# 12. Zauto7 Utility

The RVP7 and RVP8 Doppler signal processors output calibrated values of the equivalent radar reflectivity factor. **Zauto** is an interactive graphic utility for calibrating the reflectivity offset of the signal processor. For the older RVP6, use the zauto6 utility. The results are stored in a calibration file that is loaded into the DSP for use during programmed radar data collection.

For a detailed description of the theory of signal processor calibration, refer to the *RVP7 User's Manua*l for your system. In general, the same nomenclature is used here.

To perform a calibration, a calibrated RF signal generator (siggen) must be used. **Zauto** can be used with a manually controlled siggen or a siggen controlled by the RCP. For manual operation, it is most convenient if the signal generator control can be located near the workstation where **zauto** is run. The siggen should be configured for CW operation rather than pulse mode.

**Setup** allows you to input any losses that are present in the system, such as:

- Loss between the transmitter and the antenna feed.
- Loss between the antenna feed and the receiver.
- Loss between the test signal injection point and the receiver.

For the last item, don't forget to add in the loss suffered in the cable that connects the siggen to the injection point, the coupler loss, and any calibration required for the signal generator.

### In this chapter:

# 12.1 Invoking Zauto

## 12.1.1 Before running zauto

Before running **zauto**, be sure to run **setup.** Verify the setup information or the **zauto** calibrations will not be accurate. For an automatic siggen, use the **antenna** utility to verify that the siggen is setting the correct values.

For magnetron systems, check/adjust the STALO and signal generator frequencies as described below

- Set switch 2 to the A position to run the normal receiver signal into the burst channel.
- Use RVP7 TTY ”pb” command to plot burst frequency spectrum. Turn off AFC while you are there.
- Set siggen frequency to an appropriate level.
- Adjust siggen frequency until it reads out the correct IF frequency (often 30 MHz) to within 100 KHz. Alternately use MFC to adjust the STALO frequency. It is worth checking that you are not off by a multiple of 18 MHz, or on the wrong side lobe of the transmitter.
- Exit, switch the switch back, run the **zauto7** program.
- When done, recheck the frequency for drift.

## 12.1.2 Invoking zauto

### Command

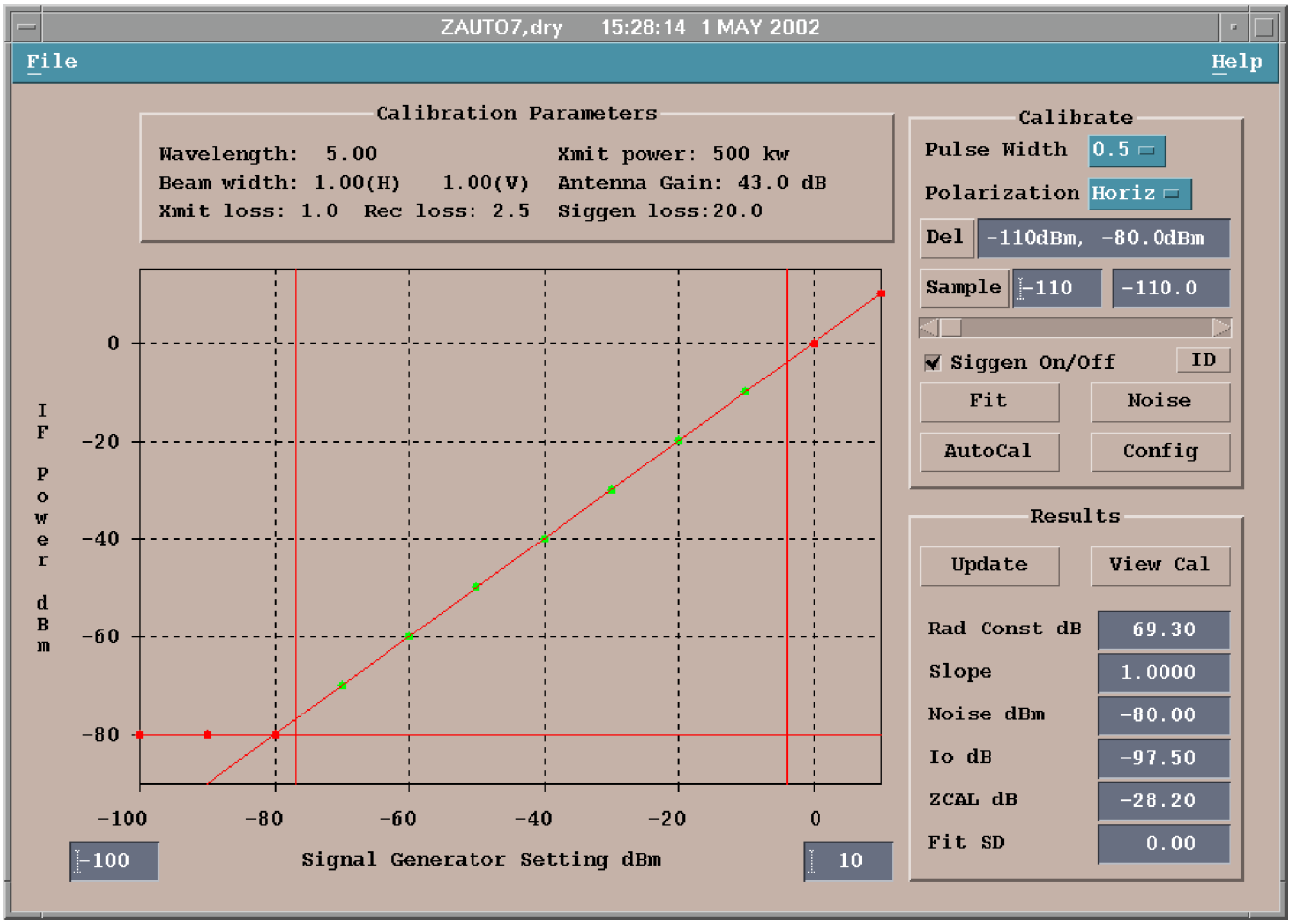
```
zauto
```

Alternatively, you can start the **zauto** from **irisnet**.

### Option

| | |
|---|---|
| `-demo` | Runs the utility without the signal processor, for testing and demonstration purposes. |
| `-cal` | Performs an automatic calibration without displaying the **zauto** menu. The results are saved to the calibration file, unless there is a value outside the tolerance range. This option is available only with an automatic siggen. |

## 12.2 Zauto Menu



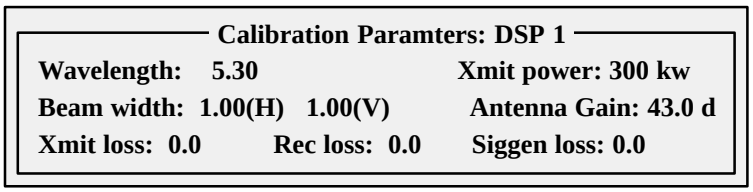

**Calibration Parameters**
**Section 12.2.1**
Displays certain calibration parameters defined with the **setup** utility.

**Calibration Plot**
**Section 12.2.2**
Displays a plot of the IF measured power vs. the signal generator setting.

**Calibration Display**
**Section 12.2.3**
Lets you control the calibration using the fields and buttons in this area of the menu.

**Results Display**
**Section 12.2.5**
Shows the temporary calibration information, such as the current noise and Zcal values for the specified pulse width.

### 12.2.1 Calibration Parameters



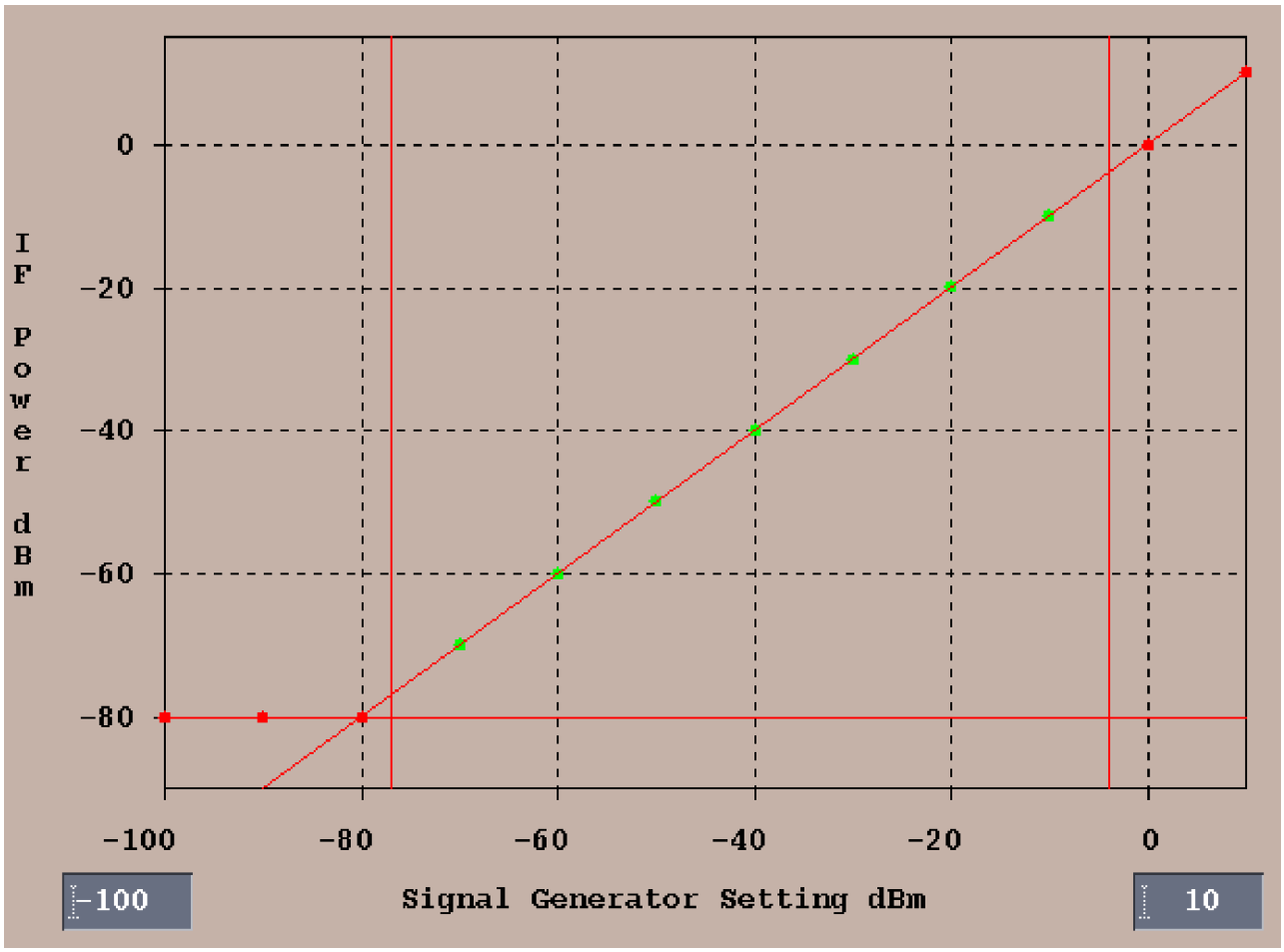

All of the calibration parameters are taken from **setup** and serve as a check that **setup** was properly configured. If you see an error in these parameters, exit from **zauto** and correct the error in **setup** before attempting a calibration. Otherwise, the calibration will be incorrect.

The following Setup parameters are displayed:

- Radar wavelength in centimeters
- Transmit power in kW
- Horizontal and vertical beamwidth in degrees
- Antenna gain in dB
- Transmit loss in dB
- Receive loss in dB
- Siggen loss in dB

These values remain fixed throughout the zauto procedure.

## 12.2.2 Calibration Plot




**Zauto** displays a plot of the IF power in dBm vs. the signal generator setting, similar to the plot shown in the Reflectivity Calibration section of the *RVP7 User's User's Manual.* In the manual, however, the horizontal axis of the plot is the input signal power at the antenna, which accounts for antenna-to-receiver loss and signal generator loss. **Zauto** corrects for these effects, based on the setup information. In performing the calibration, it displays the signal generator value on the horizontal axis.

### Left and Right Plot Limits

Plot range fields at the lower left and right of the calibration plot define the lower and upper limits, in dB, of the signals to be generated. You can change the limits, and **zauto** rescales the plot for the new range. **Zauto** does not allow a new range limit when there would be data points outside the range.

### Left and Right Fit Limits

Vertical red lines mark the limits of the least squares fit. They can be moved independently by pointing with the mouse on the graph and clicking the left mouse button. If the fit limits lie outside the plot range, they are shown as colored lines at the corresponding edge of the graph. The default limits are taken from the calibration configuration settings. (See Section 12.2.4.)

Usually, the fit limits are set after a number of points have been plotted and before doing a least squares fit. You should set the limits so that the fit is made to the linear portion of the plot, typically 15 dB above noise to the saturation point of the LOG receiver. Points that lie outside the fit limits are displayed in red to show that they are not be included in the next fit. The limits can be reset and another least squares fit performed to fine tune the plotted line. When the limits are changed, the last fit and noise lines are removed, along with the appropriate information in the results display.

### Plot Points

Plot points are the dots that mark the strength of the signal sampled at a number of specified settings.

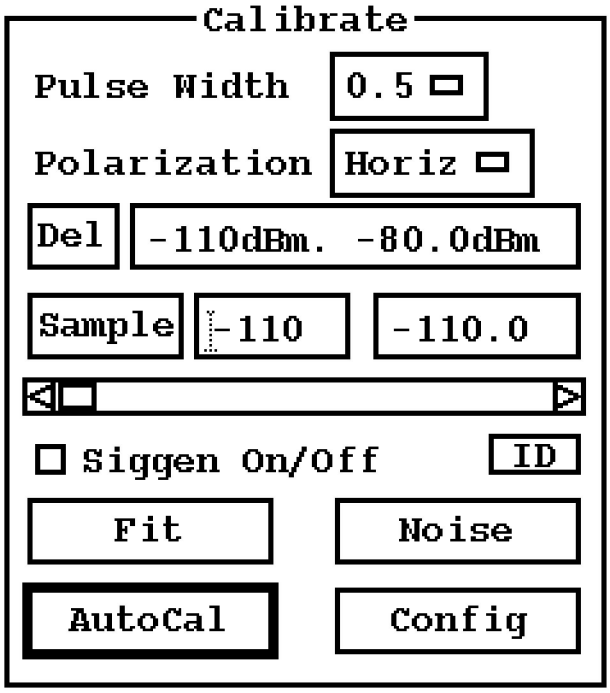
### Fit Line

Shows the least squares fit of the plot points that fall within the fit limits.

### Noise Level Line

The noise level line is a horizontal line drawn when the siggen is not generating a signal.

## 12.2.3 Calibration Display




### Pulse Width

Begins a new calibration at the specified pulse width, which you select from a pop-up menu. When you switch to a new pulse width, any prior data points and temporary results are discarded. Therefore, **zauto** lets you choose whether you want to save the calibration.

### Polarization

On multiparameter radars, calibration must be performed separately for each polarization channel. For other radars, this should not be changed as changing the polarization will erase the current calibration points.

### Delete

Clicking on the Delete button deletes the last calibration point. By clicking Delete many times, you can delete successive points, in reverse order.

### Noise

Clicking on the Noise button takes a noise sample and plots the result. The noise sample must be taken after the least squares fit is done. For a manual siggen, you must turn the siggen to its lowest setting or disconnect it before taking a noise sample. **Zauto** does this automatically when the siggen is controlled by the RCI.

When you take the noise sample, a red line is drawn at the A/D noise level. If the noise level is outside the range of 10 to 30 A/D units, align the LOG channel A/D converter by adjusting the appropriate offset pot on the DSP. This can be done using the Ascope utility. Make sure that the A/D converter gain has been adjusted as well.

### Sample

The Sample button generates and plots the specified test signal. In the field to the right of this button, you enter the desired siggen setting in dBm. For a manual siggen, you must set the siggen to match this setting. **Zauto** measures the power at IF, and plots the point on the calibration graph.

The siggen setting can be entered in one of the following ways:

- Type a number directly into the field.
- Move the slider within the sliding scale until the desired value is displayed in the field.
- Click inside the scale to move the slider in steps. The size of the step is defined in the AutoCal Configuration menu (see below).

### Siggen ON/OFF

Use this button to toggle the siggen off before taking a noise sample, then toggle it on again.

### ID

Use this button to identify which siggen is used in the calibration. This is helpful in the future when you want to compare new results to old calibration files.

### Fit

Clicking the Fit button causes zauto to perform a least squares fit to the data points that lie within the specified range limits. The resulting line is drawn on the calibration plot. At least two points are needed. The Results display shows the slope and intercept values for the line.

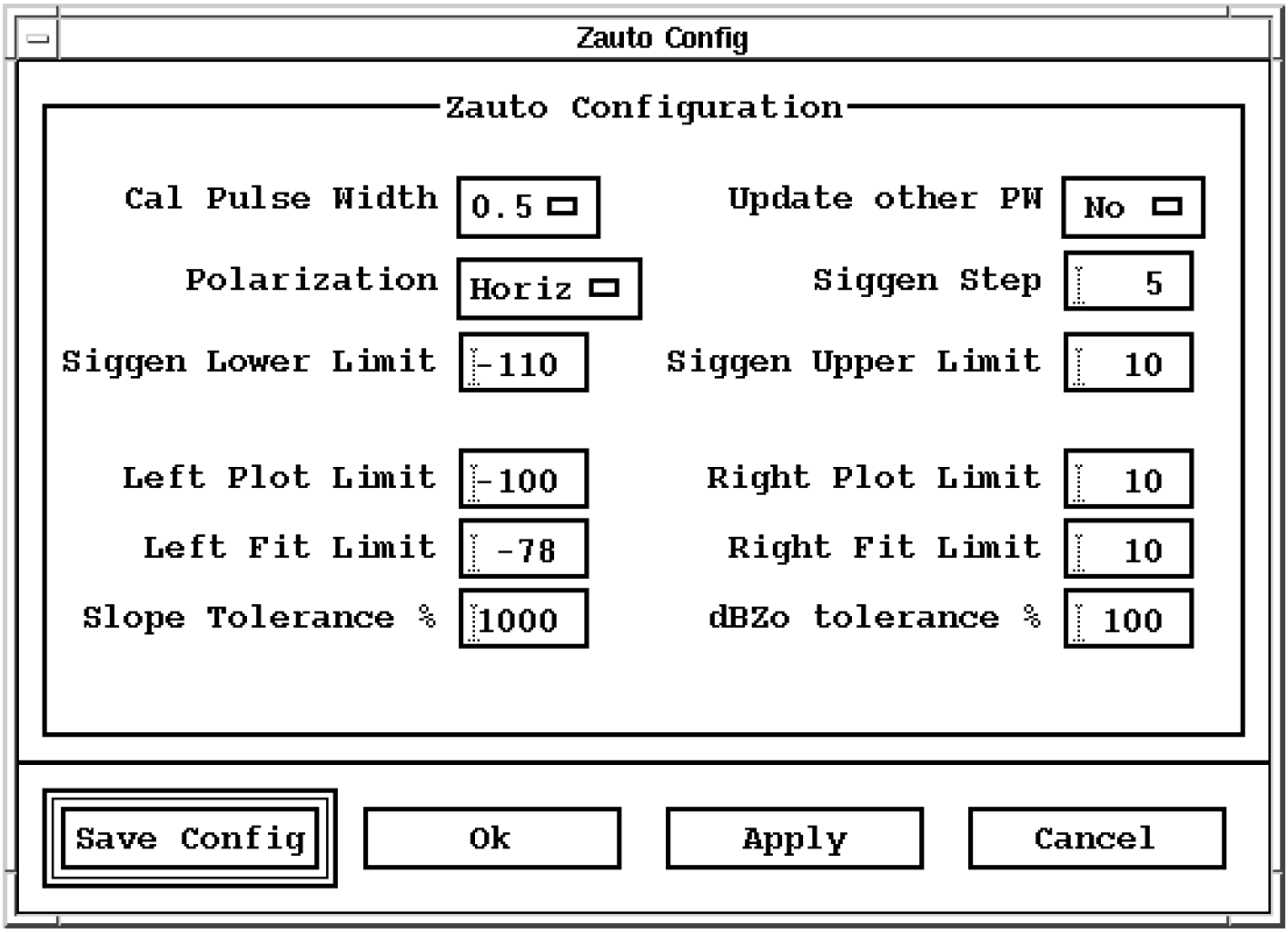
The fit is a straight line. The fit range limits should be set so that only the points in the linear region of the calibration curve are included. The signal processor corrects for the curved portion of the calibration, which corresponds to weak signals.

### Automatic Calibration

Automatic calibration is available only if you have an automatic siggen. Clicking on the AutoCal button generates a series of signals — beginning at the lower range, ending at the upper range — and plots them on the graph. When it is finished, a noise sample is taken and a least squares fit of the data points is taken. The calibration is then saved. See Section 12.5 for more information on performing automatic calibrations.

### 12.2.4 Configuration Menu

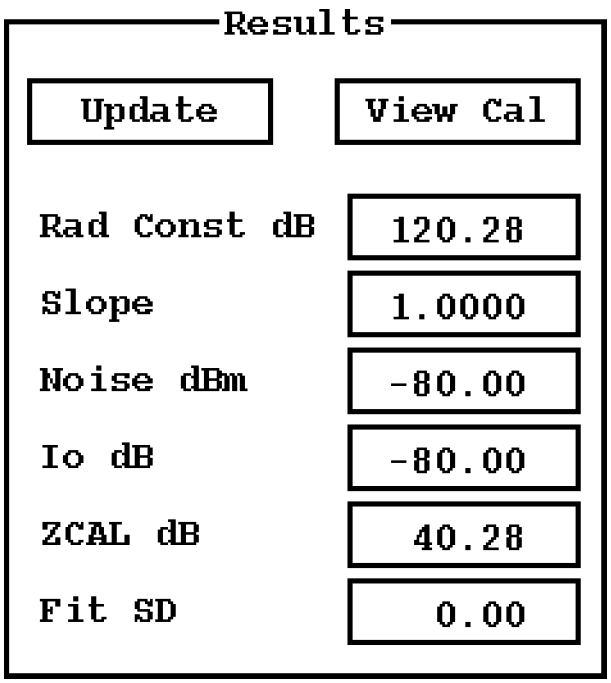
Clicking on the Config button pops up a menu in which you can define the parameters of the automatic calibration procedure.




- Calibration Pulse Width — Select the pulse width to be calibrated automatically.
- Update other PW — As an alternative to recalibrating for each pulse width, choose “Yes” to copy the results of a calibration at one pulse width to other pulse widths, scaled by the different radar constants for the two pulse widths. For the most accurate results, however, the radar should be recalibrated at each pulse width.
- Polarization – only to be changed for multiparameter radars.

- Siggen Step — The interval between generated signals. The step can be a positive or negative number between 1 and 100. A negative step moves the slide from the upper to the lower limit, from right to left.
- Left and Right Plot Limits — The range of signals to be plotted.
- Left and Right Fit Limits — The range to be included in the least squares fit.
- Slope and dBZo Tolerance % — These are positive integers between 1 and 100, used for the comparison with the reference calibration information during an automatic calibration. If the new calibration differs by more than these percentages, AutoCal does not update the calibration.

## 12.2.5 Results Display




The Results display shows the temporary calibration information such as the current slope and dBZ or Zcal values for the specified pulse width. These values apply to the most recent squares fit and noise sample. Log/averaging vs. linear/averaging signal processors may show different information. This display is updated every time a new noise level is taken, or any time the data used for linear fit changes.

### Update

Clicking the Update button stores the current calibration for the pulse width you select from the pop-up menu. The slope result is copied regardless of pulse width. The calibration reflectivity is copied over for the specified pulse width.

### Radar Constant

Displays the calculated radar constant (see the *Signal Processor User's Manual*).

### Slope

Displays the slope of the straight line fit to the data values in dB per machine number (A/D value) The slope should be close to 1. Less than 1.02 is a reasonable threshold. If a reasonable value is not acquired, adjust the fit range limits.

### Noise

Displays the LOG average DC level of the LOG receiver signal.

### Io (or Bo)

Displays the calibration intercept.

### ZCAL

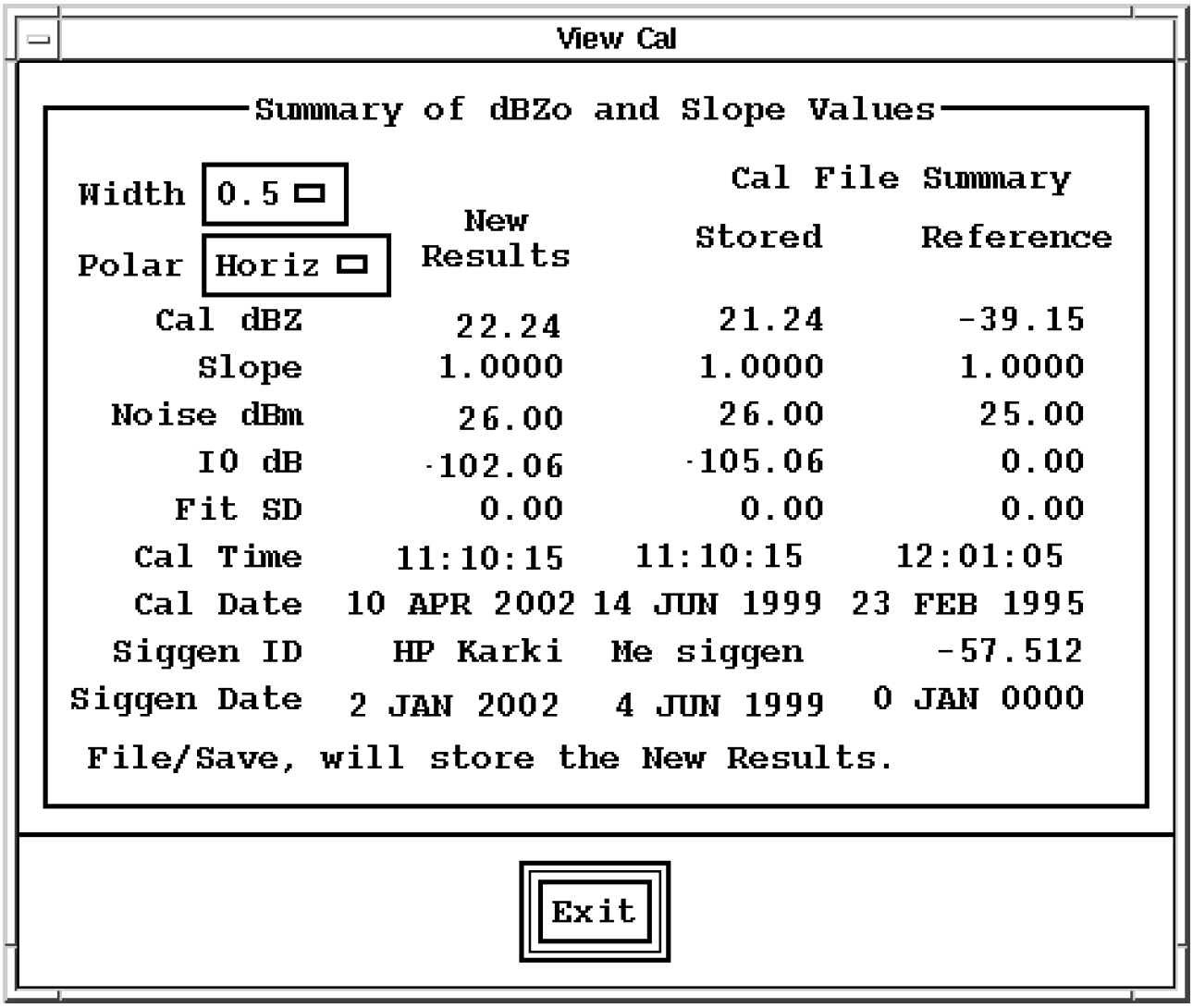
Displays the Zcal value computed from the radar equation (dBZo in the *Signal Processor User's Manual).*

### Fit SD

Displays is the standard deviation on the least squares fit in dB. This should be under 1 for a good fit. If a reasonable value is not acquired, adjust the fit range limits.

### View Calibration

The View Calibration button pops up a menu showing the current results, the last results saved to a file, and the reference calibration set by the **zcal** utility. When you have viewed the information, click on the Exit button to close the menu.


View Cal
Summary of dBZo and Slope Values
Width 0.5
Polar Horiz
Cal File Summary
New Results
Stored
Reference
Cal dBZ 22.24 21.24 -39.15
Slope 1.0000 1.0000 1.0000
Noise dBm 26.00 26.00 25.00
IO dB -102.06 -105.06 0.00
Fit SD 0.00 0.00 0.00
Cal Time 11:10:15 11:10:15 12:01:05
Cal Date 10 APR 2002 14 JUN 1999 23 FEB 1995
Siggen ID HP Karki Me siggen -57.512
Siggen Date 2 JAN 2002 4 JUN 1999 0 JAN 0000
File/Save, will store the New Results.
Exit

## 12.3 Zauto Commands

The **zauto** utility provides the following commands:

### File


**Save** writes the calibration information to a file.

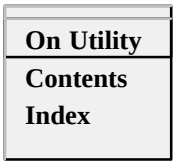
**Print** creates an X-window dump of the menu you are running, as follows:

- **Print–>to Printer** sends the output to the Postscript or color printer specified in the Printer Setup menu.
- **Print–>to File** sends the output to a file in your default home directory.
- **Print–>Setup** lets you configure the printer on your system. See the *Software Installation Manual* for details on configuring a printer.

**Exit** exits from the **zauto** utility.

Calibration information is stored in the **`config`** directory in a file called **`zscalib.conf`**. If you do not save the file before you exit from the utility, **zauto** asks if you want to update the file so the calibrations can be used for automatic data collection.

### Help




**On Utility** displays information on the **zauto** utility.
**Contents** displays the table of contents for the *IRIS Utilities Manual.*
**Index** displays the index to the *IRIS Utilities Manual.*

See Section 1.4 for more information on getting online help.

## 12.4 Manually Calibrating the Signal Processor

**Note: For manual siggen control, it is best if the control for the signal generator and the workstation are located next to each other. Otherwise, two people and some coordination are required to perform a calibration.**

**Important: The sensitivity and dynamic range of the radar can be affected by the gain of the IF signal entering the IFD. Please adjust the IF signal level first as outlined in Appendix E of the *RVP7 User's Manual*.**

To protect the signal generator, the radar is not usually set to transmit during calibration. Check with your manufacturer. If it is OK to transmit while the siggen is connected, then it should be done because the calibration can better simulate operating conditions. If transmitting is not recommended, everything should be turned on but the transmitter should not be set to radiate. This assures that all sources of noise are accounted for.

Whether or not you are transmitting, set the antenna elevation greater than 20 degrees to reduce the effect of earth temperature noise which is detectable by modern, sensitive receivers. If you are transmitting, this eliminates the possibility of weather signals interfering with the calibration.

The signal generator must be set for the CW (continuous wave) rather than the pulse mode of operation.

### To perform the calibration:

1. Select a pulse width. Note that the pulse width lines of the DSP will issue the appropriate signal. If this control is implemented on your system through the antenna controller, it is set correctly.
2. Set the plot range limits. If you have no idea what limits to set, use the defaults until you get a feel for your system. These can be adjusted later without loss of data.
3. Collect the plot points for the calibration, as follows:
   a. Enter the siggen value in the unlabeled field next to the Sample button. You can use the slide bar to do this.
   b. If the siggen is not controlled by the RCI, set the signal generator output to match the specified value. Otherwise, this is done for you.
   c. Click on the Sample button, and **zauto** draws the point on the calibration plot.

   Repeat these steps until you have collected a sufficient number of points (for example, six points in the linear range of the curve). If you make a mistake, use the Delete button to remove the point or reset the pulse width and start again.

4. After the points have been collected, set the plot limits to include only those points in the linear range.
5. Turn down or disconnect the signal generator and click on the Noise button. A horizontal line is drawn at the average noise level.
6. Click the Fit button and observe the line and results to make sure they are reasonable. Reset the limits or collect more data as required to get a representative fit to the straight line portion of the curve (typically from 15 dB above noise to 70 dB above noise). The calibration results will be filled in each time the fit button is pressed.
7. When you are satisfied with the calibration, click on the Update button to update the View Calibration display. Results from one pulse width can be used to update other pulse widths. However, for the most accurate results, you should perform a separate calibration for each pulse width. After some experience with your system, you will know if this is necessary. Errors are likely to be less than 3 dB if the update technique is used.
8. Move on to the next pulse width, if necessary, starting with Step 1.
9. When you are finished, the View Calibration display should have the values that you want to save. If so, choose **File–>Save**, then **File–>Exit** to exit from zauto.

Always check the calibration values in the View Calibration display to be sure they are reasonable.

There is an alternate way to modify the calibration file, which uses the **zcal** utility. **Zcal** allows you to simply enter the calibration reflectivity by hand. This is used primarily for testing purposes or after a component has been replaced by another with known calibration.

## 12.5 Automatically Calibrating the Signal Processor

The **zauto** utility can automatically calibrate the signal processor output, either from the utility itself or from the command line. If you perform the automatic calibration from the utility, **zauto** plots each point on the graph and draws the least squares fit and noise sample lines on the display. If you perform the calibration from the command line, **zauto** displays a series of messages indicating each siggen setting and DSP value. In both cases, the new slope is calibrated, and the results are saved in the calibration file.

Regardless of the method of running the automatic calibration, **zauto** uses the reference information from the calibration file to determine whether to accept the new calibration information. If the new calibration deviates too much from the reference settings, it is not used. This prevents loss of data if the signal generator should fail.

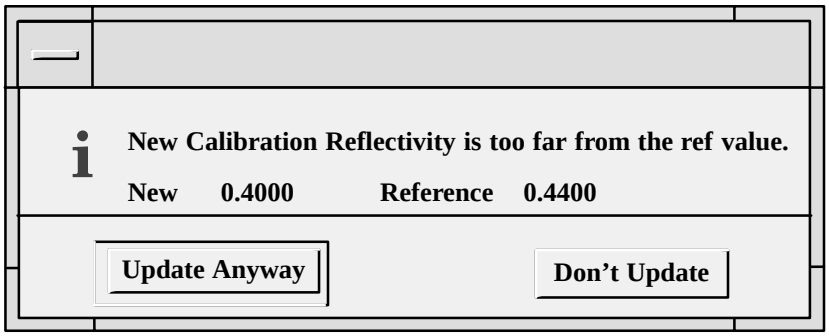
**Note: The only way to change the reference calibration information is with the zcal utility.**

### To configure the automatic calibration:

1. From the zauto menu, click on the Config button and pop up the AutoCal Config menu. From this menu, choose the pulse width for the calibration, the siggen step, and other parameters for the calibration.
2. Use the Slope Tolerance % and the dBZo Tolerance % fields to determine the amount of deviation allowed between the reference information and the new calibration. A higher percentage allows for a larger deviation, with 100% allowing any results to replace the old calibration values.
3. Click on the Save Config button to save your configuration settings.

### To perform the calibration from the zauto menu:

Click on the AutoCal button. **Zauto** steps through a series of signal values and plots the points. If the new results deviate too far from the old results, **zauto** displays the message:



For each message, you can choose to update the calibration file or reject the new calibration information.

### To perform the calibration from the command line:

Enter the following command from the operating system prompt:

```
$ zauto –cal
```

The utility displays a series of messages indicating the siggen values and DSP values used in the calibration, such as the following:

```
Setting –110.00   DSP Val   25.00
Setting –105.00   DSP Val   37.50
Setting –100.00   DSP Val   50.00
Setting  –95.00   DSP Val   62.50
Setting  –90.00   DSP Val   75.00
Setting  –85.00   DSP Val   87.50
Setting  –80.00   DSP Val  100.00
Setting  –75.00   DSP Val  112.50
Setting  –70.00   DSP Val  125.00
Setting  –65.00   DSP Val  137.50
Setting  –60.00   DSP Val  150.00
Setting  –55.00   DSP Val  162.50
Setting  –50.00   DSP Val  175.00
Setting  –45.00   DSP Val  187.50
Setting  –40.00   DSP Val  200.00
Setting  –35.00   DSP Val  212.50
Setting  –30.00   DSP Val  225.00
Setting  –25.00   DSP Val  237.50
Setting  –20.00   DSP Val  250.00
Setting  –15.00   DSP Val  262.50
Setting  –10.00   DSP Val  275.00
Setting   –5.00   DSP Val  287.50
Setting    0.00   DSP Val  300.00
Setting    5.00   DSP Val  312.50
Setting   10.00   DSP Val  325.00

Slope   New:  0.4000     Ref:  0.4400

Reflectivity Pulse Width:0.5 New:–39.4354 Ref:–20.5000

file saved
```

If the new values deviate too far from the reference information, the file is not saved. To have the new values accepted, you must run **zauto** and change the tolerance fields in the AutoCal Config menu, then rerun the utility.

## 12.6 The Siggen Calibration File

The **zauto** utility can read a calibration file which contains information detailing exactly what power level is output for each nominal setting of the signal generator. This feature is typically used to provide a very accurate calibration of an automatic signal generator which is controlled by IRIS. For example, a requested value of –30 dBm may actually be –30.2 dBm. For manual calibration, with a calibrated signal generator, it should not be necessary to use this feature.

The calibration display in zauto shows both the nominal requested setting as well as the calibrated value. The calibrated value is shown with a resolution of 0.1 dB. This calibration file is created by the user either through a calibration program, or typed in via an editer. The file is SIGGEN_CAL.DAT located in the IRIS_CONFIG directory (e.g., /usr/sigmet/config). A partial example is shown below:

```
# Comments start with #
#
# First set the date of the calibration in the following format
# Note the D in Date is capitalized.
Date: 10:15:00 20 OCT 1995
#
# Next the signal generator ID string
#
ID: XX aaa_BBB-CCC
#
# Now include a table of the integer nominal siggen values
# followed by the calibrated value as a floating point value.
# Start with the largest value.
#
0       0.1
-1     -1.1
-2     -2.1
-3     -3.1
-4     -4.1
-5     -5.1
-6     -6.1
-7     -7.1
-8     -8.1
-9     -9.1
-10   -10.1
-11   -11.1
-12   -12.1
-13   -13.1
-14   -14.1
-15   -15.1
-16   -16.1
-17   -17.1
-18   -18.1
-19   -19.1
.
.
.
```

Only the 128 dB span immediately below the first entry in the file will be used, all values outside this range, and all missing values will be treated as correctly calibrated. If the file is missing, then all values are treated as correctly calibrated, and the ID string is set to “No siggen file”. If the file exists, but does not contain an ID string, the ID string will be set to “No ID in file”. The ID, as well as the date are displayed in the **zcal** utility.