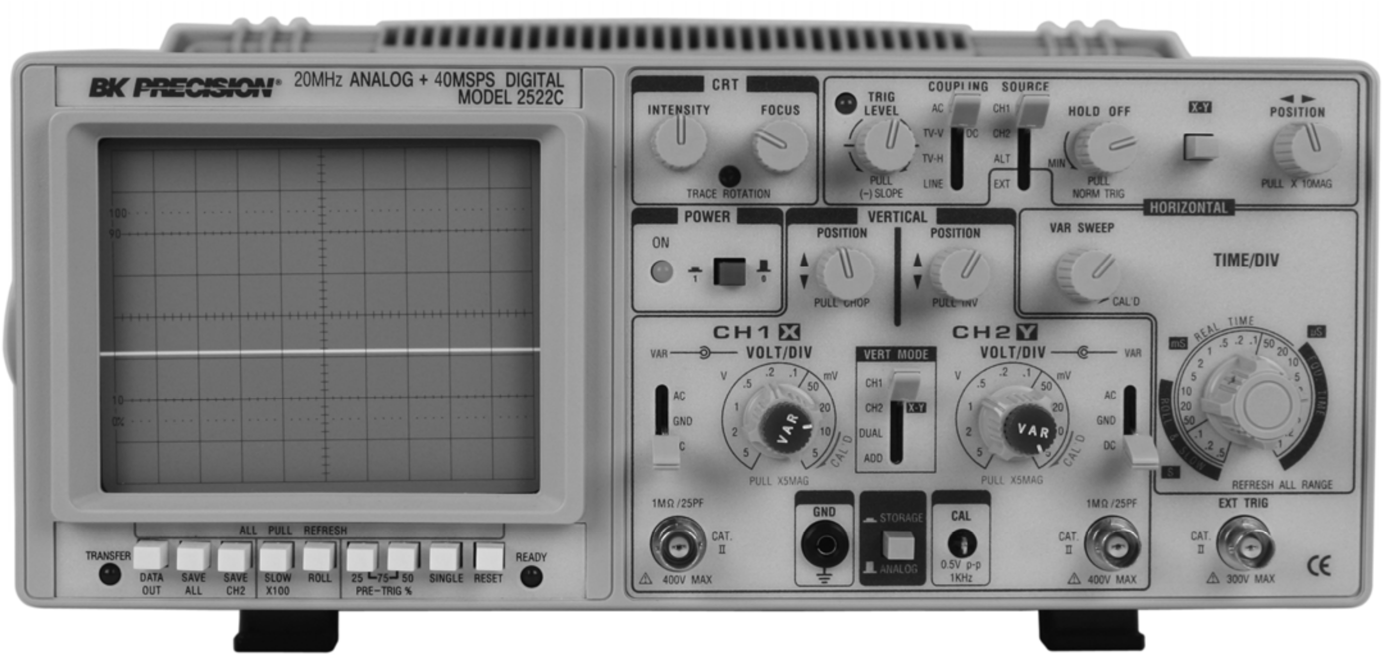
INSTRUCTION MANUAL

B+K PRECISION®

Model 2522C

20 MHz DIGITAL STORAGE/ANALOG OSCILLOSCOPE



TEST INSTRUMENT SAFETY

WARNING

Normal use of test equipment exposes you to a certain amount of danger from electrical shock because testing must often be performed where exposed high voltage is present. An electrical shock causing 10 milliamps of current to pass through the heart will stop most human heartbeats. Voltage as low as 35 volts dc or ac rms should be considered dangerous and hazardous since it can produce a lethal current under certain conditions. Higher voltage poses an even greater threat because such voltage can more easily produce a lethal current. Your normal work habits should include all accepted practices that will prevent contact with exposed high voltage, and that will steer current away from your heart in case of accidental contact with a high voltage. You will significantly reduce the risk factor if you know and observe the following safety precautions:

1. Don't expose high voltage needlessly in the equipment under test. Remove housings and covers only when necessary. Turn off equipment while making test connections in high-voltage circuits. Discharge high-voltage capacitors after removing power.
2. If possible, familiarize yourself with the equipment being tested and the location of its high voltage points. However, remember that high voltage may appear at unexpected points in defective equipment.
3. Use an insulated floor material or a large, insulated floor mat to stand on, and an insulated work surface on which to place equipment; make certain such surfaces are not damp or wet.
4. Use the time-proven "one hand in the pocket" technique while handling an instrument probe. Be particularly careful to avoid contacting a nearby metal object that could provide a good ground return path.
5. When using a probe, touch only the insulated portion. Never touch the exposed tip portion.
6. When testing ac powered equipment, remember that ac line voltage is usually present on some power input circuits such as the on-off switch, fuses, power transformer, etc. any time the equipment is connected to an ac outlet, even if the equipment is turned off.
7. Some equipment with a two-wire ac power cord, including some with polarized power plugs, is the "hot chassis" type. This includes most recent television receivers and audio equipment. A plastic or wooden cabinet insulates the chassis to protect the customer. When the cabinet is removed for servicing, a serious shock hazard exists if the chassis is touched. Not only does this present a dangerous shock hazard, but damage to test instruments or the equipment under test may result from connecting the ground lead of most test instruments (including this oscilloscope) to a "hot chassis". To make measurements in "hot chassis" equipment, always connect an isolation transformer between the ac outlet and the equipment under test. The **B&K Precision** Model TR-1 10 or 1604A Isolation Transformer, or Model 1653A or 1655A AC Power Supply is suitable for most applications. To be on the safe side, treat all two wire ac powered equipment as "hot chassis" unless you are sure it has an isolated chassis or an earth ground chassis.
8. Never work alone. Someone should be nearby to render aid if necessary. Training in CPR (cardio-pulmonary resuscitation) first aid is highly recommended

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FEATURES

LOW COST, HIGH PERFORMANCE

B&K Precision's Model 2522C is one of the lowest cost digital storage oscilloscopes in the industry, yet it includes all the basic features needed by most technicians and engineers. Unlike other digital oscilloscopes, it has a full analog mode with infinite resolution. Digital storage modes include refresh, roll, and single sweep. Equivalent time storage techniques allow storage of repetitive waveforms up to 20 MHz. This oscilloscope is built by and backed by B&K Precision, a company that has been selling reliable, durable, value priced test instruments for over 50 years.

DIGITAL STORAGE FEATURES

High Resolution

2048 samples across the width of the screen (200 samples per division) assures good resolution of stored waveforms. 1024 samples taken at sweep rates of 10 µs/div to 0.1 µs/div.

High Sampling Rate

Sampling Rate up to 40 Ms/s (Megasamples per second) for storing one-time events down to 50 nS.

Slow Event Display

X100 time base selections extend sweep time to 50 seconds/division. Excellent for displaying slow speed events.

Equivalent Time Sampling

Allows repetitive waveforms up to 20 MHz to be stored.

Pretrigger Capture

Permits viewing activity before the trigger occurs. Selectable 0%, 25%, 50%, or 75% pre-trigger view.

CRT FEATURES

Rectangular CRT

Rectangular CRT with large 8 x 10 centimeter viewing area.

Convenience

Trace rotation electrically adjustable from front panel. 0%, 10%, 90%, and 100% markers for rise time measurements.

DUAL TRACE FEATURES

Dual Trace

Model 2522C has two vertical input channels for displaying two waveforms simultaneously. Selectable single trace (either CH 1 or CH 2) or dual trace. Alternate or chop sweep selectable at all sweep rates.

Sum and Difference Capability

Permits algebraic addition or subtraction of channel 1 and channel 2 waveforms, displayed as a single trace. Useful for differential voltage and distortion measurements.

HIGH FREQUENCY FEATURES

Wide Bandwidth

Conservatively-rated 3 dB bandwidth is dc to 20 MHz.

Fast Rise Time

Rise time is less than 18 nS.

Fast Sweep

Maximum sweep speed of 10 nS/div (with X10 MAG) assures high frequencies and short-duration pulses are displayed with high resolution.

VERTICAL FEATURES

High Sensitivity

5 mV/div sensitivity for full bandwidth. High-sensitivity 1 mV/div and 2 mV/div using PULL X5 gain control.

Calibrated Voltage Measurements

Accurate voltage measurements (±3%) on 10 calibrated ranges from 5 mV/div to 5 V/div. Vertical gain fully adjustable between calibrated ranges.

SWEEP FEATURES

Calibrated Time Measurements

Accurate (±3%) time measurements. The main sweep has 21 calibrated ranges from 0.5 s/div to 0.1 S/div. Sweep time is fully adjustable between calibrated ranges.

X10 Sweep Magnification

Allows closer examination of waveforms, increases maximum sweep rate to 10 nS/div.

TRIGGERING FEATURES

Two Trigger Modes

Selectable normal (triggered) or automatic sweep modes.

Triggered Sweep

Sweep remains at rest unless adequate trigger signal is applied. Fully adjustable trigger level and (+) or () slope.

AUTO Sweep

Selectable AUTO sweep provides sweep without trigger input, automatically reverts to triggered sweep operation when adequate trigger is applied.

Five Trigger Sources

Five trigger source selections, including CH 1, CH 2, alternate, EXT, and LINE.

Video Sync

Frame (TV V) or Line (TV H) triggering selectable for observing composite video waveforms. TV-H position can also be used as low frequency reject and TV-V position can be used as high frequency reject.

Variable Holdoff

Trigger inhibit period after end of sweep adjustable. Permits stable observation of complex pulse trains.

OTHER FEATURES

X Y Operation

Channel 1 can be applied as horizontal deflection (X-axis) while channel 2 provides vertical deflection (Y-axis).

Built-in Probe Adjust Square Wave

A 0.5 V p-p, 1 kHz square wave generator permits probe compensation adjustment.

Channel 2 (Y) Output

A buffered 50 Ω output of the channel 2 signal is available at the rear panel for driving a frequency counter or other instruments. The output is 50 mV/div (nominal) into 50 Ω .

Supplied With Two Probes

SPECIFICATIONS

CRT

Type: 6-inch rectangular with integral graticule, P31 phosphor.

Display Area: 8 x 10 div (1 div = 1 cm).

Accelerating Voltage: 2 kV.

Phosphor: P31.

Trace Rotation: Electrical, front panel adjustable.

VERTICAL AMPLIFIERS (CH 1 and CH 2)

Sensitivity: 5 mV/div to 5 V/div, 1 mv/div to 1 V/div at X5 MAG.

Attenuator: 10 calibrated steps in 1-2-5 sequence. Vernier control provides fully adjustable sensitivity between steps; range 1/1 to at least 1/3.

Accuracy: 3%, 5 mV to 5 V/div; 5%, at X5 MAG.

Input Resistance: 1 M 2 % .

Input Capacitance: 25 pF ±10 pF.

Frequency Response:

5 mV/div to 5 V/div:
DC to 20 MHz (- 3 dB).

X5 MAG:
DC to 10 MHz (- 3 dB).

Rise Time:
18 nS; 35 nS atX5 MAG.

Overshoot: Less than 5%.

Operating Modes:

CH 1:	CH 1, single trace.
CH 2:	CH 2, single trace.
DUAL:	CH 1 and CH 2, dual trace. Alternate or Chop selectable at any sweep rate.
ADD:	Algebraic sum of CH 1 + CH 2.

Chop Frequency: Approximately 500 kHz.

Polarity Reversal: CH 2 invert.

Maximum Input Voltage: 400 V (dc + ac peak).

HORIZONTAL AMPLIFIER

(Input through channel 1 input)

X Y mode:
CH 1 = X axis.
CH2 = Y axis.

Sensitivity: Same as vertical channel 2.

Input Impedance: Same as vertical channel 2.

Frequency Response: DC to 1 MHz (- 3 dB).

X-Y Phase Difference: 3° or less at 50 kHz. **Maximum**

Input Voltage: Same as vertical channel 1.

SWEEP SYSTEM

Time Base: 0.1 µS/div to 0.5 S/div in 1-2-5 sequence, 21 steps. Vernier control provides fully adjustable sweep time between steps.

Accuracy: ±3%, except ±20% on 0.1 S/div.

Sweep Magnification: X10 ± 10%.

Holdoff: Continuously adjustable for main time base from NORM to 5 times normal.

TRIGGERING

Trigger Modes:
AUTO (free run), NORM, TV-V, TV-H.

Trigger Source:
CH 1, CH 2, Alternate, EXT, LINE.

Slope:
(+) or (–).

Trigger Coupling:

AUTO:	Sweep free-runs in absence of suitable trigger signal.
NORM:	Sweep triggered only by adequate trigger signal.
TV-V:	Video vertical sync pulses are selected. Also usable for high frequency reject.
TV-H:	Video horizontal sync pulses are selected. Also usable for low frequency reject.

Trigger Sensitivity:

AC: 1.0 div (internal)
≥0.5 Vp-p (external)
30 Hz – 20 MHz

TV-V: 1.0 div (internal)
≥0.5 Vp-p (external)
20 Hz – 20 kHz

TV-H: 1.0 div (internal)
≥0.5 Vp-p (external)
3 kHz – 100 kHz

Maximum External Trigger Voltage: 300 V (dc + ac peak).

DIGITAL STORAGE FACILITIES

Storage Word Size:

2048 x 8 bits/channel (2 k/channel with direct sampling, 1 k/channel with equivalent time sampling).

Vertical Resolution:

8 bit (1 in 256) approximately 25 steps/div.

Horizontal Resolution:

1 in 2048, approximately 200 samples/div.

Sampling Rate:

10 M samples/sec to 4 samples/sec, reduced in proportion to time base. Direct sampling at time base settings of 20 s/div and slower, equivalent time sampling at time base settings of 10 µs/div and faster.

Time Base Expander:

For storage of slow time events, time base steps 10 ms/div and slower have selectable 1/1 or 1/100 rate. 1/100 rate expands time base from 1 sec/div to 50 sec/div in 1-2-5 sequence.

Equivalent Time Sampling Bandwidth:

20 MHz for repetitive waveforms.

Dot Joining:

Linear interpolation between samples.

Digital Display Modes:

Roll:

Stored data and display updated continually.

Refresh:

Stored data and display updated by triggered sweep.

Hold:

Freezes channel 1 and channel 2 data immediately.

Save CH2:

Freezes channel 2 data immediately.

Pretrigger Storage:

Available in single sweep mode, switchable to 0%, 25%, 50%, or 75%.

USB Host Interface

Save screen image to USB flash drive

OTHER SPECIFICATIONS

Cal/Probe Compensation Voltage: 0.5 V p-p ± 3% square wave, 1 kHz nominal.

CH 2 (Y) Output:

Output Voltage: 50 mV/div (nominal into 50 ohm load).

Output Impedance: Approximately 50 ohms.

Frequency Response: 20 Hz to 20 MHz, - 3 dB.

Power Requirements: 100–130 VAC or 200–260 VAC, 5 0/60 Hz, 55 watts.

Dimensions (H 3 W 3 D): 5.2” X 12.8” X 15.7” (132 X 324 X 398 mm).

Weight: 18.7 lbs (8.5 kg).

Environment:

Within Specified Accuracy: +10° to +35° C, 10–80% relative humidity.

Full Operation: 0° to +50° C, 10–80% relative humidity.

Storage: -30° to +70° C, 10–90% relative humidity.

ACCESSORIES SUPPLIED:

Two Switchable X1/X10 Probes.

Instruction Manual.

AC Line Cord.

CONTROLS AND INDICATORS

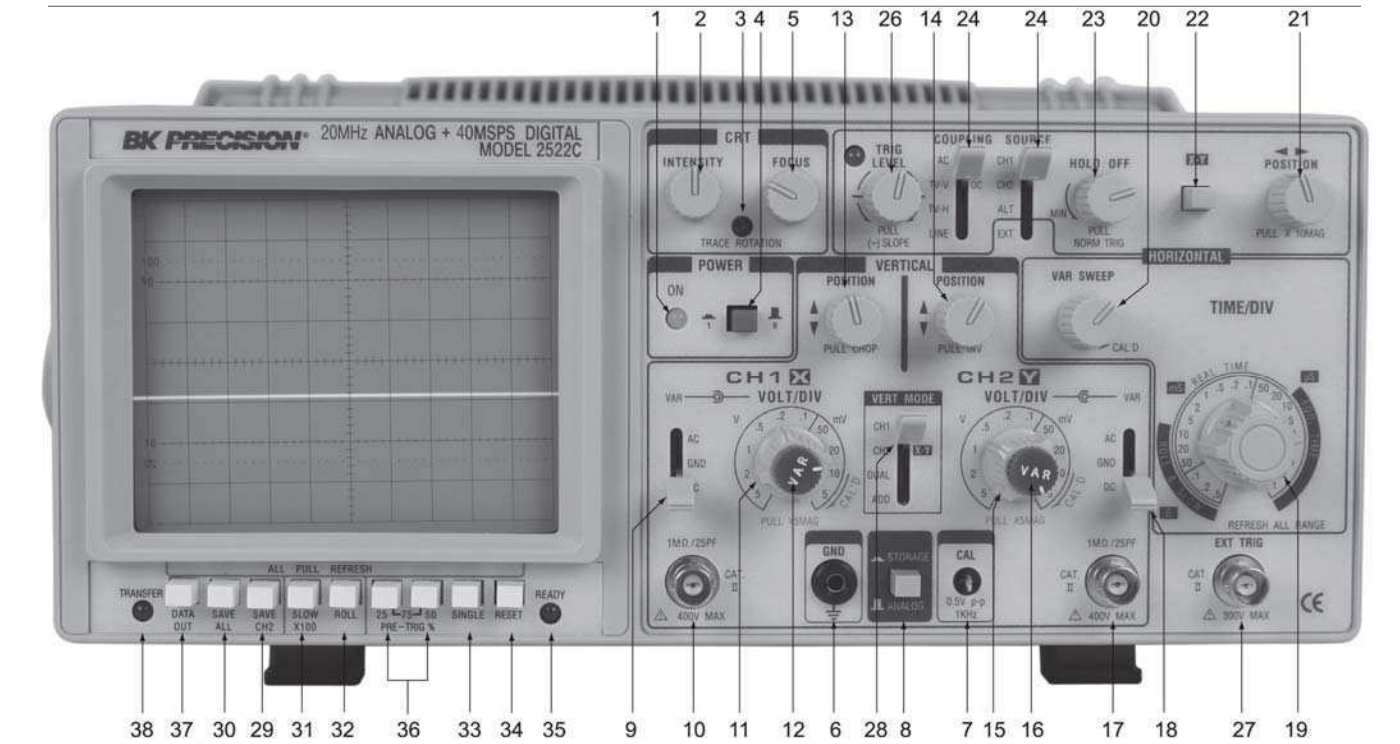

Fig. 1. Model 2522C Controls and Indicators.

GENERAL FUNCTION CONTROLS

1. **ON Indicator.** Lights when oscilloscope is "on".
2. **POWER Pushbutton.** Turns oscilloscope "on" and "off".
3. **INTENSITY Control.** Adjusts brightness of trace.
4. **TRACE ROTATION Control.** Adjusts to maintain trace at a horizontal position.
5. **FOCUS Control.** Adjusts trace focus.
6. **GND Terminal.** Oscilloscope chassis ground jack, and earth ground via three-wire ac power cord.
7. **CAL Terminal.** Terminal provides 0.5 V p-p, 1 kHz (nominal) square wave signal. This signal is useful for checking probe compensation adjustment, as well as providing a rough check of vertical calibration.

VERTICAL CONTROLS

8. **VERTical MODE Switch.** Selects vertical display mode. Four-position lever switch with the following positions:

   CH1:
   Displays the channel 1 signal by itself.

   CH2/X-Y:
   CH2: displays the channel 2 signal by itself.

   X-Y: used in conjunction with the **X-Y** control and **Trigger SOURCE** switch to enable X-Y display mode.

   DUAL:
   Displays the channel 1 and channel 2 signals simultaneously. Dual-trace mode may be either alternate or chopped sweep; see the description under **CHannel 1 POSition/PULL CHOP** control.

   ADD:
   The inputs from channel 1 and channel 2 are summed and displayed as a single signal. If the Channel 2 ⬍ **POSition/PULL INVert** control is pulled out, the input from channel 2 is subtracted from channel 1 and the difference is displayed as a single signal.

9. **CH1 AC-GND-DC Switch.** Three-position lever switch with the following positions:

   AC:
   Channel 1 input signal is capacitively coupled; dc component is blocked.

   GND:
   Opens signal path and grounds input to vertical amplifier. This provides a zero-volt base line, the position of which can be used as a reference when performing dc measurements.

Fig. 2. Rear Panel Controls and Indicators.

DC:
Direct coupling of channel 1 input signal; both ac and dc components of signal produce vertical deflection.

10. **CH1 (X) Input Jack.** Vertical input for channel 1. X-axis input for X-Y operation.

11. **CH1 (X) VOLTS/DIV Control.** Vertical attenuator for channel 1. Provides step adjustment of vertical sensitivity. When channel 1 **VARiable** control is set to **CAL,** vertical sensitivity is calibrated in 10 steps from 5 mV/div to 5 V/div in a 1-2-5 sequence. When the X-Y mode of operation is selected, this control provides step adjustment of X-axis sensitivity.

12. CH1 VARiable/PULL X5 MAG Control:

VARiable:
Rotation provides vernier adjustment of channel 1 vertical sensitivity. In the fully-clockwise **(CAL)** position, the vertical attenuator is calibrated. Counterclockwise rotation decreases gain sensitivity. In X-Y operation, this control becomes the vernier X-axis sensitivity control.

PULL X5 MAG:
When pulled out, increases vertical sensitivity by a factor of five. Effectively provides two extra sensitivity settings: 2 mV/div and 1 mV/div. In X-Y mode, increases X-sensitivity by a factor of five.

13. CH1 POSition/PULL CHOP Control:

⬍ **POSition:**
Adjusts vertical position of channel 1 trace.

PULL CHOP:
When this switch is pulled out in the dual-trace mode, the channel 1 and channel 2 sweeps are chopped and displayed simultaneously (normally used at slower sweep speeds). When it is pushed in, the two sweeps are alternately displayed, one after the other (normally used at higher sweep speeds).

14. CH2 ⬍ POSition/PULL INVert Control:

⬍ **POSition:**
Adjusts vertical position of channel 2 trace. In X-Y operation, rotation adjusts vertical position of X-Y display.

PULL INVert:
When pushed in, the polarity of the channel 2 signal is normal. When pulled out, the polarity of the channel 2 signal is reversed, thus inverting the waveform.

15. **CH2 VOLTS/DIV Control.** Vertical attenuator for channel 2. Provides step adjustment of vertical sensitivity. When channel 2 **VARiable** control is set to **CAL,** vertical sensitivity is calibrated in 10 steps from 5 mV/div to 5 V/div in a 1-2-5 sequence. When the X-Y mode of operation is selected, this control provides step adjustment of Y-axis sensitivity.

16. CH2 VARiable/PULL X5 MAG Control:

VARiable:
Rotation provides vernier adjustment of channel 2 vertical sensitivity. In the fully-clockwise **(CAL)** position, the vertical attenuator is calibrated. Counterclockwise rotation decreases gain sensitivity. In X-Y operation, this control becomes the vernier Y-axis sensitivity control.

PULL X5 MAG:
When pulled out, increases vertical sensitivity by a factor of five. Effectively provides two extra sensitivity settings: 2 mV/div and 1 mV/div. In X-Y mode, increases Y-sensitivity by a factor of five.

17. **CH2 (Y) Input Jack.** Vertical input for channel 2. Y-axis input for X-Y operation.

18. **CH2 AC-GND-DC Switch.** Three-position lever switch with the following positions:

AC:
Channel 2 input signal is capacitively coupled; dc component is blocked.

GND:
Opens signal path and grounds input to vertical amplifier. This provides a zero-volt base line, the position of which can be used as a reference when performing dc measurements.

DC:
Direct coupling of channel 2 input signal; both ac and dc components of signal produce vertical deflection.

HORIZONTAL CONTROLS

19. **Time Base TIME/DIV Control.** Provides step selection of sweep rate for the time base. When the **VARiable Sweep** control is set to **CAL,** sweep rate is calibrated. This control has 21 steps, from 0.1 S/div to 0.5 S/div, in a 1-2-5 sequence.

20. **VARiable Sweep Control.** Rotation of control is vernier adjustment for sweep rate. In fully clockwise **(CAL)** position, sweep rate is calibrated.

21. ◀▶ **POSition/PULL X10 MAG Control.**

◀▶ **POSition:**
Horizontal (X) position control.

PULL X10 MAG:
Selects ten times sweep magnification when pulled out, normal when pushed in. Increases maximum sweep rate to 10 nS/div.

22. **X-Y Switch.** Used with the **VERTical MODE** switch and **Trigger SOURCE** switch to select X-Y operating mode. The channel 1 input becomes the X-axis and the channel 2 input becomes the Y-axis. Trigger source and coupling are disabled in this mode.

TRIGGERING CONTROLS

23. **HOLDOFF/PULL NORM TRIG Control.**

PULL NORM TRIG:
When pushed in, selects **AUTO**matic triggering mode. In this mode, the oscilloscope generates sweep (free runs) in absence of an adequate trigger; it automatically reverts to triggered sweep operation when an adequate trigger signal is present. On the Model 2522C, automatic triggering is applicable to both the main sweep and delayed sweep.

When pulled out, selects **NORM**al triggered sweep operation. A sweep is generated only when an adequate trigger signal is present.

24. **Trigger SOURCE Switch.** Selects source of sweep trigger. Four-position lever switch with the following positions:

CH1
Causes the channel 1 input signal to become the sweep trigger, regardless of the **VERTical MODE** switch setting.

CH2:
The channel 2 signal becomes the sweep trigger, regardless of the **VERTical MODE** switch setting.

ALTernate:
Selects alternate triggering, used in dual-trace mode, permits each waveform viewed to become its own trigger source. Must be used with alternate sweep, cannot be used with chop sweep.

EXT:
Signal from **EXTernal TRIGger** jack becomes sweep trigger.

25. **Trigger COUPLING Switch.** Selects trigger coupling. Four-position lever switch with the following positions:

AC:
Trigger signal is capacitively coupled. Used for most waveforms except video.

TV-V:
Used for triggering from television vertical sync pulses. Also serves as lo-pass/dc (high frequency reject) trigger coupling.

TV-H:
Used for triggering from television horizontal sync pulses. Also serves as hi-pass (low frequency reject) trigger coupling.

LINE:
Signal derived from input line voltage (5 0/60 Hz) becomes trigger.

26. **TRIGger LEVEL/PULL (–) SLOPE Control.**

HOLDOFF:

Rotation adjusts holdoff time (trigger inhibit period beyond sweep duration). When control is rotated fully counterclockwise, the holdoff period is **MIN**inum (normal). The holdoff period increases progressively with clockwise rotation.

TRIGger LEVEL:

Trigger level adjustment; determines the point on the triggering waveform where the sweep is triggered. Rotation in the (–) direction (counterclockwise) selects more negative triggering point; rotation in the (+) direction (clockwise) selects more positive triggering point.

PULL (—) SLOPE:

Two-position push-pull switch. The "in" position selects a positive-going slope and the "out" position selects a negative-going slope as triggering point for main sweep.

27. **EXTernal TRIGger Jack.** External trigger input for single- and dual-trace operation.

DIGITAL STORAGE CONTROLS

28. **STORAGE/ANALOG Pushbutton.** When released, scope is in **ANALOG** mode. When engaged, scope is in digital **STORAGE** mode. In **ANALOG** mode, all digital mode controls (29–3 8) are disabled. In **STORAGE** mode, all digital mode controls (29–38) are enabled.

    In **STORAGE** mode with all digital mode controls (29–38) released, scope is in **REFRESH** mode of storage, in which it updates the stored waveform each time an adequate trigger signal is received (if the previous update has been completed). **REFRESH** mode is applicable at all **TIME/DIV** settings.

29. **SAVE CH2 Pushbutton.** Engaging this switch freezes and stores the channel 2 trace immediately. The channel 2 display and memory cannot be updated until this switch is released.
30. **SAVE ALL Pushbutton.** Engaging this switch freezes and stores the channel 1 and channel 2 traces immediately. The display and memory cannot be up-dated until this switch is released.
31. **SLOW X100 Pushbutton.** Engaging this switch expands the time base settings of 10 ms/div to 0.5 S/div by a factor of 100 to become settings of 1 sec/div to 50 sec/div. Time base settings are normal when this switch is released.
32. **ROLL Pushbutton.** Engaging this switch selects the **ROLL** mode of operation, in which the trace moves across the CRT from right to left like a strip chart recorder (opposite of conventional oscilloscope operation) and the display is continuously updated. This update takes place even in the absence of any trigger signal. The rolling speed equals the **TIME/DIV** setting (and **SLOW X100** if engaged). **ROLL** mode is applicable only at time base settings of 10 ms/div to 0.5 S/div.
33. **SINGLE Pushbutton.** Engaging this switch enables the single sweep mode of digital storage operation, in which the memory is filled in a single sweep and continuously displayed. Single sweep mode is applicable for all "real time" settings of the **TIME/DIV** control, that is, 20 s/div and slower.
34. **RESET Pushbutton.** With the **SINGLE** switch engaged, this switch readies the scope for single sweep

    operation. A suitable trigger signal arriving after pressing the **RESET** switch initiates the single sweep.

35. **READY Indicator.** Lights when the **RESET** switch readies the scope for single sweep, and goes out when trigger signal occurs.
36. **PRE-TRIGGER Pushbuttons.** Selects post-trigger or pre-trigger storage conditions. In post-trigger condition (0% pre-trigger), the entire stored waveform occurs after the trigger. The trigger point is at the extreme left of the display, as in a conventional analog oscilloscope display. In pre-trigger conditions, a portion of the waveform occurring before the trigger is displayed. Pre-trigger selections of 25%, 50%, and 75% are selectable. For 0% pre-trigger, release both **PRE-TRIGGER** pushbuttons. For 25% pre-trigger, engage the left pushbutton. For 50% pre-trigger, en-gage the right pushbutton. For 75% pre-trigger, engage both pushbuttons. Pre-trigger operation is applicable only to single sweep operation, not to **ROLL** or **REFRESH** modes.
37. **Data Out** Sends data to USB BMP.
38. **Transfer Indicator.** When flashing, indicates waveform being stored to USB drive.

REAR PANEL CONTROLS (see Fig. 2)

39. **Fuse Holder/Line Voltage Selector.** Contains fuse and selects line voltage.
40. **Power Cord Receptacle.**
41. **USB Host connector.** Store screen data to USB flash drive.
42. **Analog Output.** Output terminal where sample of channel 2 analog signal is available. Amplitude of output is 50 millivolts per division of vertical deflection seen on CRT when terminated into 50 ohms. Output impedance is 50 ohms.
43. **Factory use only** Not used.

OPERATING INSTRUCTIONS

SAFETY PRECAUTIONS

WARNING

The following precautions must be observed to help prevent electric shock.

1. When the oscilloscope is used to make measurements in equipment that contains high voltage, there is al-ways a certain amount of danger from electrical shock. The person using the oscilloscope in such conditions should be a qualified electronics technician or other-wise trained and qualified to work in such circumstances. Observe the TEST INSTRUMENT SAFETY recommendations listed on the inside front cover of this manual.

2. Do not operate this oscilloscope with the case removed unless you are a qualified service technician. High voltage up to 2100 volts is present when the unit is operating with the case removed.

3. The ground wire of the 3-wire ac power plug places the chassis and housing of the oscilloscope at earth ground. Use only a 3-wire outlet, and do not attempt to defeat the ground wire connection or float the oscilloscope; to do so may pose a great safety hazard.

4. Special precautions are required to measure or observe line voltage waveforms with any oscilloscope. Use the following procedure:

   a. Do not connect the ground clip of the probe to either side of the line. The clip is already at earth ground and touching it to the hot side of the line may "weld" or "disintegrate" the probe tip and cause possible injury, plus possible damage to the scope or probe.

   b. Insert the probe tip into one side of the line voltage receptacle, then the other. One side of the receptacle should be "hot" and produce the waveform. The other side of the receptacle is the ac return and no waveform should result.

EQUIPMENT PROTECTION PRECAUTIONS

CAUTION

The following precautions will help avoid damage to the oscilloscope.

1. Never allow a small spot of high brilliance to remain stationary on the screen for more than a few seconds. The screen may become permanently burned. A spot will occur when the scope is set up for X Y operation and no signal is applied. Either reduce the intensity so the spot is barely visible, apply signal, or switch back to normal sweep operation. It is also advisable to use low intensity with **AUTO** triggering and no signal applied for long periods. A high intensity trace at the same position could cause a line to become permanently burned onto the screen.

2. Do not obstruct the ventilating holes in the case, as this will increase the scope's internal temperature.

3. Excessive voltage applied to the input jacks may dam-age the oscilloscope. The maximum ratings of the inputs are as follows:

   CH 1 and CH2:
   400 V dc + ac peak.
   EXT TRIG:
   300 V dc + ac peak.
   Z-AXIS INPUT:
   30 V (dc and ac peak).

4. Always connect a cable from the ground terminal of the oscilloscope to the chassis of the equipment under test. Without this precaution, the entire current for the equipment under test may be drawn through the probe clip leads under certain circumstances. Such conditions could also pose a safety hazard, which the ground cable will prevent.

5. The probe ground clips are at oscilloscope and earth ground and should be connected only to the earth ground or isolated common of the equipment under test. To measure with respect to any point other than the common, use CH 2 – CH 1 subtract operation (**ADD** mode and invert channel 2), with the channel 2 probe to the point of measurement and the channel 1 probe to the point of reference. Use this method even if the reference point is a dc voltage with no signal.

OPERATING TIPS

The following recommendations will help obtain the best performance from the oscilloscope.

1. Always use the probe ground clips for best results, attached to a circuit ground point near the point of measurement. Do not rely solely on an external ground wire in lieu of the probe ground clips as undesired signals may be introduced.
2. Avoid the following operating conditions:
   a. Direct sunlight.
   b. High temperature and humidity.
   c. Mechanical vibration.
   d. Electrical noise and strong magnetic fields, such as near large motors, power supplies, transformers, etc.
3. Occasionally check trace rotation, probe compensation, and calibration accuracy of the oscilloscope using the procedures found in the MAINTENANCE section of this manual.
4. Terminate the output of a signal generator into its characteristic impedance to minimize ringing, especially if the signal has fast edges such as square waves or pulses. For example, the typical 50 Ω output of a square wave generator should be terminated into an external 50 Ω terminating load and connected to the oscilloscope with 50 Ω coaxial cable.
5. Probe compensation adjustment matches the probe to the input of the scope. For best results, compensation should be adjusted initially, then the same probe al-ways used with the same channel. Probe compensation should be readjusted when a probe from a different oscilloscope is used.

INITIAL STARTING PROCEDURE

Until you familiarize yourself with the use of all controls, the settings given here can be used as a reference point to obtain a trace on the CRT in preparation for waveform observation.

1. Set these controls as follows:

   VERTical MODE to **CH1.**
   CH1 AC/GND/DC to **GND.**
   Select **AUTO** triggering (**HOLD OFF** pushed in)
   Trigger COUPLING to **AC. Trigger SOURCE** to **CH1.**

   All **POSition** controls and **INTENSITY** control centered (pointers facing up). **Time Base** control to **1 mS/div.**
2. Press the red **POWER** pushbutton.
3. A trace should appear on the CRT. Adjust the trace brightness with the **INTENSITY** control, and the trace sharpness with the **FOCUS** control.

SINGLE TRACE DISPLAY

Either channel 1 or channel 2 may be used for single-trace operation. To observe a waveform on channel 1:

1. Perform the steps of the "Initial Starting Procedure".
2. Connect the probe to the **CH 1 (X)** input jack.
3. Connect the probe ground clip to the chassis or common of the equipment under test. Connect the probe tip to the point of measurement.
4. Move the **CH1 AC/GND/DC** switch out of the **GND** position to either **DC** or **AC.**
5. If no waveforms appear, increase the sensitivity by turning the **CH 1 VOLTS/DIV** control clockwise to a position that gives 2 to 6 divisions vertical deflection.
6. Position the waveform vertically as desired using the **CH1 POSition** control.
7. The display on the CRT may be unsynchronized. Refer to the "Triggering" paragraphs in this section for procedures on setting triggering and sweep time controls to obtain a stable display showing the desired number of waveforms.

DUAL TRACE DISPLAY

In observing simultaneous waveforms on channel 1 and 2, the waveforms are usually related in frequency, or one of the waveforms is synchronized to the other, although the basic frequencies are different. To observe two such related waveforms simultaneously, perform the following:

1. Connect probes to both the **CH 1 (X)** and **CH 2 (Y)** input jacks.
2. Connect the ground clips of the probes to the chassis or common of the equipment under test. Connect the tips of the probes to the two points in the circuit where waveforms are to be measured.
3. To view both waveforms simultaneously, set the **VERTical MODE** switch to **DUAL** and select either **ALT** (alternate) or **CHOP** with the **PULL CHOP** switch.
4. In the **ALT** sweep mode (**PULL CHOP** switch pushed in), one sweep displays the channel 1 signal and the next sweep displays the channel 2 signal in an alternating sequence. Alternate sweep is normally used for viewing high-frequency or high-speed wave-forms at sweep times of 1 ms/div and faster, but may be selected at any sweep time.

5. In the **CHOP** sweep mode (**PULL CHOP** switch pulled out), the sweep is chopped (switched) between channel 1 and channel 2. Using **CHOP,** one channel does not have to "wait" for a complete swept display of the other channel. Therefore, portions ofboth channel's waveforms are displayed with the phase relation-ship between the two waveforms unaltered. Chop sweep is normally used for low-frequency or low-speed waveforms at sweep times of 1 ms/div and slower; or where the phase relationship between channel 1 and channel 2 requires measurement.

   If chop sweep is used at sweep times of 0.2 ms/div and faster, the chop rate becomes a significant portion of the sweep and may become visible in the displayed waveform. However, you may select chop sweep at any sweep time for special applications.
6. Adjust the channel 1 and 2 st **POS**ition controls to place the channel 1 trace above the channel 2 trace.
7. Set the **CH 1** and **CH 2 VOLTS/DIV** controls to a position that gives 2 to 3 divisions of vertical deflection for each trace. If the display on the screen is unsynchronized, refer to the "Triggering" paragraphs in this section of the manual for procedures for setting triggering and sweep time controls to obtain a stable display showing the desired number of waveforms.
8. When the **VERTical MODE** switch is set to **ADD,** the algebraic sum of CH 1 + CH 2 is displayed as a single trace. When the **PULL INV** switch is pulled out, the algebraic difference of CH 1 – CH 2 is displayed.
9. If two waveforms have no phase or frequency relation-ship, there is seldom reason to observe both wave-forms simultaneously. However, these oscilloscopes do permit the simultaneous viewing of two such unrelated waveforms, using alternate triggering. Refer to the paragraphs on "Triggering — Trigger SOURCE Switch" for details on alternate triggering.

TRIGGERING

The Model 2522C Oscilloscope provides versatility in sync triggering for ability to obtain a stable, jitter-free display in single-trace, or dual-trace operation. The proper settings depend upon the type of waveforms being observed and the type of measurement desired. An explanation of the various controls which affect synchronization is given to help you select the proper setting over a wide range of conditions.

AUTO or NORM Triggering

1. In the **AUTO** mode (**PULL NORM TRIG** pushed in), automatic sweep operation is selected. In automatic sweep operation, the sweep generator free-runs to generate a sweep without a trigger signal. However, it automatically switches to triggered sweep operation if an acceptable trigger source signal is present. The **AUTO** mode is handy when first setting up the scope to observe a waveform; it provides sweep for wave-form observation until other controls can be properly set. Once the controls are set, operation is often switched back to the normal triggering mode, since it is more sensitive. Automatic sweep must be used for dc measurements and signals of such low amplitude that they will not trigger the sweep.
2. In the **NORM** mode (**PULL NORM TRIG** pulled out), normal triggered sweep operation is selected. The sweep remains at rest until the selected trigger source signal crosses the threshold level set by the **TRIG LEVEL** control. The trigger causes one sweep to be generated, after which the sweep again remains at rest until triggered. In the normal triggering mode, there will be no trace unless an adequate trigger signal is present. In the **ALT VERTICAL MODE** of dual-trace operation with the **SOURCE** switch also set to **ALT,** there will be no trace unless both channel 1 and channel 2 signals are adequate for triggering. Typically, signals that produce even one division of vertical deflection are adequate for normal triggered sweep operation.

Trigger COUPLING Switch

1. The **AC** position is used for most waveforms except video. The trigger signal is capacitively coupled. Thus, it blocks the dc component and references the average of the "changing" portion of the waveform.
2. The **TV H** and **TV V** positions are primarily for viewing composite video waveforms. Horizontal sync pulses are selected as trigger when the trigger **COUPLING** switch is set to the **TV H** position, and vertical sync pulses are selected as trigger when the trigger **COUPLING** switch is set to the **TV V** position. The **TV H** and **TV V** positions may also be used as low frequency reject and high frequency reject coupling, respectively. Additional procedures for observing video waveforms are given later in this section of the manual.

Trigger SOURCE Switch

The trigger **SOURCE** switch (**CH 1, CH 2,** etc.) selects the signal to be used as the sync trigger.

1. If the **SOURCE** switch is set to **CH 1** (or **CH 2**) the channel 1 (or channel 2) signal becomes the trigger source regardless of the **VERTICAL MODE** selection. **CH 1,** or **CH 2** are often used as the trigger source for phase or timing comparison measurements.
2. By setting the **SOURCE** switch to **ALT,** alternating triggering mode is activated. In this mode, the trigger source alternates between **CH 1** and **CH 2** with each sweep. This is convenient for checking amplitudes, waveshape, or waveform period measurements, and even permits simultaneous observation of two wave-forms which are not related in frequency or period. However, this setting is not suitable for phase or timing comparison measurements. For such measurements, both traces must be triggered by the same sync signal. Alternate triggering can only be used in dual-trace

mode (**VERT MODE** set to **DUAL),** and with alternate sweep only **(PULL CHOP** not engaged).

3. In the **EXT** position, the signal applied to the **EXT TRIG** jack becomes the trigger source. This signal must have a timing relationship to the displayed wave-forms for a synchronized display.
4. In the **LINE** position of the **COUPLING** switch, triggering is derived from the input line voltage (5 0/60 Hz) and the trigger **SOURCE** switch is disabled. This is useful for measurements that are related to line frequency.

TRIG LEVEL/PULL (–) SLOPE Control

(Refer to Fig. 3)

A sweep trigger is developed when the trigger source signal crosses a preset threshold level. Rotation of the **TRIG LEVEL** control varies the threshold level. In the **+** direction (clockwise), the triggering threshold shifts to a more positive value, and in the – direction (counterclockwise), the triggering threshold shifts to a more negative value. When the control is centered, the threshold level is set at the approximate average of the signal used as the triggering source. Proper adjustment of this control usually synchronizes the display.

The **TRIG LEVEL** control adjusts the start of the sweep to almost any desired point on a waveform. On sine wave signals, the phase at which sweep begins is variable. Note that if the **TRIG LEVEL** control is rotated toward its extreme **+** or – setting, no sweep will be developed in the normal trigger mode because the triggering threshold exceeds the peak amplitude of the sync signal.

When the **PULL (–) SLOPE** control is set to the **+ ("in")** position, the sweep is developed from the trigger source waveform as it crosses a threshold level in a positive-going direction. When the **PULL (–) SLOPE** control is set to the

– ("out") position, a sweep trigger is developed from the trigger source waveform as it crosses the threshold level in a negative-going direction.

TIME BASE Control

Set the **Time Base TIME/DIV** control to display the desired number of cycles of the waveform. If there are too many cycles displayed for good resolution, switch to a faster sweep time. If only a line is displayed, try a slower sweep time. When the sweep time is faster than the waveform being observed, only part of it will be displayed, which may appear as a straight line for a square wave or pulse waveform.

HOLDOFF Control

(Refer to Fig. 4)

A "holdoff" period occurs immediately after the completion of each sweep, and is a period during which triggering of the next sweep is inhibited. The normal holdoff period varies with sweep rate, but is adequate to assure complete retrace and stabilization before the next sweep trigger is permitted. The **HOLDOFF** control allows this period to be extended by a variable amount if desired.

This control is usually set to the **MIN** position (fully counterclockwise) because no additional holdoff period is necessary. The **HOLDOFF** control is useful when a complex series of pulses appear periodically such as in Fig. 4B. Improper sync may produce a double image as in Fig. 4A. Such a display could be synchronized with the **VAR SWEEP** control, but this is impractical because time measurements are then uncalibrated. An alternate method of synchronizing the display is with the **HOLDOFF** control. The sweep speed remains the same, but the triggering of the next sweep is "held off" for the duration selected by the **HOLDOFF** control. Turn the **HOLDOFF** control clock-wise from the **MIN** position until the sweep starts at the same point of the waveform each time.

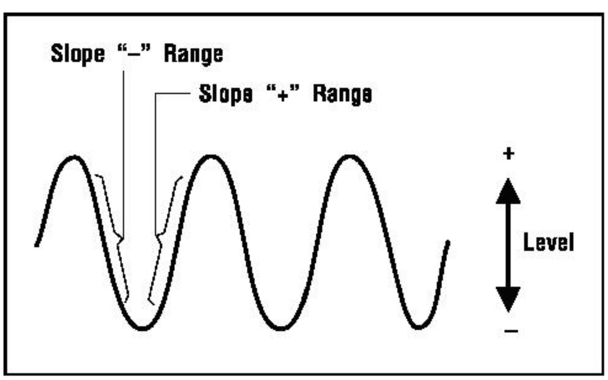

Fig. 3. Function of Slope and Level Controls.

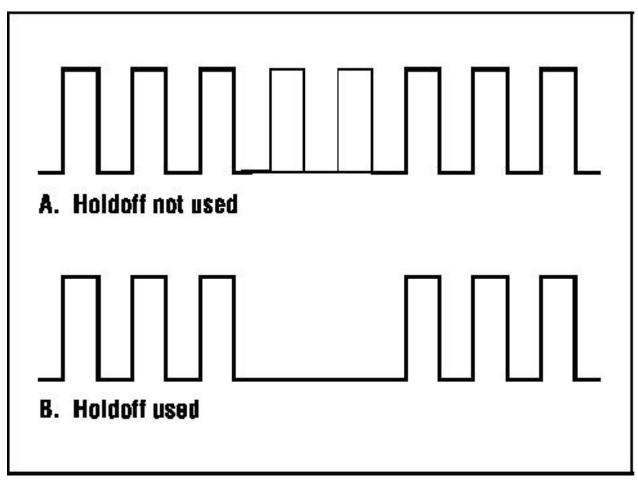

Fig. 4. Use of HOLDOFF Control.

MAGNIFIED SWEEP OPERATION

Since merely shortening the sweep time to magnify a portion of an observed waveform can result in the desired portion disappearing off the screen, magnified display should be performed using magnified sweep.

Using the ◄►**POS**ition control, move the desired portion of waveform to the center of the CRT. Pull out the **PULL X10** knob to magnify the display ten times. For this type of display, the sweep time is the **Time Base TIME/DIV** control setting divided by 10. Rotation of the ◄►**POS**ition control can then be used to select the desired portion of the waveforms.

X Y OPERATION

X Y operation permits the oscilloscope to perform many measurements not possible with conventional sweep operation. The CRT display becomes an electronic graph of two instantaneous voltages. The display may be a direct comparison of the two voltages such as stereoscope display of stereo signal outputs. However, the **X Y** mode can be used to graph almost any dynamic characteristic if a transducer is used to change the characteristic (frequency, temperature, velocity, etc.) into a voltage. One common application is frequency response measurements, where theY axis corresponds to signal amplitude and the X axis corresponds to frequency.

1. Depress the **X Y** switch and set the **Trigger Source** and **VERTical MODE** switches to **XY.**
2. In this mode, channel 1 becomes the X axis input and channel 2 becomes the Y axis input. The X and Y positions are now adjusted using the ◄►**POS**ition and the **channel 2** ▲▼**POS**ition controls, respectively.
3. Adjust the amount of vertical (Y axis) deflection with the **CH 2 VOLTS/DIV** and **VARIABLE** controls.
4. Adjust the amount of horizontal (X axis) deflection with the **CH 1 VOLTS/DIV** and **VARIABLE** controls.

VIDEO SIGNAL OBSERVATION

Setting the **COUPLING** switch to the **TV-H** or **TV-V** position permits selection of horizontal or vertical sync pulses for sweep triggering when viewing composite video waveforms.

When the **TV-H** mode is selected, horizontal sync pulses are selected as triggers to permit viewing of horizontal lines of video. A sweep time of about 10 μs/div is appropriate for displaying lines of video. The **VAR SWEEP** control can be set to display the exact number of waveforms desired.

When the **TV-V** mode is selected, vertical sync pulses are selected as triggers to permit viewing of vertical fields and frames of video. A sweep time of 2 ms/div is appropriate for viewing fields of video and 5 ms/div for complete frames (two interlaced fields) of video.

At most points of measurement, a composite video signal is of the () polarity, that is, the sync pulses are negative and the video is positive. In this case, use () **SLOPE.** If the waveform is taken at a circuit point where the video wave-form is inverted, the sync pulses are positive and the video is negative. In this case, use **(+) SLOPE.**

DIGITAL STORAGE OPERATION

Digitizing Repetitive Waveforms

While the most powerful feature of a digital storage oscilloscope (DSO) is its ability to capture one-time events, a DSO can also digitize conventional repetitive waveforms, such as those observed on a standard analog scope.

An analog/digital unit such as the Model 2522C allows the user to set up sensitivity, sweep, and triggering in a familiar analog setting, and then switch to the digital mode. This is a good way to gain familiarity with the digital features of the instrument. You may wish to pursue this method as described below in the “Refresh Mode” paragraph.

Also, some repetitive signals can be viewed and measured much more effectively in the digital store mode than in the analog mode. One example is slow signals below 60 Hz. Signals that appear as a flickering waveform or just a moving dot on the screen in the analog mode are displayed as a bright, non-flickering, easily viewed entire waveform in the digital store mode.

The digital store mode also improves viewing and measurement of repetitive signals with low trigger repetition rates relative to the sweep rate. In the analog mode, such wave-forms may be too faint for viewing. In the digital store mode, the display is equivalent to a CRT with infinite persistence. The waveform can be easily viewed.

Refresh Mode

In the refresh mode, the waveform is digitized and displayed on the screen. After the complete waveform is digitized, the next trigger causes the stored waveform to be replaced (refreshed) by a new waveform.

1. Set up the oscilloscope to view a periodic waveform in the **ANALOG** mode. Adjust the trigger, **VOLTS/DIV,** sweep **TIME/DIV,** and vertical position controls as desired.
2. Initially, disengage all of the digital storage control switches (the group of switches beneath the CRT).
3. Select digital storage operation by setting the **ANALOG/STORAGE** switch to **STORAGE** (engaged). When all digital storage control switches are released, the “refresh” mode is selected. The waveform should appear on the display, relatively unchanged from the previously displayed analog version. In the “refresh” mode, the display is continually updated as long as a suitable trigger signal remains present.

4. Once a waveform is digitized, it can be stored in long-term memory by pressing the **SAVE ALL** or **SAVE CH2** switches. The **SAVE CH2** switch immediately stores the channel 2 waveform. The **SAVE ALL** switch immediately freezes the display and stores both waveforms. Once a waveform is stored by engaging either of these switches, it will be stored until the switch is disengaged or the power is turned off.

NOTES

Any of the operating modes previously discussed in analog operation (e.g. **DUAL, ADD,** etc.) can be used in digital mode, except for X–Y operation.

Time base settings of 10 µs/div and faster result in a display that is acquired through "equivalent time sampling". This process develops the digitized image over many cycles of the repetitive signal; therefore, these higher sweep speeds cannot be used for capture of one-time events. Equivalent time sampling is discussed in detail in

Appendix II, "Unique Characteristics of Digital Storage Oscilloscopes".

Digitizing One-Time Events

One of the most powerful features of a digital storage oscilloscope (DSO) is its ability to capture one-time events. To capture one-time events, single-sweep operation is employed. This is done through the use of the SINGLE switch. When pushed, this switch releases the REFRESH or ROLL mode if previously engaged, and readies the digital storage circuit to receive a trigger signal — presumably the event to be captured or some other time-related occurrence. When the event arrives, it is stored in the memory and displayed. The procedure is as follows:

1. Set the oscilloscope to run in analog mode (**ANALOG/DIGITAL** switch to **ANALOG).** Select **NORM** triggering, and adjust the **TRIG LEVEL** control so that the unit triggers on the event to be captured.
2. Set the oscilloscope to digital **(STORAGE)** mode by engaging the **ANALOG/STORAGE** switch.
3. Initially, set the **PRE TRIG** switch to 50%. A more detailed discussion of pre- and post-triggering is given later in this section of the manual.
4. Press the **RESET** switch. The **READY** indicator will momentarily light as the scope awaits the arrival of the trigger signal. When that trigger occurs, the **READY** indicator will go off, and the event being monitored will roll to the center of the display and stop.

NOTES

Depending on the sweep **TIME/DIV** setting, the anticipated event may roll to the center of the screen very rapidly, or very slowly, after the **READY** indicator goes out.

Single-sweep mode can be used in the presence of very rapidly occurring events, even continuous waveforms if desired. In that case, the period between pushing the RE-SET switch and the arrival of the trigger may be very short or almost instantaneous. As a result, the **READY** indicator may light for only a very short time, perhaps not being visible at all.

Pushing the **SINGLE** switch automatically disengages both the **REFresh** and **ROLL** modes, which are continuous modes.

5. Once the waveform is captured, it can be stored in long-term memory through the use of the **SAVE CH2** or **SAVE ALL** switches.

Pre- and Post-Trigger Capture

Another powerful feature of a DSO is ability to display "pre-trigger" information, that is, events occurring before the arrival of a trigger event. On the Model 2522C, pre-trigger operation is available in single-sweep mode by setting the **PRE TRIG** switches. As shown in the above section on "Digitizing One-Time Events", when 50% pre-trigger operation is selected, the event to be captured is situated in the center of the memory (roughly the center of the display) after storage. The waveform to the left of center represents activity which occurred before that trigger arrived. Pre-Trigger selection of 25% and 75% are also available.

If the **PRE-TRIG** switches are released (0% pretrigger), then no pre-trigger information is stored, and the trigger event rolls to the extreme left of the display. In this case, all the information displayed on the screen represents activity after the trigger event. You may wish to use post-trigger operation first to observe where the trigger is occurring on the waveform of interest, and then switch to pre-trigger mode.

Roll Mode

In this mode of operation, the waveform rolls across the CRT from right to left (as opposed to standard oscilloscopes, which have the trace moving from left to right) in the same manner as most strip chart recorders. It is most commonly used for viewing very slow events.

1. Set up the oscilloscope in analog mode so that the event to be observed is properly positioned on the display. you may wish to use **AUTO** triggering so that the scope continues to draw a trace even if the event is especially slow.
2. Switch to digital mode **(ANALOG/STORAGE** switch to **STORAGE),** and depress the **ROLL** switch. Select a **TIME/DIV** setting that produces a roll at the desired speed. As the sweep speed is decreased, the waveform will move across the screen more slowly and the Roll feature will become more apparent. It can also be slowed by a factor of 100 on some ranges; see the discussion in the next section.

3. The rolling display can be frozen at any time by pressing the **SAVE CH2** or **SAVE ALL** switches (as discussed in the section on "Digitizing Repetitive Waveforms").

NOTE

ROLL mode cannot be used on sweep speeds greater than 10 ms/div.

Expanded Sweep Settings—SLOW X100 Mode

In digital mode, the 10 ms/div to 0.5 s/div **TIME/DIV** ranges can be expanded by a factor of 100 by depressing the **SLOW X100** switch. For example, the 10 ms/div setting becomes 1000 ms (1 sec)/div when this switch is engaged. This time base expansion is extremely useful for observing very slow events. With it, the scope is capable of recording an event up to 500 seconds in duration (.5 sec/div x100 becomes 50 sec/div).

Saving Screen images to a USB flash drive

The Model 2522C oscilloscope supports saving of screen data to a USB flash drive. To save, simply press down the SAVE ALL button first, then press down DATA OUT. The Transfer light next to it will flash or lid up. This means data is being transferred to USB drive connected in the rear USB port. When transfer is done, light will turn off. Press back up the DATA OUT button when finished.

MAINTENANCE

WARNING

The following instructions are for use by qualified service personnel only. To avoid electrical shock, do not perform any servicing other than contained in the operating instructions unless you are qualified to do so.

High voltage up to 2000 V is present when covers are removed and the unit is operating. Remember that high voltage may be retained indefinitely on high voltage capacitors. Also remember that ac line voltage is present on line voltage input circuits any time the instrument is plugged into an ac outlet, even if turned of. Unplug the oscilloscope and dis-charge high voltage capacitors before performing service procedures.

FUSE REPLACEMENT

If the fuse blows, the "ON" indicator will not light and the oscilloscope will not operate. The fuse should not normally open unless a problem has developed in the unit. Try to determine and correct the cause of the blown fuse, then replace only with the correct value fuse. For 110/125 V line voltage operation, use an 800 mA, 250 V fuse. For 220/240 V line voltage operation, use a 600 mA, 250 V fuse. The fuse is located on the rear panel adjacent to the power cord receptacle.

Remove the fuseholder assembly as follows:

1. Unplug the power cord from rear of scope.
2. Insert a small screwdriver in fuseholder slot (located between fuseholder and receptacle). Pry fuseholder away from receptacle.
3. When reinstalling fuseholder, be sure that the fuse is installed so that the correct line voltage is selected (see LINE VOLTAGE SELECTION).

LINE VOLTAGE SELECTION

To select the desired line voltage, simply insert the fuse and fuse holder so that the appropriate voltage is pointed to by the arrow. Be sure to use the proper value fuse (see label on rear panel).

PERIODIC ADJUSTMENTS

Probe compensation and trace rotation adjustments should be checked periodically and adjusted if required. These procedures are given below.

Probe Compensation

1. Connect probes to **CH 1** and **CH 2** input jacks. Per-form procedure for each probe, one probe at a time.
2. Set the probe to X10 (compensation adjustment is not possible in the X1 position).
3. Touch tip of probe to **CAL** terminal.
4. Adjust oscilloscope controls to display 3 or 4 cycles of **CAL** square wave at 5 or 6 divisions amplitude.
5. Adjust compensation trimmer on probe for optimum square wave (minimum overshoot, rounding off, and tilt). Refer to Fig. 5.

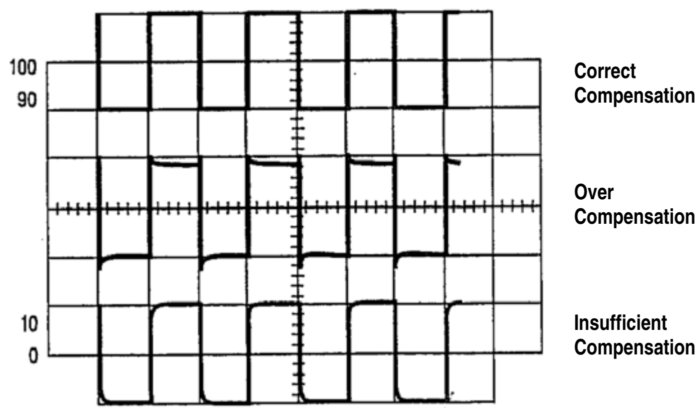

Fig. 5. Probe Compensation Adjustment.

Trace Rotation Adjustment

1. Set oscilloscope controls for a single trace display in **CH 1** mode, and with the channel 1 **AC-GND-DC** switch set to **GND.**
2. Use the channel 1 POSition control to position the trace over the center horizontal line on the graticule scale. The trace should be exactly parallel with the horizontal line.
3. Use the **TRACE ROTATION** adjustment on the front panel to eliminate any trace tilt.

CALIBRATION CHECK

A general check of calibration accuracy may be made by displaying the output of the **CAL** terminal on the screen. This terminal provides a square wave of 0.5 V p-p. This signal should produce a displayed waveform amplitude of five divisions at 0.1 V/div sensitivity for both channel 1 and 2 (with probes set for direct). With probes set for X10, there should be five divisions amplitude at 10 mV/div sensitivity. The **VARIABLE** controls must be set to **CAL** during this check.

NOTE

The **CAL** signal should be used only as a general check of calibration accuracy, not as a signal source for performing recalibration adjustments; a voltage standardcalibrated at several steps and of 0.3% or better accuracy is required for calibration adjustments.standarcalibrated at several steps and of 0.3% or better accuracy is required for calibration adjustments.

INSTRUMENT REPAIR SERVICE

Because of the specialized skills and test equipment required for instrument repair and calibration, many customers prefer to rely upon **B&K Precision** for this service. To use this service, even if the oscilloscope is no longer under warranty, follow the instructions given in the SERVICE INFORMATION portion of this manual. There is a flat rate charge for instruments out of warranty.

APPENDIX I

IMPORTANT CONSIDERATIONS FOR RISE TIME AND FALL TIME MEASUREMENTS

Error in Observed Measurement

The observed rise time (or fall time) as seen on the CRT is actually the cascaded rise time of the pulse being measured and the oscilloscope's own risetime. The two rise times are combined in square law addition as follows:

$$T_{observed} = \sqrt{(T\ pulse)^2 + (T\ scope)^2}$$

The effect of the oscilloscope's rise time is almost negligible when its rise time is at least 3 times as fast as that of the pulse being measured. Thus, slower rise times may be measured directly from the CRT. However, for faster rise time pulses, an error is introduced that increases progressively as the pulse rise time approaches that of the oscilloscope. Accurate measurements can still be obtained by calculation as described below.

Direct Measurements

The Model 2522C has a rated rise time of 18 ns. Thus, pulse rise times of about 54 ns or greater can be measured directly. Most fast rise times are measured at the fastest sweep speed and using X10 magnification. This sweep rate is 10 ns/div. A rise time of less than about five divisions at this sweep speed should be calculated.

Calculated Measurements

For observed rise times of less than 54 ns, the pulse rise time should be calculated to eliminate the error introduced by the cascaded oscilloscope rise time. Calculate pulse rise time as follows:

$$T_{pulse} = \sqrt{(T\ observed)^2 + (T\ scope)^2}$$

Limits of Measurement

Measurements of pulse rise times that are faster than the scope's rated rise time are not recommended because a very small reading error introduces significant error into the calculation. This limit is reached when the "observed" rise time is about 1.3 times greater than the scope's rated rise time, about 23 ns minimum for the Model 2522C.

Probe Considerations

For fast rise time measurements which approach the limits of measurement, direct connection via 50 Ω coaxial cable and 50 Ω termination is recommended where possible. When a probe is used, its rise time is also cascaded in square law addition. Thus the probe rating should be considerably faster than the oscilloscope if it is to be disregarded in the measurement.

APPENDIX II

UNIQUE CHARACTERISTICS OF DIGITAL STORAGE OSCILLSCOPES

Digital Storage Oscilloscopes (DSO's) use a digital sampling technique to convert analog input signals to a series of digital words that can be stored in memory. Since digital sampling has disadvantages as well as advantages, it is important to be aware of these unique characteristics of DSO's.

ALIASING

This DSO uses Real Time Sampling when sweep TIME/DIV settings of 50 sec/div to 20 µs/div are selected. Real Time Sampling simply means that samples of the input signals are taken at equal spaces (e.g., every 0.25 ms when the 50 ms/div range is selected). With Real Time Sampling, a phenomena called "Aliasing" can occur when the input signal is not sampled often enough. This causes the digitized signal to appear to be of a lower frequency than that of the input signal. Unless you have an idea what the input signal is supposed to look like, you will usually be unaware that Aliasing is occurring.

Aliasing Example

To see what actually occurs when a Digital Storage Oscilloscope is Aliasing, perform the following example.

1. Apply a 10 kHz signal to the input jack and set the sweep TIME/DIV control to 50 µs/div. You should see about 5 cycles of the waveform on the display. Since the DSO samples the input waveform 200 times per division, each cycle is sampled 400 times.
2. Now change the sweep TIME/DIV control to 2 ms/div. The display should look crowded. Because the DSO takes 200 samples per division, the sample points are 10 µs apart. Since the input signal is at a frequency of 10 kHz, it is being sampled 10 times per cycle. The resulting display is too crowded to be useful, however, it is not incorrect (it is very similar to what you would see on a conventional analog oscilloscope).
3. Change the setting of the sweep TIME/DIV control to 20 ms/div. Vary the frequency a slight amount (until the display is readable) to obtain as few cycles as possible on the CRT. If you were to calculate the frequency of the signal from the display, you would come up with a much lower frequency than that of the actual frequency of the signal at the input jack. As an example, if three cycles are displayed, the calculated frequency would be approximately 15 Hz. This is obviously incorrect. This occurs because the DSO is taking one sample every 0.1 ms and a 10 kHz signal has one cycle every 0.1 ms. What is actually happening is that the frequency is off (not perfectly 10 kHz) by just enough to cause the DSO to take one sample at a slightly different place on each cycle of the waveform.

Avoiding Aliasing

Aliasing is not limited to the above example. This phenomenon can occur anytime that at least two samples per cycle are not taken (whenever the sweep TIME/DIV setting is much too slow for the waveform being applied to the input). Whenever the frequency of the signal is unknown, always begin with the fastest real-time sweep speed (20 µs/div) or by viewing the waveform in the analog mode of operation first.

NOTE

Viewing one-time events or glitches is not possible when sweep TIME/DIV settings higher than 20 s/div are selected. Viewing one-time events poses no problem with Aliasing because Aliasing can occur only with repetitive waveforms.

EQUIVALENT TIME SAMPLING

This oscilloscope uses a sampling method called Equivalent Time Sampling when sweep speeds higher than 20 µs/div are selected. This method permits viewing of repetitive waveforms to 20 MHz, although the maximum digital sampling rate is 10 Msamples/sec. When the Equivalent Time Sampling mode is activated, one sample is taken during each cycle. Of course if one sample is taken during each cycle at the trigger point (the same point on each cycle), only a flat trace would be produced. Therefore, it is necessary to take each sample further (in time) from the trigger point than the last sample. This incremental delay is deter-mined by the sweep TIME/DIV control setting. Because 1024 (1 k) samples are needed to fill the display, the oscilloscope must sample 1024 cycles of the waveform.

Therefore, only repetitive waveforms should be observed in this mode. Irregularities that are present on an otherwise repetitive waveform are not likely to show up when the Equivalent Time Sampling method is used. With only one sample being taken during each cycle, it is very likely that glitches and other irregularities will be skipped over.

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SERVICE INFORMATION

Warranty Service: Please go the support and service section on our website www.bkprecision.com to obtain a RMA #. Return the product in the original packaging with proof of purchase to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device.

Non-Warranty Service: Please go the support and service section on our website www.bkprecision.com to obtain a RMA #. Return the product in the original packaging to the address below. Clearly state on the RMA the performance problem and return any leads, probes, connectors and accessories that you are using with the device. Customers not on an open account must include payment in the form of a money order or credit card. For the most current repair charges please refer to the service and support section on our website.

Return all merchandise to B&K Precision Corp. with pre-paid shipping. The flat-rate repair charge for Non-Warranty Service does not include return shipping. Return shipping to locations in North America is included for Warranty Service. For overnight shipments and non-North American shipping fees please contact B&K Precision Corp.

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714-921-9095

Include with the returned instrument your complete return shipping address, contact name, phone number and description of problem.

LIMITED ONE-YEAR WARRANTY

B&K Precision Corp. warrants to the original purchaser that its products and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from date of purchase.

B&K Precision Corp. will, without charge, repair or replace, at its option, defective product or component parts. Returned product must be accompanied by proof of the purchase date in the form of a sales receipt.

To obtain warranty coverage in the U.S.A., this product must be registered by completing a warranty registration form on our website www.bkprecision.com within fifteen (15) days of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. The warranty is void if the serial number is altered, defaced or removed.

B&K Precision Corp. shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitations of incidental or consequential damages. So the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may have other rights, which vary from state-to-state.

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