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# **ZED GLOBAL:**

## **Ring Selection Module**

### **USER MANUAL**

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This document applies to the ZED Global Tunnel Guidance System

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# 1. INTRODUCTION

## 1.1 BACKGROUND

Previously, ZED Tunnel Guidance produced a stand alone Ring Placer Unit which was independent of the guidance system, and without access to the guidance data. The only signal input was for x3 or x4 shove ram extensiometer data, permitting a ring build calculation to be made, based only on the shape of the void between the TBM and last ring built, and taking account of any rules regarding the alignment of circumfrential joints and key position.

However, as the technological demands of tunnelling has increased, the industry requires a Ring Placing Unit that, in addition, to the measurements noted earlier also monitors the clearances between the last built ring and the tailskin, and for the software to be linked with the guidance and alignment data, permitting the built rings to much more closely follow the machine.

## 1.2 A BRIEF DESCRIPTION OF THE SYSTEM

The ring selection module is now contained within the main guidance system software running in the Processor Display Unit. Through a series of graphical displays the new build position is shown with its global coordinates and offset with respect to the designed tunnel axis.

Other data inputs required to perform the ring selection is :-

- a). x3 or x4 shove ram extension data.
- b). x3 or x4 tail-skin extensiometer (articulation) data.
- c). The manual input of x3 or x4 shove ram extension data
- d). The manual input of x4 tail-skin clearances.



## 2. INSTALLATION

This section describes the positioning and connection of the Processor Display Unit on the tunnelling machine.

### 2.1 GENERAL

The Processor Display Unit is actually comprised of two separate parts, one is the display, whilst the other provides a power supply (PSU) and Junction Box for cable interconnections.

The display unit should be placed in a position where it will be easily viewed and operated, The PSU/Junction Box can be mounted in any convenient position. However, these units must not be damaged by movement of machinery, exposed to excessive heat, hydraulic fluid, large amounts of water, etc. Fix the units as firmly as possible, to solid parts of the machine, using the mounting holes.

Do not weld the unit directly to the machine.

Always ensure that there is enough room for the cables to be connected to the unit.

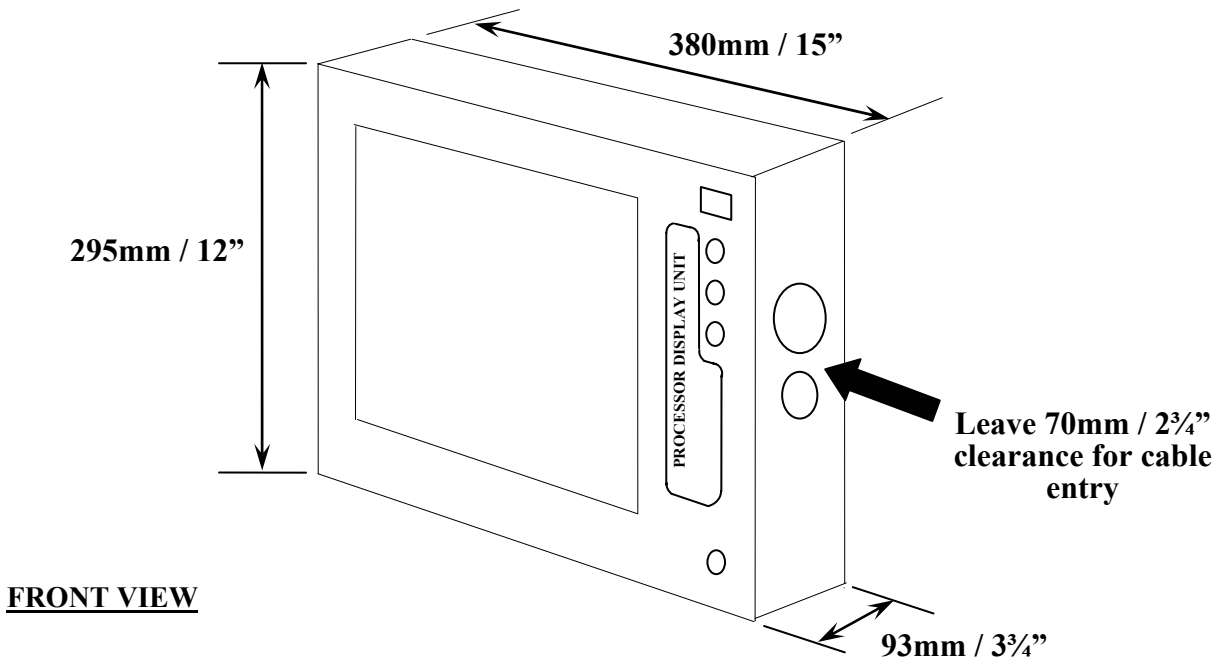
Fitting of the unit may require plates or brackets to be welded to the machine. Do not carry out this welding with the ZED equipment already fixed to the plate or bracket.

In all cases it is helpful if the machine has been designed with the knowledge that a ZED system is to be used on it.

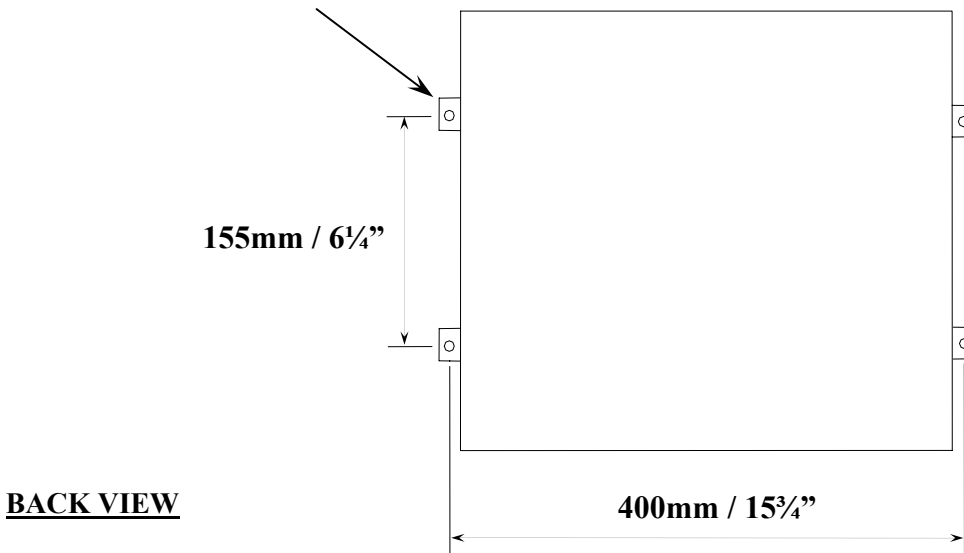
### 2.2 PROCESSOR DISPLAY UNIT

The Processor Display Unit is a rugged user display, fabricated from 8mm thick aluminium. It incorporates all the processing and interfacing electronics required to read and calculate the guidance parameters, plus any ram extensometer data, if required. It has an extremely rugged, touch screen with a toughened glass cover for user interaction and several I/O ports for additional user input equipment. It is mounted using four M4 bolts via the mounting brackets supplied.

Fig 2-2  
Processor Display Unit



x4 Holes, 4.5mm / 0.18" Ø

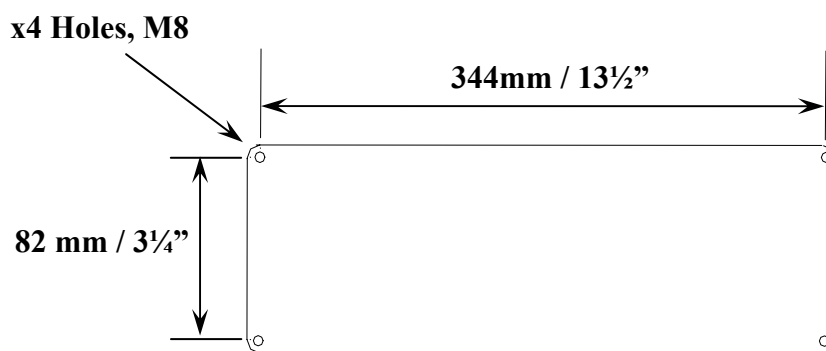
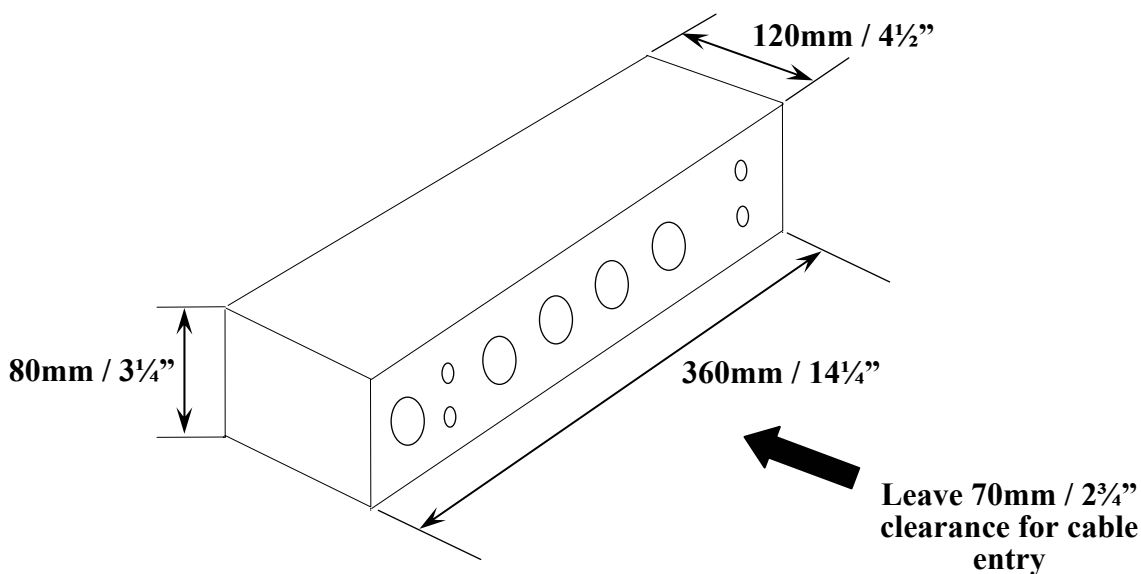


Unit Weight = 6Kg / 13lbs

### 2.3 PSU / JUNCTION BOX

The PSU/Junction box contains the power supply and all the necessary I/O ports required to link into the guidance system and obtain any other required data.

Fig 2-3  
PSU/Junction B



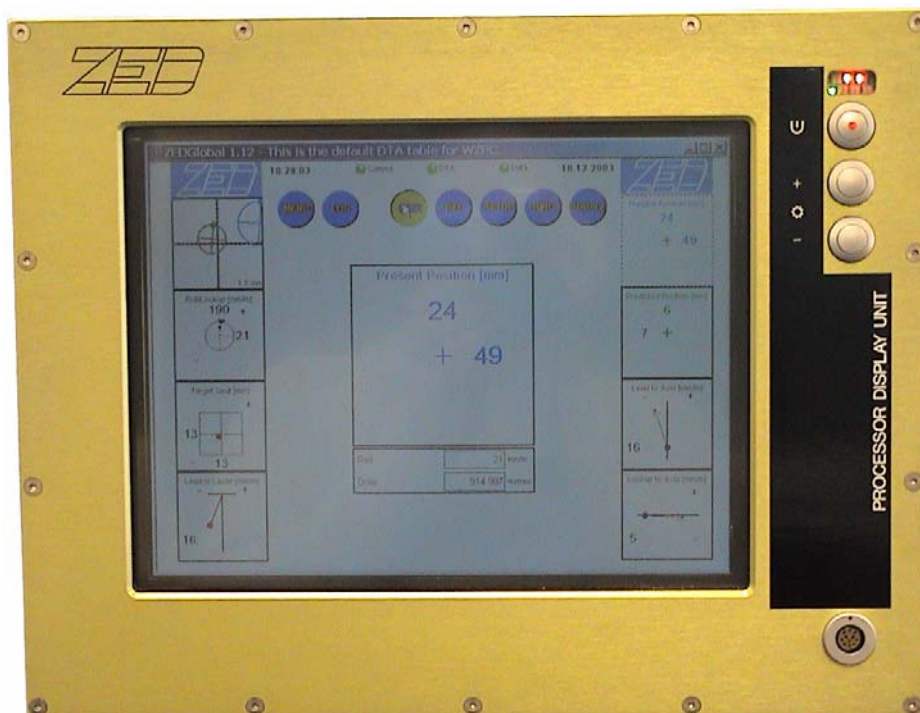
**REAR VIEW**

**Unit Weight = 2Kg / 4 1/2lbs**



### 3. OPERATION

This section describes the operation of the Processor Display Unit.

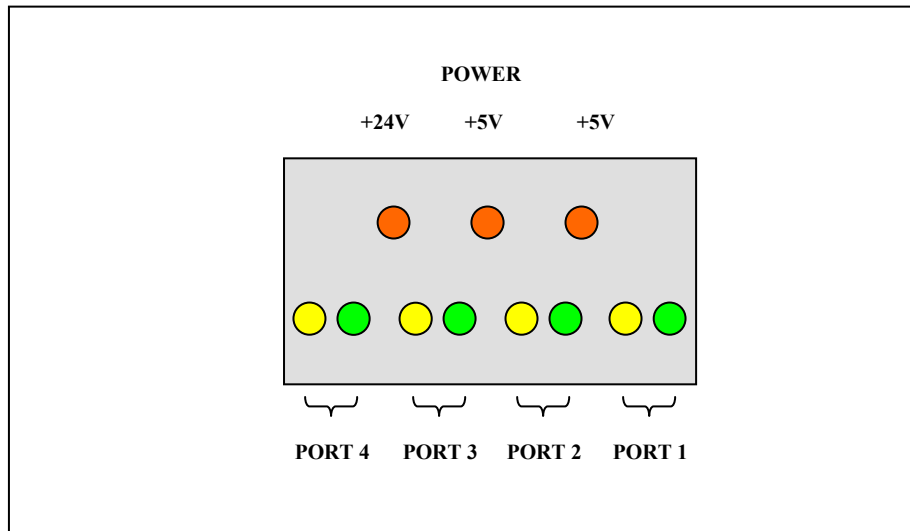


#### 3.1 GENERAL

The Processor Display Unit automatically powers on when power is first applied and goes through an initialisation period before completely powering on, ready for use. This initialisation period is indicated by a flashing red LED contained within the power push button. This LED will become constant once the initialisation sequence has finished.

Below the power push button are another two that can be used to vary the intensity of the display brightness. Pressing + increases the brightness and pressing – decreases the brightness.

Above the push buttons is a small window that contain the status indicator LEDs and are detailed in the following diagram:



The power LEDs indicate the status of the power for each supply. At present the +28V LED is not implemented.

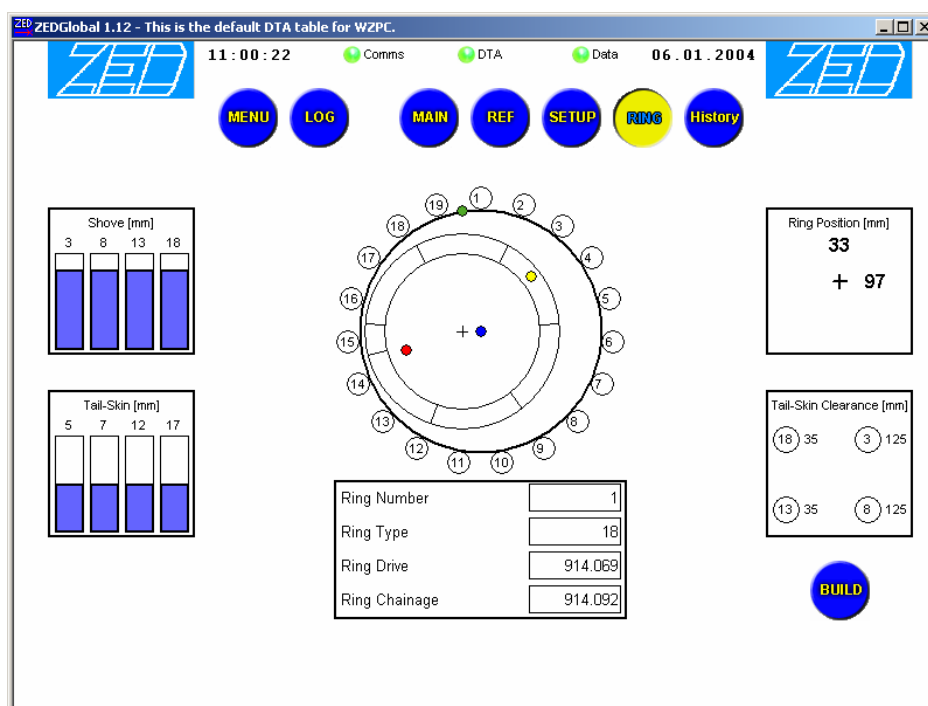
Each port has two LED indicators associated with it, the ● indicates that data is being received to the port and the ● that data is being sent from the port.

The connector port on the front panel (bottom right) is used to connect other devices.

## 4. INFORMATION DISPLAYED

### 4.1 RING BUILD VIEW

The application software has various views. The Ring Build View is used to show the operator the position of the previously built ring.



The central view is a representation of the built ring within the tail-skin. This view is from behind the TBM looking forward, in the direction of advance. The tailskin is represented by a dark circle with the machines thrust ram arrangement detailed externally.

The built ring is shown, depicted by its individual segments, positioned within the tailskin.

**Key:**

- + :- The centre of the ring.
- Blue Circle ● :- The centre of the tail-skin.
- Yellow Circle ● :- The position of the minimum ring width.

Red Circle ● :- The Designed Tunnel Alignment, as defined by the DTA table.

Green Circle ● :- The position of the minimum void

Below the central view are :-

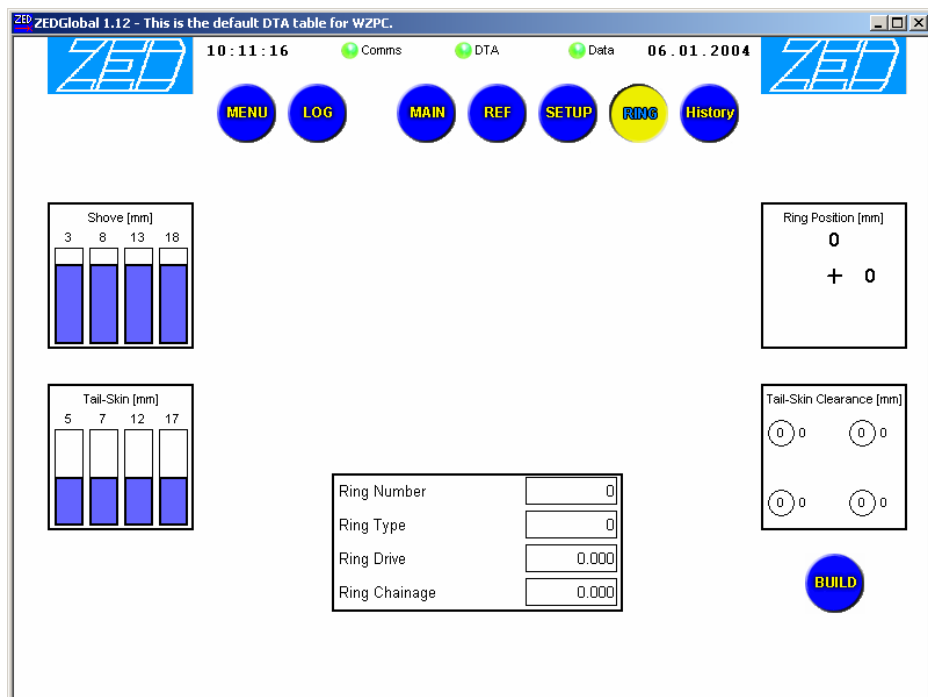
- Ring Number
- Ring Type
- Ring Drive
- Ring Chainage values.

On the left side of the display are the ram extension views for the shove and tailskin rams.

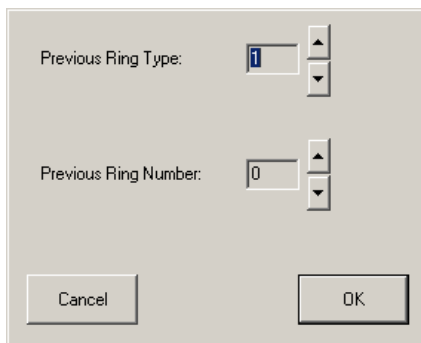
On the right side of the display is the position of the ring axis in the plane of the leading edge of the ring, or open face, relative to the DTA, and is shown as an offset in mm. The information is shown in a similar way to the Present and Predicted Position views with the guidance module. The manually entered ring clearance values are also displayed here.

### 4.2 RING BUILD PROCEDURE

Initially, on first starting to build rings there are no previous ring build values stored, on which to base the new position calculation.

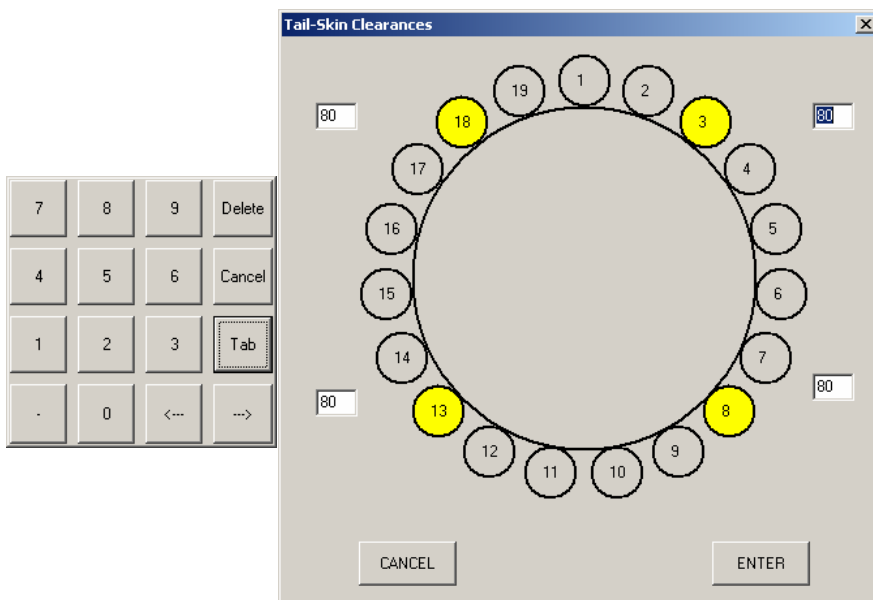


To start, press the 'BUILD' button, noting that the guidance and extensimeter data are not showing any errors. If this is the first ring to be built, then a dialog box will appear prompting the user to enter a ring type and ring number.



The increment / decrement arrows can be used to change the values for each field.

Once the information has been entered a second, 'Tail-Skin Clearances' dialog box will appear prompting the user to enter the clearances at various points.

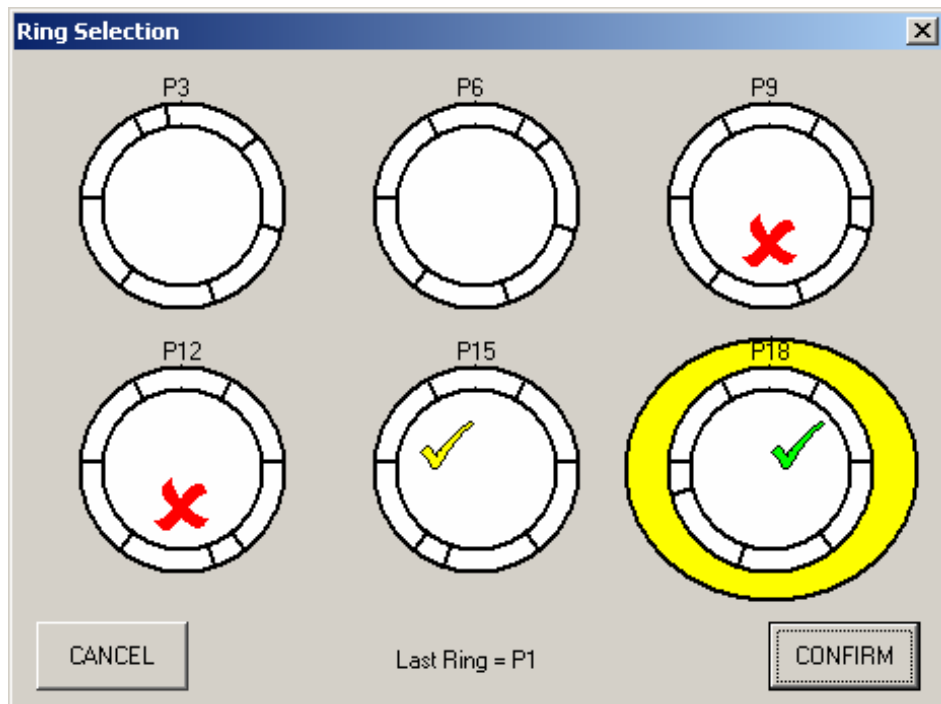


The display has four clearance value entry fields which can be edited/changed by using the numerical keypad to the side and using the TAB button to change to the next field.

The position of each measuring point, highlighted in yellow, is adjacent to the nearest thrust ram, and these can be altered by pressing a different ram if the measurement at that point is difficult. However, it is recommended that the measurement positions are equally spaced around the tailskin circumference.

At any time the 'CANCEL' button can be pressed to reset the ring build and start again.

On pressing the 'ENTER' button the Ring Selection dialog box appears.



This dialog box displays all the allowable rings that can be built and their ring type.

The best calculated ring selection is highlighted in yellow and has a green tick contained within. The yellow tick corresponds to the best ring selection if only the shove ram data is used, but excludes any adjustment due to the tailskin clearance measurements. A red cross within an allowable ring means that if this ring was built then it could possibly touch the tail-skin.

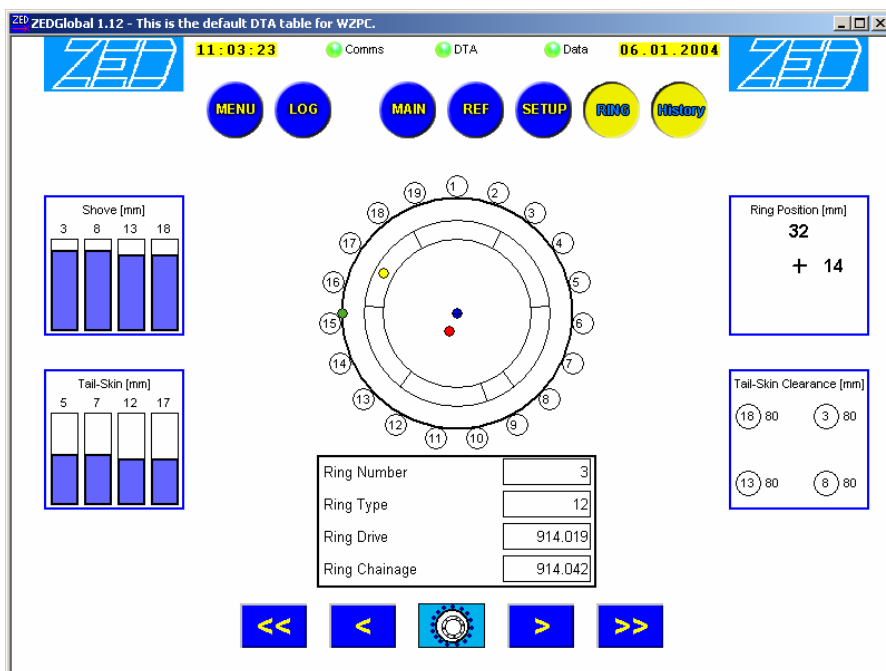
The user can, if required, select an alternative ring to that calculated by touching the desired ring to highlight it in yellow.

On pressing 'CONFIRM' the ring position the data is stored and the display is updated to show that this is the newly built ring.

### 4.3 HISTORY VIEW

The History View allows the user to access previously logged ring build data. This logged data is viewed using the same display layout as with the Ring Build View.

The History View is obtained by pressing the ‘HISTORY’ button. History View is indicated by blue borders around each display, assuming the logged data contains no errors, the time and date are highlighted in yellow and a block of selection buttons are shown near the bottom of the display.



The logged data are stored in dated files, the the data for a particular days logging stored in one file, whilst the logged data for previous days are stored in separate files.

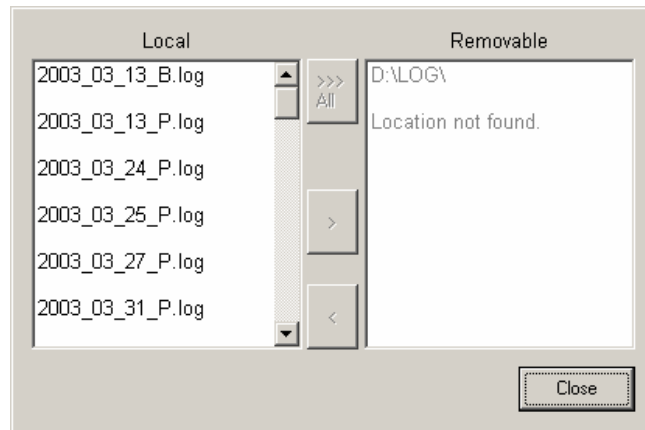
To view the different sets of logged data, press the single left or right arrows on the bottom button bar. To jump to the previous or next days logged data press the appropriate double arrow to move through the database.

The icon centrally placed in the bottom button bar depicts what type of log the data represents, in this case it will always be the Ring Log icon.

### 4.4 LOG TRANSFER

In order to transfer one or all of the previous log files it is necessary to attach a memory device to the front port using the supplied connection cable. Once a device is connected the log files can be transferred by entering the ‘MENU – CONFIG’

display and selecting the 'Log Transfer' button, see Menu System, Section 5. A transfer dialog box will appear similar as shown below :-

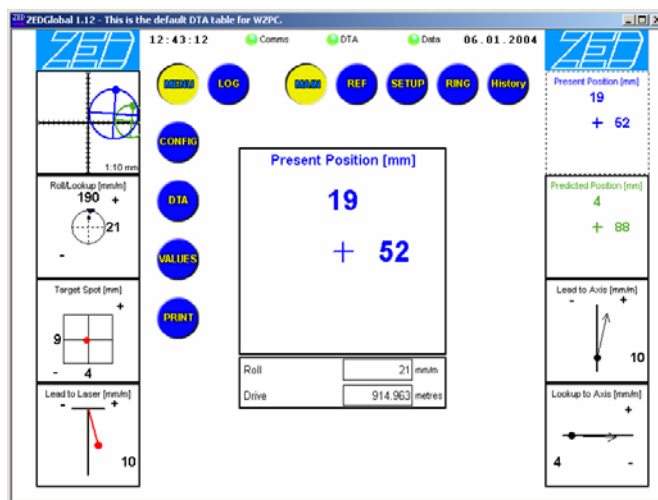


The left hand pane will detail all the log files that have been produced by the Processor Display Unit with each day contained in a separate dated file. To transfer a single file to the memory device, select it and then press the right arrow to complete the transfer. To transfer all the files press the 'All' button. If a memory device is not present or a /LOG folder is not present then the error message 'Location not found' will be shown.

## 5. MENU SYSTEM

The menu system allow the user to configure the system , view system values and print either the current data views or history views.

By pressing the menu button a sub-menu is displayed.



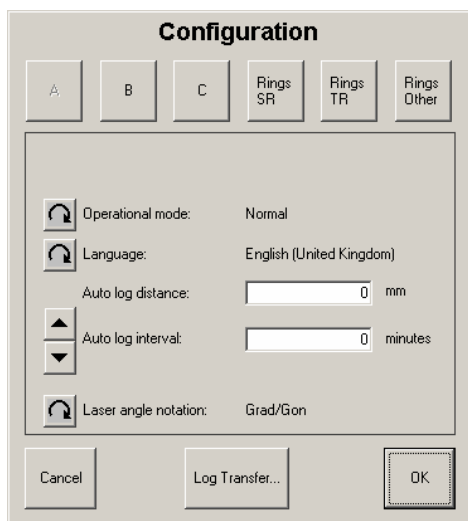
If the setup button is pressed a configuration dialog box is activated.

### Entering values

Numerical values can be entered by using the numerical keypad situated to the side of the configuration dialog box.

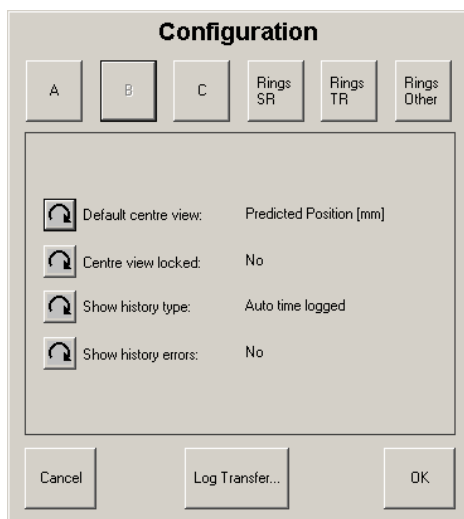


### 5.1 CONFIGURATION A



- Operational mode :-** At present set to ‘NORMAL’, no action further action required.
- Language :-** English only.
- Auto log Distance :-** Allows the user to select the distance interval that the data will be logged at in metres.
- Auto log interval :-** Allows the user to select the time interval that the data will be logged at in minutes.
- Laser Angle Notation :-** Used to select to display angles in either Gons or Degrees.

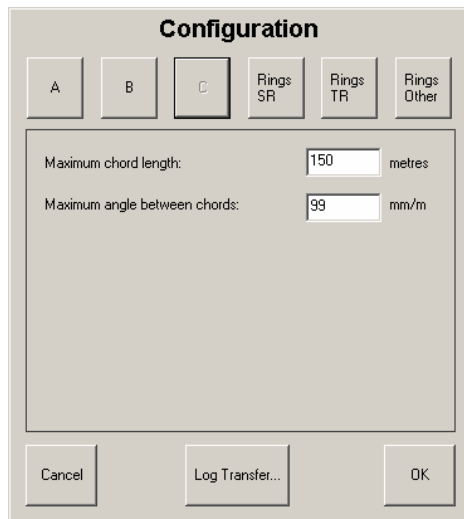
## 5.2 CONFIGURATION B



- Default centre view :-** Used to select the preferred display in the centre of the main view at application startup.
- Centre view locked :-** Used to lock users changing the centre view.
- Show history type :-** No action.
- Show history errors :-** No action.

### 5.3 CONFIGURATION C

Used to enter DTA verification parameters.



**Maximum chord length :-**

Entered value here determines the maximum separation between each DTA point.

**Maximum angle between chords :-**

Entered value here determines the maximum angle between each DTA point.

### 5.4 RINGS SR

Used to enter the positions of the shove ram extensometers in X and Y coordinates from the center of the TBM axis and its associated ram number. Note, that the coordinates must be entered in a clockwise direction, viewed in the direction of tunnelling, starting in the 12 to 3 o'clock quadrant.

Max Extension and Min Extension values are used for error limits.

Shove Ram Extensometers			
		X [mm]	Y [mm]
Ram # SR1	3	2211	2211
Ram # SR2	8	2211	-2211
Ram # SR3	13	-2211	-2211
RAM # SR4	18	-2211	2211
Max Extension	2300	Min Extension	0

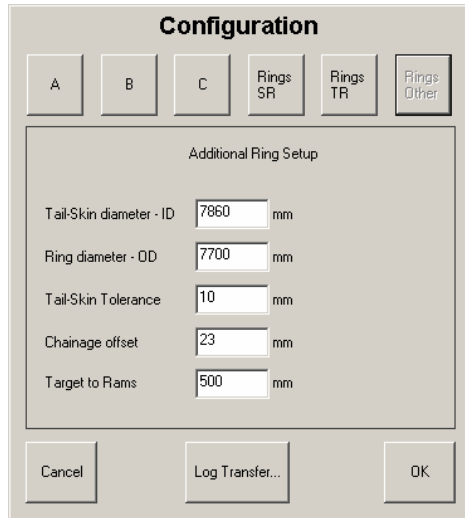
### 5.5 RINGS TR

Used to enter the positions of the tailskin ram extensometers in X and Y coordinates from the center of the TBM axis and its associated ram number. Note, that the coordinates must be entered in a clockwise direction, viewed in the direction of tunnelling, starting in the 12 to 3 o'clock quadrant.

Max Extension and Min Extension values are used for error limits.

Tail-Skin Ram Extensometers			
		X [mm]	Y [mm]
Ram # TR1	5	2690	2690
Ram # TR2	7	2690	-2690
Ram # TR3	12	-2690	-2690
RAM # TR4	17	-2690	2690
Max Extension	200	Min Extension	0

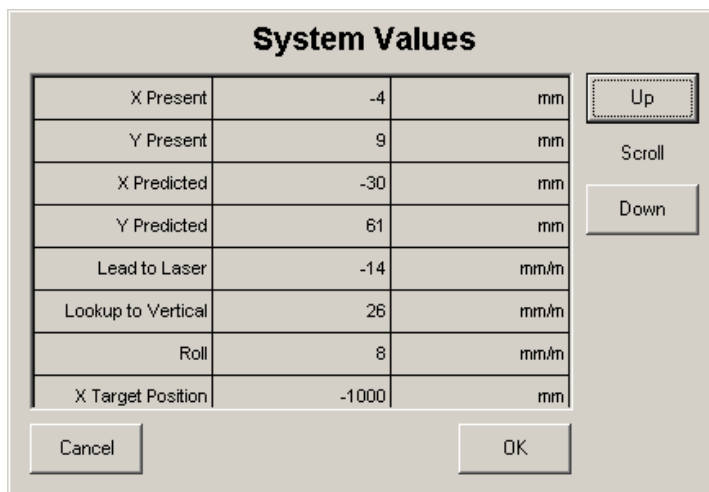
### 5.6 RINGS OTHER



- Tail-Skin diameter ID :-** Internal diameter of the tail-skin in mm.
- Ring diameter OD :-** External diameter of the ring in mm.
- Tail-Skin Tolerance :-** Minimum value between ring and tail-skin in mm.
- Chainage offset :-** Offset value to add to Drive value, to display actual chainage in mm.
- Target to Rams :-** Distance between target plane and ram plane in mm.

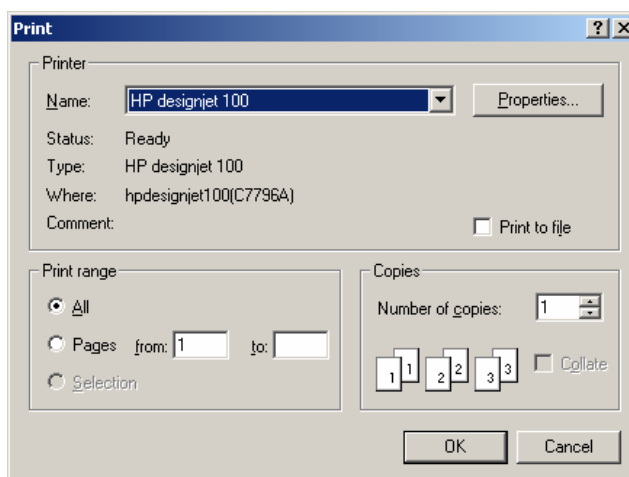
### 5.7 SYSTEM VALUES

Pressing the ‘VALUES’ button allows the user to see all the system data in one place.



### 5.8 PRINT

The print button brings up the following dialog box.



It allows the user to print each view separately, either in a current data view or in the history view.



## 6. TROUBLESHOOTING

### 6.1 ERROR MESSAGES

When the system is not receiving sufficient data to compute the displayed values, the last valid values will have one of the following error symbols appended to it, and the relevant display box on the view will be bordered in red :-

\* = **LIGHT** : Indicates that the target cannot detect the laser beam.

The most likely causes of this error are:

- Laser beam missing the target.
- Laser beam too weak.
- Laser beam too strong.
- Excessive ambient light in tunnel.
- Lead angle outside permitted range.

# = **OUT OF LIMITS** : Indicates that one of the axes of the inclinometer transducer is working outside its operational limits.

! = **TRANSMIT** : Indicates that data is not being received correctly from the Combined Target Unit.

The most likely causes of this error are:

- Combined Target Unit not connected.
- Combined Target Unit faulty.
- Cable damaged.

An error symbol will be displayed if the data to the unit is in error. If, for instance, the laser beam is lost, the **LIGHT** error symbol will show on the **PRESENT POSITION**, **PREDICTED POSITION** and **LEAD** displays, but not on the **ROLL and LOOKUP** display, since roll and lookup are measured solely by the inclinometer transducer in the Combined Target Unit, and does not require a valid signal from the target sensors

## 6.2 DIAGNOSING FAULTS

An additional fault-finding aid is the facility to display the position of the laser beam relative to the target without roll correction, by looking at the **SPOT POSITION** display. Note that with this display, a movement of the laser spot up or to the right of the target screen will increase the displayed values, in contrast to the effect such a movement would have when looking at the **PRESENT POSITION** display, since in the latter case it is the machine's position that is being shown.

If a fault is indicated, select the main view and check the error symbols displayed for each display. The origin of the fault may be traced by referring to the table below.

		PRIMARY PAGE SELECTED						
		PRES. POSN	ROLL	LKUP	LEAD	PRED POSN	SPOT POSN	POINTS TO CHECK
ERROR SYMBOL	!	!	!	!	!	!	!	<ul style="list-style-type: none"> <li>• Cable between units</li> <li>• Combined Target Unit power</li> </ul>
	*	*			*	*	*	<ul style="list-style-type: none"> <li>• Laser beam</li> <li>• Ambient light</li> <li>• Combined Target Unit</li> </ul>
					*	*		<ul style="list-style-type: none"> <li>• Excessive Lead</li> <li>• Laser beam</li> <li>• Target sensor</li> </ul>
					#	#		<ul style="list-style-type: none"> <li>• Excessive Lead</li> <li>• Target sensor</li> </ul>
	#	#	#			#		<ul style="list-style-type: none"> <li>• Excessive Roll</li> <li>• Inclinator transducer</li> </ul>
				#		#		<ul style="list-style-type: none"> <li>• Excessive Lookup</li> <li>• Inclinator transducer</li> </ul>

! = TRANSMIT

\* = LIGHT

# = OUT OF LIMITS

The most common faults are related to cables and connections, the laser, or excessive machine movement.

**IMPORTANT NOTE**

Continuity checks should be carried out with multimeter type instruments only. Buzzers, inductors, high voltage testers, insulation testers, battery/lamp type indicators may cause serious damage.

### 6.3 CONTACTING ZED TUNNEL GUIDANCE LTD

The company's address is :-

**ZED Tunnel Guidance Ltd**  
**Unit 1, Russell House, Molesey Road**  
**Walton-on-Thames**  
**Surrey**  
**KT12 3PJ**  
**UK**

Our telephone, fax numbers and email address are :-

Phone	+44 (0) 1932 251440	Email	sales@zed-tg.co.uk
Fax	+44 (0) 1932 244971		

The company's normal office hours are 0900 to 1300 and 1400 to 1730 Monday to Friday.

#### **What we need to know if you have a problem.**

It is very useful and saves time if you can prepare certain pieces of information before telephoning. If you contact by fax, the same information will be required. Please remember that the person you contact at ZED Tunnel Guidance Ltd may not be familiar with your particular system. This is especially true in situations where your system is not supplied directly from ZED Tunnel Guidance Ltd. The information we need is as follows :-

- a). Your company's name.
- b). Your location.
- c). Your name.
- d). A contact telephone number and/or address.

If we have not been in contact with you recently we will also need to know :-

- e). The type of equipment, i.e. ZED20.
- f). Any special items i.e. Articulation Interface Unit.

Finally, we require a description of the problem and what action has been taken. In particular, if the fault is not immediately identifiable, please have ready details of the displays on the application software from at least the Main View.