1. GENERAL INFORMATION

1-1. INTRODUCTION

The Model 7040A shown in Figure 1-1, is a 40 MHz dual-trace oscilloscope with many quality features: wide bandwidth, high sensitivity, dual timebases with delayed sweep, and a TV sync separator. Moreover, the large CRT has an illuminated internal graticule for parallax-free measurements and photographic applications.

1-2. SPECIFICATIONS

Specifications for the Model 7040A oscilloscope are given in Table 1-1.

Table 1-1
Model 7040A SPECIFICATIONS

<table>
<thead>
<tr>
<th>Vertical Amplifiers (Ch.1 &amp; 2)</th>
<th>DC to 40 MHz normal</th>
<th>DC to 7 MHz magnified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth (-3 dB)</td>
<td>DC coupled</td>
<td>AC coupled</td>
</tr>
<tr>
<td></td>
<td>10 Hz to 40 MHz normal</td>
<td>10 Hz to 7 MHz magnified</td>
</tr>
<tr>
<td></td>
<td>8.8 nS normal</td>
<td>50 nS magnified</td>
</tr>
<tr>
<td>Deflection Coefficients</td>
<td>5 mV/div to 5 V/div in 10 calibrated steps of a 1-2-5 sequence. Continuously variable between steps, highest uncalibrated deflection factor is at least 12.5 V/div. 5× magnifier adds 1 mV/div and 2 mV/div steps for frequencies up to 7 MHz.</td>
<td></td>
</tr>
<tr>
<td>Accuracy</td>
<td>± 3% normal; ± 5% magnified</td>
<td></td>
</tr>
<tr>
<td>Input Impedance</td>
<td>Approx. 1 megohm in parallel with 30 pF</td>
<td></td>
</tr>
<tr>
<td>Maximum Input Voltage</td>
<td>300 V (DC + peak AC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 V peak AC below 1 kHz</td>
<td></td>
</tr>
<tr>
<td>Input Coupling</td>
<td>AC, DC, or ground</td>
<td></td>
</tr>
</tbody>
</table>


Signal Delay

Permits viewing leading edge of displayed waveform

Channel 1 Output

20 mV/div into 50 ohms, 50 Hz to 5 MHz

**Horizontal Amplifier (X-Y Mode)**

*Only at Horizontal Display A*

**Bandwidth (−3 dB)**

<table>
<thead>
<tr>
<th>Type</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC coupled</td>
<td>DC to 500 kHz</td>
</tr>
<tr>
<td>AC coupled</td>
<td>10 Hz to 500 kHz</td>
</tr>
</tbody>
</table>

Phase Shift

Less than 3° at 50 kHz

Deflection Coefficients

Same as Vertical Amplifier

Input Impedance

- - -

Maximum Input Voltage

- - -

**Timebase Generators**

Display Modes

Main timebase only, Main timebase intensified, B timebase delayed, B timebase triggered

**Main (A) Timebase Speeds**

0.2 μS/div to 0.2 S/div in 19 calibrated steps of a 1-2-5 sequence. Uncalibrated continuously-variable control extends deflection factor to at least 0.5 S/div. Magnifier extends fastest sweep rate to 100 nS/div.

**Delayed (B) Timebase Speeds**

0.2 μS/div to 20 μS/div in 7 calibrated steps of a 1-2-5 sequence. Magnifier extends fastest sweep rate to 100 nS/div.

**Magnifier**

10× deflection increase at any timebase setting divides sweep rates by a factor of ten. 0.2, 0.5μS range are uncalibrated.

**Accuracy**

± 3% normal; ± 5% magnified

**Delay Time**

Continuously variable from less than 1 division to 10 divisions or more

**Delayed Timebase Jitter**

1 part in 20,000
### Triggering

<table>
<thead>
<tr>
<th>Source</th>
<th>CH1, CH2, Line, External</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coupling</td>
<td>AC, HF Reject LF Reject, DC</td>
</tr>
<tr>
<td>Trigger Modes</td>
<td>Auto, Normal, TV-V, TV-H</td>
</tr>
<tr>
<td>Slope</td>
<td>+ or -</td>
</tr>
<tr>
<td>Hold off</td>
<td>Variable</td>
</tr>
<tr>
<td>TV Sync Polarity</td>
<td>Negative</td>
</tr>
<tr>
<td>Sensitivity (Internal Trigger)</td>
<td>30 Hz to 5 MHz : 0.5 div</td>
</tr>
<tr>
<td></td>
<td>5 MHz to 40 MHz : 1.5 divs</td>
</tr>
<tr>
<td>Sensitivity (External Trigger)</td>
<td>30 Hz to 5 MHz : 0.2V</td>
</tr>
<tr>
<td></td>
<td>5 MHz to 40 MHz : 0.8 V</td>
</tr>
<tr>
<td>Sensitivity (TV-V)</td>
<td>At least 1 div or 1.0V</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>1 megohm in parallel with approx. 30 pF</td>
</tr>
<tr>
<td>Maximum Input Voltage</td>
<td>300 V (DC + peak AC)</td>
</tr>
</tbody>
</table>

### Calibrator

<table>
<thead>
<tr>
<th>Output Voltage</th>
<th>500 mV p-p ± 3%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>Approx. 1000 Hz</td>
</tr>
<tr>
<td>Waveform</td>
<td>Square wave</td>
</tr>
</tbody>
</table>

### Z-Axis Modulation

<table>
<thead>
<tr>
<th>Input Signal</th>
<th>Positive-going signal decreases intensity. +5 V signal causes noticeable modulation at normal intensity settings.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bandwidth</td>
<td>DC to 2 MHz</td>
</tr>
<tr>
<td>Coupling</td>
<td>DC</td>
</tr>
<tr>
<td>Input Impedance</td>
<td>25 k-ohms typical</td>
</tr>
<tr>
<td>Maximum Input Voltage</td>
<td>30 V (DC + peak AC)</td>
</tr>
</tbody>
</table>
### CRT Display
- **Type**: 6-inch square tube
- **Accelerating Potential**: Approx. 12 kV
- **Phosphor**: P31 standard
- **Graticule**: Internal 1 cm square divisions. 8 divisions high, 10 divisions wide. Illuminated.

### Physical & Environmental Data

<table>
<thead>
<tr>
<th>Category</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (W×H×D)</td>
<td>11.6 × 5.8 × 15 inches</td>
</tr>
<tr>
<td></td>
<td>290 × 145 × 375 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>Approx. 18.7 lbs (8.5 kg)</td>
</tr>
<tr>
<td>Temp. Range for Rated Operation</td>
<td>+10° to +35°C (50° to 95°F)</td>
</tr>
<tr>
<td>Max. Ambient Operating Temp.</td>
<td>0° to +40°C (32° to 104°F)</td>
</tr>
<tr>
<td>Max. Storage Temperature</td>
<td>−20° to +70°C (−4° to +158°F)</td>
</tr>
<tr>
<td>Humidity Range for Rated Operation</td>
<td>45 to 85%</td>
</tr>
<tr>
<td>Max. Ambient Operating Humidity</td>
<td>35 to 85%</td>
</tr>
</tbody>
</table>

### Power Requirements
- **Line Voltage**: 100, 120, 220, 240 VAC ± 10% (250V MAX)
- **Line Frequency**: 50 to 400 Hz
- **Power Consumption**: Approx. 55 W

### Supplied Accessories
- **Operator's Manual**: 1
- **Direct/Low-capacitance Probes**: 2
- **Fuse**: 1
- **AC Power Cord**: 1
FIGURE 2-1. FRONT-PANEL ITEMS

FIGURE 2-2. REAR-PANEL ITEMS
2. OPERATING INSTRUCTIONS

This section contains the information needed to operate the Model 7040A and utilize it in a variety of basic and advanced measurement procedures. Included are the identification and function of controls, connectors, and indicators, startup procedures, basic operating routines, and selected measurement procedures.

2-1. FUNCTION OF CONTROLS, CONNECTORS, AND INDICATORS

Before turning this instrument on, familiarize yourself with the controls, connectors, indicators, and other features described in this section. The following descriptions are keyed to the items called out in Figures 2-1 and 2-2.

2-1-1 Display and Power Blocks

<table>
<thead>
<tr>
<th>Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) POWER switch</td>
<td>Push in to turn instrument power on and off.</td>
</tr>
<tr>
<td>(2) POWER lamp</td>
<td>Lights when power is on.</td>
</tr>
<tr>
<td>(3) INTEN control</td>
<td>Adjusts the brightness of the CRT display. Clockwise rotation increases brightness.</td>
</tr>
<tr>
<td>(4) FOCUS control</td>
<td>To obtain maximum trace sharpness.</td>
</tr>
<tr>
<td>(5) ROTATION control</td>
<td>Allows screwdriver adjustment of trace alignment with regard to the horizontal graticule lines of the CRT.</td>
</tr>
<tr>
<td>(6) ILLUM control</td>
<td>To adjust graticule illumination for photographing the CRT display.</td>
</tr>
<tr>
<td>(7) Voltage Selector</td>
<td>Permits changing the operating voltage range.</td>
</tr>
<tr>
<td>(8) Power Connector</td>
<td>Permits removal or replacement of the AC power cord.</td>
</tr>
</tbody>
</table>
2-1-2 Vertical Amplifier Block

(9) CH1 or X IN connector

For applying an input signal to vertical-amplifier channel 1, or to the x-axis (horizontal amplifier during X-Y operation.

(10) CH2 or Y IN connector

For applying an input signal to vertical-amplifier channel 2, or to the Y-axis (vertical) amplifier during X-Y operation.

(11) CH1 AC/GND/DC switch

To select the method of coupling the input signal to the CH1 vertical amplifier.

AC position inserts a capacitor between the input connector and amplifier to block any DC component in the input signal.

GND position connects the amplifier to ground instead of the input connector, so a ground reference can be established.

DC position connects the amplifier directly to its input connector, thus passing all signal components on to the amplifier.

(12) CH2 AC/GND/DC switch

To select the method of coupling the input signal to the CH2 vertical amplifier.

(13) CH1 VOLTS/DIV switch

To select the calibrated deflection factor of the input signal fed to the CH1 vertical amplifier.

(14) CH2 VOLTS/DIV switch

To select the calibrated deflection factor of the input signal fed to the CH2 vertical amplifier.

(15) (16) VARIABLE controls

Provide continuously variable adjustment of deflection factor between steps of the VOLTS/DIV switches. VOLTS/DIV calibrations are accurate only when the VARIABLE controls are click-stopped in their fully clockwise position.

(15) (16) PULL ×5 MAG switches

(on VARIABLE controls)

To increase the vertical amplifier sensitivity by 5 times. The effective scale factor of the most sensitive position of the VOLTS/DIV switch thereby becomes 1 mV/div.

(17) (18) UNCAL lamps

Indicate when the VARIABLE controls are rotated out of their clickstops.

(19) CH1 POSITION control

For vertically positioning the CH1 trace on the CRT screen. Clockwise rotation moves the trace up, counterclockwise rotation moves the trace down.

(19) PULL ADD switch

(on CH1 POSITION control)

When pulled, the scope displays the algebraic sum of the CH1 and CH2 traces.
(20) CH2 POSITION control

For vertically positioning the CH2 trace on the CRT screen. Clockwise rotation moves the trace upward, counterclockwise rotation moves the trace downward.

(20) PULL CH2 INV switch
(on CH2 POSITION control)

When pulled, the polarity of the CH2 signal is inverted.

(21) V MODE switch

To select the vertical-amplifier display mode.

CH1 position displays only the channel 1 input signal on the CRT screen.

CH2 position displays only the channel 2 input signal on the CRT screen.

ALT position displays the input signals of both channels 1 and 2. The CRT beam is switched between channels at the end of each sweep to achieve this multi-channel display.

CHOP position displays the input signals of both channels 1 and 2. The CRT beam is switched between channels at a 250 kHz rate during the horizontal sweep to achieve this multi-channel display.

(22) CH1 OUTPUT connector

Provides amplified output of the channel 1 signal suitable for driving a frequency counter or other instrument.
2-1-3 Sweep and Trigger Blocks

(23) HORIZ DISPLAY switches
To select the sweep mode.
A pushbutton sweeps the CRT at the main (A) timebase rate when pressed.
A INT pushbutton sweeps the CRT at the main (A) timebase rate when pressed, and the B timebase intensifies a section of the trace(s). The location of the intensified section is determined by the DELAY TIME POS control.
B pushbutton sweeps the CRT at the rate selected by the B TIME/DIV switch, after a delay determined by the A TIME/DIV switch and the DELAY TIME POS control.

B TRIG'D pushbutton sweeps the CRT at the rate selected by the B TIME/DIV switch when triggered by the first trigger pulse occurring after the delay time determined by the A TIME/DIV switch and the DELAY TIME POS control.

To select either the calibrated sweep rate of the main (A) timebase, the delay-time range for delayed-sweep operation, or X-Y operation.

(24) A TIME/DIV switch
To select the calibrated sweep rate of the delayed (B) timebase.

(25) B TIME/DIV switch
To select the calibrated sweep rate of the delayed (B) timebase.

(26) DELAY TIME POS control
To determine the exact starting point within the A timebase delay range at which the B timebase will begin sweeping.

(27) A VARIABLE control
Provides continuously variable adjustment of sweep rate between steps of the A TIME/DIV switch TIME/DIV calibrations are accurate only when the A VARIABLE control is click-stopped fully clockwise.

(27) PULL ×10 MAG switch
(on A VARIABLE control)
To expand the horizontal deflection by 10 times, thus increasing horizontal sensitivity by 10 times for X-Y operation, and increasing the effective sweep speed by 10 times.

(28) UNCAL lamp
Indicates when A VARIABLE controls rotated out of its click-stopped position.

(29) Horizontal POSITION control
To adjust the horizontal position of the traces displayed on the CRT. Clockwise rotation moves the traces to the right, counterclockwise rotation moves the traces to the left.
(30) Trigger MODE switch

To select the sweep triggering mode.

AUTO position selects free-running sweep where a baseline is displayed in the absence of a signal. This condition automatically reverts to triggered sweep when a trigger signal of 25 Hz or higher is received and other trigger controls are properly set.

NORM position produces sweep only when a trigger signal is received and other controls are properly set. No trace is visible if any trigger requirement is missing. This mode must be used when the signal frequency is 25 Hz or lower.

TV-V position is used for observing a composite video signal at the frame rate.

TV-H position is used for observing a composite video signal at the line rate.

(31) Trigger COUPLING switch

To select the frequency characteristics of the trigger-circuit coupling.

AC position inserts a large capacitor in the trigger-coupling chain to remove and DC component from the trigger signal.

HF REJ position inserts a filter in the trigger-coupling chain that removes signal components higher than 4 kHz. Use this position to eliminate high-frequency noise.

LF REJ position inserts a filter that removes signal components lower in frequency than 4 kHz. Use this position to eliminate low-frequency noise or undesired trigger signals.

DC position passes the trigger signal without modification. Use this setting when triggering from a very low-frequency signal or a DC level.

(32) Trigger SOURCE switch

To conveniently select the trigger source.

CH1 position selects the channel 1 signal as the trigger source.

CH2 position selects the channel 2 signal as the trigger source.

LINE position selects a trigger derived from the AC power line. This permits the scope to stabilize display line-related components of a signal even if they are very small compared to other components of the signal.

EXT position selects the signal applied to the EXT TRIG IN connector.
2-1-4 Miscellaneous Features

(33) EXT TRIG IN connector  For applying external trigger signal to the trigger circuits.

(34) Trigger LEVEL control  To select the trigger-signal amplitude at which triggering occurs. When rotated clockwise, the trigger point moves toward the positive peak of the trigger signal. When this control is rotated counterclockwise, the trigger point moves toward the negative peak of the trigger signal.

(34) Trigger SLOPE switch (on LEVEL control)  To select the positive or negative slope of the trigger signal for initiating sweep. Pushed in, the switch selects the positive (+) slope. When pulled, this switch selects the negative (−) slope.

(35) TRIG'D lamp  Lights when the sweep generator is being triggered.

(36) HOLDOFF control  Allows triggering on certain complex signals by changing the holdoff (dead) time of the main (A) sweep. This avoids triggering on intermediate trigger points within the repetition cycle of the desired display. The holdoff time increases with clockwise rotation. NORM is a position at full counterclockwise rotation that is used for ordinary signals.

(37) EXT BLANKING INPUT connector  For applying signal to intensity modulate the CRT. Trace brightness is reduced with a positive signal, and increased with a negative signal.

(38) CAL connector  Provides a fast-rise square wave of precise amplitude for probe adjustment and vertical amplifier calibration.

(39) Ground connector  Provides an attachment point for a separate ground lead.
2-3. BASIC OPERATING PROCEDURES

The following paragraphs in this section describe how to operate the Model 7040A, beginning with the most elementary operating modes, and progressing to the less frequently-used and/or complex modes.

2-3-1 Signal Connections

There are three methods of connecting an oscilloscope to the signal you wish to observe. They are: a simple wire lead, coaxial cable, and scope probes.

A simple lead wire may be sufficient when the signal level is high and the source impedance low (such as TTL circuitry), but is not often used. Unshielded wire picks up hum and noise; this distorts the observed signal when the signal level is low. Also, there is the problem of making secure mechanical connection to the input connectors. A binding post-to BNC adapter is advisable in this case.

Coaxial cable is the most popular method of connecting an oscilloscope to signal sources and equipment having output connectors. The outer conductor of the cable shields the central signal conductor from hum and noise pickup. These cables are usually fitted with BNC connectors on each end, and specialized cable and adaptors are readily available for mating with other kinds of connectors.

Scope probes are the most popular method of connecting the oscilloscope to circuitry. These probes are available with 1X attenuation (direct connection) and 10X attenuation. The 10X attenuator probes increase the effective input impedance of the probe/scope combination to 10 megohms shunted by a few picofarads. The reduction in input capacitance is the most important reason for using attenuator probes at high frequencies, where capacitance is the major factor in loading down a circuit and distorting the signal. When 10X attenuator probes are used, the scale factor (VOLTS/DIV switch setting) must be multiplied by ten.

Despite their high input impedance, scope probes do not pickup appreciable hum or noise. As was the case with coaxial cable, the outer conductor of the probe
cable shields the central signal conductor. Scope probes are also quite convenient from a mechanical standpoint.

To determine if a direct connection with shielded cable is permissible, you must know the source impedance of the circuit you are connecting to, the highest frequencies involved, and the capacitance of the cable. If any of these factors are unknown, use a 10× low-capacitance probe.

An alternative connection method at high frequencies is terminated coaxial cable. A feed-thru terminator having an impedance equal to that of the signal-source impedance is connected to the oscilloscope input connector. A coaxial cable of matching impedance connects the signal source to the terminator. This technique allows using cables of nearly and practical length without signal loss.

If a low-resistance ground connection between oscilloscope and circuit is not established, enormous amounts of hum will appear in the displayed signal. Generally, the outer conductor of shielded cable provides the ground connection. If you are using plain lead wire, be certain to first connect a ground wire between the Model 7040A Ground connector (39) and the chassis or ground bus of the circuit under observation.

**WARNING**: The Model 7040A has an earth-grounded chassis (via the 3-prong power cord). Be certain the device to which you connect the scope is transformer operated. Do NOT connect this oscilloscope or any other test equipment to "AC/DC", "hot chassis", or "transformerless" devices. Similarly, do NOT connect this scope directly to the AC power line or any circuitry connected directly to the power line. Damage to the instrument and severe injury to the operator may result from failure to heed this warning.
2-3-2. Single-trace Operation

Single-trace operation with single timebase and internal triggering is the most elementary operating mode of the Model 7040A. Use this mode when you wish to observe only a single signal, and not be disturbed by other traces on the CRT. Since this is fundamentally a two-channel instrument, you have a choice for your single channel. Channel has an output terminal; use channel 1 if you also want to measure frequency with a counter while observing the waveform. Channel 2 has a polarity-inverting switch. While this adds flexibility, it is not too useful in ordinary single-trace operation.

The Model 7040A is set up for single-trace operation as follows:

1. Set the following controls as indicated below. Note that the trigger source selected (CH1 or CH2 SOURCE) must match the single channel selected (CH1 or CH2 V MODE).

   **POWER switch (1)**
   ON (pushed in)

   **AC/GND/DC switches (11) (12)**
   AC

   **Vertical POSITION controls (19) (20)**
   Mid rotation and pushed in

   **VARIABLE controls (15) (16)**
   Fully CW and pushed in

   **V MODE switch (21)**
   CH1 (CH2)

   **HORIZ DISPLAY switches (23)**
   A

   **A VARIABLE control (27)**
   Fully CW and pushed in

   **Trigger MODE switch (30)**
   AUTO

   **Trigger SOURCE switch (32)**
   CH1 (CH2)

   **Trigger COUPLING switch (31)**
   AC

   **Trigger LEVEL control (34)**
   Mid rotation

   **HOLDOFF control (36)**
   NORM (fully CCW)

2. Use the corresponding Vertical POSITION control (19) or (20) to set the trace near mid screen.

3. Connect the signal to be observed to the corresponding IN connector (9) or (10), and adjust the corresponding VOLTS/DIV switch (13) or (14) so the displayed signal is totally on screen.

   **CAUTION:** Do not apply a signal greater than 300 V (DC + peak AC)

4. Set the A TIME/DIV switch (24) so the desired number of signal cycles are displayed. For some measurements just 2 or 3 cycles are best; for other measurements 50-100 cycles appearing like a solid band works best. Adjust the Trigger LEVEL control (34) if necessary for a stable display.
5. If the signal you wish to observe is so weak that even the 5 mV position of the VOLTS/DIV switch cannot produce sufficient trace height for triggering or a usable display, pull the corresponding VARIABLE control knob (PULL × 5MAG switch) (15) or (16). This produces 2 mV/div sensitivity when the VOLTS/DIV switch is set to 10 mV, and 1 mV/div when it is set to 5 mV. However, the channel bandwidth decreases to 7 MHz, and the trace noise may become noticeable when this is done.

6. If the signal you wish to observe is too high in frequency that even the .2 µS position of the A TIME/DIV switch results in too many cycles displayed, pull the A VARIABLE knob to activate the PULL ×10 MAG switch (27). This increases the effective sweep speed by a factor of ten, so .2 µS becomes 20 nS/div, .5 µS become 50 nS/div, etc. 0.2 and 0.5 µS MAG are uncalibrated, 1µS is calibrated and below.

7. If the signal you wish to observe is either DC or low enough in frequency that AC coupling attenuates or distorts the signal, flip the AC/GND/DC switch (11) or (12) to DC. CAUTION: If the observed waveform is low-level AC, make certain it is not riding on a high-amplitude DC voltage.

You will also have to reset the Trigger MODE switch (30) to NORM if the signal frequency is below 25 Hz, and possibly readjust the Trigger LEVEL control (34).

2-3-3 Dual-trace Operation

Dual-trace operation is the major operating mode of the Model 7040A. The setup for dual-trace operation is identical to that of 2-3-2 Single-trace Operation with the following exceptions:

1. Set the V MODE switch (21) to either ALT or CHOP. Select ALT for relatively high-frequency signals (A TIME/DIV switch set to .2mS or faster). Select CHOP for relatively low-frequency signals (A TIME/DIV switch set to .5 mS or slower)

2. If both channels are displaying signals of the same frequency, set the Trigger SOURCE switch (32) to the channel having the steepest-slope waveform. If the signals are different but harmonically related, trigger from the channel carrying the lowest frequency. Also, remember that if you disconnect the channel serving as the trigger source, the entire display will free run.
FIGURE 2-4. USING THE TV SYNC SEPARATOR
2-3-4 Trigger options

Triggering is often the most difficult operation to perform on an oscilloscope because of the many options available and the exacting requirements of certain signals.

Trigger Mode Selection. When the NORM trigger mode is selected, the CRT beam is not swept horizontally across the face of the CRT until a sample of the signal being observed, or another signal harmonically related to it, triggers the timebase. However, this trigger mode is inconvenient because no baseline appears on the CRT screen in the absence of a signal, or if the trigger controls are improperly set. Since an absence of trace can also be due to an improperly-set Vertical POSITION control or VOLTS/DIV switch, much time can be wasted in determining the cause. The AUTO trigger mode solves this problem by causing the timebase to automatically free run when not triggered. This yields a single horizontal line with no signal, and a vertically-deflected but non-synchronized display when vertical signal is present but the trigger controls are improperly set. This immediately indicates what is wrong. The only hitch with AUTO operation is that signals below 25 Hz cannot, and complex signals of any frequency may not, reliably trigger the timebase. Therefore, the usual practice is to leave the Trigger MODE switch (30) set to AUTO, but reset it to NORM if any signal (particularly one below 25 Hz) fails to produce a stable display.

The TV-V and TV-H positions of the Trigger MODE switch insert a TV sync separator into the trigger chain, so a clean trigger signal at either the vertical-or horizontal-repetition rates can be removed from a composite video signal (Figure 2-4a). To trigger the scope at the vertical rate (Figure 2-4b), set the Trigger MODE switch to TV-V. To trigger the scope at the horizontal (line) rate (Figure 2-4c), set the Trigger MODE switch to TV-H. For best results, the TV sync polarity should be negative (Figure 2-4d) when the sync separator is used.
Trigger Point Selection. The SLOPE switch determines whether the sweep will
on a positive-going or negative-going transition of the trigger signal. (See
Figure 2-5). Always select the steepest and most stable slope or
edge. For example, small changes in the amplitude of the sawtooth shown in Figure
2-5A will cause jittering if the timebase is triggered on the positive (ramp) slope,
but have no effect if triggering occurs on the negative slope (a fast-fall edge).
In the example shown in Figure 2-5B, both leading and trailing edges are very steep
(fast rise and fall times). However, triggering from the jittering trailing edge will cause
the entire trace to jitter, making observation difficult. Triggering from the stable
leading edge (+ slope) yields a trace that has only the trailing-edge jitter of the original
signal. If you are ever in doubt, or have
an unsatisfactory display, try both slopes to find the best way.

The LEVEL control determines the point on the selected slope at which the main
(A) timebase will be triggered. The effect of the LEVEL control on the displayed
trace is shown in Figure 2-5C. The +, 0, and − panel markings for this control
refer to the waveform's zero crossing and points more positive (+) and more negative
(−) than this. If the trigger slope is very steep, as with square waves or digital
pulses, there will be no apparent change in the displayed trace until the LEVEL
control is rotated past the most positive or most negative trigger point, whereupon
the display will free run (AUTO sweep mode) or disappear completely (NORM sweep mode).
Try to trigger at the mid point of slow-rise waveforms (such as sine and triangular waveforms),
since these are usually the cleanest spots on such waveforms.
FIGURE 2-5. TRIGGER-SLOPE SELECTION

a. SAWTOOTH WAVEFORM

b. SQUARE WAVEFORM

c. TRIGGER LEVEL
Additive and differential operation are forms two-channel operation where two signals are combined to display one trace. In additive operation, the resultant trace represents the algebraic sum of the CH1 and CH2 signals. In differential operation, the resultant trace represents the algebraic difference between the CH1 and CH2 signals.

To set up the Model 7040A for additive operation, proceed as follows:

1. Set up for dual-trace operation per paragraph 2-3-3 Dual-trace Operation.

2. Make sure both VOLTS/DIV switches (13) and (14) are set to the same position and the VARIABLE controls (15) and (16) are click-stopped fully clockwise. If the signal levels are very different, set both VOLTS/DIV switches to the position producing a large on-screen display of the highest-amplitude signal.

3. Trigger from the channel having the biggest signal.

4. Pull the CH1 Vertical POSITION knob (19), thereby activating the PULL ADD switch. The single trace resulting is the algebraic sum of the CH1 and CH2 signals. Either of both of the Vertical POSITION controls (19) and (20) can be used to shift the resultant trace.

   NOTE: If the input signals are in-phase, the amplitude of the resultant trace will be the arithmetic sum of the individual traces (e.g., 4.2 div + 1.2 div = 5.4 div)
   If the input signals are 180° out-of-phase, the amplitude will be the difference (e.g., 4.2 div − 1.2 div = 3.0 div).

5. If the p-p amplitude of the resultant trace is very small, turn both VOLTS/DIV switches to increase the display height. Make sure both are set to the same position.

   To set up the Model 7040A for differential operation do everything just described and also pull the CH2 Vertical POSITION knob (20) to activate the PULL CH2 INV switch. The single trace resulting is the algebraic difference of the CH1 and CH2 signals. Now if the input signals are in-phase, the amplitude of the resultant trace is the arithmetic difference of the individual traces (e.g., 4.2 div − 1.2 div = 3.0 div.) If the input signals are 180 out-of-phase, the amplitude of the resultant trace is the arithmetic sum of the individual traces (e.g., 4.2 div + 1.2 div = 5.4 div)
2-3-6 X-Y Operation

The internal timebase of the Model 7040A are not utilized in X-Y operation; deflection in both the vertical and horizontal directions is via external signals. Vertical channel 1 serves as the X-axis (horizontal) signal processor, so horizontal and vertical axes have identical control facilities.

All of the V MODE, and trigger switches, as well as their associated controls and connectors, are inoperative in the X-Y mode.

To set up the Model 7040A for X-Y operation, proceed as follows:

1. Turn the A TIME/DIV switch (24) fully clockwise to its X-Y positions.
   
   CAUTION: Reduce the trace intensity, lest the undeflected spot damage the CRT phosphor.

2. Apply the vertical signal to the CH2 or Y IN connector (10), and the horizontal signal to the CH1 or X IN connector (9). Once the trace is deflected, restore normal brightness.

3. Adjust the trace height with the CH2 VOLTS/DIV switch (14), and the trace width with the CH1 VOLTS/DIV SWITCH (13). The PULL ×5 MAG switches (15) and (16) on the VARIABLE controls can be used if greater is necessary, so leave the TIME VARIABLE control (27) knob pushed in.

4. Adjust the trace position vertically (Y axis) with the CH2 Vertical POSITION control (20). Adjust the trace position horizontally (X axis) with the Horizontal POSITION control (29); the CH1 Vertical POSITION control has no effect during X-Y operation.

5. The vertical (Y-axis) signal can be inverted by pulling the CH2 Vertical POSITION knob to activate the PULL CH2 INV switch (20).
2-3-7 Delayed-time Operation

The Model 7040A contains two timebases, arranged so one (the A timebase) may provide a delay between a trigger event and the beginning of sweep by the second (B) timebase. This allows any selected portion of a waveform, or one pulse of a pulse train, to be spread over the entire CRT screen. Delayed sweep can be used with either single-trace or dual-trace operation. The procedure is the same regardless of the number of traces displayed.

Basic Delayed Sweep. For delayed sweep, proceed as follows:

1. Set up the instrument for whatever vertical mode you desire.
2. Make sure the B TRIG’D pushbutton (23) is out.
3. Press the A INT HORIZ DISPLAY pushbutton (23). A section of the trace(s) will brighten.

   NOTE: The intensified portion will be quite small if there is a large difference between the setting of the A and B TIME/DIV switches.

4. Turn the B TIME/DIV switch (25) until the intensified portion of the trace widens to an amount equal to the portion of the trace you wish to magnify (see Figure 2-6b).
5. Turn the DELAY TIME POS control (26) to position the intensification over the portion of the trace you wish to magnify.
6. Press the B HORIZ DISPLAY pushbutton (23). That portion of the trace intensified in Step 5 now appears spread over the full width of the CRT screen. The trace now displayed is being swept by the B timebase (Figure 2-6c).
7. If needed, additional enlargement is possible by pulling the A VARIABLE knob (27) for PULL ×10 MAG.
Triggered B Sweep. In basic delayed sweep, the B timebase is not triggered by a signal event, it begins when the main (A timebase) sweep cross compare level setting by DLY TIME POS. knob. The only problem with this is that main timebase jitter becomes apparent in the B sweep at high ratios of A to B TIME/DIV switch settings (100 : 1 and up). To circumvent this, the B sweep can be triggered by the signal itself, or a time-relate trigger signal. The DELAY TIME POS control then determines the minimum delay time between A and B sweeps; the actual delay time will be that plus the additional time until the next available trigger. The result is that actual delay time is variable only with step resolution, in increments of the interval between triggers. The maximum magnification possible by this technique is several thousand times. CRT brightness being the limiting factor.

For triggered B sweep, proceed as follows:

1. Set up the scope for basic delayed sweep as described in the preceding paragraphs.

2. Press in the B TRIG'D pushbutton (23), and adjust the Trigger LEVEL control (34) if necessary. The B timebase is now triggering on the same trigger signal as the A timbase. The start of B sweep will always be a leading or trailing edge of the trigger signal; turning the DELAY TIME POS control will not change this.
a. A TIMEBASE DISPLAY

b. A INTENSIFIED BY B DISPLAY

c. B TIMEBASE DISPLAY

FIGURE 2–6. SWEEP MAGNIFICATION BY THE B TIME BASE