AXIS 330J

ILS Glidepath Simulator

User's Manual

Release 55

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Nordic Air Navigation Consulting

Software License Notice

Warranty

Nanco Software warrants the physical diskette and documentation to be free of defects in workmanship for a period of 60 days from the date of purchase. In the event of a defect in material or workmanship during the warranty period, Nanco Software will replace the defective diskette or documentation when defective product is returned to Nanco Software by the owner. The remedy for this breach of warranty is limited to replacement only and shall not cover any other damages.

Liability

Nanco software can take NO responsibility for any damage or losses that can be traced back to the use of AXIS ILS SIMULATOR SOFTWARE. To get the optimum result from this software, the user should have a good knowl- edge of ILS theory and have proper experience in practical work with ILS equipment to use the computed results with caution.

In some cases where the simulated results from predicting signal quality due to scattering objects are in the same magnitude as the allowed tolerances, additional practical tests or advice from a second source of consultants should be considered.

Format

This file is formatted for printing double sided in A4, and then cut in half from A4 to A5 size in order to make a handier physical format.

GEN

General

Table of Content

1.Introduction

The AXIS 330 is an efficient tool for a practical ILS Glide Path simulation.

The software can simulate three basic image glide path types:

1. Null Reference
2. Sideband Reference and
3. M-ARRAY (also named Capture Effect Glide Slope).

The simulation is based on a three-dimensional mathematical model of a glide path antenna system and a terrain.

A terrain model can easily be made with longitudinal & lateral slopes and ground types as well as upto 16 scattering objects of five different types:

1. Short, truncated ground plane,
2. Semispheric Hill Tops,
3. Ridges in terrain,
4. Rectangular Sheets
5. Wire sections.

The scatter computation is based on the Fresnel-Kirchhoff diffraction integral for reflection, diffraction and shadowing.

The site models can be stored on the disk for later use or exchanged with other AXIS users.

There are eight simulation modes in the AXIS 330:

- Lateral trace : Simulation of a perpendicular orbit.
- Vertical trace : Simulation along a vertical line above given coordinates.
- Window overview :ISO-Deviation lines in the coverage sectors.
- Approach mode : Simulation of an approach path.
- Fixed position : Simulation of the deviation and amplitudes in one or two fixed positions while varying a feed parameter.
- Ground current : Visualization of the ground current induced on the reflection plane.
- Bend analysis : To analyse the bends along the flight path to find the possible origin of the reflected signals.
- Sensitive area : Simulation of moving aircraft or vehicles to find a border of the sensitive area.

In addition the AXIS 330 has a Playback Screens mode for displaying the previously saved graphic screens as a slide show.

2. Usage areas

The AXIS 330 usage is mainly in these six areas:

I Setting-up guidance

The Control Panel shows all physical and electrical settings together with readings from sample probes in the Antenna Distribution Unit. This will guide in correct ground setup & phasing in order to minimize flight inspection time at the commissioning of the installation.

II Prediction of signal quality

The influence on the signal quality from planned buildings or constructions at or near the airport area can be predicted by modelling. Experience in site modelling helps prediction of planned GP system performance.

III Finding optimum antenna system

Simulation of specific installations in a given airport model to compare the theoretical signal quality with the achieved Flight Inspection results. By adjusting the model so the simulations resemble the actual results, one gets control and understanding of the GP-system performance and behavior. When the model is established, the simulator can find the optimum adjustment settings to obtain the best possible signal quality.

IV Determine sensitive areas

Establish sensitive areas for aircraft, vehicle movements on taxiways and roads near the GP antennas by simulating the surfaces using rectangular conducting sheets with given sizes and orientations. The object will be moved around and optionally rotated to the worst-case orientation to find the border of the sensitive area where this object will produce a specified bend amplitude at a selected receiver location or flight path. The objective is to obtain qualified restrictions for the movement of various aircraft and vehicle types.

V Simulating the drifting of system parameters

Stability testing by introducing changes in antenna feeds and their mechanical alignment as well as reflection plane slopes to learn what impact this will have on both nearfield and far field signals within the coverage limits. This is important in order to specify maintenance limits for the system in order to set the proper alarm limits in the monitors as well as finding the signal response at the ground measurement points on specific installations.

VI Training

To learn how the ILS Glide Path system really works under all possible and impossible situations. A nearly unlimited “theory book” that adds neatly into any ILS theory course to supply the instructor with an animation and demonstration tool.

3. History

This software has been under development for many years, and the code is optimized to give practical results based on extensive experience with field and Flight Inspection measurements.

The file !A330.NEW contains the historical development information. Use the N-hot key in the Control Panel to read this file on screen. Any user that did suggest changes that have been carried out are named in brackets after the change description.

4. Manual

4.1 Purpose and Scope

This manual provides instructions on using AXIS 330 to make a glide path simulation. You will find it useful regardless of your level of computer expertise.

This user's guide assumes you are familiar with the ILS theory and the concepts that pertain to the ILS-glide path.

At the end of this manual in the Appendix 3 (AX3) there are briefly described the common definitions and abbreviations used in the AXIS 330.

4.2 Organization

This manual is divided into sections. Each section describes completely one module of the program. Three letters code are added into the page numbering for helping a search.

List of Sections

GEN - General
Introduction (this section)

CPN - Control Panel
This section introduces how to enter all electrical and mechanical parameters of the current GP-system.

SET - Setup
A subunit of the Control Panel for changing the default settings.

UTL - Utilities
A subunit of the Control Panel reserved for Utility routines including ADU & MCU simulation unit, Reflection Plane (RPL) slope computation and Optimizing utility.

SCA - Scattering object editor
A module for entering and modifying up to 16 scattering objects.

PLY - Playback Screens mode
A module for displaying the saved screen as a slide show.

LAT - Lateral Trace mode
A module for simulating an orbit flight (cross over) in the azimuth plane.

VRT - Vertical Trace mode
A module for simulating CDI and amplitudes along a vertical line above given coordinates in the terrain.

WND - Window Overview
A module for displaying the ISO-Deviation lines from 300uA FLY UP to 225uA FLY DOWN in the coverage sectors of the GP system.

APP - Approach mode
A module for simulating an approach path at either constant level, ideal hyperbolic line of constant zero deviation or tracked by a theodolite located at user-determined coordinates.

FIX - Fixed Position mode

A module for simulating the resulting deviation and amplitudes in one or two positions while a selected feed parameter is varied between chosen limits.

GND - Ground Current mode

A module for visualising the ground currents induced on the reflection plane.

BND - Bend Analysis mode

A module for finding the source of reflections that produce bends on the GP signal.

SNS - Sensitive Area mode

A module for defining the sensitive area of the airport where a given moving object will cause bends on the GP signals.

Appendices

AX1 - Glide Path Model

The background information of the simulation model to be used in the AXIS 330.

AX2 - Files and Directories

Description of the directories structure and the content of the data files to be used in the AXIS 330.

AX3 - Definitions and Abbreviations

A list with a brief description of the commonly used definitions and abbreviations.

4.3 How to use this manual

The AXIS 330 includes a lot of features divided into several modules.

Due to the organization of this manual, it is not necessary to read throughout the manual so you may ignore the sections you are not interested in.

In any way the usage of the AXIS 330 is based on the site and GP-system parameters that is necessary to enter before making any simulation.

These parameters are entered in the Control Panel (CPN) so it is most important to have a good understand of all parameters and functions available in the Control Panel.

If you are fairly new with the AXIS 330 we recommend to read through the Control Panel section (CPN) before going to the run modes.

4.4 Language

All terms and abbreviations of this manual are following the English language. If any other language is used the terms will be changed according to the selected language.

So if you like to follow the instructions of this manual while you are running the AXIS 330, please select the English language by <3> Setup in the Control Panel.

4.5 Typefaces

The different typefaces in this manual are used as follows:

`Bold Courier`	A text is displayed on the screen; examples: **`SBO Ampl`** **`FWD Dist.(m)`**
Italics	*Italics are used for emphasis the important information. Especially all notes and warnings are printed in italics.*
<nn>	Angle brackets indicates the special keys on the keyboards; examples : <1>,<Enter>,<PgUp> *Note: <CR> key is the same as <Return> or <Enter> key. CR is a short for Carriage Return used at typewriters.*

5. Getting Started

5.1 System Requirements

AXIS330J requires a computer system that can emulate MS-DOS. The third party DOSBox is available for most operating systems and can run AXIS in a DOS window.

5.2 User Code

AXIS 330J is delivered with different access levels to run the different MODES in the Menu. Each mode has its Access Code, which is included in the User Code that is entered the first time.

5.3 Downloading the software

The software is distributed by downloads from our web site.

5.4 Installing the AXIS 330J

The AXIS software family is written for JAVA and need JAVA to be installed on the PC.
We recommend downloading JAVA from this site: https://www.java.com/en/

When this is done, you are ready for the following steps.
Create a directory named "AXIS" directory on your computer as “C:> AXIS”, or anywhere else you prefer. The software is contained in the file “DUBAI-235.zip”. Open the ZIP file and extract it to the created AXIS directory.

Installing the AXIS 110J software
1. Navigate to the “AXIS” directory and start AXIS 110 by clicking on “axis110J.jar”
2. Enter the nine-digit user code for AXIS110J.
3. The Control Panel is opened. Press “Enter” and check that the menu contains these items:

- Orbit Cross over
- Approach
- Fixed Position
- Bend Analysing
- Sensitive Area

If not, you have not entered the correct user code. Go to (3) Setup, next screen (5) Delete user code.
4. Create a shortcut for AXIS110J
a. Right-click on the PC main screen, and select NEW and "Shortcut"
b. Navigate to your AXIS-directory and select the file axis110J.jar, click NEXT and Complete.

5. Connect the icon to the shortcut
a. Right-click on the Java icon on the PC main screen and select Properties
b. Select change icon. Above all the thumbnails, select "Browse"
c. Select the A110-64 icon, and press “OK”.

5.5 Starting the AXIS 330J first time

First time you run the software; the user code must be entered. This code is different for each user and the registered access level and is found in the attached registration letter that comes with the software.

You will only be asked for this code first time you run it on your machine.

5.6 Running the AXIS 330J

The software is started with a click on the icon A330J.

With exception of first time running, the AXIS330 comes up after opening screen to its Control Panel, showing the standard default setup. This setup can be changed by running the configuration module through the <3> key on the Control Panel.

The Control Panel displays a number of parameters, that can be changed by value stepping keys, when the desired parameter is activated (highlighted) by the arrow keys.

Value stepping keys are :

Increment	Decrement	Factor
<Insert>	<Delete>	0.1
<PgUp>	<PgDn>	1
<Ctrl-PgUp>	<Ctrl-PgDn>	10

A brief help about the operating keys is available by <1> and the (H)elp keys.
When all data are set to the desired values, press the <enter> key to proceed to the MENU.

MENU displays a list of modes you can run with the setup entered at the Control Panel.

5.8 Structure of the AXIS 330

The AXIS 330 consists of different modules. The number of available modules are depending on your access level coded into the user number.

When the software is started it begins with the control panel (CPN) showing the default settings. The control panel is used for setting all system and site data. When this is done you can proceed to the Main Menu where you can start desired module by activating (highlighting) the item and pressing <Enter>. Another way to start the module is pressing the item number.

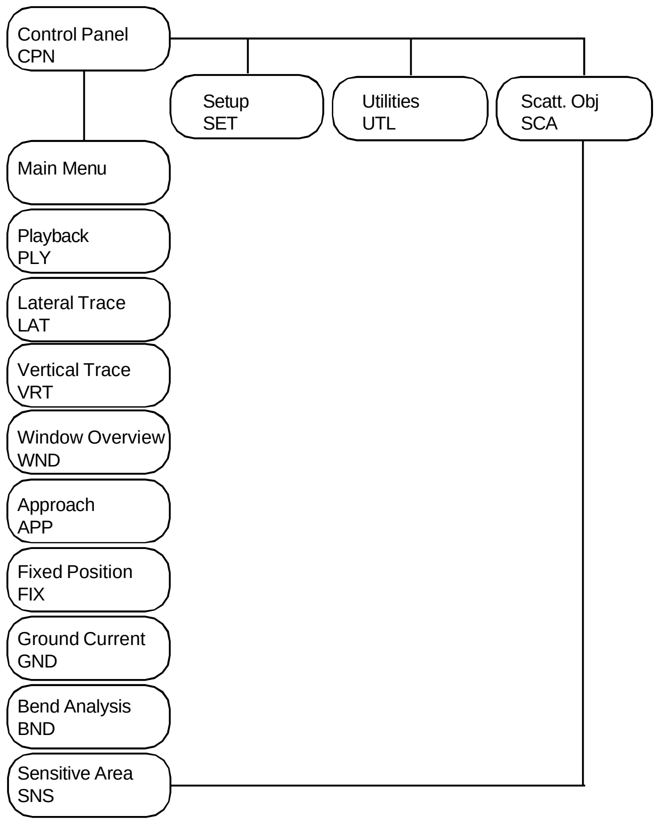

Fig. GEN501 The Main Modules of the AXIS 330

5.9 Main steps

The usage should follow these main steps.

1. Set all the DATA on the upper part of the Control Panel by using the arrow keys and value stepping keys.
2. Enter scattering objects if desired using the <8>.
3. Enter errors if desired on the lower part of the Control Panel.
   Note: Any subsequent changes in the upper part of the screen will cancel these changes. The <Alt-L> key will LOCK the lower panel in case the upper part needs to be changed later on.
4. Press <enter> to proceed to the Main Menu.
5. Select one of the Menu Items by the <Up/Dn> arrow keys and <en-ter>. The screen will show the number of the selected mode.
6. The data screen of the selected mode is opened with default data values. If any data value should be changed, press the <2> to re-enter and continue to answer all questions in two ways:
   -Press <enter> if the shown value (default value) is accepted.
   -Enter value from keyboard if another value is desired, and press <enter>.
7. If a wrong entry was made, or if the wrong menu item was selected, just press the <Esc> key to start over again.
8. Set Toggles by the first letter of the toggle to get the desired computing parameters and the display settings.
9. Press <enter> to perform the computation.
10. To break a graphic computation or exit the module you are in use the <Esc key>. To quit the program use the X in the upper right hand corner,

Editorial NOTE about this User Guide

The <F1> through <F10> keys were one-stroke keys (hot key) in earlier versions, but on modern PCs the keys they became two-stoke keys, ie. not so easy to make rapid selections as before.

The <F1> through <F9> keys were therefore replaced by <1> through <9> keys, still one-stroke. The >F10> was replaced by the <Esc> key.

There might be several <F> keys in this version of the user guide, especially in the figures, but bear in mind that you just omit the "F", and use the numeric corresponding key instead.

6. Updates

6.1 New releases

The AXIS330J comes in updated releases Rnn, where nn is the release number. When new versions of the software are issued, the new files should be updated.

Contact Nanco for more information

6.2 Access code

The AXIS 330J is delivered with different access levels to run the different items (MODES) in the Main Menu . Each mode has its Access Code, which is included in the User Code that is entered at the first time.

If higher Access Code has been given after the Software has been taken into use, delete the present Code by using the <3> key (Setup) in the Control Panel and use <5> "Delete User Code" command from the Submenu.

Restart the software and enter the new User Code.

The User Code/Access Level is in the scrambled GP.001 file.

7. System Configuration

7.1 Display Screen

The graphic screen will be adjusted to the computer in use.

7.2 Printer Drivers

These are no longer used.

7.3 The Default Setup

When starting the software, the default setup configuration will come up.

This can be changed and saved as a new setup by using the <3> key of the Control Panel.

The setup configuration includes:

- GP type
- site data (frequency and antenna front terrain data)
- clearance data in case of M-ARRAY
- GP side and antenna type
- printer settings (form feed and character set)
- receiver response (Low Pass Filter) and
- colour palette

Detailed description is given in the SET-section.

7.4 Startup Arguments

These are no longer used.

7.5 Pasting Graph into Windows applications

This is standard procedure.

CPN

Control Panel

Table of Content

Software

1. Description

The Control Panel is the most important screen in the glidepath simulation containing all electrical and mechanical data of the current glidepath system.

All data input parameters or settings are entered with arrow keys to change the values or introduce system errors directly on the screen. Any phase and amplitude change can be adjusted as well as any mechanical alignment of each individual antenna.

All input parameters are loaded from the default setup file and can be changed by the user.

2. Screen layout

The Control Panel contains two types of fields :

1. Info Fields and
2. Data Fields.

The info-fields can not be changed on the screen as they are result of computed values and are just for information purposes.

The data-fields can be activated (highlighted) by the arrow keys and their contents can be changed by the value stepping keys..

2.1 Info Fields

There are five info fields in the Control Panel:

1. Heading
2. Name of the system
3. Miscellaneous information
4. MCU- and ADU-info
5. Registration info and Function keys

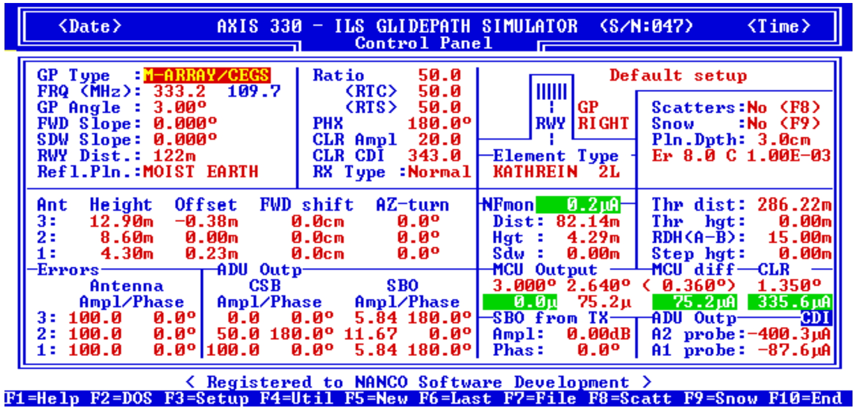

Fig. CPN201 Info Fields of the Control Panel

Heading (1)

The Heading are comprised of the Date, the Time and the Software Identification with the serial number. The <I> key will show the release number and date in the heading field.

Name of the system (2)

The name of system is an 21 characters long text field describing the setup. The default name of the system is "Default setup". It will be shown when starting up the software or pressing the <5>. The <6> key will retrieve the system used the last time the software was run.

Miscellaneous information (3)

`Scatters:No` The number of entered scattering objects. If no scattering objects are entered "No" is displayed instead of a number.

`Snow :No` The number of entered snow layers. If no layers are entered "No" is displayed instead of a number.

`Pln.Dpth: 2cm` The penetration depth to the effective reflection plane, where the antenna heights should be referenced. Subtract this value from the heights shown in the Control Panel to get the real antenna heights above the ground surface.

Note: The value of penetration is depending on the selection of the reflection plane type.

`Opt. 300/-60/2` The location of the optimization point measured from the foot of the GP mast. Format is FWD / SDW / Height in meters.

Note: If no optimization is present this line is empty.

`CDI,DDM` MCU/ADU-deflection readings is shown in uA (CDI) or % (DDM). Hotkey <Alt-D> can be used to toggle between these two states.

MCU and ADU info (4)

This infobox is displaying the data values of the MCU and ADU. This information is depending on the MCU and ADU settings (4=Util).

MCU (Monitoring Combining Unit simulation angles

The MCU shows the simulated integral monitoring signal at three given angles. The hotkey <Alt-D> can be used to toggle deflection between % and µA.

This is a very useful tool for checking the theoretical alarm limits to any feed error. The MCU will also respond to changes in the clearance signal due to the capture effect between the two carriers. The MCU outputs are:

3.000° : The signal from the Glide Path channel to the monitor input. Responds to all pertinent feed changes that can be set on the Control Panel.

2.64° : The signal from the width channel to the monitor input.

MCU Diff The Displacement Sensitivity when subtracting the the GP signal from the MCU Width signal over the 0.36° sector.

CLR : The signal from the clearance channel to the monitor input.

ADU (Amplitude Distribution Unit) output

ADU outputs shows the deflection at the two ADU probes. Hotkey <Alt-D> can be used to toggle deflection between % and µA.

ADU output:

ADU A2:-400.0uA The deviation at the ADU A2 output probe for any setting of GP system. The negative sign means FLY DOWN.

ADU A1:-100.0uA The deflection at the ADU A1 output probe for any setting of GP system. The negative sign means FLY DOWN.

When the system is optimized, the header "ADU output" is replaced with "Phase stub nn°" This shows the electrical length of the quadrature cable stub to get 0 deviation at the ADU output probes A2 and A1. This is useful information for setting up the system to optimum performance.

Phase stub 95° The electrical length of the phasing stub

ADU A2:-400.0uA

ADU A1:-100.0uA

Note: *For A2 - insert the stub in CSB*
For A1 - insert the stub in SBO
For maintenance procedures A2 must be checked and adjusted before A1.

This information is useful for on-site measurements on the system during setup or maintenance. Built-in probes at the ADU outputs for antenna 1 and 2 makes the initial setup and later checks a lot easier and safer.

Registration info and Function keys (5)

The row for Registration info shows to whom the program has been registered.

On the last row of the screen there are shown ten available function keys <1>...<Esc> in the Control Panel.

Detailed description of the F-keys are given in the chapter 4 of this section.

2.2 Data Fields

There are a lot of data fields in the Control Panel that can be changed. The data fields are grouped into the 8 groups as follows :

1. Site Data
2. M-ARRAY additions
3. GP side of runway and an antenna type
4. Mechanical setting of each antenna
5. RF-Feeds for each antenna
6. CL-Monitor position
7. Transmitter Data
8. Threshold Data

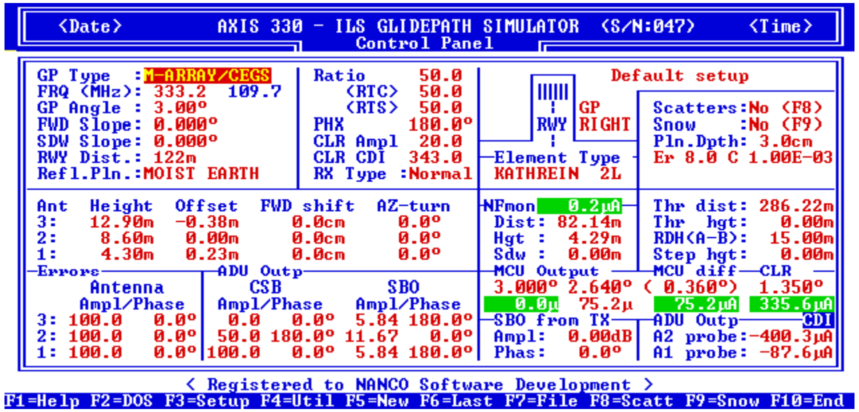

Fig. CPN202 The data field groups on the Control Panel

Site Data (1)

The Site Data are comprised of the GP type, the operating frequency and all necessary environment information for calculation.

M-ARRAY additions (2)

This group concerns only the M-ARRAY glidepath system and contains data fields for CSB/SBO-ratios (RT,RTC,RTS), phasing (PHX) as well as CLR-amplitude and modulation balance (CDI).

Note: This group will not be activated for single frequency systems.

GP side of the runway and the antenna element type (3)

The figure shows the runway and the GP-system seen from the ground towards the landing aircraft. Another data field in this group is the type of antenna element

Mechanical settings of each antenna (4)

The data of the mechanical settings for each antenna are height, offset, forward shift and azimuth turn.

RF-feeds for each antenna (5)

This data group allows to adjust the CSB and SBO-signals for each antenna element. In addition antenna gain (100%) and phase (0°) can be adjusted.

CL-monitor position (6)

This data group shows the optimum coordinates of the near field Course Line monitor in relation to the GP mast. Only adjustable parameter is the sideways distance. All other parameters (Distance and Height) will be calculated and displayed automatically.

Transmitter data (7)

The transmitter data group contain the CSB modulation balance (BAL) and the modulation sum (SDM) adjustment possibility as well as the SBO-amplitude and -phase settings.

Threshold data (8)

The threshold data group have the following THR data:

`Thr dist:`	the longitudinal distance from GP mast to THR. *Note: This field will be calculated automatically.*
`Thr hgt:`	the height of the actual RWY centreline surface at THR referred to GP-zero at the antenna mast. *Note: This data field will be calculated automatically.*
`Xing hgt:`	the height of the downward extended course line between ILS point A and B above the THR. (ILS Datum).
`Step hgt:`	the height of a terrain step or a variation of the terrain slopes between the GP mast and the runway threshold. See usage description in chapter 3.8 in this section.

3. Data Entry

In the Control Panel the data fields can be highlighted, and the value or setting can be changed on the screen directly.

Data values are changed by moving the cursor with arrow-keys to the desired data field and then using the value stepping keys.

Note: The <Home> and <End> keys can be used to move cursor directly in the first or last data field.

The value stepping keys are :

Increment	Decrement	Factor
<Insert>	<Delete>	0.1
<PgUp>	<PgDn>	1
<ctrl-PgUp>	<ctrl-PgDn>	10

3.1 Site Data

There are seven parameters in the Site Data as follows:

1. **GP Type :** Glide path type
2. **FRQ (MHz):** Operating Frequency
3. **GP Angle :** Glide Path Angle
4. **FWD Slope:** Forward Slope
5. **SDW Slope:** Sideways Slope
6. **RWY Dist.:** Runway Distance and
7. **Refl.Pln.:** Type of Reflection Plane

3.1.1 GlidePath type

GP Type :

There are three GP-types available in the AXIS 330.

M-ARRAY/CEGS
SIDBAND REF
NULL REF

Make a selection with <PgUp> or <PgDn> keys.

3.1.2 Operating Frequency

FRQ (MHz):

The operating RF-frequency can be entered as the GP or the corresponding LLZ frequency, selectable by <Alt-F>. Selection between 20 and 40 channels is made by <Alt-E>.

3.1.3 GlidePath Angle

GP Angle : (°)

This is the nominal GP angle relative to the horizontal level. This angle is adjustable between 1.5° and 15° with 0.01° steps.

3.1.4 Forward Slope (FSL)

FWD Slope: (° or %)

The Forward Slope is the average weighted slope of the first 300m of the reflecting plane in front of the GP mast. The first 20-180m are very important for the induced ground current, while remaining zone has decreasing effect in determining the average forward slope.

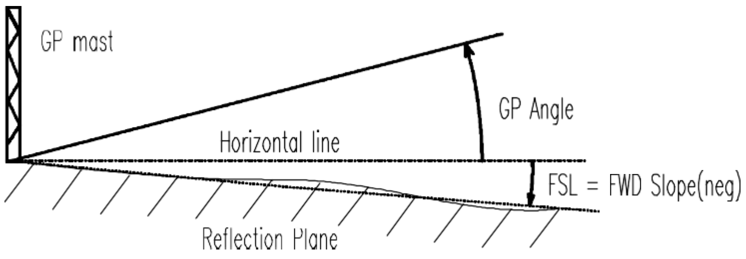

Fig. CPN301 The GP Angle and Forward Slope

The FSL is positive when the terrain rises from the GP mast towards the far field.

The hotkey <Alt-S> toggles the slope between degrees (°) or percent (%).

Note: *The reflection plane computation routine can be used (4=Util) to calculate weighted FSL.*

3.1.5 Sideways Slope (SSL)

SDW Slope: (° or %)

The Sideways Slope (SSL) is the average slope of the reflection plane perpendicular to the runway centreline.

The SSL might have several values at different distances due to the twisted terrain and it is the effective reflection zone between the antennas and the Approach minimum height (DH) that should be considered.

The SSL is defined positive if the ground slopes upwards towards the runway side regardless of the GP antennas are located on the left hand or right-hand side of the RWY. See fig.CPN302.

The hotkey <Alt-S> toggles the slope between degrees (°) or percent (%).

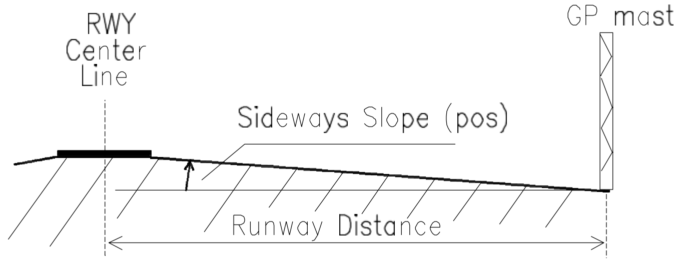

Fig. CPN302 The Sideways Slope and Runway Distance

3.1.6 Runway Distance

RWY Dist. : (m)

The RWY Dist. is the distance between the GP mast and the runway centre-line. See fig.CPN302.

3.1.7 Reflection Plane

Refl.Pln. :

The Reflection Plane is defining a ground type in the reflection plane.

The reflection plane of the GP site will in practice absorb some of the RF energy before reflecting it. The absorption is depending on the electrical properties of the ground as well as the reflection angle.

This parameter has an impact on the reflection factor of the ground plane, depending on the incident angle of the signal. It will also effect the penetration depth of the signals and hence the effective antenna heights.

Note : *The value of the penetration depth is shown on the upper right hand side of the screen (Pln.Dpth) representing the effective reflection plane, where the antenna heights should be referenced. Subtract this value from the calculated heights to get the real ones.*

The ground type selection of the reflection plane are :

Type	Penetration Depth
PERFECT	**0.0cm**
SALT WATER	**0.5cm**
FRESH WATER	**0.7cm**
SOAKED SOIL	**2.0cm**
MOIST EARTH	**3.0cm**
GRAVEL	**5.0cm**
DRY SAND	**6.0cm**
CONCRETE	**6.0cm**

3.2 Extra signals

The extra signals data group includes seven data entries and will be activated only for M-ARRAY systems.

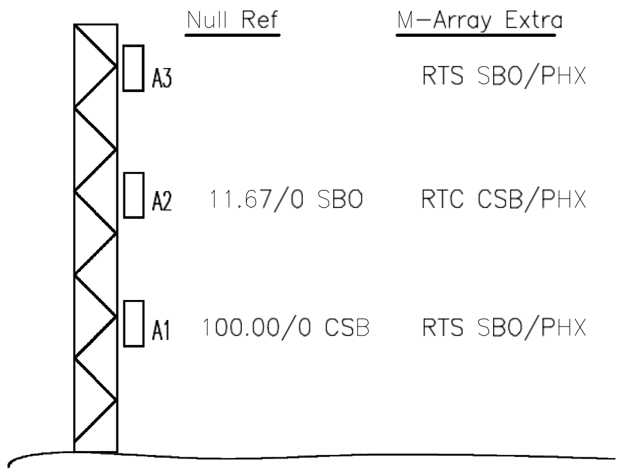

Fig. CPN303 The M-ARRAY signals

3.2.1 General ratio RT

Ratio : (%)

This is the general amplitude ratio between the extra signals and the NULL reference system in the M-ARRAY. Nominal value is 50 %.

Note: *Both RTS and RTC will follow the RT. If RTS and RTC should be set to different values, the RT has no meaning and will not be displayed.*

3.2.2 CSB-ratio RTC

(RTC) : (%)

The RTC is the percentage amplitude ratio between the CSB in A2 to CSB in A1. The nominal value is 50 %. See fig. CPN303.

3.2.3 SBO-ratio RTS

(RTS) : (%)

The RTS is the percentage amplitude ratio between the SBO in A1 & A3 with respect to SBO in A2. The nominal value is 50 %. See fig. CPN303.

Note: *RTS can be adjusted directly on the three SBO DATA fields under ADU at the bottom of the Control Panel (Fig. CPN202 and item 3.5.5). If the RTS is different from 50%, two RTS monitors will pop up above and below the SBO Amplitude fields to display the SBO ratios between antennas A3-A2 and A1-A2.*

3.2.4 Phase of extra signals PHX

PHX : (°)

The PHX is the RF phase of all extra signals relative to Null Reference system. The nominal value is 180°. See fig. CPN303.

This can be changed when optimizing the M-ARRAY to a certain terrain.

3.2.5 Clearance Amplitude CLRA

CLR Ampl :

The CLR Ampl is the amplitude of the clearance RF signal relative to the nominal CSB amplitude in antenna A1.

The nominal value is 20%, but can change depending to the manufacturers.

The default value is 0.

Note: In case of CLR is toggled OFF by <Alt-C> this value is also 0.
The following table gives the relationship of CLRA/CSB-A1 for different RF power levels fed into an average Antenna Distribution Unit (ADU), when the CSB power is held constant at 5W.

CLR-Pwr (W)	CLR Ampl (%)	CLR-Pwr (W)	CLR Ampl (%)
0,1	9,1	1,1	30,3
0,2	12,9	1,2	31,6
0,3	15,8	1,3	32,9
0,4	18,3	1,4	34,2
0,5	20,4	1,5	35,4
0,6	22,4	1,6	36,5
0,7	24,2	1,7	37,6
0,8	25,8	1,8	38,7
0,9	27,4	1,9	39,8
1,0	28,9	2,0	40,8

CLRA depending on CLR power input to ADU

3.2.6 Clearance Deviation CLRD

CLR CDI : (uA)

The CLR CDI is the deviation (uA) in the clearance signal. The value is depending on each manufacturer, and should be checked in the equipment manual. The following list indicates some examples :

Normarc	343 uA	(m = 20/60%)	(CLRA = 20%)
Plessey	343 uA	(m = 20/60%)	(CLRA = 20%)
Alcatel/Thomson	257 uA	(m = 25/55%)	(CLRA = 30%)
Wilcox	686 uA	(m = 0/80%)	(CLRA = 20%)

3.2.7 RX Type

RX Type : Normal or 51RV1A

Select receiver capture effect handling. Normal type has a rather steep transition curve, while the Collins 51RV1A used in many older planes (DC-9 etc) and flight inspection units, has a slower transition from the stronger to the weaker signal.

3.3 GP-Side and Antenna Type

3.3.1 GP-Side

The display shows the runway and the GP mast seen from the ground towards the landing aircraft. The default is on the localiser FLY RIGHT side of the RWY.

The <PgUp> or <PgDn> will toggle the GP side.

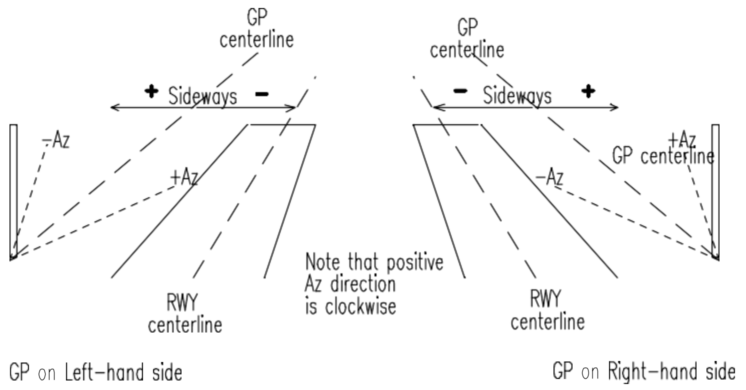

Fig. CPN304 GP side of the runway

Note: *The definition of the sign of the sideways distance is always negative towards runway.*

3.3.2 Antenna Type

The Antenna Type is simulated the antenna element radiation diagram with the theoretical gradients, nulls and sidelobes in azimuth.

There are six elements available:

ISOTROPIC Isotropic omnidirectional
1/2 L DIPOLE Half wave dipole
NORMARC LPDA Twin Log Periodic Dipole Antenna (LPDA)
KATHREIN 2L 2 lambda 4x2 dipole array
THOMSON CSF CSF 2 lambda reflector element
WILCOX 3-DPL 3 dipole array with corner reflector

3.4 Antenna mechanical setting

The mechanical setting for each antenna element is based on the height, the offset, the forward shift and the azimuth turn. The settings of each antenna can be changed independently to simulate misalignment in the installation.

Note: The antenna elements are numbered from the lowest antenna to the highest one. The lowest one is always A1. See fig. CPN303

3.4.1 Antenna height

`Height : (m)`

The computed antenna heights are based on the Site Data.

Note: The heights are measured from the effective reflection plane not necessarily top of the ground.

An alarm will sound to warn you if the value is reduced to less than zero.

Note: If any parameters are changed in the site data group the antenna heights will be recomputed to their nominal values. To override this function if not desired, use the hotkey <Alt-L> which will lock the lower part of the control panel to avoid automatic recalculation.

3.4.2 Lateral offset

`Offset : (m)`

The Lateral Offset is the position of the antenna elements and their images on a cylinder arc surface, where the cylinder axis is the RWY centreline. This will ensure far field conditions all along the localiser course line down to the ILS Reference Datum.

The Lateral Offset is computed from the inputs of the Site Data (FSL and SSL).

The offset is referred to antenna 2 (A2) and displayed in meters and can be adjusted to any value.

The offset values can be zeroed out by pressing the 0-key (zero) when one of the offset fields are highlighted by the cursor.

Note: Positive value shows increased distance from RWY centreline and negative value decreased.

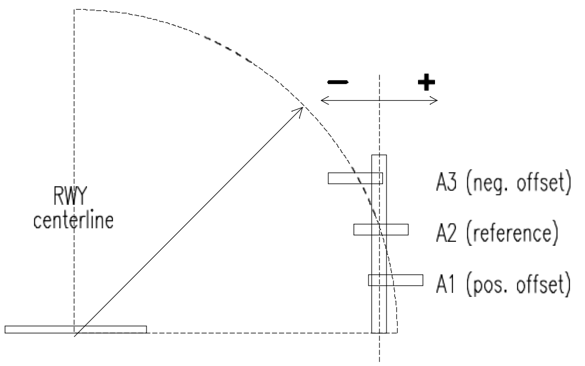

Fig. CPN305 The Lateral Offset of the GP antennas.

3.4.3 Forward shift

`FWD shift : (cm)`

The GP antennas radiation diagram are referenced to the reflection plane and the antenna mast MUST BE perpendicular to the average reflection plane.

The FWD (forward) shift is calculated from the antenna heights and the FSL. The forward shift shows the distance in centimetres the antennas must be moved forwards (positive) or backwards (negative) referenced to the GP zero point at the bottom of the GP mast.

To set the mast vertical regardless of the FSL, highlight one forward shift field by the cursor and press the key <0> "zero".

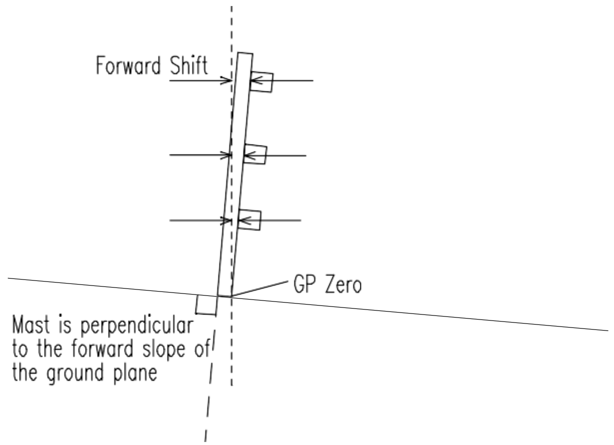

Fig. CPN306 The Forward shift of the GP-antenna

3.4.4 Azimuth turn

AZ-turn : (°)

The AZ-turn is the Azimuth turn (rotation) of the antenna element. This can be used to simulate an inaccurate mechanical alignment or an erratic radiation diagram due to wet snow on the radome or faulty contact points in the antenna element assembly. The antennas can be turned upto +90° in the horizontal plane (azimuth) to simulate errors in the antenna radiation diagram.

Note: Azimuth angles are defined POSITIVE when rotated clockwise.
The effect of AZ-turn is particularly evident on Approaches, Window diagrams and Ground current 3D graphs. The effect also depends on the antenna element type.

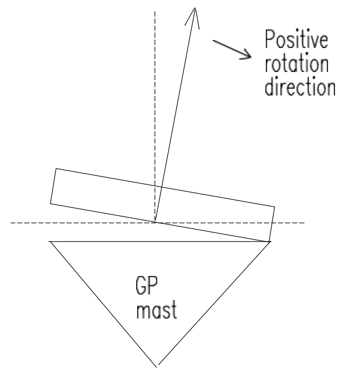

Fig. CPN307 The AZ-turn of the GP antenna

3.5 Antenna Element Feeds

The feeds of each antenna consists of six adjustable parameters that can be used to simulate the effect of the misalignment.

3.5.1 Amplitude errors

Antenna

Ampl/ : (%,dB)

The Antenna amplitude errors can be used to simulate the reduced or increased antenna gain. The normal value is 100 % or 0 dB. Use the hotkey <Alt-B> to toggle display between % and dB.

Note: The setting will effect all signals in the antenna element.

3.5.2 Phase errors

Antenna

/Phas. : (°)

The Antenna phase errors can be used to simulate the antenna radiating phase. The normal value is 0 °.

Note: The setting will effect all signals in the antenna element.

3.5.3 CSB amplitudes

Antenna

Ampl/ : (%)

The relative CSB amplitudes referenced to the nominal CSB in A1 (=100).

The value of CSB in A2 is the RTC % of CSB A1. CSB in A3 should be zero, but can be set to simulate CSB-leakage into to upper antenna.

3.5.4 CSB phases

Antenna

/Phas. : (°)

These are the absolute CSB phases. CSB phase in Antenna1 iis the reference of the entire system and changing this value is equal to a complementary phase change in all other signal components.

3.5.5 SBO amplitudes

Antenna

Ampl/ : (%)

The relative SBO amplitudes defined as the 150Hz sideband vector relative to Carrier vector in CSB A1. The SBO in A2 is the main SBO component, depending on the FSL value.

The values of SBO A1 and SBO A3 are RTS % of SBO in A2.

3.5.6 SBO phases

Antenna

/Phas. : (°)

These are the absolute SBO phases relative to the CSB nominal Phase in A1.

3.6 The Near Field monitor reading.

-NF mon: (µA or %D)-

The NF-monitor is located on the reflection plane in front of the glide path antenna mast according to the coordinates Dist, Height and Sdw below. This NF mon field will display the CDI or %DDM in the monitored point point, which should correspond to the nominal Glide Path angle.

3.6.1 Forward distance

`Dist : (m)`

The Dist is the theoretical distance from the GP-mast (GP-ZERO) to the monitor antenna. The default distance is computed from the information in field 1, but can be changed by the user.

3.6.2 Height

`Hgt : (m)`

The Hgt is the theoretical height of the monitor antenna above the effective ground plane. The default distance is computed from the information in field 1, but can be changed by the user.

3.6.3 Sideways Distance

`Sdw : (m)`

The monitor can be moved sideways along the ISO-Dephase line, where a positive value brings the monitor further away from the RWY and hence to a greater distance from the GP mast and therefore higher up. In practise the maximum horizontal angle (AZ-angle) is about 20° due to the radiation diagram first null at 30° in some of the antenna types.

The purpose is to get monitor at a higher position to reduce the impact of snow on the reflection area. Another reason is to prevent it from screening the signals going directly to the far field.

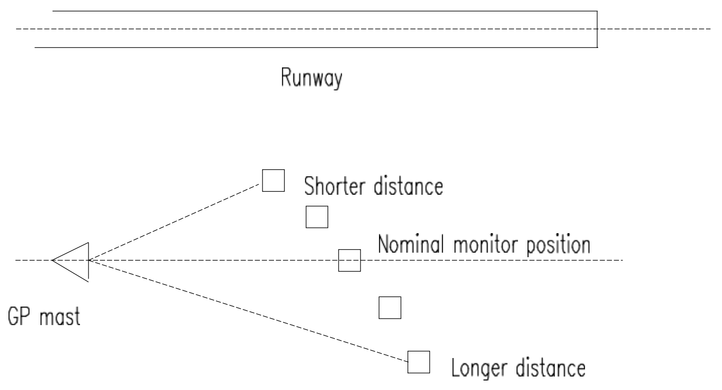

Fig. CPN308 Course Line Monitor Sideways positioning

3.7 Transmitter Data

The modulation balance in the CSB signal from modulator is fixed to 0uA.

The SUM is the modulation sum in the CSB signal is fixed to 80%.

3.7.1 SBO-amplitude from cabinet

-SBO from TX -

Ampl: (dB)

This SBO-amplitude displays the general SBO amplitude from the modulator in decibel (dB). Changes can be done in 0.01 dB steps. Nominal value is 0 dB.

Note: Data entry step will always be in percent while it is displayed in dB's, so the displayed steps might be uneven jumps.

3.7.2 SBO-phase from cabinet

-SBO from TX -

Phas: (°)

This SBO-phase displays the general phase from the modulator. The nominal value is 0°.

3.8 Threshold Data

3.8.1 Threshold Distance

Thr dist : (m)

The Thr dist is the longitudinal distance from the GP-mast to the threshold. This data value is depending mainly on the FSL and the Step Height (3.8.4).

The SSL is not affecting the Threshold Distance because the GP cone is tilted along.

Note: This data is calculated automatically and cannot be changed by the user.

3.8.2 Threshold Height

Thr hgt : (m)

The Thr hgt is the height of the actual runway centreline surface at the threshold referred to GP ZERO at the antenna mast and is the linear extensions of FSL and SSL plus the Step Height (3.8.4). See Fig. CPN309.

Note: This data is calculated automatically and cannot be changed by the user.

3.8.3 Threshold Crossing Height

Xing hgt : (m)

The Xing hgt (crossing height) is the height of the downward extended course line above the threshold.

Nominal value is 15 m in tolerance -0m / +3m.

3.8.4 Step Height

Step hgt : (m)

The Step hgt is the non-linear height variation of the terrain slopes between the GP mast and the threshold and represents the difference from linear extensions of FSL and SSL. See fig. CPN309.

If there is a step in the terrain at the runway shoulder or a variation in the slopes, the actual measured value of the Threshold Height may be different from what is computed from FSL and SSL based on the existing or planned GP antenna position. In that case the step value can be entered to this field so that the Thr hgt (3.8.2) will indicate the measured value.

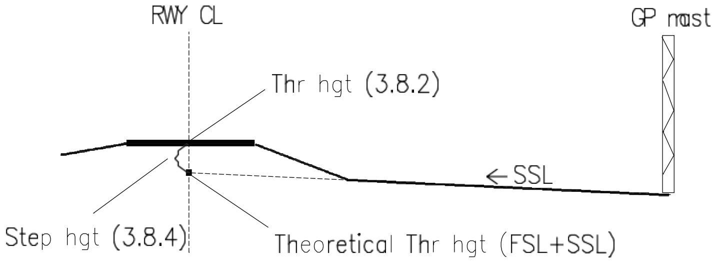

Fig. CPN309 Threshold heights

This will also change the theoretical THR distance in order to maintain the nominal threshold crossing height. There are two ways of processing this further:

1. The GP antenna is already installed:

Adjust the Threshold Crossing Height (3.8.3) until the Threshold Distance (3.8.1) shows the actual value. If the Threshold Crossing Height now reads less than 15m or more than 18m, the GP mast was not located within the correct tolerances.

2. A new site where the ideal antenna position should be found:

The change in Threshold Distance means that the GP mast must be located at a different place so that the difference in height between runway height at the threshold and the GP mast has been changed. Compute this new height manually and adjust the Step Height until this measured height is read in (3.8.2).

Iteration process:
This again will change the Threshold Distance, and the process may be repeated if the unlinearity or terrain steps appear differently from the new location and therefore require a new Step Height value.

4. Function Keys

In the Control Panel there are ten function keys available.

4.1 1 - Help

The <1> key will display a short description on the function and navigation keys as well as the value stepping keys.

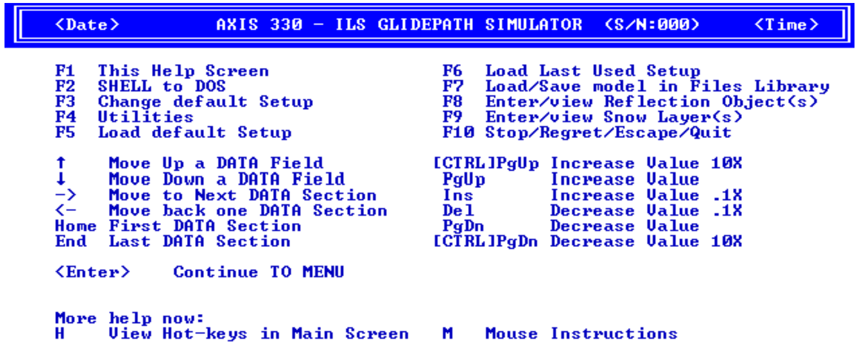

Fig. CPN401 Help Screen of the Control Panel

More help screens are displayed when pressing <H> or <M> keys.

<H> key will display the hotkeys and <M> key will display the mouse instruction.

4.2 2 - DOS

Temporary access to DOS. The AXIS 330 occupies about 350kB of RAM, leaving the remaining memory available for any other use.

Type EXIT to return to AXIS.

4.3 3 - Setup

The <3> opens the setup screen for configuring and saving the setup as a default.

You can set the system data, site data, language and the printer control as well as the screen type and the default colours. Detailed description is given in section SET.

4.4 4 - Util

The <4> opens the utility selection menu. There are three utilities available in this module.

1. MCU settings
1. ADU adjustments,
3. Reflection Plane (RPL) Slope computation
4. Optimizing.the M-ARRAY to the terrain

A complete description about the utilities is given in section UTL.

4.5 5 - New

This function gives you the default startup values and erase all entries previously set. Alter the default values by using the <3> key to change the setup which is contained in the file GP.INI. Appendix AX2 describes the format and the content of the file GP.INI.

4.6 6 - Last

The <6> key will load the setup you actually were running last time. The file GP.RUN contains this setup. Every time you stop the AXIS 330 your setup is saved into the file GP.RUN.

In the appendix A2 the format and the content of this file is described.

NOTE: GP.RUN is identical to the library files in the WORK directory.

4.7 7 - File

This key <7> allows you handle (load/save/kill) your files on the disk.

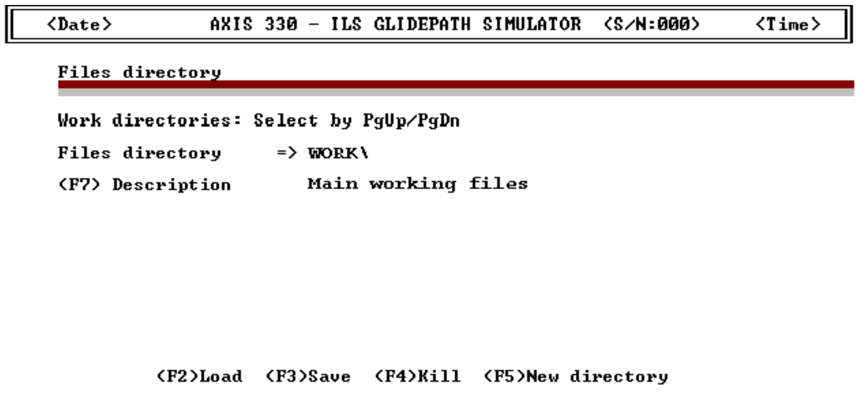

Fig. CPN402 The screen after <7> selection

If running on a Local Network, you may choose to handle files in the common area by pressing (2), or your own local area by pressing <enter>. The common area is limited to only a "WORK" directory under the server AXIS directory. Only the Network Manager is allowed to delete (Kill) files from the common area.

There are six function key commands available.

1. (2) Load
2. (3) Save file
3. (4) Kill file
4. (5) New directory
5. (7) Description
6. (8) Make new directory

The default directory is the WORK\ subdirectory under the AXIS directory. The keys <PgUp> and <PgDn> is used to scroll through directories named WORK1\..through .WORK50\.

4.7.1 Load <2>

The Load command is activated by <2> and is used to load earlier saved mod-el to the AXIS 330.

The screen shows all model (setup) files in the selected directory. On the first line in the middle of the screen is a 21-character long description of the high-lighted file.

```
  <Date>        AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

                <CR> to select   Test setup           <Esc> to cancel

<TEST    .>        <DOCUM  .>        <AIRPORT.>
 28430336 Bytes free
```

Fig. CPN403 Typical "Load" Screen

Move cursor with the arrow keys and press <Enter> for loading the highlighted file into the AXIS 330. Press <Esc> to return without loading any file.

4.7.2 Save <3>

The Save command is activated by <3> and is used to save the model in the selected directory. The command will open two fields which you have to enter for saving the file.

```
<Date>         AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

           Enter file name   nnn----     <Esc> to cancel


    description    : |mmmm----------------|
    Existing text  : |nnnnn
```

Fig. CPN404 Typical "Save" Screen

1. Enter file name ------ <Esc> to cancel

Type the file name (7 characters max) and then press <Enter>.

2. description | -----------------------|

Existing text |

The text field of 21 characters that gives a short description of the system and any particular settings or errors. This text will be displayed at the top right-hand side of the Control Panel.

Press <Esc> for returning to Control Panel without saving any file.

4.7.3 Kill <4>

The Kill command is used to kill the files and will display all the setup files in the FILES directory.

The cursor appears on the first file name. Move it with the arrow keys and press <CR> to kill the file.
Press <Esc> to return without killing any file.

```
<Date>         AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

 Kill =>       <CR> to select   Test setup          <Esc> to cancel

<TEST    .>      <DOCUM   .>      <AIRPORT.>      <MMMM    .>
<XYZ     .>      <NNN     .>
 28413952 Bytes free
```

Fig. CPN405 Typical "Kill file" Screen

The operation is similar as “Load” expect you are warned and prompted.

Are you sure (Y/N)?

before making any deletion.

4.7.4 New directory <5>

The New Directory command let you change the directory or disk drive for the files.

`Enter new directory   <CR>=Default   ->`

The command is cancelled by <Enter> otherwise type the complete path and directory without the final backlash like the following examples:

`C:\myfiles    or      A:`

Note: If the directory does not exist, a warning will be shown. Press the (8) key to create the named directory.

4.7.5 Description <7>

This command lets you write your own label in each directory. Type the text and press <enter> to create the label. This may be a simple description of what kind of files there are in this directory e.g an airport name, testing scatter objects etc.

`Description          :`

The label can be rewritten anytime.

4.7.6 Create new directory <8>

If a non-existing directory is selected, a warning will appear with a reminder that (8) can be pressed to create the directory. After pressing (8) the warn-ing disappears and the directory is ready for use. Use the (7) to make a memo label for the content.

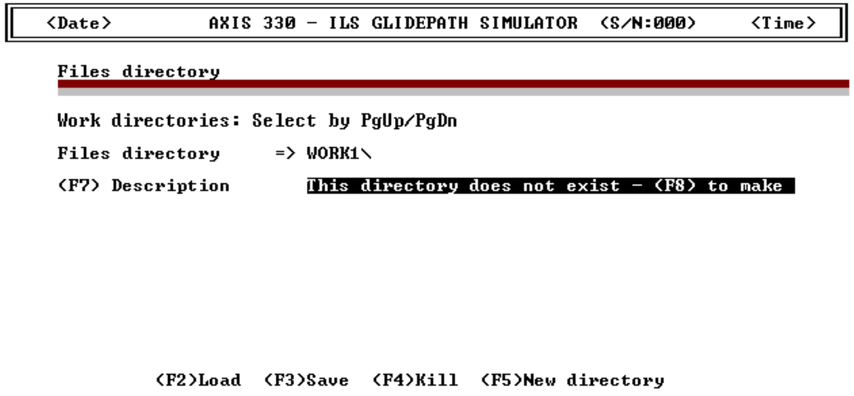

Fig. CPN406 Creating a new directory by <8>

4.8 8 - Scatt

This function enables insertion of the reflection objects into your simulation model. Detailed description is given in the SCA-section.

4.9 9 - Snow

The key <9> is used to enter snow layer on the reflection plane.

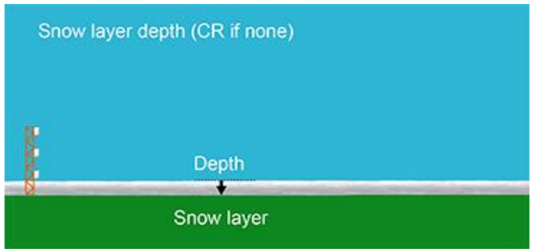

Fig. CPN407 Snow layer entering screen

First the thickness of the snow layer.is entered.

Secondly the dielectric constant of the snow is entered.

The value of the dielectric constant is fixed to 80 to simulate water until a later release.

5. Hot Keys

There are many Hot Keys available in the Control Panel. The Hot Keys or an Alt Key combination execute a given action immediately when pressed.

Here is a brief description about the Hot Keys in the Control Panel:

< B > Black & White or Colours

Hot key <B> is a toggle selecting screen between Colour and B&W.

< H > hot keys table

Hot key <H> shows the help screen about the hot keys.

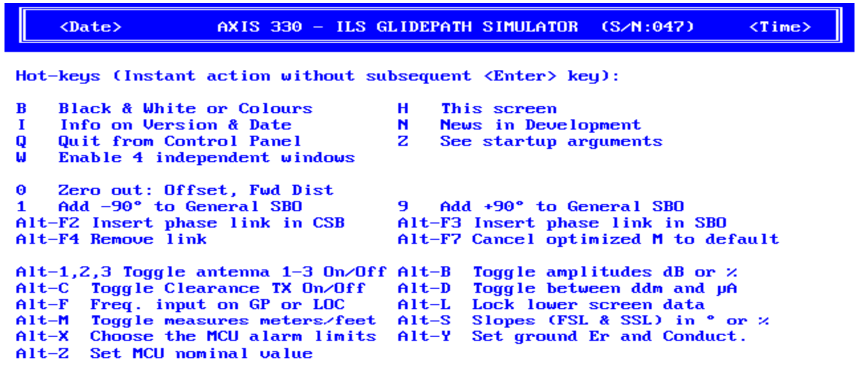

Fig. CPN501 Screen after hotkey <H> is pressed

< I > Info on Version & Date

Hot key <I> shows the program version and date. This info replaces the heading text of the Control Panel.

< N > News in Development

Hot key <N> display the **!A330.NEW** file, which briefly describe the AXIS 330 development phases.

< Q > Quit from Control Panel

Hot key <Q> can be used instead of <Esc> to exit AXIS 330.

< Z > See startup arguments

Hot key <Z> displays the switches (arguments) to be selected at startup.

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:047)     <Time>

Switches for startup AXIS software (User Guide has complete list)

Preceed only first argument with "/"   e.g:  a330 /feet nodate

ACT    - Start AXIS in Active Glide Path mode (Thales)
AIR    - Window seen from the air as default
BLACK  - Remove colours to enable saving of graphic screens
CUT    - Cut the direct signal from the output leaving scatter only
DDM    - Uses %DDM instead of CDI in µA as default
DEMO   - Enables DEMO mode if no user-code is available
FEET   - Antenna heights and distances in feet on Control Panel.
FLIGHT - Flight inspection test mode. Elimin Panel de Control.
LEFT   - GP antenna on FLY-LEFT side as default
NODATE - No date/time on screen or printout
SENSE  - Reverses the up/down sense of the graphic curves
THEO   - Enabling use of tilt-type theodolites on approaches
VOL    - Flight inspection test mode. Control Panel disabled.
```

Fig. CPN502 The screen after hot key Z is pressed.

< 1 > Add -90° to General SBO phase

Hot key <1> adds -90° to the SBO phase of the course transmitter.

< 9 > Add +90° to General SBO phase

Hot key <9> adds +90° to the SBO phase of the course transmitter.

< 0 > Zero out the Offset and Fwd Dist

Hot key <0> will zero out the Offset and FWD dist of all antenna. This hotkey is enabled only if any Offset or FWD dist is highlighted.

<Alt-1,2,3> toggle antenna 1-3 On/Off

Hot key <Alt-1,2,3> toggles antenna 1,2,3 ON / OFF.

<Alt-B> Amplitudes in dB or %.

Hot key <Alt-B> toggles all amplitudes between dB and %.

<Alt-C> Clearance TX On/Off

Hot key <Alt-C> toggles clearance transmitter ON / OFF. It sets the value 20% amplitude in antenna 1 and 3 relative to the CSB in A1.

<Alt-D> Deflections in uA or %

Hot key <D> toggles deflection between CDI uA and %DDM in ADU.

< Alt-F > Freq. input on GP or LOC

Hot key <Alt-F> swaps the GP/LOC frequency as input field on the screen.

< Alt-L > Lock lower screen

Hot key <Alt-L> locks the lower screen if site data (FSL,SSL etc.) should be adjusted without automatic update of antenna location and feeds.

<Alt-M> Measures in meters or feet

Hot key <Alt-M> toggles all measures between meters and feet.

<Alt-S> Slopes in degrees (°) or percentage (%)

Hot key <Alt-S> toggles ground slopes FSL and SSL between ° and %.

<Alt-W> Allows using up to 4 independent Windows in DOSBox

DOSBox can be opened in several windows so different tasks can be run on the same screen. In order to isolate each of them to save the individual run-files on the disc, a number (1-4) is assigned to each window. Only the numbers 2 through 4 are visible on the graphic screen.

<Alt-X> Set the Integral Monitor Alarm Limits

This will open the DATA for the alarm limits for GP, DS and the Clearance signals. The values are preset to ±35µA, ±15µA and ±50µA respectively. When changing a feed parameter on the Control Panel, the Monitor output indicates alarm when the value field turns red.

<Alt-Z> Set the nominal monitor values for the alarm circuit.

After setting up the system to new values, or changing one or more of the monitor angles, the new nominal monitor values must be set. This is only necessary to do if checking the integral alarm limits is part of the simulations.

<Ctrl-7> Reset M-ARRAY to 50180.

Hot key <Ctrl-7> removes any optimized setting of the M-ARRAY and resets to 50% RTS&RTC and 180° PHX, a so-called nominal 50180 setting. This Hot key does not reset any other parameters nor any scattering objects.

6. Main Menu

The program execution comes into the main menu when <Enter> is pressed in the Control Panel.

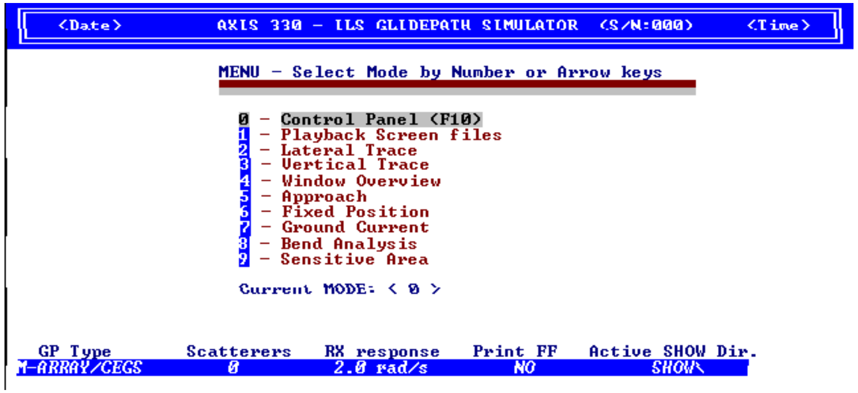

Fig. CPN601 Main Menu of the AXIS 330

Available options are depending on the access level of the user. If you do not have access to the option you can not highlight or use it.

The number between the angle bracket below the menu list shows the current selections.

Current MODE: < 1 >

Press the item number or highlight the item with <Up / Dn> keys and press <Enter> to run a current mode.

Lower part of the main menu screen are shown some settings of the Control Panel as follows:

1. GP type
2. Number of scattering objects
3. Receiver response (rad/s)
4. Printer form feed selection and
5. Type of screen

Here is a summary of the menu selections :

0 - Control Panel (Esc key)

Return to the Control Panel by pressing <0> "zero" or <Esc>

1 -Playback Screen files

The Playback Screen files mode is a slide show. It will replay previously computed and saved screens.

This mode is a useful animation tool for showing the total impact of gradually increasing errors when they are replayed as a movie or comparing nearly identical graphs. See section PLY.

2 - Lateral Trace

The Lateral Trace mode is a simulation of an orbit crossover in the azimuth plane to see the deviation, SBO/CSB amplitudes or RF-phase at a given distance and elevation angle.

See section LAT.

3 - Vertical Trace

The Vertical Trace mode is a simulation of the resulting glide path deviation and amplitudes along a vertical line above given coordinates in the terrain.

This mode can be used to check angle and sectors as well as clearance below and above the full sectors. See section VRT.

4 - Window Overview

The Window Overview mode displays the ISO-deviation lines from 300uA fly up to 225uA fly down in the coverage sectors of the GP system.

The main usage of this mode is diagnostics of erratic symptoms based on flight inspection measurements. See section WND.

5 - Approach

The Approach mode is a Simulation of an approach path at either constant level, ideal hyperbolic line of constant zero deviation or tracked by a theodolite located at the coordinates determined by user.

This mode is useful in the simulation of the scattering objects. If scattering objects are entered, they may show bends and scalloping along the approach. See section APP.

6 - Fixed Position

The Fixed Position mode is a simulation of the resulting deviation and amplitudes in one or two positions while a selected feed parameter is varied between chosen limits.

The main purpose of this mode is to compare the far field and the near field response to possible errors in the antenna system to examine the monitor and the ground check points sensitivity. See section FIX.

7 - Ground Current

The Ground Current mode is a visualization (2D or 3D) of the ground current induced on the reflection plane.

This mode is used to compare the available reflection plane area to the actual system requirements. See section GND.

8 - Bend Analysis

The Bend Analysis mode will analyse the bend wave lengths and their position along the flight path to find the possible origin of the reflection objects as intersections of hyperbolic lines plotted on the ground. See section BND.

9 - Sensitive Area

The Sensitive Area mode will simulate the tailfin of a moving aircraft or any other metallic construction, move it around and optionally rotate it to find the worst-case orientation. The computing result will be shown as the graphic curve of the sensitive area.

This mode is useful for finding the border of the sensitive area. See section SNS.

SET

Setup

Table of Content

1.Description

The Setup utility is called from the Control Panel by <3> key.

The Setup utility consists of three main functions:

1. default setup
2. language selection
3. the user code deletion.

The settings of the default setup is always used whenever the AXIS 330 is started.

Language selection is used to determine the language that is seen in help screens and names of parameters / toggles all around the AXIS 330.

The user code deletion is used for security purposes and for re-entering a new User Code with different access level.

Setup procedure is divided into two parts (actually two screens).

In the first screen (Data Panel) is used to set parameters.

After Data Panel settings you will proceed to the second screen (Command Panel) where you have five commands available (Language, Save, Rename Directories, Delete user code and No Change).

2. Data Panel

The <3> in the Control Panel will start the setup procedure by opening the first screen called Data Panel.

Data Panel configuration items are divided into three groups :

1. Site Data, Extra Signals, GPside and Ant.type
2. Printer, Screen, RX-Filter and Character Settings
3. Colour settings
4. Other settings (cannot be set in this panel)
   - CDI / DDM
   - Meter / Feet
   - Language
   - The Work and Graph directories

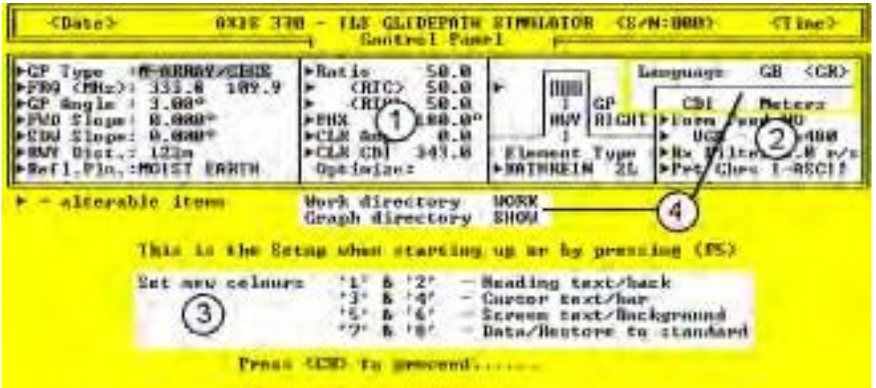

Fig. SET201 The Data Panel of the Setup

3. Data Entry

The small triangles in front of the items indicate that the item may be changed by moving the cursor with the arrow-keys to the desired data field and then using the value stepping keys.

The value stepping keys are :

Increment	Decrement	Factor
<Insert>	<Delete>	0.1
<PgUp>	<PgDn>	1
<ctrl-PgUp>	<ctrl-PgDn>	10

3.1 Site Data, Extra Signals, GPside and Ant.type

The Site Data, Extra Signals, GPside and Ant.type are exactly the same as the in the Control Panel. See details section CPN chapter 3.1. - 3.3

Fig. SET301 Site Data, Extra Signals, GPside and Antenna type settings

3.2 Printer, Screen, RX-Filter and Character Settings

This data group is consisting four settings as follows:

1. Form Feed for the Printer
2. Screen Type
3. Receiver Filter and
4. Character Set

Note: ***These settings can be only made in the Setup Data Panel.***

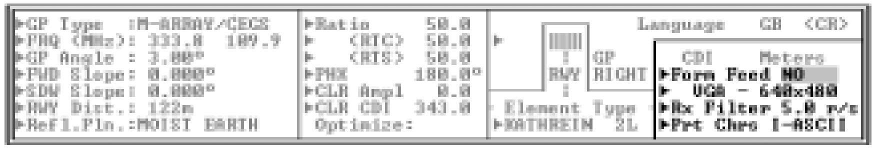

Fig. SET302 Printer, Screen, RX-filter and Character Settings.

3.2.1 Form Feed for Printer

Form Feed :

Form Feed selection has two state NO and YES indicating if the Form Feed Character is sent to the printer after each page.

If graflasr printer driver is used in the GP.BAT file, a Form Feed will automatically be sent and this field should be set to NO otherwise a blank page will be printed out.

3.2.2 Screen Type

The following screen type choices are available:

SCREEN TYPE 0 TEXT MODE	This type does not allow the graph display. *WARNING:*	 *Fatal error will be a result when a graph diagram is started.*
SCREEN TYPE 12 VGA - 640x480	16 colours graphic mode.	

3.2.3 Receiver Filter

RX Filter

The receiver/plotter has a certain time constant that determine the upper frequency limit for outputting fast scalloping. The frequency where the amplitude of the bends has decreased 3dB is called the cutoff frequency. This will be expressed in radians per second (rad/s).

The AXIS 330 simulates a digital low pass filter and the value of the cutoff frequency will affect the bend amplitudes.

In static run modes like Fixed Point and Ground Current where the receiver speed is zero the filter value has no effect.

ICAO Annex 10 attachment C recommends a time constant depending on the speed. More information about the filter is given in appendix A1 chapter 5.

3.2.4 Character Set

Prt Chrs

There are two character sets available for the printer. Normally the international ASCII code is used, but most laser printer use the Roman-8 character set.

To decide this look at the printout with international ASCII (**I-ASCII**) set selected.

If the heading underline is a series of "á" characters and the degree (°) symbol becomes a "½" you should change the character set to Roman-8 to correct the printout.

3.3 Other settings

The default setup will save some other settings that are shown in the Data Panel but cannot be set in this Panel :

1. CDI / DDM selection
2. Meter / Feet selection
3. Language selection
4. Renaming the Work and Graph directories

Fig. SET303 Information of the other default settings.

3.3.1 CDI / DDM Selection

The CDI / DDM selection was set in the Control Panel. If the system has CDI as default and DDM is wanted follow these steps:

1. Toggle from CDI to DDM by <Alt-D> on the Control Panel
2. Go to Setup by the <3> key
3. Proceed to the Setup Command Panel by pressing <enter>
4. Save the setting by the <3> key.

3.3.2 Meters / Feet selection

The Meters / Feet selection was set in the Control Panel. If the system has meters as default and feet is wanted follow these steps:

1. Toggle from meters to feet by <Alt-M> on the Control Panel
2. Go to Setup by the <3> key
3. Proceed to the Setup Command Panel by pressing <enter>
4. Save the setting by the (3) key.

3.3.3 Language selection

The default language is selected in the Command Panel of the Setup.

If another default language is wanted, follow the steps described in para 5.1 in this section.

3.3.4 Renaming the Work and Graph directories

The default directories for working files are "WORK" while for the saved graphic screens it is "SHOW".

If another default directory name is wanted, follow the steps described in para 5.3 in this section.

4. Colour Settings

The colour settings are affecting only in the text screens and the graph diagram colours must be set changing the graph colour file content manually with text editor. The graph colours are coded in the file GP.009. It should be noted that curves are drawn in preset colours so changing colours carelessly the graphic screen can look very strange. For instance, the background colour should not ever be chosen differently from black or white. See details in appendix AX2.

4.1 Change Colours

AXIS 330 is using four different colour pairs (fore/background) for :

- heading
- cursor
- text and
- data value.

Colours are changed by stepping the number-keys and you will see the effect immediately on the screen.

Colour changing number keys are as follows:

1-key	Foreground colour of the heading
2-key	Background colour of the heading
3-key	Foreground colour of the cursor
4-key	Background colour of the cursor
5-key	Foreground colour of the text
6-key	Background colour of the text
7-key	Foreground colour of the data values
8-key	RESTORE all colours to the standard settings
Note:	*Text (5) and Data (7) values have the same background colour.*

4.2 Colours Codes

Colour selection depends on the video adapter of your computer.

For standard colour graphic adapters include the following colour choices:

Fore- and BackGround		*ForeGround only*	
code	colour	code	colour
0	Black	8	Gray
1	Blue	9	Light blue
2	Green	10	Light green
3	Cyan	11	Light cyan
4	Red	12	Light red
5	Magenta	13	Light magenta
6	Brown	14	Yellow
7	White	15	High intensity white

5. Command Panel

When the settings are completed in Data Panel or you like to only delete the User’s Code you will proceed by <enter> key to this screen including four commands.

(2) Language change

(3) Save settings as the default setup

(4) Rename Work/Graph Directories (5) Delete the User Code

<CR> No Change

Fig. SET501 The Command Panel of the Setup utility .

5.1 Language <2>

(2) Language change (GB)

The language selection is based to the language files GP10.nn,GP11.nn and GP12.nn. Where the nn extension represents the country code.

For example gb=Great Britain, n=Norway, s=Sweden etc.

Purpose of three language files are:

GP10.nn Help screens for a scattering object editor

GP11.nn Help screen called from the Control Panel

GP12.nn All modules and functions declaring texts.

The command <2> opens the screen where you can see all the GP10.nn files available.

On the first row you are asked to enter the extension part (=country code) and then press <enter>.

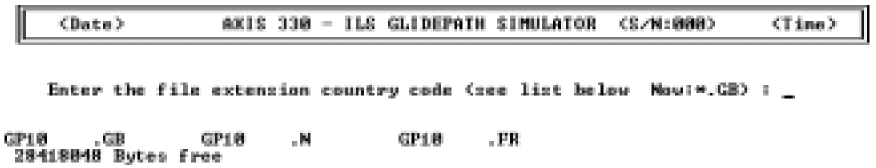

Fig. SET502 The screen for the language selection

If the country code exists you will see your selection in the parenthesis at the end of the "(2) Language change" row. If you do not want to change the language just press <enter>.

NOTE: Remember to press <3> to save the selection.

5.2 Save <3>

(3) SAVE this as the Default setup

The <3> will save the configuration permanently into the file GP.002 as the new Default Setup and the program will return to the Control Panel with the new configuration settings.

5.3 Rename default directories <4>

(4) Rename WORK/SHOW Default Directories

Use <4> to enter new names for the "WORK" and "SHOW" directories. When using another language than English, other names may look better for the users. If "WORK" is renamed, you should move the content of "WORK" into the "NEW" one to ease finding all earlier used files.

To change name follow these steps:

1. Open the renaming panel by the <4> key. The existing directory names are shown in parenthesis.
2. Type new name(s) (max 5 characters) and <enter> or press just <enter> to keep a name.
   Note: Longer directory name(s) than five characters is truncated.
3. Setup Data Panel appears - Proceed to the Command Panel by pressing <enter>
4. Save the setting by the <3> key.

Fig. SCA503 The directories renaming

5.4 Delete User's Code <5>

(5) Delete User Code

The <5> will clear the GP.001 file that contains the user code.

This will disable the usage of the AXIS 330 software.

Before doing the deletion the AXIS 330 will ask

"Are you sure Y/N ?".

By pressing the <Y> key the deletion will take place and the AXIS 330 execution will be halted. Any other key will return the program to the Control Panel.

The user's code deletion will prevent others from using the software as well as enabling you to enter a new User Code if you are given a new access level.

Note: Use this before entering a new user code with higher access, as this is the only way of preparing for re-entering the user code.

5.5 Save current Run/Toggle settings

(6) Save current Run/Toggle settings

This will keep most of the current settings you have in the run modes as starting distance, increment, graph scale etc. It will also save some of the toggle settings like graph direction etc. Whenever the software is started, these values will be the default.

5.6 Delete Run/Toggle settings

(7) Delete Run/Toggle settings

This will cancel the saving done by (6), and the software will start up with its own default values.

5.7 Cancel

<CR> No Change

The <Enter> choice will cancel all changes and the program returns to the Control Panel without any change.

UTL

Utilities

Table of Content

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5.Optimizing

This routine can be used only for optimizing the M-ARRAY.

Optimizing the GP means to suppress the SBO and CSB illumination towards a reflection object or discontinuities in the reflecting plane to reduce the occurring bends created by the reflected signals.

By adjusting the antenna feeds slightly, the M-ARRAY can be adjusted so that the radiation or ground current will cease in a certain location without affecting the signals at the GP angle and the sectors.

5.1 Optimizing type selection

When the "Optimize" is selected by the <5> key in the utility selection panel the optimizing routine will start, and the user is asked to select the type of optimizing.

There are two types available:

1. Terrain Illumination cancellation (Top) for a terrain object that generates bends to the GP signals
2. Ground Current limitation (Ground) for a truncation or a discontinuity of the reflection plane.

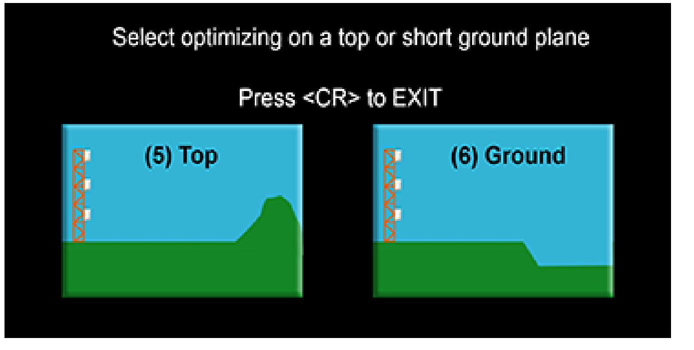


Fig. UTL501 Screen for optimizing type selection

5.2 (T)errain illumination cancellation <5>

Certain objects in the area in front of the GP system, might have surfaces, sizes and locations causing SBO and CSB signals to be reflected into the GP approach sector. These reflections will cause bends and scalloping on the glide path structure, making automatic landings difficult or disturbing for the pilots.

The M-array T-optimizing process will set up the feeds in the antenna system so the SBO and CSB radiation towards a given coordinate is close to Zero.

If more than one object is present, the selected coordinate might be on the most significant reflection object or simply somewhere between them. The signal illumination will be low in a large volume around the optimizing point.

A null illumination line will be stretch sideways in both direction from the optimiz-ing point.

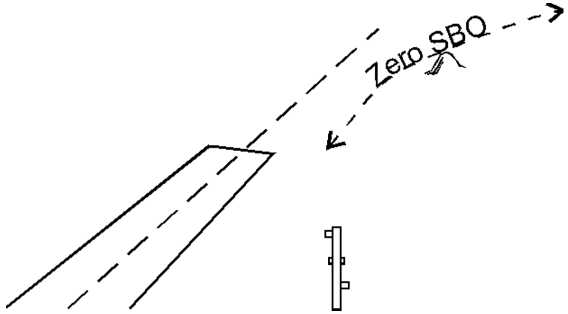


Fig. UTL502 Null illumination line for optimized M-ARRAY

The exact position of this line is depending on the lateral offset of the GP antennas.

5.2.1 Data Entry

Forward Distance

The forward distance is the longitudinal distance between the GP mast and the midpoint of the object measured along the centreline.

Note: If the entered distance is zero the entry is cancelled.

Fig. UTL503 Display for entering the forward distance of the object

Sideways Distance

The sideways distance is the lateral distance between the GP-centreline and midpoint of the object. Use negative values towards runway regardless of if it is on the right-hand or left-hand side of the GP antenna.

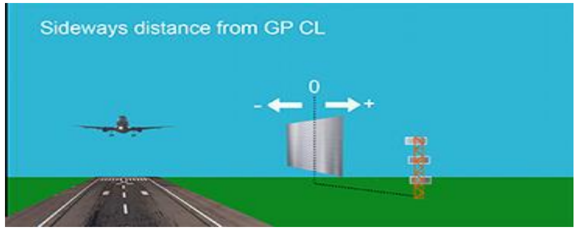


Fig. UTL504 Display for entering the sideways distance of the object.

Height Above GP zero

The height of the scattering object above GP zero can be entered in meters or as vertical angle. Use the <2> key to toggle between the meter and the angle entry mode.

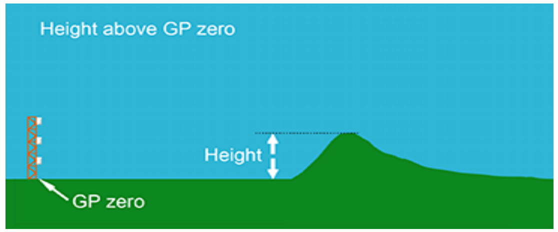


Fig. UTL505 Display for entering the height above GP-zero.

5.3 (G)round Current reduction <6>

If the reflection plane has a discontinuity in front of the GP antenna, the ground current will also get a discontinuity, causing diffracted signal to be radiated.

During the optimizing process the AXIS 330 will first compute the feeds in the antenna system so that the ground current will cease at a defined location on the reflection plane.

It is not necessary that the ground current drops to zero at this point, so the feeds are modified to a better practical value by reducing the RT to a lower value RTr :

$$RTr = 50 + 2(RT-50)/3 \qquad \text{(formula UTL-01)}$$

The RTr values will be set on the system and shown on the Control Panel.

5.3.1 Data Entry

Forward Distance from GP

The forward distance is the longitudinal distance between the midpoint of the ground edge and the GP mast measured along the GP-centreline.

Note: If the entered distance is zero the entry is cancelled.

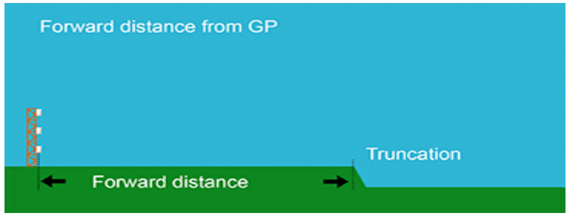


Fig. UTL506 Display for entering the forward distance of the ground edge.

Sideways Distance

The sideways distance is the lateral distance between the GP-centreline and the reference point on the edge (normally zero). Use negative values towards runway regardless of it is to the right-hand or left-hand side of the GP antenna.

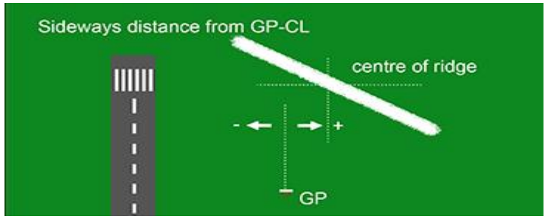


Fig. UTL507 Display for entering the sideways distance of the object.

5.4 Another method to reduce SBO ground current

Another method of reducing the SBO ground current on the reflection plane is simply to dephase the SBO signal in the upper antenna (A3) in positive direction. The impact of advancing the phase of A3 by 10 to 20° will be a significant reduction in the ground current, and hence less diffracted signals from edges in the terrain. There are no automatic routines for this method in the AXIS 330, so the user must follow good old cut and tries to find a good setting. The first step will usually be to set SBO A3 to 190° and thereafter run the AXIS 330 for a Ground Current, an Approach and a Window to check the result.

However, a side effect to this dephasing will be residual SBO signal along the glide path by a corresponding lowered GP angle. Also FLY UP signal will vary very much in different azimuth angles at low elevation angles. ALWAYS check this clearance by running a Window Overview.

5.5 Example

In front of the GP system is a hill with a large metal shelter on top of it. The distance to the shelter is 1000m in front of the GP mast, 60m towards the run-way and the height is 10m above the GP-zero point. Reflection Factor is estimat-ed to 0.2.

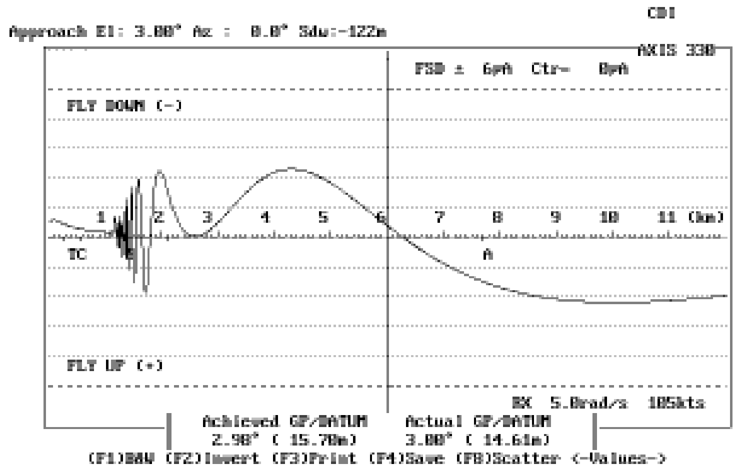


Fig. UTL508 M-array bends from the metal shelter located 1000m in front, -60m to the side and 10m high.

To do the T-type optimizing will improve the signal quality

Beginning from the Control Panel use the following steps :

1. Select Utilities by <4>
2. Select from Utilities selection panel <5> Optimize feeds
3. Select Terrain Top optimizing by <5>
4. Enter the optimizing point
   - FWD distance = 1000m
   - SDW distance = -60m
   - Height Above GP-zero = 10m

After last entry the software will return to the Control Panel and the optimization result is shown. The amplitude ratio RT is changed 52.6 and the phase PHX to 185.3°. The feeds are now already set to these values as can be seen on the Control Panel.

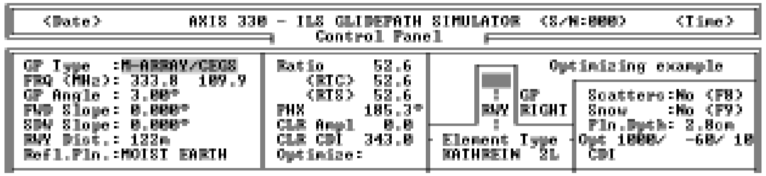


Fig. UTL509 The Control Panel shows the optimized setting

The resulting approach on the GP will now give a very straight structure with very little bends,

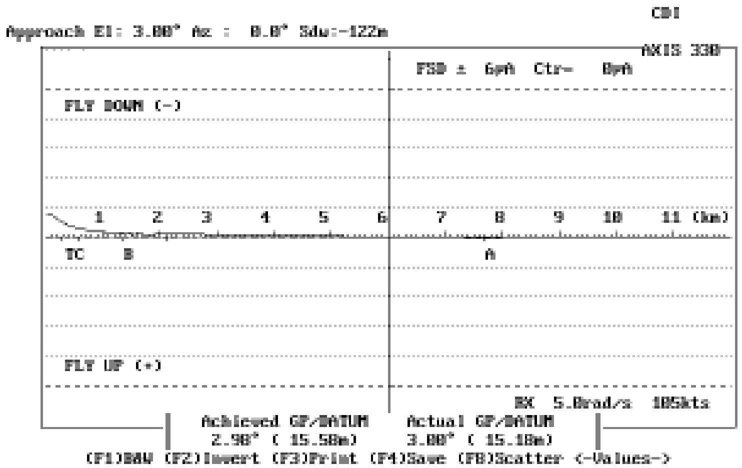


Fig. UTL510 The bends after optimizing

The signals in the immediate sectors above and below the GP angle will not be affected by this optimization. Depending on the lateral offset, the window diagram might be tilted sideways, but normally within acceptable limits.

Run the Window mode to check it.

SCA

Scattering Object Editor

Table of Contents

1. Description

The scattering objects simulates adverse environment like limited reflection plane, high hills, buildings and metal constructions that will most likely cause bends on the glidepath signals due to reflections or diffractions of the GP signals into the approach sector.

The scattering object editor is invoked by the <8> key enabling to insert, view or modify the simulated scattering objects. Additionally, it allows to optimize the antenna feeds according to the selected scattering object.

There are five types of the scattering objects available in the AXIS 330:

1. walls of buildings and aircraft tailfins (Sheet)
2. power and telephone lines (Wire)
3. earth walls (Ridge)
4. hills (Top)
5. discontinuity of the reflection plane (Ground).

The AXIS 330 can handle up to sixteen simultaneous objects.

If there are already objects entered in the system, the scattering object editor will show a list of the present objects allowing to see and to modify any of these. If there are no objects in the system, the editor will proceed automatically to the object data entry point.

2. Data Entry

There are different number of parameters for each scattering object.

During data entry each parameter will be displayed with a simple drawing as a guide. The default value of the parameter is shown inside angle brackets.

To keep this value just press <Enter> otherwise enter a different value and press <Enter> to proceed to the next data entry.

Note: All entries can be edited afterwards.

2.1 Type of the scattering object

The AXIS 330 simulates five types of scattering objects.

The selection of scatter type is made by <2> through <6>. All other keys will return the program execution to the point, where the scattering object was called.
There are five types of the scattering objects as follows:

1. (2)Sheet — a rectangular sheet simulating walls of buildings, constructions or aircraft tailfins etc.
2. (3)Wire — a wire section simulating power or telephone lines
3. (4)Ridge — a ridge simulating an earth wall or a long stretched hill
4. (5)Top — a semispheric terrain object simulating hills or any other limited sized object
5. (6)Ground — a ground truncation simulating a discontinuity of the reflection plane.

Note: Only one ground truncation (6) can be entered and this MUST be entered as the first object. From the second object this (6) option will disappear from the list.

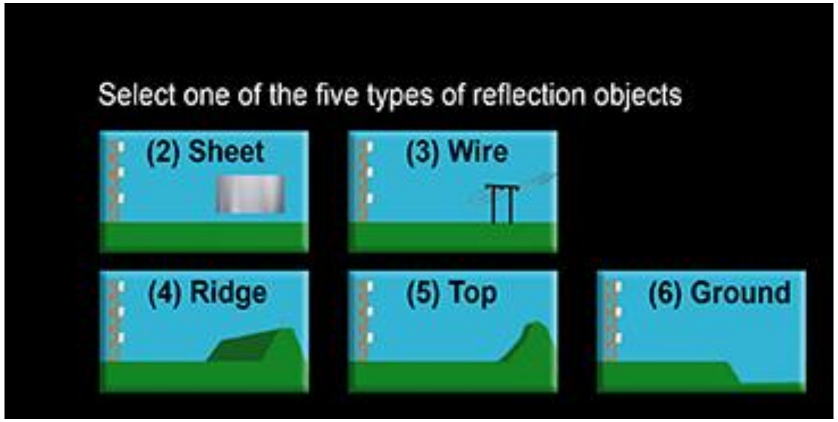


Fig. SCA201 Display for selecting type of the scattering object.

2.2 Sheet

The scattering type "Sheet" is used to simulate walls of buildings, constructions or aircraft tailfins etc.

2.2.1 Forward Distance (Fwd)

The forward distance is the longitudinal distance from the GP mast to the midpoint of the object measured along the GP-centreline.

NOTE: If the entered distance is zero the entry is cancelled.

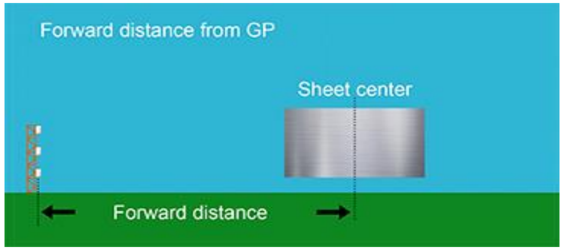


Fig. SCA202 Display for entering the forward distance of the sheet

2.2.2 Sideways Distance (Sdw)

The sideways distance is the lateral distance from the GP-centreline to the midpoint of the object. Use negative values towards runway regardless if it is to the right-hand or left-hand side of the GP antenna.

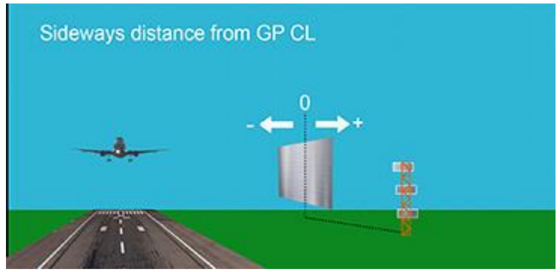


Fig. SCA203 Display for entering the sideways distance.

2.2.3 Size of the sheet

The size of the sheet can be entered in two ways :

1. Entering Length, Height and Bottom height or
2. Loading the sheet from the SCATT.EN file. A

load mode is selected by pressing <2>.

2.2.3.1 Length, Height, Bottom Height

Length (Lgt)

The default value of the length is 10 m for the sheet.

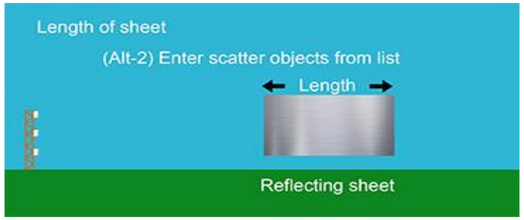


Fig. SCA204 Display for entering the length of the scattering sheet or selecting a load mode from SCATT.EN by <2>.

Height (Hgt)

The default height is 10 m for the sheet.

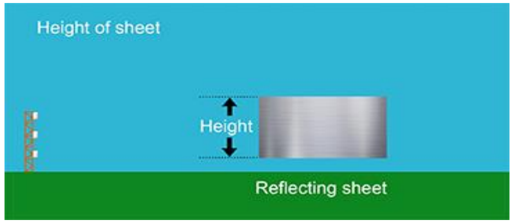


Fig. SCA205 Display for entering the height of the reflecting object.

Height of the sheet bottom (Hgt-II)

The bottom height of the scattering object. Default value is zero, meaning the object stays on the ground. In case of simulating the aircraft tailfins or the beam of a building crane the sheet should be lifted from the ground by setting the bottom height accordingly.

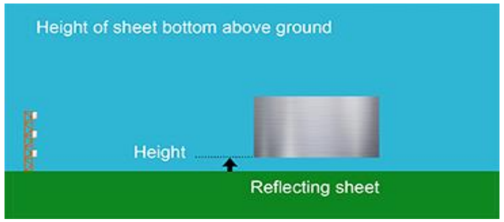


Fig. SCA206 Display for entering the bottom height of the object

Note: *Btm-Hgt cannot be set to a lower value than zero meaning the object base is on the ground.*

2.2.3.2 Sheet size from the SCATT.EN file

After <2> is pressed, the screen shows a scattering object from the file SCATT.EN. By using <PgUp> and <PgDn> keys you can scroll the objects of the file. When the desired object is shown just press <Enter>.

Note: *A SCATT file may have a different extension according to the language selection (SCATT.EN, SCATT.NO, SCATT.FR etc).*

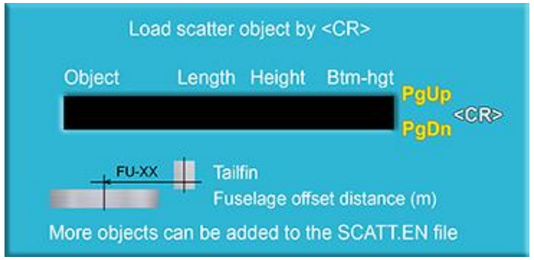


Fig. SCA207 Display for the loading the scatter object from the file scatt.en.

Note that the FU-xx value is the offset distance of the fuselage relative to the tailfin. Load the tailfin and the fuselage and use the (8) key to move them together as an aircraft model.

2.2.4 Rotation Angle (Rot)

The rotation angle of the scattering object is the horizontal angle between the object and the GP-centreline. The clockwise rotation is entered as a positive value and the negative value represents the counterclockwise rotation.

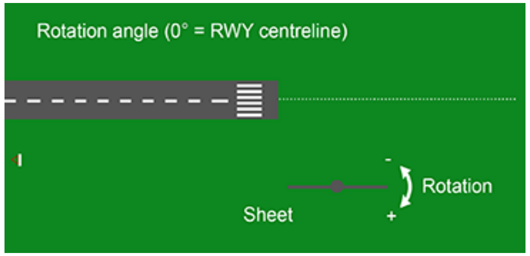


Fig. SCA208 Display for entering the rotation angle of the sheet.

2.2.5 Tilt angle of the sheet (Tilt)

The tilt angle of the scattering sheet is the vertical angle between the object and the perpendicular to the ground. The clockwise tilt as seen from the GP mast is entered as a positive value while the negative value represents the counterc l o c k w i s e tilt.

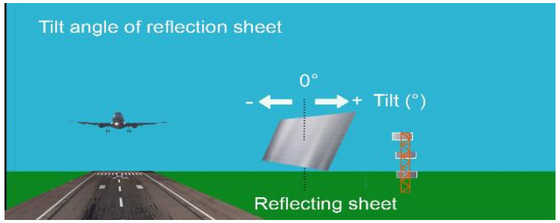


Fig. SCA209 Display for entering the tilt angle of the sheet.

2.2.6 Reflection Factor (Rfl)

The reflection factor is the ratio between incident and reflected rf-signal. The value of the factor is depending on the material of the object. Generally, the better conductivity and smoothness of the material the higher factor should be used.

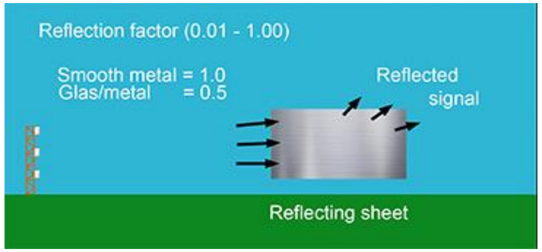


Fig. SCA210 Display for entering the reflection factor.

A metallic grid with mesh width smaller than 0.1 wave lengths (9cm) can be considered to be a continuous surface. For wider grid or uneven surfaces made of concrete or glass, the reflection factor could be set 0.5 ... 0.1.

2.3 Wire section (W)

This scattering type is used to simulate power or telephone lines.

2.3.1 Forward Distance (Fwd)

The forward distance is the longitudinal distance between the midpoint of the wire section and the GP mast measured along the GP-centreline.

NOTE: If the entered distance is zero the entry is cancelled.

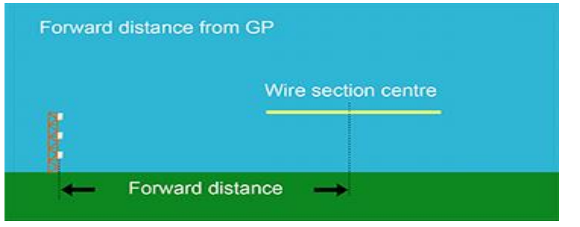


Fig. SCA211 Display for entering the forward distance of the wire

2.3.2 Sideways Distance (Sdw)

The sideways distance is the lateral distance between the midpoint of the wire section and the GP-centreline. Use negative values towards runway regardless if it is to the right-hand or left-hand side of the GP antenna.

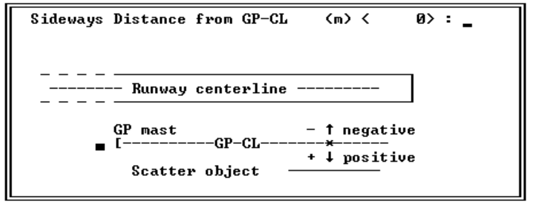


Fig. SCA212 Display for entering the sideways distance of the wire.

2.2.4 Length of the wire section (Lgt)

The default value of the length is 100m.

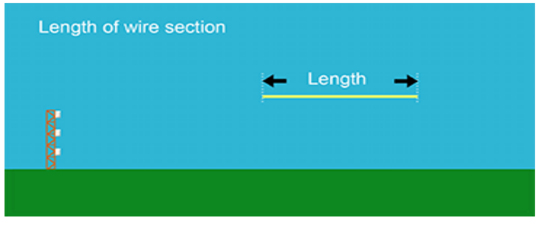


Fig. SCA213 Display for entering the length of the scattering wire.

2.2.5 Diameter of each wire (d)

The default diameter is 0.01m (=1cm).

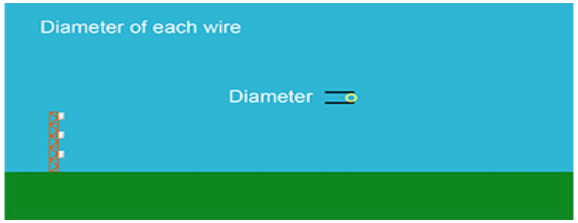


Fig. SCA214 Display for entering the diameter of each wire.

2.2.6 Height of the wire above the ground (Hgt-II)

Default value is 10 m.

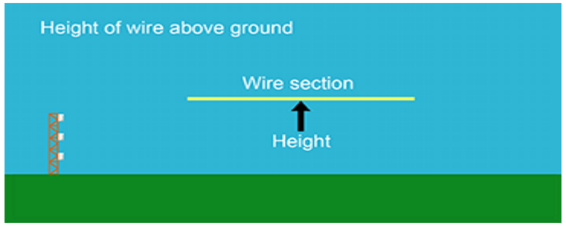


Fig. SCA215 Display for entering the bottom height of the wire.

NOTE: Hgt-II cannot be set to a lower value than zero meaning the wire is on the ground.

2.2.7 Rotation Angle (Rot)

The rotation angle of the scattering object is the horizontal angle between the object and the GP-centreline. The clockwise rotation is entered as a positive value and the negative value represents the counterclockwise rotation.

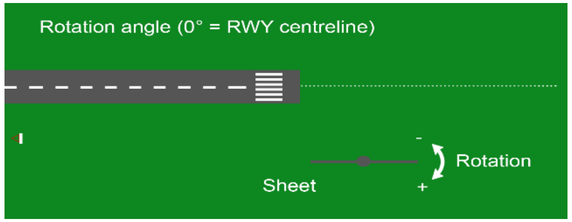


Fig. SCA216 Display for entering the rotation angle of the wire

2.2.8 Number of single wires (#)

The default value is 1.

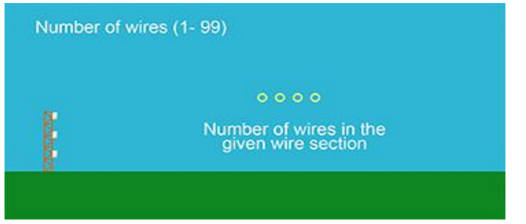


Fig. SCA217 Display for entering the number of wires

2.2.9 Reflection Factor (Rfl)

The reflection factor is the ratio between incident and reflected rf-signal. The factor depends on the material of the object. Generally the better conductivity and smoothness of the material the higher factor should be used.

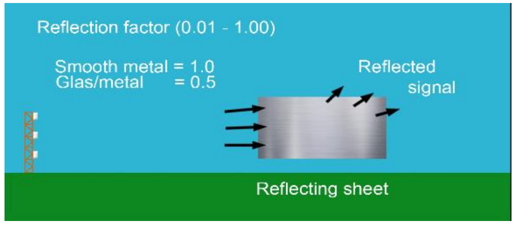


Fig. SCA218 Display for entering the reflection factor

The reflection factor of the wire is set typically between 0.5 ... 1.0.

2.4 Ridge

This type of scattering object is used to simulate earth walls or long stretched hills.

2.4.1 Forward Distance (Fwd)

The forward distance is the longitudinal distance between the midpoint of the ridge and the GP mast measured along the centreline.

NOTE: If the entered distance is zero the entry is cancelled.

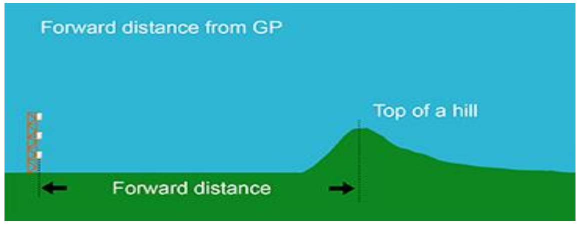


Fig. SCA219 Display for entering the forward distance of the ridge

2.4.2 Sideways Distance (Sdw)

The sideways distance is the lateral distance between the midpoint of the ridge and the GP-centreline. Use negative values towards runway regardless if it is to the right-hand or left-hand side of the GP antenna.

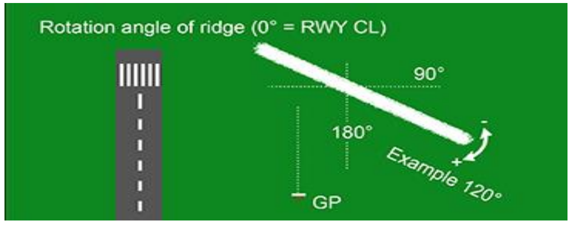


Fig. SCA220 Display for entering the sideways distance of the ridge.

2.4.3 Length of the ridge (Lgt)

The default value of the length is 100m.

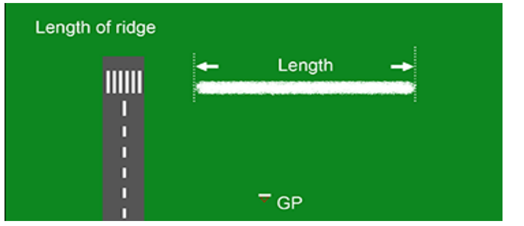


Fig. SCA221 Display for entering the length of the ridge.

2.4.4 Angle of edge front (Rot)

The rotation angle of the scattering object is the horizontal angle between the truncation line and the GP-centreline. The clockwise rotation is entered as a positive value and the negative value represents the counter clockwise rotation.

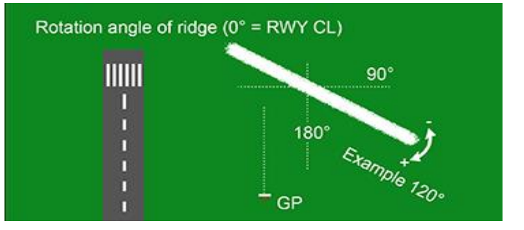


Fig. SCA222 Display for entering the rotation angle of the ridge

2.4.5 Height above GP Zero (Hgt)

The height of the scattering object relative to the GP zero can be entered in meters or vertical angle.
Press <2> to change the entry mode.
The default height is 10 m.

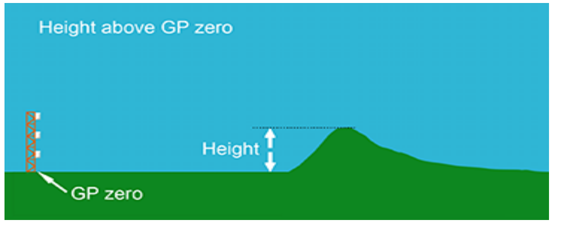


Fig. SCA223 Display for entering the height of the ridge.

2.4.6 Reflection Factor (Rfl)

The reflection factor is the ratio between incident and reflected rf-signal. The factor depends on the material of the object. Generally the better conductivity and smoothness of the material the higher factor should be used.

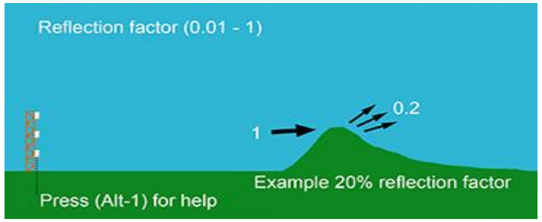


Fig. SCA224 Display for entering the reflection factor

The following table (1) gives a very rough indication of practical values.

Reflection factor (kr) @ Object width x height:

Small metal constructions, cars	.01
Small wooden shelters	.01
Small hill 10 x 5m w/vegetation	.03
Small hill 10 x 5m smooth surface	.05
Metal object 10 x 5m	.06
Medium hill 50 x 15m w/vegetation	.10
Medium hill 50 x 15m smooth surface	.15
Large hill 100 x 30m smooth surface	.20
Large hangar 100 x 30m smooth surface	.30

Fig. SCA225 Help screen for the reflection factor

2.4.7 Height above second plane (Hgt-II)

The height above a secondary reflection plane beyond the object.
The default value is zero, which means a very rough surface unable to reflect signals.

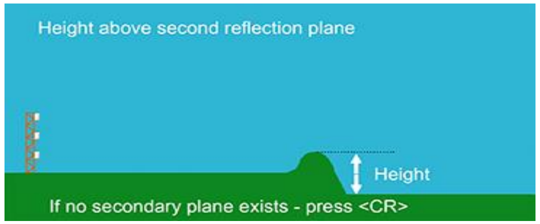


Fig. SCA226 Display for entering the height of the second plane

Note: *If there are no secondary plane beyond the object enter zero or just press <Enter>.*

2.5 Top

The scattering type Top is simulating a semispheric terrain object and is used to simulate hills or any other limited size object

2.5.1 Forward Distance (Fwd)

The forward distance is the longitudinal distance between the midpoint of the object and the GP mast measured along the centreline.

Note: If the entered distance is zero the entry is cancelled.

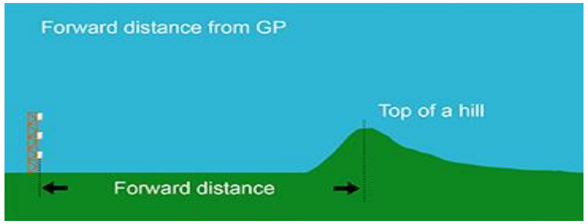


Fig. SCA227 Display for entering the forward distance of the object

2.5.2 Sideways Distance (Sdw)

The sideways distance is the lateral distance between the midpoint of the object and the GP-centreline. Use negative values towards runway regardless if it is to the right-hand or left-hand side of the GP antenna.

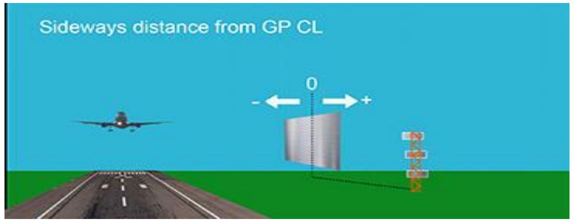


Fig. SCA228 Display for entering the sideways distance of the object.

2.5.3 Height above GP Zero (Hgt)

The height of the scattering object above GP zero can be entered in meters or vertical angles.
Press <2> to change the entry mode.
The default height is 10 m.

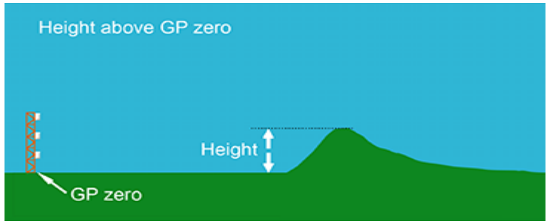


Fig. SCA229 Display for entering the height above GP-zero.

2.5.4 Reflection Factor (Rfl)

The reflection factor is the ratio between incident and reflected rf-signal. The factor depends on the material of the object. Generally the better conductivity and smoothness of the material the higher factor should be used.

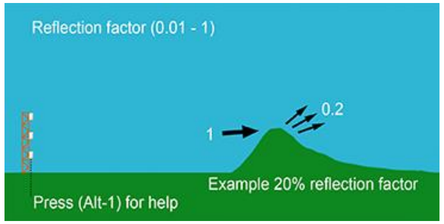


Fig. SCA230 Display for entering the reflection factor

Use the following table (1) as a guide for practical values.

Reflection factor (kr) @ Object width x height:

Small metal constructions, cars	.01
Small wooden shelters	.01
Small hill 10 x 5m w/vegetation	.03
Small hill 10 x 5m smooth surface	.05
Metal object 10 x 5m	.06
Medium hill 50 x 15m w/vegetation	.10
Medium hill 50 x 15m smooth surface	.15
Large hill 100 x 30m smooth surface	.20
Large hangar 100 x 30m smooth surface	.30

Fig. SCA231 Help screen for the reflection factor

2.5.5 Height above second plane (Hgt-II)

The height above a secondary reflection plane beyond the object.
The default value is zero, which means a very rough surface unable to reflect signals.

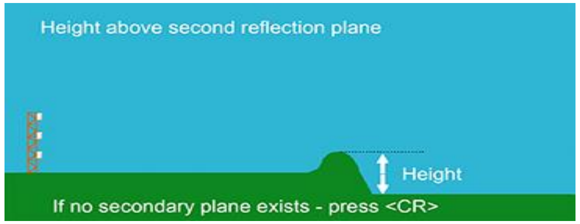


Fig. SCA232 Display for entering the height of the second plane

Note: *If there are no secondary plane beyond the object enter zero or just press <Enter>.*

2.6 Ground

The ground truncation is simulating a discontinuity of the reflection plane.

2.6.1 Forward Distance (Fwd)

The forward distance is the longitudinal distance between the midpoint of the ground edge and the GP mast measured along the GP-centreline. The minimum distance to the edge should not be less than 200m in order to avoid near field errors in the UTD calculations.

NOTE: If the entered distance is zero the entry is cancelled.

Fig. SCA233 Display for entering the forward distance of the ground edge.

2.6.2 Angle of edge front (Rot)

The rotation angle of the ground edge is the horizontal angle between the edge line and the line which is perpendicular to GP-centreline. The clockwise rotation is entered as a positive value and the negative value represents the counterclockwise rotation.

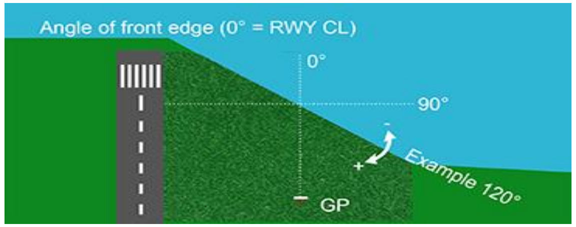


Fig. SCA234 Display for entering the rotation angle of the ground edge

2.6.3 Height above second plane (Hgt-II)

The height above a secondary reflection plane beyond the object.
The default value is zero, which means a very rough surface unable to reflect signals.

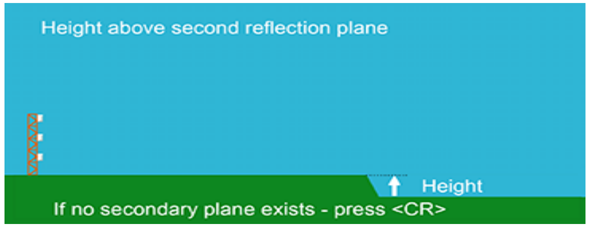


Fig. SCA235 Display for entering the height of the second plane

Note: *If there are no secondary plane beyond the object enter zero or just press <Enter>.*

3. Editing Objects

If there are object(s) in the system a list of the present objects will be displayed. At the bottom are shown the editor commands.

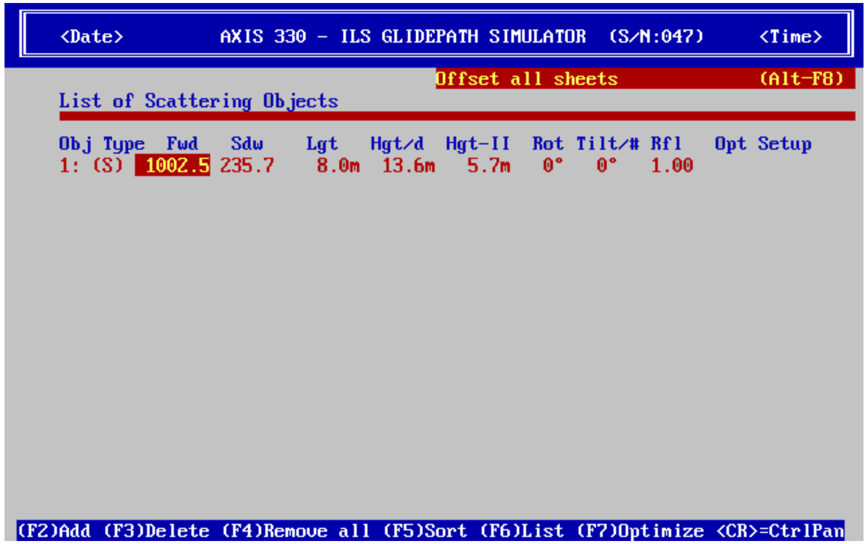


Fig. SCA301 The screen of the Scattering Object Editor.

3.1 Modify Data

To modify any data of the object, use the arrow keys to highlight the data and use <PgUp>,<PgDn> or <Ins>,<Del> keys to change the value of the data in the same way as in the Control Panel.

3.2 Commands

There are eight commands for handling the list of the object.

1. (2) Add add a new object
2. (1) Copy copy the highlighted object.
3. (3) Delete erase one object (highlighted)
4. (4) Remove remove all objects
5. (5) Sort sort the objects
6. (6) List to compute optimize setting
7. (7) Optimize set optimizing
8. (8) Offset sheets offset all sheets together in x, y, z coordinates
9. <CR> CTRL Panel exit

3.2.1 (2) Add

Add command is used to add one more scattering object. When this command is executed the program jumps to the data entry as described earlier.

3.2.2 (1) Copy

Copy command is used to copy the highlighted scattering object. This is a quick way to add another similar object to the model. After copying, adjust the necessary parameters such as forward and sideways distances and then Sort the objects (5) in the end.

3.2.3 (3) Delete

Delete command is used to delete one object from the present object list. Before executing this command move the cursor up or down to the row that will be deleted. Then hit the <3> key and the line will be deleted.

Note: After deletion there is no fast way to restore the object.

3.2.4 (4) Remove all

Remove command will remove ALL OBJECTS without WARNING.

3.2.5 (5) Sort

Sort command is used to put the present object list in the forward distance order.

NOTE: Sorting is done automatically when entering the scattering object.

3.2.6 (6) List

List-command is used to calculate optimized settings for all objects. Settings can be seen in the same row as the object.

```
<Date>         AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

                                       Offset all sheets            <Alt-F8>
List of Scattering Objects

Obj Type   Fwd     Sdw    Lgt    Hgt/d  Hgt-II   Rot Tilt/# Rfl    Opt Setup
1: <S>    300m    100m  10.0m   10.0m    0.0m    0°   0°   1.00   98.9/281.2°
2: <W>    500m    100m 100.0m 0.010m   10.0m    0° 5 wire 1.00   68.9/226.4°
3: <R>    700m    100m 100.0m    3.0m    5.0m   90° ---    0.10   59.5/210.4°
4: <T>    800m    100m  ----    30.0m   30.0m ---   ---    0.20   93.0/143.0°
5: <G>    900m      0m  ----     0.0m -----   100° ---    1.00   51.0/192.5°




<F2>Add <F3>Delete <F4>Remove all <F5>Sort <F6>List <F7>Optimize <CR>=CtrlPan
```

Fig. SCA302 Optimized settings after (6)List command.

3.2.7 (7) Optimize

Optimize command is used to set antenna feeds so that the highlighted scattering object will give a minimum bends on the glide path.

Note: Optimizing is done only for the highlighted scattering object.

3.2.8 (8) Offset all sheets together

Offset sheets is used when several sheets are brought together to simulate a complex shaped object like the airplane simulated in the file (B747TAX.). Simply type the offset distance in x (fwd), Y (sdw) and z (hgt) and press <enter>.

See a faster method using the keys Alt-U/I, Alt-H/K and Alt-B/N in page SCA-22 .

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

Offset all sheets                                 (X:    0m Y:    0m Z:   0m)

Forwards   (m) <    0> : 1
Sideways   (m) <    0> : 2
Upwards    (m) <    0> : 3
```

Fig. SCA303 The offset entry screen

The offset values will be added to the distances given to the objects. Rotation or tilt is not possible as common adjustment. That must be done individually to each object. Offset will only effect S (Sheets) and (W) wire section. Objects of G (Ground), R (Ridge) and T (Top) will remain in their original positions.

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>
          Offset all sheets              (Alt-F8) X:     1m Y:     2m Z:    3m
List of Scattering Objects

Obj Type  Fwd     Sdw     Lgt    Hgt/d   Hgt-II   Rot  Tilt/#  Rfl     Opt Setup
1: (S)    300m    100m   10.0m    10.0m    0.0m    0°    0°    1.00
2: (W)    500m    100m  100.0m  0.010m   10.0m    0°  5 wire  1.00
3: (R)    700m    100m  100.0m     3.0m    5.0m   90°  ---     0.10
4: (T)    800m    100m  ----      30.0m   30.0m  ---   ---     0.20
5: (G)    900m      0m  ----       0.0m  -----  100°  ---     1.00
```

Fig. SCA304 The screen after entered x=1m, y=2m and z=3m

Note: <8> can be used directly from the Graph Command keys so one may offset sheets directly after computed a graph.

3.2.9 <CR> CTRL Panel

Pressing the <Enter> key it will terminate the editor and the AXIS 330 will return to the location where it was activated.

4. Modeling a tailfin

In order to model a tailfin, a tapered one, into a rectangular plate, a few things should be concidered.

The incoming signal strength increases along the height of the tailfin due to the lobing of the horizontal polarized ILS signal.

The scattered field at the upper part of the tailfin will yield lower lobes than the rest of the fin, radiating a stronger field in low elevation angles.

This creates a double effect, where the received scattered field at low angles will increase with the tailfin height in the power of between 2 and 3. It is therefore more important to emulate the upper part of the tailfin than the lower part.

The plate model (sheet) should therefore be made according to figure SCA401. The plate model should have the same height as the tailfin, but the width should be determined at about 2/3 of the tailfin height.

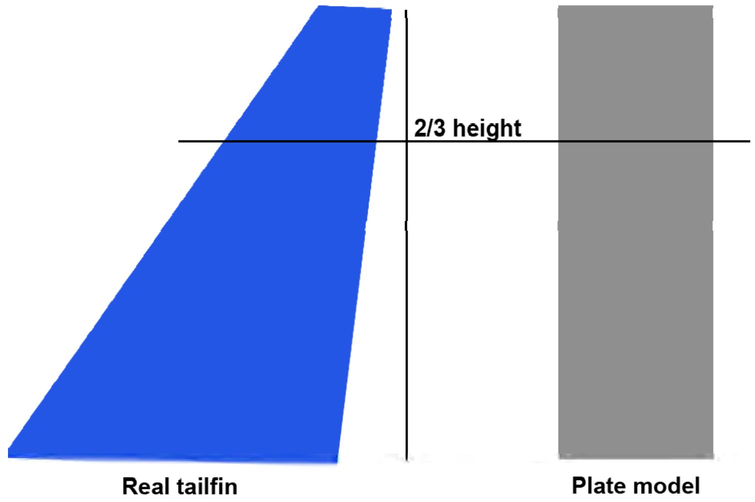


Fig. SCA401The plate model compared to the real tailfin.

4.1.1 (8) Offset all sheets together

A quick way to move combined sheets is using the

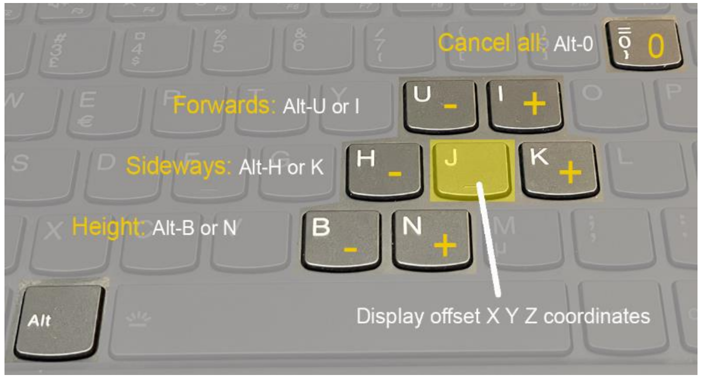


Fig. The keystrokes to be used for moving combined sheets or wires together.

Holding the Alt key:

- U and I will shift the position in forward direction.
- H and K will shift the position in sideways direction
- B and N will shift the height
- J will display the offset X Y Z coordinates

Alt-0 (zero) will cancel the offset.

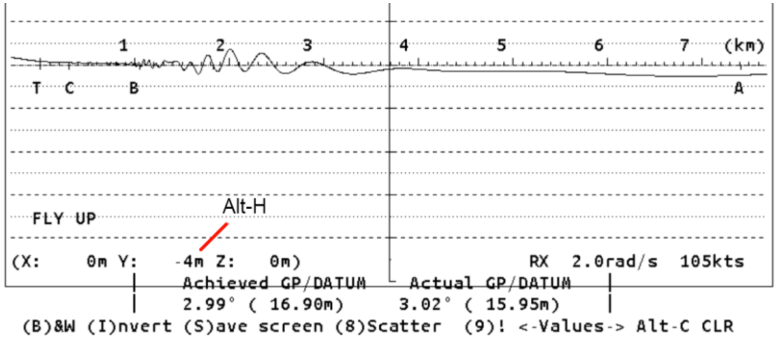


Fig. Every Alt-H shifts the object(s) sideways -1 meter (closer to the runway) and is shown on the screen.

PLY

Playback Screen files

Table of Content

1.Description

Playback Screen files option is used to show previously computed and saved graph screens in Black & White.

After a number of graphic screens have been saved on the disk, they can be seen like a slide show by this Playback option.

By computing and saving several screens with increasing change in a feed or mechanical parameter, one gets a useful animation tool for showing the total impact of gradually increasing errors when they are replayed as a movie. It can also be used to show the difference between two or more very close looking graphs to compare the impact of a new parameter. Use the PgUp/PgDn keys to switch between the graphs.

When the graphic screen is selected Black & White, the <4> Save function is enabled allowing to save the screen as a file on the disk to the selected directory. The files will be named AXG0.BAS, AXG1.BAS, AXG2.BAS etc. automatically. The default directory is "SHOW\".

When the playback is started by the "<2> Show" command, all screen files of the selected directory will be played back in the same order as saved. The show will repeat displaying the screen files from the first to the last one until any key is hit.

2. Command Screen

Before starting the Playback Screen Show you may select another directory for the screen files.

Note: *The chosen directory remains selected as long as you run the AXIS 330 and all saved graphic screens will be saved to this directory.*

There are eight commands available in the Command Screen of the Playback Screen files :

1. PgUp/PgDn Show directory quick selection
2. <2>Show Start show
3. <4>Delete all Screen files deletion
4. <5>New directory Set your own show directory
5. <6>To DOS Not in use
6. <7>Description Write your own directory label
7. <8>Make directory Make a new directory
8. <CR>Return Exit

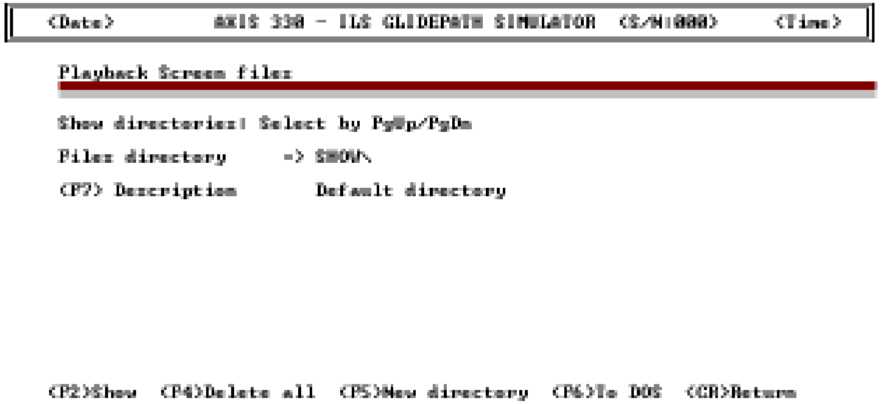


Fig. PLY201 Playback Screen files command screen

2.1 Show directory quick selection

Show directories: PgUp/PgDn

Using the keys <PgUp> and <PgDn> can scroll directories from SHOW\ and SHOW1\ through SHOW50\.

If the selected directory does not exist a warning will ask you to create it by pressing the <8> key.

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

Playback Screen files

Show directories: Select by PgUp/PgDn
Files directory      => SHOW4\
<F7> Description       This directory does not exist - <F8> to make

<F2>Show  <F4>Delete all  <F5>New directory  <F6>To DOS  <CR>Return
```

Fig. PLY202 The selected directory does not exist

2.2 Starting show

(2) Show

When a directory is selected the show can be started by the <2> key. If the first screen file (AXG0.BAS) does not exist in the selected directory, the user is warned of "No Files" and the AXIS 330 will return to the Main menu.

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

Files directory  : SHOW5\
No screen files available...

hit any key ...
```

Fig. PLY203 There are no screen files in the selected directory

2.3 Screen files deletion

(4)Delete all

This command is used to delete all screen files and the directory label in the selected directory. Before deletion the directory content is displayed and the AXIS 330 will ask

Are you sure (Y/N) ?

Pressing the <Y> key the deletion will take place. Any other key will return the program to the Main menu.

Note: This command will delete only the screen files and labels for the AXIS 330 (AXGnn.BAS).

Fig. PLY204 Deletion of the screen files

2.4 Set your own show directory

(5) New directory

This command is use to select the user's screen files directory.

The user is asked to enter a name of directory as follows

Enter new directory <CR>=Default ->

Type the name of your directory and press <Enter>. If just <Enter> is pressed the AXIS 330 will set the default screen files directory as "SHOW\".

Note: If the directory does not exist, it can be created by the <8> key.

2.5.Go to DOS

This function is not in use

2.6 Make a directory label

(7) Description

Any directory may have an optional label containing a 21 character description of the saved files. This could be a specific airport name or anything that will remain the user of the content. The label text can be changed anytime by using the <7> key and typing the new text. This label will be deleted if all files are deleted by the <4> key.

2.7 Make a new show directory

(8) Make directory

When a non existing directory name has been selected, a warning will be shown. Use the (8) key to create this directory. If not created the directory name will automatically be set to "SHOW\".

2.8 Exit

<CR>Return

Press <Enter> to return to the Main menu.

3. Speed Control of the slide show

While the slide show is running you can adjust the speed by using the - or + keys. On the left hand side of the screen you can see ± sign which is as a simple speed-gauge. The higher the position, the faster the speed. Default speed is maximum so the ± sign is shown in the highest position.

Any other key will freeze the display and at the bottom of screen will appear the help row.

In the freezed state you can

- look at each screen by stepping the <PgUp> or <PgDn> keys
- invert the screen by the <2> key for screen capture etc.
- quit the playback show by the <Esc> key.

Any other key will continue the show.

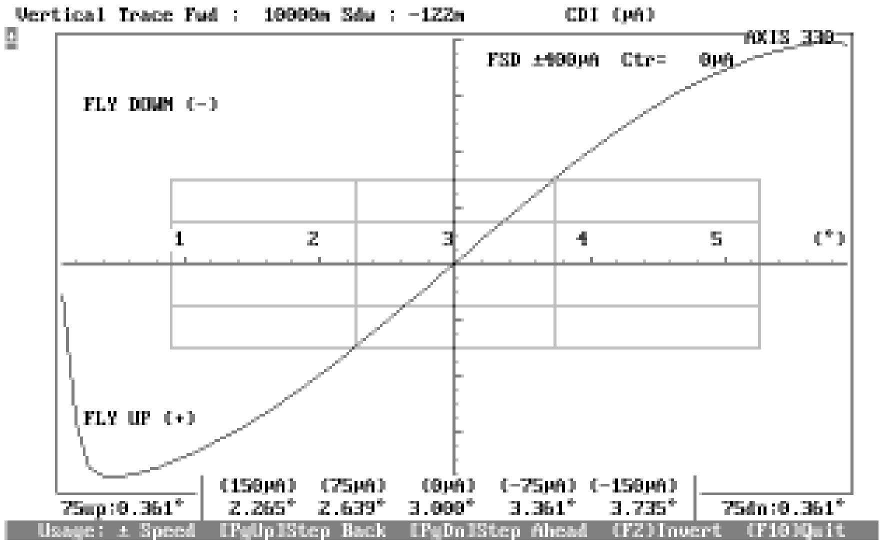


Fig. PLY301 The screen with help row at the bottom when the slide show is stopped.

LAT

Lateral Trace Mode

Table of Content

1. Description

The Lateral Trace Mode simulates a circular movement in a given sector across the course line at a defined distance from the antenna system.

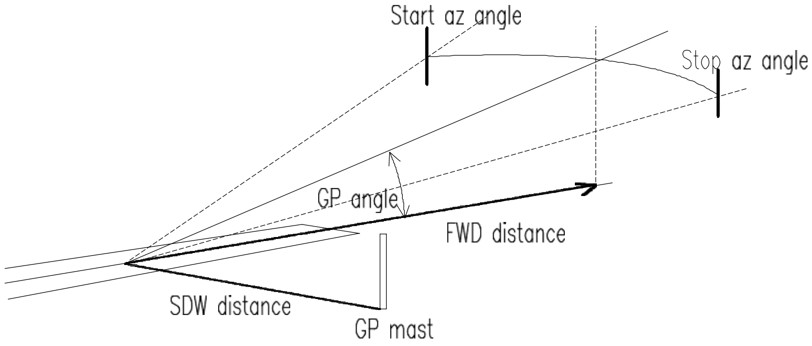


Fig. LAT101 The Lateral Trace mode

With the Lateral Trace Mode you can study different parameters like CDI (or DDM), SBO and CSB amplitude and phases as well as the Beam Bend Potential.

Upto six separate runs at user selected distances and arc centers can be done on each graph.

2.Data Screen

The Data Screen is divided into three main parts

1. the table of numeric data
2. the toggle panel
3. the command row

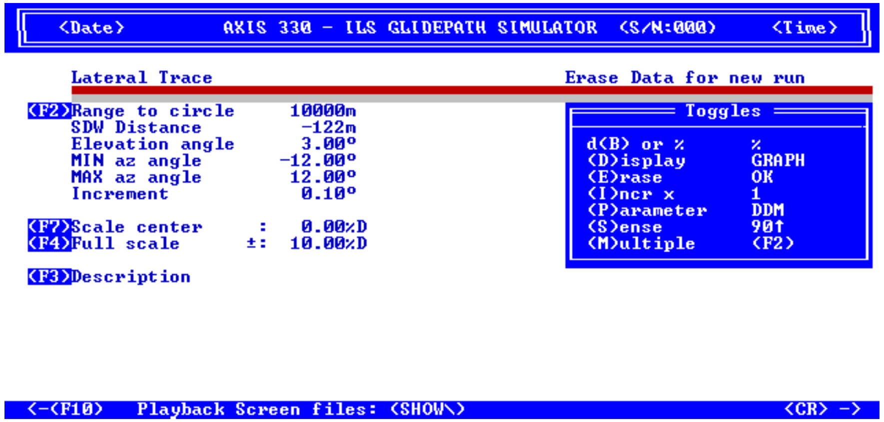


Fig. LAT201 The Data Screen of the Lateral Trace Mode

2.1 Table of Numeric data (1)

The numeric data shows the values to be used in the computation. The numeric data can be changed by the (2)change command.

Here is a brief description of the table of numeric data:

Range to circle	Orbit radius from the Runway Point of Intersection (RPI)
SDW Distance	Sideways distance from GP zero
Elevation angle	The selected elevation angle
MIN az angle	The start azimuth angle
MAX az angle	The stop azimuth angle
Increment	The step or increment angle along the orbit.
Scale Center	The graph display center in uA or %ddm.
Full Scale	The graph display full display in ±uA or %ddm.
Description	The text line displayed on the graph screen

Note: The Scale Center and Full Scale are seen only when the (D)isplay toggle is selected as a GRAPH.

2.2 Toggle panel (2)

The toggles are used to make some quick selections and include the settings for the output form of the computation.

The toggle panel includes the following toggles:

(A)mplitude	Selection between % and dB
(D)isplay	Selection between graph and table
(E)rase	Selection between old and new data
(I)ncr x	Selection for the step increment resolution
(P)arameter	Selection for the displayed parameter in graphic
(S)ense	Selection of the direction of the Y-axis (FU/FD) in graphic
(M)ultiple	Selection for multi-radius orbits

2.3 Command row (3)

The command row include commands for data entry and software control

(2) Change	Activate the numeric data entry
(3) Text	Entry for the text line to be shown on the graph
(4) FSD	Entry for the Y-scale setting (Full Scale Deflection).
(6)Excel	Enables an Excel readable file to be generated *Note: This command is seen and enabled only when the (D)isplay toggle is selected for TABL.*
(Esc)Menu	Return to main menu
<CR>Continue	Starts the lateral trace computation.

3. The Data entry

The data entry is started by the (2)Change command. It allows changing one or more items.

The present value is always shown between angle brackets. Enter new value from the keyboard or press <enter> to keep the present value.

In the title row is shown a calculated position of the course line monitor.

```
 <Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

Lateral Trace

Range to circle     (m)  <   10000> :      (F2)Multiple runs
SDW Distance        (m)  <    -122> :      [±8°=± 1405m] <-Twds RWY>

Elevation angle     (°)     <      3> :
MIN az angle        (°)      <   -12> :
MAX az angle        (°)      <    12> :
Increment           (°)      < 0.10> :

Graph Scale Centerline (uA) <    0> :

Description
Enter new Text      Tekst for figures_    |
```

Fig. LAT301 Data Entry for lateral trace.

3.1 The range to circle

FWD Dist. (m) < 10000>: (2) Multiple runs

The range of circle represents the radius of orbit where the center point lies on the line perpendicular to the runway through the GP mast.

This mode allows upto 6 orbit at user-specified distances and center points.

The default value is one run in the distance of 10000m (~6NM) and center point on the runway center. If multiple orbit is wanted press <2>, enter the number of runs and the range (radius) and center offset of each run.

```
 <Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

Lateral Trace

Range to circle     (m)  <   10000> :      (F2)Multiple runs

Number of runs   (1 - 6)                < 1> : 3
Range to circle     (m)  <    10000> :
SDW Distance        (m)  <     -122> :

Range to circle     (m)  <    10000> : 1000
SDW Distance        (m)  <     -122> : -61

Range to circle     (m)  <     1000> : 500
SDW Distance        (m)  <      -61> : 0_
```

Fig. LAT302 Data Entry for multiple range of orbit.

3.2 Sideways Distance

SDW Distance <-122> : (-Twds RWY)

The sideways distance represents the lateral distance from the GP-centreline to the orbit center.

Note: The negative sign means the distance is measured towards the runway from the GP-antenna. The positive value shows the distance away from the runway.

3.3 Elevation angle

Elevation angle (°) < 3> :

The elevation angle seen from the orbit center (RPI) referred to the horizontal.

3.4 Start angle

Min AZ angle (°) <-12>:

The start angle of the orbit is called minimum azimuth angle and measured from the orbit center in degrees. The default value is -12°.

3.5 Stop angle

Max AZ angle (°) < 12>:

The stop angle of the orbit run is called maximum azimuth angle is measured from the orbit center in degrees. The default value is 12°.

3.6 Angle step

Increment (°) <0.10>:

The angle step is an angle-increments to be used in the calculations. The default value is 0.5 °.

Note: Also the <I> key in the toggle panel can be used to shorten the increment. The toggle <I> does not effect to this setting but only the calculation.

3.7 Graphic Centreline

Graph Scale Centreline (uA) < 0>:

The center axis of the graph might be offset to the average deviation value at the approach azimuth angle in order to zoom in on the curve.

Note: The graph full scale deflection (FSD) is selected by <4> command.

3.8 Description text

Description nnnnnnnnnnnnnnnnnnn

Enter new Text _ |

Type the new text (max 21 characters) that should go along with the graph or just press <Enter> to leave the present text.

Note: Any longer text than 21 characters will be truncated.

4.Toggles

The toggles allow quick changes to some of the often used settings. Press the key shown between the brackets to execute the function. If the language is not English, the text and the letter within brackets should be different and the command will respond to the new letter.

4.1 d(B) or %

Toggles the amplitude scale between % and dB.

% linear scale

dB logarithmic scale, 10 dB/div

Note: *The effect of this toggle is only seen in the amplitude parameters such as CSB, SBO etc.*

4.2 (D)isplay

Selection for the display-mode of the computed results.

GRAPH graphical output
TABL table output

4.3 (E)rase

Selection for erasing the earlier computed data.

OK the data in the memory has been erased and a new curve may now be computed
DATA the memory still contains the latest result, and the curve may be displayed again with altered toggle settings.

4.4 (I)ncr x

Reduce the increment to ½ of the current one in order to increase the resolution in case there are short bends on the curve.

1 Increment is same as set in table of numeric data
½ Increment is divided by two representing double resolution

4.5 (P)arameter

This toggle is used to select a parameter for graphic,

CDI/DDM the deviation in uA CDI or % DDM. The parameter depends on the hot key <Alt-D> selection in the Control Panel.
Ampl the CSB and SBO curve together
CSB the CSB amplitude
SBO the SBO amplitude
bbp the Beam Bend Potential with 100% as a full scale
BBP the magnified Beam Bend Potential with 10% as a full scale
Phase the Phase of SBO/CSB

4.6 (S)ense

Selection for the sense direction in CDI graphic.

90î	Fly Down is in the upper part of the graphic
90|	Fly Down is in the lower part of the graphic

4.7 (M)ultiple

This toggle is used to select single or multi trace output.

(2)	there is only one FWD distance entered. Use (2) to make more
NO	there are more FWD distances entered but only the first one is displayed. Press <M> to switch to "YES"
YES	all entered FWD distances of the traces will be displayed. Press <M> to switch to "NO"

5. Commands

5.1 (2) Change

The Change command is used to modify the values of the numeric data used in the computation. See chapter 3. Data Entry of this section.

5.2 (3) Text

Quick command to enter text (description) into the graph. See 3.7 of this section.

5.3 (4) FSD

Graph Full Scale Deflection

[FSD: (±) 800, 400, 200, 100, 50, 25, 12, 6 (uA)]

Default value is ±50uA (±400uA in Level Run) on the full vertical scale, but can be changed to any of the indicated values. Move the cursor with the Left-Right arrow keys and press <CR>.

5.4 (6) Excel

Note: This command is only shown and enabled when the Display-toggle is selected as a TABL.

With this command you can generate an Excel readable file.

When the <6> is pressed the AXIS 330 ask the name of the file as follows:

Current file name 'DATA.XL' <CR> or enter new:

The default name is 'DATA.XL' . Type a new name or just press <Enter> to keep the default name. The name must be according to the DOS specification otherwise it will be truncated (name = 8 letters and extension = 3 letters).

After the file name is entered this command will be shown as a filename between angle brackets. To disable this function press <6> again and the original command text (6)Excel is displayed.

5.5 (Esc) Menu

Function key <Esc> returns the program execution into the main menu.

5.6 Continue <CR>

Starts the lateral trace mode run.

6. Table display

If the (D)isplay toggle is selected as a TABL the computed results will be shown as a list of the parameter values. This will also enable an Excel readable file to be saved on the disk if the (6) command key is pressed.

Before the execution of the list it is asked if the user wants to take the results to the printer.

Hardcopy of Results ? (y) or <SPACE>

Enter Y (or another letter if the language is not English) for printing out.

The display will stop while the screen is full and the user is asked to hit any key to continue.

That will be repeated as long as the all computed results are shown.

The list includes the following parameters:

(x)	Aximuth angle from the GP zero in degrees
CDI	Course deviation in uA or (%DDM)
CSB	Course CSB-amplitude
SBO	Course SBO-amplitude
Phase	Course Phase between CSB and SBO

<Date> AXIS 330 - ILS GLIDEPATH SIMULATOR (S/N:000) <Time>

(x)	CDI(µA)	CSB	SBO	Phase
-6.90	-13.23	176.0	5.37	255
-6.85	-13.05	176.3	5.34	255
-6.80	-12.87	176.6	5.31	255
-6.75	-12.69	176.9	5.28	255
-6.70	-12.51	177.1	5.25	255
-6.65	-12.34	177.4	5.22	255
-6.60	-12.16	177.7	5.20	255
-6.55	-11.99	177.9	5.17	256
-6.50	-11.82	178.2	5.14	256
-6.45	-11.64	178.4	5.11	256
-6.40	-11.47	178.7	5.08	256
-6.35	-11.30	179.0	5.05	256
-6.30	-11.14	179.2	5.02	256
-6.25	-10.97	179.5	4.99	256
-6.20	-10.80	179.7	4.96	256
-6.15	-10.64	180.0	4.93	256
-6.10	-10.48	180.2	4.90	257

hit any key ...

Fig. LAT601 The typical screen for table display results of the lateral trace mode

7.Graphic Display

When the (D)isplay-toggle is selected as a GRAF the computed results will be shown as a graphic diagram.

7.1 Graphic Diagram

The graphic diagram includes all information that is set in data panel.

Additionally on the bottom row there are six functions available for handling or examining of the graph results.

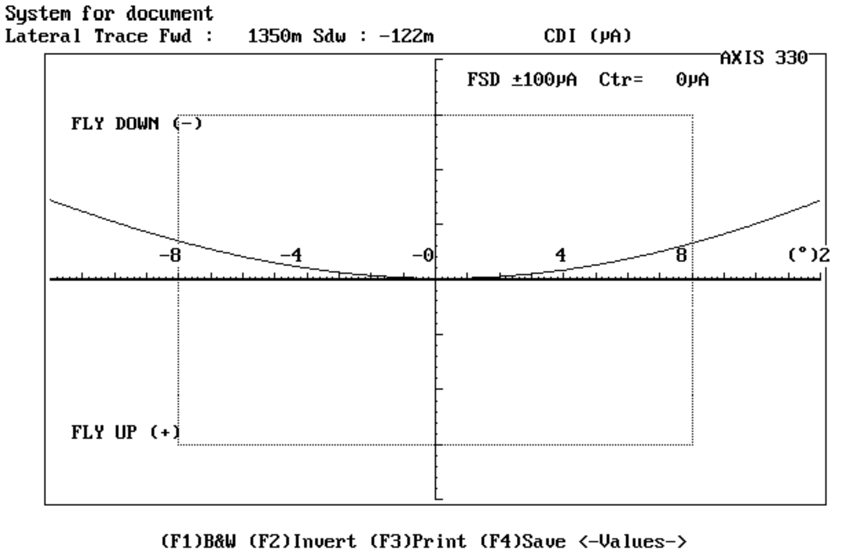


Fig. LAT701 The typical graphic diagram for the CDI parameter.

At the bottom of the graph, the distance (range) and lateral offset of the center point of the arc are shown.

An interesting feature of the graphs is showing bend patterns from a scattering object in the lateral direction. This shows that bends occur in all directions, also in the lateral direction. When flying down a rough glide path along the localiser course line, deviations of the aircrafts path from the localiser will often cause the glide path recording to look different from a track made exactly along the localiser course line.
This is one of the reasons why it is very difficult to get repetitive runs look similar. The more exact the aircraft can be flown, the more similar the curves will be. This effect can not be compensated by the theodolite differential compensation as the bend patterns are different in all directions in the space.

7.2 Functions

The functions of the graphic display are

(B)&W	Black & White to Colour Selector
(2) Invert Display	invert the colours for cut & paste purposes
(4) Save	Save a B&W graph for later play back
<-Values->	Curve Tracer

7.2.1 (B)lack & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

7.2.2 (I) Display Inverter

(I)nvert

This function will invert the colours of the display. In the colour display the colours will be changed to their complementary-ones.

7.2.3 (3) Printout

This function is obsolete and no longer in use.

7.2.4 (4) Graph Saver

(4)Save

Note: *This function is enabled and displayed only when the screen is selected as black & white.*

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

7.2.5 Curve Tracer

<- Values ->

This function is used to show the exact value along the curves. The point on the curve is shown with a small square (called cursor) and can be moved by using the <Left> or <Right> arrow keys. Pressing the arrow key the cursor will move along the curve while the value of the selected parameter and the distance will be displayed in the upper left hand part of the graphic screen.

With <Left> and <Right> arrows the cursor is moving with one computed step increment (selected in data panel) while holding the <Ctrl> key, the steps will be 10 times larger.

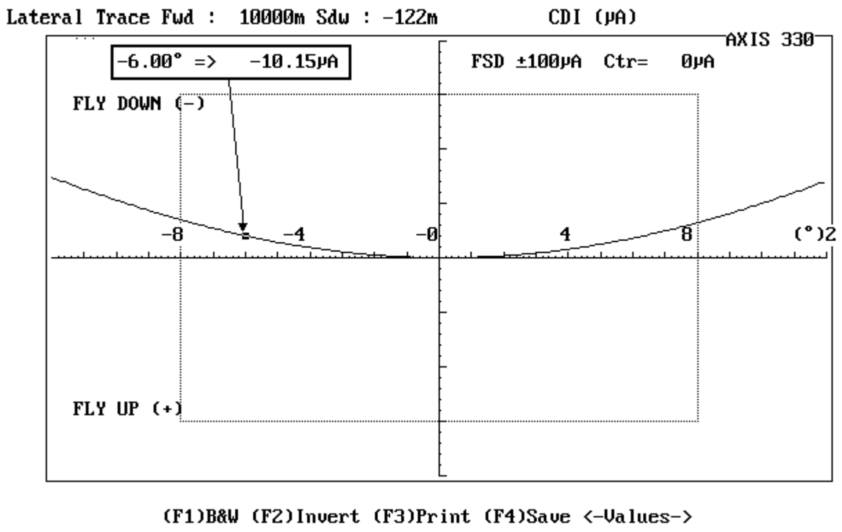


Fig. LAT702 Azimuth angle and parameter reading of the cursor location.

VRT

Vertical Trace Mode

Table of Content

1. Description

The Vertical Trace Mode simulates a vertical movement above a defined point on the ground.

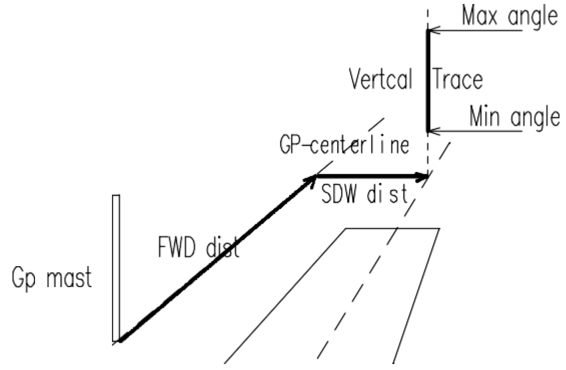


Fig. VRT101 Vertical Trace Mode

The software needs to know the x-y coordinates (FWD- and SDW-distance) on the ground location where the trace take place.

For the trace inputs it needs the minimum and maximum angles as well as the increment angle to step. These angles are measured from the foot of the GP mast so called GP-zero point.

This simulation is useful for checking angle and sectors as well as clearance below and above the full sectors. The display can be a table, 2-Dimensional or 3-Dimensional graphic diagram. The graphics shows the Deviation, SBO-, CSB-amplitudes and SBO/CSB phase. After a 2D vertical trace, the theoretical Glide-path angle and sectors are computed.

The 3D graphs are identical to the 2D graph while showing 13 curves side by side in different azimuth angles from -12° to +12° making a curtain-like grid diagram. This will give an instant view of the sideways coverage of CDI and carrier field strength in required ±8° azimuth coverage sector.

2. Data Panel

The data panel shows the values to be used in the vertical trace mode computation.

The data panel is divided into three main parts

1. the table of numeric data,
2. the toggle panel
3. the command row.

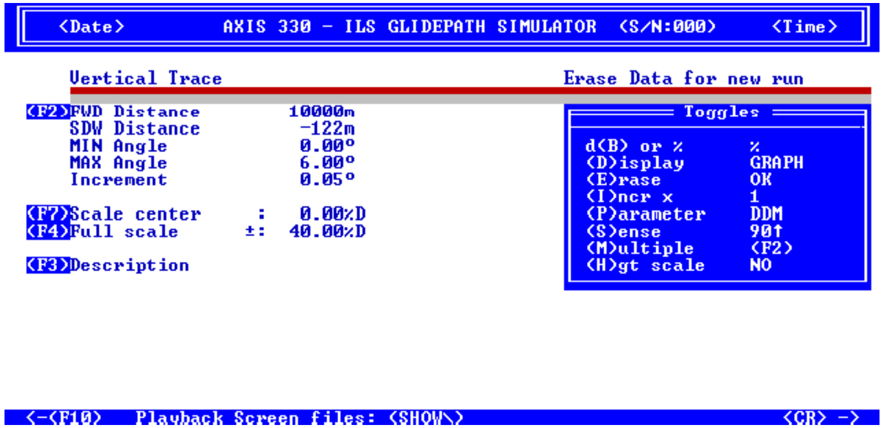


Fig. VRT201. The data panel of the vertical trace mode

2.1 Table of Numeric data (1)

The numeric data shows the values to be used in the computation. The numeric data can be changed by the (2) change command.

Here is a brief description of the table of numeric data:

FWD Distance	A forward distance from GP-zero point to the trace
SDW Distance	The sideways distance from GP-centreline to the trace
MIN Angle	The start angle of the trace
MAX Angle	The stop angle of the trace
Increment	The step angle along the trace
Receiver speed	The speed of the receiver for low pass filtering
Scale center	The offset of the center axis of the graph
Full Scale	The graph full scale deflection
Description	The text added into the graph

2.2 Toggle Panel (2)

The toggles are used to make some quick selections.

The toggle panel includes the following toggles:

(A)mplitude	Select logarithmic dB or linear % vertical scale
(D)isplay	Selection between graph and table
(E)rase	Selection between new and old computed curve
(I)ncr x	A reduction factor of the increment step 1/2 or 1/4.
(P)arameter	Selects the displayed parameter CDI, CSB, SBO, BBP or phase
(S)ense	The direction of the Y-axis of the graph 90Hz up or down
(M)ultiple	For more than one curve on the graph
(H)gt scale	Make an additional elevation scale in meters

2.3 Command row (3)

The row of the commands includes the commands, which start the function or control the program execution.

(2) Change	Change one or more data items
(3) Text	Enter text line to be displayed with the graph.
(4) FSD	Change the Y-scale (Full Scale Deflection).
(6) Excel	Enable an Excel readable file. *Note: this command is shown only when the Display toggle is selected for Table.*
(Esc) Menu	Return to menu
<CR> Continue.	Starts the computation.

3. Data Entry

The numeric data are entered by the <2> command allowing to change one or more items.

The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

In the title row is shown a calculated position of the course line monitor.

```
 <Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

 Vertical Trace        [Monitor Fwd : 81.48  Sdw :  0.00  Hgt :  4.27m]

 FWD Distance        (m)  <   10000> :     <F2>Multiple runs
 SDW Distance        (m)  <    -122> :     <F2>Multiple runs
                                           [±8°=± 1405m] <-Twds RWY>
 MIN Angle           (°)     < 0.10> :
 MAX Angle           (°)     < 5.90> :
 Increment           (°)     < 0.10> :

 Graph Scale Centerline (uA) <    0> :

 Description
 Enter new Text      Text to follow model |
```

Fig. VRT301 Numeric data entries

3.1 Forward Distance

FWD Distance < 10000 >: (2)Multiple

Forward distance represents the longitudinal distance from the GP zero to the trace, measured along a GP-centreline.

Pressing <2> enables running upto 6 runs at user specified distances.

First enter the number of traces and then the longitudinal and lateral distances for each run. As seen below, previous values are default <in brackets> for sub-sequent runs.

```
 <Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

 Vertical Trace        [Monitor Fwd : 81.48  Sdw :  0.00  Hgt :  4.27m]

 FWD Distance        (m)  <   10000> :     <F2>Multiple runs

 Number of runs  (1 - 6)               < 1> : 3
 FWD Distance        (m)  <    10000> :
 SDW Distance        (m)  <     -122> :

 FWD Distance        (m)  <    10000> : 1000
 SDW Distance        (m)  <     -122> : -60

 FWD Distance        (m)  <     1000> : 500
 SDW Distance        (m)  <      -60> : 0
```

Fig. VRT302 Data entry for multiple run

3.2 Sideways Distance

`SDW Distance   < -122 >:`

Sideways distance represents the lateral distance from the GP-centreline to the trace.

Note: *The negative sign means the distance is measured towards the runway from the GP-antenna. The positive value shows the distance away from the runway.*

3.3 Minimum Angle

`MIN Angle (°)    < 0.10>`

The Minimum Angle is the start angle of the trace, measured from the GP zero point in degrees.

3.4 Maximum Angle

`MAX Angle    (°) <  5.90>:`

The Maximum Angle is the stop angle of the trace, measured from the GP zero point in degrees.

3.5 Increment

`Increment Step  (°)   <  0.10>:`

The Increment Step is a angle increment to be used in the calculations.

Note: *Also the <I> key in the toggle panel can be used to shorten the increment. ½ or even ¼. The toggle <I> does not effect to this setting but only the calculation.*

3.6 Graphic Centreline

`Graph Scale Centreline  (uA) <  0>:`

The center axis of the graph might be offset to the average deviation value at the approach azimuth angle in order to increase the resolution.

Note: The graph full scale deflection (FSD) is selected by <4> command.

3.7 Description text

`Description    nnnnnnnnnnnnnnnnnnnn`

`Enter new Text _                    |`

Type the new text (max 21 characters) that should go along with the graph or just press <Enter> to leave the present text.

Note: Any longer text than 21 characters will be truncated.

4. Toggles

The toggles allow quick changes to some of the often used settings. Press the key shown between the brackets to execute the function. If the language is not English, the text and the letter within brackets should be different and the command will respond to the new letter.

4.1 d(B) or %

Toggles the amplitude scale between % and dB.

% linear scale

dB logarithmic scale, 10 dB/div

Note: The effect of this toggle is only seen in the amplitude parameters such as CSB, SBO etc.

4.2 (D)isplay

Selection for the display-mode of the computed results.

GRAPH graphical output
3D three dimensional graphical output
TABL table output

4.3 (E)rase

Selection for erasing the earlier computed data.

OK the data in the memory has been erased and a new curve may now be computed
DATA the memory still contains the latest result, and the curve may be displayed again with altered toggle settings.

4.4 (I)ncr x

Reduce the increment to ½ or ¼ of the current one in order to increase the resolution in case there are short bends on the curve.

1 Increment is same as set in table of numeric data
½ Increment is divided by two representing double resolution
¼ Increment is divided by four representing quadruble resolution

4.5 (P)arameter

This toggle is used to select a parameter for graphic,

CDI/DDM the deviation in uA CDI or % DDM. The parameter depends on the hot key <Alt-D> selection in the Control Panel.
Ampl the CSB and SBO curve together
CSB the CSB amplitude
SBO the SBO amplitude
bbp the Beam Bend Potential with 100% as a full scale
BBP the magnified Beam Bend Potential with 10% as a full scale
Phase the Phase of SBO/CSB

4.6 (S)ense

Selection for the sense direction in CDI graphic.

90î	Fly Down is in the upper part of the graphic
90|	Fly Down is in the lower part of the graphic

4.7 (M)ultiple

This toggle is used to select single or multi trace output.

(2)	there is only one FWD distance entered. Use (2) to make more
NO	there are more FWD distances entered but only the first one is displayed. Press M to switch to "YES"
YES	all entered FWD distances of the traces will be displayed. Press M to switch to "NO"

4.8 (H)gt scale

This toggle is used to add height (in meters) to the x-scale

NO	no height values are added
YES	the height values are displayed

Note: *The height is only shown when the FWD distance of the trace is less than 1500m.*

5. Commands

5.1 (2) Change

The Change command is used to modify the values of the numeric data used in the computation. See chapter 3. Numeric Data Entry of this section.

5.2 (3) Text

Quick command to enter text (description) into the graph. See para 3.7 of this section.

5.3 (4) FSD

Graph Full Scale Deflection

[FSD: (±) 800, 400, 200, 100, 50, 25, 12, 6 (uA)]

Default value is ±50uA (±400uA in Level Run) on the full vertical scale, but can be changed to any of the indicated values. Move the cursor with the Left-Right arrow keys and press <CR>.

5.4 (6) Excel

Note: This command is only shown and enabled when the Display-toggle is selected as a TABL.

With this command you can generate an Excel readable file.

When the <6> is pressed the AXIS 330 ask the name of the file as follows:

Current file name 'DATA.XL' <CR> or enter new:

The default name is 'DATA.XL' . Type a new name or just press <Enter> to keep the default name. The name must be according to the DOS specification otherwise it will be truncated (name = 8 letters and extension = 3 letters).

After the file name is entered this command will be shown as a filename between angle brackets. To disable this function press <6> again and the original command text (6)Excel is displayed.

5.5 (Esc) Menu

Function key <Esc> returns the program execution into the main menu.

5.6 Continue <CR>

Starts the vertical trace mode run.

6. Table display

If the Display-toggle is selected as a TABL the computed results will be shown as a list of the parameter values. This will also enable an Excel readable file to be saved on the disk if the (6) command key is pressed.

Before the execution of the list it is asked if the user want to take the results to the printer.

`Hardcopy of Results ? (y) or <SPACE>`

Enter Y (or another letter if the language is not English) for printing out.

The display will stop while the screen is full and the user is asked to hit any key to continue.

This will be repeated as long as the all computed results are shown.

The list includes the following parameters:

(x)	Angle from the GP-zero in meters
CDI/DDM	Course deviation in uA or (%DDM)
CSB	CSB-amplitude
SBO	SBO-amplitude
Phase	Phase between CSB and SBO

<Date> AXIS 330 - ILS GLIDEPATH SIMULATOR <S/N:000> <Time>

<x>	CDI<μA>	CSB	SBO	Phase
0.10	-2.80	1.4	0.25	90
0.20	10.09	2.6	0.43	88
0.30	28.05	3.8	0.61	84
0.40	51.60	5.2	0.79	78
0.50	77.21	6.9	0.97	71
0.60	102.06	8.9	1.15	62
0.70	125.28	11.1	1.37	53
0.80	146.36	13.6	1.63	44
0.90	164.54	16.5	1.96	35
1.00	179.70	19.9	2.36	27
1.10	191.83	23.6	2.84	21
1.20	200.49	28.0	3.41	16
1.30	205.55	33.0	4.05	12
1.40	207.42	38.5	4.72	9
1.50	206.12	44.6	5.41	7
1.60	201.64	51.3	6.06	5
1.70	194.72	58.4	6.65	3

hit any key ...

Fig. VRT601 The typical screen for table display results of the vertical trace mode

7. Graphic Display

When the Display-toggle is selected as a GRAF the computed results will be shown as a graphic diagram.

7.1 Graphic Diagram

There are 2D and 3D graphic diagrams depending on the selection of the (D)isplay-toggle.

7.1.1 Two dimensional graphic diagram

Two dimensional (2D) graphic diagram includes all information that is set in data panel. The CDI diagram shows additionally the calculated angles in the points of +150, +75, 0, -75, -150uA as well as the upper and lower half sectors (75uA up/dn).

On the bottom row there are six functions available enabling to handle or examine the graph result.

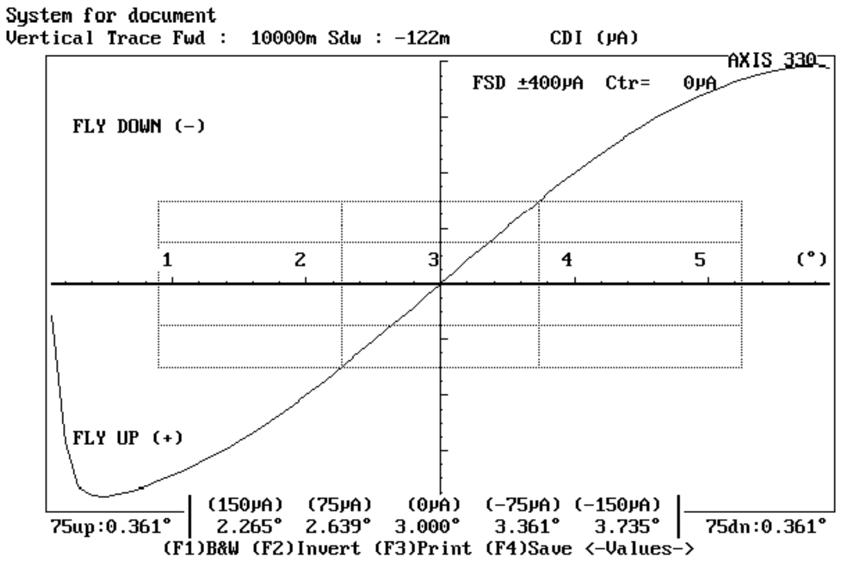


Fig. VRT701 The typical 2D graphic diagram of the vertical trace mode for the CDI parameter.

7.1.2 Three dimensional graphic diagram

Three dimensional (3D) graphic diagram shows 13 curves side by side in different azimuth angles from -12° to +12° as a curtain-like grid diagram.

On the bottom row there are five functions available enabling to handle the graph result.

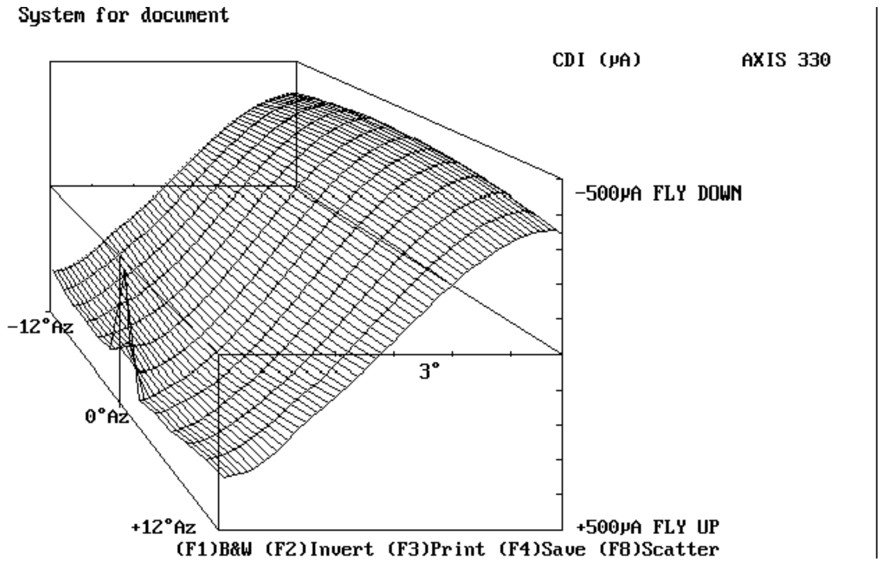


Fig. VRT702 The typical 3D graphic diagram of the vertical trace mode for the CDI parameter.

7.2 Functions

The functions of the graphic display are

(B)&W	Black & White to Colour Selector
(I)nvert	Display invert the colours for cut & paste purposes
(4) Save	Save a B&W graph for later play back
(8) Scatter	Scattering Object Editor
(8) <-	Offset all sheets together
Values->	Curve Tracer (Only for 2D graphs)

7.2.1 (B)lack & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

7.2.2 (I) Display Inverter

(I)nvert

This function will invert the colours of the display. In the colour display the colours will be changed to their complementary-ones.

7.2.3 (3) Printout

This function is obsolete and no longer in use.

7.2.4 (4) Graph Saver

(4)Save

Note: This function is enabled and displayed only when the screen is selected as black & white.

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory by the PgUp/PgDn keys. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

7.2.5 (8) Scattering Object Editor

`(8)Scatter`

Note: This function is enabled and displayed only when at least one scattering object is entered.

This function starts the scattering object editor in a same way as in Control Panel allowing to modify scattering objects. The detailed description is given in SCA-section.

7.2.6 (8) Offset all Scattering Sheets together

`non visible`

Offset the positions of all sheets in X(fwd), Y(sdw) and Z(hgt) coordinates together. This is useful when moving a complex object that is built up of several sheets.

7.2.7 Curve Tracer

<- Values ->

Note: This function is disabled in 3D graphic.

This function is used to show the exact value along the curves. The point on the curve is shown with small square (called cursor) and can be moved by using the <Left> or <Right> arrow keys. Pressing the arrow key the cursor will move along the curve while the value of the selected parameter and the distance will be displayed in the upper left hand part of the graphic screen.

With <Left> and <Right> arrows the cursor is moving with one computed step increment (selected in data panel) while holding the <Ctrl> key, the steps will be 10 times larger.

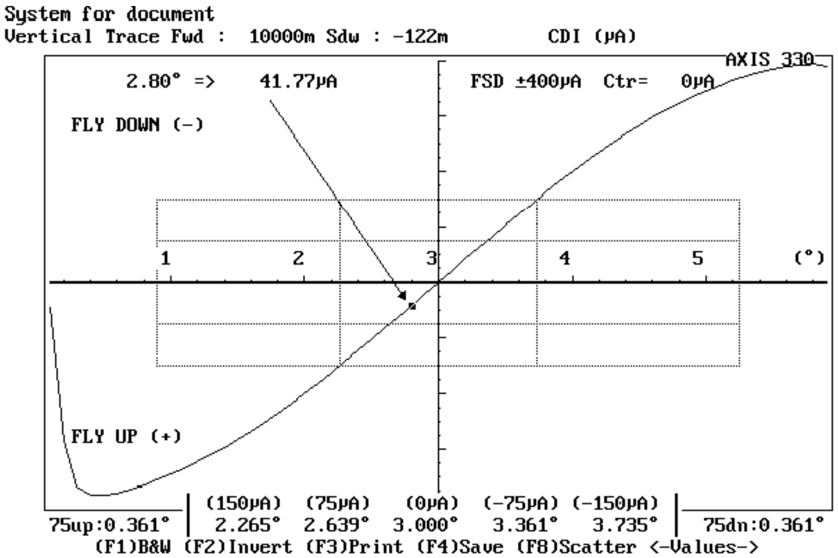


Fig. VRT703 Angle and parameter reading of the cursor location.

WND

Window Overview Mode

Table of Content

1.Description

The Window Diagram shows the Approach Window as seen from the ground station towards the approaching aircraft or from the air towards GP.

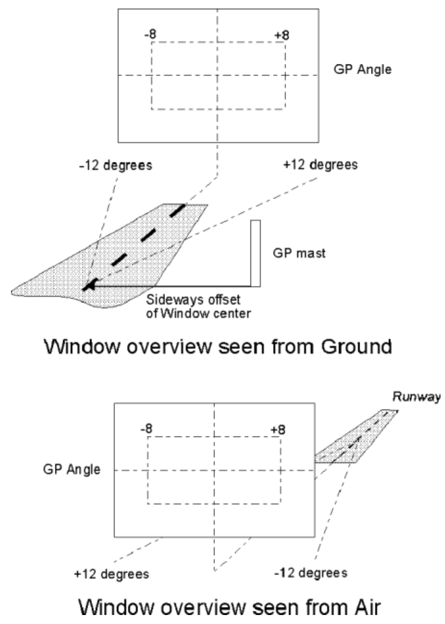


Fig. WND101 The Window Diagram

The Window covers elevation angles from zero to 1.75 times GP angle and azimuth angles from -12° to +12°.

The GP courseline position is shown as a ISO CDI line (Constant Deviation) stretching between -12° and +12° in azimuth.

The Window diagram is very useful of detecting system errors from the position and appearance of the ISO-CDI lines.

The Window Diagram is often called a footprint of the GP site. Any changes in this footprint is an indication of that something is going wrong.

Especially in M-Array systems the window will change considerably even for small errors, and long before detected by the monitors.

2. Data Screen

The Data Screen is divided into three main parts

1. the table of numeric data
2. the toggle panel
3. the command row.

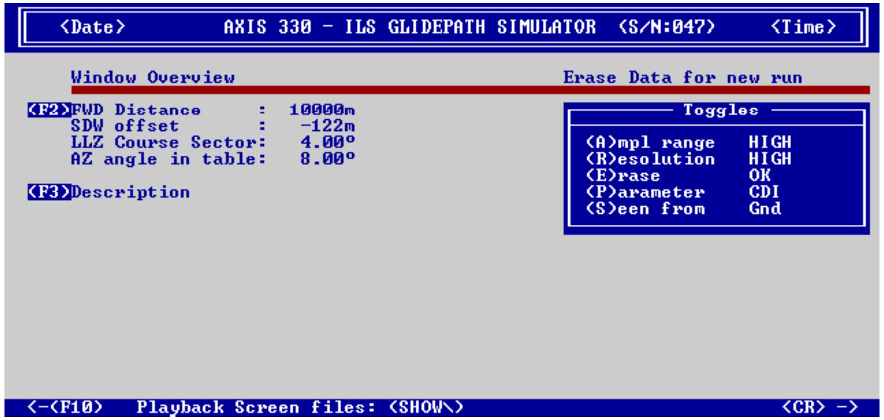


Fig. WND201 The Data Screen of the Lateral Trace Mode

2.1 Table of Numeric data (1)

The numeric data include the parameters used for the orbit computation

FWD Distance	Distance from the antenna array to the Window plane
SDW offset	Sideways distance to the Window center

2.2 Toggle panel (2)

The toggles includes the settings for the output form of the computation

(A)mpl range	Selection for the amplitude resolution
(D)efinition	Selection for the graphic resolution
(E)rase	Erasing an earlier computed Window Data
(P)arameter	Selection for the displayed parameter
(S)een from	Selection from where the window is seen
(W)nd <-> 3D	Three dimensional graph (is enabled after graph run)

2.3 Command row (3)

The commands include utilities for data entry and software control

(2) Change	Activate the numeric data entry
(3) Text	Entry for the text line to be shown on the graph
(Esc)Menu	Return to main menu
<CR>Continue	Starts the Window computation

3. The Data entry

The numeric data are entered by the <2> command allowing to change one or more items.

The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

```
<Date>        AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

Window Overview

FWD Distance        (m)  <   10000> :
SDW offset          (m)  <    -122> :
```

Fig. WND301 Data Entries in window overview

3.1 Forward Distance

FWD Distance (m) < 10000>:

The FWD Distance represents the longitudinal distance from the GP mast to the location of the Window plane.

The default value is 10000m.

3.2 Sideways Offset

SDW Offset (m) < -122>:

The SDW Offset represents the lateral distance between the GP zero and the Window center. Negative values are towards the runway.

The default distance is the distance to the runway centreline.

3.3 Localiser Course Sector

Localiser Course Sector (°) < 4.00°>:

Yellow vertical lines show the localiser course sector. These can be adjusted on the gaph by this setting.

3.4 AZ angle in Table

AZ angle in Table (°) < 8.00°>:

The table shows tha elevation angle for different given CDI values shown as lines on the graph. The Table can show these values at three different symmetrical azimuth angles. This setting will select the az angle between 2 and 12 degrees in 1 or 2 degrees step, depending on the resolution. See para 4.2

4. Toggles

The toggles are used to change the settings of graphic. Press the key shown between the brackets to execute the function. If the language is not English, the text and the letter within brackets should be different and the toggle will respond to that letter.

4.1 (A)mplitude range

The Amplitude range toggle is effecting to the CSB and SBO curves. The range defines the density of the ISO-curves the higher range the bigger step between ISO-curves.

LOW low range
MED medium range
HIGH high range

Note: *Only eight ISO curves are displayed beginning from the lowest value, so LOW and MED ranges may only show areas with low field strength.*

4.2 (R)esolution

Selection for the computing resolution (grid size in Azimuth/Elevation).

LOW low resolution gives a fast look using a very coarse grid (4/0.8°)
MED medium resolution is a normal mode with (2/0.4°) grid
HIGH high resolution is good when having errors and scattering objects, using (1/0.2°) grid
V.HI very high resolution uses a (1/0.1°) grid giving a best resolution but ismore time consuming.

4.3 (E)rase

Selection for erasing the earlier computed data.

OK the data in the memory has been erased and a new curve may now be computed
DATA the memory still contains the last results, and the curve may be displayed again with altered toggle settings.

4.4 (P)arameter

Selects the displayed parameter like CDI, CSB, SBO and Phase.

When showing amplitudes, the levels are referred to the peak CSB level at the course line, which is set to 100% in the 2D mode.

CDI The CDI diagram. DDM values are not available.
CSB Shows the CSB curves
SBO Shows the SBO curves
Phas Phase curves show the SBO/CSB phase relationship. When CLR signal is on, this will be the Clearance amplitude instead of

phase.

4.5 (S)een from

Selection from where the window overview is seen.

Air seen from the air

Gnd seen from the ground

4.6 (W)nd <-> 3D

Note : This toggle is enabled and shown only in case there are computed data in the memory (Erase-toggle shows DATA).

The (W)nd toggle starts three dimensional graphic utilizing the vertical trace mode graphic.

Actually the program execution will jump to the data panel of the vertical trace mode with changed toggle settings.

That toggle "(W)nd <-> 3D is added into the vertical trace toggles allowing to return to the window overview mode. See details in para 6.2 in this section.

5.Commands

5.1 (2) Change

The Change command is used to modify the values of the numeric data used in the computation. See chapter 3. Data Entry of this section.

5.2 (3) Text

The (3) text command is used to enter a text (description) into the graph.

After pressing <3> the user is asked to enter a new text.

```
Description     nnnnnnnnnnnnnnnnnnnn
Enter new Text _                    |
```

Type the new text (max 21 characters) that should go along with the graph or just press <Enter> to leave the present text.

Note: Any longer text than 21 characters will be truncated.

5.3 (Esc) Menu

Function key <Esc> returns the program execution to the Main menu.

5.4 Continue <CR>

Starts the window diagram computation.

6. Graphic Display

There are two graphic types in the Window overview mode

1. Two dimensional
2. Three dimensional

In the Data Panel of the Window overview the 2D-graphic is started by <enter> whereas 3D-graphic is started by the (W)in-toggle.

6.1 Two dimensional graphic

The 2D diagram includes a lot of information and changes according the displayed parameter but can be divided into four parts :

1. Equipment information
2. Graphic diagram
3. Elevation angles for given CDI values
4. Half sectors

Additionally on the bottom row there are four functions available for handling the graph result.

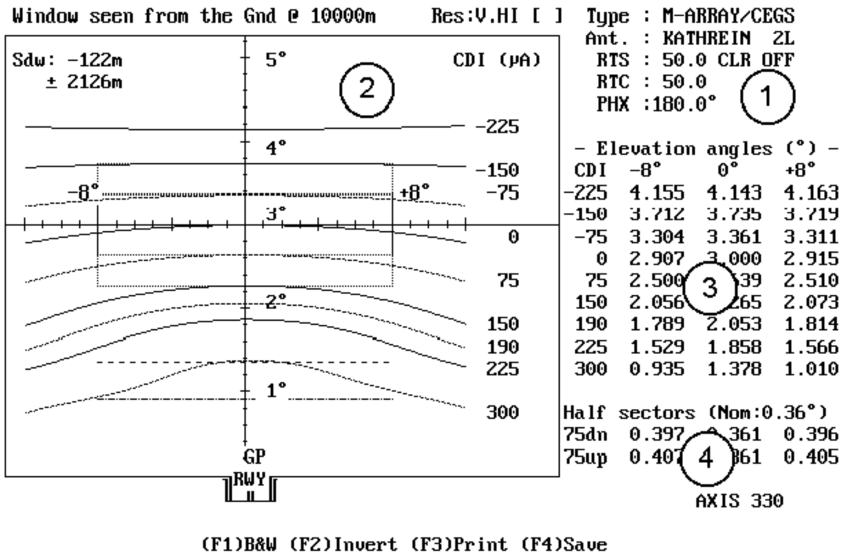


Fig. WND601 The typical graphic diagram for the CDI parameter.

6.1.1 Equipment info (1)

This part of the screen gives the information of the equipment status showing the GP type, Antenna type, Values of extra signals and the amplitude and CDI value of the CLR-signals in A1/A3.

6.1.2 Graphic diagram (2)

The top row tells where the window center is located and from where it is seen.

On the left hand top of the graphic square is shown the SDW offset and the width of the Window diagram in meters for ±12° at the FWD distance.

The graphic diagram shows the ISO-CDI lines with the following values:

-225 uA Fly Down
-150 uA Fly Down
-75 uA Fly Down
0 uA Course Line
75 uA Fly Up
150 uA Fly Up
190 uA Fly Up (the ICAO defined 0.22 DDM)
225 uA Fly Up
300 uA Fly Up

Note: Positive values means FLY UP sense.

6.1.3 Elevation angles (3)

This part of the screen shows the exact value of the vertical angles measured from the GP zero horizontal line in 0° and ±8° azimuth angles.

6.1.4 Half sectors (4)

This part of screen shows the computed half sector widths (75uA FD and 75uA FU) at 0° and ±8° azimuth angles.

6.2 Three dimensional graphic

Pressing the <W> in the data panel ("(W)in <-> 3D" toggle) the AXIS 330 jumps to the vertical trace mode and changes some toggles over there.

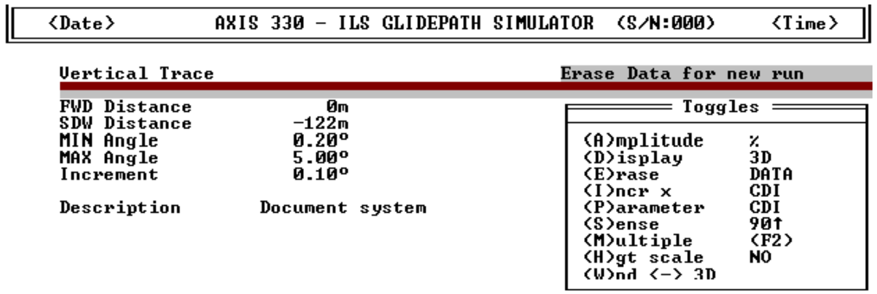


Fig. WND602 The vertical trace data panel after jumped from Window mode.

WARNING: USE ONLY (P)arameter and (W)nd toggles. *Other toggles will break the connection to the Window overview mode and the AXIS 330 starts to behave as in vertical trace mode.*

Parameter toggle includes now five selections, CDI, (4), CSB, SBO, and Phase. The Parameter selection (4) will show CDI,CSB,SBO and Phase on the same-

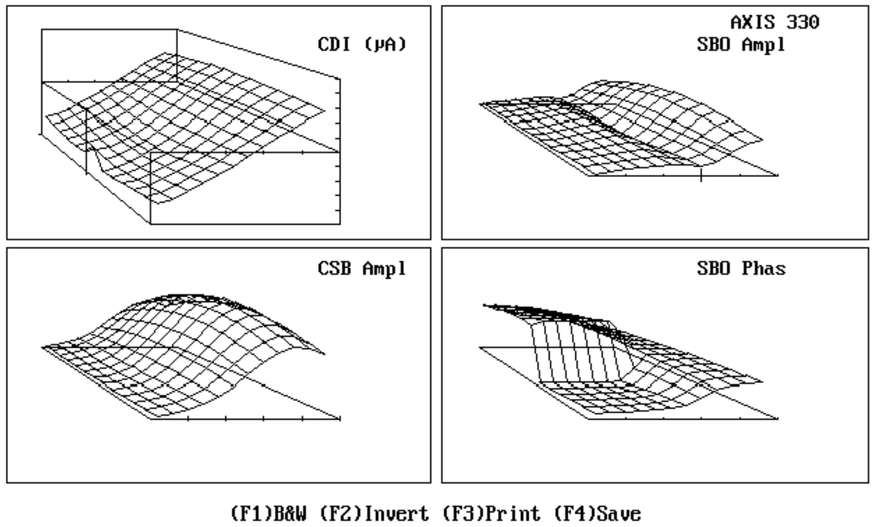


Fig. WND603 The 3D graphic with the Parameter toggle (4) selection.

6.3 Functions

The functions of the graphic display are

(B)&W	Black & White to Colour Selector
(I) Invert	Display invert the colours for cut & paste purposes
(4) Save	Save a B&W graph for later play back

6.3.1 (B)lack & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

6.3.2 (I) Display Inverter

(I)nvert

This function will invert the colours of the display. In the colour display the colours will be changed to their complementary-ones.

6.3.3 (3) Printout

This function is obsolete and no longer in use.

6.3.4 (4) Graph Saver

(4)Save

Note: *This function is enabled and displayed only when the screen is selected as black & white.*

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

7. More about Window diagram

The Window Diagram is a very sensitive indicator to show if something is going wrong. It also shows the impact of the scattering objects. The Window Diagram can be regarded as a footprint of the installation site and equipment condition.

Note: *For M-ARRAY's the CLR signal will mask the impact of small errors seen on the CDI lines at lower angles. Both theoretical and practical checks should therefore be done with the CLR switched off.*

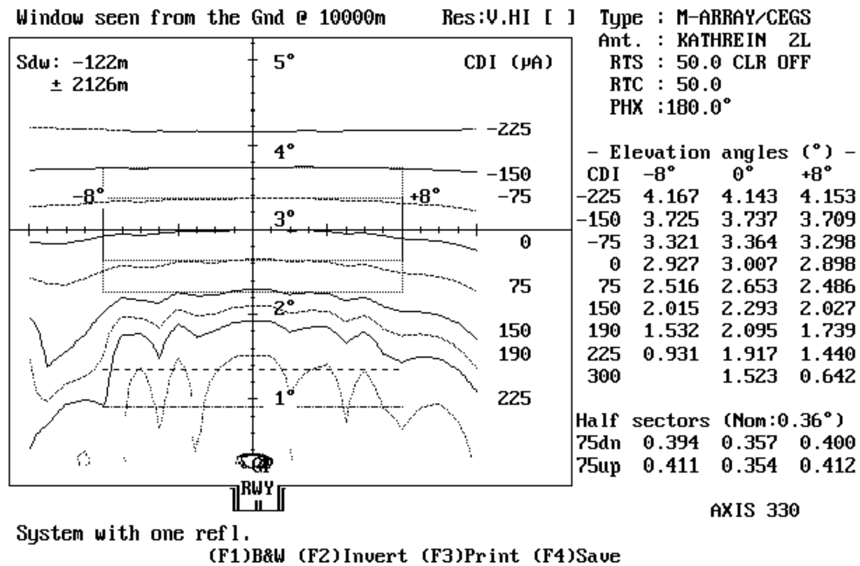


Fig. WND701 The Window Diagram with one scattering object

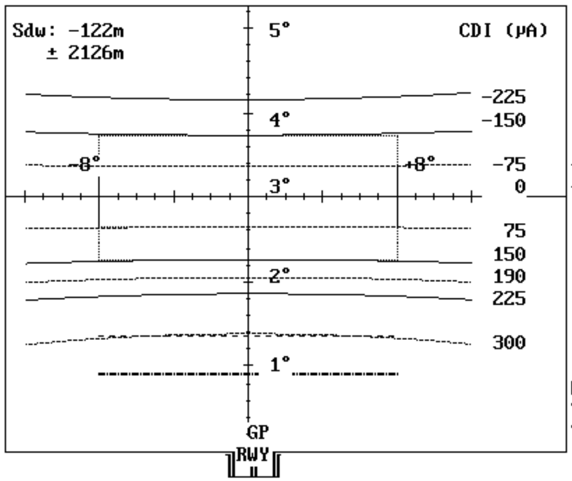
Flight Inspection can obtain the window diagram by making level run at ±8° Azimuth in addition to a centred one at the localiser course line. Even better resolution is obtained if ±4° are included.

7.1 Null Reference Window Diagram

In a Nominal Window Diagram for a Null Reference Glidepath system is shown in Fig WND702.

The Course Line (0uA line) is absolute straight across the Window coverage, parallel to the terrain side slope. The lower FLY UP lines will bend slightly downwards at each side due to the phase errors between the antennas caused by the impact of the lateral antenna offset.

Window seen from the Gnd @ 10000m   Res:V.Hi L J   Type : NULL REF
Ant. : KATHREIN 2L



- Elevation angles (°) -

CDI	-8°	0°	+8°
-225	4.171	4.143	4.180
-150	3.751	3.735	3.758
-75	3.367	3.361	3.372
0	2.998	3.000	3.002
75	2.628	2.639	2.632
150	2.244	2.265	2.248
190	2.026	2.054	2.030
225	1.824	1.858	1.828
300	1.322	1.379	1.327

Half sectors (Nom:0.36°)

75dn	0.369	0.361	0.370
75up	0.369	0.361	0.370

AXIS 330

Nominal 0-ref GP

(F1)B&W (F2)Invert (F3)Print (F4)Save

Fig. WND702 Nominal Window Diagram for a Null Reference GP.

When looking at the antennas from above, the lateral offset of antenna A1(⨯$_{L1}$) will act like the antennas are displaced side by side in a broadside array.

When moving sideways in azimuth (AZ) the received phase errors ⨯4 will be :

⨯4 ≈ ◡◡⌒◡ $^{238}_{92}$ ◡ 2⌉21 *LOsin(AZ)   (formula WND 1)

The Deviation value (CDI) at a given position follows a cosine function to the SBO/CSB phase relationship.

CDI=DDM*150/0.175 * cos⨯4   (formula WND 2)

If the nominal CDI without phase error is CDI_p, the CDI will be reduced to:

$$CDI=CDI_p \cos\times\overline{4} \qquad \text{(formula WND 3)}$$

Substituting $\times\overline{4}$ in formula (WND 3) with formula (WND 1) we will get the deteriorated CDI value for Null Reference:

$$CDI=CDI_p\cos[360°/2\overline{)21} \times_{L1}\sin(AZ)] \qquad \text{(formula WND 4)}$$

The phase error will be symmetrical with opposite sign to each side of the GP centreline directly in front of the antennas at very long distances.

The cos($\times\overline{4}$) function is symmetrical and has positive values when -90°< $\times\overline{4}$ < +90°.

The ISO-CDI lines will therefore be symmetrical to each side of the GP centerline.

If there is any phase error $\times\overline{4}_{SBO}$ in the nominal SBO/CSB radiation, this will add to the $\times\overline{4}_{L1}$ caused by the offset, and make the ISO-CDI lines unsymmetrical. In this case the ISO-CDI lines in the upper and lower section will have their normal elevation angular value at an azimuth when $\times\overline{4}_{SBO}$ cancels $\times\overline{4}_{L1}$.

This azimuth angle will be:

$$AZ=\sin^{-1}[\times\overline{4}_{SBO}\ 2\overline{)21}/(360°\times_{L1})] \qquad \text{(formula WND-5)}$$

7.2 M-Array Window Diagram

On M-Array systems without CLR signal the Window Diagram will change considerably even for small errors, and long before detected by the monitors.

By using the Window Diagram Mode for entering system errors on specific systems, one can learn a lot the behaviour and responses to errors that come close to the monitor alarm limits.

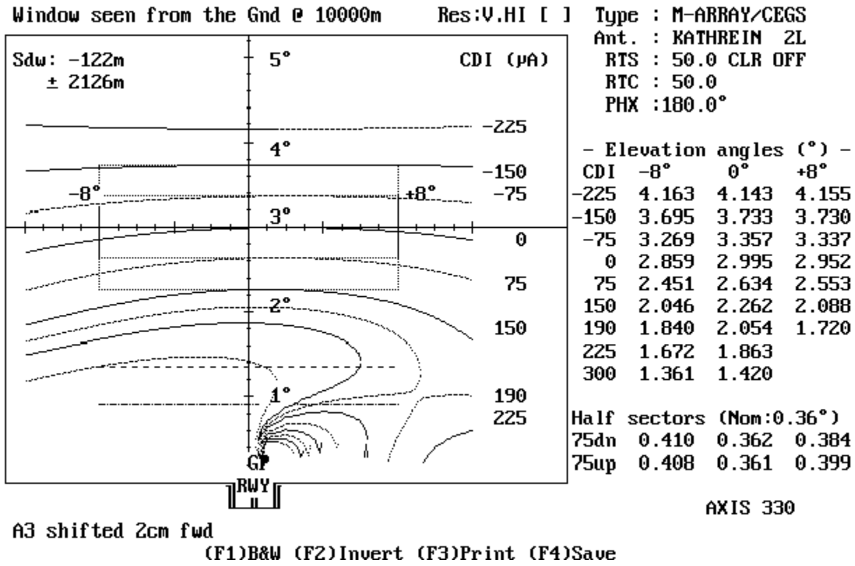


Fig. WND703 The Window Diagram shown when the upper antenna A3 is shifted 2cm forwards from its original position, yielding a +8° phase error in the far field.

APP

Approach Mode

Table of Content

1. Description

The Approach Mode simulates a movement along the approach path towards the landing point on the runway depending on the tracking option.

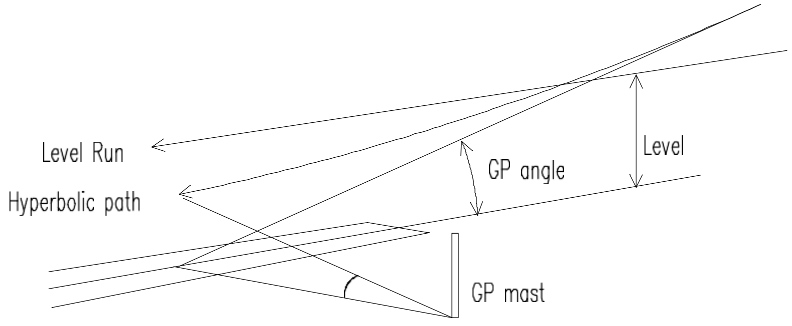


Fig. APP101 Approach mode

There are three tracking options in the Approach mode :

1. Hyperbolic
   This tracking mode represents an ideal hyperbolic line along the zero deviation line of an ideally adjusted GP-system. Any deviation from the zero deviation the AXIS 330 will indicate some abnormalities in the system or environment.
2. Theo
   The Theo is a theodolite guided approach tracked by a theodolite at a given position relative to the GP zero (a point at the foot of the antenna mast).
3. Level
   The Level run is a simulation of approaching at a constant level (fixed height).

If scattering objects are entered into the terrain model, reflections may show bends and scalloping along the approach.

2. Data Panel

The data panel shows the values to be used in the approach mode computation.

The data panel is divided into three main parts

1. the table of numeric data,
2. the toggle panel
3. the command row.

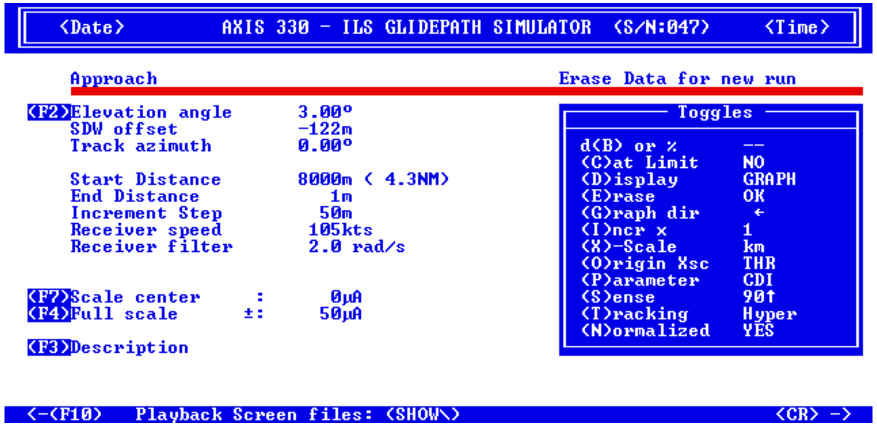


Fig. APP201 The data panel of the approach mode

2.1 Table of Numeric data (1)

The numeric data shows the values to be used in the computation. The numeric data can be changed by the (2) change command.

Here is a brief description of the table of the numeric data:

Elevation angle	Vertical angle of the approach path
Level (feet)	Flying level in feet. *Note: This will show instead of the elevation angle when level run is selected.*
SDW Offset	Sideways offset of the track
Track azimuth	Horizontal angle of the approach path seen from the array
Theo Fwd Sdw Hgt	The theodolite position relative to the GP zero point at the foot of the antenna mast. *Note: This is displayed only when theodolite guided approach is selected.*
Theo upwards tilt	Mechanical tilt of the theodolite vertical pilot axis. *Note: This option will appear only when AXIS 330 is started with /THEO switch.*
Start Distance	The start point of the approach from the GP mast
End Distance	The end point of the approach from the GP mast

Increment step	The step distance along the approach
Receiver speed	The speed of the receiver for low pass filtering
Scale Center	The offset of the center axis of the graph
Full Scale	The graph full scale deflection
Description	The text added into the graph

2.2 Toggle Panel (2)

The toggles are used to make some quick selections.

The toggle panel includes the following toggles:

d(B) or %	Select amplitude scale in dB or per cent.
(C) at Limit	Select the CAT I, II or III limits to be drawn in the graph.
(D) isplay	Selection between graph and table
(E) rase	Select between new and old computed curve
(G)raph dir	The approach direction on the graph
(I)ncr x	A reduction factor of the increment step 1/2 or 1/4.
(X)-scale	Select distance scale in meters, feet or Nautical Miles
(O)rigin Xsc	Start point of the X-scale. Threshold or Antenna system
(P)arameter	Select display parameter as CDI or Modulus
(S)ense	The direction of the Y-axis of the graph 90Hz up or down
(T)racking	Track mode hyperbolic, theodolite or level run
(N)ormalized	Cancel the effect of signal loss as a function of the distance

2.3 Command Row (3)

The Command Row includes the commands, which start the function or control the program execution.

(2) Change	Change one or more data items
(3) Text	Enter text line to be displayed with the graph.
(4) FSD	Change the Y-scale (Full Scale Deflection).
(6) Excel	Enable an Excel readable file. *Note: this command is shown only when the Display toggle is selected for Table.*
(Esc) Menu	Return to menu
<CR> Continue.	Starts the computation.

3. Data Entry

The numeric data are entered by the <2> kjey command allowing to change one or more items.

The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

The content of the data entry is changed according to the selected tracking mode (Hyper,Theo,Level).

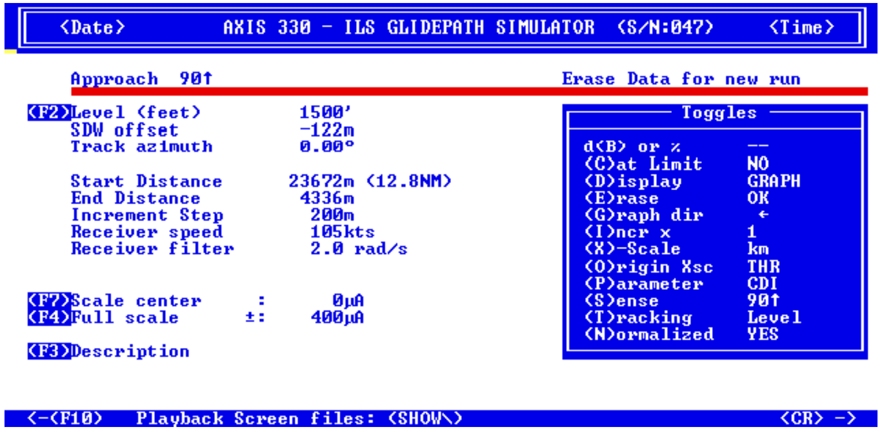


Fig. APP301 Numeric data entries in case of the theodolite tracking

3.1 Theodolite position

The ideal position for a theodolite would be at the foot of the GP mast. As the practical theodolite can not be positioned in the ideal position, the impact of the position error must be calculated. Information about the theodolite positioning error is given in chapter 8.

Note: *The theodolite position data input is requested only when tracking toggle is selected as a theodolite.*

3.1.1 Theodolite forward position

Theodolite FWD position (m) < 0>:

The theodolite FWD position is the longitudinal distance from the GP-zero point. Positive values are in front of the GP antennas.

3.1.2 Theodolite sideways position

Theodolite SDW position (m) < 0>: <-Twds RWY>

Theo Sdw is the sideways displacement compared to the GP zero point. Negative distances are towards the runway regardless left or right hand side.

3.1.3 Theodolite height

Theodolite HGT above GP zero (m) < 0>:

The theodolite HGT above GP zero is the height of the theodolite eye relative to the GP zero.

3.1.4 Theodolite upward tilt angle

Theo upwards tilt (°) < 3>:

Mechanical tilt of the theodolite vertical pilot axis. This type of theodolite will point at 0° elevation angle when rotated to ±90° in azimuth.

The theodolite rotation axis will normally be exactly vertical and not tilted relative to the reflection plane FSL and SSL.

Note: *This option will appear, when the AXIS 330 is started with the /THEO switch.*

3.2 Elevation Angle

Elevation Angle (°) < 3>:

This value is preset to the GP angle set in the Control Panel. The run follows the Glide path angle down according to the tracking mode.

3.3 Level run

Level (feet) <1500>

The fixed height in feet above the GP zero level. The default value is 1500 ft.

Note: *This entry replaces the elevation angle in case of the level tracking mode.*

3.4 Sideways offset

SDW offset (m) < -122>:

This is the sideways offset of the track, and is preset to -RWY (Track along the Runway Centreline)

3.5 Track Azimuth

Track azimuth (°) < 0>:

The Azimuth Angle relative to the GP centreline, normally identical to the localiser Courseline. Positive angles are in clockwise direction according to the geographical convention.

3.6 Start distance

Start Distance (m) <8000>:

The beginning of the run. Default start distance is 8 km plus the threshold distance, to include the ILS point A at 7408 m (4NM) from THR.

3.7 End Distance

End Distance (m) < 1>:

This is the end longitudinal distance of the approach run. Default is 1m in front the GP mast

3.8 Increment Step

Increment Step (m) < 50>:

The distance between the computed points. Default is 50 m.

This step should be smaller if there are bendpatterns with short bendlengths. Use the <I> key in the toggle panel to shorten the increment. ½ (25m) or even ¼ (12.5m) are better values when reflection objects are present.

3.9. Receiver Speed

Receiver speed (kts) <105>:

The aircraft speed given in knots.

3.10. Receiver Filter

Receiver filter (rad/sec) <2.0>:

The receiver/plotter frequency response will influence on the smoothening of the curve. See Appendix 1 for details on the low pass filtering effect.

3.11 Graph Centreline

Graph Scale Centreline (uA) < 0>:

The center axis of the graph might be offset to the average deviation value at the approach azimuth angle in order to increase the resolution.

Note: The graph full scale deflection (FSD) is selected by <4> key.

3.12 Description text

Description nnnnnnnnnnnnnnnnnnnn

Enter new Text _ |

Type the new text (max 21 characters) that should go along with the graph or just press <Enter> to leave the present text.

Note: Any longer text than 21 characters will be truncated.

4. Toggles

The toggles allow quick changes to some of the often used settings. Press the key shown between the brackets to execute the function. If the language is not English, the text and the letter within brackets should be different and the command will respond to the new letter.

4.1 d(B) or %

Show amplitude curves as dB or % related to the maximum CSB level.

4.2 (C)at Limit

Show in the graph the ICAO Annex 10 bend limits (95%) for Cat I, II and III.

4.3 (D)isplay

Selection for the display-mode of the computed results.

GRAPH graphical output

TABL table output

4.4 (E)rase

Selection for erasing the earlier computed data.

OK the data in the memory has been erased and a new curve may now be computed

DATA the memory still contains the last results, and the curve may be displayed again with altered toggle settings. Press <E> for new computation.

4.5 (G)raph dir

Selection for the displayed direction of the graphic curve.

<- direction will be from right to left (default)
-> direction will be from left to right

4.6 (I)ncr x

Reduce the increment to ½ or ¼ of the current one in order to increase the resolution when there are short bends on the curve.

1 Increment is same as set in table of numeric data
½ Increment is divided by two representing double resolution
¼ Increment is divided by four

4.7 (X)-scale

Selection for distance scale given in meters, feet or Nautical Miles (NM)

4.8 (O)rigin Xsc

Toggle start point of the X-scale between the Threshold and the Antenna system.

4.9 (P)arameter

Selection which parameter to be displayed,

CDI Graphics will display the DDM (deviation in uA)
MOD Graphics will display the BBP (modulus)

4.10 (S)ense

Selection for the sense direction.

90$^{2}_{8}$ Fly Down will be in the upper part of the graph
90$^{235}_{92}$ Fly Down will be in the lower part of the graph

4.11 (T)racking

Selection for tracking mode

Hyper Hyperbolic path follows the glide path angle from the base of the GP mast at any point along the approach. It also corrects for changes in the GP angle along the track due to FSL and SSL. This gives a straight line of zero DDM if the glide path system is normal.
Theo Tracked by a theodolite adjusted to the Elevation angle, located at a user specified position. This will yield a curve different from zero DDM along the approach, which should be identical to Flight Inspection measurements.
Level A horizontal run at a user specified level above the GP base.

4.12 (N)ormalized

Nomalize the amplitude along the approach in order to cancel the effect of signal loss depending on the distance. The reason is to check for effects in lobing and reflections. Normalized "NO" is the real case while "YES" is analytical case.

5. Commands

5.1 (2) Change

The Change command is used to modify the values of the numeric data used in the computation. See chapter 3. Numeric Data Entry of this section.

5.2 (3) Text

Quick command to enter text (description) into the graph. See 3.11 of this section.

5.3 (4) FSD

Graph Full Scale Deflection

[FSD: (±) 800, 400, 200, 100, 50, 25, 12, 6 (uA)]

Default value is ±50uA (±400uA in Level Run) on the full vertical scale, but can be changed to any of the indicated values. Move the cursor with the Left-Right arrow keys and press <Enter>.

5.4 (6) Excel

Note: *This command is only shown and enabled when the Display-toggle is selected as a TABL.*

With this command you can generate an Excel readable file.

When the <6> is pressed the AXIS 330 ask the name of the file as follows:

Current file name 'DATA.XL' <CR> or enter new:

The default name is 'DATA.XL' . Type a new name or just press <Enter> to keep the default name. The name must be according to the DOS specification otherwise it will be truncated (name = 8 letters and extension = 3 letters).

After the file name is entered this command will be shown as a filename between angle brackets. To disable this function press <6> again and the original command text (6)Excel is displayed.

5.5 (Esc) Menu

Function key <Esc> returns the program execution into the main menu.

5.6 Continue <CR>

Starts the approach mode run.

6. Table display

If the Display-toggle is selected as a TABL the computed results will be shown as a list of the parameter values. This will also enable an Excel readable file to be saved on the disk if the (6) key is pressed.

Before the execution of the list it is asked if the user want to take the results to the printer.

Hardcopy of Results ? (y) or <SPACE>

Enter <Y> or <SPACE> if the results should be printed out.

Note: Letter Y may be another letter if the language is not English.
The display will stop while the screen is full and the user is asked to hit any key to continue.

That will be repeated as long as the all computed results are shown.

The list includes the following parameters:

(x)	Distance from the GP mast in meters
CDI	Course deviation in uA or (%DDM)
CSB	Course CSB-amplitude
SBO	Course SBO-amplitude
Phase	Course Phase between CSB and SBO

<Date> AXIS 330 - ILS GLIDEPATH SIMULATOR (S/N:000) <Time>

(x)	CDI(µA)	CSB	SBO	Phase
2050.00	-0.10	193.0	0.27	267
2000.00	-0.10	192.8	0.27	267
1950.00	-0.10	192.5	0.27	267
1900.00	-0.10	192.3	0.27	267
1850.00	-0.10	192.0	0.27	267
1800.00	-0.11	191.7	0.27	267
1750.00	-0.11	191.3	0.27	267
1700.00	-0.11	191.0	0.27	267
1650.00	-0.11	190.6	0.27	267
1600.00	-0.12	190.1	0.27	267
1550.00	-0.12	189.7	0.27	267
1500.00	-0.12	189.1	0.27	267
1450.00	-0.13	188.6	0.27	267
1400.00	-0.13	187.9	0.28	266
1350.00	-0.14	187.2	0.28	266
1300.00	-0.14	186.4	0.28	266
1250.00	-0.15	185.5	0.28	266

hit any key ...

Fig. APP601 The typical screen for table display results of the approach mode

7. Graphic Display

When the Display-toggle is selected as a GRAF the computed results will be shown as a graphic diagram.

7.1 Graphic Diagram

The graphic diagram includes all information that is set in data panel.

Below the centreline is shown the letters (A,B,C,T) presenting the ILS-points specified in ICAO Annex 10.

Additionally on the bottom row there are six functions available enabling the handle or examine the graph result.

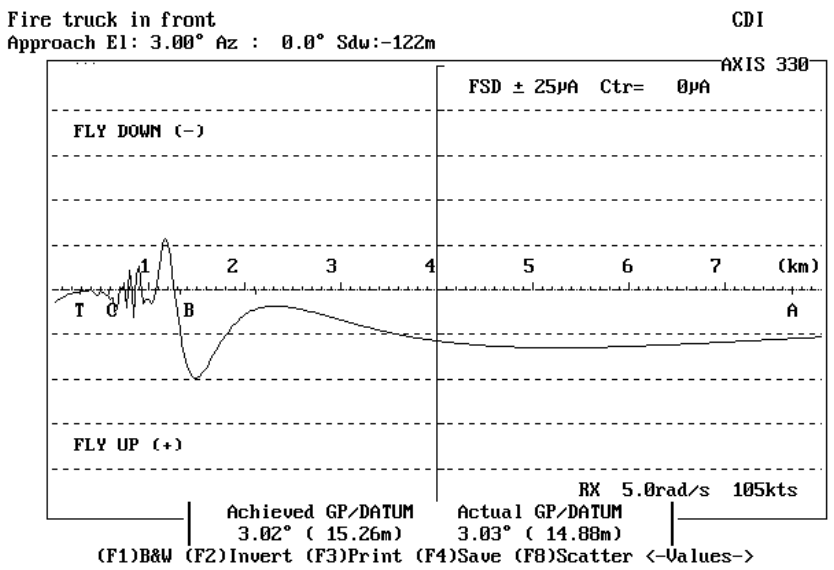


Fig. APP701 The typical graphic diagram of the approach mode for the CDI parameter with one scattering object.

7.2 Functions

The functions of the graph display are

(B)&W	Black & White to Colour Selector
(I)nvert	Display invert the colours for cut & paste purposes
(4) Save	Save a B&W graph for later play back
(8) Scatter	Scattering Object Editor
(8) Offset	Offset of all scattering sheets together.
<-Values->	Curve Tracer

7.2.1 (B)lack & White to Colour Selector

(B)&W

This function is used to toggle the graph between colours and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

7.2.2 (I) Display Inverter

(I)nvert

This function will invert the colours of the display. In the colour display the colours will be changed to their complementary-ones.

7.2.3 (3) Printout

This function function is obsolete and no longer in use.

7.2.4. (4) Graph Saver

(4)Save

Note: *This function is enabled and displayed only when the screen is selected as black&white.*

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory by the PgUp/PgDn keys. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

7.2.5 (8) Scattering Object Editor

(8)Scatter

Note: This function is enabled and displayed only when at least one scattering object is entered.

This function starts the scattering object editor in a same way as in Control Panel allowing to modify scattering objects. The detailed description is given in SCA-section.

7.2.6 (8) Offset all Scattering Sheets together

non visible

Offset the positions of all sheets in X(fwd), Y(sdw) and Z(hgt) coordinates together. This is useful when moving a complex object that is built up of several sheets.

7.2.7 Curve Tracer

<- Values ->

This function is used to show the exact values along the curve. The cursor is shown as small square and can be moved along the curve by using the <Left> or <Right> arrow keys. The value of the selected parameter and the distance will be displayed in the upper left hand part of the graphic screen.

The cursor is moving with one computed step increment (selected in data panel) while holding the <Ctrl> key, the steps will be 10 times larger.

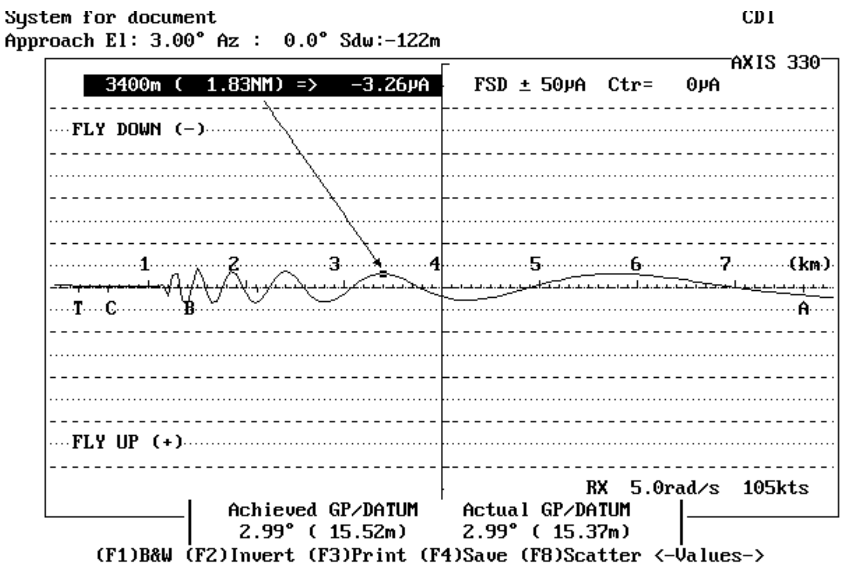


Fig. APP702 Distance and parameter reading of the cursor location.

The curve tracing function includes also an automatic point loader for learning bend analysing.

This tutorial feature is used in the following way:

1. Find a maximum, middle or minimum point on a bend section and press the 0 (zero) key. The distance will read zero because this point is now set as a reference.
   A further move of the cursor will display the relative distance from the reference point.

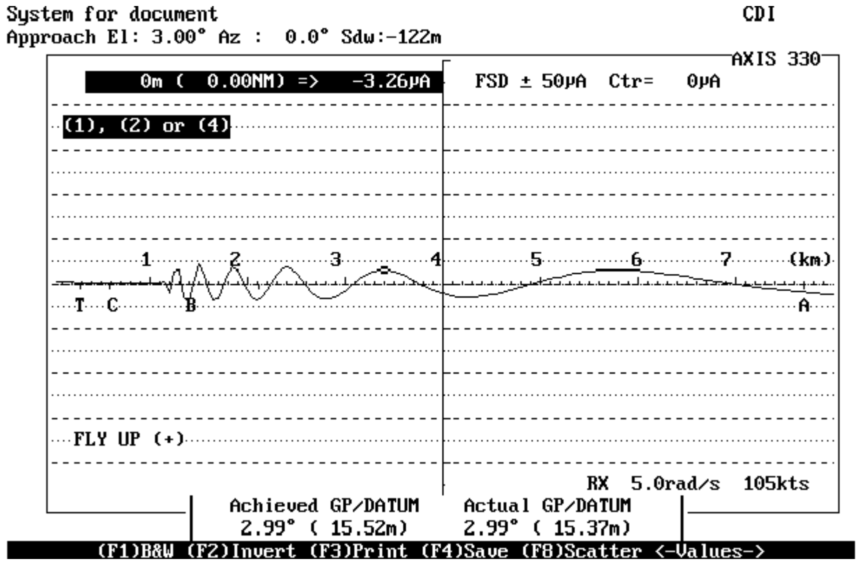


Fig. APP703 Graphic Screen after 0 key pressed.

2. Move the cursor either a full, half or quarter bend cycle and then press
   1 (one) for full cycle or (less accurate)
   2 (two) for half cycle or
   4 (four) for quarter cycle (most accurate)
   This will load the bend distance/length combination into the bend analyser module.
3. Make two or three entries repeating 1) and 2) and then return to the Main Menu (use the <Enter> key and then <Esc>). Select Bend Analysing mode (mode 8) and press <Enter> several times to proceed directly to the graphic display. The crossing of the hyperbolic lines will show where the bends might have their origin.

7.3 Computing the Glidepath Angle and Datum

After a Level Run, the GP angle and the sectors are computed and shown at the bottom of the graph.

After a Hyperbolic or Theodolite approach, the average glidepath angle and the height of the downward extension of the straight average glidepath angle above the threshold is computed for two sections of the approach.

1. Actual GP/Datum. Between ILS point A and B (7408m and 1050m) before the threshold respectively.
2. Achieved GP/Datum. Between 1830m (6000') and ILS point C (300m,1000') before threshold.

Since the glidepath courseline bends slightly upwards toward the end of the approach, the slope angle will be slightly less for the inner section (typically two hundredth of a degree). The threshold crossing height will therefore also be slightly higher than the ideal 15m.

8. Theodolite positioning

The ideal position for a theodolite would be at the foot of the GP mast where the signals have their geometrical origin. As the theodolite can not normally be positioned in the ideal mast foot position, a good practical position is found elsewhere.

8.1 Error compensation

To minimize the error, the theodolite should be positioned where the GP angle goes through the theodolite eye.

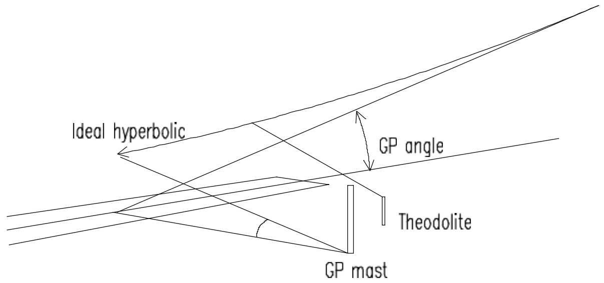


Fig. APP801 Minimum error theodolite position

This position has the disadvantage of taking too much azimuth movement to track the aircraft down to the threshold. A better position is to locate the theodolite closer to the runway and slightly behind the GP antenna mast.

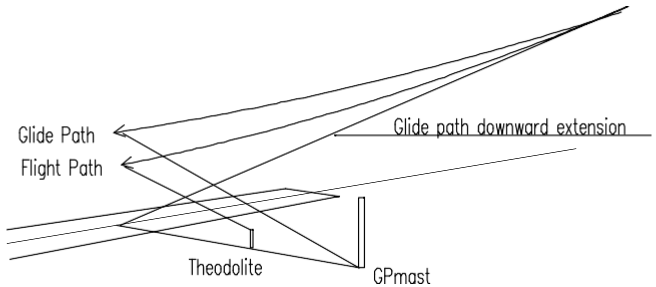


Fig. APP802 Position for enable tracking beyond the threshold

In this position the GP system and theodolite will not agree upon the GP angle and an error compensation curve will show a difference. This should be identical to practical results.

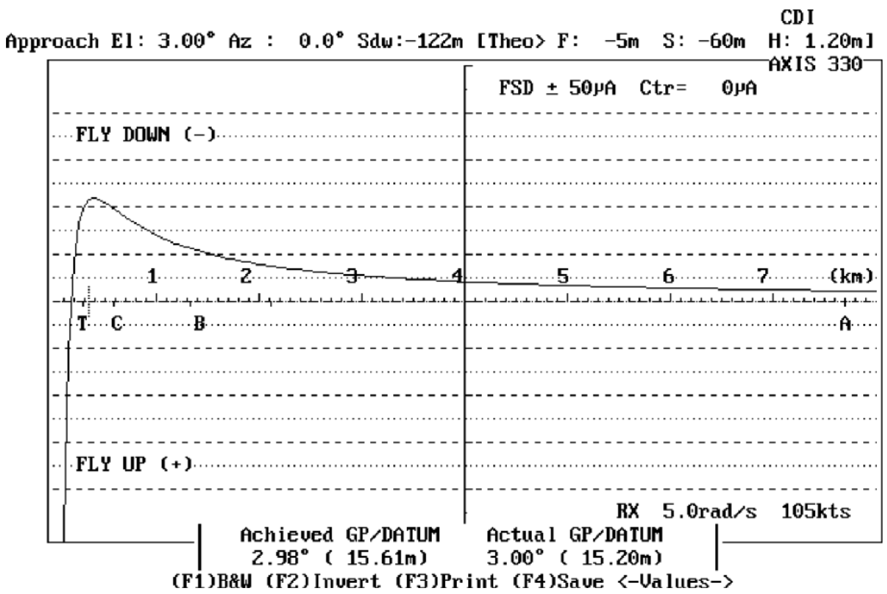


Fig. APP803 Theodolite error tracking curve for a normally operating GP system

8.2 Error by sloping reflection plane

If a reflection plane has a forward and/or sideways tilt angle, the vertical angles seen from the theodolite and the GP will not agree in different azimuth angles. This is due to the theodolite rotation axis references which are perfectly horizontal and vertical, while the GP reference axis is orthogonal to the reflection plane.

Example:

A GP system has 3.0° GP angle and -0.5° FSL. The antenna heights are adjusted to a 3.5° GP as this is the angle between the GP angle and the reflection plane in forward direction. A theodolite pointing forward to the far field will be set up at 3.0° referenced to the horizontal.

Looking sideways directly towards the runway, the reflection plane is horizontal, but the antenna heights produce a 3.5° GP angle relative to groundplane in that direction too. The theodolite will still see 3.0° towards the runway, making the measured GP angle look 0.5° too high.

A similar but opposite effect is observed when the sideways slope (SSL) is not horizontal.

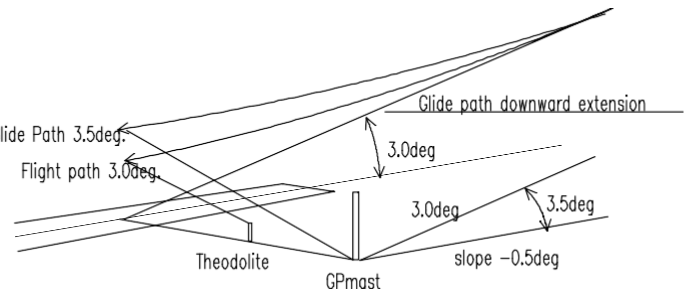


Fig. APP804 Theodolite error by sloping Reflection Plane (-0.5°).

This error can neither be adjusted nor corrected and the error curve should be computed and used as the reference nominal path. Any deviations from this nominal path indicates that something is wrong with the system.

8.3 Tilting angle

If the elevation angle must be set by mechanically tilting the theodolite, use the / THEO switch for every start-up of the software to enable this function.

Such theodolites will point horizontally when turned 90° in azimuth.

Blank page

FIX

Fixed Position Mode

Table of Content

1. Description

The Fixed Position mode simulates a variable error in one of the feed parameters while measuring the deviation or amplitudes in one or two fixed positions.

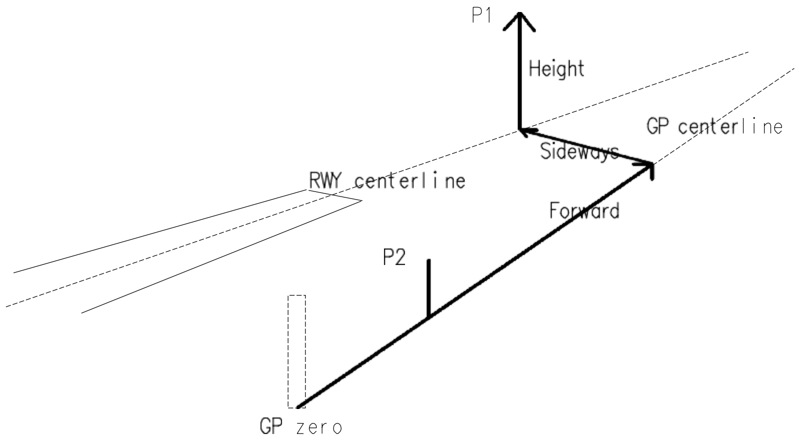


Fig. FIX101 Fixed Position Mode

This mode is very useful to determine whether a selected monitor position or a measuring point in the field will give the same response to feed errors as the far field along the approach path.

2. Data Panel

The data panel shows the values to be used in the fixed position mode computation.

The data panel is divided into four main parts

1. the fixed points position data
2. the error data
3. the toggle panel
4. the command row.

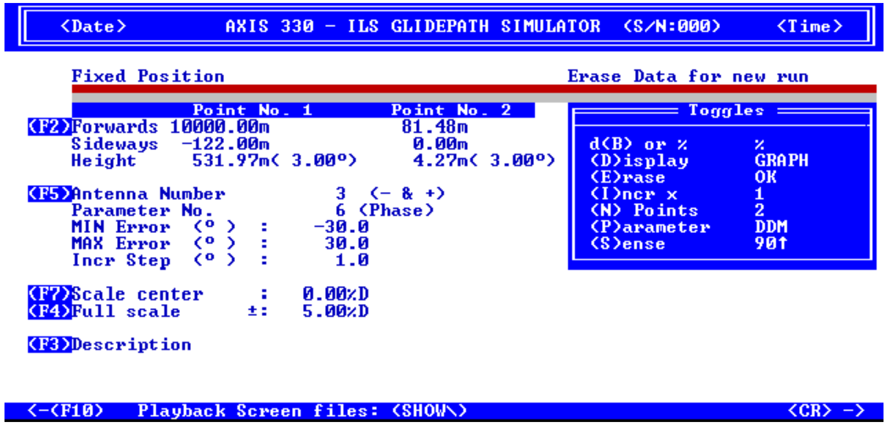


Fig. FIX201 The data panel of the fixed position mode

2.1 Fixed point position data (1)

This table shows all the numeric parameters that is used in simulation. The value of the numeric data can be changed by (2) command.

Point No. 1 / Point No. 2

Forward	Forward distance of the point along the centreline
Sideways	Sideways distance of the point
Height	Height of the point (meters and angles)

2.2 Error data (2)

Antenna Number	Antenna element
Parameter No.	Error source / parameter
MIN Error	Error start value
MAX Error	Error stop value
Incr Step	Error step value
Scale Center	Graph display center (not shown in TABL mode)
Full Scale	Graph display full scale (not shown in TABL mode)
Description	Text line displayed on graph diagram

2.3 Toggle panel (3)

The toggles consist of the set of fixed value parameters/settings that can be changed by toggling the character key allocated to the item (letter inside the brackets).

(A) mplitude	Selection between percent (%) and decibel (dB)
(D) isplay	Selection the output form between graph and table
(E) rase	Erase last computed DATA for enabling a new run
(I)ncr x	Factor for step value to be used to increase the computing resolution
(N) Points	Selection the number of points between one or two
(P)arameter	Select the displayed parameter

2.4 Command row (4)

The commands effect the program execution or allow to enter some numeric data directly.

(2) Change	Change the position of the fixed points
(3) Text	Enter a text line to be displayed with the graph diagram
(4) FSD	Change the Y-scale (Full Scale Deflection)
(5) Error	Change the error parameter of the numeric data
(6) Excel	Enable an Excel readable file when in TABL mode
(Esc) Menu	Return to main menu
<CR>Continue	Start computing

3. Data Entry

The data is entered by the <2> and the <5> keys.

The <2> is used to enter or modify the location(s) of the receiver (fixed points).

The <5> is used to enter a simulated error.

The current value of the data is shown between angle brackets. If you accept the shown value just press <Enter> to proceed to the next data entry. Otherwise enter the new value and press <Enter>.

3.1. Position of the point(s)

The position of the fixed points (receiver position) are entered by <2>. In the title row between square brackets is displayed the monitor coordinates.

Note: If only one point is selected by N-toggle the entry includes only one point.

```
<Date>        AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

Fixed Position [Monitor Fwd : 81.48  Sdw :  0.00  Hgt :  4.27m]

Point No.  1 (Far Field)
Forwards   (m)               <    10000> :
Sidesways  (m)                  <  -122> :      (-Twds RWY)
Height Above GP Zero  (F2)Angl  <531.97> :

Point No.  2 (Near Field)
Forwards   (m)               <    81.48> :
Sidesways  (m)                  <     0> :      (-Twds RWY)
Height Above GP Zero  (F2)Angl  <  4.27> :         [∆h=  0.002m]
```

Fig. FIX301 Position of points Data entry screen for fixed points, where point 1 SDW is entered as metric and point 2 SDW as angular.

3.1.1 Forward Distance

Forwards (m) <10000> :

The longitudinal distance between the receiver point and the antenna mast in meters along the GP centreline.

Note: This value must be positive.

3.1.2 Sideways Distance

Sideways (m) < -122>: (-Twds RWY)

The lateral distance between GP-zero and the receiver point in meters. The negative sign means the distance is measured towards the runway from the GP-antenna.

3.1.3 Height of the Receiving Point

The height of the receiving point can be entered either as angular or metric values. The <2> is used to toggle between these two entering modes.

```
Height above GP zero  (2)Angl    < 531.97>:
Vertical Angle (°)    (2)Hgt     <   3.00>:
```

Height or Vertical Angle of the receiving point is measured from the GP-zero level.

Note 1: The height in meters at long distances will be influenced by the curvature of the earth, and is always referred to the local height above the ground.

Note 2: The position of the monitor antenna above ground is displayed at the top of the screen. The AXIS 330 will automatically preset the height of the monitor into the point no 2. If the reflection plane slopes, this height will be given above the GP-mast zero height for reference purposes.

3.2 The Error Data Entry

The error data are entered by the <5> key allowing you modify the error parameter to be examined.

The Error Data is entered in two steps, firstly is selected the error source and type and secondly is entered the error range

3.2.1 Error Source and Type

The first step of the data entry includes the error source and type selection. First is selected the error source and then the error type.

The error source can be

- the SBO-signal feed from transmitter (press <0>)
- one antenna (press <1>,<2>or <3>) or
- a layer of wet snow (press <4>).

```
<Date>        AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

Item No. to be changed

 SBO  Error       <0>
 Antenna Number   <1 - 3 >
 Wet snow layer   <4>

 Item No. to be changed <0 - 3  or 4> < 4> :
```

Fig. FIX302 Data screen for the error source selection

SBO-signal Error

1 - SBO Ampl
2 - SBO Phase

Parameter No. (1-2) <1>:

The error parameters in case of SBO-signal error are amplitude and phase.

Enter <1> (one) for the amplitude and <2> (two) for the phase.

Antenna Error

1 - SBO Ampl
2 - SBO Phase
3 - CSB Ampl
4 - CSB Phase
5 - Ampl
6 - Phase

Parameter No. (1-6) <1>:

In case of Antenna Error there are six possible error parameters available.

Enter a number from 1 to 6 according to the error type.

Note: Parameter 5 (amplitude) and 6 (phase) will be changed both SBO- and CSB-signal of the selected antenna.

Wet Snow Layer

In the Wet Snow Layer simulation the AXIS 330 will change the thickness of the snow layer from 0m to 1m. In this case no other parameter is asked except the centreline of the graphic.

3.2.2 Error range

Next step of the numeric data entry is the error range selection that includes the entry for max and min error as well as the error increment step.

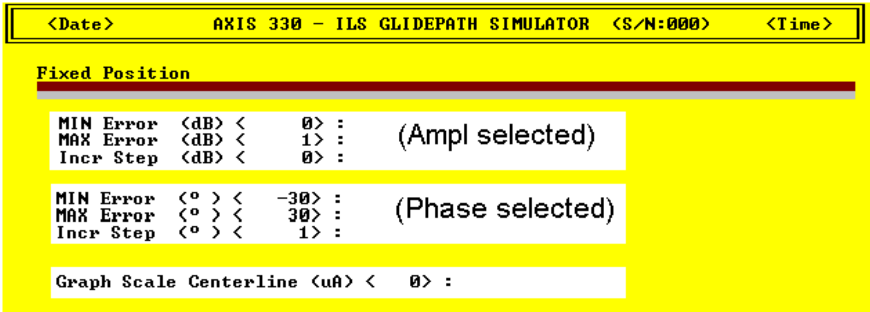


Fig. FIX303 Data entry for the error range

Note: For amplitude errors, enter the error in dB's and for phase errors, enter the error in degrees.

3.3.1 Start Value of the Error

`MIN Error (dB,°)     <  -10>:`

The MIN error is the start value of the error simulation and the value should be the lowest number.

3.3.2 End Value of the Error

`MAX Error (dB,°)     <   10>:`

The MAX error is the end value of the error simulation and the value should be the highest number.

3.3.3 Increment Step of the Error

`INCR. Step    (dB,°)     <    1>:`

The INCR.Step is the value of the calculation step.

Note: The value must be a positive number.

3.3.4 Scale Center

`Graph Scale Centreline (uA)      <  0 > :`

The scale center can be offset to zoom in small changes around any deviation value.

Note: If (D)isplay-toggle is selected as a TABL the scale center is disabled.

4. Toggles

There are six toggles in the fixed position mode allowing you quickly change some of the often used settings.

Pressing the key shown between the brackets will execute the function.

4.1 d(B) or %

Selection for the amplitude diagrams (CSB or SBO) y-axis unit

%	Amplitudes will display in percent
dB	Amplitudes will display in decibel 10 dB/div

4.2 (D)isplay

Selection for the output of the computed results.

GRAF	Computed result will be displayed in graph form
TABL	Computed result will be displayed in table form

4.3 (E)rase

Selection for erasing the earlier computed data.

OK	the old data in the memory will be erased and a new curve may now be computed
DATA	the memory still contains the last results, and the curve may be displayed again with altered toggle or scale settings.

4.4 (I)ncr x

Selection for the x-axis increment factor during computation.

The factor will decrease the selected increment step in order to increase the resolution of the curve.

1	Resolution will be as selected for increment step
½	Double resolution
¼	Resolution will increase by four

4.5 (N) Points

Selection for the number of fixed points

1	One fixed point will be handled
2	Two fixed points will be handled

4.6 (P)arameter

Selection for the parameter to be displayed in graph diagram

CDI	selection between CDI in uA and %DDM
Ampl	SBO- and CSB-amplitude
CSB	CSB-amplitude
SBO	SBO-amplitude
Phase	the SBO/CSB phase

Note: The amplitude-display is depending on the toggle (A)mplitude.

5. Commands

There are six commands in Fixed Position Data Panel that is used to control the program execution or to allow to enter numeric data.

5.1.(2) Change

The Change command is used to modify the receiver location(s). See chapter 3. Data Entry of this section.

5.2.(3)Text

This command is used to change the description text line to be shown in the graphic diagram.

5.3. (4)FSD and (7) Center of scale

Graph Full Scale Deflection

[FSD: (±) 800, 400, 200, 100, 50, 25, 12, 6 (uA)]

Default value in this mode is 50uA on the full vertical scale, but can be changed to any of the indicated values. Move the cursor with the Left-Right arrow keys and press <Enter>.

5.4 (5) Errors

This command is used to set the Error Parameters to be examined and the amount of errors to be introduced. See section 3.

5.5 (6) Excel

Note: *This command is only shown and enabled when the Display-toggle is selected as a TABL.*

With this command you can generate an Excel readable file.

When the <6> is pressed the AXIS 330 asks the name of the file as follows:

Current file name 'DATA.XL' <CR> or enter new:

The default name is 'DATA.XL' . Type a new name or just press <Enter> to keep the default name. The name must be according to the DOS specification otherwise it will be truncated (name = 8 letters and extension = 3 letters).

After the file name is entered this command will be shown as a filename between angle brackets. To disable this function press <6> again and the original command text (6)Excel is displayed.

5.6.(Esc)=Menu

The Esc key returns the program execution into the Main menu.

5.7.Continue <CR>

Starts the fixed mode run.

6. Table display

If the Display-toggle is selected as a TABL the computed results will be displayed as a list of the parameter values. This will also enable an Excel readable file to be saved on the disk if the (6) key is pressed.

Before the execution of the list the user is asked if the list should be printed out.

Hardcopy of Results ? (y) or <SPACE>

Enter Y or <SPACE> if the results should be printed out.

The display will stop while the screen is full and the user is asked to hit any key to continue.

That will be repeated until all computed results are shown.

The list includes the following parameters:

(x)	Error value
CDI	Course deviation in uA or %DDM
CSB	Course CSB-amplitude
SBO	Course SBO-amplitude
Phas	Course Phase between CSB and SBO
C-CDI	Clearance deviation in uA
C-CSB	Clearance CSB-amplitude
C-SBO	Clearance SBO-amplitude
C-Phas	Clearance Phase between C-CSB and C-SBO

<Date> AXIS 330 - ILS GLIDEPATH SIMULATOR <S/N:000> <Time>

(x)	CDI(µA)	CSB	SBO	Phase
-13.00	-2.47	197.4	2.36	96
-12.00	-2.10	197.4	2.16	96
-11.00	-1.76	197.4	1.96	95
-10.00	-1.45	197.4	1.76	95
-9.00	-1.17	197.4	1.56	94
-8.00	-0.93	197.4	1.36	94
-7.00	-0.71	197.4	1.16	94
-6.00	-0.52	197.4	0.96	93
-5.00	-0.36	197.4	0.75	93
-4.00	-0.23	197.4	0.55	92
-3.00	-0.14	197.4	0.35	92
-2.00	-0.07	197.4	0.15	93
-1.00	-0.03	197.4	0.05	265
0.00	-0.03	197.4	0.25	269
1.00	-0.05	197.4	0.45	269
2.00	-0.11	197.4	0.65	268
3.00	-0.19	197.4	0.85	268

hit any key ...

Fig. FIX601 The typical screen for table display results of the fixed position mode for antenna A3 phase error

7. Graphic Display

When the Display-toggle is selected as a GRAPH the computed results will be displayed as a graphic diagram.

7.1 Graphic Diagram

The graphic diagram includes all information that is set in data panel.

On the second line is shown the position of the fixed points.

In the upper right hand part of the graph can be seen the correlation factor and the response ratio in case of two fixed points are entered.

Additionally on the bottom row there are four functions available enabling the handle the graph result.

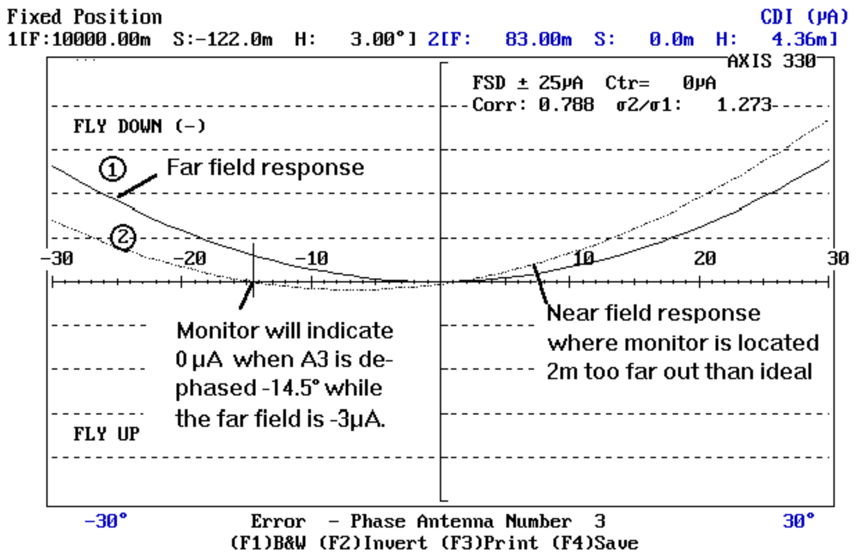


Fig. FIX701 The typical graphic diagram of the fixed position mode in case of A3 phase error.

7.1.1 Position of the fixed points

In the second row of the screen is shown between the angle brackets the position(s) of the fixed point(s) where

- F: forward position
- S: sideway position and
- H: height

7.1.2 Correlation factor

Corr:0.788

The correlation factor will tell how equal the curves respond to the same error range.

Best correlation is +1 and the worst is 0 (zero). A value of -1 indicates that the curves respond in exactly the opposite way. The correlation factor will also depends on the min and max error range. For monitor correlation examination the phase should not be more that ±20° and the amplitude ±5dB to be within the expected operating range.

7.1.3 Response ratio

$\frac{1}{10}$2/$\frac{1}{10}$1: 1.273

The response ratio $\frac{1}{10}2/\frac{1}{10}1$ indicates how much curve 2 changes in amplitude compared to curve 1. The ideal ratio is 1, but if curve 2 shows only half the amplitude variation, the ratio will be 0.5. The correlation factor might still be +1 in this case meaning the curves are similar in appearance except for the Y-scale deflection.

7.2 Functions

The functions of the graph display are

(B)&W Black & White to Colour Selector
(I)nvert Display invert the colours for cut & paste purposes (4)
Save Save a B&W graph for later play back

7.2.1 (B)lack & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The B-key will turn the graph into black background and white lines. Repeating the B-key will restore the colour display.

7.2.2 (I) Display Inverter

(I)nvert

This function will invert the colours of the display. In the colour display the colours will be changed to their complementary-ones.

7.2.3 (3) Printout

This function is obsolete and no longer in use.

GND

Ground Current Mode

Table of Content

1. Description

This mode visualises the ground current induced on the reflection plane, yielding the total reflected signal from the ground plane.

This mode is used to compare the available reflection plane area to the actual system requirements and get an impression of where the signal reflections basically takes place in around the antenna system.

Calculating the ground current is useful to determine whether a reflection plane area is sufficient to reflect the entire distributed ground current and will also indicate which area is sensitive or critical for ground movements. The currents can be displayed either two or three dimensionally.
When the reflection plane is limited, changes in system feeds will be seen to have significant impact on the signal quality along the approach path.
The M-ARRAY glide path can often be optimized to operate satisfactory under such environment.

2. Data Panel

The data panel shows the values and settings to be used in ground current calculation.

The data panel consists of three main parts

1. the numeric data
2. the toggle panel
3. the commands.

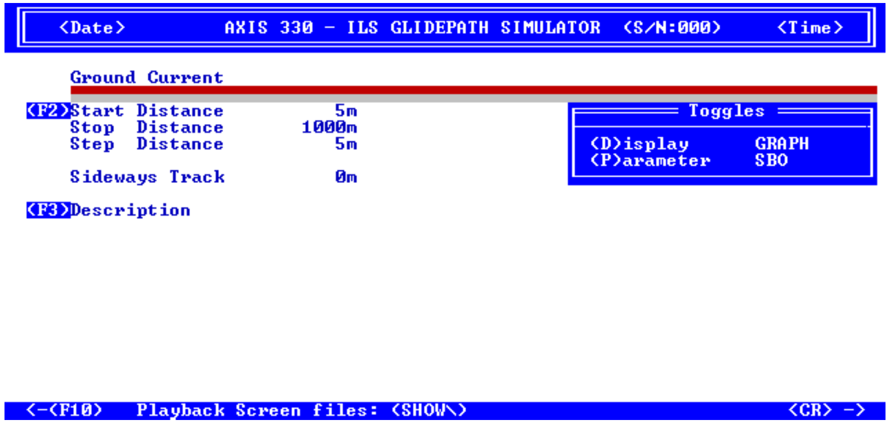


Fig. GND201 The data panel of the ground current mode

Numeric data

The numeric data show the values to be used in the computation. The numeric data are entered by (2) Change command key.

Here is a brief description of the numeric data:

Start Distance	The start distance from the GP mast
Stop Distance	The stop distance from the GP mast
Step Distance	The computation distance increment. In three dimensional mode it will be the grid size.
Sideways Track	The sideways distance from the GP mast. Negative numbers towards the runway.

Toggles

There are two toggles in the Data Panel controlling the computing result.

(D)isplay	The selection between two or three dimensional graphic (GRAPH,3D) and table (TABL).
(P) arameter	The selection between CSB, SBO and CLR.

Commands

(2) Change — Activate a numeric data entry for changing one or more numeric data

(3) Text — Entry for a text line (Description) to be displayed in graph screen

(6) Excel — Enable an Excel readable file to be generated

Note: This command is only shown and enabled when the Display-toggle is selected as TABL.

(Esc)=Menu — Return to Main menu

<CR> Continue — Starts the ground current computation

3. Data Entry

The numeric data are entered by the <2> command allowing to change one or more items.

The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

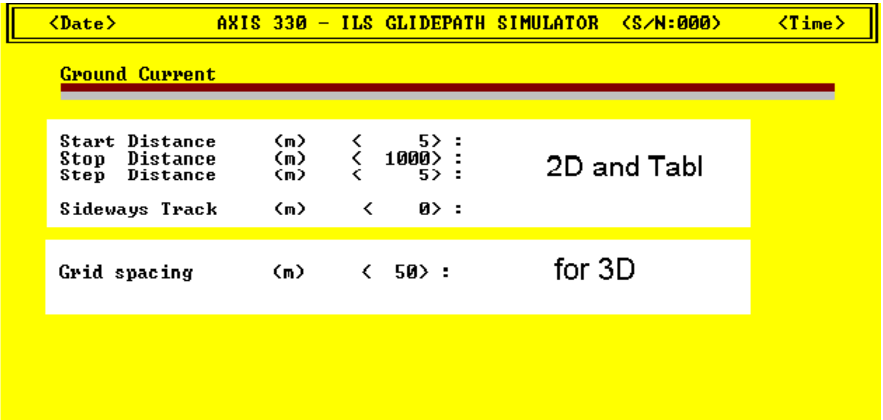


Fig. GND301 Ground current numeric data entry.

The data entry is depending on the selection of the Display-toggle.

In the GRAPH and TABL the data entry comprises in the Start-distance, Stop-distance, Step-distance and Sideways Track.

Whereas in the 3D selection only the grid spacing is entered. The Start- and Stop-distance are entered in 2D mode. In other words if you want to change Stop- and Start-Distance for the 3D-mode, you have to select Display-toggle as a GRAPH temporarily.

3.1 Start Distance

Start Distance (m) < 5>:

The distance where the computation will begin (the closest to the antenna system). The default value is 5m.

3.2 Stop Distance

Stop Distance (m) < 1000>:

The distance where the computation will stop. The default value is 1000m.

3.3 Step size

3.3.1 Step Distance

`Step Distance  (m)   <   5>:`

The Step Distance is a distance increment between each computation.

The default value is 5m in the state of the Display-toggle "GRAPH".

The default value is 50m in the state of the Display-toggle "TABL".

3.3.2 Grid Spacing

`Grid Spacing   (m)   <  50>:`

The Grid Spacing defines a grid size for 3D-mode for setting a coarser or a finer grid pattern. .

3.4 Sideways Track

The Sideways Track distance is referred to the centreline in front of the GP mast.

Note: *This Entry is only done for Table or 2D graphic. The 3D graphic will always display the fixed area from -150m to 250m sideways from the GP mast.*

4. Toggles

4.1 (D)isplay

The Display-toggle is used to select display mode between 2D- or 3D-graph or table form. 2D Two-dimensional graph will be displayed. The 2D graph will show a straight line (in dB's) according to the numeric data settings.

GRAPH Computed results will be displayed as two-dimensional graphic.

TABL Computed results will be displayed in table form. This selection also enables an Excel readable file to be generated. The <6> command key invokes this file generation.

3D Three-dimensional graph (carpet) will be displayed. The 3D graph will show the entire reflection plane from Start- to Stop-distance in front of the GP mast with a selected grid resolution.

4.2 (P)arameter

The Parameter-toggle is used to select either CSB, SBO or CLR ground current.

CSB Ground current of the CSB-signal will be displayed.

SBO Ground current of the SBO-signal will be displayed.

CLR Ground current of the Clearance-signal will be displayed if the clearance signal is switched on.

5.Commands

5.1 (2) Change

The Change command is used to modify the values of the numeric data used in the computation. See chapter 3. Numeric Data Entry of this section.

5.2 (3) Text

The entry for text line (Description) to be displayed on the graph.

Description nnnn

Enter New Text : |

Enter new text (max 21 letters) or just press <Enter> to keep the present one.

5.3 (6) Excel

Note: *This command is only shown and enabled when the Display-toggle is selected as a TABL.*

With this command you can generate an Excel readable file.

When the <6> is pressed the AXIS 330 asks the name of the file as follows:

Current file name 'DATA.XL' <CR> or enter new:

The default name is 'DATA.XL' . Type a new name or just press <Enter> to keep the default name. The name must be according to the DOS specification otherwise it will be truncated (name = 8 letters and extension = 3 letters).

After the file name is entered this command will be shown as a filename between angle brackets. To disable this function press <6> again and the original command text (6)Excel is displayed.

5.4 (Esc) Menu

Function key <Esc> returns the program execution into the main menu.

5.5 <CR> Continue

Starts the ground current computation.

6. Table display

If the Display-toggle is selected as a TABL the computed results will be shown as a list of the parameter values. This will also enable an Excel readable file to be saved on the disk if the (6)Excel command key is pressed.

Before the execution of the list it is asked if the user want to take the results to the printer.

Hardcopy of Results ? (y) or <SPACE>

Enter Y (or another letter if the language is not English) if the results should be printed out.

The display will stop while the screen is full and the user is asked to hit any key to continue.

That will be repeated as long as the all computed results are shown.

The list includes the following parameters:

(x) Distance from the GP mast in meters

CDI(uA) not applicable

CSB CSB-amplitude

SBO SBO-amplitude

Phase Phase between CSB and SBO

<Date> AXIS 330 - ILS GLIDEPATH SIMULATOR <S/N:000> <Time>

(x)	CDI(µA)	CSB	SBO	Phase
5.00	0.00	5780.1	797.45	201
55.00	0.00	1515.3	119.80	214
105.00	0.00	646.8	172.13	148
155.00	0.00	322.4	86.86	107
205.00	0.00	189.9	49.45	84
255.00	0.00	124.5	31.53	69
305.00	0.00	87.8	21.79	58
355.00	0.00	65.1	15.95	50
405.00	0.00	50.2	12.18	44
455.00	0.00	39.9	9.60	39
505.00	0.00	32.5	7.77	35
555.00	0.00	27.0	6.42	32
605.00	0.00	22.8	5.39	29
655.00	0.00	19.5	4.59	27
705.00	0.00	16.8	3.96	25
755.00	0.00	14.7	3.45	23
805.00	0.00	13.0	3.04	21

hit any key ...

Fig. GND601 The table output of the ground current

7. Graphic Display

7.1 Graphic diagrams

7.1.1 Two-dimensional graph

The two-dimensional graph calculates the current along a line parallel to the runway centreline at a selected distance from the GP centreline. showing the current in dB's.

The 0dB level is a Cat III limit value that will produce a diffracted signal at the edge yielding 2uA bends. If there is a secondary reflection plane below and beyond the truncation, the reflected diffracted signal will add to it and make a worst case of 4uA bends.

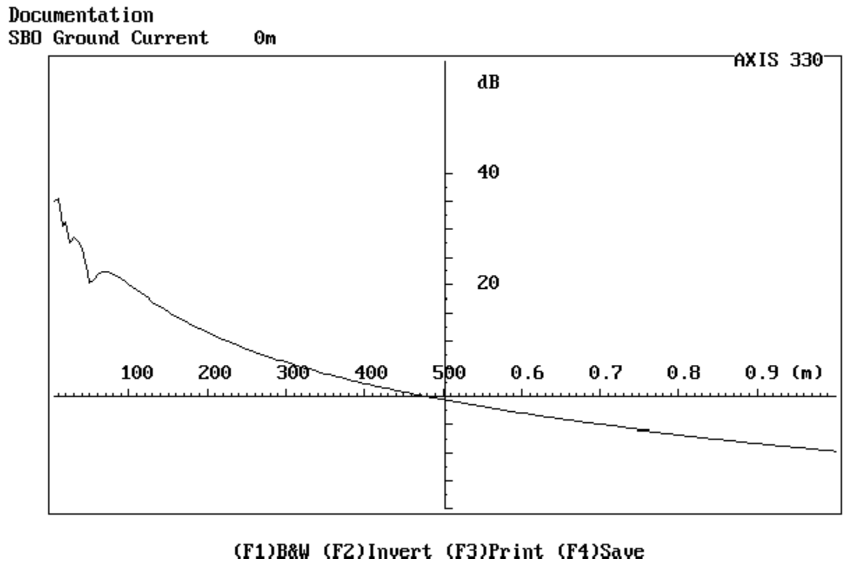


Fig. GND701 Typical 2D-graph of the M-array SBO ground current.

7.1.2 Three-dimensional graph

The three-dimensional graph makes similar calculations along many parallel lines side by side. All calculations are made 50m apart in a grid pattern. The currents are shown as linear values rather than dB's to give a better visual view of the current distribution on the reflection area. Showing the ground current is useful to determine whether a reflection plane area is sufficient to reflect the entire distributed ground current and will also indicate which area is sensitive or critical for ground movements.

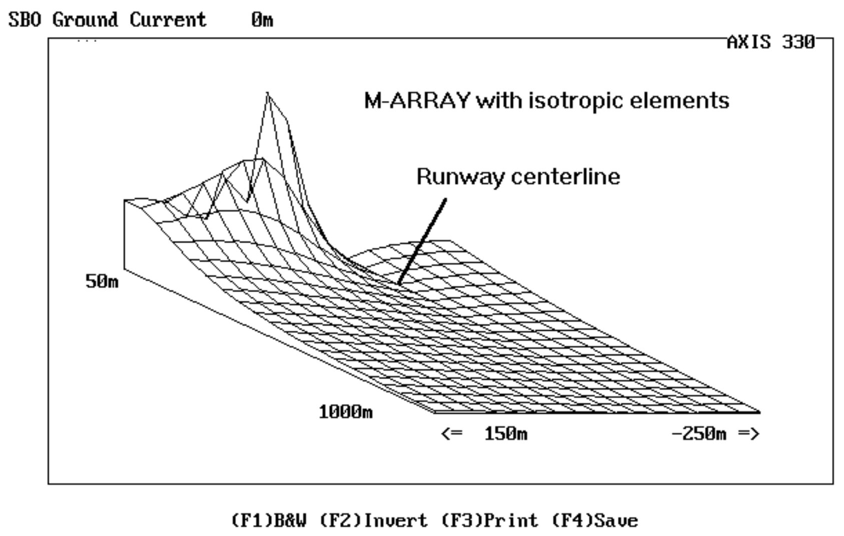


Fig. GND702 The SBO ground current for the M-ARRAY system.

7.2 Functions

The functions of the graph display are

(B)&W	Black & White to Colour Selector
(I)nvert	Invert the display colours for cut & paste purposes
(4)Save	Save a B&W graph for later playback

7.2.1 Black & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

7.2.2 Display Inverter

`(I)nvert`

This function will invert the colours of the display for later grabbing and pasting the figure into a document. In the colour display the colours will be changed to their complementary ones.

7.2.3 Printout

This function is obsolete and no longer in use.

7.2.4 Graph Saver

`(4)Save`

Note: This function is enabled and displayed only when the screen is selected as black & white.

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically, and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory by the PgUp/PgDn keys. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

Blank page

BND

Bend Analysis Mode

Table of Content

1. Description

The Bend Analysis mode includes two options

1. Analyse Bend
2. Make Bend.

The Analyse Bend option is used for finding the possible origin of reflections that produce bends on the GP signals. Make Bend option is a reverse process and is used for tutorial purposes.

Analyse Bend Option

The Analyse Bend option is based on the entered bend wavelengths and their location along the flight path, which can be read from the flight measurement recordings.

Every entered bend-point (max 6) is then computed and plotted as a hyperbolic curve on the horizontal plane. The hyperbolic curve represents a line where the reflection source must be located to cause the observed bend pattern. The possible origin of the reflection object(s) can be found where the hyperbolic curves intersect, or as we often say, the curves converge into a solution. If the curves do not intersect each other, we have no result or in other words, a divergent solution.

The horizontal surface on which the hyperbolic curves are drawn, is called the projection level. This level can be raised to any level to be able to find high reflection objects.

Make Bend Option

The Make Bend option is started with entering the known location of the reflecting object. The theoretical bend wavelengths are then computed at the entered distances (max 6). These points will be converted into hyperbolic curves in order to give analysing exercise when the answer is known.

2. Analysing process

The first step in analysing bend from an approach on a given elevation angle is to select some periodic-like bends at different distances.

As the bend length vary along the approach path, momentary values should be found. Use only a half or quarter bend wavelength from the curve to determine the distance as exact as possible. Convert the fractional bend length to one wave-length at this distance by multiplying it by two or four.

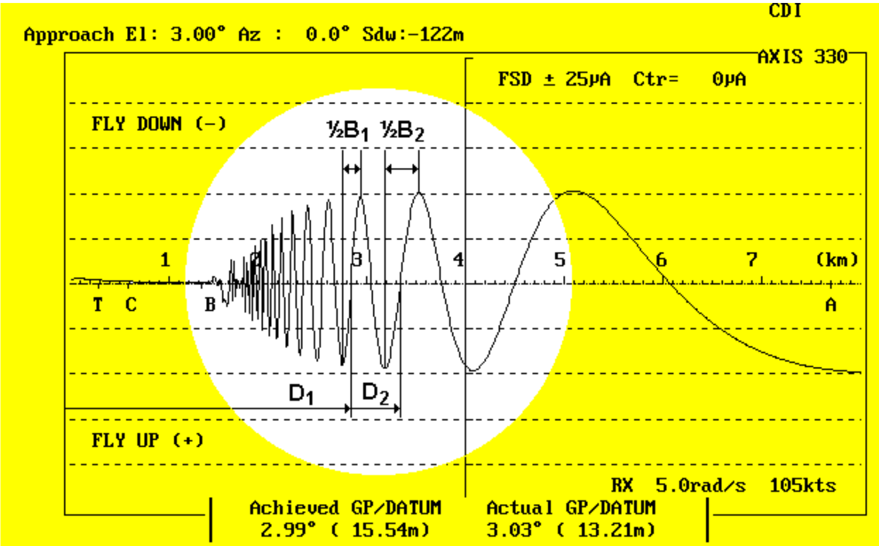


Fig. BND201 Bend selection using a half bend wavelength (½B),
D=distance to bend center.

The bend length corresponds to an angle between the direct and incident reflect-ed signal given by

$$\square = \cos^{-1}(1-2\overline{)21}/ \text{Bend length}) \qquad \text{(formula BND201)}$$

when approaching towards the glide path.

This angle represents the opening angle in a cone, whose intersection with the terrain gives the geometrical solution for the possible origin of the reflec-tion object. This intersection forms a hyperbolic curve on the ground.

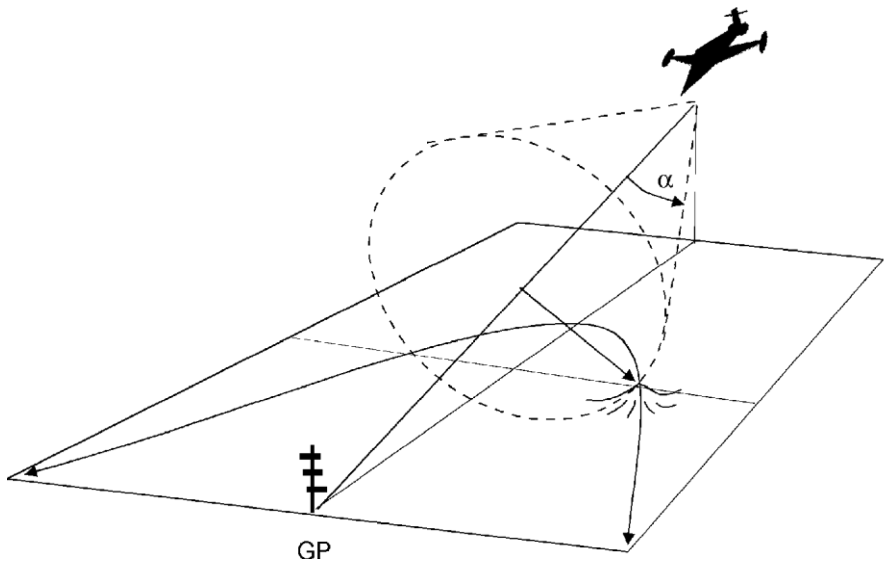


Fig. BND202 The hyperbolic curve represents the projection of the opening angle in a cone.

After entering two or three selected points, the software will calculate the incident angle of the reflected signal, and project this angle on a flat ground as hyperbolic curves. If the reflection object is located near this flat ground, these hyperbolic curves will converge at the reflection object. If the object is located at a higher position, the curves may diverge (not cross but lay inside each other) or converge at a different location.

The next step in analysing the bends will be to interpret the hyperbolic curves. It takes a lot of experience on known objects to do this properly.

Reflection object analysis will often give two solutions to point out of the origin of the reflected signals.

By using the <2>key Make Bends option, bend lengths can be computed for different distances when the coordinates of a known reflection object are entered.

3. Data Entry

The data is entered in two parts

1. approach path location and option selection
2. data entry for bends or reflection object depending on the selected option

The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

```
<Date>        AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

Bend Analysis

Approach Elevation Angle   (°)  <    3> :
Sideways offset           (m)  <  -122> :

<F2>Make Bends     <CR> Analyze Bends
```

Fig. BND301 First part of data entry in bend mode

3.1 Approach path location and option selection

3.1.1 Approach Elevation Angle

Approach Elevation Angle (°) < 3>:

Enter the elevation angle which was used during the run to be analysed.

3.1.2 Sideways Offset

Sideways Offset < -122>:

The distance from the GP mast to the approach path, normally the runway centerline. A zero means the flight took place directly towards the GP mast.

Negative values are towards the runway.

3.1.3 Option Selection

(2) Make Bends <CR> = Analyse Bends:

This is the end of the first part of the data entry and the second part of the data entry depends on the selected option.

Press the <2> key for Make Bend option or <Enter> for Analyse Bend option.

3.2 Analyse Bends Option

At first in this option is asked how many bend-points will be entered and after that it is asked to enter every point.

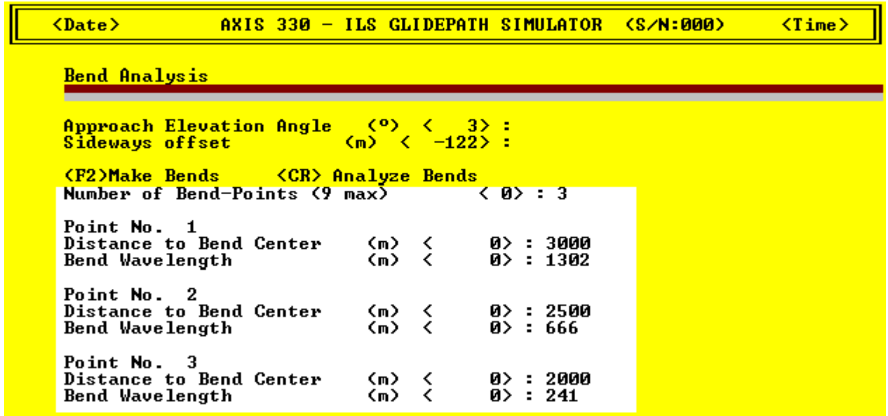


Fig. BND302 Data entry for Analyse Bends Option

3.2.1 Number of Bend Points

Number of Bend Points (6 max) < 3>:

Enter the number of bend point from a flight inspection approach curve to be entered. The next two items will be repeated for each point.

Note: *If higher number than 6 is entered the maximum number (6) will be entered. If smaller number than 1 (zero or negative) is entered the AXIS 330 will return to the Main menu.*

3.2.2 Distance to Bend Center

Distance to Bend Center (m) < 3000>:

The distance from the GP mast to the midpoint of the selected bend point on the flight inspection curve.

3.2.3 Bend Wave Length

Bend Wave length (m) < 1302>:

The Bend wave length in meters measured from the flight measurement record.

Note: *Measure only a fraction of the bend, as their bendlength will vary even over one single bend wave length. Usually a quarter of a bend wave length is picked on the graph. Multiply the measured value by four to convert it to a full wave length for the entry.*

3.3 Make Bend Option

This option is for tutorial purposes and is first entered as a scattering object as in the Control Panel. Then the position of the desired object is entered.

There are two types of scattering object available.

1. (5)Top is simulating a semispheric terrain object and is used to simulate hills or any other limited size object
2. (6)Ground is simulating a discontinuity of the reflection plane.

Press <5> for Top and <6> for Ground. By pressing <Enter> the AXIS 330 will exit from the Bend Analysis mode and return to the Main menu.

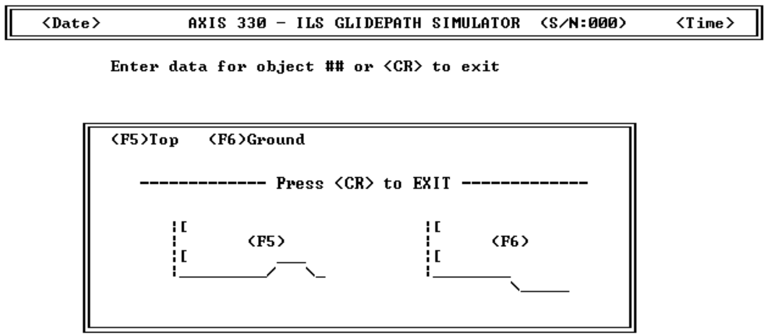


Fig. BND303 Data Entry Selection in Make Bend Option

3.3.1 (5)Top

Forward Distance

The forward distance is the longitudinal distance between the GP mast and the midpoint of the object measured along the centreline.

Note: If the entered distance is zero the entry is cancelled.

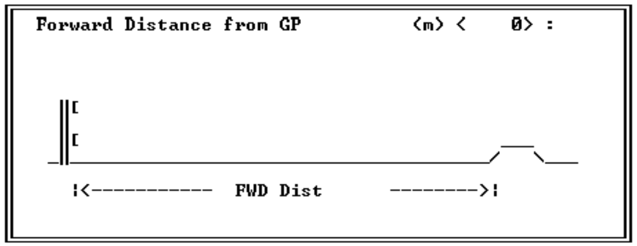


Fig. BND304 Display for entering the forward distance of the object

Sideways Distance

The sideways distance is the lateral distance between the GP-centreline and midpoint of the object. Use negative values towards runway regardless of if it is to the right-hand or left-hand side of the GP antenna.

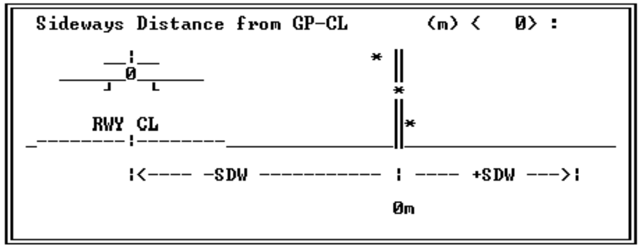


Fig. BND305 Display for entering the sideways distance of the object.

Height Above GP zero

The height of the scattering object above GP zero can be entered in meters or vertical angles.
Use <2> to toggle between the meter and the angle entry mode.

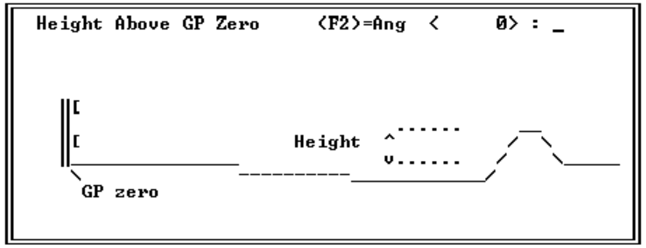


Fig. BND306 Display for entering the height above GP-zero.

3.3.2 (6)Ground

Forward Distance from GP

The forward distance is the longitudinal distance between the midpoint of the ground edge and the GP mast measured along the GP-centreline.

Note: If the entered distance is zero the entry is cancelled.

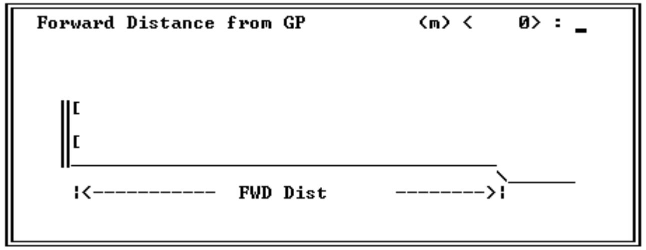


Fig. BND307 Display for entering the forward distance of the ground edge.

Sideways Distance (normally zero)

The sideways distance is the lateral distance between the GP-centreline and the reference point on the edge (normally zero). Use negative values towards runway regardless if it is to the right-hand or left-hand side of the GP antenna.

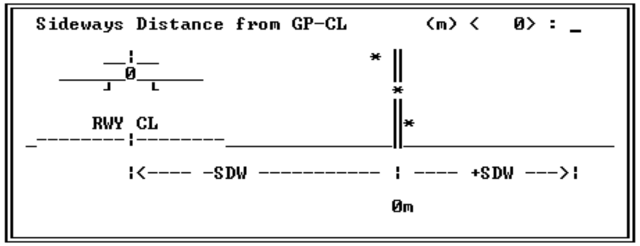


Fig. BND308 Display for entering the sideways distance of the object.

3.3.3 Distance(s) where bends are computed

The software is asking repeatedly to enter distances where the bends are computed until a zero is entered or the maximum number of 6 distances are entered.

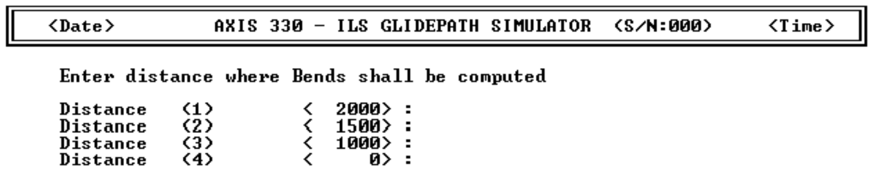


Fig. BND309 Three distances are entered in Make Bends Option.

3.4 Data Panel

In the Data Panel are shown

1. Entered (analyse option) or calculated (make option) bend points
2. Computing and graphic control data
3. Command row

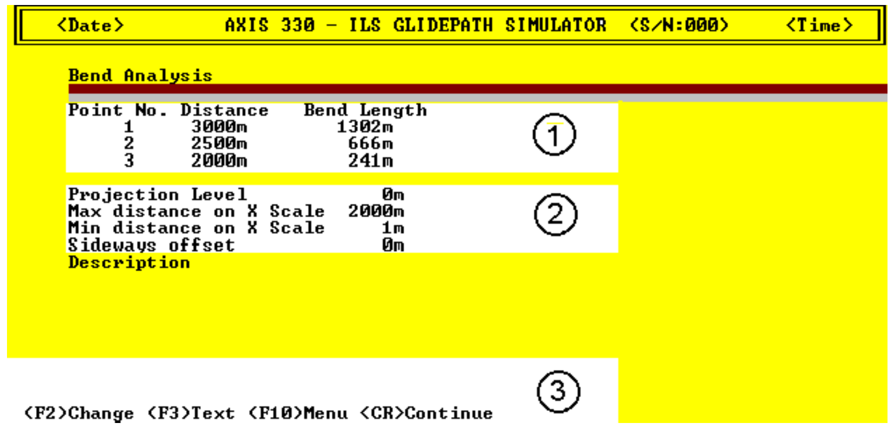


Fig. BND310 Data Panel of the Bend Analysis mode

3.4.1 Bend points (1)

A list of entered points include the point number, distance and the bend wave-length.

Note: *These values cannot be changed in the data panel. These points will be shown as the hyperbolic curves in the graphic.*

3.4.2 Projection level and Graphic scales (2)

These data values can be changed with (2) command and represent the initial settings of the graphic. In the graphic screen these values can be changed with position adjustment keys. See chapter 5 Graph Diagram.

Projection Level

The level where the hyperbolic lines will be projected.

Max Distance on X-scale

The end point of the X-scale in graphic.

Min Distance on X-scale

The start point of the X-scale in graphic.

Sideways offset

Lateral offset of the GP mast and the approaching path.

3.4.3 Command row (3)

The commands effect the program execution or allow to enter some numeric data directly.

(2) Change — Change the initial settings of the projection level and the graphic scales.

(3) Text — Enter a text line to be displayed with the graph diagram

(Esc) Menu — Return to main menu

<CR>Continue — Start computing

4. Commands

4.1 (2) Change data

The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

```
<Date>        AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

Bend Analysis

Projection Level          (m)  <     0> :
Max distance on X Scale   (m)  <  1500> :
Min distance on X Scale   (m)  <     0> :
Sideways offset           (m)  <     0> :
```

Fig. BND401 Change data entries in Bend Analysis mode

4.1.1 Projection Level

Projection level of lines (m):

The hyperbolic lines should be projected on to a level corresponding to the height of the reflection object. Cut and try with different levels when the origin of the object is known in order to gain experience in using this feature.

The + and - keys are used for level shift when the graphic screen displays the lines.

4.1.2 Max Distance on graph X-scale

Max distance on X-Scale <3000>:

To adjust the display maximum scale along the distance axis. To find an optimum value, one has to see the first set of graphic curves to see how far these curves extend.

4.1.3 Min Distance on graph X-scale

Min distance on X-Scale < 0>:

To adjust the display minimum scale along the distance axis. To find an optimum value, one has to see the first set of graphic curves to see where these curves begin.

4.1.4 Sideways offset

Sideways offset (m) < -122> :

The sideways offset represents the lateral distance from the GP-centreline to the flight path.

Note: *The negative sign means the distance is measured towards the runway from the GP-antenna. The positive value shows the distance away from the runway.*

4.2 (3) Description

Description nnnnnnnnnnnnnnnnnnnn

Enter new Text _ |

Type the new text (max 21 characters) that should go along with the graph or just press <Enter> to leave the present text.

Note: Any longer text than 21 characters will be truncated.

4.3 (Esc) Menu

Use the <Esc> key to escape to the Menu if desired. The <Esc> will stop executing and escape from anywhere in the program to a higher level.

4.4 <CR> Continue

Starts the graphic screen computation of the Bend Analysis.

5. Graph Diagram

5.1 Graphic Screen

The result of computation are hyperbolic curves which represents the possible origin of the bends on the chosen projection level.

Every bend-point will have its own curve and in case of the common "bend source" object the curves will be crossing each other. How to find the origin of the bends is described in chapter 6. of this section.

At the bottom row are shown the keys to be used to modify the graphic result. These keys are divided into two groups :

1. position adjustment keys "[± 2 23 235 2 4 11 92 8 PgUp PgDn]"
2. keys "(B)&W) (I)nvert (3)Print (4)Save".

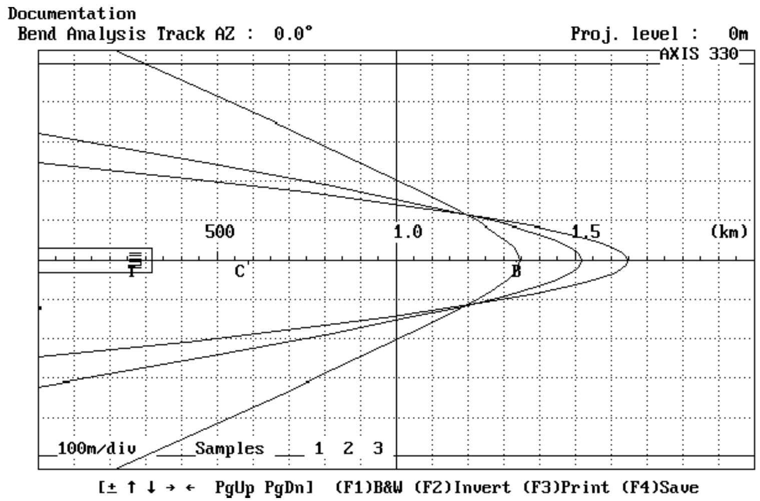


Fig. BND501 A typical Graph screen in the Bend Analysis mode after three entered bend points.

5.2 Position Adjustments

[± 2 235 23 2 8 92 11 4 PgUp PgDn]

For zooming in there are four adjustable position parameters in graph :

1. Projection level (+ , - keys)
2. Y-offset adjustment (2 8 , 235 92 keys)
3. Minimum distance (23 11 , 2 4 keys)
4. Maximum distance (<PgUp> , <PgDn> keys)

When pressing any positioning key the program execution goes to the adjustment mode and in the middle of the upper part of the graph there will appear the warning text

<Position is adjusted - Press CR to ReDraw>

5.2.1 Projection Level

[±]

We can change the projection level of the hyperbolic lines, so they are drawn on an imaginary horizontal plane at a selected height above the surrounding ground level. We are normally selecting a level that corresponds to the center of the reflection objects that can be found in the given area.

Using the + or - key will alter the projection level in 1m steps while in the graphic screen to ease the cut and try procedure of determining the location of a scattering object.

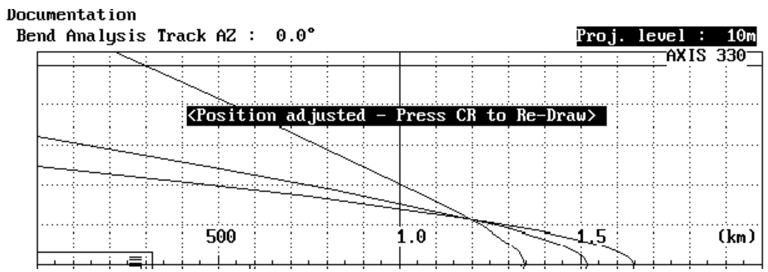


Fig. BND502 The graph screen when projection level is adjusted

5.2.2 Y-shift

[2235 892]

The <Up/Dn> arrow keys are used to move the center of the graph up or down in 10m steps.

The value of the parameter is stepped by <Up/Dn> arrow keys and the text field shows the value until you press <enter> for redraw or use another position key.

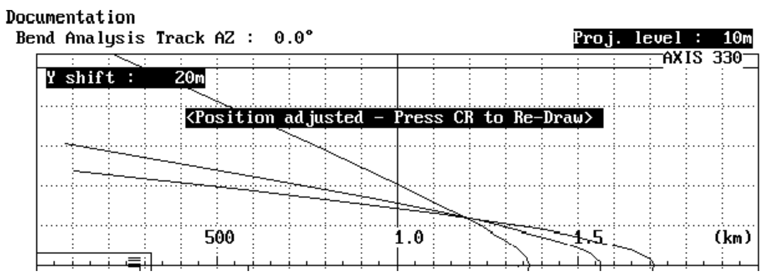


Fig. BND503 The graph screen when Y-shift is adjusted

5.2.3 Minimum Distance

[232 114]

The <Left/Right> arrow keys can be used to change the minimum displayed distance in 10m steps. <Ctrl-Left/Ctrl-Right> will change in 100m steps.

The value of the parameter is stepped by <Left/Right-arrows> and the text field is shown the value until you press <enter> for redraw or use another position key.

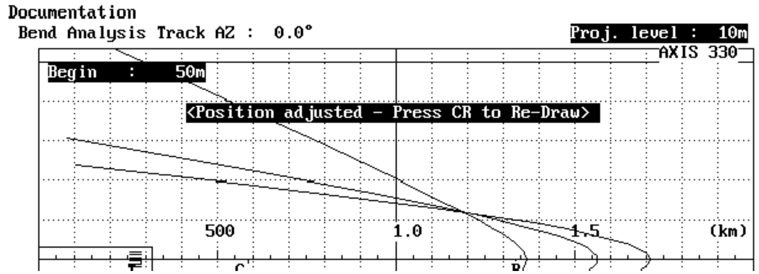


Fig. BND504 The graph screen when Minimum Distance (Begin) is adjusted

5.2.4 Maximum distance

[PgUp PgDn]

The <PgUp>,<PgDn> keys can be used to change the maximum displayed distance in 100m steps.

The value of the parameter is stepped by <PgUp>,<PgDn> keys and the text field is shown the value as long as you press <enter> for redraw or another position keys.

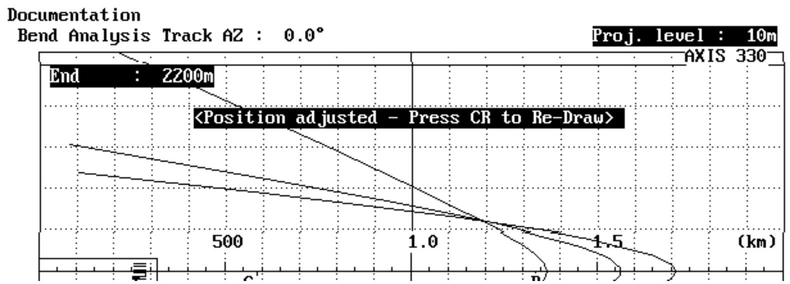


Fig. BND505 The graph screen when Maximum Distance (End) is adjusted

5.3 Functions

The functions of the graph display are

(B)&W	Black & White to Colour Selector
(I)nvert	Invert the display colours for cut & paste purposes
(2)Save	Save a B&W graph for later playback

5.3.1 Black & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

5.3.2 Display Inverter

(I)nvert

This function will invert the colours of the display for later grabbing and pasting the figure into a document. In the colour display the colours will be changed to their complementary ones.

5.3.3 Printout

This function function is obsolete and no longer in use.

5.3.4 Graph Saver

(4)Save

Note: *This function is enabled and displayed only when the screen is selected as black & white.*

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically, and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory by the PgUp/PgDn keys. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

6. Analysing examples

The following examples will show how to analyse when the answer is known. In order to show the principal effect of changing the projection level, the GP mast is in 6.1 and 6.2 located on the runway centreline.

6.1 Reflecting object at near zero height

A reflecting point located 1250m directly in front of a 3° GP, near the terrain level gives these bend-lengths at some distances, when flying directly towards the GP system:

Distance	Bend length
3000m	1302m
2500m	666m
2000m	241m

Entering these values give these hyperbolic curves, all converging at 1250m forward and 0m sideways distance from the GP.

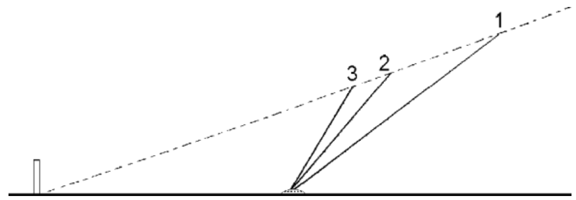


Fig. BND601 Projection of hyperbolic lines for an object in zero level

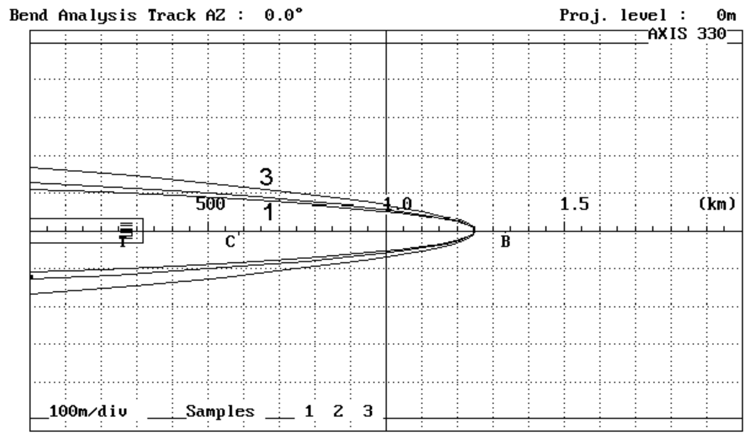


Fig. BND602 Hyperbolic lines for a reflecting point 1250m directly in front of the 3° GP, near ground level.

6.2 Reflecting object at 15m height

This example describes how to utilize the projection level adjustment.

We will now change the projection level of the hyperbolic lines, so they are drawn on an imaginary horizontal plane at a selected height above the surrounding ground level. We are normally selecting a level that corresponds to the center of the reflection objects that can be found in the given area.

Using the + or - key will alter the projection level while in the graphic screen to ease the cut and try procedure of determining the location of a reflection object.

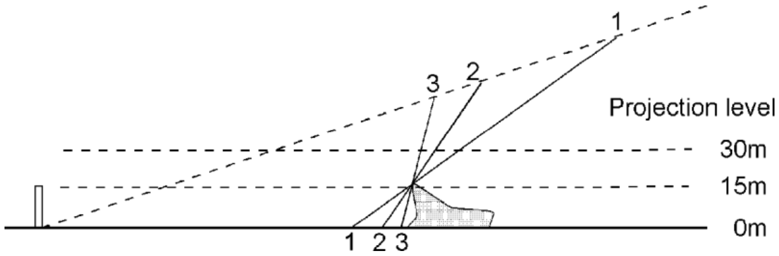


Fig. BND603 Projections of hyperbolic lines for an elevated reflection object.

We assume the reflecting point is located in the same position as in example 6.1. but now at 15m height above the terrain level giving the following bends:

Distance	Bend length
3000m	2188m
2500m	1118m
2000m	404m

Entering these values will give divergent hyperbolic curves that do not cross, but lay inside each other. See fig. BND606.

Lifting the projection level up to +15m will give the result where the hyperbolic curves are converging in one point. See fig. BND605.

Lifting the projection level up to +30m will give the result where the hyperbolic curves do converge, but give another solution. See fig. BND606.

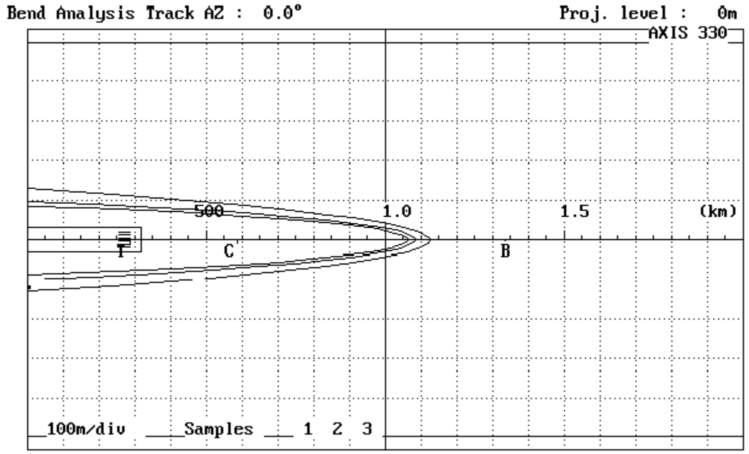


Fig. BND604 Divergent hyperbolic lines for zero level projection for a reflecting point 1250m directly in front of the 3° GP, elevated 15m. The curves are not touching each other - see fig. BND603 along the 0m projection level.

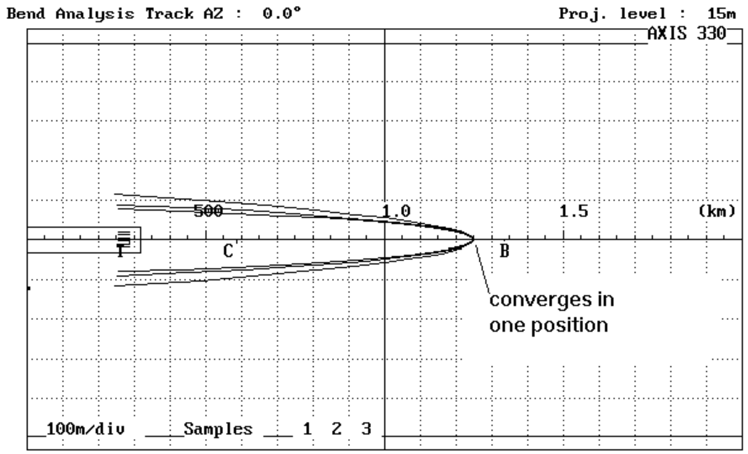


Fig. BND605 Convergent hyperbolic lines for +15m level projection for a reflecting point 1250m directly in front of the 3° GP, elevated 15m. The curves are touching each other at the object surface - see fig. BND603 along the 15m projection level.

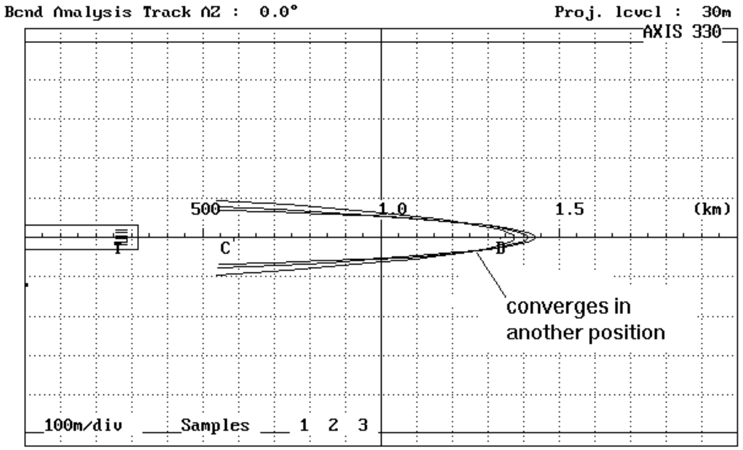


Fig. BND606 Convergent hyperbolic lines for +30m level projection for a reflecting point 1250m directly in front of the 3° GP, elevated 15m. The curves are converging at another location as they will not meet directly above the object - see fig. BND603 along the 30m projection level.

6.3 Reflecting object for a normal GP site

This GP is located at the nominal 122m (400') to the side of the runway. A reflecting point located 1250m directly in front of a 3° GP, at 10m height gives these bend-lengths at some distances, when flying along the runway centreline: (use <2> to compute the bend lengths)

Distance	Bend length
3000m	433m
2500m	201m
2000m	66m

The projection level is not critical when not flying directly towards the GP-mast. At the following graph, the hyperbolic curves seem to intersect at the object location even though the projection level is 0m.

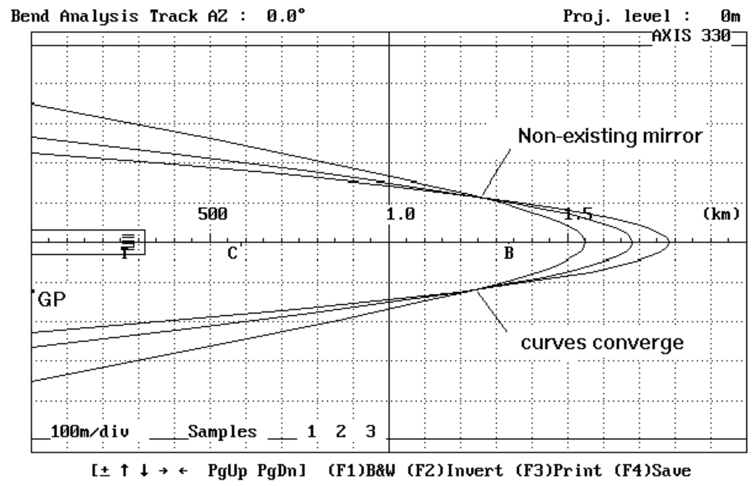


Fig. BND607 Hyperbolic lines for a 10m high reflecting object 1250m directly in front of the 3° GP. The curves converge very near the object location even when the projection level is 0m.

6.4 Convergence of the hyperbolic curves.

Bend analysis has several limitations. The three most important are:

6.4.1 Several reflection objects.

If there are several reflection objects, the bend patterns from each of them will interfere with each other so when in phase they will add to large amplitudes and when in antiphase, they may cancel. Picking bends from such a pattern may lead to divergent or misleading solutions. One good solution is to carefully observe the approach curve and select short portions that may look like periodic sine waves. Here is a good chance that one object dominates the bend pattern, and it may be possible to locate that. Further sine wave looking portions on the curve may be caused by another object, making it impossible to get a reliable result. If only one bend-point sample can be taken, this will produce only one hyperbolic curve. Use a local map and plot the curve on to it to see if it will come near a hill or any other suspected object seen at site survey.

6.4.2 The object falls inside the inversion point.

When a flight inspection makes an approach, the bend frequency gets a minimum and the bend phase inverts if the aircraft passes through the extended line between the GP-mast and the object. Measurements taken before this inversion point may not be suitable for bend analysing and may give divergent or misleading solutions. A convergent solution can only be expected when the object is located outside (away from the approach path) the direct line between the GP-mast and the receiver.

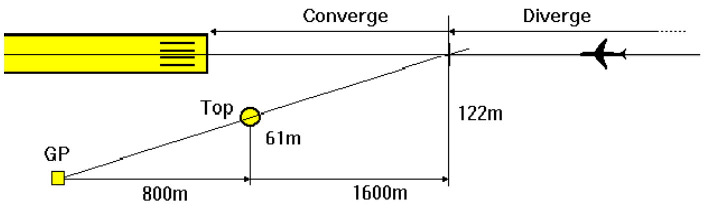


Fig. BND608 Null Reference GP with a Top (5) located 800m forwards, -61m sideways (halfway to the runway) and 5m high. A direct line from the GP-mast through the object will intersect the runway centreline at 1600m distance from the GP-mast.

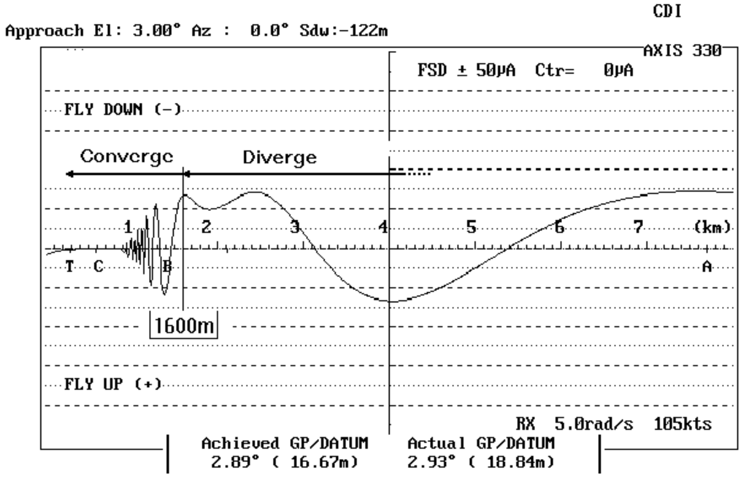


Fig. BND609 Bend pattern shows inverion taking place outside 1600m.

6.4.3 The actual flight path deviates from the ideal one.

The bend pattern is a cut through a complex volume of longitudinal and lateral waves. The bends will be shifted and change in appearance even for small deviations from the ideal track. The tracker or theodolite correction for deviation from the wanted track is only a fixed value for the assumed average displacement sensitivity making the curve look straight even when the aircraft is moving up and down from the intended track. This works fine when there are no bends on the curve. As soon as they appear, the theodolite correction will not be able to make the received bend pattern look like the pattern along the ideal track. For azimuth deviations from the localiser course line no corrections are done, but the bend pattern is likely to be different. It is practical impossible to fly exactly the same track twice, so for say 10 approaches none of them would be identical.

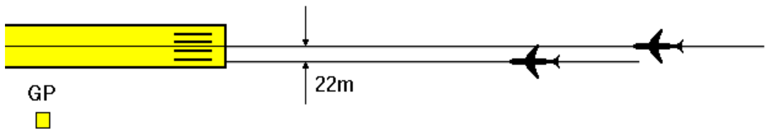


Fig. BND 610 A track along the localiser course line can be difficult to follow in windy conditions. The simulations in the next two figures were done with a track on the localiser course line and a track offset of 22m closer to the GP-mast.

The tracking example shows one constant track offset of 22m, corresponding to 0.3° azimuth at 4km distance. This may very well occur if there are varying crosswind along the track. When picking bend-points from a flight inspection curve, watch the tracker curves and do the corresponding offsets in the inputs for GP angle and azimuth offset.

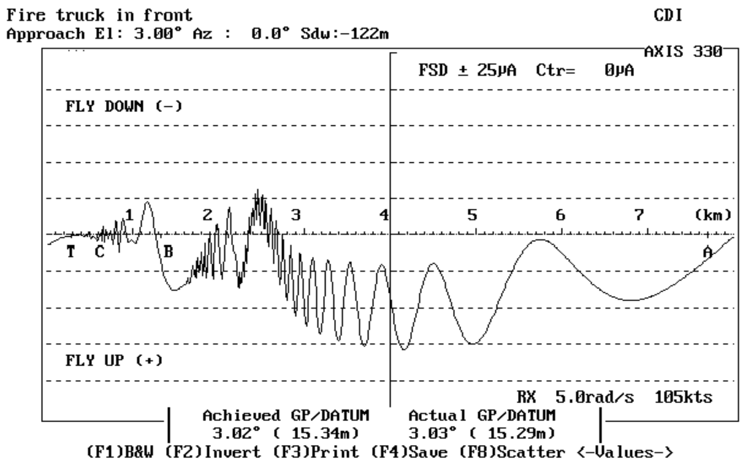


Fig. BND 611 A bend pattern following the ideal track along the localiser course line.

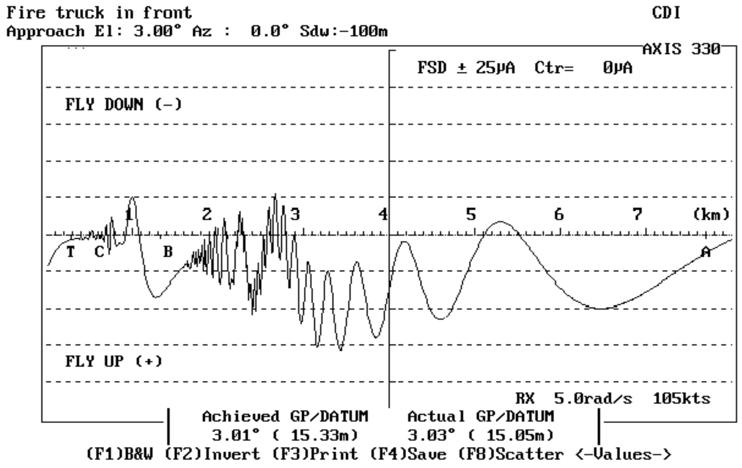


Fig. BND 612 The bend pattern when the airplane flies 22m closer to the GP mast all the way in. Note that the bend pattern seems to be shifted inwards.

SNS

Sensitive Area Mode

Table of Contents

1. Description

This module is a tool for finding the border of the sensitive area where a given object will produce bends of a pre- determined amplitude on the GP signals. The objective is to advise the airport authority in establishing movement restrictions for vehicles, taxing aircraft, lifting cranes, de-icing equipment etc.

ICAO Annex 10 limits the maximum bend amplitude as follows :

CAT I	30uA down to ILS point C
CAT II & III	30uA down to ILS point A
	from ILS point A decreasing at a linear rate to 20uA at ILS point B
	20uA down to ILS point T (ILS reference datum)

This will be the total in a bend budget consisting of the geometric sum of the static bends from fixed installations and the dynamic bends from moving objects.

The AXIS 330 will simulate the tailfin of a moving aircraft or any other metallic construction, move it around and optionally rotate it to find the worst-case orientation in producing the greatest bend amplitude along the selected receiver flight path or fixed location. Enter the amount of existing static bends and the AXIS 330 will compute and draw the sensitive area for the remaining allowed dynamic bends for any glidepath system and aircraft type.

A general consensus for allowed bends from moving objects, is that they should be restricted to 4µA each. This value is considered to just start small disturbances along the flight path. In AXIS 330, the default value is therefore set to 4µA.

2. Data Panel

The data screen shows the values to be used in the sensitive area computation.

The screen consists of four main parts

1. Numeric data
2. Scattering Object data
3. Toggles and
4. Commands.

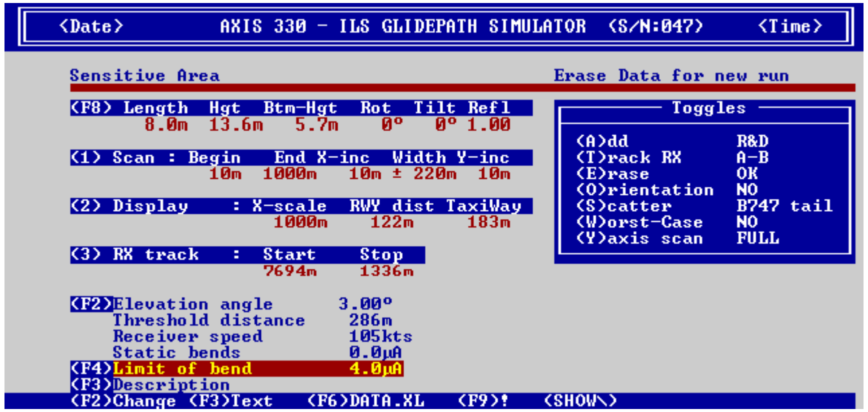


Fig. SNS201 The data panel of the Sensitive Area mode

2.1 Numeric data (1)

Numeric data shows the values to be used in the computation. The numeric data are divided into five group and can be changed by <1>,<D>,<R>,<2> and <4> keys.

Scan

Scan area is the area where the sheet is moved around

Begin	the longitudinal start from the GP mast
End	the longitudinal stop from the GP mast
X-inc	the longitudinal step increment
Width	the maximum lateral distance of the scan area
Y-inc	the lateral step increment

Display

Display data determines the scale and background figure of the display including the graph x-scale and the position of the Runway and Taxiway

X-scale	the maximum longitudinal distance
RWY dist	the runway lateral distance from the GP mast (*This can be set only in the Control Panel).*
TaxiWay	the lateral distance between the runway and taxiway centres

RX position / track

The data of the RX (=receiver) position is depending on the (T)rack toggle.

In the Point C option the RX position is fixed whereas in the Track A - X option the end point X can be seleceted as point B, C or T (Threshold).

For Pt C

Fwd	the longitudinal distance from the GP mast
Sdw	the lateral distance from the GP mast
Hgt	the height above the GP zero

For Track A - X

Start	the tracking start distance from the GP. Point A is default.
Stop	the tracking stop distance from the GP.

Calculation parameters

These parameters determines the receiver path as well as the maximum allowable bends.

Elevation ang.	the elevation angle of the tracking path of the RX
Threshold dist	the landing threshold distance from the GP
Receiver speed	the receiver speed in knots
Static bends	the maximum bends from fixed objects
Limit of bend	the maximum allowable bends of the scattering object

2.2 Scattering Object Data (2)

Scattering object is a moving sheet to be used for computation

Length	the length of the sheet
Hgt	the height of the sheet
Btm-Hgt	the height of the sheet bottom edge above the ground
Rot	the rotation angle of the sheet
Tilt	the tilt angle of the sheet
Refl	the reflection factor of the sheet

2.3 Toggles (3)

There are seven toggles in the sensitive area mode allowing you to change the setting of the parameters effecting the graph computation.

(A)dd	selection for what items are added into the graph display
(T)rack	The receiver track along the glide path.
(E)rase	old computed sensitive area data erasing
(O)rientation	the sensitive area border type (border can be a continuous line or shows the sheet orientation)
(S)catter	selection of scattering sheets
(W)orst-Case	the sheet rotation step for finding the worst case
(Y)-axis scan	sideways scanning mode selection

2.4 Commands (4)

There are nine command in the Data Panel allowing the data entry or control the program execution

(8) Sheet	Data entry for the scattering object
(1) Scan area	Data entry for the scanning area
(2) Display	Data entry for the runway and the taxiway
(3) RX position	Data entry for receiver position or track
(2)Change	Data entry for other calculation parameters
(3)Text	Text entry (description) added into the graph
(4)Limit of Bend	Data entry for the maximum bend
(6)DATA.XL	Nama and save a file for computed area
(9)!	Display a table of computed data
<CR>Continue	Starts the Sensitive Area computation

3. Data Entry

Numeric data entry is divided into five parts as follows

1. the scattering sheet,
2. the scanning area,
3. the display data,
4. the RX position / track and
5. the calculation parameters.

The numeric data is entered by a key shown between brackets allowing to change the value of the numeric data. The present value is always shown between angle brackets. Enter new value from the keyboard or press <Enter> to keep the present value.

3.1 Scattering Sheet (8)

The scattering sheet is entered by the <8> key or by (S)catter toggle.

The (S)catter toggle will load pre-programmed sheets representing the tailfin of the aircraft. One (S)catter toggle option is called FREE and this can be set by the <8> key.

The <8> key will open the Scattering Object Editor for the sheet entry without the entry of the position of the object. See SCA-section.

WARNING: All previously set scattering objects will be removed.

The default scattering sheet is 10m wide and 20m high based on ground level.

For aircraft tails the sheet should be lifted from the ground by setting the Btm-Hgt to a greater than zero.

Simulating the building cranes can be set in a similar way. The beam height will be approximately 1-2m, the length could be 20 - 50m and the Btm-Hgt 10 - 40m.

The horizontal rotation of the sheet can be set to a certain value, but is not necessary if the Worst-case toggle is used. Note that a positive value rotates clockwise.

The tilt option is not used in establishing the sensitive area.

The reflection factor option may be used if the object does not have a smooth metallic surface.

A metallic grid with mesh width smaller than 0.1 lambda (0.09m) can also be considered to be a smooth reflecting surface. For wider grid or uneven surfaces made of concrete or glass, the reflection factor could be set to values between 0.5 - 0.95.

Simulating an aircraft is sufficiently done by modelling the tailfin, since this gives the dominant contribution to the bends by a factor of 3 to 5 over the fuselage. For larger aircraft there might be interesting to model the fuselage in addition to the tailfin, but this must be done as a separate task. The final sensitive area will then be the outer limit when both diagrams are superimposed on the same graph. This is simply done by putting the two sheets on top of each other and look towards a strong light source.

3.2 Scan Area data (1)

The scan area data entry is selected by the <1> key (number one).

The scan area data is including the scanning steps and the size of the area where the scattering sheet is moved.

```
<Date>         AXIS 330 - ILS GLIDEPATH SIMULATOR  (S/N:000)     <Time>

T: 286m  C: 572m  B:1336m  A: 7694m

Scan area

Scan begin dist      (m) <    10> :
Scan stop dist       (m) <  1000> :
X - increment        (m) <    10> :
Scan width           (m) <   152> :
Side Increment       (m) <    10> : _
```

Fig. SNS301 Data Entries for the Scan Area

Note: Entry for the scan area data is disabled if the memory already includes the earlier computed data (Erase-toggle=DATA).

3.2.1 Start Distance

Scan begin dist (m) < 10> :

The longitudinal distance from the GP mast where the scan starts.

3.2.2 Stop Distance

Scan stop dist (m) < 1000> :

The longitudinal distance from the GP mast where the scan is stopped even if the sensitive area extends. If the sensitive area extends beyond this distance, the end tips of the area line will have a small circle attached to them. At the bottom of the graph the text "Not-completed" will appear.

Note: Stop distance must be greater than start distance.

3.2.3 Longitudinal Step

X - Increment (m) < 10> :

The test process moves the scattering object longitudially (forward) with this increment (X-inc). The default step is 10m.

3.2.4 Scan Width

Scan width (m) < 152> :

The maximum lateral distance of the scan even if the sensitive area extends outside this distance.

Note: This value must be increased if the boarder of the sensitive area seems to extend beyond this width wider on the graphs.

3.2.5 Lateral Step

```
Side Increment   (m) <    10> :
```

The test process moves the scattering object laterally (sideways) with this increment (Y-inc). The default step is 10m.

3.3 Display data (D)

The display data is comprising of the x-axis range of the graph and the position of the taxiway.

Whether the runway and the taxiway should be shown on the graph is depending on the setting of the Add-toggle.

The display data entry is selected by the <D> key.

Note: *The RWY dist is the Sideways distance and can be set in the Control Panel.*

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

Graph distances

Display X-range      (m) <  1000> :
Taxi way   dist      (m) <   183> :
```

Fig. SNS302 Data Entry for Display Settings

3.3.1 Length of the X-axis

```
Display X-range   (m)    <   1000> :
```

The maximum longitudinal distance from the GP mast that will be displayed in the graphic diagram.

3.3.2 Taxiway Location

```
Taxi way    dist   (m)    <    183> :
```

The lateral distance between the runway and the taxiway centres.

Default value is 183m = 600feet. If less than 101m is selected, the taxiway will disappear.

3.4 Receiver Position or Track (R)

Data entry for the receiver is selected by R-key and is depending on the selected track options selected by the Track-toggle. In case of Pt C the AXIS330 is using a fixed receiver position. In the other options the computation is made by moving the receiver position (track) along the glide path downward extension down to the threshold at 15m height.

The first line of the entry screen is showing the calculated distances to the ICAO Annex10 ILS-points A thorugh C (plus T).

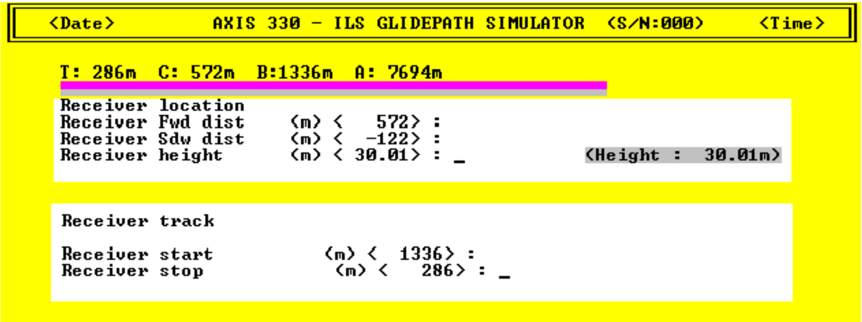


Fig. SNS303 Data Entry for Receiver position / track

Note: *Entry for the receiver data is disabled as long as the memory has the earlier computed results (Erase-toggle=DATA).*

3.4.1 Receiver Location (Pnt C)

The default values of the receiver location represent the ILS point C.

Forward Distance

Receiver Fwd dist (m) < 572> :

The receiver fwd distance is the longitudinal distance from the GP mast.

Sideways Distance

Receiver Sdw dist (m) < -122> :

The receiver sideways distance is the lateral distance from the GP mast.

Height

Receiver height (m) < 30.01> :

The receiver height is the height above the GP zero (foot of the mast).

Note: *The shadowed value on the right side between brackets is the calculated height of the ILS point C with the selected elevation angle.*

3.4.2 Track Rx, Receiver Track

The receiver will start at ILS pt A and follow the extended glidepath angle (elevation angle) downwards passing the threshold at 15m height.

3.4.2.1 Start Distance

`Receiver start (m) < 7694> :`

The receiver start is the start distance of the track measured from the GP mast. Default value is ILS point A, but can be set to any positive value greater than the stop distance.

3.4.2.2 Stop Distance (selectable)

`Receiver stop (m) < 286> :`

The receiver stop is the stop distance of the track measured from the LOC-array. These are the default options when pressing the T-key:

Pt A - B A normal track range for Low Visibility landings

Pt A - C A test track down to Cat I specification

Pt A - T A test track down to Cat II & III specification

NOTE: Only the first Track Option (Pt A-B) represents the conditions during Low Visibility Procedures. The next aircraft should be no closer than 2NM from THR when the previous aircraft exits the Sensitive Area.

3.5 (2) Calculation parameters

The data entry for calculation parameters is activated by <2>key.

```
<Date>          AXIS 330 - ILS GLIDEPATH SIMULATOR  <S/N:000>     <Time>

T: 286m  C: 572m  B:1336m  A: 7694m

Elevation angle        <°>   <      3> :
Threshold distance     <m>   <    286> :

Receiver speed         <kts><    105> :
Static bends           <µA> <      0> :
Limit of bend          <µA> <      4> :

Description
Enter new Text
```

Fig. SNS304 Data Entry for the calculation parameters

3.5.1 Elevation Angle

`Elevation Angle   (°)      <       3> :`

Elevation angle of the receiver track (normally 3°).

Note: *If the elevation angle is changed the receiver position / track settings should be changed accordingly.*

3.5.2 Threshold distance

`Threshold Dist     (m)      <    286> :`

The longitudinal distance between the threshold and the GP mast.

Note: *If the threshold distance is changed the receiver position / track settings should be changed accordingly.*

3.5.3 Receiver Speed

`Receiver speed   (kts)     <      105> :`

The objective for finding the sensitive area is to ensure acceptable signal quality for the aircraft using the ILS during approach and landing. The receiver speed should therefore be set to the lowest speed used for instrument rated aircraft at the particular runway.

Default speed is set to 105kts (knots = nautical miles/h).

Note: *The receiver/plotter frequency response (rad/s) can be set in the Control Panel by using the <3>-key. See SET-section.*

3.5.4 Bends

The bends are composed of static and dynamic bends.

The default bend limits are the maximum allowed amplitudes when there are no present static bends on the site. This is hardly true in practical cases, and the value of the present static bends caused by fixed installations must be taken into account.

The maximum bend limit will be the geometric sum of the static and the dynamic bends.

Static Bends

`Static bends    (uA)     <      0> :`

The bend amplitude caused by fixed installation on the site.

Note: *It should be remember that all fixed reflection objects are removed in Sensitive Area mode.*

Limit of Dynamic Bends

`Limit of bend   (uA)   <     4> :`

The maximum allowed dynamic bend amplitude caused by the moving scatter object on the simulation. Also the command <4> allow to enter this limit.

The dynamic bend limit will be:

$$DynBend = \sqrt{MaxBend^2 - StatBend^2} \qquad \text{(SNS-1)}$$

where MaxBend = maximum allowed bend amplitude
StatBend = static bend amplitude (from fixed objects)

Note: *Maximum bend value is depending on category and is shown between brackets. The AXIS 330 will suggest but not set the dynamic bend value as it will use 4µA as default.*
The Dynamic Bend can be also set by the <4>.

3.5.5 Description text

`Description :`

`Enter new Text >:`

Entry for the description string to be shown on the graph.

Note: *This entry can be set also with <3>.*

4.Toggles

4.1 (A)dd

NO Only the dotted grid with 100m square is shown in the graph.
RWY The runway with a taxiway is drawn on the graph.
R&D Both the runway and a distance scale are shown.
DIST A distance scale along the x-axis is displayed in the graph.

4.2 (T)rack Rx

This toggle is used to set the track options for different test conditions.

Pt C The receiver is positioned in ILS point C .
A-B The receiver follows a track from ILS point A to point B
A-C The receiver follows a track from ILS point A to point C
A-T The receiver follows a track from ILS point A to point T, also named the ILS Reference Datum Height (IRD or RDH).

The Bend Limit is set by default to 4uA.

NOTE: The second Track Option (A-B) represents the case when operating under Low Visibility Procedures. For computing the sizes for sensitive areas in Cat II & III conditions, this will be the correct setting. The subsequent settings where the end point is closer to the runway than Pt B are for testing the theortical effect on the signals in the specified usable tracks for Cat I, I and III.

4.3 (E)rase

OK means there are no DATA from the last computed sensitive area in the memory. A new area may now be computed.
DATA means the memory still contains the last result, and the area may be displayed again with altered range or runway/distance labels.

Note: If the memory contains the last result the data entry for scan area and rx position are disabled.

4.4 (O)rientation

YES displays the worst case sheet orientation along the border of the sensitive area.
NO displays the border of the sensitive area as a continuous line.

Note: This toggle cannot be activated unless the Worst-Case toggle has been set.

4.5 (S)catter

A ready made set of scattering sheet sizes for some aircraft tails like MD80, B737, B747 and B767 plus a number of other objects.

The file SCATT.GB contains these objects. The user may add with a text editor any number of new objects to this file by following the rows and columns used for the present ones.

For other sizes this toggle must be set to FREE-option and use <8> to enter the scattering object.

4.6 (W)orst-Case

This toggle is used to set the sheet rotation step for testing through a number of horizontal orientations (rotation) to produce the largest bend amplitude for a current scattering sheet location.

The increment options are 45°, 30°, 10°, 5°, 2° and NO.

Repeat pressing the W-key to set the rotation increment.

4.7 (Y)axis scan

FULL scan will force the scatter sheet to be moved sideways out to the ScanWidth for every forward step.

FAST scan will scan outwards only until the first occurrence of the Bend Limit has been reached.

Note: *FULL-option will take a lot of computing time, may be necessary if the antenna element diagrams has significant sidelobes in azimuth.*

5.Commands

5.1 (8) Scattering Sheet

The <8> key is used to set scattering sheet values of the Scatter-toggle FREE-option.

5.2 (1) Scan Area

This command is activated by the <1> key (number one) allowing to enter or change the scan area settings.

Note: *This command cannot be activated if there are computed results in the memory. In this case you first have to erase the memory content by Erase-toggle.*

5.3 (2) Display

This command is activated by the <2> key (number two) allowing to enter or change the graph range or the location of the runway and the taxiway.

5.4 (3) RX Position or Track

Press the <3> key (number three) to activate this command which allows you enter or change the receiver data values.

Note: *This command cannot be activated if there is a computed result in the memory. In this case you have to erase the memory content first by Erase-toggle.*

5.5 (2)Change

The <2> command allows you enter or change the data values of the computation parameters.

5.6 (3)Text

The <3> is used to enter text line (description) to be shown on graph.

5.7 (4)Limit of Bend

The <4> is used for fast setting of the maximum bend limit.

5.8 (6)DATA.XL

To name and save a DATA file for further processing with excel.

5.9 (9)!

To see the values in table form. FWD dist, SDW dist and Worst case angle.

5.10 <CR>Continue

<Enter>-key will start the Sensitive Area computation.

6. Computed Result

The result of the sensitive area computation is shown always in the graph form. A cursor is moving down the graph to show the present location of the scattering object during computation. At any time the computation can be stopped by the <Esc> key. There is also CDI-tone available by the <9> key for audio monitor-ing. The momentarily computed bend result will give a tone frequency of CDI(µA)x100 (Hz). This function operates as an on/off-switch.

The sensitive areas may sometimes have quite a different shape from what one might expect.

The area size will also increase with the ILS operational category II/III as the re-ceiver will move along a track to test the scattering.

The result is very dependent on the aircraft speed and the receiver / plotter fre-quency response due to the filtering effect.

6.1 Graphic Display

The graphic display consists of a dotted grid with 100m per square. The position of the receiver is shown as a small circle. Other shown items are depending on the data and toggle settings.

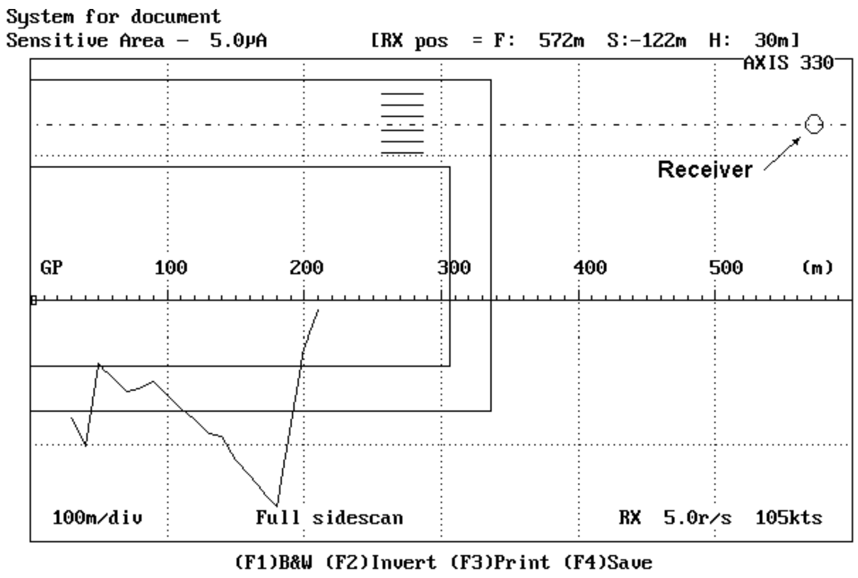


Fig. SNS601 Typical Sensitive Area result for the Cat I M-ARRAY GP with 5uA maximum bends. The scattering object is B747 tailfin rotating in 30° steps.

6.2 Functions

The functions of the graphic display are

(B)&W	Black & White to Colour Selector
(I)nvert	Display invert the colours for cut & paste purposes
(4) Save	Save a B&W graph for later play back

6.2.1 (B)lack & White to Colour Selector

(B)&W

This function is used to toggle the graph between colour and black & white.

The <B> key will turn the graph into black background and white lines. Repeating the <B> key will restore the colour display.

6.2.2 (I)invert display colour

(I)nvert

This function will invert the colours of the display. In the colour display the colours will be changed to their complementary-ones.

6.2.3 (3) Printout

This function function is obsolete and no longer in use.

6.2.4 (4) Graph Saver

(4)Save

Note: This function is enabled and displayed only when the screen is selected as black & white.

The Graph Saver is used to save the graphic screen to the disk on a selected SHOW directory. The names of the files will be generated automatically and the first save is named as AXG0.BAS, second AXG1.BAS, third AXG2.BAS and so on. Before saving, go to the Playback menu item on the Main Menu and select the wanted directory. See the PLY section.

The saving format is the basic-language BSAVE/BLOAD mode enabling the fastest Load and play back in the AXIS 330.

AX1

Appendix 1

Glide Path Model

Table of Contents

1.Description

The AXIS 330 Software is a mathematical model of a glide path consisting of

- a glide path antenna system,
- a reflection plane,
- optional scattering objects
- a receiver lowpass filtering.

Changes in any of these parts can be done, and the software will simulate the signals at given points in the three-dimensional space around the model, computing

- the CDI (Course Deviation Indicator) in uA or %DDM
- amplitude in % or dB
- phase
- bend origin lines
- ground current levels
- sensitive areas

and print out either a table or a graphic diagram.

It should be noted that no mathematical model can fully simulate a real situation. A model is always a compromise between accuracy, amount of input data and calculation time.

Adverse terrain like high hills, buildings and metal constructions will most likely cause bends on the signals due to reflections or diffraction of the course and/or clearance signals into the approach path and coverage sector.

This model will be of reasonable accuracy to predict the impact of scatters from limited ground plane, hills, buildings and aircraft tailfin along the taxiways. It is designed for following purposes:

* to find the sensitive area around a specific glide path system in order to restrict taxing aircraft movements during instrument landing.
* to examine the effect of planned buildings or constructions in order to make a qualified recommendation for approval or disapproval of erecting it.
* to learn what impact different antenna systems will have in different airport environments. For procurement situations, this may also form a check on the manufacturers claim of system performance. For possible arguments that might occur in this context, it should be noted that no mathematical model can fully simulate a real situation, and that the manufacturer probably has long and qualified experience in modelling sites.

2. Antenna system

The computation of the antenna system radiation pattern is based on the individual antenna-element radiation pattern, the physical position and orientation and the feeds (amplitude and phase).

The input parameters for each element are

- type of antenna element
- height above the effective ground plane
- lateral offset
- azimuth turn
- complex signal components (CSB,SBO and CLR)
- gain
- phase.

The horizontal radiation pattern is based on an approximation formula. Every type of antenna element has its own formula and the error in ± 80 ° azimuth is less than 5 % compared to the original one.

3.Reflection Plane

The radiating pattern is very much depending on the ground plane in front of the antenna.

The model assumes that this reflection plane is a homogeneous and straight with a given forward (FSL) and sideways (SSL) slope. The type of ground is determining how much signal will be reflected at different elevation angles.

The reflection plane is modelled as a set of image antennas under the earth surface. The reflecting properties are simulated to be homogeneous for several types of ground from Perfect Conducting to Concrete.

Note: The model DO NOT calculate the effect of the geographical geometry but it assumes the surroundings of the airport is flat.

3.1 Forward Slope (FSL)

The Forward Slope is the average weighted slope of the first 300m of the reflecting plane. The first 20-180m are very important for the induced ground current, while remaining zone has decreasing effect in determining the average forward slope.

3.2 Sideways Slope (SSL)

The Sideways Slope (SSL) is the average slope of the reflection plane perpendicular to the centreline in front of the GP antennas near threshold.

The SSL might have several values at different distances due to the twisted terrain and it is the effective reflection zone between the antennas and the Approach minimum height (DH) that should be considered.

3.3 Reflection Plane type

The reflection plane of the GP site will in practice absorb some of the RF energy before reflecting it. The absorption is depending on the electrical properties of the ground as well as the reflection angle.

The reflection factor of the ground plane depends on the incident angle of the signal. The reflection plane type also effects the penetration depth of the signals and hence the effective antenna heights.

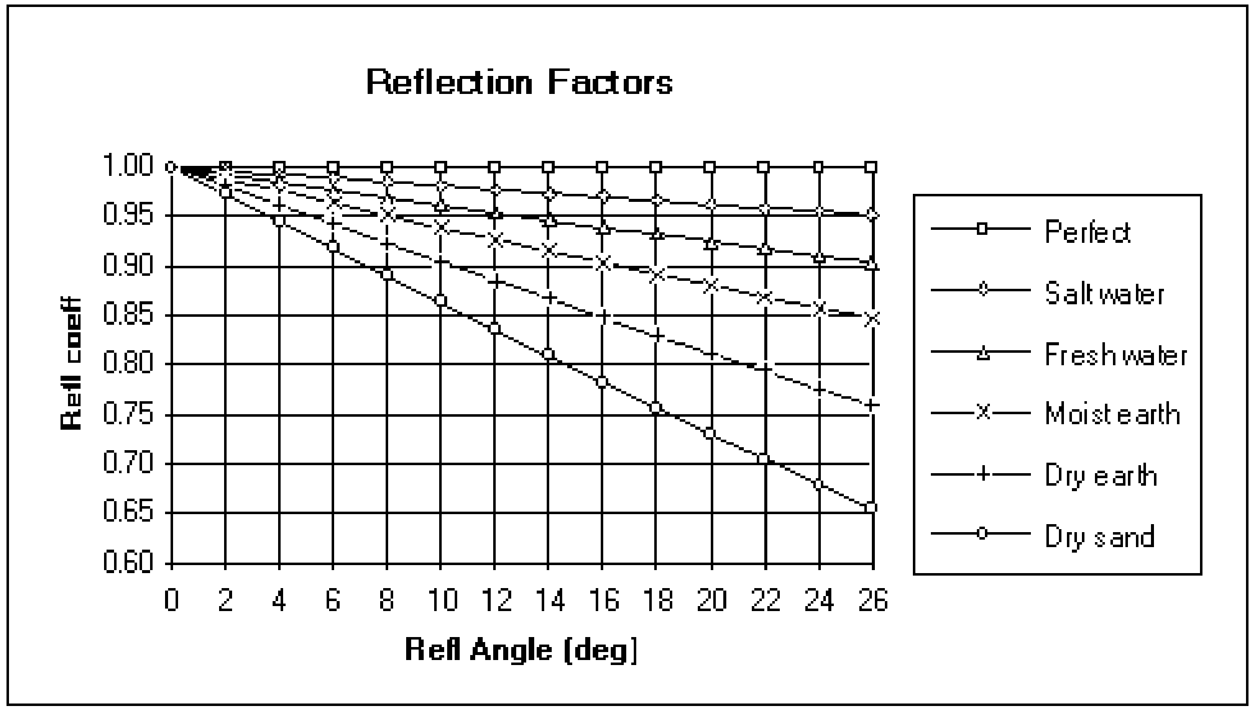


Fig.AX1-301 Reflection factors of different ground types

3.4 Penetration Depth

The signal at these frequencies will penetrate into the ground at an average depth that is depending on the earth electromagmetic properties. Research and separate computations have given us a thumb set rules applied in AXIS 330. Based on that we have set a 7mm increment in penetration depth for each type of ground material selected. This depth, displayed on the Control Panel in cm, should be subtracted from the antenna heights when measuring them from the average top of ground.

3.5 Snow layers

Snow layers are in this release only simulating very wet snow reflecting all signal at the top surface. The epsilon (dielectric constant) is therefore forced to 80 (water) for all layers. In a later release this can be set to any value. together with the proerties of the ground (frozen, wet etc.).

4. Adverse environment model

Adverse terrain like limited reflection plane, high hills, buildings and metal constructions will often cause bends on the glide path signals due to reflections and diffraction of the GP signals into the approach sector.

The AXIS 330 can simulate five types of scattering objects:

1. The Rectangular (S)heet (S-type)
2. The (W)ire Section (W-type)
3. The Semispheric Hill (T)op (T-type)
4. The (R)idges or earth walls (R-type)
5. The Truncated (G)round Plane (G-type)

4.1 The Rectangular Sheet

The S-type scattering model is used to simulate vertical conducting sheets, the walls of buildings facing the glide path antennas and the runway. Back walls in the shadow of the direct glide path signal ARE NOT simulated.

Also aircraft tailfin or any metallic construction can be simulated by using rectangular sheets positioned and oriented in the three dimensional space.

Scattering calculation is divided into reflections and diffractions.

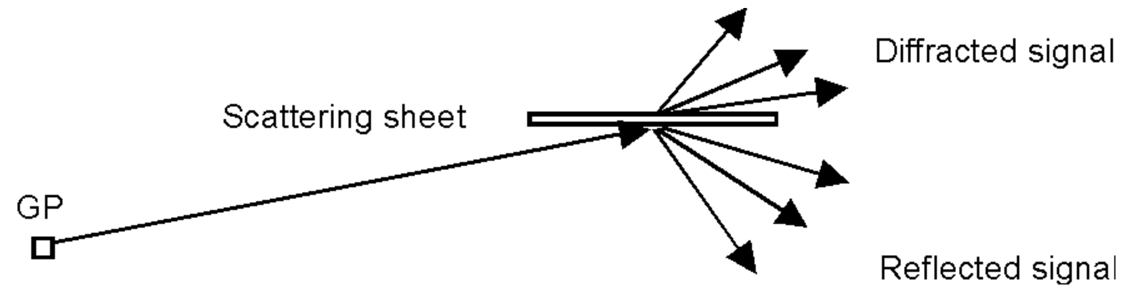


Fig. AX1-401 The scattering sheet

4.1.1 Reflection

The maximum reflection occurs mainly in the optical specular angle. A number of sidelobes occur similar to the function k*sin(x)/x, where k and x depend on the length and height of the sheet.

The re-reflection from ground between the sheet and the receiver is set to 95% as we assume flat airport surface.

4.1.2 Diffraction

Depending on the horizontal rotation angle of the sheet, a similar diffracted signal with sidelobes will arise behind the sheet along the extended line from the transmitter to the sheet.

The Physical Optics mathematical model uses the Fresnel-Kirchhoff diffraction integral to compute the scattered signal in the three dimensional space around the sheet.

Reflection from a smooth rectangular area is computed as a diffraction from an equivalent transformed aperture (Babinets principle).

Assuming far field conditions where the distance >> sheet size and antenna aperture, large surfaces are not broken down into smaller ones as one will obtain the same result with a big one.

For near field conditions or having large sheets like fences, the objects should be divided into smaller pieces by defining smaller sheets standing side by side or stacked on top of each other, making up a similar area.

The Fresnel-Kirchhoff diffraction integral:

$$E_{SCAT} = \frac{jA}{2\lambda} \iint \frac{\cos\Theta_i \cos\Theta_e}{R_i R_e} e^{j(R_i+R_e)} ds$$

Where: A - incident signal amplitude at the sheet center,

R_i - incident signal path length

R_e - emanent signal path length

Q_i - incident angle to the sheet normal

Q_e - emanent angle from the sheet normal

The reflection/diffraction will emanate from the center of the sheet

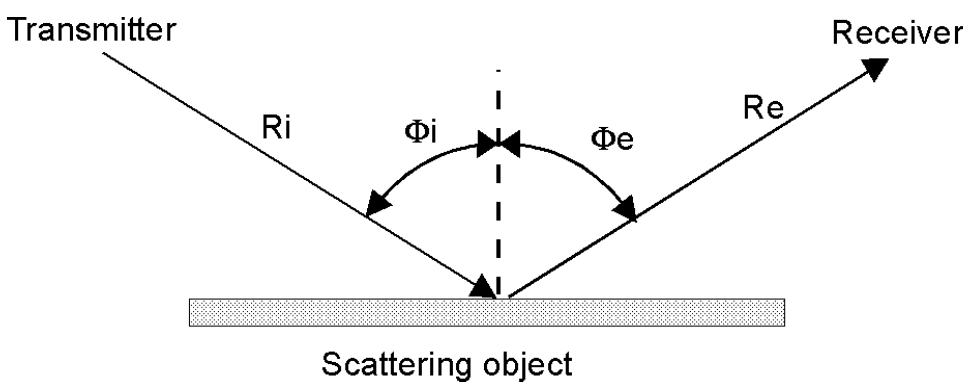


Fig. AX1-402 The scattering geometry for incident and emanent signals. The double integration is made over the area of the scattering object.

4.1.3 Shadowing

The direct signal will not pass through the sheet. Only the diffracted signal from the sheet center will be received behind it. This will cause the CDI/DDM value to be constant in the shadow region as there will be only one signal source with a fixed SBO/CSB ratio. Dividing the sheet into two adjacent half sheets will correct this problem.

4.2 The Wire Section

The W-type scattering model is used to simulate a section of parallel wires.

It is quite similar to the S-type, where the reflected and diffracted signals in certain directions are computed by integration over the length of the section, but the wires will have a near cylindric free space re-radiation diagram. The effective reflection factor depends also on the wire diameter and the number of independent wires within the section. The user should set the reflection factor to 1 for metal wire as the computed factor will be limited by the integration. Due to assumed uneven terrain the reflection factor in the ground between wire and the receiver is set to 0.9.

4.3 The Semispheric Hill Top

The T-type scattering model is used to simulate a semispheric terrain like hills or any other limited sized object.

A general reflecting object of undetermined size which reflects the incident signal at given coordinates with a given reflection factor. This factor must be determined by the user and depends on the object size, smoothness and geometrical structure. Normally a factor will be in the range of 0.01 - 0.25.

The T-type model for a hill top is a semispheric point size object re-radiating the incident signals with a selected reflection factor. The effective reflection factor will decrease with increasing azimuth reflection angle from the object. This is a combination of less reflected signal at steeper reflection angles where the object has some loss, and the directivity of an average receiver antenna. In addition the low-pass filtering effect will take place in the receiver depending on the approach speed.

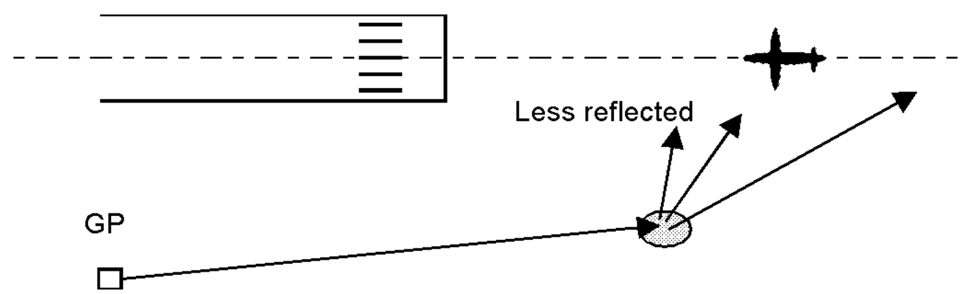


Fig. AX1-403 Reflection factor will depend on the azimuth angle of the reflection.

The reflection factor will depend on the size, surface and geometry of the modelled object. A factor of 0.01 to 0.25 is normally within the practical range. A help screen is found using <1> when entering this factor:

Reflection factor (kr) @ Object width x height:

Small metal constructions, cars	.01
Small wooden shelters	.01
Small hill 10 x 5m w/vegetation	.03
Small hill 10 x 5m smooth surface	.05
Metal object 10 x 5m	.06
Medium hill 50 x 15m w/vegetation	.10
Medium hill 50 x 15m smooth surface	.15
Large hill 200 x 30m smooth surface	.20
Large hangar 100 x 30m smooth surface	.20

If a secondary reflection plane exists beyond the object, it is assumed to be a horizontal but not well graded surface with a reflection factor of 0.3.

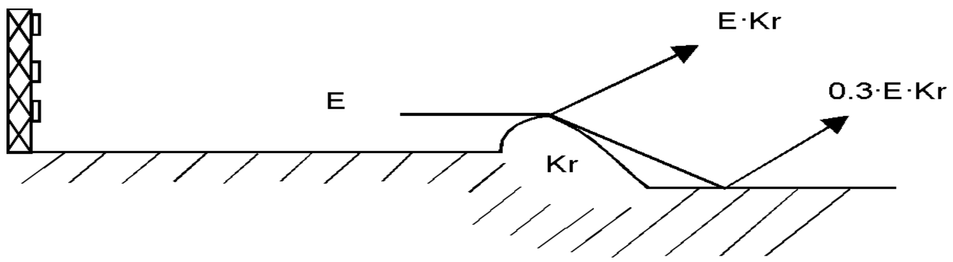


Fig.AX1-404 A Top may have a secondary reflection plane beyond it.

The vertical height difference between the secondary plane and the top can be set between 0.1m to 999m. If this height is set to zero, a secondary plane is assumed to be non-existing like a very rough and absorbing terrain, and only the top will radiate like a free space signal source.

The T-type object is useful to insert a general reflection object into a specific GP model to compare bend patterns from certain sections from the flight inspection approaches.

4.4 The Ridges or earth walls

The R-type scattering model is used to simulate ground edges besides or in front of the reflection plane.

Similar to Semispheric Hill Top, but this ridge can be a long stretched hill where the reflection point is located on the ridge along a line directly from the GP mast to the receiver.

The R-type model for a horizontal ridge is very much like the T-type object, where the line of intersection through the ridge slices out a hill top on the stretch from the GP mast to the receiver position. Depending on the length and the azimuth orientation of the ridge, the “top” slice will move so it will be in line between the GP mast and the receiver. When this line intersects the ridge, the signals will behave like a T-type object. If this line goes outside the ridge, the “top” will stay at the nearest end of the ridge and the reflection factor drops suddenly to one third of the selected value.

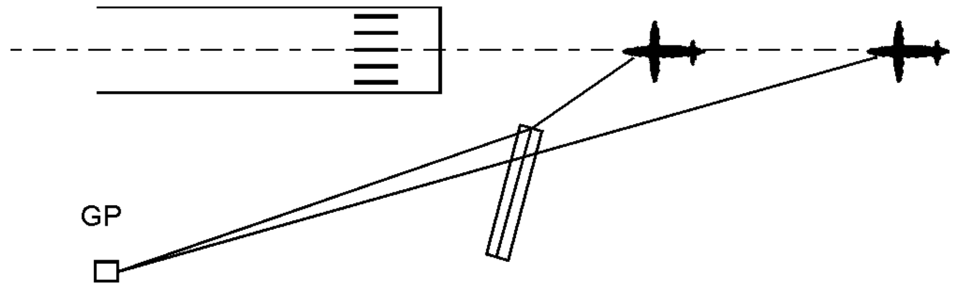


Fig.AX1-405 The simulated reflection point moves until it hits the end of the ridge.

If a real ridge is not horizontal or changes direction or height, several ridges could be modelled beside each other so the combinations of length and azimuth rotation angles will make their ends meet.

For reflection factors and reflection in a secondary reflection plane, refer to the text for T-type.

4.5 The Truncated Ground Plane

The G-type scattering model is used to simulate a ground truncation (discontinuity) of the reflection plane.

The reflection plane should be several hundred meters long in order to provide a near ideal ground reflection for each antenna element. When the available ground plane is too short, the induced ground current at the ending edge will yield a non-homogeneous diffracted signal that will interfere with the homogeneous direct glide path signals.

The G-type model for limited ground plane is a smooth linear reflection plane, ending in a 90° angle truncation. The edge of the reflection plane will create a diffracted signal from each of the radiating antenna elements, computed according to the Uniform Theory of Diffraction (UTD).

There may be an optional secondary reflection plane below the edge, which in the model is assumed to be a smooth horizontal surface with a fixed reflection factor of 0.9. The vertical height difference between the secondary plane to the edge can be set between 0.1m to 999m. If this height is set to zero, a secondary plane is assumed to be non-existing like a very rough and absorbing terrain, and only the edge will radiate like a free space signal source.

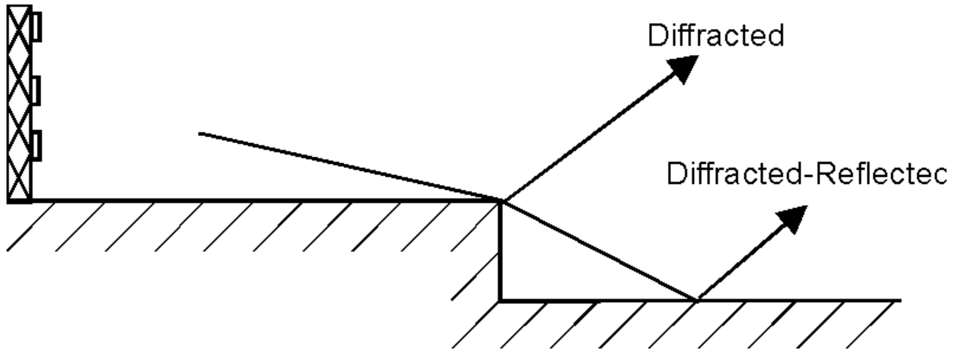


Fig.AX1-406 Diffracted and diffracted-reflected signals

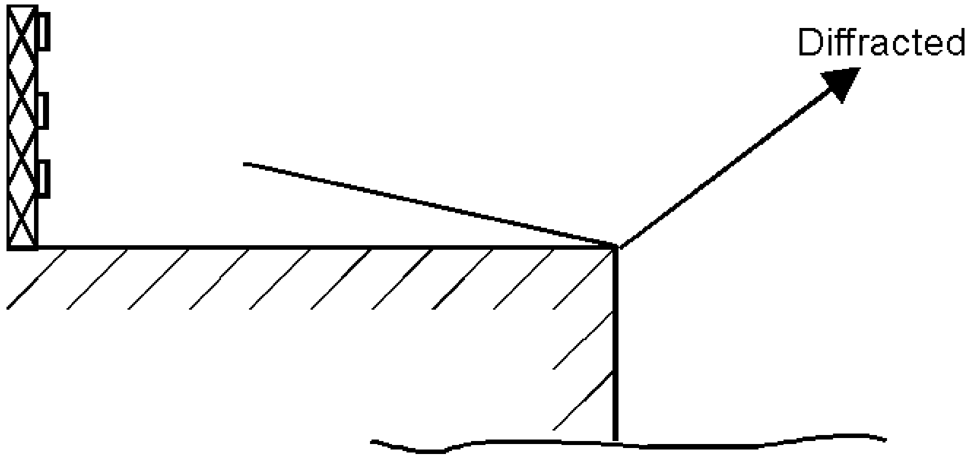


Fig.AX1-407 Diffracted signal only when Hgt-II is set to zero

The diffracted signal is computed on the edge along the direct line between each antenna element and the receiver. The longitudinal distance to the edge is entered by the user for a point located directly in front of the GP mast. The actual diffraction point will vary depending on the receiver position and the azimuth angle of the edge.

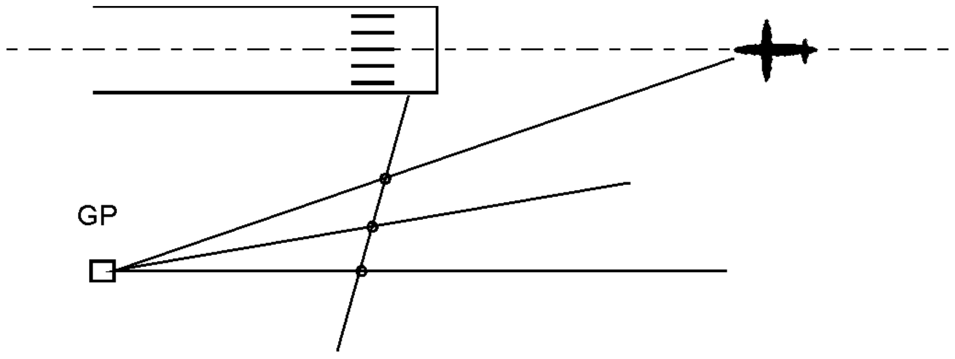


Fig.AX1-408 Diffraction point will depend on the receiver position and the azimuth angle of the edge.

If the diffraction point moves inwards closer than 50m from the runway centreline, it is assumed that the runway shoulders will meet the edge, and the diffraction will cease. There can be only one G-type scatter object at a time, and it must always be entered as the first one.

5. The low pass filter

The receiver and/or plotter has a certain upper frequency limit for outputting fast scalloping. The frequency where the amplitude of the bends has dropped 3dB will be the cutoff frequency. This will be expressed in radians per second:

$$\omega_0 = 2\pi f_0 \qquad \text{rad/s} \qquad \text{(formula AX1-501)}$$

The software has a digital low pass filter to simulate this, and the default value is set to 5 rad/s as a measured average of available plotters. Modern plotters might have up to 15 rad/s so it is recommended that the user adjust this value according to the actual equipment. Use the <3> key in the Control Panel to change the default setup.

If the receiver/plotter output specifies a certain Time Constant ( ), the conversion to rad/s will be as:

$$\omega_0 = \tau^{-1} \qquad \text{(formula AX1-502)}$$

ICAO Annex10 Volume I attachment C recommends a time constant of 50/V seconds, where the ground velocity in kts, and 92.6/V seconds where V is the velocoty in km per hour. For 105 kts, this will be 0.48 s, corresponding to approximately 2 rad/s response in the receiver.

For static measurements, where the receiver speed is set to 0kts, the receiver response setting has no effect on the output. For ground measurements, the vehicle normally drives along the runway centreline at 60km/h, which corresponds to 32kts, corresponding to 0.64 rad/s.

For aircraft simulations, the speed may be set in the range of 90 - 150kts. For conservative results with less filtering, use the speed of the slowest aircraft operating on the particular runway.

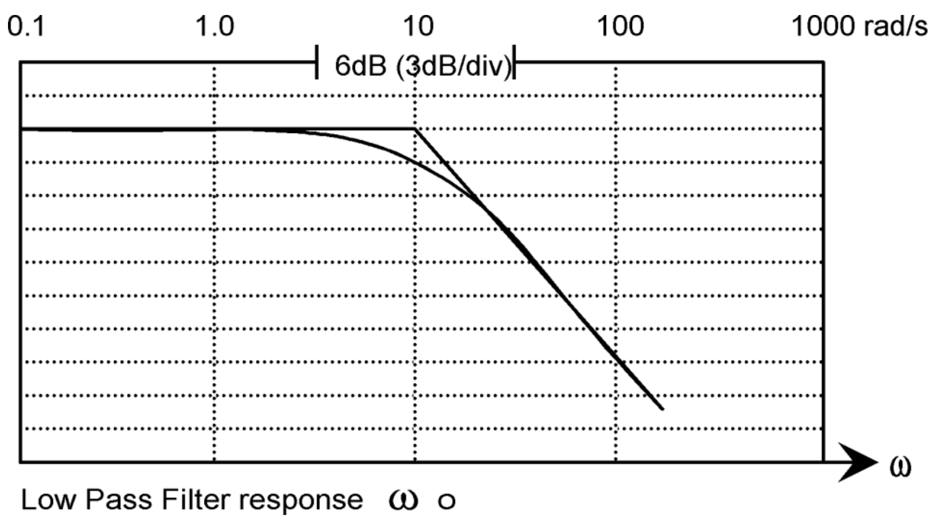


Fig. AX1-501 The digital filter response in the frequency domain where the cutoff frequency is shown for 10 rad/sec (1.6 Hz) and the asymptotic cutoff 6 dB/octave or 20 dB/decade.

AX2

Appendix 2

Files in the AXIS 330

Table of Contents

1.Directory structure

In the single user version of the AXIS 330 the installation will generate three main directories as follows:

1. homedir\AXIS\

   This is the main directory including all files necessary to run the AXIS 330.

2. homedir\AXIS\WORK\

   The default directory for library working files, examples etc.

   In addition there are optional WORKnn\ directories for separate working files that can be selected with the PgUp/PgDn keys. The number nn will range from 1 through 50.

3. homedir\AXIS\SHOW\

   The default directory for saved graphic screens.

   In addition there are optional SHOWnn\ directories for separate screen files that can be selected with the PgUp/PgDn keys. The number nn will range from 1 through 50.

Note: homedir is the path where the AXIS 330 has been installed

2.Description of Files

After installation, the AXIS directory contains the following files:

GP.001	The Access file that contains the registration code and enables running the software. This file will be changed the first time you run the software and entering the user code. To disable this file, run the <3> key Setup and "DELETE YOUR ACCESS CODE" from the MENU. This will prevent others from using the software, as well as enabling you to enter a new USER CODE if you are given a new access level.
GP.INI	Contains the standard glide path setup on the Control Panel when starting the software. Each of the network users have their own file in their user area for separate setups. The <5> key will fetch this setup at the Control Panel. To change the content of this file permanently, run the <3> key Setup, or use an Editor to modify it. See chapter 3 of this appendix for the content.
GP.RUN	Contains the last values you were running, including all error settings, and all reflection objects. There as a separate file for each user in the network version. The <6> key will retrieve these data at the Control Panel. See chapter 4 of this appendix for the content.
GP.004	Contains the current parameters for start, stop and incre-ment values in Vertical and Approach mode. The last used values can be saved in the GP.004 file in the Control Panel Setup <3> key.
GP.009	Contains the codes for graphic screen colours. See chapter 5 of this appendix for the content.
GP10.EN	Help screen figures for scattering objects with text lines
GP11.EN	Help screens for using the keys.
GP12.EN	All text lines in the software divided into sections.
!A330.NEW	Text file containing information of the new features or chang-es given to each version.
A330.EXE	The MAIN running file.
A330RPX.EXE	The module for computing the average Forward Slope
A330ADU.EXE	The module for setting and adjusting the ADU and MCU.

3.The file GP.INI

Comments are written *italics* and do not appear in the file.

[AXIS 330 R43]	*Release number*
Default setup	*Text for display*
3	*Antenna system (NR=1, SBR=2, M=3)*
15011404010704	*Colour codes for the panels*
12	*Screen Type (2-CGA, 3-Herc, 9-EGA, 12-VGA)*
3	*Antenna Element Type*
0	*GP Site on FLY: Right(0)/Left(1) side of RWY*
0	*Not used*
0	*20 (0) or 40 (1) Frequency Channels*
333.800	*Frequency*
3.000	*Glide path angle*
0.0000	*Forwardslope*
0.0000	*Sideways slope*
122	*Runway distance*
4	*Reflection plane type*
5.0	*Receiver response in rad/s*
R	*Not used*
GB	*English language files in use*
CDI	*CDI is used (DDM can be selected)*
Meters	*Meters are used (feet can be selected)*
WORK	*Name of the Work Files directory family*
SHOW	*Name of the Graphic Screen Files directory family*
[M-ARRAY DATA]	*Only if M-ARRAY GP*
50.0	*Ratio common for RTS and RTC*
50.0	*RTS (%)*
50.0	*RTC (%)*
180.0	*PHX (°)*
0.0	*CLR amplitude in % of CSB in A1.*
343.0	*CLR deviation in µA*
[End of GP.INI]	

Reflection plane code

1 - PERFECT
2 - SALT WATER
3 - FRESH WATER
4 - SOAKED SOIL
5 - MOIST EARTH
6 - WET SAND
7 - DRY EARTH
8 - DRY SAND
9 - CONCRETE

4.The file GP.RUN

The file GP.RUN is a file containing the latest used System Setup and all data entered from the Control Panel.

The structure of the file consist of parts and every part begins with the headline in square brackets.

Comments are written *italics* and do not appear in the file.

```
[AXIS 330  R43]     Release number
Work file  text     Text for display
 3                  Antenna system (NR=1, SBR=2, M=3)
 3                  Antenna Element Type
 0                  GP Site on FLY: Right(0)/Left(1) side of RWY
 0                  20 (0) or 40 (1) Frequency Channels
333.800             Frequency
  3.000             Glide path angle
  0.0000            Forward slope
  0.0000            Sideways slope
 122                Runway distance
   4                Reflection plane type

[M-ARRAY  DATA]     Only if M-ARRAY GP
 50.0               Ratio common for RTS and RTC
 50.0               RTS (%)
 50.0               RTC (%)
180.0               PHX (°)
  0.0               CLR amplitude in % of CSB in A1.
343.0               CLR deviation in µA

[Threshold]
 286              Distance to Threshold (m)
 15               Threshold crossing height (m)
 0                Threshold runway height over GP zero (m)
 0                Step height due to non-linear reflection plane

[MCU setting]
Ant  Attn. PhShift  Phaser
3   7.205 180.000   0.000
2   2.489   0.000   0.000
1   0.000   0.000   0.000
    2.265  El Ang
    0.66   Min Att
    3      Mem GP type
    3.00   Mem GP ang
    0.00   Mem FSL

[Monitor]
 80.85                  Distance to Monitor (m)
  4.29                  Height of Monitor (m)
  0.00                  Sideways position of Monitor (m)
```

```
[Modulator]
    0              Modulation Balance (µA)
  800              Mod Sum (10 x SDM)

[Errors]
Ant  Ampl   Phase    Turn  Sw (Sw=0 is antennas switched off by Alt-1 trought
Alt-3)
3   100.0     0.0     0.0   1
2   100.0     0.0     0.0   1
1   100.0     0.0     0.0   1
SBO: Ampl   Phase   Bal A3/A1
       0.0     0.0     0.0

[Feeds]
Ant  SBOA   SBOPh    CSBA   CSBPh
3   5.835  180.0ø   0.000    0.0ø
2  11.670    0.0ø  50.000  180.0ø
1   5.835  180.0ø 100.000    0.0ø

[Positions]
Ant   Fwd     Sdw     Hgt
3   0.000  -0.378  12.879
2   0.000   0.000   8.586
1   0.000   0.227   4.293

[Optimized]
    2              Optimize Code  (2=Optimized on a point)
 1500              FWD Distance to point (m)
 -122              SDW Distance to point (m)
    1              HGT of point above GP zero (m)

[Offset of all sheets (X-Y-Z)]
      0m    -29m      0m

[Scatters]
Type  Fwd      Sdw     Lgt    Hgt/d  Hgt-II    Rot    Tilt/#   Rfl
G     500m      0m    0.0m    0.0m    2.4m   90.0ø    0.0ø    1.00
R    1200m      0m  100.0m    8.0m    9.0m  110.0ø    0.0ø    0.11
S     800m    -50m   34.0m   14.0m    0.0m   10.0ø    2.0ø    1.00
T    1000m    -40m    0.0m   12.0m   13.0m    0.0ø    0.0ø    0.10
W    2000m    300m  200.0m   0.01m   10.0m   85.0ø   3 wire   1.00
[End of file]
```

Type:

* G = Ground Plane discontinuity (generates diffraction)

Only the first object can be of ‘G’ type.

R = Horisontal section of a Ridge top

S = Rectangular sheet of conducting metal

T = Point size Top of a hill or reflecting construction

W = Wire section of horisontal metal cylinder(s)

5. The file GP.009

The file GP.009 contains the codes for graphic screen colours. Note that the curves are drawn in preset colours, so be careful about the background colour by using only numbers between 0 and 8. Use an text editor to make custom colour combinations for the graphics by changing the first number. The code below shows the standard colour palette.

```
AXIS [Graphic Colours]
0    Background
14   Text 1
15   Text 2
9    Frame 1
1    Scale spare
15   Scales
11   Limit 1
12   Limit 2
15   Spare 1
15   Spare 1
```

Code:

0 Black	4 Red	8 Dark Grey	12 Light Red
1 Blue	5 Magenta	9 Light Blue	13 Light Magenta
2 Green	6 Brown	10 Light Green	14 Light Yellow
3 Cyan	7 Light Grey	11 Light Cyan	15 White

6. The file GP12.EN

The text file GP12.EN has a certain format which is important to observe when translating into another language. Comments are written in this document in Italics and do not appear in the file itself but are shown for guidance. The file consists of a number of sections each headed by a text line between square brackets. These serve as identifiers for the software and must not be translated or modified. The following items are some important rules:

1) The line order must not be changed within each section, but the sections themselves, headed by a square bracket text, may appear anywhere in the file.
2) The content of the [Square Brackets] must not be changed as it serves as identifiers to the software.
3) Some text lines are divided into several text label parts, and each label (word) must always begin on the given position on the line.
4) [Mo X] type headings indicate the text in run mode number X. from the menu. E.g. [Mo 1] contains all text in the Playback mode since Playback is the 1st menu item.
5) [To X] type headings give the text and action keys on the Toggle Panels in run mode number X. The characters between brackets e.g. the ‘A’ in (A)dd will automatically be the key to be pressed to execute the given function. When the toggle list is translated, this letter may be changed in the new word, and the new first charcter between brackets will now be the action key. However, <u>the order of the listed commands must not be changed</u> as the software will always take the first command as the ‘Add’ command regardless of the text language and action key it has been given. There <u>can not be two identical first characters</u> among the words on the same list as the software will only respond to the first one listed.
6) Except the first two sections (Control Panel and Menues) and the Toggle panel lists [To x], the text lines are terminated by a colon to measure a certain line length so it can match to other text lines. If there is a group of several lines where the colon is located in the same column, the colon column may be changed, but they should all have the same length. Where it is important that the length should not be changed at all in translation to another language, the line is terminated by an asterisk (*) .

Note that the longest lines are not shown in their full length.

The F-keys (F1 through F9) are in later versions been replaced by <1> through <9> keys.

```
GP12.EN

[AXIS 330 R43]
English
Control Panel
GP Type  FRQ (MHz)GP Angle FWD SlopeSDW SlopeRWY Dist.Refl.Pln.
Ratio       (RTC>    (RTS> PHX      CLR Ampl CLR CDI  RX Type
RWY Element Type Scatters Snow Pln.Dpth Antenna from TX  Errors
Thr dist Thr  hgt RDH(A-B) Step hgt MCU diff ADU Outp A2 probe A1 probe
Dist Hgt  Sdw  SBO  Ampl/PhaseMCU OutputCSB  CLR  GP      LEFT  RIGHT
Ant  Height  Offset  FWD shift  AZ-turn  NFmon         ----------  Phase stub
1=Help 2=DOS 3=Setup 4=Util 5=New 6=Last 7=File 8=Scatt 9=Snow Esc=End
Jan.FebrMar.Apr.May  JuneJulyAug.SeptOct.Nov.Dec.
Are You Sure (Y/N)?

PERFECT       SALT WATER   FRESH WATER  SOAKED SOIL  MOIST EARTH  GRAVEL
DRY SAND      CONCRETE
NULL REF      SIDEBAND REF M-ARRAY/CEGS
ISOTROPIC     1/2 L DIPOLE NORMARC LPDA KATHREIN  2L THOMSON  CSF WILCOX 3-DPL
NO
YES

[Menues]
MENU - Select Mode by Number or Arrow keys
Playback Screen files
Lateral Trace
Vertical Trace
Window Overview
Approach
Fixed Position
Ground Current
Bend Analysis
Sensitive Area
Current MODE:
NORM DUMMY Tx SBO Phase ADU adjustments
GP Type       Scatterers   RX response   --------   Active SHOW Dir.
Description
Enter new Text
HardCopy of Results?  (Y) or <CR>
Scale center offset
Scale center     :
Full scale      ñ:
(2)Change (3)Text
(5)Errors
(Esc)Menu <CR>Continue
(Alt-C) CLR
hit any key ...
(B)&W (2)Invert
(4)Save
(8)Scatter
<-Values->
<spare>
points loaded
(Esc) to break Carrier
FLY DOWN
FLY UP
<spare>
Toggles
Erase Data for new run
```

```
RWY   SHEET DIST  OK    DATA  TABL  GRAPH 3D    *
SBO   CSB   CRS   CLR   bbp   BBP   Ampl  Phase
Current file name 'DATA.XL' <CR> or enter new
Offset all sheets             Forwards  Sideways  Upwards

[User handling]
THIS VERSION NEEDS A NEW INSTALLATION DISK...:
Not Licensed for NetWork use...:
Start it in the AXIS directory.:
The SoftWare has detected a change since registration....:
Please re-enter the user code to enable usage.:
Contact supplier for Registration Code!"
Enter User Code :
Incorrect PassWord :
ACCESS DENIED - Contact Network Manager.:

[Error messages]
The Software is not installed properly! :
Use the installation Diskette. :
file is missing. :
Sorry - not enough memory available for this ...:
Printer is not Connected to the Computer...:
file has wrong format... :
File Directory not Found...:
A fatal error has occurred...*
If necessary report the following information:
along with a description of how it happened. :
Program Name     *
Program Date     *
Error  Number    *
Error Location   *
File Reference   *
Hit any key...   *
Restart the program  *  6-key recalls data *
file is not found on Disk... :

[HotO]
Computed on :
Printer NOT connected or turned on....... :
RF-Frq  GP    FSL   SSL  RWY  *
Rtc  Rts    Phx   ClrA  ClrD    *
SBOA   SBOP *
Ant Height  Offs  Fwd shift  Azim  CSBA  CSBP      SBOA  SBOP | Ampl Phase"
Fly Right Fly Left  *
Elmt Gnd  *
Scatter object on test  :
tail*
Lgt    Hgt  BtmHgt    Rot   Tilt   Rfl.*
Tested for worst case orientation in steps of :
Scatter objects  :
Type Fwd   Sdw    Lgt   Hgt/d  Hgt-II    Rot   Tilt/#  Rfl Opt Setup"
wire*
BEND Analyzing using following points on bendpattern:
Pnt #    Dist     Bend Length *

[HotY]
Enter Ground Plane properties:
Relative Dielectric Constant :
Conductivity                 :
```

```
[HotX]
Enter MCU alarm limits:
Glide Path                :
Displacement Sensitivity :
Clearance                 :
NF monitor limits         :

[F2key]
Type EXIT <Ù to Return to Program....:

[F3key]
Getting the default settings first...:
(2) Language change :
(3) SAVE this as the Default setup:
(4) Rename the Work/Graph directories
(5) Delete the User Code:
<CR> No Change:
alterable items :
---------   Rx Filter ----------- *
This is the Setup when starting up or by pressing (5):
Set new colours *
Heading text/back :
Cursor text/bar :
Screen text/Background :
Data/Restore to standard :
Press <CR> to proceed...... :
Enter the file extension country code (see list below  Now:
Language *
Work directory  *
Graph directory *

[F4key]
Select utility :
(2) MCU setting :
(3) ADU Adjustments :
(4) Reflection plane slope computation :
(5) Optimize feeds to a Top or Ground Plane :

[F7key]
Kill *
<CR> to select *
<Esc> to cancel:
No files found...:
Enter file name :
Enter model description      :
Sorry - You are not authorized to do this...:
Files directory :
(2)Common or <CR> Private File Library :
(2)Load  (3)Save  (4)Kill  (5)New directory :
<Spare>
Enter new directory  <CR>=Default :
Work directories:   Select by PgUp/PgDn :
This directory does not exist - (8) to make :

[F8key]
List of Scattering Objects :
Obj Type  Fwd   Sdw    Lgt   Hgt/d  Hgt-II  Rot Tilt/# Rfl   Opt Setup:
(2)Add (3)Delete (4)Remove all (5)Sort (6)List (7)Optimize
<CR>=CtrlPan*
Enter data for object ## or <CR> to exit :
```

```
New Object - <CR> if finished entering :
(R)idge  (S)heet  (T)op  (W)ire :
wire*
(G)round :
Height Above GP Zero      (2)=Ang :
Vertical Angle (ø)        (2)=Hgt :
No # Depth #.##m  Er :
Enter thickness :
Bottom Layer :
Snow Layers Depth & Dielectric Constant :
Layer    Depth   îr :

[F9key]
<CR> to select antenna system :
<Esc> to cancel:
No files found...:

[MO 1  Playback Mode]
Files directory :
Usage: ñ Speed  [PgUp]Step Back  [PgDn]Step Ahead  (2)Invert
(Esc)Quit :(2)Show  (4)Delete all  (5)New directory  (6)To DOS
<CR>Return : Show directories: Select by PgUp/PgDn :
Enter new directory  <CR>=Default :
No screen files available...:
This directory does not exist - (8) to make :

[MO 2  Lateral Trace]
Range to circle   :
SDW Distance      :
MIN az angle      :
MAX az angle      :
Increment         :
(2)Multiple runs :
Elevation angle   :
Monitor Fwd  Sdw  Hgt :
SBO & CSB Ampl. :
(-Twds RWY):
Number of runs  (1 - 6)  *
FWD Dist. of run No:     *

[To 2]
d(B) or %
(D)isplay
(E)rase
(I)ncr x
(P)arameter
(S)ense
(M)ultiple

[MO 3  Vertical Trace]
FWD Distance      :
SDW Distance      :
MIN Angle         :
MAX Angle         :
Increment         :
(2)Multiple runs (3)NF mon:
GP angle          :
Monitor Fwd  Sdw  Hgt :
SBO & CSB Ampl. :
(-Twds RWY):
```

```
Number of runs  (1 - 6)  *
FWD Dist. of run No:      *
CDI  SBO  CSB  CLR  OFF  Ampl Phase :

[To 3]
d(B) or %
(D)isplay
(E)rase
(I)ncr x
(P)arameter
(S)ense
(M)ultiple
(H)gt scale
(W)nd <-> 3D

[MO 4 Window Mode]
FWD Distance     :
SDW offset       :
LLZ Course Sector:
LOW  MED  HIGH V.HI Air  Gnd  dn     up :
CDI  SBO  CSB  CLR  OFF  Ampl Phase :
Type Ant. RTC  RTS  PHX  CLRA CLRC :
Elevation angles (ø):
Half sectors (Nom:
SBO/CSB Phase (ø):
Clearance ampl.:
Window seen from the:
AZ angle in table:

[To 4]
(A)mpl range
(R)esolution
(E)rase
(P)arameter
(S)een from
(W)nd <-> 3D

[Mo 5 Approach Mode]
Elevation angle    :
Level (feet)       :
SDW offset         :
Start Distance     :
End Distance       :
Increment Step     :
Start Angle (Low)  :
End Angle  (High)  :
Track azimuth      :
Receiver speed     :
Receiver filter    :
Hyper Theo  Level :
Theodolite FWD position (m) :
Theodolite SDW position (m) :
Theodolite HGT above GP zero(m) :
Hyperbolic - Ideal :
<Spare> :
Theodolite Located... :
Theo Fwd Sdw Hgt :
Theo upwards tilt:
Achieved GP/DATUM    Actual GP/DATUM:
Level Run at :
```

```
Approach El:
Az   Sdw:
Theo FSH:
(-Twds RWY):

[To 5]
d(B) or %
(C)at Limit
(D)isplay
(E)rase
(G)raph dir
(I)ncr x
(X)-Scale
(O)rigin Xsc
(P)arameter
(S)ense
(T)racking
(N)ormalized

[Mo 6 Fixed Position Mode]
Height Above GP Zero  (2)Angl *
Vertical Angle (ø)     (2)Hgt  *
Point No. *
(Far Field)     *
(Near Field)    *
Item No. to be changed :
Antenna Number :
Parameter No.  :
MIN *
MAX *
Incr Step :
Forwards *
Sideways *
Height   *
Error :
Wet snow layer *
Monitor Fwd  Sdw  Hgt *
(-Twds RWY):

[To 6]
d(B) or %
(D)isplay
(E)rase
(I)ncr x
(N) Points
(P)arameter
(S)ense

[Mo 7 Ground Current Mode]
Grid spacing      :
Start Distance    :
Stop  Distance    :
Step  Distance    :
Sideways Track    :

[To 7]
(D)isplay
(P)arameter

[Mo 8 Bend Analysis Mode]
```

```
Approach Elevation Angle  :
Track Azimuth Angle        :
(2)Make Bends      <CR> Analyze Bends     :
Number of Bend-Points (6 max) *
Point No. *
Distance to Bend Center    :
Bend Wavelength            :
Distance   Bend Length     :
Threshold distance       :
<Spare> :
Projection Level         :
Max distance on X Scale :
Min distance on X Scale :
Sideways offset          :
Samples :
Proj. level *
Y shift *
Begin   *
End     *
<Position adjusted - Press CR to Re-Draw> :
Enter the position of the object relative to GlidePath :
Forward  Dist. *
Sideways Dist. *
Height         *
Enter distance where Bends shall be computed :
div  Track AZ  *

[To 8]
(N)one

[Mo 9 Sensitive Area Mode]
Scan area           *
Scan begin dist      :
Scan stop dist       :
X - increment        :
Scan width           :
Y - increment        :
Graph distances      :
Display X-range      :
<spare>              :
Taxi way   dist      :
Receiver location    :
Receiver Fwd dist    :
Receiver Sdw dist    :
Height :
Receiver height      :
Receiver track       :
Receiver start       :
Receiver stop        :
Elevation angle      :
Threshold distance  :
Receiver speed       :
Static bends         :
Limit of bend        :
(8) Length  Hgt  Btm-Hgt  Rot  Tilt Refl  *
(1) Scan : Begin   End X-inc  Width Y-inc  *
(2) Display     : X-scale  RWY dist TaxiWay *
(3) RX position:   Fwd    Sdw   Hgt  *
(3) RX track   : Start     Stop  *
FREE  FULL  FAST *
```

```
GP   div pos  track *
Full sidescan :
Fast sidescan :
not completed :
(2) Fast/Full  (9) CDI tone :

[To 9]
(A)dd
(T)rack RX
(E)rase
(O)rientation
(S)catter
(W)orst-Case
(Y)axis scan

[AMUnits]
Antenna Distribution Unit or Monitor Combining Unit Adjustments :
<spare>
Thomson New ADU :
Normarc M-array ADU (Standard Type) :
Normarc M-array ADU (Type B) :

[ADUMCU]
Move slider to the LEFT     (Connector ON/OFF):
Move slider to the RIGHT    (Connector ON/OFF):
Move to a higher Control  or  Connector :
Move to a lower Control   or  Connector :
PgUp Move slider to the LEFT     (Connector ON/OFF) :
PgDn Move slider to the RIGHT    (Connector ON/OFF) :
[CTRL]PgUp Move slider FAST to the LEFT :
[CTRL]PgDn Move slider FAST to the RIGHT :
.....hit ANY Key.:
DEMO VERSION - ADJUSTMENTS NOT ENABLED :
SUB MODULE TO AXIS 330 - Can not be run alone.... :
NORM DUMMYADU  MCU  SBO  CSB  RTC  RTS  PHX  CLR  Att  Phase*
Balance :
NULL REFERENCE :
SIDEBAND REFERENCE :
M-ARRAY :
Type :
1=Help    [CTRL] PgUp=Incr.  [CTRL] PgDn=Decr.  <Enter>=RETURN  Esc=Quit *
Monitor Combining Unit :
Select simulation angle:
Output :

[REFLECTION PLANE]
SUB MODULE TO AXIS 330 - Can not be run alone.... :
Weighted Reflection Plane FSL Computation :
(2)Load file  (3)Compute New  (4)Continue  <CR>Quit :
Start :
Stop :
Step :
Sdw :
SideWays :
Forward :
Distance :
Multiple SideWays Lines  <Y/N> :
Entering from :
Press <CR> to accept value :
Point No :
```

```
Press <CR> to skip input :
Enter height :
Weight distance (m)    <:
Dist.    Height    (Base Line)     :
(2)Graph (3)Save results (4)FSL :
(5)List data  <CR> to Quit :
Hit any key to continue.... :
Dist.    Height     ExtBase Weight W.Height :
Null REF :
Sideband REF :
M-ARRAY :
Enter Filename without Extension :
Reflection plane profile :
Weight dist :
GP zero height :
(I)Invert :

[End of file]
```

AX3

Appendix 3

Definitions

and

Abbreviations

0-9

2D	Two dimensional
3D	Three dimensional

A

A1, A2, A3	Glidepath antennas. A1 is the lowest antenna and A3 the highest one.
AAD	Antenna Array Designer section of this manual
ADU	Antenna Distribution Unit. This unit is between antenna array and the transmitter dividing the signals (CSB, SBO, C-CSB, C-SBO) from the transmitter to the antenna elements of the array.
AF	Audio Frequency
Ampl.	Amplitude
ASY	File extension for antenna system files
APP	Approach mode section of this manual
Ant	Antenna
Antenna	A physical device that converts a RF signal in cable into an electromagnetic field in space.
Antenna Array	A number of antenna elements arranged in a group in order to direct the RF signal in certain directions and/or avoiding RF signal into other directions.
Antenna Element	A physical unit consisting of one or more tuned radiating devices, connected to a single feeder cable.
Att.	Attenuation
ASY	File name extension for antenna array systems
AZ	Azimuth
AX1...AX4	Appendices of this manual

B

BAL	Modulation balance. The amplitude of both navigation modulation (90Hz and 150Hz) are equal.
BBP	Beam Bend Potential. The maximum possible bend amplitude along the course line if 100% of the radiated SBO signal in a given azimuth angle is reflected into the course line.
BND	Bend Analysis mode section of this manual
Btm-Hgt	Bottom Height (scattering object)
B&W	Black & White

C

Capture Ratio	The ratio between the course and clearance carrier amplitudes.
CAT	Category
C-CSB	Clearance CSB
C-DEV	Clearance deviation.
CDI	Course Deviation Indication. The full scale of the cockpit indicator is ±150uA representing 15.5 % DDM.
CEGS	Capture Effect Glide Slope.
CL	Courseline
Clearance	The CSB and SBO signals that will cover the sectors outside the coverage of the course signal in dual frequency systems. The clearance carrier frequency is normally spaced 8 kHz from the course carrier frequency. Also used for CDI values greater than ±150uA outside the course sector.
CLR	Clearance
Course	The CSB and SBO signals that will radiate with maximum signal along the localiser course line in single and dual frequency systems.
Course line	The locus of points to the runway centreline in any horizontal plane at which the DDM is zero.
C-PHI	Clearance Phase
CPN	Control Panel section of this manual
CR	Carriage Return (=Enter key)
CRS	Course, also called COU
CS	Course Sector. A sector in a horizontal plane containing the course line and limited by the loci of points nearest to the course line at which the DDM is 0.155.
C-SBO	Clearance SBO
CSB	Carrier and SideBands. The carrier equally modulated (40%) with 90 Hz and 150 Hz sine wave. Amplitude and phase defined as only the carrier part of CSB.
CTR	Center
CTRL panel	Control Panel

D

dB	deciBel
DEV	Deviation. Same as CDI
DEF	Abbreviation of this section
DEG	Degrees
DDM	Difference in Depth of Modulation. In this context defined as m150 - m90.
Dist.	Distance
Div	Division

E

Elmt	Antenna Element
Extra signals	The addition of SBO and CSB compared to NULL REF GP

F

FRQ	Frequency
FSD	Full Scale Deflection
FSL	Forward Slope
FWD	Forward
FIX	Fixed Position mode section of this manual

G

GEN	General Section of this manual
GND	Ground Current mode section of this manual
GP	Glide Path
GP centreline	A line in front of GP mast parallel to RWY centreline
GP Zero	The point on ground where antenna heights are measured
GRAPH	Graphic result of the analysis

H

Hgt	Height
Hyper	Hyperbolic path

I

ILS	Instrument Landing System
ILS Point A	A point on the extended runway centreline a distance of 7.5 km (4NM) from the threshold
ILS Point B	A point on the extended runway centreline a distance of 1050m (3500ft) from the threshold
ILS Point C	A point on the extended centreline where the nominal ILS glide path passes at a height of 30m (100ft).
ILS Point D	A point 4m (12ft) above the runway centreline and 900m (3000ft) from the threshold in the direction of the localiser.
ILS Point E	A point 4m (12ft) above the runway centreline and 600m (2000ft) from the stop end of the runway in the direction of the threshold.
ILS Point T	A point (normally 15m) above the threshold where the downward extended straight portion of the ILS glide path passes. Also called ILS reference Datum.
ICAO	International Civil Aviation Organisation
Incr	Increment
IRD	ILS Reference Datum. See ILS Point T.
ISO-CDI	Constant Deviation line. (Used in window overview graphic)

K

Kill	Same as delete.
Kts	Knots (Nautical Miles per hour, 1.852km/h)

L

LAT	Latitude Trace mode section of this manual
Lgt	Length
LOC	Localiser
LPDA	Log Periodic Dipole Antenna

M

M-ARRAY	
MCU	Monitor Combining Unit
MOD	Modulus
Modulus	The maximum possible bend amplitude along an approach if the reflected SBO signals arrive in the worst possible phase relationship to the direct CSB signal. Also called the envelope of the bend pattern.

N

NULL REF	Two antennas GP type (basic type GP) where the lower antenna (A1) radiates the CSB and the upper (A2) the SBO.

O

Optimize	Optimized GP is the M-ARRAY system where the amplitude and phase relation is slightly adjusted so that the SBO and CSB illumination towards reflection object or dicontinuities in the reflecting plane is suppressed in order to reduce the occuring bends created by the reflecting signals.
ORB	Orbit mode section of this manual

P

PLY	RePlay the Screens section of this manual
PHI	Phase
PHX	Phase of the extra signals. Nominal value is 180°
Pos	Position

R

Reflection plane
Refl.Pln.

RPL	Reflection PLane
RF	Radio frequency
RFL	Reflection Object or reflection factor
Rot	Rotation
r/s	Radians per Second
RT	Ratio
RTC	Ratio CSB in % between A2 and A1
RTS	Ratio SBO in % between A1/A3 and A2
RWY	Runway
RX	Receiver

S

SBO	SideBands Only. The 90 Hz and 150 Hz modulated in opposite AF phases. Amplitude and phase defined as the 150 Hz sideband sum vector relative to the carrier part in the CSB reference signal.
SBOA	SBO Amplitude
SBOP	SBO Phase
SCA	Scattering Object Editor of this manual
SDM	Sum of Depth of modulation defined as m150 + m90. A deviation of 387uA or a DDM at 40% is the maximum. Any value above this correspond to increased SDM while DDM will remain at the maximum value.
SDW	Sideway
SET	Setup section of this manual
Sense	The direction of FLY UP/DOWN on the screen
SIDEBAND REF	Two antennas GP type
SNS	Sensitive Area Mode
SSL	Sideways Slope
Step Hgt	Height difference on RWY centreline ref average SSL

T

TABL	Table result of the analysis
TaxiW	Taxiway
Tilt	Vertical Angle of the scattering object
THEO	Theodolite
THR	Threshold
TX	Transmitter
µA	Micro Ampere

U

V

VRT	Vertical Trace mode

W

W/R	With Reflector
WND	Window diagram section of this manual

X

Xinc	X-direction increment. (Forward direction steps)
Xing Hgt	Crossing height

Y

Yinc	Y-direction increment. (Sideways direction step)

Appendix A4

Questions and Answers