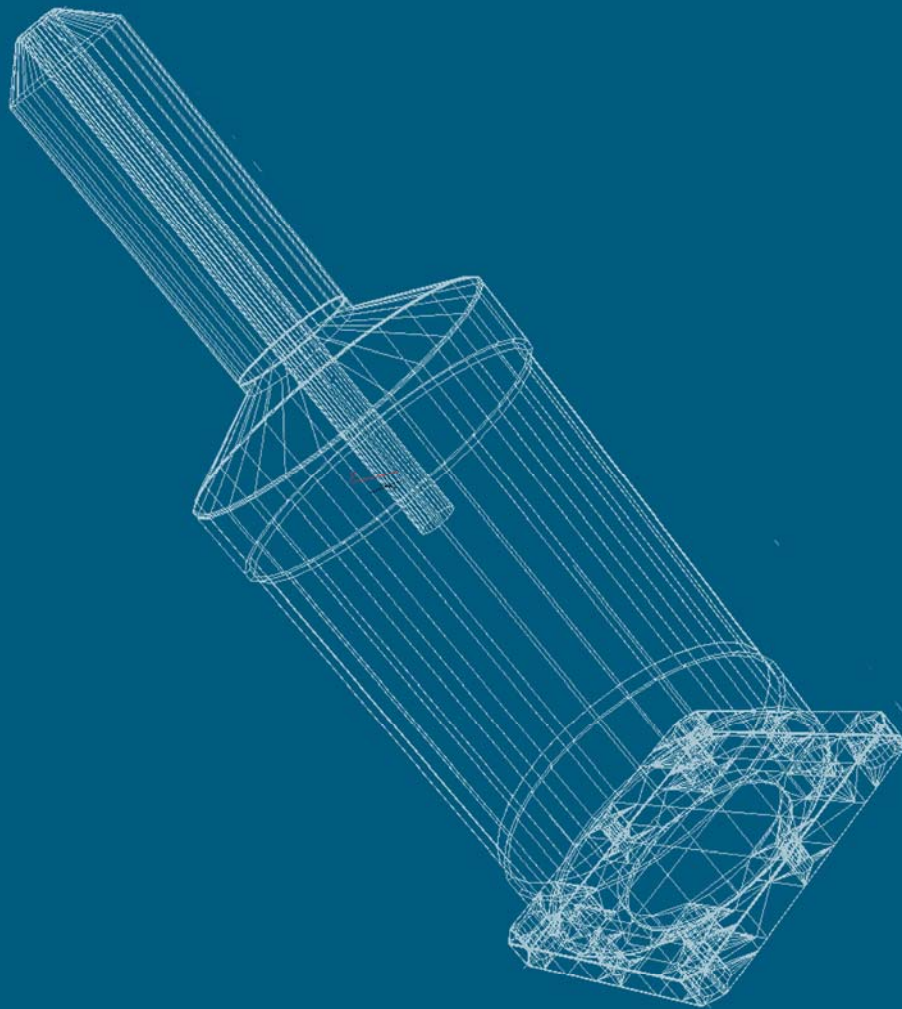




# MiniSense

Technical Manual



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**Document Rev D**

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## REVISION HISTORY

### 1.0. DOCUMENT REVISION HISTORY

**REVA** First version of this document.

### 1.1. FIRMWARE REVISION HISTORY

- V1.01** Sampled output from the VR101 and changed format to the VR101 prototype to allow Sentera's software to be used.
- V1.02** Add new features made available by new Sentera string
- V1.03** fixed CR LF issue
- V1.04** Add new combined output mode and fix feature that means when mode is removed there is no carriage return linefeed
- V1.05** Allows FIR filters to be read and changed

## INTRODUCTION

### 2.0. GENERAL DESCRIPTION

The MiniSense uses low-noise MEMS accelerometers and MEMS rate gyros. The MiniSense's triad of accelerometers measure accelerations in the range of  $\pm 2g$ , and the triad of gyros measure rotational rates in the range of  $\pm 150^\circ/\text{sec}$  ( $\pm 300^\circ/\text{sec}$  version available). With a high sampling rate of 1 KHz and user-configurable FIR filters, the MiniSense bandwidth can be easily customized to suit the requirements of the application. Data fusion of accelerometer and gyro data is performed by a Kalman Filter implemented on the on board digital signal processor. The result of the filter is to complement the short term accuracy of the gyros with the long term stability of the accelerometers to achieve the optimal estimation of the dynamic roll and pitch angles.



Figure 3.1: Bare MiniSense

The MiniSense has 3 output ports:

- Port 1: User configurable RS232 ASCII output
- Port 2: RS232 Raw binary output
- Port 3: RS422 Either ASCII data or raw binary data

The ASCII output allows the user to select various options such as baud rate, pitch and roll axis swap etc. This has a maximum output rate of 48Hz dependant on the selected baud rate.

The raw output is a binary string of length 10 bytes to 26 bytes depending on the mode. It has an update rate of 96 Hz and is a fixed baud rate of 38,400 bps

## 2.1. SURFACE VERSION

The surface version of MiniSense contains a complete mechanically calibrated unit inside an anodized aluminium housing. The housing has 4 mounting holes machined into the base that can be used to attach the MicroTilt to any flat surface. The unit has a moulded in tail that can have any suitable connector attached to the end



Figure 3.2: Sub-sea and Surface Housing

## 2.2. SUBSEA VERSION (3000M)

The sub-sea version of MiniSense, figure 3.2, contains a complete mechanically calibrated unit inside an aluminium housing depth rated to 3000m in seawater.

The MiniSense housing is machined from solid aluminium to provide a high quality and extremely rugged case. Hard anodising to the housing gives protection from corrosion in the sub-sea environment. The housing is sealed with a single piston 'O'-ring that should be cleaned and re-greased whenever the housing is opened. As with the surface version the unit has a moulded in tail that can have any suitable waterproof connector attached to it.

## 2.3. OEM VERSION

The OEM version can come as either a bare unit, figure 3.3, or fitted with a 90° bracket to allow easy mounting, figure 3.4



Figure 3.3: Bare OEM Unit



Figure 3.4: OEM unit with 90° bracket

**SPECIFICATION**

**3.0. MINISENSE SPECIFICATION**

Table 4.1 shows the initial specification for the MiniSense unit.

Specification		Units
Update Rate	96	Hz
Fully Stabilized Data	<10	S
<b>Attitude</b>		
• Range: Roll, Pitch	±180, ±90	°
• Static accuracy	<0.5	°
• Dynamic accuracy	<1.0	° rms
• Resolution	0.01	°
<b>Angular Rate</b>		
• Range: Roll, Pitch, Yaw	±150	°/sec
• Bias: Roll, Pitch	±1	°/sec
• Scale factor accuracy	<2	%
• Non-linearity	0.1	% FS
• Resolution	<0.025	°/sec
• Bandwidth	User adjustable up to 40	Hz
• Random walk	3	°/hr <sup>1/2</sup>
<b>Acceleration</b>		
• Range: X/Y/Z	±2	g
• Bias: X/Y/Z	±10	mg
• Scale factor accuracy	<2	%
• Non-linearity	0.5	% FS
• Resolution	<0.3	mg
• Bandwidth	User adjustable up to 40	Hz
• Random walk	3	m/s/hr <sup>1/2</sup>
<b>Environment</b>		
• Operating temperature	-40 to 85	°
• Storage temperature	-55 to 125	°
• Non-operating shock	2000	g
<b>Electrical</b>		
• Supply Voltage	8 to 30	V
• Power Consumption	1.13	W
• Output types	RS232, RS422	

Table 4.1: Specification

### 3.1. ORIENTATION

The MiniSense unit orientation is shown in Figure 4.1. Where x is the pitch axis, y is the roll axis and z is the heave axis.

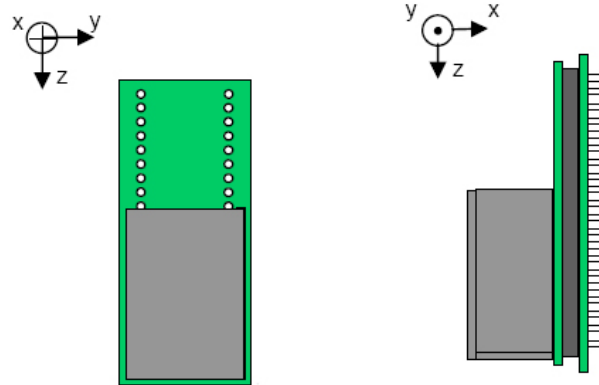


Figure 4.1: Unit Orientation

Although the z-axis has to remain the heave axis the pitch and roll axes are easily swapped when using the ASCII output port, see section 5. However, when using port 2 the user is tied to the orientation shown in figure 4.1.

---

**CONNECTIONS****4.0. OEM VERSION**

The base board has 2 connectors on it. The first is an 8-way mini Molex, figure 5.1, this has power, port 1 and port 2 connections. This is referred to as Mx1 on the PCB. The second is a 4 way mini Molex, figure 5.2 that is used for port 3. This is referred to as Mx3 on the PCB.



Figure 5.1: Mx1, 8-way Molex

Connections to Mx1 are as shown in Table 5.1.

Pin	Function
1	Ground
2	+V <sub>supply</sub> 8v to 30 v DC
3	Port 2 RS232 Rx (Data in)
4	Port 2 Ground
5	Port 2 RS232 Tx (Data Out)
6	Port 1 RS232 Rx (Data in)
7	Port 1 Ground
8	Port 1 RS232 Tx (Data Out)

Table 5.1: Mx1 Connections



Figure 5.2: Mx3, 4-way Molex

Connections to Mx2 are shown in table 5.2.

Pin	Function
1	Tx +, non-inverting output
2	Tx -, inverting output
3	Rx -, inverting input
4	Rx +, non-inverting input

Table 5.2: Mx3 connections

The MiniSense board also has another connector on it, a 5-way Molex. This is for production purposes only and on no account should anything be connected to this. **CONNECTION TO Mx2 WILL INVALIDATE WARRENTY**

#### 4.1. SURFACE AND SUB-SEA VERSION

The Sub-sea and surface versions come with a moulded on tail. This tail has the numbering shown in table 5.3.

Wire No.	Function	
1	0v DC	
2	8-30v DC	
3	Rx Data (disabled)	Port 2
4	Data Ground	
5	Device Tx	
6	Rx data	Port 1
7	Ground	
8	Tx Data	

Table 5.3: Sub-sea and surface housing

**CONFIGURATION**

**6.0. HARDWARE SETUP**

The MiniSense has 3 i/o ports that can be configured in various ways to make the unit flexible, figure 7.1. The Jumpers, J1 - J4 are 0805 size and connections are made using 0805 0 Ohm links.

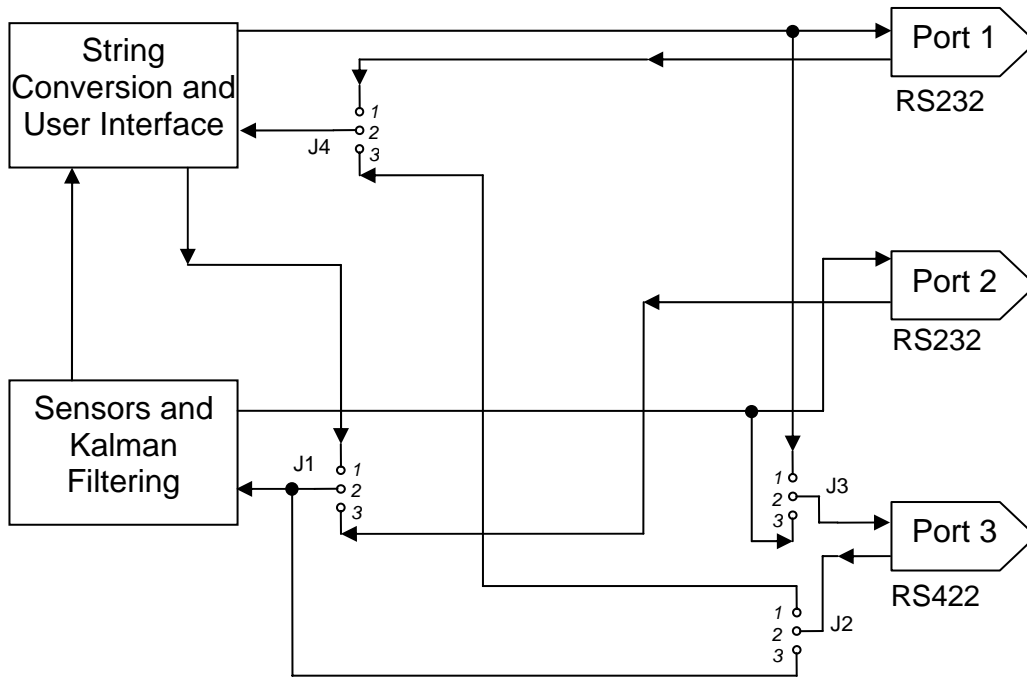


Figure 6.1: Jumper Set-up

**6.0.1. Standard Setup**

As standard the unit is shipped in the configuration shown in Table 7.1. In this configuration Port 1 is an Input/Output port with all data in ASCII. Port 2 and 3 are output only, with port 2 outputting RAW RS232 data and Port 3 outputting ASCII RS422 data.

Jumper	Position
J1	1 & 2
J2	NC
J3	1 & 2
J4	1 & 2

Table 6.1: Standard set-up

## 6.1. FURTHER CONFIGURATIONS

In these further Configurations Port 1 and Port 2 still output ASCII and binary data respectively but have had their input facility disabled.

### 6.1.1. RS422 ASCII Output and Control

In this mode Port 3 outputs an ASCII string and accepts ASCII commands as in section 8.

Jumper	Position
J1	1 & 2
J2	1 & 2
J3	1 & 2
J4	2 & 3

Table 6.3: RS422 ASCII output and control jumper settings

### 6.1.2. RS422 Binary Output with ASCII Control

In this mode Port 3 outputs a binary string but still accepts ASCII commands as in section 8.

Jumper	Position
J1	1 & 2
J2	1 & 2
J3	2 & 3
J4	2 & 3

Table 6.4: RS422 Binary output ASCII control jumper settings

## DATA OUTPUT FORMATS

### 7.0. INTRODUCTION

The MiniSense has 2 RS232 ports, port 1 and 2, and one RS422 port, port 3. Port 1 outputs an ASCII data string as detailed below. This port is also used for changing modes and configuring the outputs using the extended ASCII character set. Port 2 is used for the raw output also detailed below. It is possible to use this port to change the mode of the unit using commands detailed in section 8. To do this jumpers must be changed as detailed in section 6.

Both output formats have 8 data bits, no parity and 1 stop bit (8,N,1)

Port 3 is a full duplex RS422 port and can be completely configured to be either an ASCII output or RAW binary output. Table 7.1 details some of the differences between the data types.

	ASCII	Raw Binary
Update Rate	Dependant on baudrate max 96 packets/s	96 packets/s
Baud Rate	9600bps – 115200bps	38400bps
Axis Swap	Yes	No
Sign Swap	Yes	No
Modes	4	4

Table 7.1: ASCII and Binary output differences

### 7.1. ATTITUDE OUTPUT

This is the simplest output consisting of 10 bytes in binary mode and 29 bytes in ASCII mode. This output has pitch, roll and yaw data only.

### 7.1.1. Raw binary Data

This is the shortest of the output strings from the unit being only 10 bytes, detailed in table 7.2. Roll, Pitch and Yaw are output as scaled 16-bit signed integers. To scale into degrees, multiply Roll, Pitch or Yaw by this factor:  $360/2^{15}$

Byte No	Content	Description
1	0xBD	First header byte
2	0xDB	Second header byte
3	Status	Status byte
4	Roll	LSB of roll
5		MSB of roll
6	Pitch	LSB of pitch
7		MSB of pitch
8	Yaw	LSB of yaw
9		MSB of yaw
10	Checksum	Byte-wise XOR of bytes 1 to 9

Table 7.2: Binary attitude output

### 7.1.2. ASCII output

Output string consists of:

P±123.45R±123.45Y±123.45M0001

Figure 7.1: Attitude ASCII output

Where:

- P Pitch field
- R Roll field
- Y Yaw field
- M Mode Field

Both the Yaw and Mode fields can be removed if desired see section 8 for the commands to do this

## 7.2. HEAVE AND ATTITUDE OUTPUT

This output is essentially the same as the Attitude output except that there is a heave field incorporated into the string, see sections 7.2.1 and 7.2.2.

### 7.2.1. Raw binary data output

Roll, Pitch and Yaw are output as scaled 16-bit signed integers. Vertical Velocity and Heave are output as scaled 16-bit signed integers. To scale into degrees, multiply Roll, Pitch or Yaw by this factor:  $360/2^{15}$ . To scale into meters per second, multiply Vertical Velocity by this factor:  $10/2^{15}$ . To scale into meters, multiply Vertical Position by this factor:  $20/2^{15}$ .

Byte No	Content	Description
1	0xBD	First header byte
2	0xDB	Second header byte
3	Status	Status byte
4	Roll	LSB of roll
5		MSB of roll
6	Pitch	LSB of pitch
7		MSB of pitch
8	Yaw	LSB of yaw
9		MSB of yaw
10	Vertical Velocity	LSB of Vertical Velocity
11		MSB of Vertical Velocity
12	Heave	LSB of Vertical Position
13		MSB of Vertical Position
14	Checksum	Byte-wise XOR of bytes 1 to 9

Table 7.3: Binary Heave and Attitude Output

### 7.2.2. ASCII Output

P±123.45R±123.45Y±123.45V±123.45H±123.45M0502

Figure 7.2: Heave and Attitude ASCII output

Where:

P Pitch

R Roll

Y Yaw

V Vertical velocity

H Heave

M A mode statement, this can be removed if required

## 7.3. SENSOR OUTPUT

### 7.3.1. Raw Binary data

Rotational and linear accelerations are 16-bit scaled integers. To scale rotational accelerations into degrees per second multiply GX, GY or GZ by a factor of  $150/2^{15}$ . To scale linear accelerations into g, multiply AX, AY or AZ by a factor of  $2/2^{15}$ .

Byte No	Content	Description
1	0xBD	First header byte
2	0xDB	Second header byte
3	Status	Status byte
4	GX	LSB of x-axis gyro
5		MSB of x-axis gyro
6	GY	LSB of y-axis gyro
7		MSB of y-axis gyro
8	GZ	LSB of z-axis gyro
9		MSB of z-axis gyro
10	AX	LSB of x-axis accelerometer
11		MSB of x-axis accelerometer
12	AY	LSB of y-axis accelerometer
13		MSB of y-axis accelerometer
14	AZ	LSB of z-axis accelerometer
15		MSB of z-axis accelerometer
16	Checksum	Byte-wise XOR of bytes 1 to 15

Table 7.4: Binary Acceleration Output

### 7.3.2. ASCII output

GX-000.59GY+000.31GZ+000.26AX+0.005AY-0.011AZ+0.999M0103

Figure 7.3: Sensor ASCII output

GX,GY,GZ are rotational accelerations in the x-y-z planes  
AX,AY,AZ are linear accelerations in the x-y-z planes  
M is a mode statement, this can be removed if required

## 7.4. COMBINED OUTPUT

### 7.4.1. Raw binary data

There is also a combined output that includes all sensor information as shown below in table 7.5. The values are encoded in the same way as corresponding values in table 7.4 and table 7.3.

Byte No	Content	Description
1	0xBD	First header byte
2	0xDB	Second header byte
3	Status	Status byte
4	Roll	LSB of roll
5		MSB of roll
6	Pitch	LSB of pitch
7		MSB of pitch
8	Yaw	LSB of yaw
9		MSB of yaw
10	Vertical Velocity	LSB of Vertical Velocity
11		MSB of Vertical Velocity
12	Heave	LSB of Vertical Position
13		MSB of Vertical Position
14	GX	LSB of x-axis gyro
15		MSB of x-axis gyro
16	GY	LSB of y-axis gyro
17		MSB of y-axis gyro
18	GZ	LSB of z-axis gyro
19		MSB of z-axis gyro
20	AX	LSB of x-axis accelerometer
21		MSB of x-axis accelerometer
22	AY	LSB of y-axis accelerometer
23		MSB of y-axis accelerometer
24	AZ	LSB of z-axis accelerometer
25		MSB of z-axis accelerometer
26	Checksum	Byte-wise XOR of bytes 1 to 15

Table 7.5: Binary Combined Output

### 7.4.2. ASCII output

P±123.45R±123.45Y±123.45V±123.45H±123.45 GX-  
000.59GY+000.31GZ+000.26AX+0.005AY-0.011AZ+0.999M0404

Figure 7.4: Combined ASCII output

Where:

P is pitch

R is roll

Y is Yaw

V is vertical velocity

H is heave

GX,GY,GZ are rotational accelerations in the x-y-z planes

AX,AY,AZ are linear accelerations in the x-y-z planes

M is a mode statement, this can be removed if required

## COMMANDS

### 8.0. COMMAND LIST ASCII MODE

To enter any of the below commands into the MiniSense the > sign must be sense input first, this is case sensitive. Unless stated no other commands are case sensitive.

The MiniSense uses the extended ASCII character set. To enter some of the commands a terminal capable of sending these is required, such as TeraTerm.

> (Case sensitive) Enter command mode  
A Swap pitch and roll axis  
P Swap pitch sign  
R Swap roll sign  
. Toggle output of decimal point  
Y Toggle output of yaw  
M Toggle output of mode information  
C Toggle output of checksum errors  
Enter End command mode  
Esc End command mode

Ctrl R Output raw binary data  
Ctrl U Slow data output

B Change baud rate

1	9600 bps
2	19200 bps
3	38400 bps
4	57600 bps
5	115200 bps

\$ (Case sensitive) Enter Mode Change

Ctrl A Attitude mode  
Ctrl H Heave mode  
Ctrl S Sensor mode  
Ctrl C Combined output mode  
Ctrl O Change between V1 and V2 binary output format  
Esc Cancel mode change and exit

V View FIR filter coefficients and enter FIR change mode

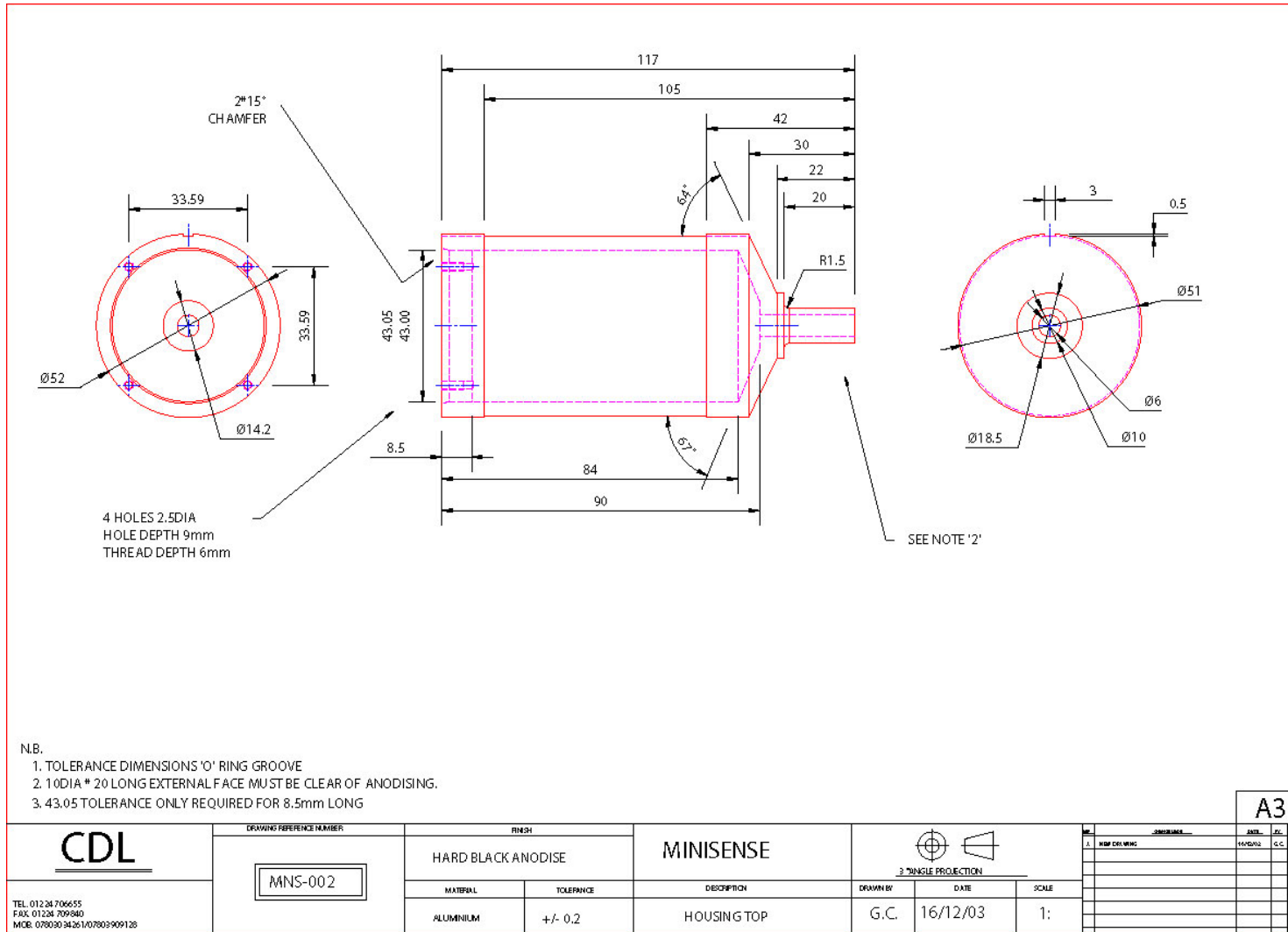
F	View filters again
R	Restore default values to the FIR filters
Ctrl F	Change FIR filters

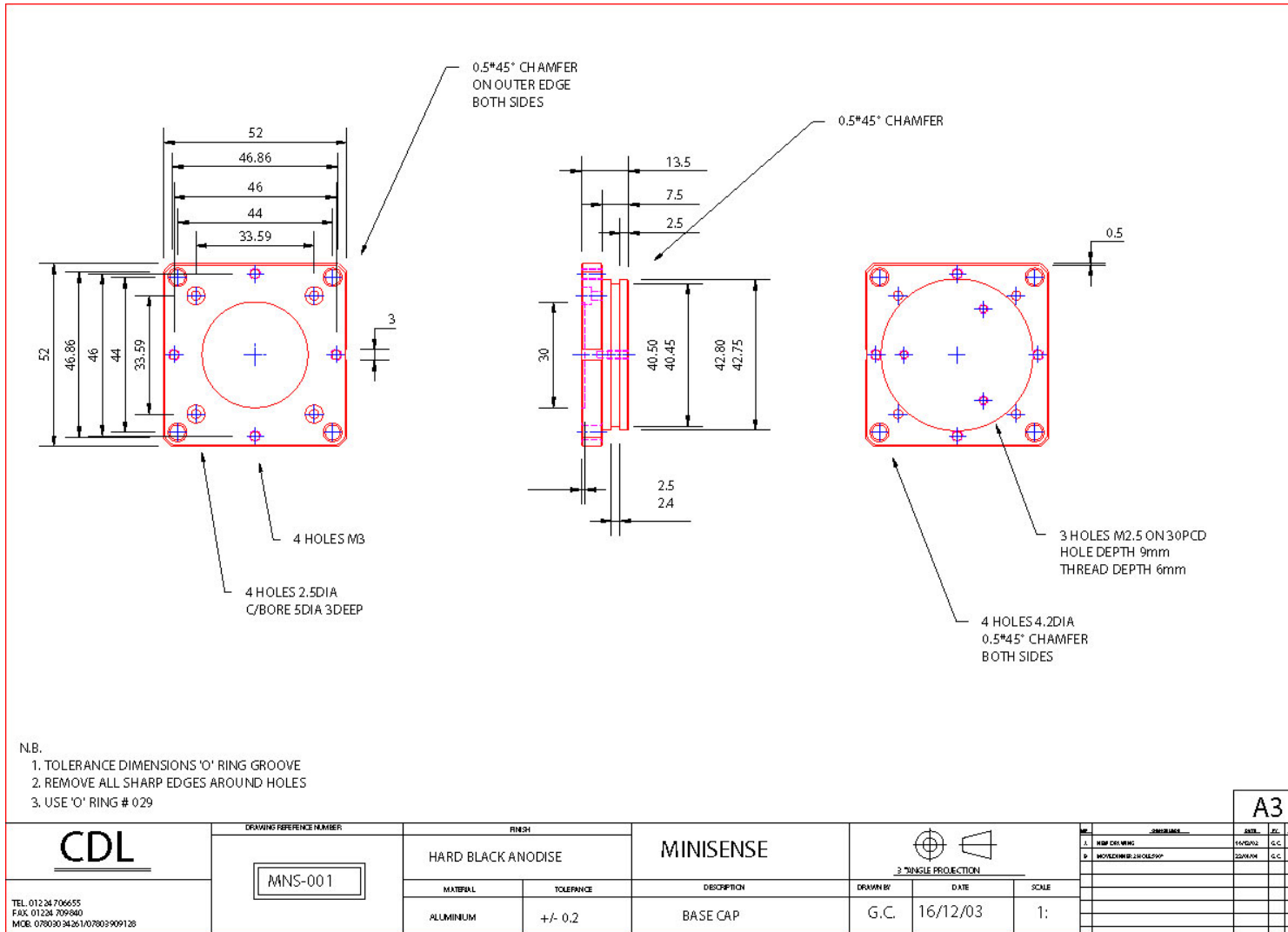
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When changing the FIR filters the user will be prompted for to enter each value in turn. The number must be prefixed with either a + or -. After the number has been entered the return key should be pressed. The number will then be displayed and the next coefficient will be prompted pressing enter at this point will confirm changes made so far and display the updated values.

Pressing Backspace deletes previous value and allows it to be re-entered  
Pressing Tab exits and does not save changes.

MECHANICAL DRAWINGS





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