# 7 CALIBRATION ADJUSTMENT PROCEDURE

## 7.1 INTRODUCTION

The calibration adjustment procedure can be split up in two:
- Manual adjustment
- Automatic calibration (AUTOCAL).

All calibration is done with the oscilloscope's cabinet closed. This eliminates calibration inaccuracies due to temperature changes.

Manual calibration data are protected by a keyword and a seal and must be changed by qualified personnel only. Some of the adjustments require external calibration equipment. A list of necessary equipment is given in chapter 6 (performance test). Manual calibration should be done after 2000 service hours or once a year.

Operation of the front panel CAL key activates the automatic calibration. AUTOCAL can only function usefully if the manual adjustments (especially the 'screen calibrations') are correct. The AUTOCAL function should in general be activated once a week. AUTOCAL should be used always after warming-up if the oscilloscope is used in extreme environmental conditions such as very high or low temperatures while maximum accuracy is needed. AUTOCAL requires no external calibration equipment.

The calibration adjustment should be started after a warming-up time of 30 minutes.

The most accurate adjustments are done with a well-focused low intensity display.

The calibration parameters are saved after power-down if the memory back-up batteries are installed. Additionally these parameters can be saved into the instrument's non-volatile memory. This is done by pressing softkey 'save calibr data' and then activation of the pin hole key. The number of times that this save action can be done is limited. The memory is full after a number (10x) of actions and needs to be cleared. Refer to chapter 8 (corrective maintenance) for how to proceed then.

## 7.2 DARK LEVEL OF CRT

- Press the STATUS and TEXT OFF keys simultaneously: this gives a defined position of the instrument settings.
- Adjust MTB/VAR to 1.00 ms/div.
- Select the key sequence 'UTILITY > MAINTENANCE > ENTER KEYWORD'.
- Enter the five digit keyword '3 2 4 1 5'. If correct, an automatic return to the UTIL MAINTENANCE menu is done.
- Press softkey MANUAL CALIBR.
- Select 'dark' with the TRACK rotary.
- Press softkey 'analog': the $\Delta$ sign is displayed behind 'analog'.
- Put the TRACE INTENSITY rotary in minimal intensity position.
- Adjust the $\Delta$ rotary so that the dot at the beginning of the CH1 trace is just invisible. Use X POS to move the start of the trace away from the ground level indicator.
- Press softkey 'digital': the $\Delta$ sign is displayed behind 'digital'.
- Press the front panel key 'ANALOG' (message DIGITAL MODE appears briefly) and the oscilloscope switches to digital mode.
- Put the TRACE INTENSITY rotary in minimal intensity position.
- Adjust the $\Delta$ rotary so that the CH1 trace is just invisible.
- Put TRACE INTENSITY rotary in normal intensity position again.
- Press softkey RETURN to go to the UTIL MAINTENANCE MENU.

## 7.3 TRACE ROTATION

* Press the ANALOG key (message ANALOG MODE appears briefly) and the oscilloscope switches to analog mode.
- Adjust the INTENS TRACE rotary for a well-visible horizontal on the screen.
- Align the CH1 trace exactly in parallel with the horizontal graticule lines using screw-driver operated TRACE ROT rotary.

## 7.4 HORIZONTAL (X) GAIN AND OFFSET (CRT)

- Press softkey SCREEN CALIBR. This activates the UTIL SCREEN CALIBR CRT menu.
- Select 'x-gain' with the softkeys.
- Adjust the TRACK (gain) and Δ (offset) rotary so that the two vertical lines coincide exactly with the 3rd and 9th graticule line.

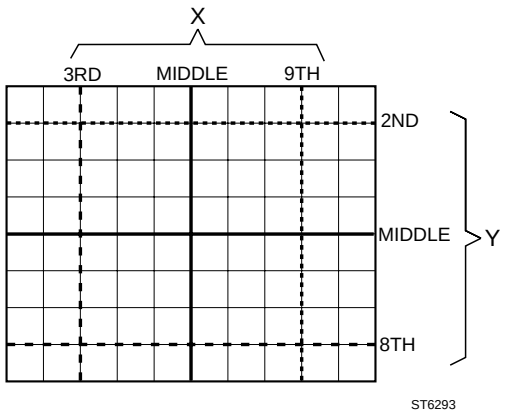


*Figure 7.1 Position of lines for horizontal (X) and vertical (Y) gain and offset calibration.*

## 7.5 TEXT STABILITY AND X-OFFSET (CRT)

- Select 'x-text' with the softkeys (menu header is UTIL SCREEN CALIBR CRT).
- Adjust the TRACK rotary to maximal stability of the text
- Adjust the Δ rotary so that the vertical line is exactly in the middle of the graticule.

## 7.6 VERTICAL (Y) GAIN AND OFFSET (CRT)

- Select 'y-gain' with the softkeys (menu header is UTIL SCREEN CALIBR CRT).
- Adjust the TRACK (gain) and Δ (offset) rotary so that the two horizontal lines coincide exactly with the 2nd and 8th graticule line.
- Select 'y-offs' with the softkeys.
- Adjust the TRACK rotary so that the horizontal line is exactly in the middle of the graticule.

## 7.7 HORIZONTAL GAIN AND OFFSET (VECTOR)

- Push the second softkey again to obtain 'x-gain' (menu header is changed into UTIL SCREEN CALIBR VECTOR).
- Adjust the TRACK rotary to minimal over- or undershoot in horizontal direction.
- Select 'x-offs' with the softkeys.
- Adjust the TRACK rotary so that the lines of the test pattern coincide exactly with the graticule in horizontal direction.

## 7.8 VERTICAL GAIN AND OFFSET (VECTOR)

- Select 'y-gain' with the softkeys (menu header is UTIL SCREEN CALIBR VECTOR).
- Adjust the TRACK rotary to minimal over- or undershoot in vertical direction.
- Select 'y-offs' with the softkeys.
- Adjust the TRACK rotary so that the lines of the test pattern coincide exactly with the graticule in vertical direction.
- Press softkey 'accept' if the screen calibrations are correct.
- Press softkey RETURN to go to the UTIL MAINTENANCE MENU.

## 7.9 ASTIGMATISM

- Press softkey MANUAL CALIBR.
- Select 'astig' with the TRACK rotary.
- Position the CH1 trace in the centre of the graticule.
- Adjust the $\Delta$ rotary for the best possible sharpness of text across the screen: the small dots from which the text is composed must be well visible. Adjustment of the FOCUS rotary is necessary during the adjustment.

## 7.10 AUTOCAL PROCEDURE

- Press the CAL key during 2 seconds.
- Within 4 minutes the instrument automatically does its main calibrations.
- Watch the CRT and check that no errors are reported. If errors are mentioned, the oscilloscope will need corrective maintenance. The error number indicates in what part of the oscilloscope the fault may be expected.

## 7.11 LF SQUARE-WAVE RESPONSE CH1

- Press the STATUS and TEXT OFF keys simultaneously: this gives a defined position of the instrument settings.
- Select the key sequence UTILITY > MAINTENANCE > MANUAL CALIBR.
- Select 'lf ch1' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δ sign is displayed behind 'lfx100'.
- Put CH1 in 1 V/div with DC coupled input.
- Apply a 100 kHz square-wave signal of 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH1. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).

- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH1 in 0.1 V/div.
- Change the square-wave signal into 10 kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

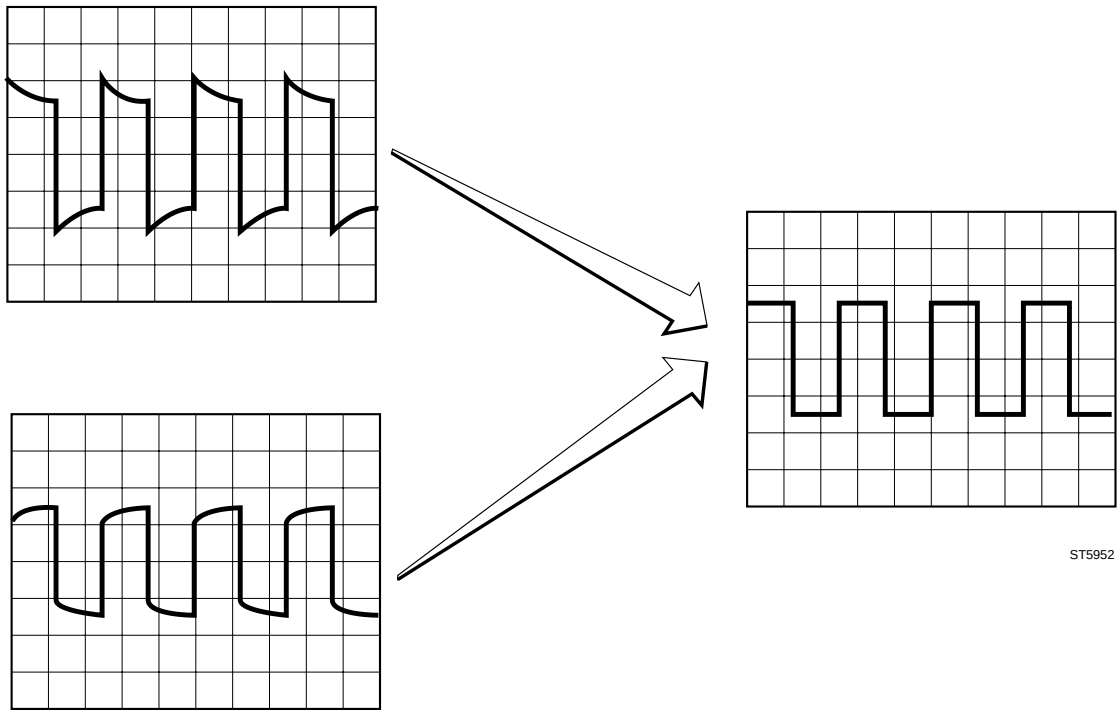


*Figure 7.2 Adjustment of LF square wave response CH1, CH2, CH3 and CH4.*

## 7.12 LF SQUARE-WAVE RESPONSE CH2

- Select 'lf ch2' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δ sign is displayed behind 'lfx100'.
- Switch CH2 to ON and CH1 off.
- Press the TRIG 2 key.
- Put CH2 in 1 V/div with DC coupled input.
- Apply a square-wave signal of 100 kHz and 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH2. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).

- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH2 in 0.1 V/div.
- Change the square-wave signal into 10 kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

## 7.13 LF SQUARE-WAVE RESPONSE CH3

This section can be skipped for PM3370A, PM3380A and PM3390A.
For PM3382A and PM3392A only the step 'lfx10' has to be adjusted.

- Select 'lf ch3' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δsign is displayed behind 'lfx100'.
- Switch CH3 to ON and CH2 off.
- Press the TRIG 3 key.
- Put CH3 in 1 V/div with DC coupled input.
- Apply a square-wave signal of 100 kHz and 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH2. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).

- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH3 in 0.1 V/div.
- Change the square-wave signal into 10kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

## 7.14 LF SQUARE-WAVE RESPONSE CH4 and EXT TRIG

For PM3370A, PM3380A, PM3382A, PM3390A and PM3392A only the step 'lfx10' has to be adjusted.

- Select 'lf ch4' with the TRACK rotary.
- Select 'lfx100' with the softkeys: the Δ sign is displayed behind 'lfx100'.
- Switch CH4 to ON and CH3 off.
- Press the TRIG 4 key.
- Put CH4 in 1 V/div with DC coupled input.
- Apply a square-wave signal of 100 kHz and 2.75V (pp into 50Ω) from a calibrator (mode 'edge') to CH2. As an alternative you may use a 100 kHz / 5 Vpp square-wave from a function generator.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor between cable and oscilloscope input.
- Adjust MTB/VAR to 2.00 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Select 'lfx10' with the softkeys: the Δ sign is displayed behind 'lfx10'.
- Put CH4 in 0.1 V/div.
- Change the square-wave signal into 10 kHz/500 mV peak-peak.
- Adjust MTB/VAR to 20.0 μs/div.
- Adjust the Δ rotary for a flat pulse top (the initial overshoot should not be adjusted).
- Remove the input signal.

## 7.15 HF SQUARE-WAVE RESPONSE FINAL Y AMPLIFIER

- Apply a 1V/1 MHz square-wave signal with a rise-time faster than 1 nsec to CH1. This signal is delivered in the 'edge' mode of the calibrator. As an alternative you may use the fast-rise output of the square-wave calibration generator. Use a 10x attenuator at the end of the cable from the generator. For reduced channels (0.1 and 0.5 V/div) and EXT TRIG (0.1 and 1 V/div) use a 2:1 (6dB) attenuator.
- Press AUTOSET.
- Put CH1 in 20 mV/div with DC coupled input.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Adjust MTB/VAR to its fastest position (20.0 or 50.0 ns/div). Small adjustments of MTB/VAR may be necessary to have a good view of signal details of interest.
- Select the key sequence 'UTILITY > MAINTENANCE > MANUAL CALIBR' and then select 'hf y' with the TRACK rotary .
- Select in succession 'pulse t4', 'pulse t3', 'pulse t2', 'pulse t1' and 'pulse t0' with the softkeys. Adjust the pulse top to maximum flatness and the risetime to the required value with the Δ rotary. The adjustments are a compromise between fast risetime and minimal pulse distortion (aberrations). The influence of these adjustments ranges from mid-frequency (pulse t4) to high-frequency (pulse t0). The requirement is a rise-time of ≤ 6ns for 60 MHz, ≤ 3,6 ns for 100 MHz and ≤ 2 ns for 200 MHz instruments. This value includes the generator rise-time. The pulse aberrations must not exceed + or - 10%.

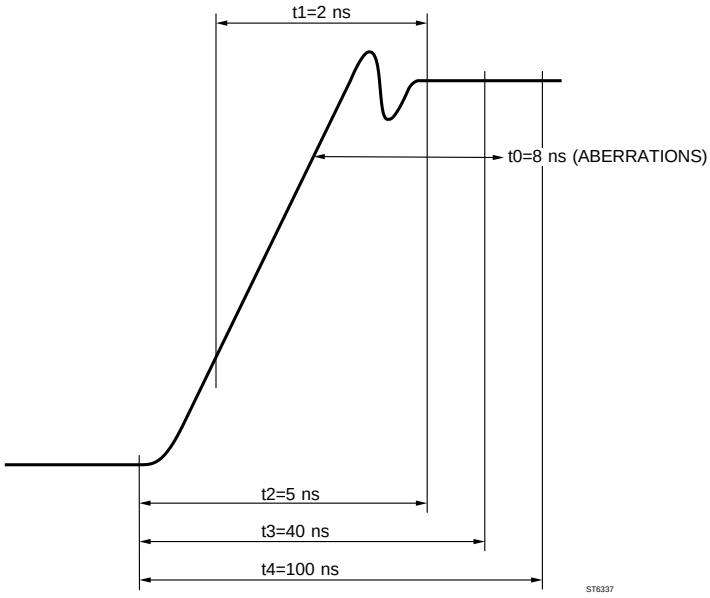


*Figure 7.3 Influence of t4, t3, t2, t1 and t0 on HF square wave response.*

- Remove the input signal.
- Pulse response and bandwidth are interdependent: the higher the pulse aberrations, the higher the bandwidth and vice versa. To check the bandwidth apply a 120 mV/50 kHz sinewave from a constant amplitude sinewave generator (5500A in mode 'levsine') to CH1.
  For reduced channels and EXT TRIG input apply 600 mV / 50 kHz.
- Press AUTOSET.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Adjust the amplitude of the sine-wave to 6 div exactly.
- Increase the frequency of the sinewave up to 60 MHz (for 60 MHz instruments), 100 MHz (for 100 MHz instruments) or 200 MHz (for 200 MHz instruments) and check that the amplitude on the screen does not become smaller then 4,2 div.
- Remove the input signal.
- Repeat the bandwidth check for CH2, CH3, CH4 and EXT TRIG input (the bandwidth check for CH3 and CH4 of PM3392A and EXT TRIG input of PM3390A must be checked via the 10:1 probe that is delivered with the oscilloscope).
- Remove the input signal.

## 7.16 HF RESPONSE DSO MODE

- Press the ANALOG key (message DIGITAL MODE appears briefly) and the oscilloscope switches to digital mode.
- Apply a 1V/1 MHz square-wave signal with a rise-time faster than 1 nsec to CH1. This signal is delivered in the 'edge'mode of the calibrator. As an alternative you may use the fast- rise output of the square-wave calibration generator. Use a 10x attenuator at the end of the cable from the generator. For reduced channels (0.1 and 0.5 V/div) and EXT TRIG (0.1 and 1V/div) use a 2:1 (6 dB) attenuator.
- Press AUTOSET.
- Put CH1 in 20 mV/div with DC coupled input. Reduced channels and EXT TRIG must be put in 0.1 V/div.
- Put MTB/VAR in 5.00 ns/div position.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Use POS CH1 to position the signal in the vertical mid of screen.
- Adjust the TRIGGER LEVEL to -100%.
- Select key sequence UTILITY > MAINTENANCE > MANUAL CALIBR and then 'hfdso' with the TRACK rotary.
- Select 'hf CH1' with the softkeys: the Δ sign appears behind 'hf CH1'. Adjust the pulse top to maximum flatness and the risetime to the required value with the Δ rotary. The adjustments are a compromise between fast risetime and minimal pulse distortion (aberrations). The requirement is a rise-time of ≤ 6 ns for 60 MHz, ≤ 3,6 ns for 100 MHz and ≤ 2 ns for 200 MHz instruments. This value includes the generator rise-time. The pulse aberrations must not exceed + or – 12%.
- Remove the input signal from CH1.
- Check for an equal pulse response (rise-time and aberrations) of all input channels in 20 mV/div. For reduced channels and EXT TRIG input use 0.1 V/div. In case of major differences, repeat the adjustment for a pulse response as equal as possible.
- Remove the input signal.

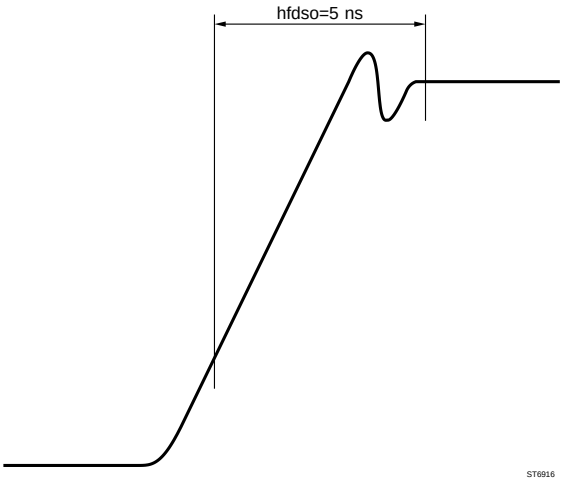


*Figure 7.4 Influence of 'hfdso' on HF square wave response.*

- Pulse response and bandwidth are interdependent: the higher the pulse aberrations, the higher the bandwidth and vice versa. To check the bandwidth apply a 120 mV/50 kHz sinewave from a constant amplitude sinewave generator (5500A in mode 'levsine') to CH1. For reduced channels and EXT TRIG input apply 600 mV/50 kHz
- Press AUTOSET.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Adjust the amplitude of the sine-wave to 6 div exactly.
- Increase the frequency of the sinewave up to 60 MHz (for 60 MHz instruments), 100 MHz (for 100 MHz instruments) or 200 MHz (for 200 MHz instruments) and check that the amplitude on the screen does not become smaller then 4,2 div.
- Remove the input signal.

- Repeat the bandwidth check in sequence for CH2, CH3, CH4 and EXT TRIG input (the bandwidth check for CH3 and CH4 of PM3392A and EXT TRIG input of PM3390A must be checked via the 10:1 probe that is delivered with the oscilloscope).
- Remove the input signal.

## 7.17 TRIGGER DELAY ADJUSTMENT

For PM3390A, PM3380A and PM3370A the 'logic' and 'state' adjustment can be skipped.

- Apply a 1V/1 MHz square-wave signal with a rise-time faster than 1 nsec to CH1. This signal is delivered in the 'edge'mode of the calibrator. as an alternative you may use the fast-rise output of the square-wave calibration generator.
- Press AUTOSET.
- Put CH1 in 0.2 V/div with DC coupled input.
- Select 50Ω input impedance; if not available use a 50Ω termination resistor directly at the oscilloscope input.
- Position the signal exactly in the vertical mid of screen.
- Put MTB/VAR TIME/DIV in 2.00 ns/div (200 MHz instruments) or in 5.00 ns/div position.
- Press menu key TRIGGER and select 'edge', level-pp 'off' and 'dc' trigger coupling.
- Turn the TRIGGER LEVEL rotary and adjust the level indicator (-T) 0.2 div under the vertical mid of screen.
- Adjust the TRIGGER POSITION rotary to a Delay read out of -5 div.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'edge' with the softkey: the Δ sign appears behind 'edge'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

- Press menu key TRIGGER and select 'logic' and 'state' (not present in PM3370A/80A/90A).
- Use the front panel keys TRIG1 ... TRIG4 to obtain the trigger pattern '↑xxx' in the TRIGGER MAIN TB menu.
- Turn the TRIGGER LEVEL rotary and adjust the level indicator (-T) 0.2 div under the vertical mid of screen.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'logic' with the softkey: the Δ sign appears behind 'logic'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

- Select key sequence TB MODE > EVENT DELAY > 'on' and 'CHANNEL 1'.
- Turn the TRIGGER LEVEL rotary and adjust the level indicator (-T) 0.2 div under the vertical mid of screen.
- Turn the Δ rotary to adjust the event level indicator (-E) 0.2 div under the vertical mid of screen.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'events' with the softkey: the Δ sign appears behind 'events'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

- Select the key sequence TB MODE > EVENT DELAY > off.
- Press menu key TRIGGER and select 'edge'.
- Press menu key DTB and select DEL'D TB on, trig'd, dc and MAIN TB off.
- Put MAIN TB TIME/DIV to 100 ns/div and DEL'D TB TIME/DIV to 20.0 ns/div.
- Adjust MAGNIFY to 4x.
- Turn the Δ rotary (DTB TRIGGER LEVEL) and adjust the level indicator (-D) 0.2 div under the vertical mid of screen.
- Select the key sequence UTIL > MAINTENANCE > MANUAL and then select 'tr com' with the TRACK rotary .
- Select 'dtb' with the softkey: the Δ sign appears behind 'dtb'.
- Adjust the Δ rotary so that the leading edge crosses the center of the screen.

## 7.18 SAVING THE CALIBRATION DATA

If you are sure that the instrument is well calibrated, the calibration data must be saved. For this proceed as follows:
- Press softkey RETURN.
- If present, remove the calibration sticker from the pin hole.
- Press softkey 'save calibr data'.
- Press the pin hole key (e.g. with a paperclip). When doing this, it is indicated in the viewing area how many 'calibration fields' are free to save calibration data.

*Note: The number of times that this 'save' action can be done is limited to 10. Refer to chapter 8.9.2 for how to proceed if the memory is full.*

- Close the pin hole key with a new calibration sticker, part number 5322 455 81144.

## 7.19 TESTING THE INSTRUMENT'S PERFORMANCE

If you want, you can check the instrument's performance by means of chapter 6 'PERFORMANCE TEST'. In general a quick check of the instrument's main characteristics will be sufficient. For this use the following paragraphs in chapter 6 of this manual:
- Vertical deflection; deflection coefficients (6.3.6).
- Horizontal deflection; MAIN TB deflection coefficients (6.3.24).
- Horizontal deflection; delayed time-base deflection coefficients (6.3.27).