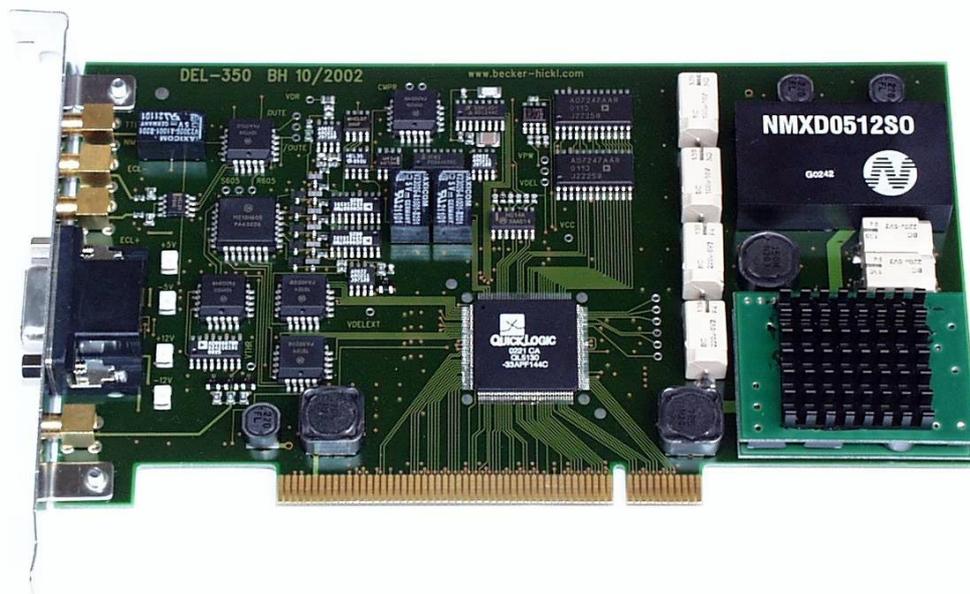




DEL-350 ps Delay Module

- **Delay Resolution down to 2.5 ps**
- **Low Jitter: 10 ps or 0.05 % of Delay Range**
- **Delay Range 20 ns to 20 us**
- **Input Trigger Threshold -2V to + 2V**
- **Output TTL, ECL or positive NIM**
- **Output Pulse Duration 2 ns to 200 ns**
- **PCI bus Module for Pentium PC**
- **Works under Windows 95, 98, 2000, NT and XP**



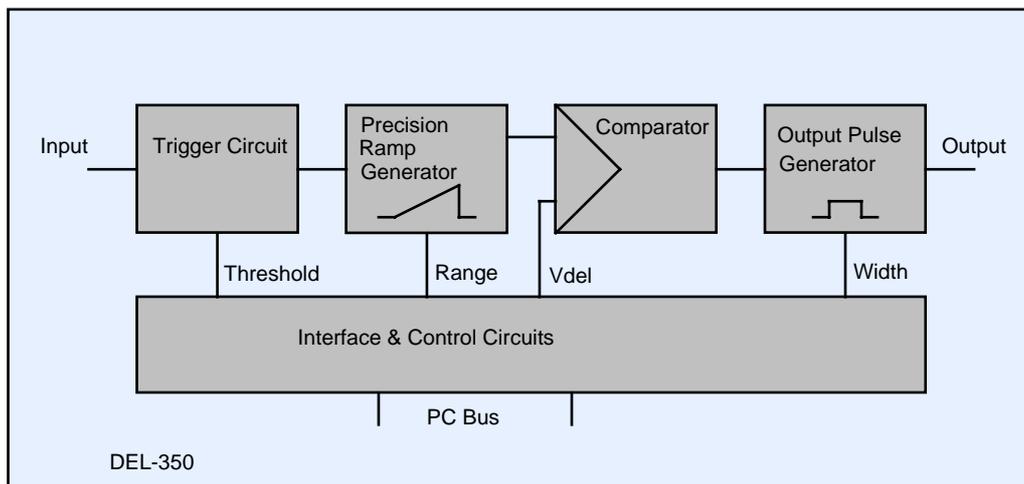
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Introduction

A basic block diagram of the DEL-350 module is shown in the figure below. The module contains a fast trigger circuit, a fast and accurate ramp generator, a comparator and a generator for the output pulses.

When the input voltage exceeds a selectable threshold the trigger circuit responds and the ramp generator is started. A comparator compares the ramp signal to the delay control voltage V_{del} . When the ramp voltage reaches V_{del} the comparator triggers the output pulse generator.



DEL-350 architecture

The DEL-350 provides pulse delay times from the ns range to the us range with a delay resolution down to 2.5 ps. Its low jitter and short intrinsic delay makes it useful for a wide variety of triggering and pulse shaping applications.

All module parameters are controlled by the DEL-350 Windows software. For user programmed special applications a DLL library of the basic module functions is available.

Specification

Trigger input impedance	50 Ω (MCX Connector)
Trigger threshold	-2 V to + 2 V
Trigger pulse amplitude	50 mV to 4 V
Trigger pulse width	min. 2.5 ns
Trigger pulse rise time	max. 50 ns
Frequency of trigger signal	max. 130 MHz
Internal trigger rate	max. $0.5 \cdot \text{Delay Range}^{-1}$ or 30 MHz
Delay range	10 ns to 100 us
Delay resolution	12 bit
Minimum delay	10 ns + $0.05 \cdot \text{Delay Range}$
Delay jitter (rms)	0.05 % of delay range, min. 10 ps
Absolute delay accuracy	5 %
Output pulse width	2 ns to 200 ns
Output signals	2 differential ECL Signals 1 TTL or NIM Output
Output impedance	50 Ω (MCX Connectors)
Operation environment	Pentium PC
Bus interface	PCI
Dimensions	PCI board 170 x 98 mm

Installation

Requirements to the Computer

The computer must be a PC 486 or Pentium PC with at least 64 Mb memory a display card of 1024 by 628 resolution. The DEL-350 Standard Software requires approximately 2 MB hard disk space. Although not absolutely required, we recommend to use a computer with a speed of at least 500 MHz for convenient working with the DEL-350.

Installation of the DEL-350 Standard Software

The DEL-350 modules come with the 'DEL Standard Software' which controls all hardware and software parameters of the module. Several DEL-350 modules in one computer can be operated by opening the same number of DEL applications.

The DEL-350 Standard Software runs under Windows 95, 98, 2000, NT and XP. To facilitate the development of user-specific software a DLL library is available.

The installation of the DEL-350 Standard Software is simple. Start setup.exe from the installation disk and follow the instructions of the installation software.

You can install the DEL-350 software also from the Becker & Hickl web site, e.g. if you want to upgrade your system with a new computer or if a new DEL software version has been released. In this case proceed as described under 'Installation or Update from the Web'.

The DEL-350 software is based on 'LabWindows/CVI' of National Instruments. Therefore the so-called 'CVI Run-Time Engine' is required to run the DEL software. The 'Run-Time Engine' contains the library functions of LabWindows CVI and is loaded together with the DEL software. The installation routine suggests a special directory to install the Run-Time Engine. If the required version of the Run-Time Engine is already installed for another application, it is detected by the installation software and shared with the existing LabWindows CVI applications.

Software Update

If you install a new DEL software version over an older one only the files are copied which have a newer date. This, to a certain extend, avoids overwriting setup files like auto.set, i.e. the last system settings. Consequently, you cannot install an older software version in place of a newer one. If you want to do this (actually there is no reason why you should), run the 'Uninstall' program before installing.

Installation or Update from the Web

The latest software versions for all bh modules are available from the Becker & Hickl web site. To install the DEL-350 software from the web, please open www.becker-hickl.de, and click on the 'Software' button.

On the 'Software' page, click on 'Experiment Control', 'Operating Software for Windows 95 / 98 / NT4 / 2k /XP'. Then click on 'Setup' for DEL-350. and get a ZIP file containing the complete installation. Unpack this file into a directory of your choice and start setup.exe. The installation will run as usual.



After downloading a new software version we recommend also to download the corresponding manual. Click on 'Manual' and download the PDF file.

Installation of the DEL-350 Module

To install the device, switch off the computer and insert the DEL-350 module into a free slot. To avoid damage due to electrostatic discharge we recommend to touch the module at the metallic back shield. Then touch a metallic part of the computer with the other hand. Then insert the module into a free slot of the computer. Keep the DEL module as far as possible apart from loose cables or other computer modules to avoid noise pick-up.

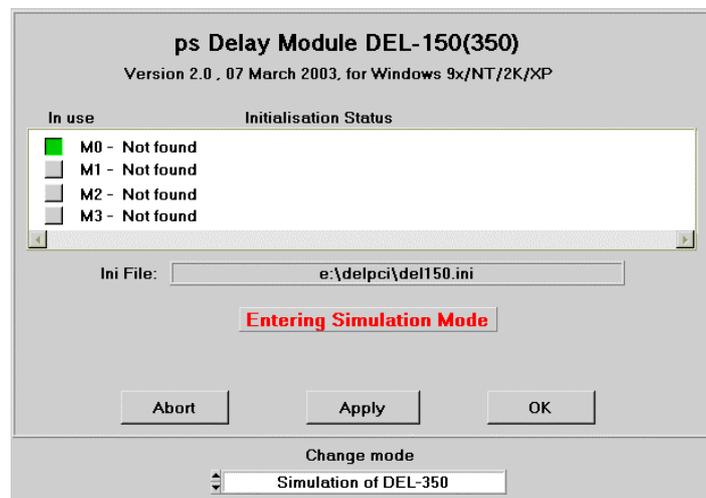
Windows has a list of hardware components, and on the start of the operating system, it automatically assigns the required hardware resources to the components of this list. If you have several DEL-350 modules in the computer each module gets its own address range.

When the computer is started the first time with the DEL-350 Windows detects the DEL module and attempts to update the list of hardware components. Therefore it may ask for driver information from a disk.

If you don't have the driver disk, please download the driver file from www.becker-hickl.com or www.becker-hickl.com, 'Software', 'Windows 95/98/NT/2000', 'Device drivers for bh modules'.

Running the DEL-350 Software without a DEL-350 Module

You can run the DEL-350 Standard Software without a DEL-350 module. In its start window the software will display a warning that there is no DEL module present, see figure below.



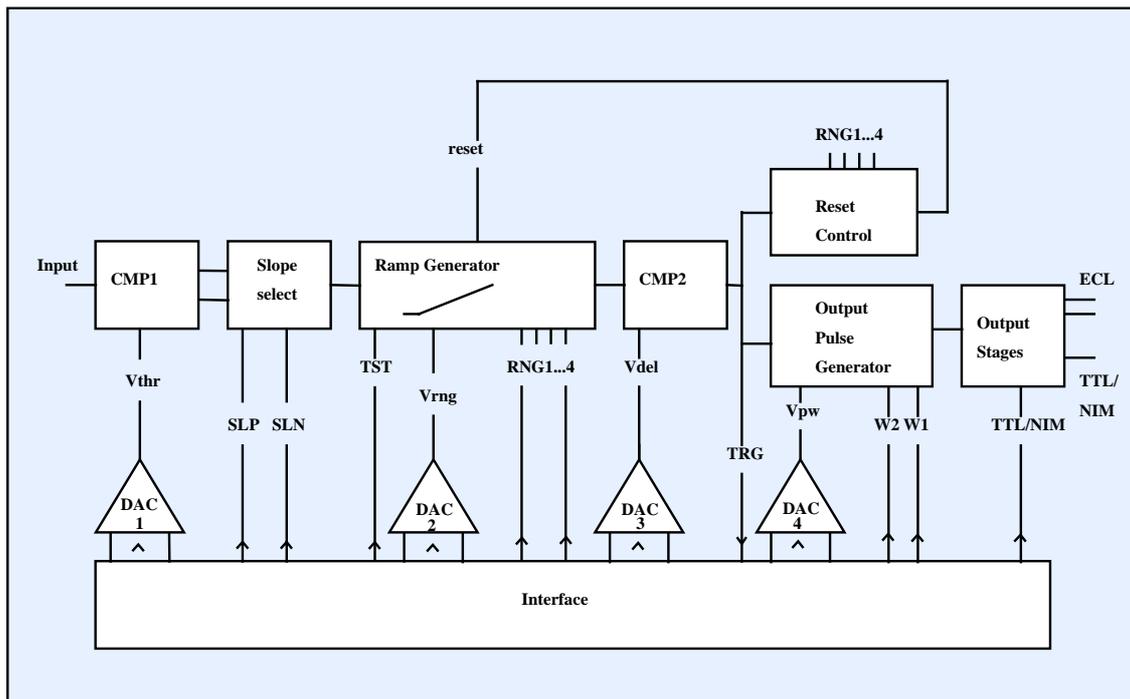
Start window

To configure the software the correct module type, click into 'Change Mode' and select 'Simulation of DEL-350'. Then click on 'Apply', 'OK'. The software will start and emulate the non-existent DEL module.

Internal Control Functions

In this section the internal control functions of the DEL-350 module are described. Reading of this section is recommended to users who are going to create their own application software by using the DEL-350 DLL functions. A detailed block diagram of the DEL-350 is given in the figure below.

The input comparator threshold is set by DAC1. The threshold can be set in the range of -2 V and +2 V so that the input characteristic can be fit to the most common logic families (TTL, CMOS, ECL, NIM pulses).



DEL-350 block diagram with control functions

Controlled by the bits SLP and SLN, in the slope select circuit either the positive or the negative edge of the input pulse can be selected for triggering the subsequent ramp generator. If neither SLP nor SLN are set triggering of the DEL-350 is disabled.

The slope speed of the ramp generator is controlled by the range select bits RNG1..4 in conjunction with the Vrng signal from DAC2. By RNG1 through RNG4 one of four delay ranges (10 to 100ns, 100 to 1000ns, 1us to 10us or 10us to 100us) is selected. Vrng provides for a fine adjustment inside the selected range. Since Vrng has a resolution of 12 bit virtually any ramp duration from 10ns to 100us can be set.

The comparator CMP2 compares the ramp voltage to the 12 bit delay control signal Vdel. When the ramp voltage reaches Vdel, CMP2 triggers the output pulse generator. At the same time the reset sequence of the ramp generator is initiated. Since the recovery time of the ramp generator is range-dependent, the duration of the reset pulse is controlled by the same range select bits which control the ramp generator. Furthermore, there is the TRG bit to inform the software that the module has been triggered. This bit is set by a trigger event and reset by reading the TRG bit.

The delay time from the trigger pulse to the output pulse is

$$T_{del} = \text{Range(RNG1..4)} \frac{V_{del}}{V_{rng}} + T_0$$

With

Range = 10ns, 100ns, 1us or 10 us depending on RNG1..4

T₀ = Intrinsic delay of trigger, slope select logic, ramp generator and output stages

Consequently, there are two possibilities to control the delay value - via the V_{del} and via V_{rng}. Controlling via V_{del} yields a linear characteristic and is used for delay scanning in conjunction with gated signal recording devices such as boxcars or gated photon counters. Controlling via V_{rng} at maximum V_{del} is recommended to set fixed delay values with minimum jitter.

The output pulse width is controlled by the 12 bit signal V_{pw} and the width range bits W1 and W2. The output stages deliver two complementary ECL pulses and a TTL or NIM pulse. The selection of TTL or NIM level is done by the TTL/NIM bit.

The equation for the output pulse width is

$$\text{Width} = \text{WRNG(W1..2)} \frac{4095}{V_{pw}}$$

with WRNG = 2ns, 20ns and 200ns depending on the width select bits W1 and W2

V_{pw} = 0 4095 (digital value applied to the internal control DAC)

In addition to the functions described above the DEL-350 module device incorporates some test facilities which are used to test the module in the initialisation phase. There is a TST bit whose positive going edge triggers the ramp generator. In the test sequence, it is used to initiate a normal working cycle and to test the state of the TRG bit. To test the DACs for V_{del}, V_{rnd}, V_{pw} and V_{thr} these voltages are fed to comparators which respond at the corresponding half-range voltage. By sending both 0 and the full scale values to the DACs and reading the comparator bits the basic function of the DACs is tested.

Control Signals and Power Supply Output

The DEL-350 has a 15 pin high density sub-D connector for control signals and power supply outputs to amplifiers, detectors, or other small peripheral components. The pin assignment is listed in the table below.

1	+5V out, short protected, max 100mA	9	don't connect
2	V _{delext} , external delay input, 0 to +5V	10	+12V out, short protected, max 80mA
3	V _{delout} , delay output, 0 to +5V via 1kΩ	11	-12V out, not short protected, max. 80mA
4	V _{DROUT} , delay range output, 0 to +5V via 1kΩ	12	ScanTrg, Scan Trigger
5	GND	13	not connected
6	-5V out, short protected, max 100mA	14	not connected
7	don't connect	15	GND
8	don't connect		

External Delay Input

The delay of the DEL-350 can be controlled via this input. 0V corresponds to minimum delay, +5V to maximum delay within the selected delay range. The delay of the external input is added to the delay set internally.

Delay Output

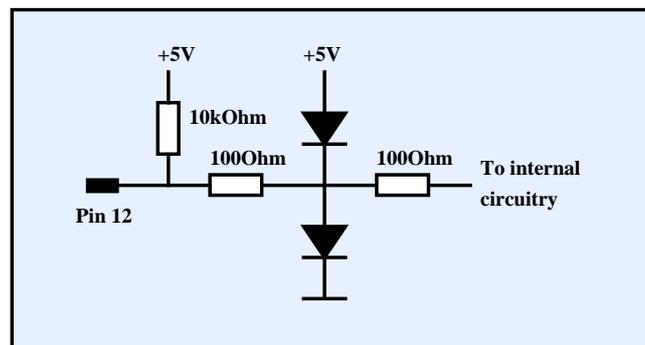
The current delay setting appears as a voltage from 0 to +5V at the delay output. 0V corresponds to minimum delay, +5V to maximum delay within the selected delay range. The output impedance is 1k Ω .

Delay Range Output

The delay range output delivers the Vrng voltage, please see 'Internal Control Functions'. The range is 0 to +5V, the output impedance is 1k Ω .

Scan Trigger

This input can be used to control the internal scan function of the DEL-350. A new scan cycle does not start until a TTL high is recognised at the Scan Trigger Input. The internal logic of the DEL-350 samples the Scan Trigger Input with 10 MHz. That means the duration of a trigger signal must be at least 100 ns, and there is a scan trigger delay uncertainty of 100 ns. The Scan Trigger input is overload-protected and has a 10 k Ω pull-up resistor, see below. The unconnected Scan Trigger input is interpreted as a TTL high.

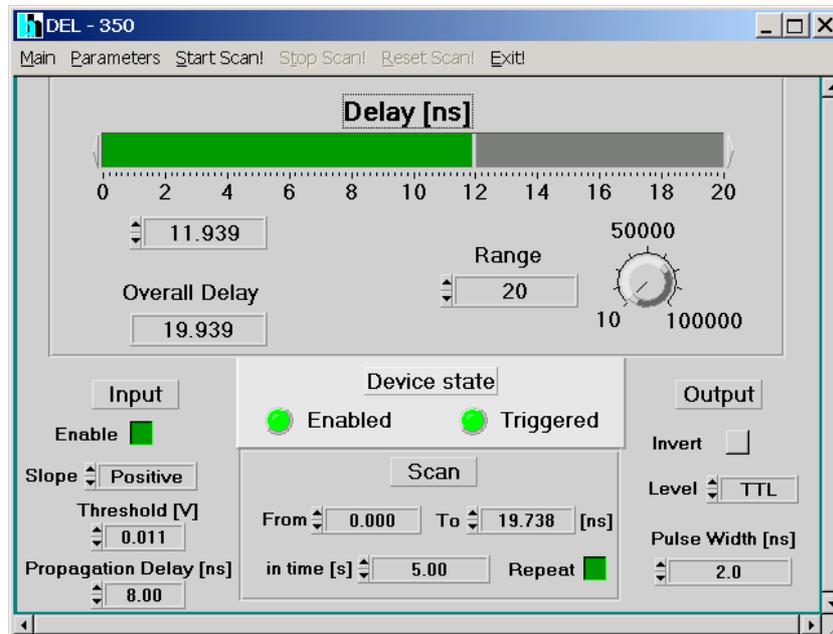


Scan trigger input

User Interface

Main Panel

The main panel of the DEL-350 software is shown in the figure below.



DEL-350 Main Panel

Module Parameters

Input

The settings under 'Input' allow to select the trigger slope (positive or negative), the trigger threshold (from - 2 V to + 2 V) and to enable or disable the triggering.

To include cable delays or the response time of a device triggered by the DEL-350, the 'Propagation Delay' parameter can be used. This value is added to the delay of the DEL-350 and displayed as 'Overall Delay'.

Delay and Delay Range

The 'Range' setting represents the overall duration of the delay ramp. The actual delay can be set to any value inside the 'Range' value with a resolution of 12 bit. Both the 'Range' and the 'Delay' can be set either numerically or by turning the 'Range' knob or moving the 'Delay' bar by the mouse.

To include cable delays or the response time of a device triggered by the DEL-350, an 'Overall Delay' value is displayed. This delay is the sum of the delay of the DEL-350 and any additional delay specified by the parameter 'Propagation Delay'.

Output

The output parameters control the output pulse duration, polarity and the setting of the TTL / NIM output. Caution: Although the TTL/NIM output is set to 'NIM' by the power-on reset of the computer, care should be taken not to damage a connected NIM device by possible TTL levels.

Scan

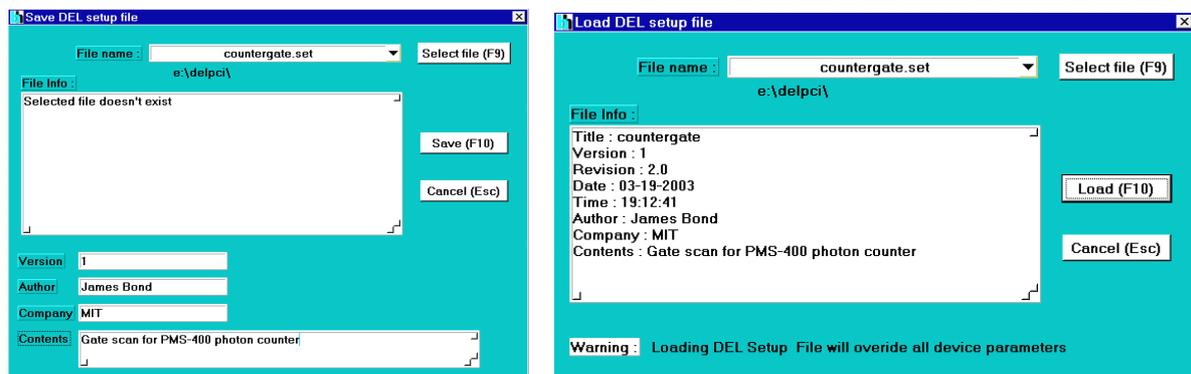
Delay scanning is controlled by the parameters in the 'Scan' section of the main panel. Start delay ('from') and stop delay ('to') and the overall time for the scanning operation can be specified. Scanning is repeated automatically if the 'repeat' button is pressed. The start and stop delay values must be both inside the current 'Range' setting. Scanning is started by pressing 'StartScan' and stopped by pressing 'StopScan' in the menu bar. When stopped, the scan operation can be restarted from the current delay by 'StartScan', or reset by 'ResetScan'.

The scan operation can be triggered, please see 'Control Signals and Power Supply Output'.

Menu Bar

Save and Load

Setup parameters can be saved into a file or loaded from a file by clicking on 'Main' and 'Save' or 'Load'. The 'Save' and 'Load' panels are shown below.



Save panel

Load panel

To save a setup file, type a file name into the file name field or click on 'Select File' to select an already existing file name. You can also select a file name from the history of previously saved files by clicking on the triangle at the right end of the file name field. After typing in a file name or selecting an existing file a 'file info' is displayed. For an existing file the name, the software revision, the time and the date along with user defined information is displayed. If you type in a new file name the file info window says 'selected file doesn't exist'.

In the lower part of the 'Save' panel you can type in your own information, usually a version number, author and company name, and a description of the contents of the setup. Saving is completed by clicking on the 'Save' button.

To load a setup file, click on 'Main' and 'Load'. Type a file name into the file name field or click on 'Select File' to select a file from a list of setup files. You can also select a file name from the history of previously saved files by clicking on the triangle at the right end of the file name field. After a file has been selected the 'file info' is displayed. Loading is completed by clicking on the 'Load' button.

Parameters

Adjust Parameters

Adjust values and production information is stored in an EEPROM on the DEL-350 module. The adjust values are accessible via the adjust parameters panel shown below.

Production Data			
Device Type	DEL-350	Reload from EEPROM (F9)	
Serial Number	3696520001		
Production Date	15.02.03	Save in EEPROM (F10)	

Adjust Parameters			
Del_adjust1	↑ 1.01		
Del_adjust2	↑ 1.04	Adjust_t0 [ns]	↓ 8.00
Del_adjust4	↑ 0.98		
Del_adjust8	↑ 1.02		

Return (Esc)

DEL-350 adjust parameters panel

To change the adjust parameters a sound knowledge about the DEL-350 hardware is required. Wrong inputs may seriously deadjust the module. Therefore you can change the adjust parameters, but to save them to the EEPROM a password is required. The changed adjust values are used by the device, but they will be replaced with the original values after reloading from the EEPROM or after restarting the DEL software.

Production Data Section

This area contains manufacturing information about the particular module. The information is used by the software to recognise different module versions. Please do not change these parameters.

Adjust Parameter Section

These parameters adjust the delay scale and correct for the intrinsic delay of the DEL-350 circuitry.

Switching the +12V Output

The DEL-350 has a +12V output to operate photodiodes, photomultiplier modules, or preamplifiers. The +12V output can be switched on and off by clicking on 'Parameters', '+12V active'.

Start, Stop and Reset Scan

Delay scanning is started by pressing 'StartScan' and stopped by pressing 'StopScan' in the menu bar. When stopped, the scan operation can be restarted from the current delay by 'StartScan', or reset by 'ResetScan'.

Exit

The DEL-150 software is closed by 'Exit'. When the program is terminated, the system parameters are saved in a file 'auto.set'. This file is loaded automatically at the next program start. Thus the system will come up in the same state as in the moment of the exit.

If you do not want to save the current settings you can reject the saving by switching off the 'save data on exit' button.

Technical Support

We are pleased to assist you in case of any problems you may have with your DEL-350 module. To fix the problem we ask you to send us a setup file (.set) with your system settings.

Furthermore, please add as much as possible of following information:

Description of the Problem

DEL-350 Serial Number

Software Version

Trigger signal source

Trigger signal shape, amplitude and repetition rate

System Connections: Cable Lengths, Ground Connections. Add a drawing if necessary.

Environment: Possible Noise Sources

Your personal data: E-mail, Telephone Number, Postal Address

The fastest way is to send us an email with the setup file(s) attached. We will check your system settings and – if necessary – reproduce the problem in our lab. Usually we will be able to send you an answer within one or two days.



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