NOTE

A nomenclature change has been introduced for the 5000 Series products. The 5403/D41 is now called the 5441 Storage Oscilloscope.

This composite manual incorporates the 5403 and D41 manuals, formerly bound under separate cover.

TEKTRONIX®

5441 STORAGE OSCILLOSCOPE

INSTRUCTION MANUAL

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077

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SECTION 3 SERVICE INFORMATION

OPERATING INSTRUCTIONS

The D41 Single Beam storage display module operates with a Tektronix 5400-series power supply/amplifier module to form an oscilloscope mainframe. This section gives a familiarization procedure, and general operating information.

The Installation section of the 5403 instruction manual should be referred to for initial preparation. It contains information for installation of plug-ins, correct operating voltage and temperature, and general oscilloscope usage.

A brief description of the function of the front and rear panel controls and connectors is given on the controls and connectors foldout page. More detailed information is given under General Operating Information.

BASIC OPERATION

Setup Information

The following steps demonstrate the use of the controls and connectors of the D41.

1. Make sure the oscilloscope system is complete. The D41 must be properly connected to the power supply/amplifier module. A 5A-series amplifier plug-in should be in one of the vertical (left or center) plug-in compartments and a 5B-series time-base plug-in should be in the horizontal (right) compartment.

2. Set the POWER switch to off (pushed in) and connect the D41 to a power source that meets the voltage and frequency requirements of this instrument. See Installation section in this manual, or in the 5403 manual.

3. Turn the INTENSITY and READOUT INTENS controls counterclockwise and pull the POWER switch out to turn the instrument on. Set the front-panel controls as follows:

D41

STORE	Non-Store (Button out)
SAVE	Off (Button out)
WRITING SPEED	Midrange
VARIABLE PERSIST (and Save Time)	Midrange
INTENSITY	See text above
FOCUS	As is
READOUT INTENS	See text above
GRAT ILLUM	As desired
BEAM FINDER	Not depressed
POWER	See text above

Amplifier Plug-In

Display	On
Position	Centered
Ch 1 Volts/Div	.1
CH 1 Variable Volts/Div	Cal (fully clockwise)
CH 1 Input Coupling	DC
Trigger	CH 1
Mode	CH 1

Time-Base Plug-In

Display	Alternate (Button out)
Position	Centered
Main Sec/Div	5 ms
Variable Seconds/Div	Cal (fully clockwise)
Mag	Off (Button out)
Main Trig Level	Counterclockwise
Source	Left (or Right if the amplifier plug-in is in the center compartment)
Coupling	Auto Trig, AC Coupl, + Slope
Mode	Main Sweep

4. Advance the INTENSITY control until the trace is at the desired viewing level. The trace should appear near the graticule center.

5. Connect a 1X probe or test lead from the CALIBRATOR loop to the amplifier plug-in input connector.

6. Turn the Main Trig Level control clockwise until a stable display is obtained. Adjust the vertical and horizontal

THEORY OF OPERATION

Z-AXIS AMPLIFIER AND CRT CIRCUIT

The CRT circuit produces the high voltage potentials and provides the control circuits necessary for operation of the cathode-ray tube (CRT). The Z-Axis amplifier circuit is included with the CRT circuit discussion, since it sets the intensity of the CRT display.

Z-Axis Amplifier

The Z-Axis amplifier is a current driven, shunt-feedback operational amplifier with a voltage output. The amplifier consists of Q345, Q352, and Q356. The feedback path is from the Q352-Q356 collectors through C350-R349-R350 to the summing point at the base of Q345. Q352 and Q356 are connected as a collector-coupled complementary amplifier that provides a fast linear output signal while consuming minimum quiescent power. Q356 acts as the pull-up transistor and Q352 acts as the pull-down transistor for the amplifier. The output voltage from the amplifier provides the drive signal to control the CRT intensity level through the control-grid supply.

The output voltage level of the Z-Axis amplifier is determined by the voltage drop across R349 and R350 in reference to the voltage level at the summing point for the amplifier (base of Q345). The current through R349-R350 is determined by the input current from any combination of several sources, such as INTENSITY control, plug-in interface (unblanking, readout unblanking), and from Q320 and Q335. Q320 is an operational amplifier that sets the EXT INTENSITY INPUT connector signal to a level suitable for proper Z-Axis amplifier response. Q335 acts as an electronic switch to cause the CRT display intensity to increase when the BEAM FINDER switch is pushed. Q340 acts as an impedance-matching and bias-setting transistor for the Z-Axis amplifier. CR352 and current limiting resistor R352 act as a protection circuit for the Z-Axis amplifier in case of a high-voltage short.

High-Voltage Regulator

High-Voltage Primary. A repetitive, sinusoidal signal is produced by a regenerative feedback oscillator in the primary of T410 and induced into the secondary. Current drive for the primary winding is furnished by Q410.

The conduction of Q410 is controlled by the collector voltage of Q400.

High-Voltage Regulation. Regulation is accomplished by sampling the −1.5 kV across voltage divider R395A-R395B. If the output level of the cathode supply goes above the nominal −1.5 kV (goes more negative), the input base of Darlington transistor Q390 goes negative from its quiescent 0 V. The output of Q390 goes more positive, reducing the conduction of Q400 and Q410. This reduces the peak-to-peak sinusoidal signal amplitude, resulting in a reduced voltage in the secondary of T410. Conversely, if the output decreases below −1.5 kV (goes more positive), Q410 will conduct more, i.e., have a larger sinusoidal signal amplitude. CR395 and C395 form a delay turn-on circuit to prevent the CRT beam from coming on immediately at instrument turn-on. The delay time is controlled by the time it takes the (+) end of C395 to charge to +30.6 V through R392 from the +200 V power supply. At the moment the top of C395 reaches +30.6 V, diode CR395 will turn on and clamp the CR395-C395-R397-R395A junction at +30.6 V. R402 and C402 limit the bandwidth of the regulator to prevent oscillations.

High-Voltage Outputs

The secondary winding of T410 provides the negative and positive accelerating potentials for the CRT and the bias voltage for the control grid.

Positive accelerating voltage for the CRT screen is supplied by voltage doubler U410. The applied voltage to the input of U410 from the T410 secondary winding is about +1.5 kV peak-to-peak. The output voltage of U410 is about +7 kV at the CRT anode. The negative accelerating voltage for the CRT cathode is also obtained from the T410 secondary winding. CR412 half-wave rectifies the transformer output and supplies the −1.5 kV to the CRT cathode. R419 connects the CRT cathode voltage to the CRT filament to prevent cathode-to-filament breakdown.

Diodes CR420 and CR422 provide the rectified negative control voltage for the CRT control grid. The output level of this supply is set by the Intens Range adjustment R435. Diodes CR428 and CR430 clip the CRT grid bias voltage from the T410 secondary, to determine the operating level at the control grid. CR428 limits the negative excursion of the bias voltage, depending upon the output voltage of the Z-Axis amplifier. The positive clipping level at the cathode of CR430 is set by the Intens Range adjustment. CR420 acts as a DC restorer and CR422 as a rectifier. This results

SERVICE INFORMATION

SPECIFICATIONS

The electrical specifications are valid only if (1) the instrument has been calibrated at an ambient temperature between +20°C and +30°C; (2) the instrument is operating at an ambient temperature between 0°C and +50°C unless otherwise noted; (3) each plug-in must be operating (fully installed) in a calibrated system.

Unless otherwise stated, specification are referenced to the plug-in connectors of the 5403. Any conditions that are unique to a particular specification are stated as part of that specification.

TABLE 3-1

5403-D41 Vertical Amplifier

Characteristics	Performance Requirements	Supplemental Information
Input Signal Amplitude (Differential)		50 mV/division ±2%. Less than 0.5% difference between left and right vertical plug-in compartments.
Bandwidth (6-Division Reference)	Dc to at least 90 MHz with a 067-0680-00 Calibration Fixture. Dc to at least 60 MHz with a calibrated 5A48.	
Risetime (6-Division Reference)	3.9 ns or less with a 067-0680-00 Calibration Fixture. 5.8 ns or less with a calibrated 5A48.	
Aberrations (6-Division Reference)	6% or less measured with a 067-0680-00 Calibration Fixture. 3% or less measured with a calibrated 5A48.	
Position Effect on Aberrations (6-Division Reference with a 067-0680-00 Calibration Fixture.		Front corner aberrations of +step or —step response signal should not exceed ±6% when the waveform is positioned not more than 1 division beyond graticule center.
Vertical Centering		Within ±0.5 division of graticule center.
Delay Line Length		140 ns
Modes	Chop and alt.	
Rate		
Chop	50 kHz +50% —30%; 3 μs on, 2 μs off.	
Alt	Once every two sweeps.	

TABLE 3-2

5403-D41 Horizontal Amplifier

Characteristics	Performance Requirements	Supplemental Information
Bandwidth	DC to at least 2 MHz.	Eight division signal used as a reference.
Horizontal Centering		Within 0.5 division of graticule center.
X-Y Operation	Less than 2° phase shift from DC to at least 20 kHz.	

MANUAL CHANGE INFORMATION

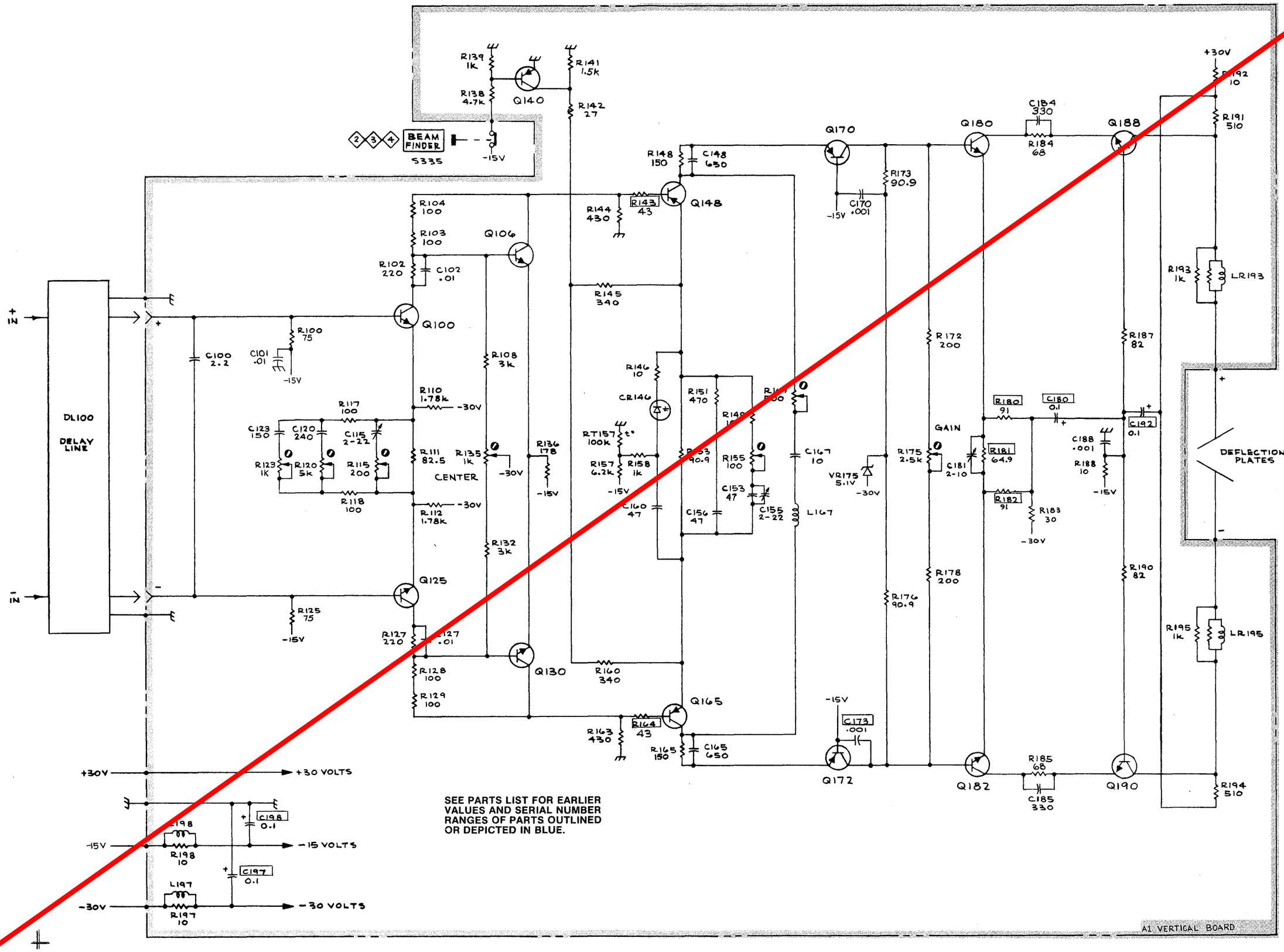
At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.


+IN
-IN
DL100
DELAY LINE
R100 75
C100 2.2
C101 .01
-15V
Q100
R102 220
C102 .01
R103 100
R104 100
Q106
R108 3k
R110 1.78k
-30V
R111 82.5
R112 1.78k
R117 100
R118 100
C123 150
C120 240
C115 2-22
R123 1K
R120 5k
R115 200
R135 1k
CENTER
R136 178
R132 3k
Q125
R125 75
R127 220
C127 .01
R128 100
R129 100
Q130
R139 1k
R138 4.7k
Q140
R141 1.5k
R142 27
BEAM FINDER
2 3 4
S335
R144 430
R143 43
Q148
R145 340
R160 340
R163 430
R164 43
Q165
R165 150
C165 650
R146 10
CR146
RT157 100k t°
R157 6.2k
R158 1k
C160 47
R151 470
R153 90.9
R140 100
R155 100
C153 47
C156 47
C155 2-22
C167 10
L167
VR175 5.1V
R148 150
C148 650
Q170
R173 90.9
C170 .001
R172 200
R176 90.9
C173 .001
Q172
R178 200
Q180
C184 330
R184 68
Q182
R185 68
C185 330
Q188
R187 82
R190 82
Q190
+30V
R192 10
R191 510
R193 1k
LR193
R195 1k
LR195
R194 510
R180 91
C180 0.1
GAIN
R175 2.5k
R181 64.9
C181 2-10
R182 91
R183 30
C188 .001
R188 10
C192 0.1
DEFLECTION PLATES
+30V
+30 VOLTS
-15V
C198 0.1
L198
R198 10
-15 VOLTS
C197 0.1
L197
-30V
R197 10
-30 VOLTS
SEE PARTS LIST FOR EARLIER VALUES AND SERIAL NUMBER RANGES OF PARTS OUTLINED OR DEPICTED IN BLUE.
A1 VERTICAL BOARD