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INSTRUCTION MANUAL

B+K PRECISION

MODELS 5105A

150 MHz (200MS/s) ANALOG/DIGITAL OSCILLOSCOPE

B+K PRECISION®

Oscilloscope 5105A

St.250900-Hüb/tke

General information regarding the CE marking

B&K instruments fulfill the regulations of the EMC directive. The conformity test made by B&K is based on the actual generic and product standards. In cases where different limit values are applicable, B&K applies the severer standard. For emission the limits for residential, commercial and light industry are applied. Regarding the immunity (susceptibility) the limits for industrial environment have been used.
The measuring- and data lines of the instrument have much influence on emmission and immunity and therefore on meeting the acceptance limits. For different applications the lines and/or cables used may be different. For measurement operation the following hints and conditions regarding emission and immunity should be observed:

1. Data cables
For the connection between instruments resp. their interfaces and external devices, (computer, printer etc.) sufficiently shielded cables must be used. Without a special instruction in the manual for a reduced cable length, the maximum cable length of a dataline must be less than 3 meters long. If an interface has several connectors only one connector must have a connection to a cable.
Basically interconnections must have a double shielding.

2. Signal cables
Basically test leads for signal interconnection between test point and instrument should be as short as possible. Without instruction in the manual for a shorter length, signal lines must be less than 3 meters long. Signal lines must shielded (coaxial cable - RG58/U). A proper ground connection is required. In combination with signal generators double shielded cables (RG223/U, RG214/U) must be used.

3. Influence on measuring instruments.
Under the presence of strong high frequency electric or magnetic fields, even with careful setup of the measuring equipment an influence of such signals is unavoidable.
This will not cause damage or put the instrument out of operation. Small deviations of the measuring value (reading) exceeding the instruments specifications may result from such conditions in individual cases.

4. RF immunity of oscilloscopes.

4.1 Electromagnetic RF field
The influence of electric and magnetic RF fields may become visible (e.g. RF superimposed), if the field intensity is high. In most cases the coupling into the oscilloscope takes place via the device under test, mains/line supply, test leads, control cables and/or radiation. The device under test as well as the oscilloscope may be effected by such fields.

Although the interior of the oscilloscope is shielded by the cabinet, direct radiation can occur via the CRT gap. As the bandwidth of each amplifier stage is higher than the total –3dB bandwidth of the oscilloscope, the influence RF fields of even higher frequencies may be noticeable.

4.2 Electrical fast transients / electrostatic discharge
Electrical fast transient signals (burst) may be coupled into the oscilloscope directly via the mains/line supply, or indirectly via test leads and/or control cables. Due to the high trigger and input sensitivity of the oscilloscopes, such normally high signals may effect the trigger unit and/or may become visible on the CRT, which is unavoidable. These effects can also be caused by direct or indirect electrostatic discharge.

The 150 MHz (200MS/s) Analog-/Digital-Oscilloscope 5105A

Autoset

Auto Cursor

Readout / Cursor

Save / Recall

2 Reference Memories

Dual Time Base

Component Tester

1kHz/1MHz Calibrator

RS232 Interface

Analog:

- **2 x DC to 150MHz, 2 x 1mV-50V/div**
- **Time Base A with Trig. DC to 250MHz**
- **Time Base B with 2ndTrig. to 250MHz**
- **Trig. DC to 250MHz, TV Sync. Separator**
- **1kHz/1MHz Calibrator, CRT with 14kV**

Digital:

- **Refresh, Single, Roll-, Envelope-, Average-,XY-Mode**
- **Max. Sampling Rate 200MS/s, Storage 2x2048x8 bit**
- **Time Base A: 100s - 50ns/div., B: 20ms - 50ns/div.**
- **Pre Trigger 25-50-75-100%, Post Trigger 25-50-75%**
- **Screen Refresh 180/s, Dot Join (linear)**

Specifications

Vertical Deflection

Operating modes: Channel I or II separate
both Channels (alternated or chopped)
Chopper frequency: approx. 0.5MHz)
Sum or **Difference:** from CH I and CH II
Invert: CH I and CH II
XY-Mode: via channel I (Y) and channel II(X)
Frequency range: DC to 150MHz (-3dB)
Rise time: <2.3ns
Overshoot: ≤1%
Deflection coefficient: 14 calibrated positions from **1mV/div to 20V/div** in 1-2-5 sequence, variable 2.5:1 to min. **50V/div**.
Accuracy in calibrated positions
1mV/div – 2mV/div: ±5%(DC-10MHz(-3dB))
5mV/div – 20V/div: ±3%
Input impedance: 1MΩ II 15pF
Input coupling: DC-AC-GD (ground)
Input voltage: max. 400V (DC + peak AC)
Delay line: approx. 70ns

Triggering

Automatic (peak to peak):**20Hz-250MHz** (≥0.5div.)
Normal with level control:DC-250MHz (≥0.5div.)
Indicator for trigger action: LED
Slope: positive or negative
Sources: Channel I or II, line and external
ALT. Triggering: CH I/CH II (≥ 0.8div.)
Coupling: **AC** (10 – 250MHz)
DC (0 – 250MHz)
HF (50kHz – 250MHz)
LF (0 – 1.5kHz)
NR (Noise reject)0 - 50MHz (≥ 0.8div.)
Triggering time base B:normal with level control and slope selection (0 – 250 MHz)
External: ≥0.3V_{pp} (0 – 250MHz)
Active TV Sync. Separator: field & line, + / –

Horizontal Deflection

Analog Time Base:

Accuracy in calibr. position 3%; 1-2-5 sequence
A: 0.5s-50ns/div.
B: 20ms-50ns/div.
Operating modes: **A** or **B**, alternate **A/B**
Variable: 2.5:1 up to 1.25s/div.
X-MAG. x10 (±5%) max. 5ns/div.
Holdoff time: variable to approx. 10:1
Bandwidth X-amplifier: 0 – 3MHz (-3dB)
X-Y phase shift: <3° below 220kHz

Digital Time Base:

Accuracy: 3%; 1-2-5 sequence
A: 100s-0.1µs/div.
Peak detect: 100s – 5µs/div.
B: 20ms-0.1µs/div.
Peak detect: 20ms – 5µs/div.
Operating modes: **A** or **B**, alternate **A/B**
X-MAG. x10 (±5%): 10ns/div.
Bandwidth X-Amplifier: 0 – 20MHz (-3dB)
X-Y phase shift: <3° below 20MHz
Input X-amplifier: via Channel II
Sensitivity: see CH II

Digital Storage

Operating modes: Refresh, Roll, Single, XY
Peak Detect, Average (2 to 512), Envelope
Dot Join function: automatically
Acquisition (real time)
8 bit flash A/D max. 200MS/s
Peak detect: 5ns
Display refresh rate: max. 180/s
Memory & display: 2k x 8bit per channel
Reference memory: 2 waveforms 2k x 8bit
Saved in: (EEPROM).
Resolution (samples/div.): **X** 200/div.
Y 25 /div.
XY 25 x 25/div.
Pre-/Post Trigger: 25,50,75,100, -25,-50,-75%

Operation / Control

Manual: front panel switches
Auto Set: signal related automatic parameter selection
Save & Recall:9 user defined parameter settings

Readout & Cursor (analog/digital)

Display of parameter settings and other functions on the screen. Trigger point indication.
Cursor measurement of ΔU, Δt or 1/Δt (frequency), separate or in tracking mode.
Readout intensity: separately adjustable.

Interface

PC remote control: built in RS232 interface

Component Tester

Test voltage: max. 7V_{rms} (o/c).
Test current: max. 7mA_{rms} (s/c)
Test frequency: approx.50Hz
One test lead is grounded (Safety Earth)

General Information

CRT: D14-375GY, 8x10cm internal graticule
Acceleration voltage: approx. 14kV
Trace rotation: adjustable on front panel
Calibrator: 0.2V ±1%, ≈ 1kHz/1MHz (tr <4ns)
Line voltage: 100-240V AC ±10%, 50/60Hz
Power consumption: approx. 47 Watt at 50Hz
Min./Max. ambient temperature: 0°C...+40°C
Protective system: Safety class I (IEC1010-1)
Weight: approx. 6.5kg (12.4lbs)
Color: techno-brown
Cabinet: **W** 285, **H** 125, **D** 380 mm
Lockable tilt handle 7/00

Accessories supplied: Operators Manual, 4 Disks, Line Cord, 2 Probes 10:1

General Information

This oscilloscope is easy to operate. The logical arrangement of the controls allows anyone to quickly become familiar with the operation of the instrument, however, experienced users are also advised to read through these instructions so that all functions are understood.

Immediately after unpacking, the instrument should be checked for mechanical damage and loose parts in the interior. If there is transport damage, the supplier must be informed immediately. The instrument must then not be put into operation.

Symbols

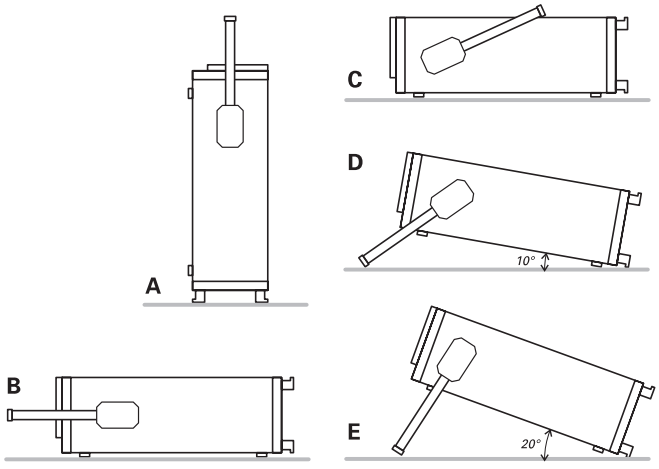
ATTENTION - refer to manual

Danger - High voltage

Protective ground (earth) terminal

Use of tilt handle

To view the screen from the best angle, there are three different positions (C, D, E) for setting up the instrument. If the instrument is set down on the floor after being carried, the handle automatically remains in the upright carrying position (A). In order to place the instrument onto a horizontal surface, the handle should be turned to the upper side of the oscilloscope (C). For the D position (10° inclination), the handle should be turned to the opposite direction of the carrying position until it locks in place automatically underneath the instrument. For the E position (20° inclination), the handle should be pulled to release it from the D position and swing backwards until it locks once more. The handle may also be set to a position for horizontal carrying by turning it to the upper side to lock in the B position. At the same time, the instrument must be lifted, because otherwise the handle will snap back to the previous position.



Safety

This instrument has been designed and tested in accordance with IEC Publication 1010-1 (overvoltage category II, pollution degree 2), Safety requirements for electrical equipment for measurement, control, and laboratory use. The CENELEC regulations EN 61010-1 correspond to this standard. It has left the factory in a safe condition. This instruction manual contains important information and warnings which have to be followed by the user to ensure safe operation and to retain the oscilloscope in a safe condition.

The case, chassis and all measuring terminals are connected to the protective earth contact of the appliance inlet. The instrument operates according to Safety Class I (three-conductor power cord with protective earthing conductor and a plug with earthing contact).

The main line plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action must not be negated by the use of an extension cord without a protective conductor.

The main line plug must be inserted before connections are made to measuring circuits.

The grounded accessible metal parts (case, sockets, jacks) and the main line supply contacts (line/live, neutral) of the instrument have been tested against insulation breakdown with 2200V DC.

Under certain conditions, 50Hz or 60Hz hum voltages can occur in the measuring circuit due to the interconnection with other main line powered equipment or instruments. This can be avoided by using an isolation transformer (Safety Class II) between the main line outlet and the power plug of the device being investigated.

Most cathode-ray tubes develop X-rays.

However, the dose equivalent rate falls far below the maximum permissible value of 36pA/kg (0.5mR/h).

Whenever it is likely that protection has been impaired, the instrument shall be made inoperative and be secured against any unintended operation. The protection is likely to be impaired if, for example, the instrument

- shows visible damage,
- fails to perform the intended measurements,
- has been subjected to prolonged storage under unfavorable conditions (e.g. in the open or in moist environments),
- has been subject to severe transport stress (e.g. do to packaging).

Intended purpose and operating conditions

This instrument must be used only by qualified experts who are aware of the risks of electrical measurement.

The instrument is specified for operation in industry, light industry, commercial and residential environments.

Due to safety reasons the instrument must only be connected to a properly installed power outlet, containing a protective earth conductor. The protective earth connection must not be broken. The power plug must be inserted in the power outlet while any connection is made to the test device.

The instrument has been designed for indoor use. The permissible ambient temperature range during operation is +10°C (+50°F) ... +40°C (+104°F). It may occasionally be subjected to temperatures between +10°C (+50°F) and -10°C (+14°F) without degrading its safety. The permissible ambient temperature range for storage or transportation is -40°C (-0°F) ... +70°C (+158°F). The maximum operating altitude is up to 2200m (non-operating 15000m). The maximum relative humidity is up to 80%.

If condensed water exists in the instrument it should be acclimatized before switching on. In some cases (e.g. extremely cold oscilloscope) two hours should be allowed before the instrument is put into operation. The instrument

should be kept in a clean and dry room and must not be operated in explosive, corrosive, dusty, or moist environments. The oscilloscope can be operated in any position, but the convection cooling must not be impaired. The ventilation holes may not be covered. For continuous operation the instrument should be used in the horizontal position, preferably tilted upwards, resting on the tilt handle.

The specifications stating tolerances are only valid if the instrument has warmed up for 30minutes at an ambient temperature between +15°C (+59°F) and +30°C (+86°F). Values without tolerances are typical for an average instrument.

EMC

This instrument conforms to the European standards regarding the electromagnetic compatibility. The applied standards are: Generic immunity standard EN50082-2:1995 (for industrial environment) Generic emission standard EN50081-1:1992 (for residential, commercial and light industry environment).

This means that the instrument has been tested to the highest standards.

Please note that under the influence of strong electromagnetic fields, such signals may be superimposed on the measured signals.

Under certain conditions this is unavoidable due to the instrument's high input sensitivity, high input impedance and bandwidth. Shielded measuring cables, shielding and earthing of the device under test may reduce or eliminate those effects.

Protective Switch-Off

This instrument is equipped with a switch mode power supply. It has both overvoltage and overload protection, which will cause the switch mode supply to limit power consumption to a minimum. In this case a ticking noise may be heard.

Power supply

The oscilloscope operates on main line voltages between 100VAC and 240VAC. No means of switching to different input voltages has therefore been provided.

The power input fuses are externally accessible. The fuse holder is located above the 3-pole power connector. The power input fuses are externally accessible, if the rubber connector is removed. The fuse holder can be released by pressing its plastic retainers with the aid of a small screwdriver. The retainers are located on the right and left side of the holder and must be pressed towards the center. The fuse(s) can then be replaced and pressed in until locked on both sides.

Use of patched fuses or short-circuiting of the fuse holder is not permissible; B&K assumes no liability whatsoever for any damage caused as a result, and all warranty claims become null and void.

Fuse type:

**Size 5x20mm; 0.8A, 250V AC fuse;
must meet IEC specification 127,
Sheet III (or DIN 41 662
or DIN 41 571, sheet 3).
Time characteristic: time-lag (T).**

**Attention!
There is a fuse located inside the instrument within the switch mode power supply:**

**Size 5x20mm; 0.8A, 250V AC fuse;
must meet IEC specification 127,
Sheet III (or DIN 41 662
or DIN 41 571, sheet 3).
Time characteristic: fast (F).**

This fuse must not be replaced by the operator!

Type of signal voltage

The following description of the **5105A** relates to the analog-oscilloscope mode. Please note **"Storage Operation"**.

The oscilloscope **5105A** allows examination of DC voltages and most repetitive signals in the frequency range up to at least 150MHz (-3dB).

The vertical amplifiers have been designed for minimum overshoot and therefore permit a true signal display.

The display of sinusoidal signals within the bandwidth limits causes no problems, but an increasing error in measurement due to gain reduction must be taken into account when measuring high frequency signals. This error becomes noticeable at approx. **70MHz.** At approx. **110MHz** the reduction is approx. 10% and the real voltage value is 11% higher. The gain reduction error can not be defined exactly as the **-3dB** bandwidth of the amplifiers differ **between 150MHz and 170MHz.**

For sine wave signals the -6dB limit is approx. 220MHz.

When examining square or pulse type waveforms, attention must be paid to the harmonic content of such signals. The repetition frequency (fundamental frequency) of the signal must therefore be significantly smaller than the upper limit frequency of the vertical amplifier.

Displaying composite signals can be difficult, especially if they contain no repetitive higher amplitude content which can be used for triggering. This is the case with bursts, for instance. To obtain a well-triggered display in this case, the assistance of the variable hold off function or the second time base may be required. Television video signals are relatively easy to trigger using the built-in **TV-Sync-Separator (TV)**.

For optional operation as a **DC** or **AC** voltage amplifier, each vertical amplifier input is provided with a **DC/AC** switch. DC coupling should only be used with a series-connected attenuator probe or at very low frequencies or if the measurement of the DC voltage content of the signal is absolutely necessary.

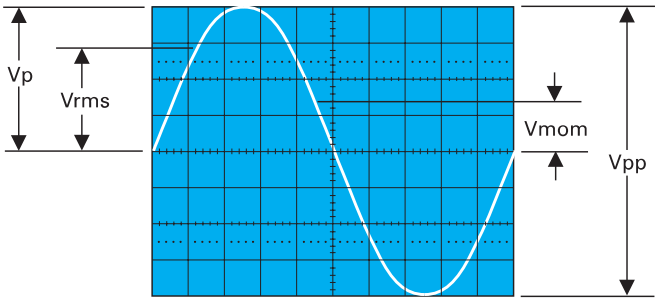
When displaying very low frequency pulses, the flat tops may be sloping with **AC** coupling of the vertical amplifier (AC limit frequency approx. 1.6 Hz for 3dB). In this case, **DC** operation is preferred, provided the signal voltage is not superimposed on a too high **DC** level. Otherwise a capacitor of adequate capacitance must be connected to the input of the vertical amplifier with **DC** coupling. This capacitor must have a sufficiently high breakdown voltage rating. **DC** coupling is also recommended for the display of logic and pulse signals, especially if the pulse duty factor changes constantly. Otherwise the display will move upwards or downwards at each change. Pure direct voltages can only be measured with **DC** coupling.

The input coupling is selectable by the AC/DC pushbutton. The actual setting is displayed in the readout with the " **=** " symbol for **DC**- and the " ~ " symbol for **AC** coupling.

Amplitude Measurements

In general electrical engineering, alternating voltage data normally refers to effective values (rms = root-mean-square value). However, for signal magnitudes and voltage designations in oscilloscope measurements, the peak-to-peak voltage (V_{pp}) value is applied. The latter corresponds to the real potential difference between the most positive and most negative points of a signal waveform. If a sinusoidal waveform, displayed on the oscilloscope screen, is to be converted into an effective (rms) value, the resulting peak-to-peak value must be divided by $2x\sqrt{2} = 2.83$. Conversely, it should be observed that sinusoidal voltages indicated in V_{rms} (V_{eff}) have 2.83 times the potential difference in V_{pp}.

The relationship between the different voltage magnitudes can be seen from the following figure.



Voltage values of a sine curve
V_{rms} = effective value; V_p = simple peak or crest value; V_{pp} = peak-to-peak value; V_{mom} = momentary value.

The minimum signal voltage which must be applied to the Y input for a trace of 1div height is $1mV_{pp}$ (± 5%) when this deflection coefficient is displayed on the screen (readout) and the vernier is switched off (VAR-LED dark). However, smaller signals than this may also be displayed. The deflection coefficients are indicated in mV/div or V/div (peak-to-peak value).

The magnitude of the applied voltage is ascertained by multiplying the selected deflection coefficient by the vertical display height in div. If an attenuator probe x10 is used, a further multiplication by a factor of 10 is required to ascertain the correct voltage value.

For exact amplitude measurements, the variable control (VAR) must be set to its calibrated detent CAL position.

With the variable control activated the deflection sensitivity can be reduced up to a ratio of 2.5 to 1 (**please note "controls and readout"**). Therefore any intermediate value is possible within the 1-2-5 sequence of the attenuator(s).

With direct connection to the vertical input, signals up to 400Vpp may be displayed (attenuator set to 20V/div, variable control to 2.5:1).

With the designations

H = display height in div,
U = signal voltage in V_{pp} at the vertical input,
D = deflection coefficient in V/div at attenuator switch,

the required value can be calculated from the two given quantities:

$$U = D \cdot H \qquad H = \frac{U}{D} \qquad D = \frac{U}{H}$$

However, these three values are not freely selectable.

They have to be within the following limits (trigger threshold, accuracy of reading):

H between 0.5 and 8div, if possible 3.2 to 8div,
U between $0.5mV_{pp}$ and $160V_{pp}$,
D between 1mV/div and 20V/div in 1-2-5 sequence.

Examples:
Set deflection coefficient **D** = 50mV/div 0.05V/div,
observed display height **H** = 4.6div,
required voltage **U** = 0.05x4.6 = 0.23V_{pp}.

Input voltage **U** = 5V_{pp},
set deflection coefficient **D** = 1V/div,
required display height **H** = 5:1 = 5div.

Signal voltage **U** = 230Vrmsx 2?√2 = 651V_{pp}
(voltage > 160V_{pp}, with probe 10:1: **U** = 65.1V_{pp}),
desired display height **H** = min. 3.2div, max. 8div,
max. deflection coefficient **D** = 65.1:3.2 = 20.3V/div,
min. deflection coefficient **D** = 65.1:8 = 8.1V/div,
adjusted deflection coefficient **D** = 10V/div.

The previous examples are related to the CRT graticule reading. The results can also be determined with the aid of the ΔV cursor measurement (please note **"controls and readout"**).

The input voltage must not exceed 400V, independent from the polarity.

If an AC voltage which is superimposed on a DC voltage is applied, the maximum peak value of both voltages must not exceed + or -400V. So for AC voltages with a mean value of zero volt the maximum peak to peak value is 800V_{pp}.

If attenuator probes with higher limits are used, the probes limits are valid only if the oscilloscope is set to DC input coupling.

If DC voltages are applied under AC input coupling conditions the oscilloscope maximum input voltage value remains 400V. The attenuator consists of a resistor in the probe and the 1MΩ input resistor of the oscilloscope, which are disabled by the AC input coupling capacity when AC coupling is selected. This also applies to DC voltages with superimposed AC voltages. It also must be noted that due to the capacitive resistance of the AC input coupling capacitor, the attenuation ratio depends on the signal frequency. For sine wave signals with frequencies higher than 40Hz this influence is negligible.

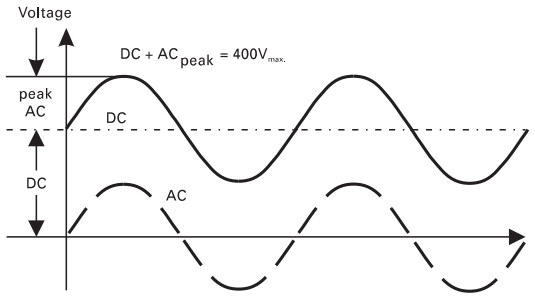
With the above listed exceptions **B&K** 10:1 probes can be used for DC measurements up to 600V or AC voltages (with a mean value of zero volt) of 1200V_{pp}. The 100:1 probe HZ53 allows for 1200V DC or 2400V_{pp} for AC.

It should be noted that its AC peak value is derated at higher frequencies. If a normal x10 probe is used to measure high voltages there is the risk that the compensation trimmer bridging the attenuator series resistor will break down causing damage to the input of the oscilloscope. However, if for example only the residual ripple of a high voltage is to be displayed on the oscilloscope, a normal x10 probe is sufficient. In this case, an appropriate high voltage capacitor (approx. 22-68nF) must be connected in series with the input tip of the probe.

With **Y-POS.** control (input coupling to **GD**) it is possible to use a **horizontal graticule line as reference line for ground potential before the measurement.** It can lie below or above the horizontal central line according to whether positive and/or negative deviations from the ground potential are to be measured.

Total value of input voltage

The dotted line shows a voltage alternating at zero volt level. If superimposed on a DC voltage, the addition of the positive peak and the DC voltage results in the max. voltage (DC + ACpeak).



Time Measurements

As a rule, most signals to be displayed are periodically repeating processes, also called periods. The number of periods per second is the repetition frequency. Depending on the time base setting (**TIME/DIV.**-knob) indicated by the readout, one or several signal periods or only a part of a period can be displayed. The time coefficients are stated in **ms/div**, **µs/div** or **ns/div**. The following examples are related to the CRT graticule reading. The results can also be determined with the aid of the Δt and 1/Δt cursor measurement (**please note " controls and readout"**).

The duration of a signal period or a part of it is determined by multiplying the relevant time (horizontal distance in div) by the (calibrated) time coefficient displayed in the readout .

Uncalibrated, the time base speed can be reduced until a maximum factor of 2.5 is reached. Therefore any intermediate value is possible within the 1-2-5 sequence.

With the designations
L = displayed wave length in div of one period,
T = time in seconds for one period,
F = recurrence frequency in Hz of the signal,
Tc = time coefficient in ms, µs or ns/div and the relation
F = 1/T, the following equations can be stated:

$$T = L \cdot T_c \qquad L = \frac{T}{T_c} \qquad T_c = \frac{T}{L}$$

$$F = \frac{1}{L \cdot T_c} \qquad L = \frac{1}{F \cdot T_c} \qquad T_c = \frac{1}{L \cdot F}$$

However, these four values are not freely selectable. They have to be within the following limits:

L between 0.2 and 10div, if possible 4 to 10div,
T between 5ns and 5s,
F between 0.5Hz and 100MHz,

Tc between 50ns/div and 500ms/div in 1-2-5 sequence (with X-MAG. (x10) inactive), and

Tc between 5ns/div and 50ms/div in 1-2-5 sequence (with X-MAG. (x10) active).

Examples:
Displayed wavelength L = 7div,
set time coefficient Tc = 100ns/div,
required period T = 7x100x10^{-9} = 0.7µs
required rec. freq. F = 1:(0.7x10^{-6}) = 1.428MHz.

Signal period T = 1s,
set time coefficient Tc = 0.2s/div,
required wavelength L = 1:0.2 = 5div.

Displayed ripple wavelength L = 1div,
set time coefficient Tc = 10ms/div,
required ripple freq. F = 1:(1x10x10^{-3}) = 100Hz.
TV-line frequency F = 15625Hz,

set time coefficient Tc = 10µs/div,
required wavelength L = 1:(15625x10^{-5}) = 6.4div.

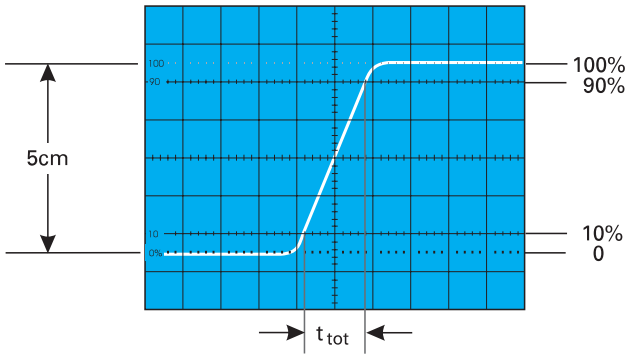
Sine wavelength L = min. 4div, max. 10div,
Frequency F = 1kHz,
max. time coefficient Tc = 1:(4x10^{3}) = 0.25ms/div,
min. time coefficient Tc = 1:(10x10^{3}) = 0.1ms/div,
set time coefficient Tc = 0.2ms/div,
required wavelength L = 1:(10^{3}x0.2x10^{-3}) = 5div.

Displayed wavelength L = 0.8div,
set time coefficient Tc = 0.5µs/div,
pressed X-MAG. (x10) pushbutton: Tc = 0.05µs/div,
required rec. freq. F = 1:(0.8x0.05x10^{-6}) = 25MHz,
required period T = 1:(25x10^{6}) = 40ns.

If the time is relatively short as compared with the complete signal period, an expanded time scale should always be applied (X-MAG. (x10) active). In this case, the time interval of interest can be shifted to the screen center using the X-POS. control.

When investigating pulse or square waveforms, the critical feature is the rise time of the voltage step. To ensure that transients, ramp-offs, and bandwidth limits do not unduly influence the measuring accuracy, the rise time is generally measured between 10% and 90% of the vertical pulse height. For measurement, adjust the Y deflection coefficient using its variable function (uncalibrated) together with the Y-POS. control so that the pulse height is precisely aligned with the 0% and 100% lines of the internal graticule. The 10% and 90% points of the signal will now coincide with the 10% and 90% graticule lines. The rise time is given by the product of the horizontal distance in div between these two coincident points and the calibrated time coefficient setting. The fall time of a pulse can also be measured by using this method.

The following figure shows correct positioning of the oscilloscope trace for accurate rise time measurement.



With a time coefficient of 5ns/div (X x10 magnification active), the example shown in the above figure results in a total measured rise time of

t_{tot} = 1.6div x 5ns/div : 10 = **8ns**

When very fast rise times are being measured, the rise times of the oscilloscope amplifier and of the attenuator probe has to be deducted from the measured time value. The rise time of the signal can be calculated using the following formula.

$$t_r = \sqrt{t_{tot}^2 - t_{osc}^2 - t_p^2}$$

In this t_{tot} is the total measured rise time, t_{osc} is the rise time of the oscilloscope amplifier (approx. 2.3ns), and t_p the rise time of the probe (e.g. = 2ns). If t_{tot} is greater than 34ns, then t_{tot} can be taken as the rise time of the pulse, and calculation is unnecessary.

Calculation of the example in the figure above results in a signal rise time

$$\mathbf{tr} = \sqrt{8^2 - 2{,}3^2 - 2^2} = \mathbf{7{,}4\ ns}$$

The measurement of the rise or fall time is not limited to the trace dimensions shown in the above diagram. It is only particularly simple in this way. In principle it is possible to measure in any display position and at any signal amplitude. It is only important that the full height of the signal edge of interest is visible in its full length at not too great steepness and that the horizontal distance at 10% and 90% of the amplitude is measured. If the edge shows rounding or overshooting, the 100% should not be related to the peak values but to the mean pulse heights. Breaks or peaks (glitches) next to the edge are also not taken into account. With very severe transient distortions, the rise and fall time measurement has little meaning. For amplifiers with approximately constant group delay (therefore good pulse transmission performance) the following numerical relationship between rise time **tr (in ns)** and bandwidth **B (in MHz)** applies:

$$t_r = \frac{350}{B} \qquad B = \frac{350}{t_r}$$

Connection of Test Signal

In most cases briefly depressing the **AUTO SET** causes a useful signal related instrument setting. The following explanations refer to special applications and/or signals, demanding a manual instrument setting. The description of the controls is explained in the section **"controls and readout"**.

Caution:
When connecting unknown signals to the oscilloscope input, always use automatic triggering and set the input coupling switch to AC (readout). The attenuator should initially be set to 20V/div.

Sometimes the trace will disappear after an input signal has been applied. Then a higher deflection coefficient (lower input sensitivity) must be chosen until the vertical signal height is only 3-8div. With a signal amplitude greater than 160Vpp and the deflection coefficient **(VOLTS/DIV.)** in calibrated condition, an attenuator probe must be inserted before the vertical input. If, after applying the signal, the trace is nearly blanked, the period of the signal is probably substantially longer than the set time deflection coefficient (**TIME/DIV.**). It should be switched to an adequately larger time coefficient.

The signal to be displayed can be connected directly to the Y-input of the oscilloscope with a shielded test cable such as PR37AG, or reduced through a x10 or x100 attenuator probe. The use of test cables with high impedance circuits is only recommended for relatively low frequencies (up to approx. 50kHz). For higher frequencies, the signal source must be of low impedance, i.e. matched to the characteristic resistance of the cable (as a rule 50Ω). Especially when transmitting square and pulse signals, a resistor equal to the characteristic impedance of the cable must also be connected across the cable directly at the Y-input of the oscilloscope. When using a 50Ω cable. When

transmitting square signals with short rise times, transient phenomena on the edges and top of the signal may become visible if the correct termination is not used. A terminating resistance is sometimes recommended with sine signals as well. Certain amplifiers, generators or their attenuators maintain the nominal output voltage independent of frequency only if their connection cable is terminated with the prescribed resistance. If a

x10 or x100 attenuator probe is used, no termination is necessary. In this case, the connecting cable is matched directly to the high impedance input of the oscilloscope. When using attenuators probes, even high internal impedance sources are only slightly loaded (approx. 10MΩ II 12pF. Therefore, if the voltage loss due to the attenuation of the probe can be compensated by a higher amplitude setting, the probe should always be used. The series impedance of the probe provides a certain amount of protection for the input of the vertical amplifier. Because of their separate manufacture, all attenuator probes are only partially compensated, therefore accurate compensation must be performed on the oscilloscope (**see Probe compensation**).

Standard attenuator probes on the oscilloscope normally reduce its bandwidth and increase the rise time. In all cases where the oscilloscope bandwidth must be fully utilized (e.g. for pulses with steep edges).

The probes mentioned have a HF-calibration in addition to low frequency calibration adjustment. Thus a group delay correction to the upper limit frequency of the oscilloscope is possible with the aid of an 1MHz calibrator.

In fact the bandwidth and rise time of the oscilloscope are not noticeably changed with these probe types and the waveform reproduction fidelity can even be improved because the probe can be matched to the oscilloscopes individual pulse response.

If a x10 or x100 attenuator probe is used, DC input coupling must always be used at voltages above 400V. With AC coupling of low frequency signals, the attenuation is no longer independent of frequency, pulses can show pulse tilts. Direct voltages are suppressed but load the oscilloscope input coupling capacitor concerned. Its voltage rating is max. 400 V (DC + peak AC). DC input coupling is therefore of quite special importance with a x100 attenuation probe which usually has a voltage rating of max. 1200 V (DC + peak AC). A capacitor of corresponding capacitance and voltage rating may be connected in series with the attenuator probe input for blocking DC voltage (e.g. for hum voltage measurement).

With all attenuator probes, **the maximum AC input voltage** must be derated with frequency usually above 20kHz. Therefore the derating curve of the attenuator probe type concerned must be taken into account.

The selection of the ground point on the test object is important when displaying small signal voltages. It should always be as close as possible to the measuring point. If this is not done, serious signal distortion may result from spurious currents through the ground leads or chassis parts. The ground leads on attenuator probes are also particularly critical.

They should be as short and thick as possible. When the attenuator probe is connected to a BNC-socket, a BNC-adapter, should be used. In this way ground and matching problems are eliminated. Hum or interference appearing in the measuring circuit (especially when a small deflection coefficient is used) is possibly caused by multiple grounding because equalizing currents can flow in the shielding of the test cables (voltage drop between the protective conductor connections, caused by external equipment connected to the mains/line, e.g. signal generators with interference protection capacitors).

Controls and Readout

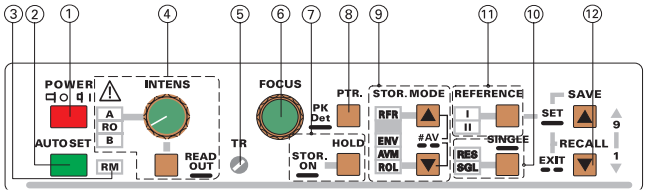
The following description assumes that the instrument is not set to **"COMPONENT TESTER"** mode.

If the instrument is switched on, all important settings are displayed in the readout. The LED's located on the front panel assist operation and indicate additional information. Incorrect operation and the electrical end positions of control knobs are indicated by a warning beep.

Except for the power pushbutton (POWER), the calibrator frequency pushbutton (CAL. 1kHz/1MHz), the focus control (FOCUS) and the trace rotation control (TR) all other controls are electronically selected. All other functions and their settings can therefore be remote controlled and stored. Some controls are only operative in storage mode or have different functions in analog operation. See **"STORAGE MODE ONLY"**.

The front panel is subdivided into sections.

On the top, immediately to the right of the CRT screen, the following controls and LED indicators are placed:



(1) POWER - Pushbutton and symbols for **ON (I)** and **OFF (O)**.
After the oscilloscope is switched on, all LEDs lit and an automated instrument test is performed. During this time the **B&K** logo and the software version are displayed on the screen. After the internal test is completed successfully, the overlay is switched off and the normal operation mode is present. Then the last used settings become activated and one LED indicates the ON condition.

Some mode functions can be modified (SETUP) and/or automated adjustment procedures (CALIBRATE) can be called if the **"MAIN MENU"** is present. To enter this menu the **AUTO SET** pushbutton must be pressed constantly when the B&K logo is displayed until **"MAIN MENU"** becomes visible. For further information **please note "MENU"**.

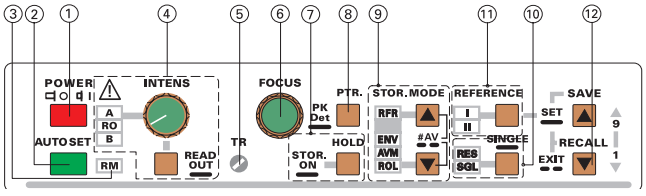
(2) AUTO SET - Briefly depressing this pushbutton results in an automatic signal related instrument setting (**please note "AUTO SET"**), if the signal frequency and height are suited for automatic triggering (**AT**). In Yt mode the actual channel operating conditions (**CH I, CH II** or **DUAL**) remain unchanged, whereas the time base is automatically set to **A** time base mode.

In case of **XY** or **CT** (Component Tester) operation, the instrument is set to the last used Yt mode setting.

Automatic CURSOR supported voltage measurement
If **CURSOR** voltage measurement is present, the **CURSOR** lines are automatically set to the positive and negative peak value of the signal. The accuracy of this function depends on the signal frequency and is also influenced by the signal's pulse duty factor. If the signal height is insufficient, the **CURSOR** lines do not change. In **DUAL** mode the **CURSOR** lines are related to the signal which is used for internal triggering.

STORAGE MODE ONLY
Additionally, **AUTOSET** automatically selects refresh mode **(RFR)** when **SINGLE (SGL)** or **ROLL (ROL)** function is in operation.

Automatic CURSOR supported measurement
In contrast to analog mode, **AUTO SET** also causes an automatic **CURSOR** line setting if time or frequency measurement has been selected and at least one signal period is displayed. Neither the signal frequency nor the pulse duty factor have an effect on the accuracy when **CURSOR** voltage measurement is chosen.



(3) **RM** - The remote control mode can be switched on or off via the **RS232** interface. In the latter case the "RM" LED is lit and the electronically selectable controls on front panel are inactive. This state can be left by depressing the **AUTO SET** pushbutton provided it was not inactivated via the interface.

STORAGE MODE ONLY
The **RM** LED is lit during signal transfer via the built in **RS232** interface. At this time the controls are inactive.

(4) **INTENS** - Knob with associated pushbutton and LEDs.

This control knob is for adjusting both the trace and readout intensity. Turning this knob clockwise increases and turning it counterclockwise decreases the intensity of the selected function (A, RO resp. B).

The **READ OUT** pushbutton below is for selecting the function in two ways.

Depending on the actual time base mode and the readout (**RO**) not switched off, briefly pressing the **READ OUT** pushbutton switches over the **INTENS** knob function indicated by a LED in the sequences:

A - RO - A in condition A time base,
A - RO - B - A if alternate time base mode is present,
B - RO - B in condition B time base,
A - RO - B in XY mode and
A - RO - A in Component Tester (CT) mode.

Pressing and holding the **READ OUT** pushbutton switches the readout on or off. In readout off condition the INTENS knob function can consequently not be set to RO. Briefly pressing the pushbutton causes an error tone if only A or B time base mode are present. If alternate time base mode is used the switching sequence is A - B - A.

Switching the readout off, may be required if interference distortions are visible on the signal(s). Such distortions may also originate from the chopper generator if the instrument is operated in chopped DUAL mode.

In **XY** mode only **A** (for the signal) and **RO** can be selected unless the readout is switched off. Then just the A-LED is lit.

The readout is automatically switched off in **COMPONENT TEST** mode and no other LED on the front panel is lit except A.

All **INTENS** settings are stored after the instrument is switched off.

The **AUTO SET** function switches the readout on and selects A time base mode (A-LED lit). The **INTENS** setting for each function is automatically set to the mean value, if less intensity was previously selected.

(5) **TR** - The trace rotation control can be adjusted with a small screwdriver (please note "trace rotation TR")

(6) **FOCUS** - This control knob effects both the trace and the readout sharpness.

(7) **STOR. ON** / **HOLD** - Pushbutton with two functions.

STOR. ON
Pressing and holding the pushbutton switches from analog (**Yt** or **XY**) to storage mode and vice versa. If **CT** (Component Tester) mode is present (only available in analog mode), it must be switched off first to enable switching over to storage mode.

The oscilloscope is in analog mode if none of the LED's associated with the **STOR.MODE (9)** pushbuttons are lit and a pre- or post trigger value (**PT...%**) is not indicated by the readout. Pressing and holding the **STOR. ON** pushbutton switches over to the digital mode, but without changing the channel operating mode (**CH I, CH II, DUAL, ADD** and **XY**).

The actual signal capture mode is indicated by one of the **STOR. MODE-LED's** (**RFR - ENV - AVM - ROL**) and in addition displayed by the readout. In digital **XY** mode the **RFR**-LED is lit and the readout indicates XY.

If digital **SINGLE** event **(SGL)** capture mode is selected, all **STOR. MODE**-LED's are dark, but the readout displays the pre- or post trigger value (**PT...%**).

Attention:
The time base ranges are different between analog and storage mode operation depending on the operating mode!

In ALTernate and B time base mode the B time coefficient can never be set to a larger value than the actual A time coefficient. The following information excludes the X magnifier factor.

Analog mode:
A time base from 500ms/div to 50ns/div.
B time base from 20ms/div to 50ns/div.

Storage mode:
A time base from 100s/div to 100ns/div,
B time base from 20ms/div to 100ns/div,

This results in the following behavior when switched from analog to digital mode and vice versa:

1. If in analog mode, the time base has been selected between 200ns/div and 50ns/div, then on switching to digital mode the lowest available time coefficient will be automatically selected, i.e. 100ns/div. If now one switches back to analog mode without having made any time base changes in the digital mode, then the last time base selected in the analog mode is again active (e.g. 50ns/div).

   If on the other hand, the time base is changed after switching over to digital mode (e.g. to 2µs/div). Then,

when switched back to analog mode, the time base in analog mode will be set to the value selected in the digital mode (e.g. 2µs/div).

2. If a time base between 100s/div and 1s/div has been set in the digital mode and the mode is switched to analog, then the time base in analog mode is automatically set to 500ms/div. The rest is as described before.

The X-MAG x10 setting remains unchanged when switched from analog to digital mode and vice versa.

STORAGE MODE ONLY
If by pressing and holding the **STOR. ON / HOLD pushbutton**, the mode is switched to digital, then one of the associated LED's lights up. Which one, depends on the last selected digital operation.

Exception
Switching over from analog SINGLE mode to digital mode sets the instrument automatically to digital SINGLE mode.

For additional information regarding the digital mode, see section **STORAGE OPERATION**.

HOLD

STORAGE MODE ONLY
Briefly pressing the **STOR. ON / HOLD** pushbutton switches over between protected and unprotected mode of the current memory contents.

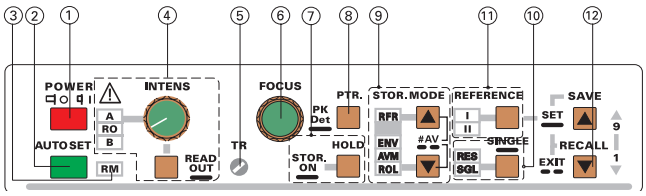
The current contents of the memory are protected against overwriting when **HLD (HOLD)** instead of channel information (e.g. Y1...) is displayed in the readout. This prevents a change in the Yt mode setting, but it is possible to select between **DUAL** (Yt) and **XY** display by pressing the **DUAL (23)** pushbutton if one of these modes was selected before activating **HOLD**.

If **HOLD** is switched off, one can observe how the existing memory contents are successively overwritten by new data especially with slow time base settings and refresh mode. Protecting the memory contents in the middle of a data acquisition process can result in an irregularity at the junction of old (right) and new data (left). This can be avoided by recording in single shot mode **(SGL)**, even though the input signal is repetitive. At the end of a sweep, one can use **HOLD** to protect the contents against being overwritten by an unintentional actuation of **RESET (RES)**.

The signal in each of the current memory can be shifted in the vertical direction (+/- 4div) with the corresponding **Y-POS** rotary knob when **HOLD** is operative.

The original trace position will be lost when shifted vertically, but this can be found again. To this end the **Y-POS** knob in question must be rotated quickly. Once the original position is reached, the trace does not shift anymore although the knob is rotated further. Simultaneously a signal tone sounds. To shift the trace vertically again it will be required to stop rotating the knob for at least about 2 seconds.

Attention!
The dynamic range limits of the A/D converter may become visible if a Y -position shift is performed after storage. This can affect those signal parts which were originally above or below the screen.



(8) PTR / PK Det - Pushbutton with two functions.

Neither function is available in analog mode.

PTR
Briefly pressing selects the **PRE**- and **POST-**Trigger value.

The **PRE TRIGGER** function is used to capture signals that occur prior to a trigger event, making the prehistory visible. In contrast to this function, the **POST TRIGGER** is used to capture signals occurring after the trigger event, which could not be captured in **"0%"** pre trigger condition. Due to the dependence on trigger events, neither function is available in the trigger independent modes **XY** and **ROLL**.

The actual **PRE-** or **POST TRIGGER** value is displayed by the readout and changes each time the **PTR** pushbutton is pressed briefly, in the following **sequence: PT0%, PT25%, PT50%, PT75%, PT100%, PT-75%, PT-50%, PT-25%** and back to **PT0%**.

The values refer to the X-axis (graticule) of the screen display (10% = 1div).

The following description assumes that the X magnifier (x10) is inactive and the signal display starts on the leftmost vertical graticule line. It is also assumed that a trigger mode (source, coupling) is chosen, in which the trigger point symbol is displayed. In contrast to analog mode, using pre trigger the trigger point symbol can be shifted in X-direction.

PRE TRIGGER

0% PRE TRIGGER (readout **"PT0%"**) means that the signal display starts with the trigger event. The trigger point symbol indicates this position. If the **X-POS.** control is not in center position, an arrow pointing to the left may be displayed. Then the **X-POS.** (**19**) control must be turned clockwise until the arrow is no longer visible.

25% PRE TRIGGER (readout **"PT25%"**) is achieved after pressing the **PTR** pushbutton once. The signal display starts with 25% prehistory and the trigger point symbol is shifted 2.5 divisions to the right.

Each time the **PTR** pushbutton is pressed the **PRE TRIGGER** value increases by 25% until 100% is reached. If in 100% condition an arrow symbol is displayed in addition to the trigger point symbol, the **X-POS.** control should be turned ccw. to make the trigger point visible on the screen.

The duration of the prehistory is determined by multiplying the time coefficient by the pre trigger value (in divisions). E.g. 20ms/div x 7,5 div (= 75% pre trigger) = 150ms.

POST TRIGGER

In POST TRIGGER condition the trigger point is always to the left of the screen and therefore not visible. The trigger point symbol then only indicates the **LEVEL**

setting. An additional arrow symbol which points to the left is displayed to indicate post trigger operation. In POST TRIGGER condition the arrow symbol does not indicate a wrong **X-POS.** setting. A minus sign (-) placed in front of the percentage value, is displayed by the readout for POST TRIGGER mode indication.

Proceeding from 100% pre trigger, the instrument switches over to **75% POST TRIGGER ("PT-75%")** after the PTR pushbutton is pressed. Then the trigger point is 7.5 div to the left of the trace start on the screen. This means that the signal capture starts 7.5 x time deflection coefficient after the trigger event occurred.

Every time the **PTR** pushbutton is pressed the POST TRIGGER value changes in 25% steps until PTR-25% is active. When the PTR pushbutton is pressed again, both post and pre trigger are switched off and the readout indicates **"PT0%"**.

Attention!
In time base settings from 100s/div to 50ms/div the pre- or post trigger is automatically switched off ("PT0%) if refresh (RFR), envelope (ENV) or average (AVM) mode is active. This is to avoid excessive waiting times.

If the pre- or post trigger function is required in combination with those time coefficients, **SINGLE (SGL)** mode operation must be used.

PK Det
Pressing and holding switches the peak value detection (**"PK Det"** = peak detect) on or off. This function is available only with deflection coefficients from 100s/div to 5µs/div in combination with REFRESH, ENVELOPE, ROLL or SINGLE modes. **"PK Det"** will be disabled automatically if AVERAGE mode is active or a time coefficient from 2µs/div to 100ns/div is chosen.

The **"PK Det"** function is indicated by the time coefficient display in the readout. Switching **"PK Det"** on, changes from e.g. **"A:20ms"** to **"P:20ms"** and consequently in B time base mode from **"B:100µs"** to **"P:100µs"**. In alternate (A and B) time base mode, the **"PK Det"** function only affects the A time base and the readout displays e.g. **"P:20ms"** and **"B:100µs"**.

In **"PK Det"** operation the sampling rate is always 40MS/s and the signal will be sampled every 25ns. The advantage of this sampling method is as follows:

Without **"PK Det"** and a time coefficient of 100s/div, the signal is sampled every 0.5 seconds (2 Samples/second) and stored at a new address. A signal amplitude change with a duration of e.g. 30ns appearing 0.2 seconds after the last sampling procedure will not be captured. In combination with **"PK Det"** the sampling interval is reduced to 25ns and then the samples will be evaluated and the most deviating value captured within 0.5s after the last storage procedure, will be stored at the next address.

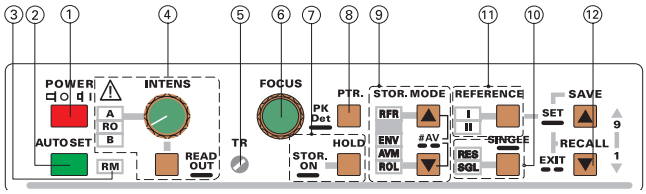
(9) STOR. MODE - Pushbuttons with associated LEDs.

These functions are not available in analog mode.

If digital **SINGLE (SGL)** mode has not been chosen, one of the associated LEDs is lit. The signal capture and display mode can be selected by pressing one of the pushbuttons. The mode setting is indicated by one of the LEDs (**RFR, ENV, AVM** and **ROL**) and also displayed by the readout. The only exception is in **XY** storage mode. Then the **RFR-LED** is lit and the readout displays **XY**. No other signal capture and display mode can be chosen in XY mode.

The desired Yt signal capture mode can be selected by pressing the upper or lower **STOR. MODE** pushbutton.

The following description presumes that **HOLD (HLD)** is not activated and the trigger conditions are met.



(9) RFR - stands for refresh operation. In this mode, as in analog mode, periodically repeating signals can be captured and displayed.

The signal acquisition is started by triggering the digital time base. Then the previously captured and displayed signal will be overwritten with the current signal. This will be displayed until the digital time base is triggered again. This is in contrast to analog operation where the screen remains blank when the time base is not triggered.

In refresh mode, the signal acquisition can be effected with pre- or post triggering when a time base between 20ms/div and 100ns/div is selected. The pre triggering or post triggering will be automatically switched off (PT0%), with larger time coefficients (100s/div to 50ms/div) in order to avoid excessive waiting times. If it is required to measure with pre- or post trigger in this time base range, one should select single shot **(SINGLE = SGL)**.

In XY digital mode the **RFR-LED** lights. It indicates a continuous, trigger independent signal acquisition. The trigger circuit is switched off.

(9) ENV - is the abbreviation for **ENVELOPE** operation.

In this mode the minimum and maximum values of the signal during several signal acquisitions will be determined and displayed. Except for this display, the ENVELOPE operation is identical to the refresh operation.

Changes in the signal are easier to measure and are more visible in ENVELOPE operation. This is valid not only for amplitude changes but also for frequency variations (Jitter).

The ENVELOPE evaluation begins anew when the **SINGLE (10) pushbutton** is pressed briefly, to actuate the **RESET (RES)** function.

Attention!
The pre- or post trigger will be automatically switched off (PT0%) in the time base range from 100s/div to 50ms/div.

(9) AVM - indicates **AVERAGE** (mean value) mode.
This operation is effective when the AVM-LED lights up and the readout displays **AV...** .

In this case also several signal acquisition scans are required; hence, it is similar to Refresh operation. The signal is averaged over the several acquisitions so that

amplitude variations (e.g. noise) and frequency variations (Jitter) are minimized or eliminated in the display.

The accuracy of the mean value evaluation increases as the number of signal acquisition scans used for evaluation is increased. One can select the number between 2 and 512. The selected setting is displayed in the readout. Of course, with increasing accuracy the time required for this also increases.

To select a different value briefly press both **STOR. MODE** pushbuttons simultaneously. The **AV...** display in the readout flashes indicating the setting mode. Now, the value can be changed by briefly pressing the upper or lower **STOR. MODE** pushbutton. The setting mode can be exited by again briefly pressing the two pushbuttons simultaneously. The setting mode will also be switched off automatically if none of the two pushbuttons is actuated during a 10 seconds period.

The averaging begins anew after briefly pressing the **SINGLE (10)** pushbutton (**RESET** function).

Attention!
The pre- or post trigger will be automatically switched off (PT0%) in the time base range from 100s/div to 50ms/div.

(9) ROL - indicates ROLL mode.

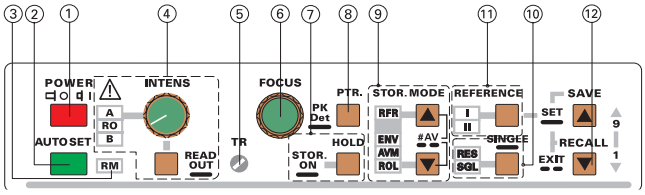
In **ROLL** mode the **ROL**-LED is lit and the readout displays **"ROL"**.

In this mode, the memory contents and including the signal display, are continuously updated. Because signal capture is untriggered, no idle states arise while waiting for a new trigger event to start signal capture. With each signal sampling the new value is shown on the right-hand edge of the screen, while the previously captured data are shifted to the left. The leftmost value is shifted out of the memory and lost.

The recording can be stopped at any time by selecting the **HOLD (7)** function.

ROLL mode can only be used with time coefficients from 100s/div to 50ms/div, as lower time coefficients (faster time base speeds) are impractical.

If the time base is set to values between 20ms/div and 100ns/div and ROLL mode is selected, the time base will be automatically set to 50ms/div. The time deflection coefficient set previously before switching to ROLL mode will be internally stored (e.g. 20ms/div). If ROLL mode has been selected inadvertently and the **TIME/DIV.** knob has not been changed, the time base will be automatically set to the internally stored coefficient when switching from **ROLL** to **AVERAGE** mode.



(10) SINGLE - Pushbutton with two functions and associated LEDs.

SINGLE
Pressing and holding this pushbutton switches the **SINGLE** event capturing mode on or off. **SINGLE** mode is indicated by the associated **SGL**-LED.

SINGLE mode is available in digital as well as in analog mode and remains unchanged when switching over from analog to digital mode or vice versa. The main purpose of **SINGLE** is the capture of one time events, but it can also be used in combination with repetitive signals. **SINGLE** mode automatically selects **A time base** mode and normal triggering (**NM**-LED lit). Otherwise the automatic trigger (**AT**) would occur without an input (trigger) signal.

If the trigger circuit is activated by **RESET**, one time base sweep (analog mode) or one complete data acquisition (digital mode) is performed after a suitable signal caused triggering. Switching over to SINGLE in analog mode interrupts the time base sweep and blanks the beam.

Storage mode only
Selecting SINGLE stops the current data acquisition. Until a new data acquisition is started, the memory content is displayed continuously.

In combination with **Yt** (time base) mode, SINGLE is indicated by the readout. It displays the actual pre- or post trigger value and **"SGL"** instead of " RFR", " ENV", " AV..." or " ROL". If **XY** mode is active the A time deflection coefficient is replaced by the sampling rate (e.g. 100MS/s) display in the readout and additionally the trigger regarding information is switched off.

Attention!
If SINGLE mode is present in combination with DUAL mode, the minimum time coefficient is 2µs/div instead of 100ns/div. Similarly if X-MAG. x10 is operative, then 200ns/div replaces 10ns/div.

ANALOG MODE ONLY
Selecting **SINGLE** mode switches the current sweep off and blanks the screen.

SINGLE mode is indicated by the lit **SGL-LED** and the readout displaying **SGL** next to the / **(SLOPE)** symbol.

RESET (RES)
Briefly pressing the **SINGLE** pushbutton causes a **RESET** activating the trigger circuit if Yt mode is active. The result depends on the current signal capture mode.

STORAGE MODE ONLY

a)
In combination with **SINGLE**, briefly pressing the **SINGLE** pushbutton activates the **RESET** function. Then both LEDs (**SGL** and **RES**) are lit. Whether the **RES-LED** flashes once or is lit constantly, depends on:

1. the presence or absence of a trigger signal,
2. the selected time coefficient (time base) and
3. the pre- or post trigger setting.

After the **RESET** function is switched on, the signal acquisition will be effective at once if the **HOLD** function is not active. If the pre trigger function is active, the prehistory must elapse before the trigger event becomes effective. The signal capture terminates with the trigger event only with 100% pre trigger setting.

With all other pre trigger and post trigger settings, the signal acquisition is not complete when the trigger occurs

and will only be terminated later. After termination the **RES**-LED extinguishes but the signal display remains. Briefly pressing the **SINGLE** pushbutton (**RESET** function) again restarts a new single event capture which then overwrites the previously recorded display.

Single events recorded in DUAL mode can also be displayed in the XY mode when switched over to XY operation.

XY mode
Briefly pressing the SINGLE pushbutton (RESET function) causes one complete trigger independent signal recording. The **RES**-LED extinguishes after completion. Thereafter it is possible to switch over to DUAL mode to display the signals in Yt (time base) mode.

Attention!
If time coefficients between 100s/div and 50ms/div are present the signal acquisition becomes visible at once as a ROLL display, but the signal acquisition has nothing to do with ROLL mode.

b)
Briefly pressing the **SINGLE** pushbutton (**RESET** function) is also effective if (instead of **SINGLE**) **ENVELOPE** or **AVERAGE** mode is selected.

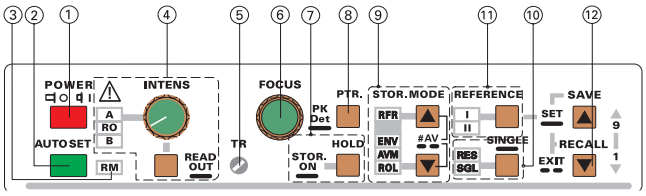
In both modes the evaluation / averaging begins anew.

ANALOG MODE ONLY
Capturing single events can also be carried out in analog **Yt** (time base) mode (e.g. photographing).

Briefly pressing the **SINGLE** pushbutton activates the **RES-LED** in **SINGLE** mode. The next trigger event then unblanks the beam and causes a one time base sweep.

Only in chopped **DUAL** mode can both channels be displayed during one time base sweep.

XY mode is not available in combination with SINGLE operation.



(11) REFERENCE - Reference memory pushbutton with two associated LEDs.

The instrument contains two non volatile signal data memories. Signal(s) stored in these memories can be displayed separately or together in addition to the current signal(s). The REFERENCE memory content will not be erased by switching the instrument off.

Display
If neither the associated **"I"** nor the **"II"** LED is lit, no reference signal is displayed. Briefly pressing the **REFERENCE** pushbutton switches LED **"I"** on. Then in addition to the current signal the reference **I** memory content is displayed. The switching sequence is:
dark – I – II - I and **II - dark**.

The LED(s) indicate the memory content(s) which are displayed. The display of the current signal(s) is not affected by the reference display.

In XY mode the switching sequence is:
dark – I and **II – dark**.

Overwrite
To overwrite the reference memory content with current signal(s) the following procedure is required:

Determine the reference memory(ies) by briefly pressing the **REFERENCE** pushbutton. Then press and hold the pushbutton until a beep confirms reference memory acquisition. Before starting the procedure, the current signal can, but must not be protected by the **HOLD** function.

As the reference signal is then equal to the current signal, it is usually not visible at once. If neither **HOLD** nor **SINGLE** is active, the current signal can be shifted by the **Y-POS**. control(s) to make the reference signal visible.

If both **REFERENCE I** and **II** LEDs lit and **DUAL** or **XY** mode is active, both reference memories can be overwritten at the same time. The signal from **channel I** is stored in reference **memory I** and consequently **channel II** in reference **memory II**. The relation between channel and reference memory is present only during DUAL or XY operation. If only **REFERENCE I** is active and consequently displayed, only the current signal of channel I can overwrite it.

In single channel mode (**CHI** or **CHII**) the current signal can be stored in each of both reference memories. This permits creation of two reference curves with different Y positions and to display them in condition **REFERENCE I** and **II** LEDs lit. The current signal then may not exceed these limits. To avoid overwriting both reference memories with the same signal, pressing and holding the **REFERENCE** pushbutton only causes a warning beep if single channel mode is present.

(12) SAVE / RECALL – Pushbuttons.

The instrument contains 9 non volatile memories. These can be used by the operator to save instrument settings and to recall them. This relates to all controls which are electronically selected.

SAVE
Press the **SAVE** pushbutton briefly to start the save procedure. The readout then indicates the letter **"S"** followed by a cipher between **1** and **9**, indicating the memory location. If the instrument settings stored in this memory location shall not be overwritten, briefly press the **SAVE** or the **RECALL** pushbutton to select another memory location. Each time the **SAVE** pushbutton is briefly pressed the memory location cipher increases until the location number 9 is reached. The **RECALL** pushbutton function is similar but decreases the memory location cipher until 1 is reached. Press and hold **SAVE** for approx. 3 seconds to write the instruments settings in the memory and additionally switch the readout information (i.e. **"S8"**) off.

RECALL
To recall a front panel setup, start that procedure by briefly pressing the **RECALL** pushbutton. The readout then indicates the letter **"R"** and the memory location number. If required, select a different memory location as described above. Recall the settings by pressing and holding the **RECALL** pushbutton for approx. 3 seconds.

If the **SAVE** or the **RECALL** pushbutton was depressed inadvertently, briefly press both pushbuttons at the same

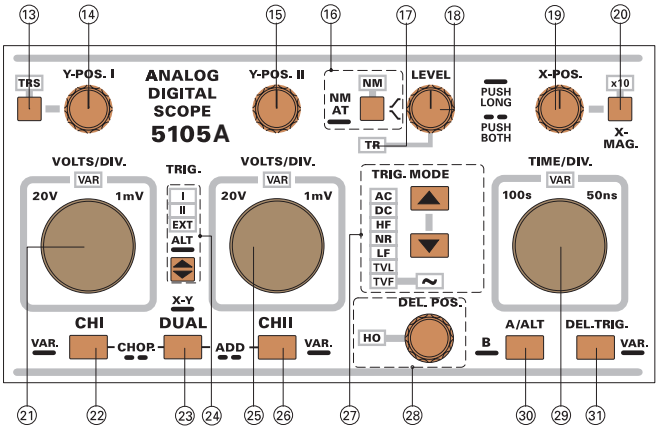
time or wait approx. 10 seconds without pressing either pushbutton to leave that function.

Attention:
Make sure that the signal to be displayed is similar to the one that was present when the settings were stored. If the signal is different (frequency, amplitude) to the one during storage then a distorted display may result.

If the **SAVE** or the **RECALL** pushbutton was depressed inadvertently, briefly press both pushbuttons at the same time or wait approx. 10 seconds without pressing either pushbutton to exit that function.

Switching the instrument off results in an automatic SAVE procedure of the present settings in memory location 9 and overwrites the data in that location. If the instrument settings in memory location 9 are of importance, RECALL location 9 settings before switching the instrument off.

The setting controls and LED's for the Y amplifiers, modes, triggering and time base are located underneath the sector of the front panel described before.



(13) TRS – Pushbutton and associated LED.

The instrument contains a trace separation function which is required in the alternate time base mode to separate the **B** time base trace from the **A** time base in Y direction. Subsequently this function is only available in alternate time base mode.

After the **TRS** pushbutton is pressed once the LED related to that pushbutton is lit. Then the **Y-POS. I** control knob is operative as vertical position control for the trace of the **B** time base. The maximum position shift is approx. +/-4 div. Without a change of the **Y-POS. I** controls the trace separation function is switched off automatically after approx. 10 seconds. The trace separation function can also be left by pressing the **TRS** pushbutton.

(14) Y-POS. I – Control knob with two functions.

The vertical trace position of channel I can be set with this control knob. In **ADD** (addition) mode both (**Y-POS. I** and **Y-POS. II**) control knobs are active. In **alternate time base** mode, this control knob can be used to separate the **B** time base trace from the **A** time base trace. **Please note TRS (13)**.

If automatic triggering **(AT)** is present and the input is set to **GD (34)**, the vertical trace position corresponds with 0 Volt (reference) at the input and can be set to any suitable position. In **ADD** mode these conditions apply to both channels. After switching **GD** off and selecting DC input coupling it is possible to determine the DC content of a signal by comparing the actual Y position with the previously determined 0 Volt Y position.

Y-POS. I Symbol
Provided that the readout is displayed and **"DC REFERENCE = ON"** is selected in the **"SETUP"** submenu **"MISCELLANEOUS"** the 0 Volt reference position is indicated by a ground (⊥) symbol. For channel I this symbol is displayed on the left of the vertical (graticule) center line, if the **Y-POS. I** trace position is set within the screen. This allows you to determine the 0 Volt reference position at any time.

Attention!
In XY mode the 0 Volt reference symbol is automatically switched off.

STORAGE MODE ONLY
The **Y-POS. I** control knob can also be used for shifting the position of a signal stored with **HOLD** in vertical direction. Additional information relating to this operation is described under **HOLD** (**7**).

(15) Y-POS. II – Control knob with two functions.

The vertical trace position of channel II can be set with this control knob. In **ADD** (addition) mode both (**Y-POS. I** and **Y-POS. II**) control knobs are active. If the instrument is set to analog **XY** mode this control knob is inactive and the **X-POS**. knob must be used to shift trace horizontally.

If automatic triggering **(AT)** is present and the input is set to **GD (38)**, the vertical trace position corresponds with 0 Volt (reference) at the input and can be set to any suitable position. In **ADD** mode these conditions apply to both channels. After switching **GD** off and selecting DC input coupling it is possible to determine the DC content of a signal by comparing the actual Y position with the previously determined 0 Volt Y position.

Y-POS. II Symbol
Provided that the readout is displayed and **"DC REFERENCE = ON"** is selected in the **"SETUP"** submenu **"MISCELLANEOUS"** the 0 Volt reference position is indicated by a ground (⊥) symbol. For channel II this symbol is displayed on the right of the vertical (graticule) center line, if the **Y-POS. II** trace position is set within the screen. This allows you to determine the 0 Volt reference position at any time.

Attention!
In XY mode the 0 Volt reference symbol is automatically switched off.

STORAGE MODE ONLY

In contrast to analog mode the **Y-POS. II** knob must be used for **X position shift** in storage **XY** mode and the **X-POS.** knob is disabled. The **Y-POS. II** control knob can also be used for shifting the position of a signal stored with **HOLD**. Additional information relating to this operation is described under **HOLD** (**7**).

(16) NM - AT - ⎍ (SLOPE)- Pushbutton with a double function and associated **NM-LED**.

The following description assumes that **Yt** (time base) mode has been chosen.

NM - AT selection
Press and hold the pushbutton to switch over from automatic to normal triggering (**NM**-LED above the pushbutton lit) and vice versa. If the LED is dark, automatic triggering is selected.

Whether the peak value detection in automatic trigger mode is automatically activated or not, depends on the trigger coupling setting (**TRIG.MODE (27)**). The way the trigger point symbol in the readout responds on different LEVEL control knob settings indicates the situation:

1. If the trigger symbol can not be shifted in the vertical direction when no signal is applied or the signal height is not sufficient, the peak value detection is active.

2. Under the condition that the trigger point symbol cannot be shifted in such a way that it leaves the signal display on the screen, the peak value detection is active.

3. The peak value detection is switched off if the trigger point can be set outside the maximum peak values of the signal, thus causing an untriggered signal display.

Slope selection
Briefly pressing this pushbutton selects which slope of the signal is used for triggering the time base generator. Each time this pushbutton is briefly pressed, the slope direction switches from falling edge to rising edge and vice versa. The current setting is displayed in the readout by a slope symbol.

AT/NM and ⎍ **(SLOPE)**
The current time base mode determines the pushbutton function:

a) **A** time base mode: Both functions affect the **A** time base only.
b) **alternate** time base mode, with **B** in free run condition: Both functions affect the **A** time base only.
c) **alternate** time base mode, with **B** in triggered **(DEL.-TRIG.)** condition: **B** time base **SLOPE** selection only.
d) **B** time base in free run condition: Both functions affect the - not displayed - **A** time base.
e) **B** time base in triggered **(DEL.TRIG.)** condition: **B** time base **SLOPE** selection only.

Function settings which are not accessible in the current operating conditions remain unchanged.

Attention!
In digital mode, the operating conditions described under item c) are not available.

(17) TR - Trigger indicator LED

The **TR LED** is lit in **Yt** (time base) mode if the triggering conditions are met. Whether the LED flashes or is lit constantly depends on the frequency of the trigger signal.

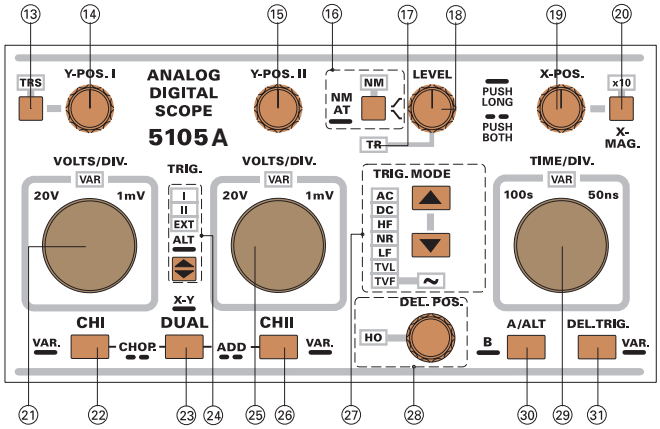
(18) LEVEL – Control knob

Turning the control knob causes a different trigger point setting (voltage). The trigger unit starts the time base when the edge of a trigger signal (voltage) crosses the trigger point. In most **Yt** modes the trigger point is displayed in the readout by the symbol on the left vertical graticule line. If the trigger point symbol would overwrite other readout information or would be invisible when being set above or below the screen, the symbol changes and an arrow indicates in which vertical direction the trigger point has left the screen.

The trigger point symbol is automatically switched off in those modes where there is no direct relation between the trigger signal and the displayed signal. The last setting in **A** time base mode is stored and still active if the alternate (**A and B**) or **B** time base are selected.

This allows for a different level setting for the **B** time base if the **DEL. TRIG.** function is active. Under this condition the letter **"B"** is added to the trigger point symbol.

STORAGE MODE ONLY
In storage mode the trigger point symbol also indicates the post or pre trigger condition by a horizontal position shift. **Please note "PTR" (8)**.



(19) X-POS. – Control knob

This control knob enables an **X** position shift of the signal(s) in **Yt** and **analog XY** mode. In combination with X magnification x10 this function makes it possible to shift any part of the (Yt) signal on the screen.

STORAGE MODE ONLY
In **XY** mode the **X-POS.** knob is inoperative. The **Y-POS. II** (**15**) knob must be used for X position shift.

(20) X-MAG. x10 – Pushbutton and LED

Each time this pushbutton is pressed the **x10** LED is switched on or off. If the **x10** LED is lit,
the signal display in all Yt and time base modes is expanded 10 fold and consequently only a tenth part of the signal curve is visible. The relevant part of the signal can be made visible with aid of the **X-POS.** control. As the X expansion results in a higher time base speed (lower time deflection coefficient), all time and frequency relevant information in the readout is switched over. Please note that in alternate time base mode the intensified sector may become invisible due to the X position setting.

This pushbutton is not operative in XY mode.

(21) VOLTS/DIV. – Control knob.

This control knob for **channel I** has a double function. The following description relates to the input attenuator function (**VAR** LED dark).

Turning the control knob clockwise increases the sensitivity in a 1-2-5 sequence and decreases it if turned

in the opposite direction (ccw.). The available range is from 1mV/div up to 20V/div. The knob is automatically switched inactive if the channel related to it is switched off, or if the input coupling is set to GD (ground).

The deflection coefficients and additional information regarding the active channels are displayed in the readout, i.e. "**Y1: deflection coefficient, input coupling**". **The** " **:** " symbolizes calibrated measuring conditions and is replaced by the " **>** " symbol in uncalibrated conditions.

In **DUAL, ADD** (addition) and **XY** mode both deflection coefficients etc. are displayed. Instead of **"Y1:..."** and **"Y2:..."** the readout displays **"Y:..."** and **"X:..."** in **XY** mode.

(22) CH I
VAR. - Pushbutton with several functions

CHI
Briefly pressing the pushbutton sets the instrument to channel I (**Mono CH I**) mode. The deflection coefficient displayed in the readout indicates the current conditions (**"Y1..."**). If neither external nor line (main) triggering was active, the internal trigger source automatically switches over to channel I (**"TR:Y1..."**). The last function setting of the **VOLTS/ DIV (21)** knob remains unchanged.

All channel related controls are active if **INPUT CHI (32)** is not set to **GD (34)**.

VAR.
Pressing and holding this pushbutton selects the **VOLTS/ DIV. (21)** control knob function between attenuator and vernier (variable). The current setting is displayed by the **VAR-**LED located above the knob.

After switching the **VAR-LED (21)** on, the deflection coefficient is still calibrated. Turning the **VOLTS/ DIV. (21)** control knob counter clockwise reduces the signal height and the deflection coefficient becomes uncalibrated. The readout then displays i.e. "**Y1>...**" indicating the uncalibrated condition instead of "**Y1:...**" . Pressing and holding the **CHI** pushbutton again switches the LED off, sets the deflection coefficient into calibrated condition and activates the attenuator function. The previous vernier setting will not be stored.

The **CHI** pushbutton can also be pressed simultaneously with the **DUAL(23) pushbutton**. **Please note item (23)**.

(23) DUAL - Pushbutton with multiple functions

DUAL
Briefly pressing this pushbutton switches over to DUAL mode. Then both deflection coefficients are displayed. The previous trigger setting stays as it was, but can be changed.

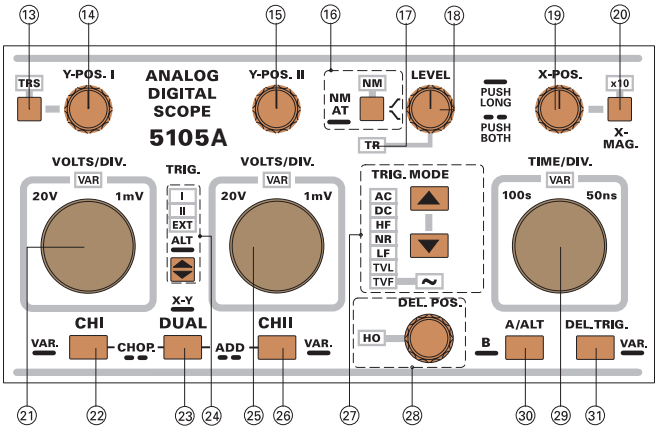
All controls related to both channels are active, if the inputs **(32)** and **(36)** are not set to **GD (34) (38)**.

Whether alternated or chopped channel switching is present in analog mode depends on the actual time base setting, and is displayed in the readout.

ALT (analog mode only)
displayed in the readout, indicates alternate channel switching. After each time base sweep the instrument internally switches over from channel I to channel II and vice versa. This channel switching mode is automatically selected if any time coefficient from 200µs/div to 50ns/ div is active.

CHP (analog mode only)
indicates chopper mode, whereby the channel switching occurs constantly between channel I and II during each sweep. This channel switching mode occurs when any time base setting between 500ms/div to 500µs/div has been chosen.

The actual channel switching can be changed to the opposite mode by briefly pressing both **CHI (22)** and **DUAL (23)** simultaneously. If afterwards the time coefficient is changed, the channel switching is automatically set to the time coefficient related mode.



STORAGE MODE ONLY
In DUAL storage mode the signal capture is performed by both A/D converters. As there is no requirement to select between ALT and CHP, the selection is switched off. The readout then displays the current signal capture and display mode.

ADD
(addition) mode can be selected by briefly pressing the **DUAL (23)** and **CHII (26) pushbutton**s simultaneously. Whether the algebraic sum (addition) or the difference (subtraction) of both input signals is displayed, depends on the phase relationship and the **INV (34) (38)** setting(s). As a result both signals are displayed as one signal. For correct measurements the deflection coefficients for both channels must be equal.
Please note "Operating modes of the vertical amplifiers in Yt mode".

In ADD mode the readout indicates a "**+**" sign located between both channel deflection coefficients. The trigger point symbol is switched off.

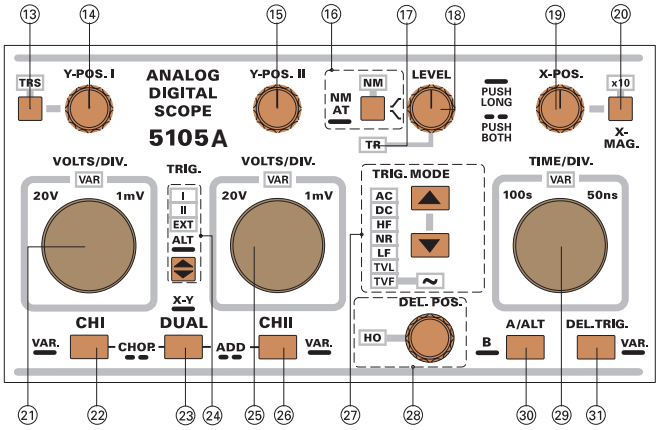
The Y -position of the signal can be influenced by both **Y-POS** controls **(14)** and **(15)**.

XY (analog mode)
mode can be switched on or off by pressing and holding the **DUAL pushbutton (23)**.

In **XY** mode the deflection coefficients are displayed as **"Y..."** for channel I and "**X**...") for channel II, followed by **"XY"**. Except the cursor lines which may be active and cause the display of the voltage measurement, all other readout information including the trigger point symbol are switched off. In addition to all trigger and time base related controls, the **Y-POS. II (15)** knob and **INV (38) pushbutton** are deactivated. For X position alteration, the **X-POS. (19)** knob can be used.

STORAGE MODE ONLY
In **XY** storage mode the readout indicates **"XY"** and the **RFR LED (9)** is lit. No other STOR. MODE can be chosen. Instead of the time deflection coefficient, the readout displays the sampling rate (e.g. " 100MS/s") which can be selected by the **TIME/DIV.** knob **(29)**.

In contrast to analog mode, the **INV. (38)** pushbutton is active and the X signal can be inverted. Also the **Y-POS. II (15)** knob must be used for X position shift instead of the **X-POS. (19)** control. If **HOLD** is active, the current **XY** signal can be moved in **X (Y-POS. II)** and **Y (Y-POS. I)** direction.



(24) TRIG.
ALT- Pushbutton with double function and associated LEDs.

The pushbutton and the LEDs are deactivated in XY mode and if line (mains) triggering is selected.

TRIG.
With the aid of this pushbutton, the trigger source can be chosen. There are three trigger sources available:

channel I, channel II (both designated as internal trigger sources) and the **TRIG. EXT. (39)** input for external triggering. The availability of the internal sources depends on the actual channel mode. The actual setting is indicated by the associated LED(s) and the readout.

Briefly pressing the pushbutton switches over in the following sequence:
I - II - EXT - I in DUAL mode,
I - EXT - I if mono channel I is present,
II - EXT - II under mono channel II conditions.

Each condition is indicated by the associated LED and displayed by the readout (**"TR:Y1..."**, **"TR:Y2..."** and **"TR:EXT..."**). The trigger point symbol is switched off in external trigger condition.

ALT
Pressing and holding the pushbutton selects alternate triggering in DUAL mode. Under these conditions both **I** and **II** LEDs lite and the readout displays **"TR:ALT.."**. As alternate triggering requires alternate channel operation in analog mode, alternate channel switching is set automatically. A change of the time base then has no affect regarding the channel switching mode. In addition to the deflection coefficients display, **"ALT"** is displayed by the readout instead of **"CHP"** if analog mode is present.

In alternate trigger mode the trigger point symbol is switched off. **TVL**, **TVF** trigger coupling and line (~) triggering can not be selected.

Alternate triggering is not available or automatically switched off under the following conditions:

SINGLE (SGL) mode
ADD (addition) mode,
alternate (A & B) time base mode,
B time base mode and
line (mains) trigger coupling.

STORAGE MODE ONLY
In **ROLL** mode the signal capture is untriggered. Consequently alternate triggering is not available.

(25) VOLTS/DIV. – Control knob

This control knob for **channel II** has a double function. The following description relates to the input attenuator function (**VAR** LED dark).

Turning the control knob clockwise increases the sensitivity in a 1-2-5 sequence and decreases it if turned in the opposite direction (ccw.). The available range is from 1mV/div up to 20V/div. The knob is automatically switched inactive if the channel related to it is switched off, or if the input coupling is set to GD (ground).

The deflection coefficients and additional information regarding the active channels are displayed in the readout, i.e. **"Y2: deflection coefficient, input coupling"**. The **" : "** symbolizes calibrated measuring conditions and is replaced by the " **>** " symbol in uncalibrated conditions.

In **DUAL**, **ADD** (addition) and **XY** mode both deflection coefficients etc. are displayed. Instead of **"Y1:..."** and **"Y2:..."** the readout displays **"Y:..."** and **"X:..."** in XY mode.

(26) CH II
VAR. - Pushbutton with several functions.

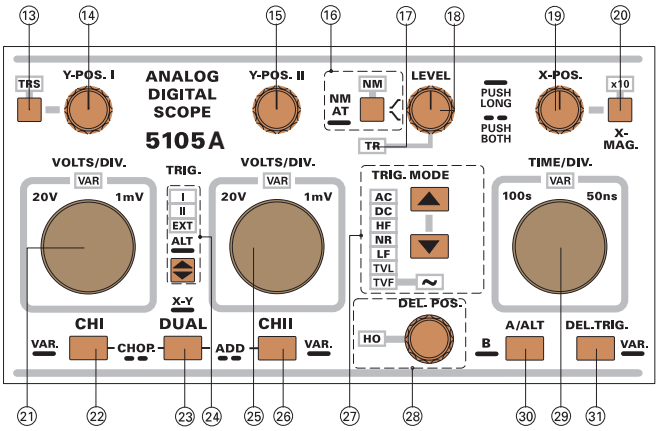
Channel mode
Briefly pressing the pushbutton sets the instrument to **channel II (Mono CH II)** mode. The deflection coefficient displayed in the readout indicates the current conditions (**"Y2..."**). If neither external nor line (main) triggering was active, the internal trigger source automatically switches over to channel II (**"TR:Y2..."**). The last function setting of the **VOLTS/DIV (25)** knob remains unchanged.

All channel related controls are active if **INPUT CHII (36)** is not set to **GD (38)**.

VAR.
Pressing and holding this pushbutton selects the **VOLTS/DIV. (25)** control knob function between attenuator and vernier (variable). The current setting is displayed by the **VAR-**LED located above the knob.

After switching the **VAR-LED (25)** on, the deflection coefficient is still calibrated. Turning the **VOLTS/DIV. (25)** control knob counter clockwise reduces the signal height and the deflection coefficient becomes uncalibrated. The readout then displays i.e. **"Y2>..."** indicating the uncalibrated condition instead of **"Y2:..."**. Pressing and holding the **CHII** pushbutton again switches the LED off, sets the deflection coefficient into calibrated condition and activates the attenuator function. The previous vernier setting will not be stored.

The **CHII** pushbutton can also be pressed simultaneously with the **DUAL (23) pushbutton**. Please note item **(23)**.



(27) TRIG. MODE - Pushbutton with double function and indicator LEDs.

Pressing the upper or lower pushbutton selects the **trigger coupling**. The actual setting is indicated by a LED and by the readout ("**TR: source, slope, AC**").

Each time the lower **TRIG. MODE** pushbutton is pressed the trigger coupling changes in the sequence:

AC (DC content suppressed),
DC (peak value detection inactive),
HF (high-pass filter cuts off frequencies below approx. 50kHz)
trigger point symbol switched off,
NR (high frequency noise rejected),
LF (low-pass filter cuts off frequencies above approx. 1.5kHz),
TVL (TV signal, line pulse triggering)
trigger point symbol switched off,
TVF (TV signal, frame pulse triggering)
trigger point symbol switched off.
~ (line/mains triggering) trigger point symbol and **TRIG.** LEDs **(24)** switched off.
The readout displays "**TR:~**". The ~ symbol can be changed by 180° by using the trigger slope function (**NM/AT - (16)**).

Please note:
In delay trigger mode (B time base) the instrument is automatically set to DC trigger coupling. This setting can not be changed with the TRIG. MODE pushbuttons.

In some trigger modes such as alternate triggering, some trigger coupling modes are automatically disabled and can not be selected.

This trigger mode is present if the trigger coupling information in the trigger point symbol is inactive in line/main trigger mode as there is no direct amplitude relationship between the trigger voltage and the signal voltage.

(28) DEL.POS.
HO –LED - Control knob with two functions and associated LED.

The function of this control knob depends on the time base mode.

HO (hold off)
In A time base mode, the control knob applies to the hold off time setting. If the **HO**-LED associated with the knob is dark, the hold off time is set to minimum.

Turning the control knob clockwise switches the LED on and extends the hold off time until the maximum is reached (please note "Hold Off-time adjustment"). The hold off time is automatically set to minimum (LED dark), if the A time base setting is changed. The last hold off time setting is stored if alternate (A and B) or B time base mode is selected.

DEL.POS.
In **alternate** (A and B) and **B** time base modes, the knob controls the delay time setting. Under alternate time base mode conditions, the delay time is visible on the A trace, beginning at the trace start and ending at the start of the intensified sector. In the free run condition (delay trigger not active) of the **B** time base, an approximate value is displayed in the readout ("**Dt:...**"). This is an aid to find the position of the intensified sector which may be very small.

If only the **B** time base is being operated, the delay time can be varied, but there is no intensified sector as the A trace is not visible.

STORAGE MODE ONLY
The HOLD OFF function is not available in storage mode.

(29) TIME/DIV. - Control knob with two functions.

The following description applies to the time base switch function (**VAR** LED dark).

ANALOG MODE
Turning the control knob clockwise reduces the deflection coefficient in a 1-2-5 sequence and increases it if turned in the opposite direction (ccw.). The time coefficient(s) is (are) displayed in the readout.

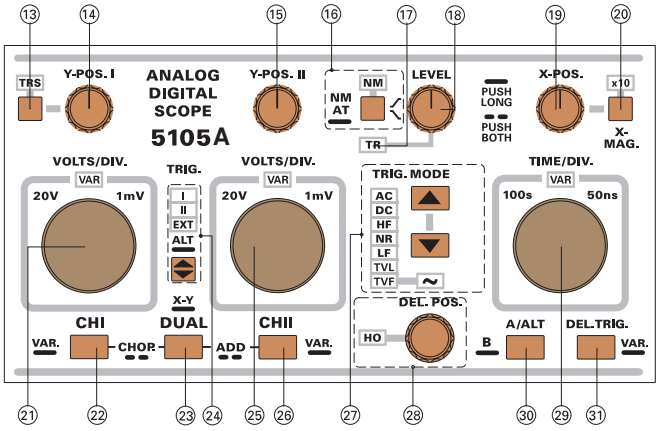
In **A** time base mode, time deflection coefficients between 500ms/div and 50ns/div can be chosen in 1-2-5 sequence, if the X-MAG. x10 function is not activated. During alternate **(A and B)** and **B** time base operation, the control knob changes the B time base setting in 1-2-5 sequence. The available deflection coefficient range is from 20ms/div up to 50ns/div (without X-MAG. x10) but the availability depends on the **A** time base setting. The internal control of the oscilloscope prevents the **B** time deflection coefficient from becoming higher than the **A** deflection coefficient, as such an operation condition would make no sense. If the **A** time base setting is 200µs/div the **B** time base range from 20ms/div up to 500µs/div is not available and the maximum time deflection coefficient for **B** would be 200µs/div. In the last named condition the change of the **A** time base from 200µs/div to 100µs/div switches the **B** time base also to 100µs/div. However the **B** time base setting remains unchanged if the **A** time base is set to 500µs/div.

As already mentioned under **DUAL (23)** the channel switching depends on the time deflection coefficient setting. In the time base ranges from 500ms/div to 500µs/div chopped **(CHP)** channel switching is automatically selected, through which the switching occurs constantly during the time base sweeps. Alternate **(ALT)** channel switching is automatically used in all other time deflection coefficient settings (200µs/div - 50ns/div). In the latter case the active channel is switched off and the previously inactive channel is switched on after the completion of each time base sweep. To avoid interference in chopped mode, or to make both channels appear simultaneously visible, the actual setting **(ALT**

or CHP) displayed in the readout can be overwritten and changed to the opposite mode. This is carried out by simultaneously pressing and holding the **CHI (22)** and the **DUAL (23)** pushbutton.

STORAGE MODE ONLY
The time deflection ranges are different in storage mode and therefore must be considered (**please note item (7)**). In **DUAL** mode a selection between **alternate** or **chopped** signal capture is **neither required nor possible**. Consequently the readout does not display such information **(ALT, CHP)**.

In **XY** storage mode the **TIME/DIV.** knob is still active. It is used to determine the sampling rate, which is then displayed by the readout.



(30) A/ALT-
B - Pushbutton with multiple function.

The instrument contains two time bases designated **A** and **B**. With the aid of the **B** time base, signal parts displayed by the **A** time base can be expanded in X direction. The expansion ratio depends on the time deflection coefficient ratio of both time bases (i.e. **"A: 100µs"**, **"B:1µs" = 100**). With higher expansion ratios the **B** time base trace intensity reduces if analog mode is active.

SINGLE (SGL) event signal capture mode is enabled in **A** time base mode only.

A/ALT function**:**
Each time the **A/ALT- B** pushbutton is briefly pressed, the time base mode changes in the sequence **A** – **alternate** - **A**.

A
In **A** time base mode the **TIME/DIV. (29)** control knob is operative only for this time base. The readout then only displays the **A** time coefficient. The time base settings for this condition are stored if the time base mode is changed.

ALT
If **alternate (ALT)** time base mode is selected, the **TIME/DIV (29)** knob only controls the **B** time base.

The alternate time base mode is a sub function of the **B** time base mode where both time base traces are displayed. Consequently the readout displays both time deflection coefficients (e.g. **"A:100µs B:1µs"**). Unlike the former **A** time base mode, an intensified sector is also visible on the **A** trace. This sector indicates the signal part which is displayed by the **B** time base. The intensified segment can be shifted horizontally by the **DEL. POS. (28)** control knob continuously (if the B time base is operated in free run conditions). The difference between the start of the **A** time base trace and the beginning of the intensified sector shows the delay time. This information is also displayed in the readout as an approximate value (e.g. **"Dt:2.5ms"**) related to the calibrated **A** time coefficient (uncalibrated i.e. **"Dt> 2.5ms"**). The width of the segment decreases when the B time coefficient is set to a lower value (higher time deflection speed).

Alternate time base mode causes the display to alter between **A** and **B** time base after each sweep (analog mode). In alternate **DUAL** mode the sequence is channel I with **A** time base, **channel I** with **B** time base, **channel II** with **A** time base and **channel II** with **B** time base.

For better reading, the vertical position of the **B** trace position can be shifted (**please note "TRS" (13)**).

B function**:**
Pressing and holding the pushbutton switches between **A** or **alternate** time base mode to **B** time base mode and vice versa.

In **B** time base mode the display of the **A** trace(s), the intensified sector(s) and the **A** time coefficient display in the readout are disabled. As the trace separation **(TRS)** is no longer required under these circumstances, this function is switched off too. Consequently only the **B** time coefficient is displayed by the readout.

Briefly pressing the pushbutton switches **B** time base mode off and **A** time base mode on. Pressing and holding the pushbutton switches over from **B** to **alternate** time base mode.

STORAGE MODE ONLY
In the combination of storage mode and **alternate** or **B** time base operation, the pre- and post trigger are automatically switched off. The **PTR (8) pushbutton** is deactivated and instead of a pre- or post trigger value the readout displays the delay time.

ROLL mode is not available in **alternate** or **B** time base mode.

(31) DEL. TRIG.
VAR. - Pushbutton with double function.

DEL. TRIG. function**:**

ANALOG MODE ONLY
Each time the pushbutton is briefly pressed, the instrument switches between free run (untriggered) and triggered **B** time base, if **alternate** or **B** time base mode is present.

DIGITAL MODE ONLY
In contrast to analog operation the **B** time base can not be triggered in **alternate** time base mode.

ANALOG and DIGITAL MODE
The actual setting is displayed in the readout. Instead of the approximate delay time (**"Dt:..."**) in free run mode, the readout displays **"DTr: slope, DC (trigger coupling)"** in triggered delay mode. In this mode, the former **A** time base trigger settings regarding the trigger mode (automatic or normal), -coupling, -slope and -level settings are stored but still active.

With the activated delay trigger the instrument is automatically set to normal **(NM)** trigger mode and **DC**

trigger coupling for the **B** time base. As the instrument contains a separate trigger unit for the **B** time base, the trigger level and slope can be set independently using the same controls used before for the **A** time base trigger setting. The trigger point is indicated again but has the added letter **B** in the readout.

In delay trigger mode **(DEL.TRIG.)**, the delay signal first must elapse. Then the next suitable signal slope (direction and height) starts the **B** time base. If those basic requirements are not met, the trace is blanked in analog mode and the signal acquisition is stopped in digital mode. Under the condition that the signal contains several suitable slopes after the delay time, it can be seen in alternate time base mode that the delay time setting **(DEL. POS.)** now causes the intensified sector to jump from one slope to the other.

VAR.

ANALOG MODE ONLY
Pressing and holding the **DEL.TRIG. - VAR.** pushbutton selects the **TIME/DIV. (29)** control knob function between time base switch and vernier (variable). The current setting is displayed by the **VAR-**LED located above the knob.

The variable function can be activated for the **A** time base or the **B** time base, the settings are stored separately. As **alternate** time base mode is a **B** time base sub mode, only the **B** time base is affected in this operation.

A time base:
After switching the **VAR**-LED on, the time deflection coefficient is still calibrated. Turning the **TIME/DIV. (29)** control knob counter clockwise increases the time deflection coefficient (reduces the deflection speed) and the deflection coefficient becomes uncalibrated. Instead of e.g. "**A:**10µs", the readout then displays "**A>**10µs" indicating the uncalibrated condition.

This setting is stored if the instrument is switched to **alternate** or **B** time base mode.

Pressing and holding the **DEL.TRIG. - VAR.** pushbutton again in **A** time base mode switches the **VAR.**-LED off, the time base switch function on, and sets the time deflection coefficient back into the calibrated condition.

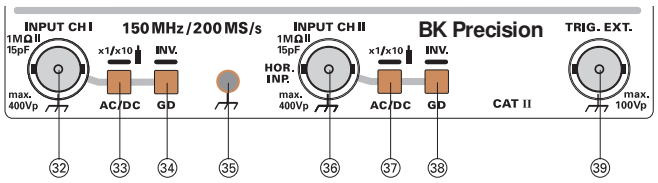
ALTERNATE or **B** time base**.**
In **alternate** as well as in **B** time base mode, pressing and holding the **DEL.TRIG. - VAR.** pushbutton selects the **TIME/DIV.** knob function between **B** time base switch and **B** vernier (**VAR**. -LED on). In the latter case the **TIME/DIV.** knob can be used in the same way as described before under **A** time base condition.

STORAGE MODE ONLY
Pressing and holding the **DEL.TRIG. - VAR.** pushbutton causes no reaction, as a variable time deflection coefficient setting is not possible in storage mode.

Underneath the front panel sector described before, the BNC sockets and four pushbuttons are located.

(32) INPUT CH I – BNC socket.

This BNC socket is the signal input for **channel I**. In **XY** mode, signals at this input are used for the **Y** deflection. The outer (ground) connection is galvanically connected to the instrument ground and consequently to the safety earth contact of the line/main plug.



(33) AC / **DC** - Pushbutton with two functions.

Input coupling:
Briefly pressing this pushbutton switches over from **AC** (~ symbol) to **DC** (**=** symbol) input coupling and vice versa, if the **INPUT CHI (32)** is not switched to **GD (34)**. The **AC/DC** setting is displayed in the readout with the deflection coefficient.

Probe factor:
Pressing and holding the pushbutton selects the indicated deflection coefficient of channel I displayed in the readout, between **1:1** and **10:1**. In condition 10:1 the probe factor is thus indicated by a probe symbol displayed by the readout in front the channel information (e.g. **"probe symbol"**, **Y1...**). In the case of cursor voltage measurement, the probe factor is automatically included.

Please note:
The probe symbol should not be activated unless a x10 (10:1) attenuator probe is used.

(34) GD
INV. - Pushbutton with two functions.

GD
Each time this pushbutton is pressed briefly, the **INPUT CHI** is switched from active to inactive and vice versa. It is displayed in the readout as an earth (ground) symbol instead of the deflection coefficient and the **~ (AC)** or **= (DC)** symbol.

The **GD** setting disables the input signal, the **AC/DC (33)** input coupling selection and the **VOLTS/DIV (21)** knob. In automatic trigger mode the undeflected trace is visible representing the " 0 Volt" trace position. See **Y-POS. I (14)**.

INV.
Pressing and holding this pushbutton switches the channel I invert **(INV.)** function on or off. The invert " on" condition is indicated by the readout with a horizontal bar above **"Y1"** (Yt mode) or **"Y"** (XY mode). The invert function causes the signal display of channel I to be inverted by 180°.

(35) Ground socket - 4mm banana jack galvanically connected to safety earth.

This socket can be used as a reference potential connection for DC and low frequency signal measurement purposes and in COMPONENT TEST mode.

(36) INPUT CH II – BNC socket.

This BNC socket is the signal input for **channel II**. In **XY** mode, signals at this input are used for the **X** deflection. The outer (ground) connection is galvanically connected to the instrument ground and consequently to the safety earth contact of the line/main plug.

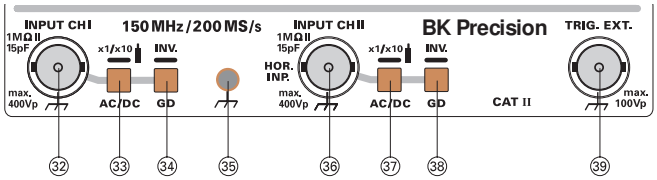
(37) AC / **DC** - Pushbutton with two functions.

Input coupling:
Briefly pressing this pushbutton switches over from **AC**

(~ symbol) to **DC** (= symbol) input coupling and vice versa, if the **INPUT CHII (36)** is not switched to **GD (38)**. The **AC/DC** setting is displayed in the readout with the deflection coefficient.

Probe factor:
Pressing and holding the pushbutton selects the indicated deflection coefficient of channel I displayed in the readout, between **1:1** and **10:1**. In condition 10:1 the probe factor is thus indicated by a probe symbol displayed by the readout in front the channel information (e.g. **"probe symbol"**, **Y2...**). In the case of cursor voltage measurement, the probe factor is automatically included.

Please note:
The probe symbol should not be activated unless a x10 (10:1) attenuator probe is used.



(38) GD
INV. - Pushbutton with two functions.

GD
Each time this pushbutton is pressed briefly, the **INPUT CHII** is switched from active to inactive and vice versa. It is displayed in the readout as an earth (ground) symbol instead of the deflection coefficient and the **~ (AC)** or **= (DC)** symbol.

The **GD** setting disables the input signal, the **AC/DC (37)** input coupling selection and the **VOLTS/DIV (25)** knob. In automatic trigger mode the undeflected trace is visible representing the "0 Volt" trace position. See **Y-POS. II (15)**.

INV.
STORAGE MODE
Pressing and holding this pushbutton switches the channel II invert **(INV.)** function on or off. The invert "on" condition is indicated by the readout with a horizontal bar above **"Y2"** (Yt mode) or **"X"** (XY mode). The invert function causes the signal display of channel I to be inverted by 180°.

ANALOG MODE
The invert function is not available in **XY** mode.

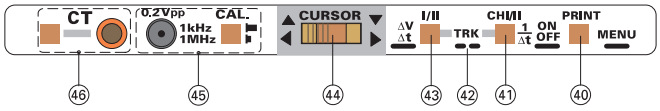
(39) TRIG. EXT. – BNC socket.

This BNC socket is the external trigger signal input. Briefly pressing the **TRIG. (24)** pushbutton (until the information "TR:**EXT**, slope, coupling" is visible in the readout and the **EXT**-LED is lit) switches the input active.

The trigger coupling depends on the **TRIG. MODE (27)** setting. If external triggering is active line/mains (~) triggering is not available

The outer (ground) connection is galvanically connected to the instrument ground and consequently to the safety earth contact of the line/mains plug.

Below the CRT there are the controls for the readout, the component tester and the square wave calibrator with their outputs.



Please note:
The following description of the cursor related controls assumes that the readout is visible and component test is inactive.

(40) PRINT / MENU - Pushbutton with 2 functions.

STORAGE MODE ONLY
PRINT
Briefly pressing the pushbutton starts a document (hardcopy) if the following preconditions are met:

1. The oscilloscope must be connected to the external **B&K** interface **HO79-6**.

2. The software version installed in **HO79-6** should not be < V2.00.

The device used for documentation (e.g. printer, plotter) must be connected with one of the **HO79-6** ports. The document includes the signal display, the graticule, the measurement parameters and additional information such as oscilloscope type and **HO79-6** software version. The **PRINT** function replaces the actuation of the **HO79-6 "START"** pushbutton, which may not be accessible (e.g. rack mount).

For further information please note the HO79-6 manual.

ANALOG and DIGITAL MODE

MENU
Pressing and holding the pushbutton activates the display of the **MAIN MENU**. It contains the submenus **SETUP**, **CALIBRATE** and **HO79** if connected.

Once a menu is displayed, the following pushbuttons are of importance:

1. **SAVE** and **RECALL (12)** pushbutton.
   Briefly pressing save or recall selects the submenu or an item within the submenu.

2. **SAVE (12)** pushbutton **SET** function.
   Pressing and holding the **SAVE (12)** pushbutton calls (sets) the menu or the previously selected item. In those cases where the item is marked with **ON / OFF** the setting changes from **ON** to **OFF** or vice versa.

   In some cases the called function is not performed at once and a warning is displayed to protect from calling the function inadvertently. Then the function can be called by pressing and holding the **SAVE** pushbutton (**SET function**) again, otherwise if the function is called inadvertently the proceeding can be cancelled by pressing the **AUTOSET (2)** pushbutton.

3. **AUTOSET (2)** pushbutton.
   Each time the **AUTOSET** pushbutton is pressed the menu is switched back one step until **MAIN MENU** is displayed. Then pressing the **AUTOSET** pushbutton again switches the menu operation off and the **AUTOSET** is automatically set to the normal function.

(41) ON/OFF –
CHI/II –
1/Δt - Pushbutton with several functions.

ON/OFF
Pressing and holding the pushbutton switches both **CURSOR** lines on or off. As the cursor lines are part of the readout, they are visible only if the readout is switched on.

CHI/II
This function is required and available only in **DUAL** and **XY** mode if **ΔV (43)** measurement is active.

Briefly pressing the pushbutton selects between the deflection coefficients of channel I and channel II. The actual setting is part of the result displayed as **"ΔV1..."** for channel I or **"ΔV2..."** for channel II. Of course the horizontal cursor lines must be set on the relevant signal. In **XY** mode the instrument is automatically set to **ΔV** measurement. In this mode two signals are normally applied causing an **X** and a **Y** deflection. The deflection coefficient selected for each channel may be different, thus as in DUAL mode the **ΔV** cursor measurement requires a channel selection. Under channel I (Y signal) measuring condition the cursor lines are displayed as horizontal lines and the readout displays **"ΔVY..."**. Briefly pressing the pushbutton changes to channel II (X signal) voltage measurement. Then the cursor lines are displayed as vertical lines and the readout indicates **"ΔVX..."**.

In CHI and CHII mode, only one deflection coefficient is present and there is no requirement to select between different deflection coefficients. Consequently the pushbutton is inactivated in combination with **ΔV** measurements.

1/Δt
If the **ΔV** function is not present, briefly pressing this pushbutton selects between time and frequency measurement which is **not available in XY mode**.

The vertical cursor lines and the measurement result apply to the active time base (**A** or **B**, resp. **B** in alternate time base mode).

In calibrated time base condition the readout displays **"Δt:..."** if time measurement is chosen. After briefly pressing the pushbutton and switching over to **1/Δt** (frequency) **"f:..."** is displayed. If the time base is uncalibrated the readout displays **"Δt>..."** or **"f<..."**.

STORAGE MODE ONLY

Extended CURSOR measurement.

The extended CURSOR measurement functions are available under the following conditions:

1. " EXTENDED CURSOR" in the menu <Setup, Miscellaneous> must be in ON condition.
2. Time base mode must be present.
3. Δt or 1/Δt (f) cursor measurement must be activated.

Briefly pressing the CHI/II – 1/Δt - ON/OFF pushbutton switches from " f " to " Δt " and the following measurement modes until the readout displays " f " again. In all conditions vertical cursor lines are displayed even if voltage measurements are performed.

CX:
Time measurement of the active cursor is related to the trigger point. If the active cursor position is on the left of the trigger symbol, a negative value will be displayed.

ATTENTION!
The following description relates to voltage measurement. To avoid misinterpretation, the measurement functions are available only in mono channel operation (channel I or channel II) and invert (INV) function inactive.

The signal height and position should be set in such a way, that the cursor line(s) is(are) crossing the signal.

CY:
Voltage measurement of the momentary signal value is related to 0 Volt, by the aid of the active cursor.

ΔY:
Shows the relative voltage difference between the signal momentary values, as selected by CURSOR I and CURSOR II.

V↑:
The maximum positive peak value related to 0 Volt will be displayed. Only those signal portions within CURSOR I and CURSOR II will be evaluated.

V↓:
The maximum negative peak value related to 0 Volt will be displayed. Only signal portions within CURSOR I and CURSOR II will be evaluated.

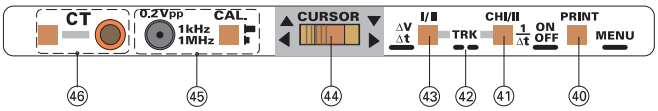
Vpp:
The maximum voltage difference between the maximum positive and negative peak value of the signal within the CURSOR lines will be displayed.

V=:
Shows the arithmetical mean value of the signal between CURSOR I and CURSOR II as related to 0 Volt.

Y~:
Calculates the root mean square value of an AC voltage displayed within the CURSOR lines. If the AC voltage is superimposed on a DC voltage, the DC content will be suppressed even if DC input coupling is present.

$\bar{y}$:
The root mean square value of the signal between the CURSOR lines will be calculated related to 0 Volt and displayed unsigned. AC, DC and AC voltages superimposed on DC voltages are taken into consideration.

Note: DC signals require DC input coupling.



(42) TRK - Track function.

Briefly pressing simultaneously both pushbuttons **ON/OFF - CH I/II - 1/Δt (41)** and **I/II - ΔV/Δt (43)** switches between single cursor line operation to track mode and vice versa.

In **TRK** (track) mode both cursor lines are indicated as active (both dotted lines uninterrupted).

(43) I/II – ΔV / Δt - Pushbutton with two functions.

I/II:
Briefly pressing this pushbutton changes the active

(controllable) cursor in the sequence **I - II - I**, if TRK (track) mode is not active. The active cursor is indicated by a continuously dotted line. An interrupted dotted line indicates the inactive cursor.

ΔV / Δt:
Pressing and holding this pushbutton changes from voltage to time (or frequency) measurement and vice versa. In **XY** mode the instrument is automatically set to **ΔV**, as the time base is disabled and consequently time or frequency measurements can not be performed.

ΔV
Cursor supported voltage measurement can be made in different operating modes. This causes differences.

item 1: Time base mode.

In the voltage measurement mode, the cursors are displayed as horizontal lines and the result is displayed in the readout.

Single channel mode (channel I or channel II)
The **ΔV** measuring result is automatically related to the deflection coefficient of the active channel. The readout displays **"ΔV1..."** or **"ΔV2..."**.

Dual mode
The **CURSOR** lines must be set on the channel I or channel II signal. As the deflection coefficients may be different, it will be required to select between the deflection coefficients of channel I and II. **Please note item CH I/II (41)**.

Addition (ADD) mode
In **ADD** (addition) mode normally two input signals are displayed as one signal (sum or difference). As the result can only be determined if both (calibrated) deflection coefficients are equal, the **CH I/II (41)** selection function is deactivated. In that case the readout indicates **"ΔV..."** without any additional channel information. Different deflection coefficient settings or uncalibrated deflection coefficient(s) are indicated in the readout as **"Y1<>Y2"**.
item 2: XY mode

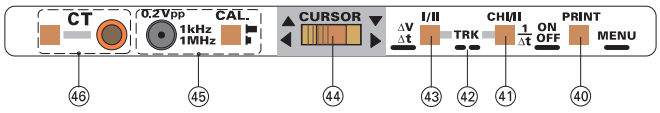
In **XY** mode the instrument is automatically set to **ΔV** measurement. The deflection coefficient selected for each channel may be different, thus as in **DUAL** mode the **ΔV** cursor measurement requires a channel selection (**CHI/II (41)**). Under channel I (Y signal) measuring condition the cursor lines are displayed as horizontal lines and the readout displays **"ΔVY..."**. Briefly pressing the **CHI/II (41)** pushbutton selects channel II (X signal) measuring. Then the cursor lines are displayed as vertical lines and the readout indicates **"ΔVX..."**.

Please note!
In all ΔV (voltage) measurement conditions, the division ratio of the probe(s) must be taken into account. The voltage value displayed in the readout must be multiplied by 100 if e.g. a x100 (100:1) probe is used. In case of x10 (10:1) probes, the probe factor can be automatically included (see AC/DC (33) and AC/DC (37)).

Δt:
In time or frequency measurement condition two vertical cursor lines are displayed. The measurement result is indicated as **"Δt..."** (time measurement) or **"f..."** (frequency measurement). **Please note item (41) 1/Dt.**

NOTE:
For frequency measurement, the distance between the cursors must equal exactly one signal period.

In XY mode the time base is switched off. Consequently time or frequency measurement is disabled.



(44) CURSOR - Center biased lever.

The active cursor line (in track mode: both lines) can be shifted in the selected direction, until the graticule limits are reached. The directions are marked on the front panel and depend on the selected measurement (**ΔV**, **Δt** or **1/Δt**).

Which of two shift speeds is used, depends on how far the **CURSOR** lever is pressed. With slight knob pressure the cursor line(s) moves slowly. If the knob is pressed to the full extent the cursor moves fast. If the knob is released it automatically reverts to the center position and the cursor shift stops.

(45) CAL. - Pushbutton and concentric socket.

A square wave signal of $0.2V_{pp}$ ±1% is available from the socket for probe adjustment purposes.

The signal frequency depends on the pushbutton setting. If the pushbutton is released it is approx 1kHz. If the switch is depressed tje output is 1MHz. The pulse duty factor may deviate from 1:1.

(47) CT - Pushbutton and banana jack.

Pressing the pushbutton switches the instrument between oscilloscope to component test (analog) mode and vice versa.

In component test mode, all controls are inactivated with the exception of the **CT pushbutton**, **AUTO SET (3)** and **INTENS (4)**. All LEDs except "**A**" (associated with the INTENS knob) are dark. The readout displays only "**CT**" in this condition.

One test lead is connected to the CT socket. The second test lead uses the ground socket **(37)**. Please note **"Component Tester".**

The maximum test voltage is approx. 20Vpp under open circuit conditions, while the max. test current under short circuit condition is approx. $20mA_{pp}$.

Menu

The instrument software contains several menus. The controls regarding the menus are described under item **(40) PRINT / MENU** in section "Controls and Readout".

The following menus, submenus and items within the submenus are available:

1. **MAIN MENU** contains:

   1.1 **CALIBRATE**
   Information regarding this can be found in the section "Service Instructions" item "Adjustments".