SOFTWARE UTILITY
USER MANUAL

MODEL 2165

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RACAL INSTRUMENTS

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http://www.racalinstruments.com/downloads

If you have any questions about software driver downloads or our privacy policy, please contact us at

info@racalinstruments.com.

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For the specific terms of your standard warranty, or optional extended warranty or service agreement, contact your Racal Instruments customer service advisor. Please have the following information available to facilitate service.

1. Product serial number
2. Product model number
3. Your company and contact information

You may contact your customer service advisor by:

E-Mail:	Helpdesk@racalinstruments.com	
Telephone:	+1 800 722 3262	(USA)
	+44(0) 8706 080134	(UK)
Fax:	+1 949 859 7309	(USA)
	+44(0) 1628 662017	(UK)

RETURN of PRODUCT

Authorization is required from Racal Instruments before you send us your product for service or calibration. Call your nearest Racal Instruments support facility. A list is located on the last page of this manual. If you are unsure where to call, contact Racal Instruments, Inc. Customer Support Department in Irvine, California, USA at 1-800-722-3262 or 1-949-859-8999 or via fax at 1-949-859-7139. We can be reached at: helpdesk@racalinstruments.com.

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FOR YOUR SAFETY

Before undertaking any troubleshooting, maintenance or exploratory procedure, read carefully the **WARNINGS** and **CAUTION** notices.

CAUTION
RISK OF ELECTRICAL SHOCK
DO NOT OPEN

This equipment contains voltage hazardous to human life and safety, and is capable of inflicting personal injury.

If this instrument is to be powered from the AC line (mains) through an autotransformer, ensure the common connector is connected to the neutral (earth pole) of the power supply.

Before operating the unit, ensure the conductor (green wire) is connected to the ground (earth) conductor of the power outlet. Do not use a two-conductor extension cord or a three-prong/two-prong adapter. This will defeat the protective feature of the third conductor in the power cord.

CAUTION
SENSITIVE ELECTRONIC DEVICES
DO NOT SHIP OR STORE NEAR
STRONG ELECTROSTATIC,
ELECTROMAGNETIC, MAGNETIC OR
RADIOACTIVE FIELDS

Maintenance and calibration procedures sometimes call for operation of the unit with power applied and protective covers removed. Read the procedures and heed warnings to avoid "live" circuit points.

Before operating this instrument:
1. Ensure the proper fuse is in place for the power source to operate.
2. Ensure all other devices connected to or in proximity to this instrument are properly grounded or connected to the protective third-wire earth ground.

If the instrument:
-         fails to operate satisfactorily
-         shows visible damage
-         has been stored under unfavorable conditions
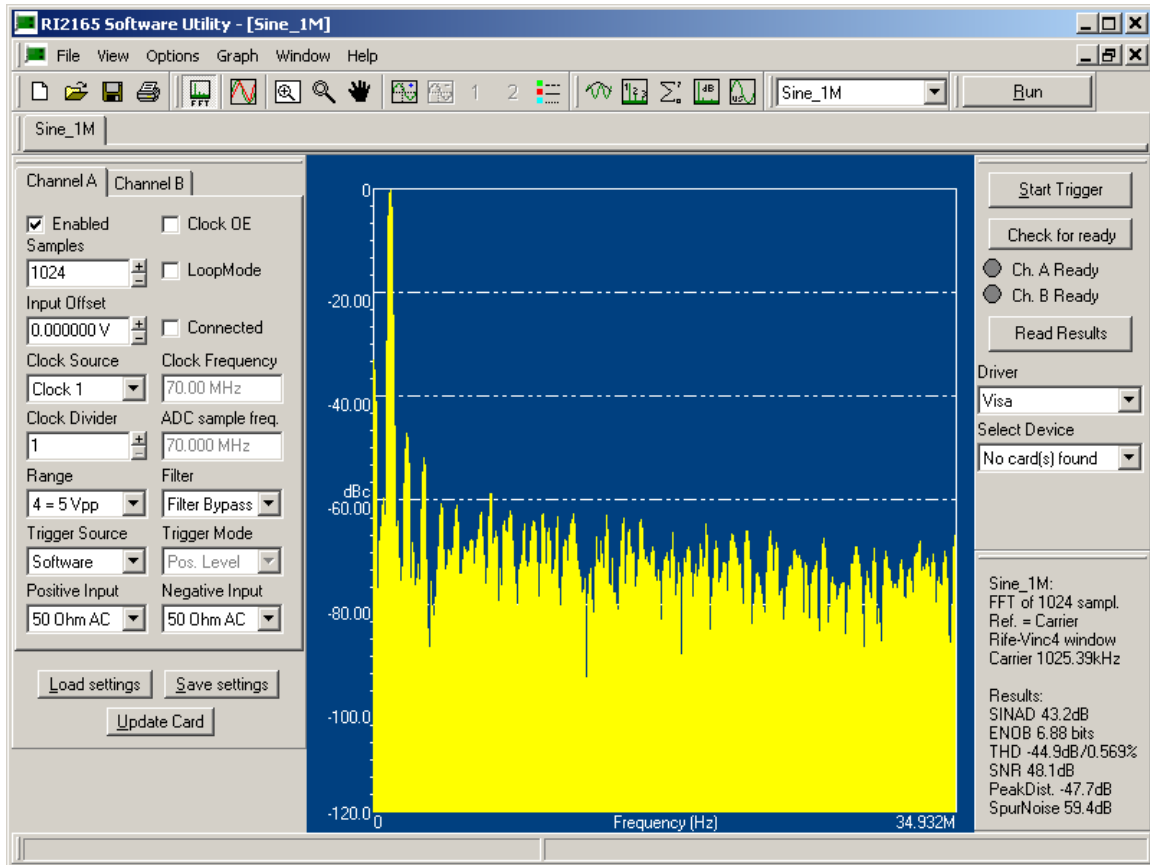-   has sustained stress

Do not operate until performance is checked by qualified personnel.

TABLE OF CONTENTS

Introduction

The Racal Instruments' Model 2165 Software Utility can be used to adjust the 2165 digitizer and analyze the captured data.

The Software Utility includes the following features:

- Adjust the RI 2165 instrument;
- Do a software trigger to start data capture;
- Check the test status;
- Analyzing the results by using the Fast Fourier Transform or Discrete Fourier Transform algorithm.

Some analyzing features:

- 8 different windowing types (e.g. Hanning, Hamming, Flat-Top, Blackman-Harris and Rife Vincent);
- Summary of Harmonics;
- Adjustable harmonics level and count level for parameter calculations;
- Adjustable noise level for parameter calculations;
- Fixed reference level (dBc) or adjustable reference level (dB);

1 Adjusting The Instrument

1.1 Block Diagram

It is easier to understand the instrument settings if the hardware structure is known:
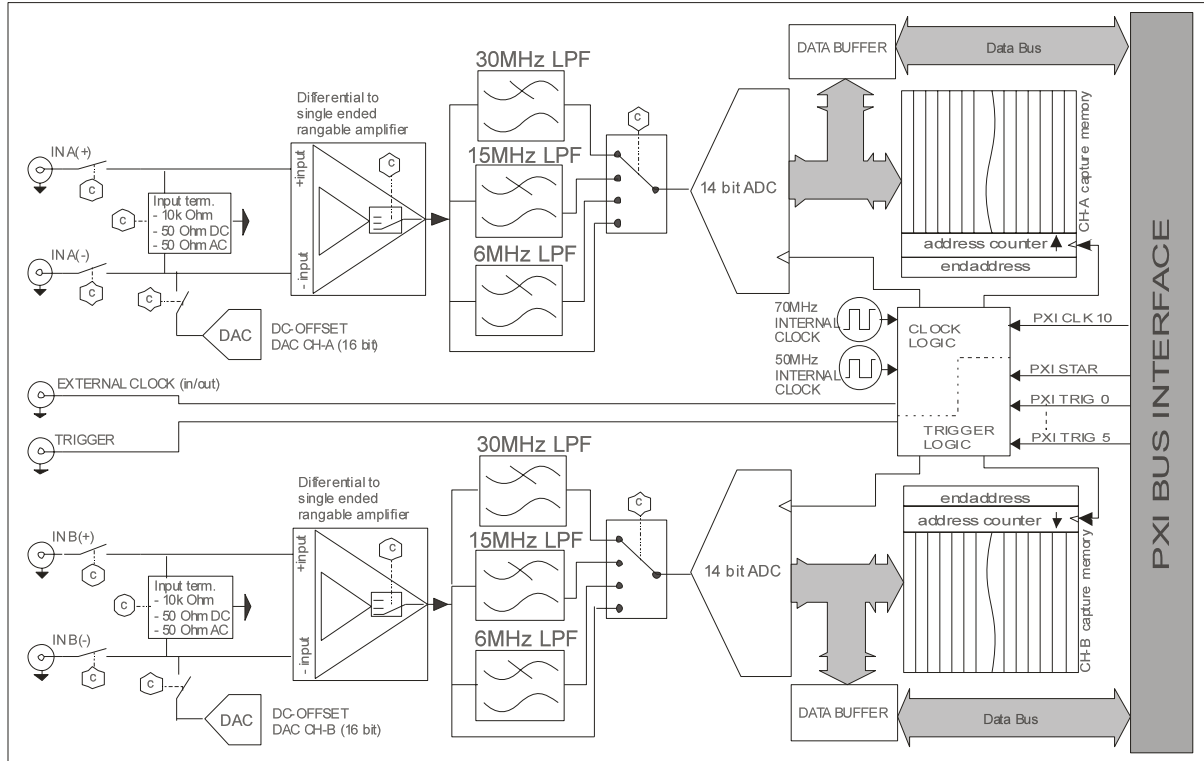
For details, please read the Hardware User Manual Model 2165

1.2   The instrument Settings Panel

The instrument can be adjusted with the following panel:

The instrument can be configured by adjusting the following parameters:

- **Enabled:** Determines if the channel will be updated and set in lockmode.
- **Samples:** Number of samples that will be read and can be analyzed.
- **LoopMode:** Set channel in loopmode. If channel is in loopmode the data will be captured as long as the channel is triggered and in lockmode. When the data is read, the software starts reading "samples" before the last captured sample. If the channel is not in loopmode data capture stops at the end of the capture memory. When the data is read, the reading starts at the first captured sample after the trigger.
- **Input offset:** Set the DC input offset voltage at a specified level.
- **Connected:** Connect or disconnect the DC input offset.
- **Clock source:** Select the clock source.
- **Clock frequency:** Can only be adjusted if the External clock source is selected. Please fill in the supplied clock frequency for a correct time and frequency axis.
- **Clock divider:** The clock divider for the desired (ADC) sample frequency.
- **Sample divider:** The sample divider for the desired sample frequency. The sample divider will not change the ADC sample frequency. E.g. a sample divider of 2: 1 of the 2 samples will be stored in the capture memory.
- **Range:** Select the input voltage range.
- **Filter:** Select a filter or bypass the filter.
- **Trigger source:** Select the trigger source. If using the "Start" button of the software utility, select Software-trigger.
- **Trigger mode:** Select if the trigger mode.
- **Positive and Negative input:** Select the input connection.

The load and save buttons can be used to load and store predefined settings. Use the "Update Card" button to update the Instrument.

1.3   Performing a Test

Perform the following steps before the test:

1. Select the driver (Visa or kernel driver);
2. Select the Device;
3. Adjust the instrument settings;
4. Press button "Update Card";
5. Press the "Start" button in case of software trigger;
6. Press the "Check for ready" button and wait till the enabled channel(s) is/are ready;
7. Press the "Read Results" button. The result will be displayed in the active window.
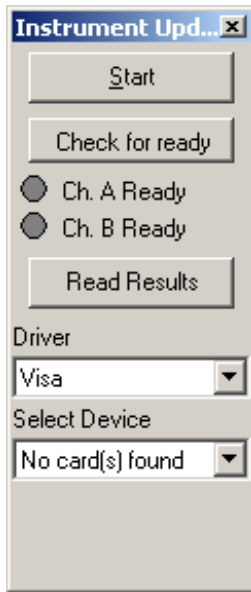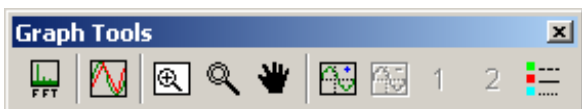
It is possible to run a test by pressing the "Run" button on the toolbar. This will perform the steps 4 till 7 automatically.

2 Analyzing The Data

2.1 General

Some general tools can be found in the Graph Toolbar. These options can also be found in the Menu Graph.

FFT: Do a Fast Fourier analysis (if samples are a power of 2) or discrete Fourier analyses (in all other cases).
Overlay: Place more than one graph in the same window.
Undo zoom: Graph will be displayed in original position.
Zoom: Zoom in/out or area. For an accurate zoom use the Options->Time Domain Settings dialog.
Scroll: Scroll the graph.
Add cursor: Add a cursor to the active line.
Remove cursor: Remove the active cursor.
Activate cursor 1 or 2: If the cursor is the active cursor, the cursor can also be move with the arrow keys.
Graph colors: Change the graph colors.

The graph can be saved as a bitmap (Graph->Save Graph As Bitmap) and can be copied to the Clipboard (Graph->Copy Graph To Clipboard).

2.2 Time Domain

Select "Time Domain Settings" from the Option menu or toolbar. The X-axis can display samples or a time axis. For an accurate zoom select the option "Selection" of Visible Samples.
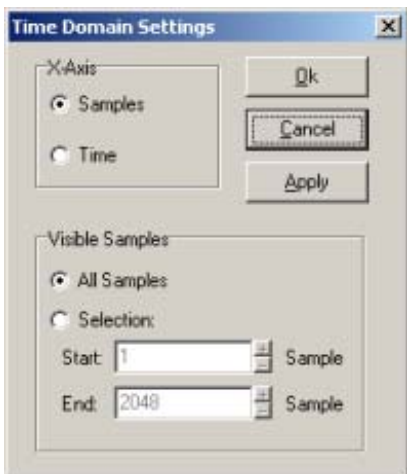
2.3   Frequency Domain

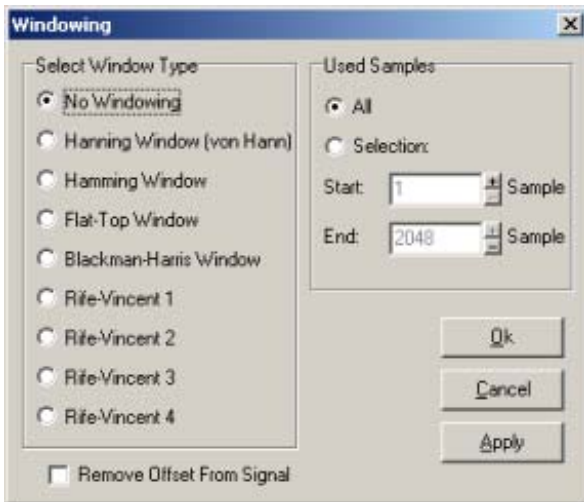**Windowing**

There are two reason why you would apply a window:

1. Your signal has a non-integer number of periods. Analyzing the signal in the frequency
    domain will result in spectral leakage. Applying a window reduces the spectral leakage.
2. You want to analyze a part of the signal.

The general equation of the window-function is:

$$Wk = \sum_{m=0}^{m=M-1} a_m \cos\left(\frac{2\pi k}{N} m\right) \quad 0 \leq k < N$$

The coefficients for each window are:

Window type	a0	a1	a2	a3	a4
No window (also Rectangular)	1.0	0.0	0.0	0.0	0.0
Hanning	0.5	-0.5	0.0	0.0	0.0
Hamming	0.54	-0.46	0.0	0.0	0.0
Flat-Top	0.281	-0.521	0.198	0.0	0.0
Blackman-Harris	0.432	-0.497	0.079	0.0	0.0
Rife Vincent 1	0.5	-0.5	0.0	0.0	0.0
Rife Vincent 2	0.375	-0.5	0.125	0.0	0.0
Rife Vincent 3	0.3125	-0.46875	0.1875	-0.03125	0.0
Rife Vincent 4	0.2734375	- 0.4375	0.21875	-0.0625	0.0078125

In the "Used samples" section you can select a part of the signal to be analyzed.

Summary of Harmonics

This data for the summary of harmonics is only available if the signal is displayed in the frequency
domain.

The dialog window shows an overview with the frequency bins that are multiples of the carrier. The carrier is the frequency bin with the highest amplitude. The number of harmonics is determined in the dialog box "Calculation options", described below. Calculation of the harmonic bin:

$$Bin_n = (Carrierbin - 1) * n - 1$$

Calculation Settings

The parameters SINAD, ENOB, THD, SNR, Peak Distortion and Spurfree can be determined after defining the function of each bin (noise, distortion or carrier). The carrier is determined by the software (frequency bin with the highest amplitude). Multiples of the carrier are the harmonics. All frequency bins that are not harmonic or carrier are assumed to be noise elements.
With the option ""Calculation settings" the user can define some selection criteria, which can determine for each frequency bin to be distortion or not and noise or not.


Harmonics:

The "Maximum included harmonics" parameter determines the maximum number of frequency bins to be distortion. With the field "Include harmonics above level" it is possible to exclude bins below a certain level.

Noise:
All frequency bins that are not distortion or carrier and are below the level-parameter are assumed to be noise.

Frequency Domain Settings

With the "Frequency domain settings" option you can configure how to display the data in the frequency domain.
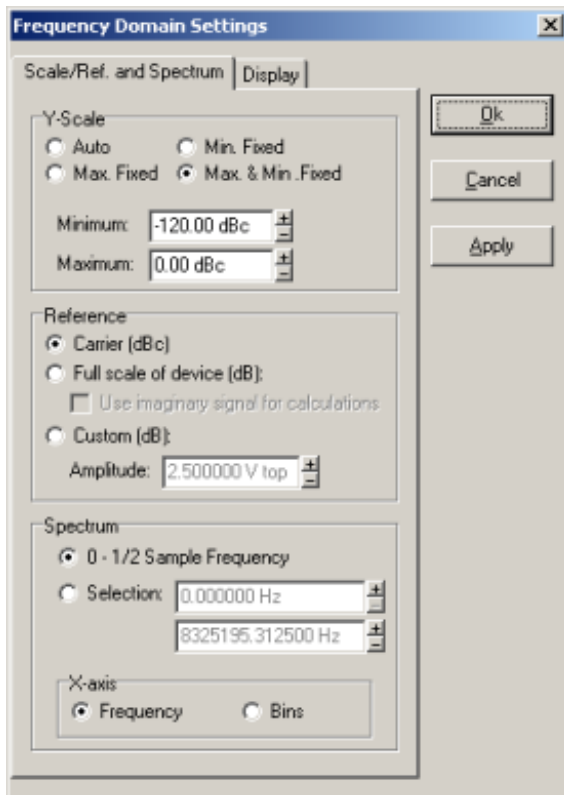
Y-scale:
- Auto: Maximum and minimum y-scale values are determined by the software. The minimal scale value is limited to minimum calculated level, maximum scale is limited to the maximum calculated level;
- Min. fixed: The minimum y-scale value is fixed to the "Minimum" parameter;
- Max. fixed: The maximum scale y-value is fixed to the "Maximum" parameter;
- Max. and min. fixed: The maximum scale y-value is fixed to the "Maximum" and the minimum y-scale value is fixed to the "Minimum".

Reference:
- Carrier (dBc): All frequency bins are related to the carrier (frequency bin with the highest amplitude). So the carrier itself is 0 dBc;
- Full scale of device (dB): All frequency bins are related to the maximum amplitude of the range (determined by the instrument range setting).
- Custom (dB): All frequency bins are related to the "Amplitude (top)" parameter.

Spectrum:
- Display all bins of the spectrum. All bins are taken into account for the parameter calculations.
- Display a selection of the spectrum. Only the displayed bins are taken into account for the parameter calculations.

Display:
- Amplitude plot: Displays the amplitude of the frequency spectrum with a logarithmic y-scale (dB/dBc) or linear y-scale (top-values or rms-values);
- Phase plot: Displays the phase of the frequency spectrum in radians or degrees;
- Imaginary parts only: Shows only the imaginary results of the Fourier transform;
- Real parts only: Shows only the real results of the Fourier transform.

There are three possible draw styles:
- Line: A line from data point to data point is drawn;
- Filled: The area below all data points is filled up;
- Small bars: A line (small bar) from the minimal y-scale to the data point is drawn.

2.4   Parameter Calculation

The definitions of dynamic result parameters are:

$$SINAD = \frac{c}{n+d} \quad ENOB = \frac{SINAD - 1.8}{6.02} \quad SNR = \frac{c+d}{n} \quad THD = \frac{d}{c}$$

Where:

$$c = \sqrt{\mathrm{Re}^2{}_{carrier} + \mathrm{Im}^2{}_{carrier}} \quad d = \sqrt{\sum_{distortion} \mathrm{Re}^2{}_{dist.} + \mathrm{Im}^2{}_{dist.}}$$

$$n = \sqrt{\sum_{noise} \mathrm{Re}^2{}_{noise} + \mathrm{Im}^2{}_{noise}}$$

The Peak distortion is the largest harmonic. The Spurfree is the absolute value of the largest noise element.

Product Support

Racal Instruments has a complete Service and Parts Department. If you need technical assistance or should it be necessary to return your product for repair or calibration, call 1-800-722-3262. If parts are required to repair the product at your facility, call 1-949-859-8999 and ask for the Parts Department.

When sending your instrument in for repair, complete the form in the back of this manual.

For worldwide support and the office closes to your facility, refer to the Support Offices section on the following page.

Warranty

Use the original packing material when returning the 2165 to Racal Instruments for calibration or servicing. The original shipping container and associated packaging material will provide the necessary protection for safe reshipment.

If the original packing material is unavailable, contact Racal Instruments Customer Service for information.

Support Offices

RACAL INSTRUMENTS

United States

(Corporate Headquarters and Service Center)
4 Goodyear Street, Irvine, CA 92618
Tel: (800) 722-2528, (949) 859-8999; Fax: (949) 859-7139

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Tel: (210) 699-6799; Fax: (210) 699-8857

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(European Headquarters and Service Center)
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Tel: +44 (0) 1202 872800; Fax: +44 (0) 1202 870810

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Racal Instruments Group Limited, Technologie Park,
D-51429 Bergisch Gladbach, Germany
Tel: +49 2204 844205; Fax: +49 2204 844219

REPAIR AND CALIBRATION REQUEST FORM

To allow us to better understand your repair requests, we suggest you use the following outline when calling and include a copy with your instrument to be sent to the Racal Instruments Repair Facility.

Model_____Serial No._____Date_____

Company Name_____Purchase Order #_____

Billing Address_____
<div align="center">City</div>

<div align="center">State/Province   Zip/Postal Code   Country</div>

Shipping Address_____
<div align="center">City</div>

<div align="center">State/Province   Zip/Postal Code   Country</div>

Technical Contact_____Phone Number (   )_____
Purchasing Contact_____Phone Number (   )_____

1. Describe, in detail, the problem and symptoms you are having. Please include all set up details, such as input/output levels, frequencies, waveform details, etc.

_____

_____

_____

_____

2. If problem is occurring when unit is in remote, please list the program strings used and the controller type.

_____

_____

_____

_____

3. Please give any additional information you feel would be beneficial in facilitating a faster repair time (i.e., modifications, etc.)

_____

_____

_____

_____

4. Is calibration data required?   Yes   No   (please circle one)
Call before shipping   Ship instruments to nearest support office.
Note: We do not accept
"collect" shipments