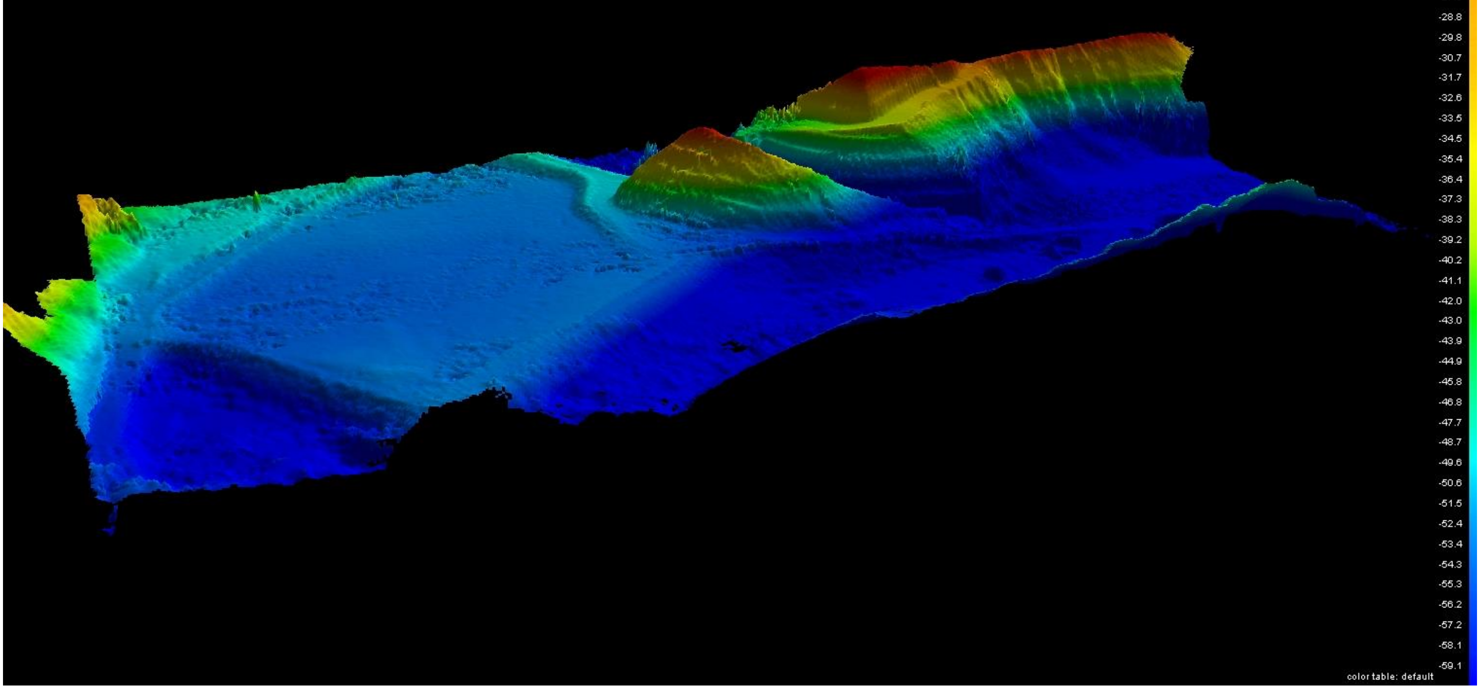
PicoMB-120 and PicoMB-140 Integration Manual



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VOIDS

Void	Section	Notes
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LIST OF MODIFICATIONS

Version	Date	Modifications	Pages	Writer	Checker
1.12	27/07/18	Add new pulse types and sync PDU.		AW	MT
1.11	11/06/18	Add sync to water column data and AUX PDUs. Add time stamp to water column data. Add section describing hydrophone stimulation data.		AW	MT
1.10	04/06/18	Add PicoMB-140 specifications, update drawings		AW	MT
1.09	01/06/18	Add status PDU, beam widths for all frequencies		AW	MT
1.08	28/11/16	Update drawings for PicoFLS-120		AW	MT
1.07	29/09/16	Update drawings for short PicoMB TX XDCR		AW	MT
1.06	20/06/16	Add ZDA baud		AW	MT
1.05	29/05/16	Add In-system Reprogramming		AW	
1.04	10/05/16	PPS polarity when ZDA over RS232		AW	
1.03	05/05/16	Testing, TVG, pulse and rate commands		AW	
1.02	23/02/16	Operation without transducers for test		MFG	
1.01	25/11/15	New transducer shape		MFG	
1.00	25/09/15	Review and void fill from Allan		MFG	AW
0.02	24/09/15	More information from Allan		MFG	AW
0.01	23/09/15	Initial document		MFG	AW

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1 INTRODUCTION

1.1 REFERENCES

Ref 1 Picotech website http://www.picotech-ltd.com/

1.2 GLOSSARY & ACRONYMS

WORDS & ACRONYMS	DEFINITION
ARP	Address Resolution Protocol
AUV	Autonomous Underwater Vehicle
CW	Continuous Wave
DC	Direct Current
FPGA	Field-Programmable Gate Array
ICMP	Internet Control Message Protocol
INS	Inertial Navigation System
IO	Input - output
LFM	Linear Frequency Modulation
MRU	Motion Reference Unit
NMEA 0183	A standard interface format for data sent between marine data systems
OEM	Original Equipment Manufacturer
PGA	Programmable Gain Amplifier
PC	Personal computer
PDU	Protocol Data Unit, i.e. a data "packet"
PPS	Pulse Per Second: a system of timing pulses typically output by GPS systems
PRF	Pulse (or Ping) Repetition Frequency
PRI	Pulse Repetition Interval (the inverse of PRF)
ROV	Remotely-Operated underwater Vehicle
SAS	Synthetic Aperture Sonar
Sonar head	The active part of the sonar, the transducers
TVG	Time Varying Gain
USV	Unmanned Surface Vehicle (radio-controlled or autonomous boat)
UUV	Unmanned Underwater Vehicle: includes AUVs and ROVs
ZDA	An NMEA 0183 message, defining timing, used together with PPS pulses

1.3 SCOPE

This document provides instructions for integrating PicoMB systems into systems and vehicles.

It covers the PicoMB multibeam sonars.

1.4 PICOMB

PicoMB is a small beam-forming bathymetric sonar. It forms a fan of beams extending from the sonar head, and measures the distance to the seabed (or other hard objects) in each beam. PicoMB integrates an Applanix POS MV® GNSS and IMU.

1.5 PRECAUTIONS

Precautions should be taken while working with PicoMB:

1. ***When operating the system, the transducers must be fully immersed in water. Never operate the system in air as this may cause permanent damage. For testing ashore, immerse the sonar in a bucket of fresh water.***
2. ***Do not immerse the deck unit or LEMO connectors in water.***
3. ***The power amplifier inside the deck unit has high voltage on it, do not touch it with bare hands or tools when it is live; there is sufficient energy stored in the board to cause injury or death.*** (There should be no need to access the inside of the deck unit in normal integration and use; see the note below).
4. ***There are no user-serviceable parts inside the deck unit, so do not open it. Opening the deck unit invalidates the product warranty.***
5. Clean the transducers with warm, soapy water. Do not use abrasive or scouring tools or cleaning products.
6. ***Do not turn on the power supply before all the connections are made, do not hot-plug the transmit or receive transducers. Do not unplug the transmit or receive transducers whilst power is applied to the system.***
7. ***Transducers supplied with PU mounting lugs must not be over-tightened; the lugs must not be deformed when mounting the transducers. Do not use the compliance of the lugs to lock the fasteners' threads – use nylocs or thread locking fluid to achieve this.***
8. ***Transducers supplied with plastic mounting lugs must be tightened to a torque no greater than 5nm.***

2 OVERVIEW

2.1 SYSTEM COMPONENTS

PicoMB consists of the following components:

- Transmit transducer
- Receive transducer
- Deck unit
- Umbilical cable
- SVS and SVS cable

The deck unit may be supplied with integrated Applanix POS MV® GNSS+IMU, or without, if the user wishes to use an external GNSS+IMU.

The Umbilical cable connects the deck unit to the user's equipment.

The systems work with the PicoSonar Windows UI and drivers for the following software have been developed;

- Xylem HYPACK®
- QPS QINSy®
- Teledyne PDS®
- EIVA NaviSuite®
- OIC GeoDAS® and SAMM®
- ITER Bathyswath®

2.2 PICOMB-120

PicoMB-120 is a small, low-power, low-cost multibeam echosounder, developed by Picotech Ltd. PicoMB-120 has a wide 120° swath and is intended for bathymetric survey using 3rd party acquisition and processing software. It is small enough to fit within a USV's ADCP moon pool, but is supplied as standard with 3m length transducer cables and 6m length umbilical cable enabling it to be used on small survey vessels.

2.2.1 Specifications, PicoMB-120

Item	Dimensions Height / length (mm)	Width / diameter (mm)	Depth (mm)	Weight in air (kg)	Weight in water (kg)
Transmit transducer (Standard)	36.0	170.0	84.0	0.91	0.26
Transmit transducer (EchoBoat®)	36.0	142.0	84.0	0.67	0.22
Receive transducer	36.0	170.0	84.0	1.08	0.56
Deck unit	85	162	164	2.9	-

Operational Parameters	
Swath sector	120°
Beam width (Standard Projector)	1.4° x 1.4° @380kHz 1.5° x 1.5° @360kHz 1.6° x 1.6° @337kHz
Beam width (EchoBoat® Projector)	1.4° x 1.8° @380kHz 1.5° x 1.9° @360kHz 1.6° x 2.0° @337kHz
Frequency	300-400 kHz
Pulse length	500µs, 5ms
Number of beams	256 spaced @ 0.47°
Maximum range	240 m
Range Resolution	37mm
Power	20 to 28 VDC, 12 W
Transducer Pressure depth	300 m

2.3 PICOMB-140

PicoMB-140 is a low-power, low-cost multibeam echosounder, developed by Picotech Ltd. PicoMB-140 has a wide 140° swath and is intended for bathymetric survey using 3rd party acquisition and processing software. PicoMB-140 is designed for larger USVs and small survey vessels, supplied as standard with 3m length transducer cables and 6m length umbilical cable.

2.3.1 Specifications

Item	Dimensions Height / length (mm)	Width / diameter (mm)	Depth (mm)	Weight in air (kg)	Weight in water (kg)
Transmit transducer	36.0	170.0	84.0	0.91	0.26
Receive transducer	44.0	453.0	84.0	2.8	1.1
Deck unit	85	162	164	2.9	-

Operational Parameters	
Swath sector	140°
Beam width	0.47° x 1.4° @380kHz 0.50° x 1.5° @360kHz 0.53° x 1.6° @337kHz
Frequency	300-400 kHz
Pulse length	500µs, 5ms
Number of beams	512 spaced @ 0.27°
Maximum range	240 m
Range Resolution	18mm
Power	20 to 28 VDC, 30 W
Transducer Pressure depth	300 m

3 SOFTWARE

3.1 INTERFACING

PicoMB and can be interfaced to software applications directly through their data interfaces, which operate over Ethernet. PicoMB drivers for the following software have been developed;

- Xylem HYPACK®
- QPS QINSy®
- Teledyne PDS®
- EIVA NaviSuite®
- OIC GeoDAS® and SAMM®
- ITER Bathyswath®

See section 4.3 for the details of the software interfaces.

4 INTEGRATION

4.1 MECHANICAL INTEGRATION

4.1.1 Safety

When powered up, the deck unit has stored energy inside. **This could cause serious injury to people if it is accidentally touched.** There are no user-serviceable parts inside the deck unit, so do not open them.

4.1.2 Dimensions

See the specifications in sections 2.3.1 and 2.2.1.

4.1.3 Drawings

Drawings of the PicoMB-120 and PicoMB-140 are shown on the following pages.

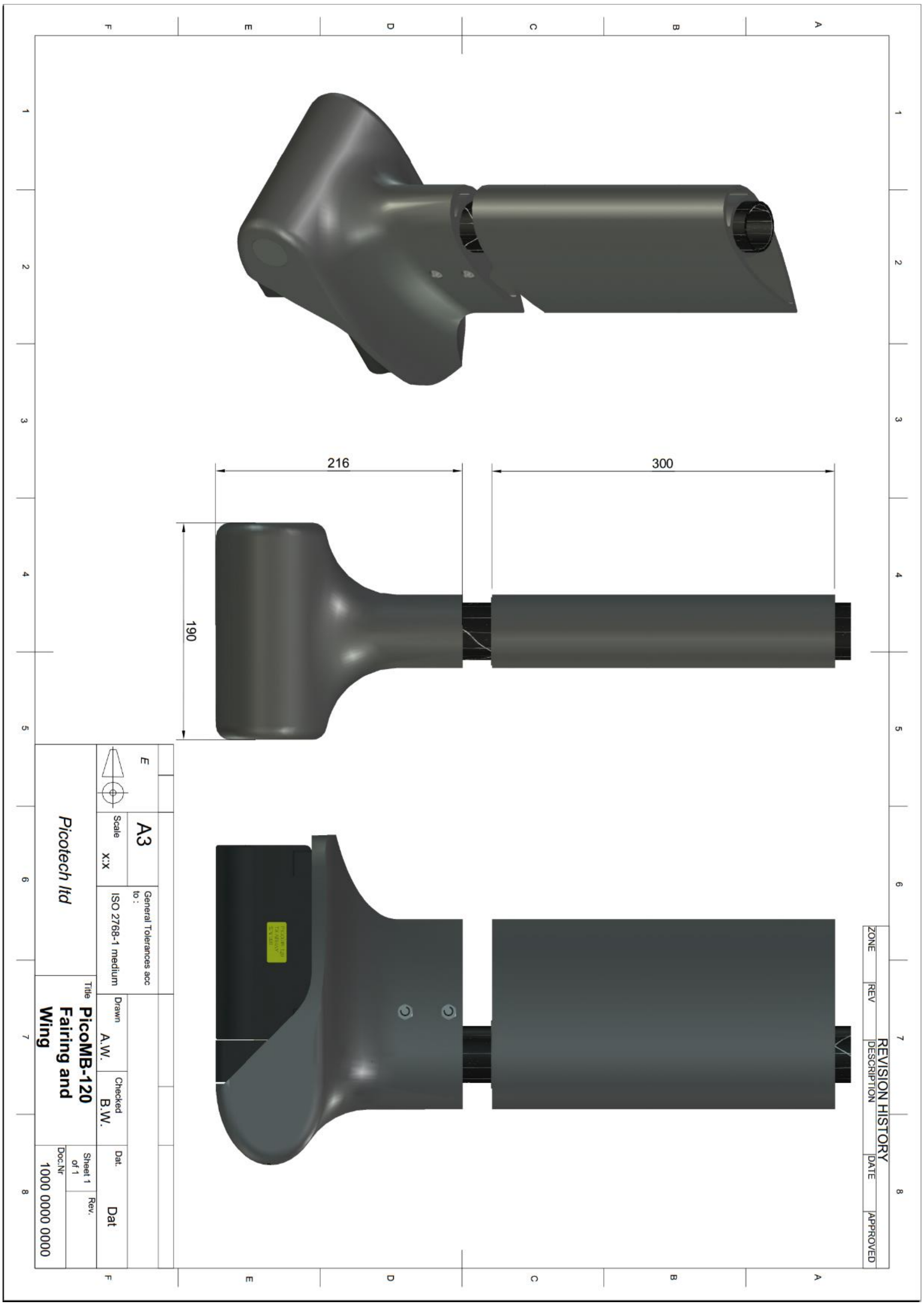


Figure 1 PicoMB-120 Fairing and Wing.

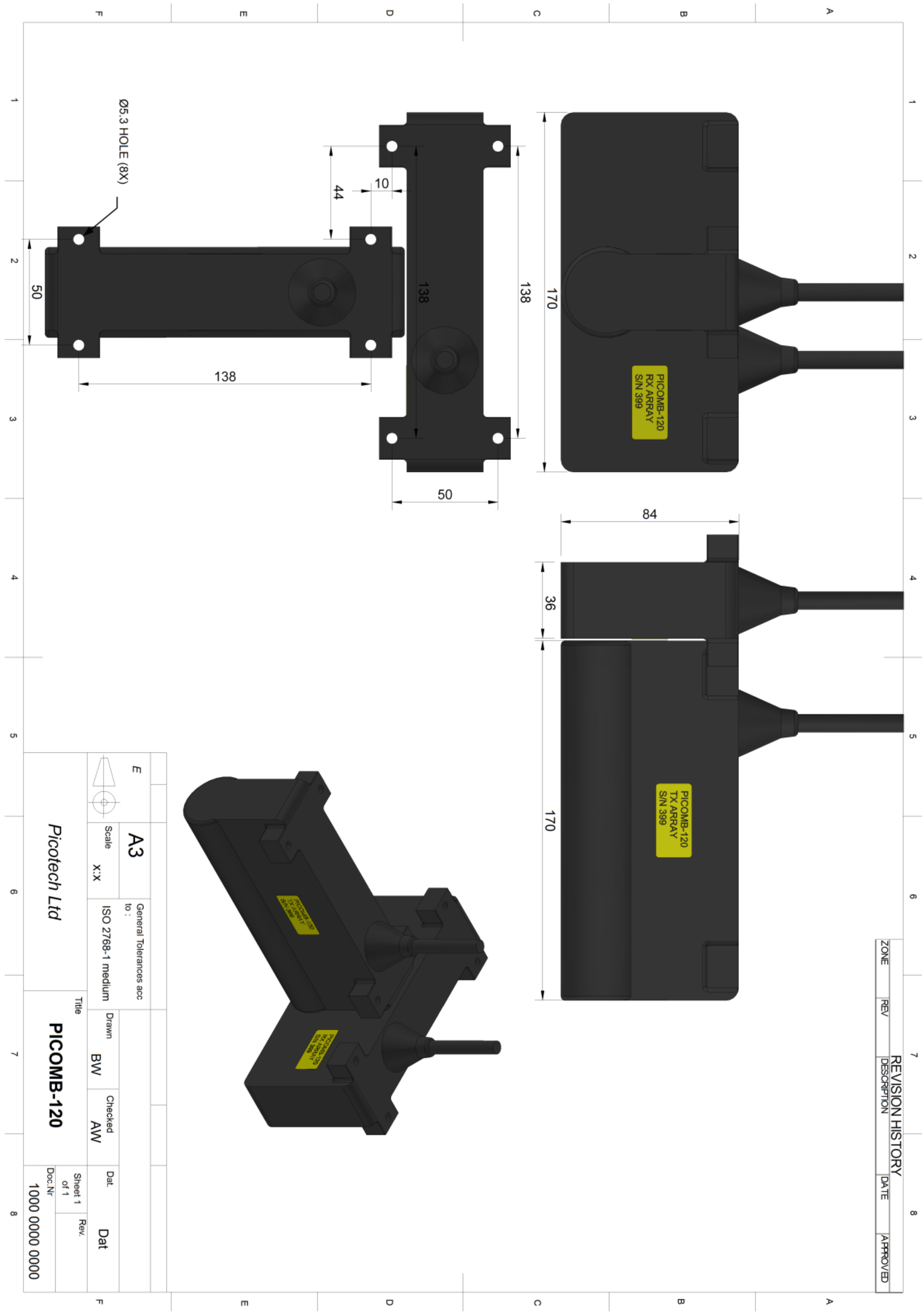


Figure 2 Standard PicoMB-120.

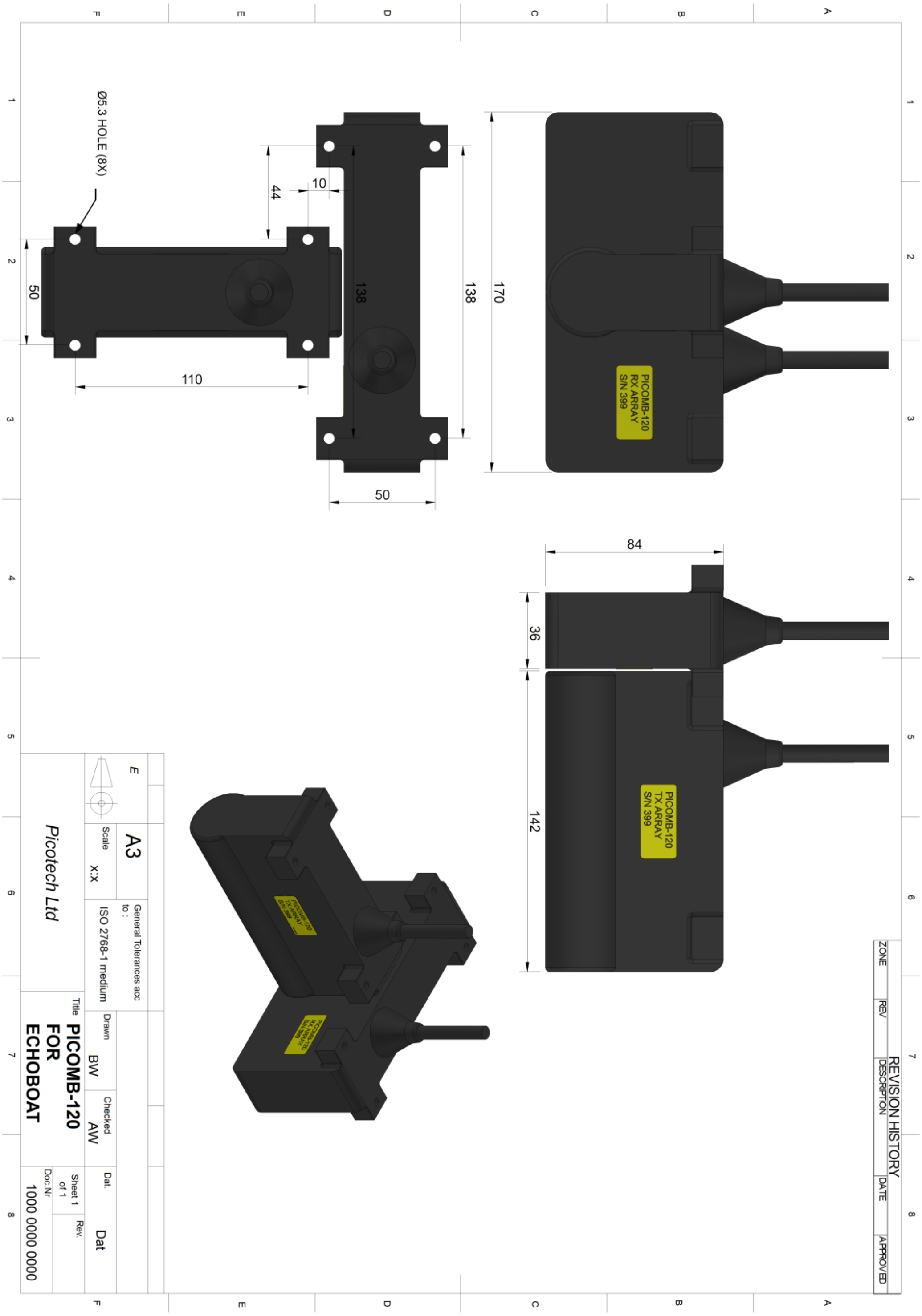


Figure 3 PicoMB-120 for Seafloor System's EchoBoat^{tm}.

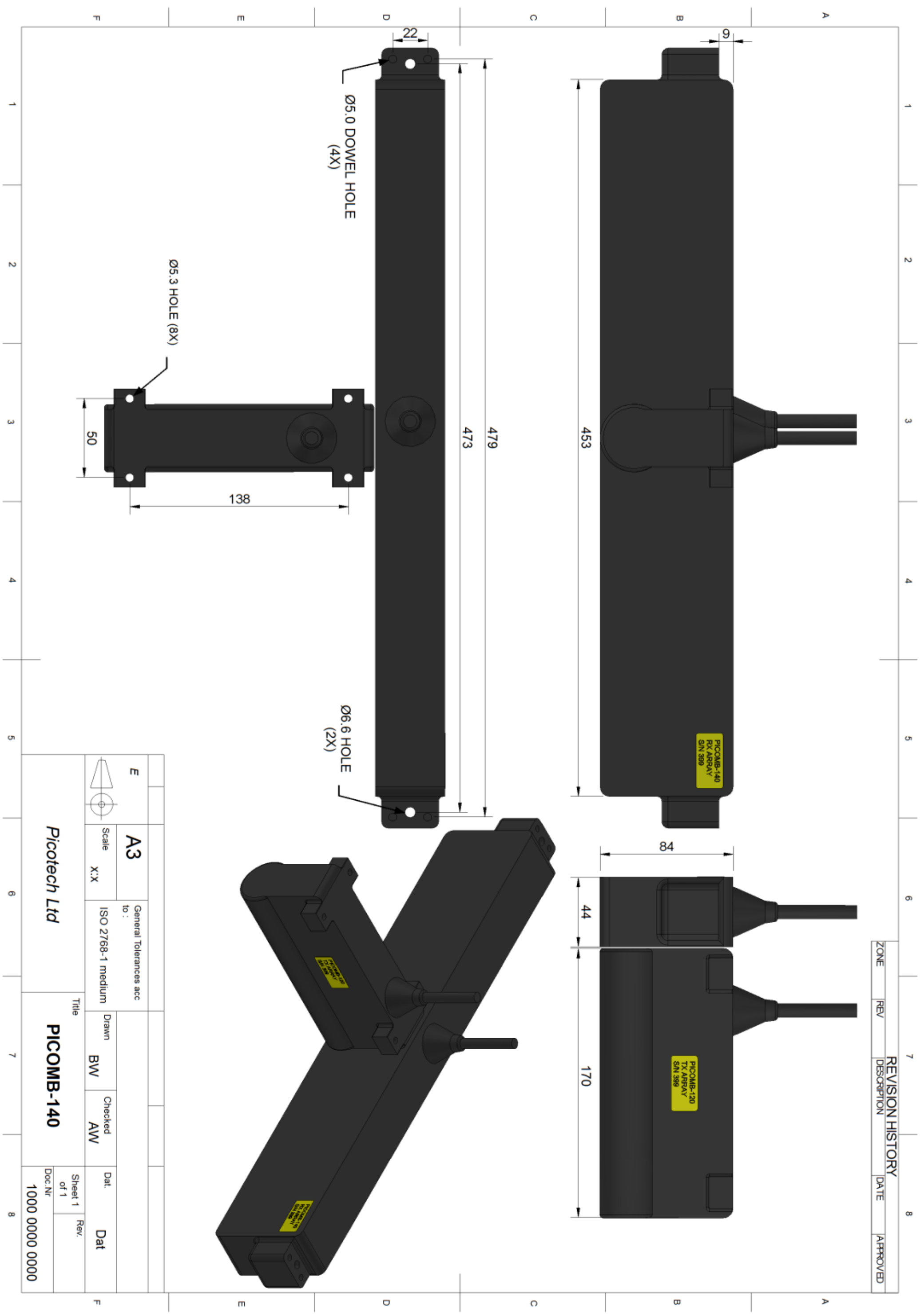


Figure 4 PicoMB-140.

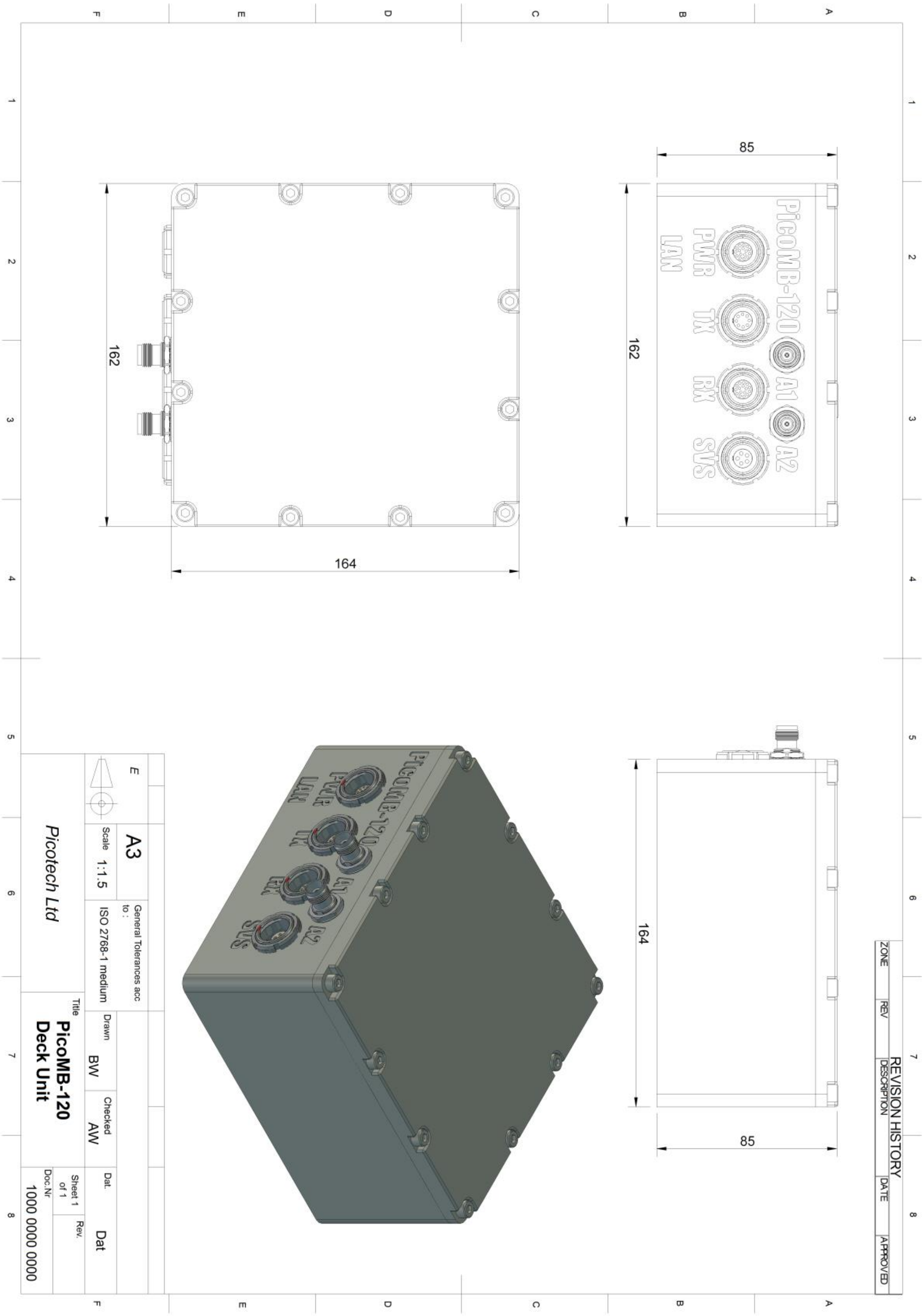


Figure 5 Deck unit for PicoMB-120 and PicoMB-140.

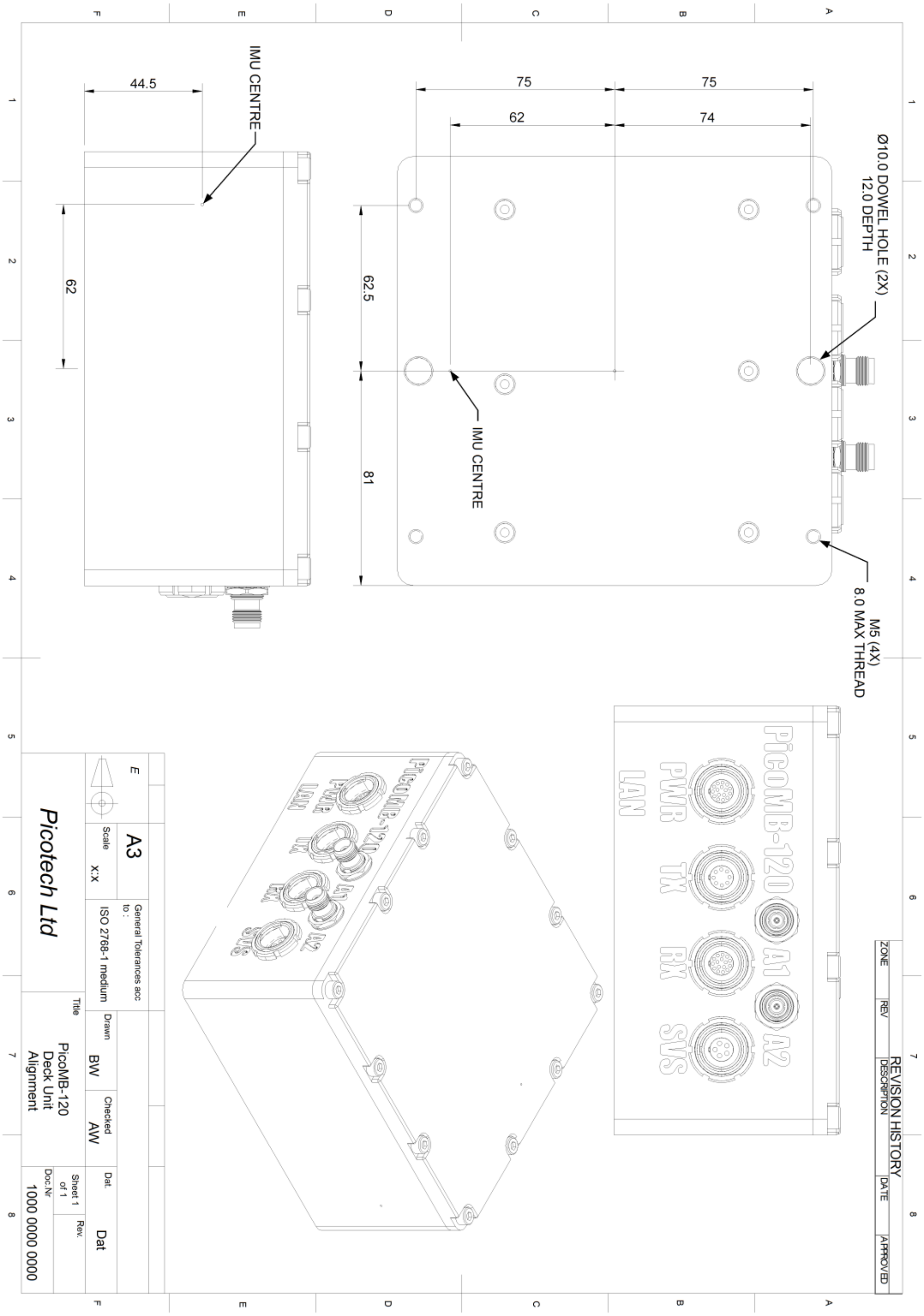


Figure 6 Deck unit alignment.

4.1.4 Mounting the Transducers

The PicoMB-120 transducers are fitted with 4-off lugs with 5.3mm holes, to take M5 fixings. PicoMB-140 receive transducers are secured using M6 fasteners and 5mm dowels. Use marine-grade stainless steel screws, dowels, washers and nuts to fix the transducers to a baseplate.

- **Transducers supplied with PU mounting lugs must not be over-tightened; the lugs must not be deformed when mounting the transducers. Do not use the compliance of the lugs to lock the fasteners' threads – use nylocs or thread locking fluid to achieve this.**
- **Transducers supplied with plastic mounting lugs must be tightened to a torque no greater than 5nm.**

The PicoMB transducers are typically mounted pointing straight down, with the long axis of the transmit array in the direction of travel, and the long axis of the receive array across the direction of travel. The RX lead should be on the starboard side of the RX transducer, the TX lead forward or aft. The TX transducer may be mounted in front or behind the RX transducer.

4.1.5 Tools

No special tools are required to install and maintain PicoMB. All fixings are metric, except where otherwise stated (the Subconn wet-mate connectors are sized in inches).

4.2 ELECTRICAL INTEGRATION

4.2.1 Summary of Electrical Connections

The transducers are connected to the deck unit using the cables supplied.

4.2.2 Cathodic Mitigation

No metal bonds are exposed to sea water.

4.2.3 External Connections

The PicoMB deck unit is connected to external systems using a 16-pin LEMO connector.

Pin	Function
1	0V
2	+24V
3	100BaseT-RXD+
4	100BaseT-RXD-
5	100BaseT-TXD+
6	100BaseT-TXD-
7	0V ISO
8	PPS_OUT
9	RS232-0 TX
10	RS232-0 RX
11	RS232-1 TX

Pin	Function
12	RS232-1 RX
13	RS232-2 TX
14	RS232-2 RX
15	RS232-3 TX
16	RS232-3 RX

4.2.4 Power

PicoMB takes 20 to 28V DC power, 12W (PicoMB-120), 30W (PicoMB-140), to pins 1 and 2.

4.2.5 Ethernet

PicoMB supports 100BaseT (100 Mbit/s) Ethernet communications, on four wires. Ethernet connections should be made through CAT5 cables. Short wire runs should at least be twisted in pairs: “pair 1 +” with “pair 1 -” and “pair 2 +” with “pair 2 -”.

4.2.6 Serial and IO

Pins 8-16 are soft connections to PicoMB’s internal Applanix POS MV® referenced to pin 7 ‘0V ISO’. Please contact Picotech Ltd for further details or for custom requirements for these.

4.3 DATA INTEGRATION

4.3.1 General

Data is provided over an Ethernet connection, using UDP/IP. Users may connect PicoMB direct to their own logging systems using the data formats below.

PicoMB drivers for the following software are available;

- Xylem HYPACK®
- QPS QINSy®
- Teledyne PDS®
- EIVA NaviSuite®
- OIC GeoDAS® and SAMM®
- ITER Bathyswath®

4.3.2 UDP Ports

PicoMB outputs both range-angle data from the bottom detection process and the full water column data, on different UDP/IP port numbers, so the user can choose to record one or the other or both. The address/port set up is as follows:

Windows Client	PicoMB	Data	Direction
10.0.100.70:13000	10.0.100.120:9000	MBES angle/range data from sonar	From Pico
		Commands	To Pico
10.0.100.70:13001	10.0.100.120:9001	Water column data @25kHz (PicoMB-120) @50kHz (PicoMB-140)	From Pico
		Hydrophone stimulation data to	To Pico

Windows Client	PicoMB	Data	Direction
		the sonar for BIT=pod mode	
10.0.100.70:13002	10.0.100.120:9002	Micro-Nav/Bathymetry PDUs	From Pico
10.0.100.70:13003	10.0.100.120:9003	AUX PDUs	From Pico
10.0.100.70:13004	10.0.100.120:9004	Status	From Pico
10.0.100.70:13005	10.0.100.120:9005	Sync PDUs	From Pico

Note that this means that the receiving computer must be set to the static IP address of 10.0.100.70.

Modes

PicoMB systems exhibit the following modes.

Mode	Code	Description
Off	OFF	All components of the PicoMB system are powered OFF. There is no shut down mode for PicoMB; power may be removed at any time.
Start	START	The PicoMB system is powering up, authenticating, and initialising essential functions
Offline	OFFL	The PicoMB system is in an installed or deployed state and is ready to acquire data and make transmissions. This mode is used for test, calibration, re-configuration, training and “wait” activities.
Online	ONL	The PicoMB system is acquiring and processing acoustic and nonacoustic data. The PicoMB system may be making acoustic transmissions if they have been enabled. If the Picotech solid state recorder is installed, data is being recorded.
Test	BIT	The PicoMB system is performing built-in self-tests

The system changes between modes as shown in the diagram below.

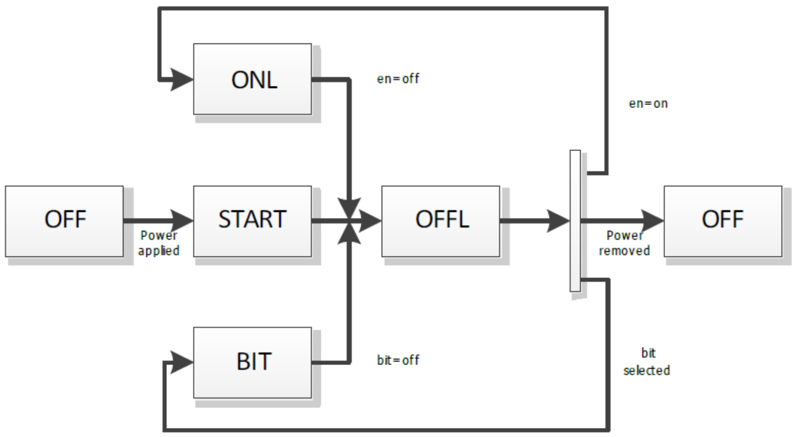


Figure 7 PicoMB Mode Transition Diagram

4.3.3 Commands

PicoMB receives commands from the host system by the host system setting registers in the sonars' register set.

4.3.4 PicoMB Register Set

PicoMB has a set of internal registers that can be accessed through its UDP/IP command interface.

Each register is 28 bits wide plus a 4 bit address, so 32 bits are sent for each command. Some registers within the set expose FIFO inputs; successive writes to these registers load FIFOs behind the register.

4.3.5 PRI Register

The PRI register, address 0x8, is written with the required Pulse Repetition Interval (PRI) expressed with 20µs resolution as follows;

PRI register value = floor(PRI*50e3) - 1

- where PRI is the required Pulse Repetition Interval in seconds. For example, to set a 1 second PRI the command sent to PicoMB would be `0x8000c34f`. Note: for PicoMB-120 only, if the PRI register value calculated above is even, it must be rounded up to the next odd integer.

PicoMB imposes a lower limit to the PRI to prevent over-stressing the sonar's power amplifiers and high voltage power supplies. The limit depends upon the particular PicoMB configuration

4.3.6 Pulse Type Register

The pulse type register, address 0x5, configures the transmit pulse type. The lower byte of the register defines the pulse type, for example

- `0x50000000` Pulse type 0
- `0x50000001` Pulse type 1
- `0x50000002` Pulse type 2
- `0x50000003` Pulse type 3

Pulse Type	Centre Frequency	Bandwidth	Pulse Length	Description
0	337kHz	20kHz	5ms	LFM Up CHIRP
1	337kHz	20kHz	500µs	LFM Up CHIRP
2	360kHz	20kHz	5ms	LFM Up CHIRP
3	360kHz	20kHz	500µs	LFM Up CHIRP
4	380kHz	20kHz	5ms	LFM Up CHIRP
5	380kHz	20kHz	500µs	LFM Up CHIRP
6	450kHz	20kHz	5ms	LFM Up CHIRP
7	450kHz	20kHz	500µs	LFM Up CHIRP

Figure 8 PicoMB-120 Pulse Types

Pulse Type	Centre Frequency	Bandwidth	Pulse Length	Description
0	337kHz	40kHz	5ms	LFM Up CHIRP
1	337kHz	40kHz	500µs	LFM Up CHIRP
2	360kHz	40kHz	5ms	LFM Up CHIRP
3	360kHz	40kHz	500µs	LFM Up CHIRP
4	380kHz	40kHz	5ms	LFM Up CHIRP
5	380kHz	40kHz	500µs	LFM Up CHIRP

Figure 9 PicoMB-140 Pulse Types

4.3.7 ZDA Register

GPS ZDA strings are sent to PicoMB over Ethernet by writing the ZDA string characters to the lower byte of the ZDA register at address 0xC.

ADDRESS IN HEX	D 27	D 26	D 25	D 24	D 23	D 22	D 21	D 20	D 19	D 18	D 17	D 16	D 15	D 14	D 13	D 12	D 11	D 10	D 9	D 8	D 7	D 6	D 5	D 4	D 3	D 2	D 1	D 0
C		1	x																		x	x	x	x	x	x	x	x

- Bit D26 must be set to '1'.
- Bit D25 defines the PPS polarity; '0' => rising edge, '1' => falling edge.
- Bits D0-D7 are written with the ZDA characters
- The ZDA characters are pushed into the register at 0xC, one character at a time
- The commands may be sent 4 bytes at a time in separate UDP/IP datagrams, or be coalesced and sent as a single UDP/IP datagram.

For example, to write the ZDA string corresponding to 2015-05-01 19:22:11, the following commands would be sent to PicoMB;

```
0xc4000024
0xc4000047
0xc4000050
0xc400005a
0xc4000044
0xc4000041
0xc400002c
0xc4000031
0xc4000038
0xc4000032
0xc4000032
0xc4000031
0xc4000030
0xc400002e
0xc4000036
0xc4000035
0xc400002c
0xc4000030
0xc4000031
0xc400002c
0xc4000030
0xc4000035
0xc400002c
0xc4000032
0xc4000030
0xc4000031
0xc4000035
0xc400002c
0xc4000078
0xc4000078
0xc400002c
0xc4000079
0xc4000079
0xc400002a
0xc4000063
0xc4000063
```

Alternatively GPS ZDA strings may be sent to PicoMB via RS-232 (baud 9600-8-N-1), pin 10 of the 16-pin LEMO. In this instance pin 12 of the 16-pin LEMO connector is for TTL PPS and the ZDA register at address 0xC is used to configure the PPS polarity;

- Bit D26 must be set to '0'.
- Bit D25 defines the PPS polarity; '0' => rising edge, '1' => falling edge.

4.3.8 Time Varying and Programmable Gain

To compensate for attenuation and spreading losses, PicoMB applies a time varying gain (TVG) curve. The start and end gain of the TVG curve may be configured. In addition PicoMB features programmable gain amplifiers which allow gain to be pre-set to four levels. TVG and PGA are specified by writing register at address 0x1.

ADDRESS IN HEX	D27	D26	D25	D24	D23	D22	D21	D20	D19	D18	D17	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
1			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

- Bits D11 down to D0 set TVG Min register
- Bits D23 down to D12 set TVG Max register
- Bits D25 down to D24 set PGA

TVG Min and Max registers are calculated as follows;

TVG register value = floor(gain/46*4000)

- where gain is in dB and lies between 0 and 46. Setting the Min register value greater than the Max creates constant gain with range set at the Min value.

PGA is specified as follows;

D25	D24	PGA GAIN
0	0	20dB
0	1	25dB
1	0	27dB
1	1	30dB

4.3.9 Range Gate

The bottom detection range gate may be specified by writing register at address 0x7. Bits D13 down to D0 specify the start sample, bits D27 down to D14 the end sample. The sample is calculated from range as follows;

Sample register value = floor(range*bw/1500*2)

- where range is in metres and bw is 25000 for PicoMB-120 and 50000 for PicoMB-140. The maximum range is 240m for PicoMB-120 and PicoMB-140.

4.3.10 Bottom Detection

PicoMB bottom detection algorithm may be selected by writing register at address 0xF as follows;

D0	Bottom Detection Algorithm
0	Amplitude
1	Amplitude and Phase

4.3.11 Water Column Data Rate

PicoMB outputs water column data in real-time, the format is described in 4.3.14 below. The data rate of water column data may be throttled to reduce network bandwidth and storage file size by writing to register at address 0xD;

- `0xd0000003` rate = 1/8
- `0xd0000002` rate = 1/4
- `0xd0000001` rate = 1/2
- `0xd0000000` rate = 1

The water column data rate command has no effect on PicoMB internal processing - it only controls the water column data output rate over Ethernet.

4.3.12 Operation without Transducers

To test PicoMB systems with no transducers attached, the following command should be sent:

`0x00450002`

This causes the sonar to return an undulating seabed test pattern in the MBES bottom detection data.

4.3.13 PicoMB Data Format

Byte Num	Num Bytes	Encoding	Item	Notes
0	4	-	Magic	PicoMB - '51C03BE5'
4	4	unsigned int	Version	System type & version. eg.0x0120.0402 => PicoMB-120 v4.2 eg.0x0140.0006 => PicoMB-140 v0.6
8	8	unsigned int unsigned int	Time	Timestamp expressed as seconds and micro-seconds since Thursday 1 Jan 1970.
16	4	float	Sound Speed	Speed of sound in m/s.
20	4	-	Engineering	Internal use only.
24	4	unsigned int	N	Number of beams.
28	4	float	Angle	Angle of first beam in degrees, typ. -60.0f
32	4	float	Angle	Angle of Nth beam in degrees, typ. 60.0f
36+i*4	4	float	Range	Beam range in metres. i=0,1,2,...N-1
36+N*4	N/4	-	Quality	Beam quality

Notes:

1. Little-endian, least significant byte first.
2. For N=256 beams, PDU size is 1124 octets, for N=512 beams, the PDU size is 2148
3. Emitted once per ping.
4. The angle of the i^{th} beam is **first + i * (last - first) / (N – 1)**
5. Quality is encoded as bitfields, 2 bits per beam.

Quality	Amplitude Detection	Phase Detection	Colour Encoded in PicoSonar UI
0	Low	-	Red
1	Medium	-	Amber
2	High	-	Green
3	-	High	Blue

6. Timestamp ordering is micro-seconds then seconds.

4.3.14 PicoMB Water Column Data Format

Each beam has 64 one-byte amplitude samples, written out in order at the sample rate (see below). Each PDU sends the beam data for eight beams.

Byte Num	Num Bytes	Encoding	Item	Notes
0	4	-	Magic	'51C03AC1'
4	8	unsigned int unsigned int	Time	Timestamp expressed as seconds and micro-seconds since Thursday 1 Jan 1970.
12	4	unsigned int	Index	PDU Index i (see note 5)
16	64	unsigned char	Magnitude	Beam i magnitude
80	64	unsigned char	Magnitude	Beam i+1 magnitude
144	64	unsigned char	Magnitude	Beam i+2 magnitude
208	64	unsigned char	Magnitude	Beam i+3 magnitude
272	64	unsigned char	Magnitude	Beam i+4 magnitude
336	64	unsigned char	Magnitude	Beam i+5 magnitude
400	64	unsigned char	Magnitude	Beam i+6 magnitude
464	64	unsigned char	Magnitude	Beam i+7 magnitude

Notes:

1. Little-endian, least significant byte first
2. Timestamp ordering is micro-seconds then seconds.
3. PDU size is 528 octets
4. Emitted
   @ 50kHz*rate, rate = 1, ½ , ¼ , 1/8 , sampled at 50kHz*rate (PicoMB-140)
   @ 12.5kHz*rate, rate = 1, ½ , ¼ , 1/8 , sampled at 25kHz*rate (PicoMB-120)
5. Index is reset to zero at the start of each ping
6. Beam number i,
   i=mod(Index,64)*8 (PicoMB-140)
   i=mod(Index,32)*8 (PicoMB-120)

4.3.15 DPCA Micro-Nav PDU Format

Byte Num	Num Bytes	Encoding	Item	Notes
0	4	-	Magic	PicoDPCA - '51C0D5CA'
4	4	unsigned int	Version	System version number.
8	8	unsigned int unsigned int	Time	Timestamp expressed as seconds and micro-seconds since Thursday 1 Jan 1970.
16	4	float	Sound Speed	Speed of sound in m/s.
20	8	double	Roll	Roll in degrees.
28	8	double	Pitch	Pitch in degrees.
36	8	double	Yaw	Yaw in degrees.
44	8	double	Surge	Surge in metres.

52	8	double	Sway	Sway in metres.
60	8	double	Heave	Heave in metres.
68+i*8	4	float	Range	Plan range in metres. i=0,1,2,...57
72+i*8	4	float	Depth	Depth in metres. i=0,1,2,...57

Notes:

1. Little-endian, least significant byte first.
2. PDU size is 532 octets.
3. Emitted once per ping.
4. Firmware versions to date (<5.2) do not populate Roll, Pitch, Yaw, Sway & Heave.
5. Current f/w Surge limits;
   @1Hz PRF => +/-0.24m/s = +/-0.47kts
   @2Hz PRF => +/-0.48m/s = +/-0.93kts
   @4Hz PRF => +/-0.96m/s = +/-1.87kts
   @8Hz PRF => +/-1.92m/s = +/-3.73kts
6. Timestamp ordering is micro-seconds then seconds.

4.3.16 PicoMB Sync PDU

PicoMB sends sync PDUs at the start of each acoustic transmission. These may be used to synchronise the transmissions from other acoustics devices. PicoMB's IP stack is implemented wholly within the FPGA fabric, so these sync PDUs are transmitted with deterministic low latency.

Byte Num	Num Bytes	Encoding	Item	Notes
0	4	-	Magic	'51C0573C'
4	8	unsigned int unsigned int	Time	Timestamp expressed as seconds and micro-seconds since Thursday 1 Jan 1970.

Notes:

1. Little-endian, least significant byte first.
2. Timestamp ordering is micro-seconds then seconds.
3. PDU size is 12 octets.
4. Emitted at the start of each acoustic transmission.

4.3.17 PicoMB Status PDU Format

The status PDU comprises;

- 16 32 bit registers which reflect the contents of the command registers
- 16 32 bit status registers
- 256 32 bit performance metric registers

Byte Num	Num Bytes	Encoding	Item	Notes
0	4	-	Magic	'51C057A7'
4	4	unsigned int	Cmd Reg 1	TVG
8	4	unsigned int	Cmd Reg 2	
12	4	unsigned int	Cmd Reg 3	
16	4	unsigned int	Cmd Reg 4	
20	4	unsigned int	Cmd Reg 5	Pulse Type
24	4	unsigned int	Cmd Reg 6	
28	4	unsigned int	Cmd Reg 7	Range Gate
32	4	unsigned int	Cmd Reg 8	PRI
36	4	unsigned int	Cmd Reg 9	
40	4	unsigned int	Cmd Reg 10	
44	4	unsigned int	Cmd Reg 11	
48	4	unsigned int	Cmd Reg 12	
52	4	unsigned int	Cmd Reg 13	Water Column Data Rate
56	4	unsigned int	Cmd Reg 14	
60	4	unsigned int	Cmd Reg 15	Bottom Detection
64	4	unsigned int	Board Rev	Hardware revision
68	4	unsigned int	Version	Firmware version
72	8	unsigned int unsigned int	Time	Timestamp expressed as seconds and micro-seconds since Thursday 1 Jan 1970.
80	1	signed char	Array 1 Temp	Array 1 temperature in °C.
81	1	signed char	Array 2 Temp	Array 2 temperature in °C.
82	1	signed char	Topside Temp1	Topside temperature in °C.
83	1	signed char	Spare Temp	
84	4	unsigned int	Engineering1	For engineering use.
88	4	unsigned int	Engineering2	For engineering use.
92	4	unsigned int	SVS Voltage	Programmed voltage for SVS.
96	4	unsigned int	Engineering3	For engineering use.
100	4	unsigned int	Spare1	
104	4	unsigned int	Spare2	
108	4	unsigned int	Spare3	
112	4	unsigned int	Spare4	
116	4	unsigned int	Spare5	
120	4	unsigned int	Spare6	
124	4	unsigned int	Spare7	

128	1024	unsigned int	Engineering4	For engineering use.

Notes:

1. Little-endian, least significant byte first.
2. PDU size is 1152 octets.
3. Emitted once per ping.
4. Timestamp ordering is micro-seconds then seconds.
5. Board Rev

Board Rev	Hardware Revision
3	1
2	2
1	3
0	4

6. SVS Voltage

SVS Voltage	Voltage Programmed (V)
0	3.3
1	5
2	12
3	15

4.3.18 PicoMB AUX PDUs

PicoMB features a virtual COM port; any valid GPS NMEA string received on PicoMB's RS232 input, or via the ZDA register described above, is zero padded and transmitted to the host in a UDP/IP datagram. These virtual COM port datagrams are recorded by the host Android and PC apps with the beamformed data, MBES and Micro-Nav PDUs and may be accessed on replay.

Byte Num	Num Bytes	Encoding	Item	Notes
0	4	-	Magic	'51C0AC81'
4	124	char	Payload	GPS NMEA string zero padded to 124 bytes

Notes:

1. Little-endian, least significant byte first.
2. PDU size is 128 octets.
3. Emitted on reception of valid GPS string.

4.3.19 Hydrophone Stimulation Data

Pre-recorded hydrophone level data may be played through the deck unit in lieu of real-time data from the receive array. The deck unit will process this hydrophone data in a similar manner to that in which it would process receive array data and output water column, bottom detection, status and auxiliary PDUs. In this way hydrophone stimulation data may be used to test the deck unit or for software integration purposes.

To play hydrophone stimulation data through the deck unit;

- Power off the system.
- Disconnect the transmit and receive arrays, the SVS may be left connected.
- Transmit hydrophone stimulation data PDUs to the deck unit.

To transmit hydrophone stimulation data PDUs to the deck unit, the hydrophone stimulation data file provided by Picotech Ltd should be read sequentially and transmitted as 256 byte (PicoMB-120) or 768 byte (PicoMB-140) PDUs using the port numbers listed in section 4.3.2. Put an 80µs (PicoMB-120) or 240µs (PicoMB-140) sleep between PDU transmissions.

Note that in this mode, processing within the deck unit is data driven and time-stamps within MBES, water column and status PDUs will reflect time of hydrophone stimulation data reception rather than acoustic transmission times.

5 UPDATING PICOMB FIRMWARE

5.1 OVERVIEW

The firmware in the deck unit may be updated with new revisions. New firmware revisions address bugs and add important new features. The firmware update process is simple, requires no special tools and takes approximately 20 seconds. There is no risk of ‘bricking’ the sonar system during the update process as PicoMBs have a ‘golden image’ which cannot be overwritten by the firmware update process.

The firmware in the transducers may also be updated with new revisions. A similar process is used to that for the deck unit. However in the unlikely event of the transducers requiring a firmware update, this is best undertaken by the supplier.

5.2 UPDATING THE DECK UNIT FIRMWARE

5.2.1 Setting to Work

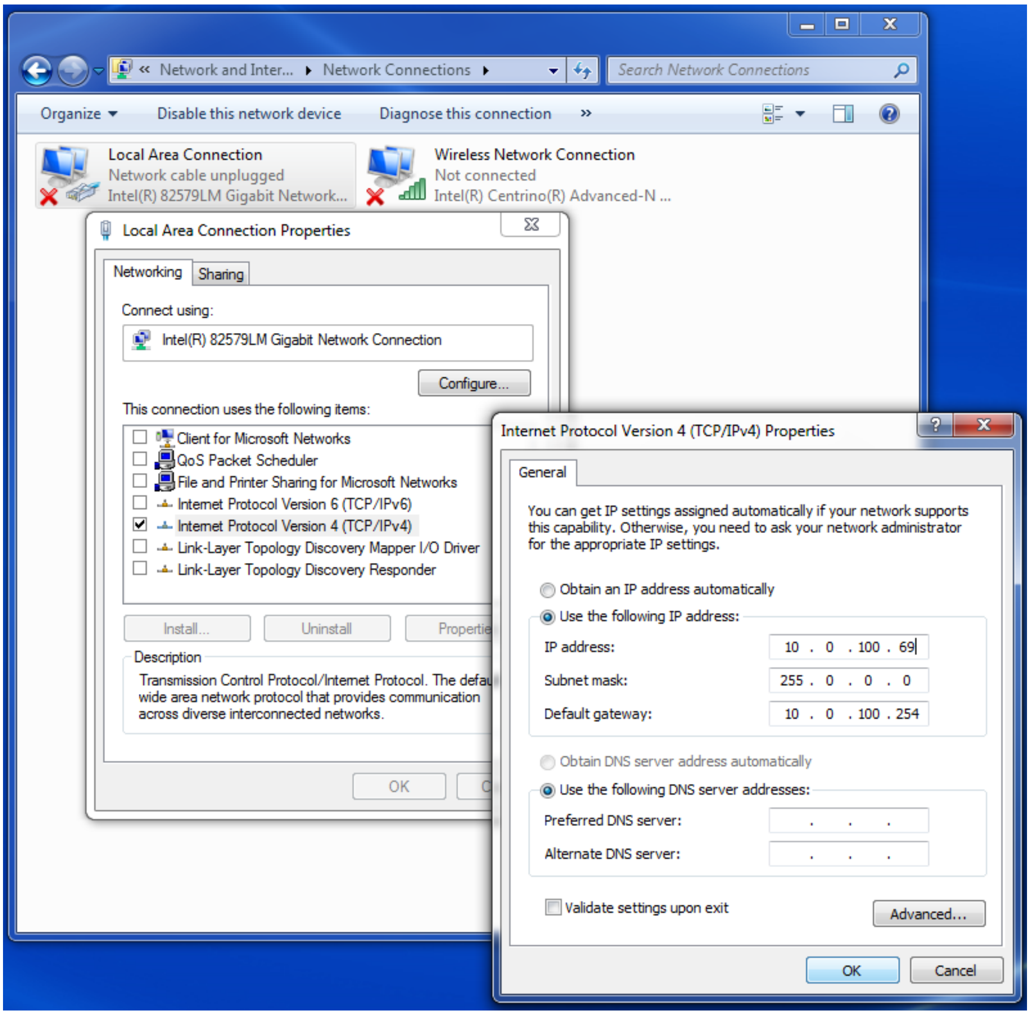
To update the PicoMB deck unit firmware the following items are required;

- PicoMB deck unit and umbilical cable
- Windows PC running Windows 7 or higher
- Bench power supply capable of 24V @ 4A or 20C NiMH battery pack

Configure the bench power supply for 24V @ 4A. Connect the deck unit to the umbilical cable. Connect the umibilcal cable’s RJ45 to the PC’s Ethernet socket and its banana plugs to the bench power supply but do not power on yet.

5.2.2 Setting up the Windows PC

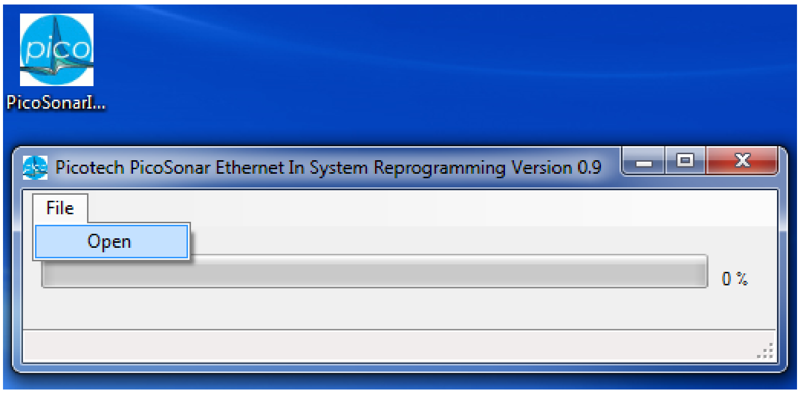
Configure the PC's wired Ethernet adapter with IP address 10.0.100.69 as shown below.



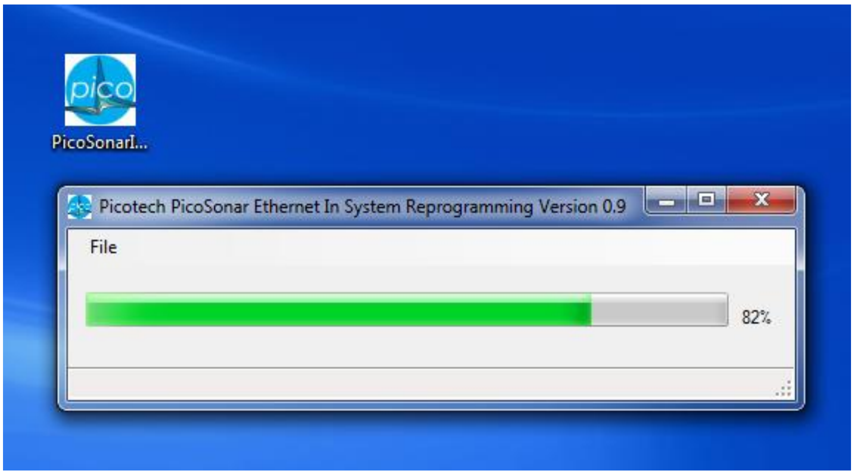
5.2.3 Updating the Firmware

- Power on PicoMB, wait 10s, then launch the PicoMB In-System Reprogramming application by double clicking its icon.

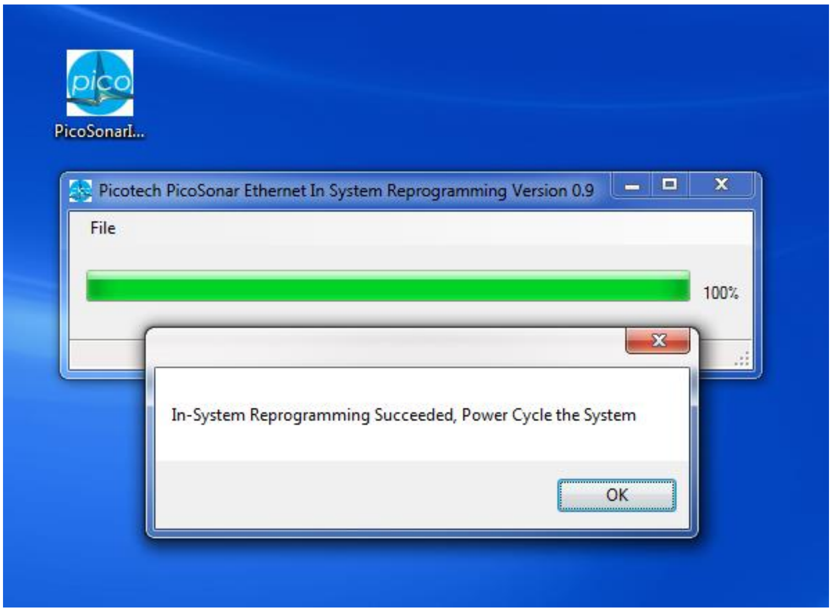
- In the PicoMB In-System Reprogramming application, select File->Open, and navigate to the firmware image – a 4MB file with **.bin** extension – open the file. **Note:** *the firmware image file must be opened within 30s of powering on PicoMB, otherwise the sonar will boot into its normal operating mode, and not accept reprogramming commands. If this occurs simply repeat the process from the beginning.*



* Reprogramming will now commence with a progress bar showing completion.
  Note: *there will be an initial delay whilst the PicoMB flash is being erased.*



* Upon completion, the PicoMB In-system Reprogramming application will display the following message.



* Power off the sonar, disconnect the Ethernet RJ45 and reconfigure the PC with IP address 10.0.100.70
* In the unlikely event of reprogramming failing, simply repeat the above process.