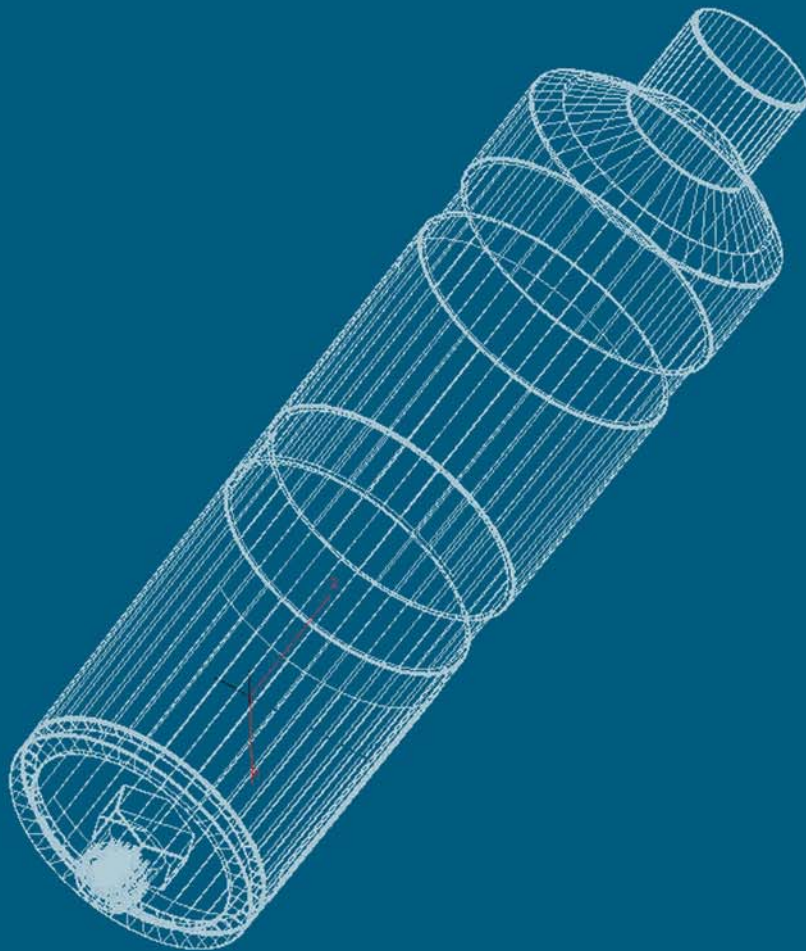




DATUM

Technical Manual



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Document Rev A



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2. INTRODUCTION

2.1 GENERAL DESCRIPTION



Figure 2.1 - CDL DATUM

The CDL DATUM is an underwater spread spectrum acoustic modem. The DATUM is capable of data rates of up to 480 bits per second and uses the latest modulation schemes to ensure data reliability and error detection.

The DATUM system consists of a pair of identical acoustic modems each capable of transmitting and receiving data as a transparent link in between the two devices.

Each DATUM is device addressable with a 6 digit number meaning that up to 999999 individual modems could theoretically be communicated to within a network of systems.

The system is fully configurable through the serial port with no need to open the unit to set switches.

2.2 WARNINGS AND NOTES

Through out the manual the following symbols are used.



Indicates a warning. Failure to follow these instructions will result in serious injury, damage to equipment or incorrect operation of equipment.



Indicates a note. This indicates important information that should be followed to ensure correct operation of the unit.

3. INSTALLATION

3.1 SYSTEM CONTENTS

When the system is received it should comprise of the following components:

- 2x CDL DATUM Acoustic Modems
- 2x 1m Burton tails for connection to the units
- Instruction Manual
- Transit Case

3.2 UNPACKING AND INSPECTION

The system was shipped from CDL in a specially designed transit case that contains cavities that exactly fit each system component. This transit case should ensure that the equipment reaches its destination in perfect working order.

On receipt of the equipment the contents of the packing case should be carefully unpacked and checked against the items on the shipping documents for any errors or omissions. It is recommended that the original packing case be used for subsequent transportation of the equipment.

In particular the Red transducers on the top of each DATUM unit should be inspected for any damage.



3.3 PHYSICAL INSTALLATION

The unit should be placed where the transducer is free on all sides, away from any other acoustic systems. In particular the DATUM units should be kept away from ROV thrusters that will effect the correct communication of the system. Mounting details are shown in the specifications section of the manual.

The depth rating of this unit is 3000m.



The maximum depth rating for this unit must not be exceeded; this may result in permanent damage.

3.4 ELECTRICAL INSTALLATION

The DATUM has a single BURTON 15-08 connector. This is used for pre deployment configuration of the unit and for receiving and transmitting data during a mission from connected devices.

The DATUM requires to be connected to a DC Power Supply between 10-30VDC. Further details about power requirements can be found in the Electrical Specification section.

The table below shows the pin outs for this connector and the diagram below shows the pin orientation for the connector.

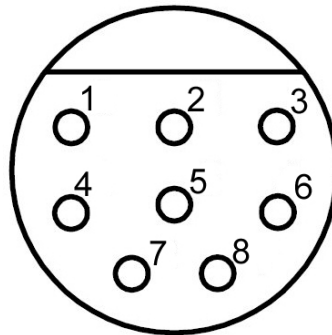


Figure 3.1 - Burton 15-08 Female Connector

Pin	Name	Function	RS 232
1	+24VDC in	+V Supply (18-30VDC)	
2	+24VDC Rtn	DC Ground	
3	Data TX	Comms	Tx
4		Comms	
5	Data RX	Comms	Rx
6	Data GND	Comms	Ground
7	NC	Not Connected	
8	NC	Not Connected	



Failure to power the unit from a 10-30VDC source could result in permanent damage to the unit.



Whilst the Communication lines are Zener Barrier protected from overvoltage care should be taken not to connect these lines to the power supply accidentally.

4. OPERATING INSTRUCTIONS

4.1 INITIAL POWER ON

Connect the DATUM to a PC and connect to it using a serial terminal emulation program. Default communication settings for the DATUM are 9600 Baud, 8 Data Bits, 1 Stop Bit and No Parity.

On initial power on a “Welcome” Message will be output from the modem.

If characters are sent to the modem the unit will, after a short period, start sending data. This process should be audible and the unit will make a brief chirping noise followed by a click if it is operating correctly.

4.2 CONFIGURING THE UNIT

The DATUM is configured entirely through the serial port. A test lead should be made up that connections power and communication lines as shown in the electrical installation section. Communication lines of the unit should be connected to the serial port of a suitable PC, Laptop or similar device.

The DATUM needs to be configured correctly to allow the modems to communicate to each other. Both the Transmit Power and Receive Sensitivity need to be tuned for the application.

When the unit first powers up it will be in DATA mode which is the transparent serial link mode, this is indicated by DAT being shown on the serial output of the unit. To configure the unit the modem needs to be set in to the Command Mode or COM mode.

The unit can be toggled in between DAT and COM mode by sending a break command (<Alt>+B or <Ctrl> +B in most programs) to the unit from a serial terminal program. On sending this command the three letter identifier DAT or COM will appear to tell the user which mode it is currently operating in.

Once in COM mode specific commands can be sent to the unit, please refer to the Programming and Communication Protocol section of the manual for the specific configuration commands.

4.2.1 Adjustment for fixed data links

The transmit power should be adjusted to the required strength to achieve reliable communications. If the environment is very noisy then the threshold value should be increased to reduce the sensitivity.

The threshold can be reduced to improve the maximum range of the modems however care should be taken and the receive circuitry can be overloaded by background noise.

4.2.2 Adjustment for mobile data links

In mobile situations with moving platforms like ROVs, AUVs or boats, the transmit power should be set to a high level and the threshold should be set to a default value. The Digital Automatic Gain Controller will take care of adjusting the receive level for dynamic range situations.

The below parameters are guidelines for allowing operation in certain conditions.

Parameter	In Air (1m separation)	In Water (Starting Condition, may need tuning)
Transmit Power	0150	0200
Receive Sensitivity	0150	0150

4.3 NORMAL OPERATION

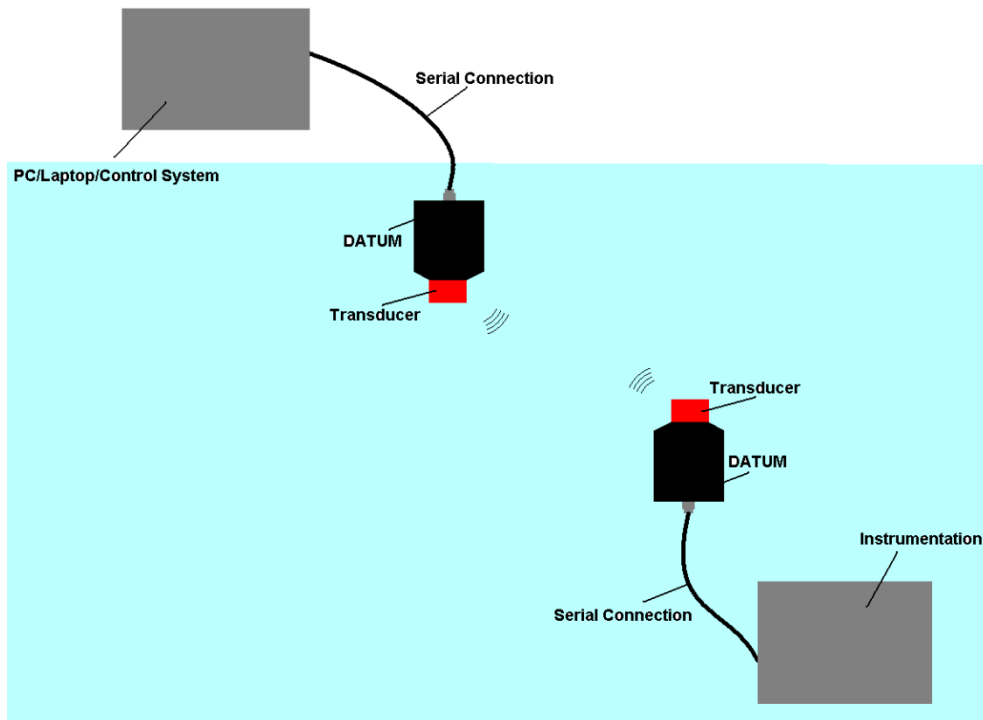


Figure 4.1 - Normal Operation



The DATUM units must be configured correctly in order for correct operation. Specifically the TX Power and RX Sensitivity need to be tuned for each operation.

During normal operation the host PC connected to the surface can receive data from and send data to the “Instrument” mounted unit.

Data sent to the modem is transmitted in packages which are periodically sent. By transmitting the data in packages it reduces the data overhead required and improved the data rate of the modem. The time the unit waits for data is set through the Transmit Delay command in the Programming and Communication Protocol section of the manual.

5. PROGRAMMING AND COMMUNICATION PROTOCOL

The DATUM Acoustic Modem has two main operating modes; Data Mode and Command Mode.

- **Data mode:** Any communication on the serial line will be transmitted acoustically to the matching modem with the same address as the sending unit.
- **Command Mode:** The unit can be configured, the current address changed debug information requested.

5.1 DATA MODE COMMUNICATION

Whilst in data mode any data coming in on the serial lines will be packaged up and transmitted by the modem to a remote modem.

As each device can uniquely be addressed data can be transmitted to several different modems. A modem set with address 000001 will send data to a modem with the same address. If the modem wants to communicate to modem 000002 then its own address must be changed to suit.

The following flowchart gives an example of operation when a modem when it is required to transmit to more than one modem sequentially.

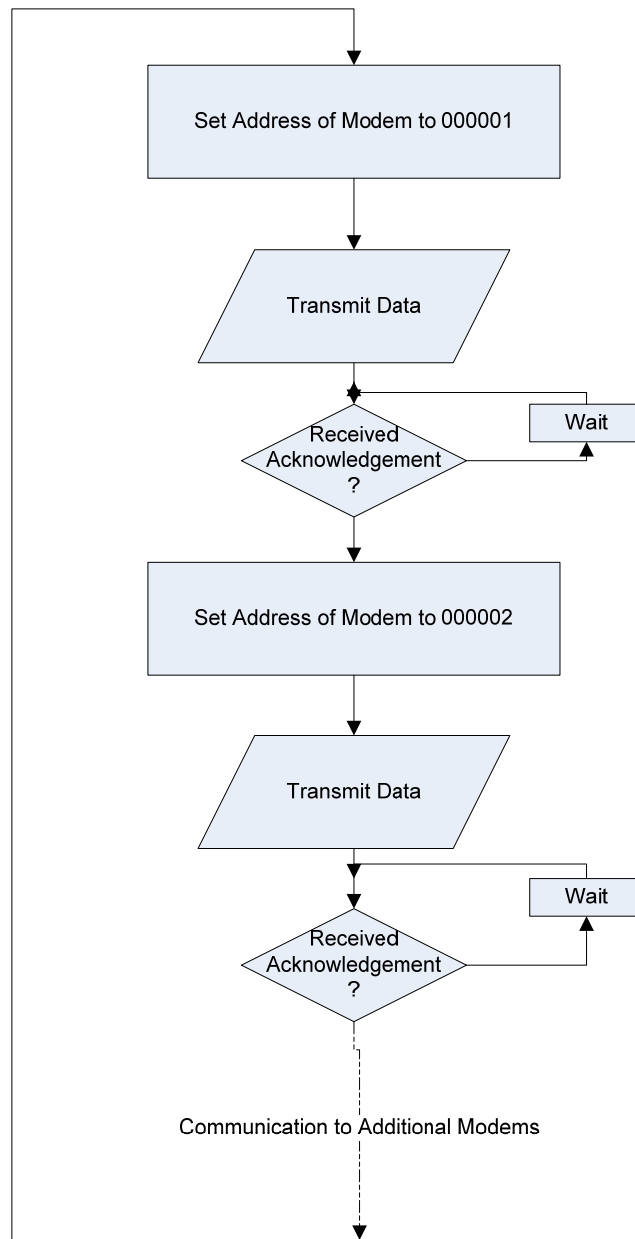


Figure 5.1 - Data Mode Communication

5.2 COMMAND MODE COMMANDS

This section describes the commonly used commands whilst the unit is in Command Mode. All of the commands are based on the following format.

<Command Number (2 Chars)><Number of bytes to follow (2 Chars)>< Variables>

For example

1106000123 can be broken down in to the following parts

- 11 – Command to Set Address
- 06 – Number of Bytes to follow in the variables
- 000123 – Value that the address will be set to.

Some commands like Report RMS do not require a variable so are just sent in the following format

1700

- 17 - Command to Report RMS of received signal
- 00 – No variables to follow

Command	Code	Description	Example
Reset Serial Link	00		0000
RXON	03	Turn the TX and RX off	030200-RX Off 030201-RX On 030202-RX in power save
SLEEP	04	Put modem in to low power mode	04000
Set Config Bits (Explained Further Below)	09	Configuration String sent by host	091201500150038E
Ping	10	Ping Remote Modem	1000
Set Address	11	Sets the Address of the Modem	1106000012
Read Configuration	12	Reads the Configuration presently set in the modem	1200
Save Configuration	13	Saves the Config to Flash	1300
Transmit Delay	14	Transmit Delay 0500 is a 2 second delay	14040500
Set Sound Velocity	15	Set Sound Velocity for range measurements	15041497
Report RMS	17	Report RMS of received signal	1700

5.2.1 Set Configuration Command

The 12 Byte command is used to set various parameters and settings of the modem, it is essential to correctly configure this for correct operation of the modems. The current configuration can be read with the Read Config Command (1200) and saved to memory using the Save Configuration Command (1300).

The first 4 bytes are for the transmit amplitude the next are for the receive sensitivity and the last 4 are for setting various parameters such as the number of times to retransmit.

The Configuration Command takes the following format.

09	12	TX Amplitude 4 Bytes	Rx Sensitivity 4 Bytes	Config Parameters 4 Bytes
----	----	----------------------	------------------------	---------------------------

Transmit Amplitude 4 Bytes:

Location in Config Command	First 4 Bytes after command number and size
Format	ASCII Decimal
Value Range	0000-00350
Default Value	0350
Description	This number sets the transmit voltage level. Larger the number the larger the voltage setting. The maximum power out put is about 2.5 Watts and equates to a value of 0350, halving this value to 175 will quarter the power output.

Receive Sensitivity 4 Bytes:

Location in Config Command	Middle 4 bytes
Format	ASCII Decimal
Value Range	0120-2000
Default Value	0150
Description	This number sets the receive sensitivity, the higher the number the lower the sensitivity. This value should be set between 120-500 during normal operation.

Configuration Parameters

The 4 bytes of the Configuration Parameters are made up of the following

Hex Byte 3	Hex Byte 2	Hex Byte 1	Hex Byte 0
ASCII Unused	ASCII <ul style="list-style-type: none"> • Transmit Message Time out 	ASCII <ul style="list-style-type: none"> • Data mode transmit retry level 	ASCII <ul style="list-style-type: none"> • No of Retries • Rx Signal Strength Reporting • Debug Mode

The bit maps for each of the functions are described below.

Configuration Parameters Hex Byte 0

Bit 3	Bit 2	Bit 1	Bit 0
Number of Transmit Retries		Rx Signal Strength	Debug On/Off
Number can vary between 1 and 3, meaning that the modem will send the packet at least once and a maximum of 3 times.		This option will return the strength of a signal after it has received data	Normally Turned off during operation.

Example: If hex byte 0 is set to 0xA (0b1010), this means that the modem is set to retransmit two times, signal reporting is turned on and debug reporting is turned off.

Configuration Parameters Hex Byte 1

Bit 3	Bit 2	Bit 1	Bit 0
Data Mode Transmit Retry Level		Reserved	Reserved
This is used in addition to the Number of retries field and is used to increase the number of retries from whilst in DATA mode. If the No of Retries is set to 2 and the Data Mode Retry level is set to 2 then the modem will try 6 times Number of tries = (DAT mode TX retry level +1) x transmit retries		Set to Zero (Factory test only)	Set to Zero

Example: if hex byte 1 is set to 0xC (0b1100) then the Data Mode Transmit level is set to 4 and the other options are both disabled.

Configuration Parameters Hex Byte 2

Bit 3	Bit 2	Bit 1	Bit 0
Unused	Transmit Message Acknowledgement time out (ATO)		
Set to Zero	<p>Default: 2 Value Range: 0-7</p> <p>This important parameter sets the time period that the modem will wait for a transmission to be acknowledged by the receiving modem. When this value is set to 0 the modems will wait at least 1 second. Each increment of the value adds 0.5seconds to the wait time so a maximum of 4.5 second.</p> <p>If the remote modem is a long distance away this setting should be configured to suit. For example if the modem is 2km away and the speed of sound in water is 1500ms^{-1} then the round trip delay can be calculated as follows:</p> $\frac{\text{Return Distance (m)}}{\text{Speed of Sound in water (ms}^{-1}\text{)}} = \frac{2000}{1500} = 1.33\text{sec}$ <p>So the Transmit Message Acknowledgement should be set to 1 giving a 1.5 second period time out for the receipt of acknowledgement.</p>		

Example: If hex byte 2 is set to 0x7 (0b0110) then the transmit message acknowledgement time out is set to $(1 + (7/0.5)) = 4.5$ seconds.

5.3 PROGRAMMING EXAMPLES

5.3.1 Switching between DAT mode and COM Mode

This example shows how to change between DAT mode and COM mode and vice-versa:

Switching from DAT to COM

1. Send break signal. This break signal for Hyperterminal is <Ctrl>+B, for Terra Term it is <Alt>+B. These key combinations to send a break signal will vary depending on the serial terminal emulation program used.
2. The modem will reply COM on the screen signifying that the modem is in the command mode and ready to receive commands

Switching from COM to DAT

1. Send break signal. This break signal for Hyperterminal is <Ctrl>+B, for Terra Term it is <Alt>+B. These key combinations to send a break signal will vary depending on the serial terminal emulation program used.
2. The modem will reply DAT on the screen signifying that the modem is in the transparent data transmission mode. In this mode any characters entered from the keyboard will be transmitted

5.3.2 Setting the Transmit Power and Receive Sensitivity Example.

This example shows how to set the transmit voltage to 200 and the Receive Sensitivity to 175:

1. Switch from DAT to COM mode by sending the break command to the modem
2. Type 1200 to list the current configuration. The modem will display the current configuration as shown below:

```
PWR: 0350    (transmit voltage setting)
THR: 0150    (receive threshold or sensitivity setting)
DBG: 0       (debug messages on/off)
RXS: 1       (receive signal strength reporting on/off)
TXR: 3       (number of transmit retries)
RLB: 0       (remote acoustic control of hardware pin enable/disable)
RXD: 0       (reserved)
SRT: 2       (Data mode transmit retry level)
ATO: 3       (Transmit acknowledge time out - round trip delay)
TSD: 500     (Transmit send delay in transparent mode)
HDM: 0       (Host data communication mode)
SBR: 9600    (Serial port baud rate)
TTM: 0       (Transparent transmit mode)
REM: 0       (Report RX messages with errors)
WDT: 1       (Watch dog function)
ADR: 123456   (Six digit modem address)
FRQ: 000000   (Reserved)
```

3. Type 091202000175038C to set the new transmit voltage level to 200 and the receive sensitivity to 175.
4. Type 120 command to display the configuration again to check that the parameters have been set correctly.
5. Send the command 1300 to save the changes to non-volatile memory.
6. Switch back to DAT mode if required.

5.3.3 Changing the Address

Go into COM mode if the modem is in DAT mode.

1. Type 1106000003 to change the address to 000003



2. Type 1200 to display and confirm that the change has taken place
3. If required, enter 1300 to save parameter to Non-Volatile memory
4. Return to DAT mode.

6. SPECIFICATIONS

6.1 GENERAL

Power Supply Input Voltage	10-30VDC (Reverse Polarity Protected)
Current Consumption at 10VDC	42mA in normal make operation 4.2mA in power save receive 1A Max required during Transmission.
Data Communication	R232 serial communication 9600 baud (default), 1 stop bit, no parity 4800, 2400 or 1200 programmable Either TTL or RS232 levels selectable
Host Command	Simple ASCII command to set and command the modem

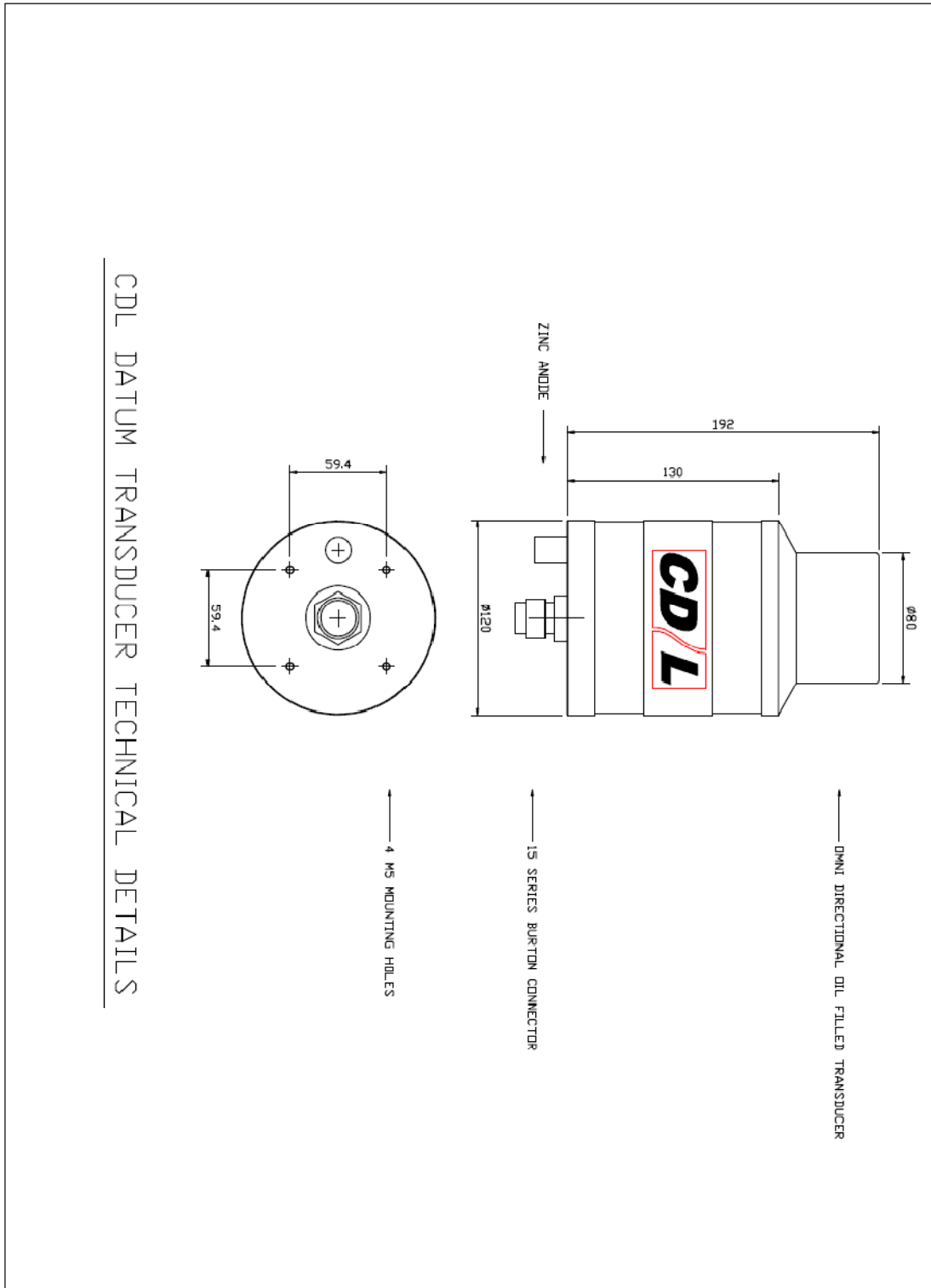
6.2 DATA COMMUNICATION

Data Rates	480 bits per second
Bit Error Rate	10 ⁻⁶ or better
Acoustic Doppler Tolerance	High Immunity to noise and to multipath and Doppler fading Acoustic Doppler tolerance of $\pm 5\text{ms}^{-1}$
Bandwidth	Broadband operation 16KHz to 30KHz
Range	Tested to 3km range. Longer ranges possible
Modulation	Direct sequence spread spectrum/ OFDM
Error detection	CRC16
Through water communication protocol	Confirmed packet delivery with error detection. If the transmitting end does not receive an acknowledgement, it will resend the data two or more times. Number of retries is configurable
Addressing	Uniquely Addressable with a 6 digit address
Receive Sensitivity	Configurable
Transmit Power	Configurable

6.3 PHYSICAL

Total Height	192mm
Diameter of Housing	120mm
Diameter of Transducer	80mm
Weight: In Air In Water	
Material: Housing Transducer	Hard Black Anodised Aluminium
Depth Rating	3000m

6.4 MECHANICAL DRAWING



7. CONTACT CDL

7.1 BY PHONE

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