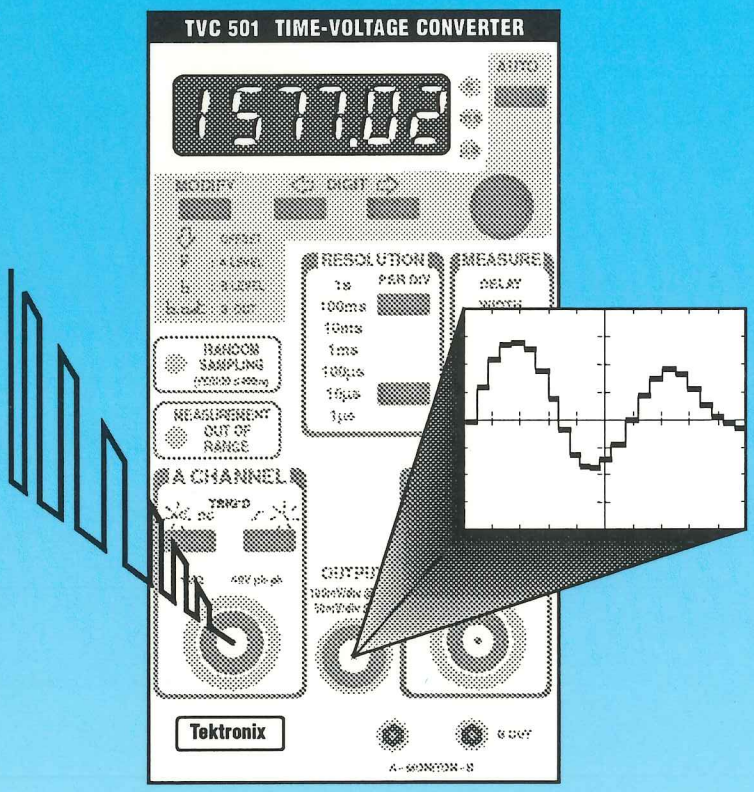
TVC 501

Time to Voltage Converter



Service Manual

Tektronix®
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TVC 501
TIME-TO-VOLTAGE CONVERTER

SERVICE MANUAL

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About This Manual

This manual describes how to service the TVC 501 Time-to-Voltage Converter. The information is organized into eight chapters:

Chapter 1: Theory of Operation explains the basic operation of each of the three circuit boards and how these boards interact with each other. This information helps you troubleshoot the instrument more easily if a failure occurs.

Chapter 2: Acceptance Tests provides test procedures that verify the TVC 501 is operating within the specifications listed in Chapter 7: Specifications.

Chapter 3: Calibration includes procedures to maintain the accuracy of the TVC 501.

Chapter 4: Diagnostics and Troubleshooting describes the power-up diagnostics performed by the TVC 501. A troubleshooting guide is also provided for various instrument failures. This guide helps you determine which circuit board or boards are faulty.

Chapter 5: Disassembly/Assembly describes how to remove the replaceable parts of the TVC 501. Use these procedures when replacing defective instrument components.

Chapter 6: Rear Panel Interface describes how to use the rear panel interface feature available with all TM 5000 and most TM 500 Series Power Modules.

Chapter 7: Specifications lists the performance, environmental, and physical specifications of the TVC 501.

Chapter 8: Replaceable Parts lists the replaceable parts for the TVC 501. Use this information to order parts from your local Tektronix field representative.

Conventions Used in This Manual

This manual uses the following references for instrument components:

TVC 501 refers to the TVC 501 Time-to-Voltage Converter.

Terms in upper-case bold type (such as **AUTO**) refer to a control, connector, or indicator.

Words with boxes (such as b.out 1) refer to a literal that is displayed on the TVC 501 six-digit readout.

Power Module or Power Mainframe refers to the Tektronix TM 500 or TM 5000 Series Power Modules.

This manual includes three types of supplemental information.

>> Note: *Notes include information to help you use the TVC 501 more efficiently.*

Caution: **Caution statements call attention to practices that could cause damage to the instrument.**

WARNING

These statements call attention to practices that could lead to personal injury or death.

SAFETY SUMMARY

The general safety information in this summary is for operating and service personnel. Specific warnings and cautions may be found throughout the manual where they apply and do not appear in this summary.

Terms Used in This Manual

Caution: **These statements call attention to practices that could cause damage to the instrument.**

WARNING

These statements call attention to practices that could lead to personal injury or death.

Terms Marked on Equipment

CAUTION indicates a personal injury hazard not immediately accessible or a hazard to property including the instrument itself.

DANGER indicates a personal injury hazard immediately accessible.

GENERAL SAFETY INFORMATION

To avoid injury or equipment damage, observe the following safety practices.

Power Source

The TVC 501 operates in a Tektronix TM 500 or TM5000 Series Power Module. To avoid personal injury or damage to the instrument, do not operate the TVC 501 with any other power source.

Grounding

To maintain proper grounding of the TVC 501, operate the Power Module according to the instructions provided in the Power Module instruction manual.

Danger from Loss of Ground

All accessible conductive parts (including controls that appear to be insulated) can cause electric shock upon loss of ground connection.

Explosive Atmospheres

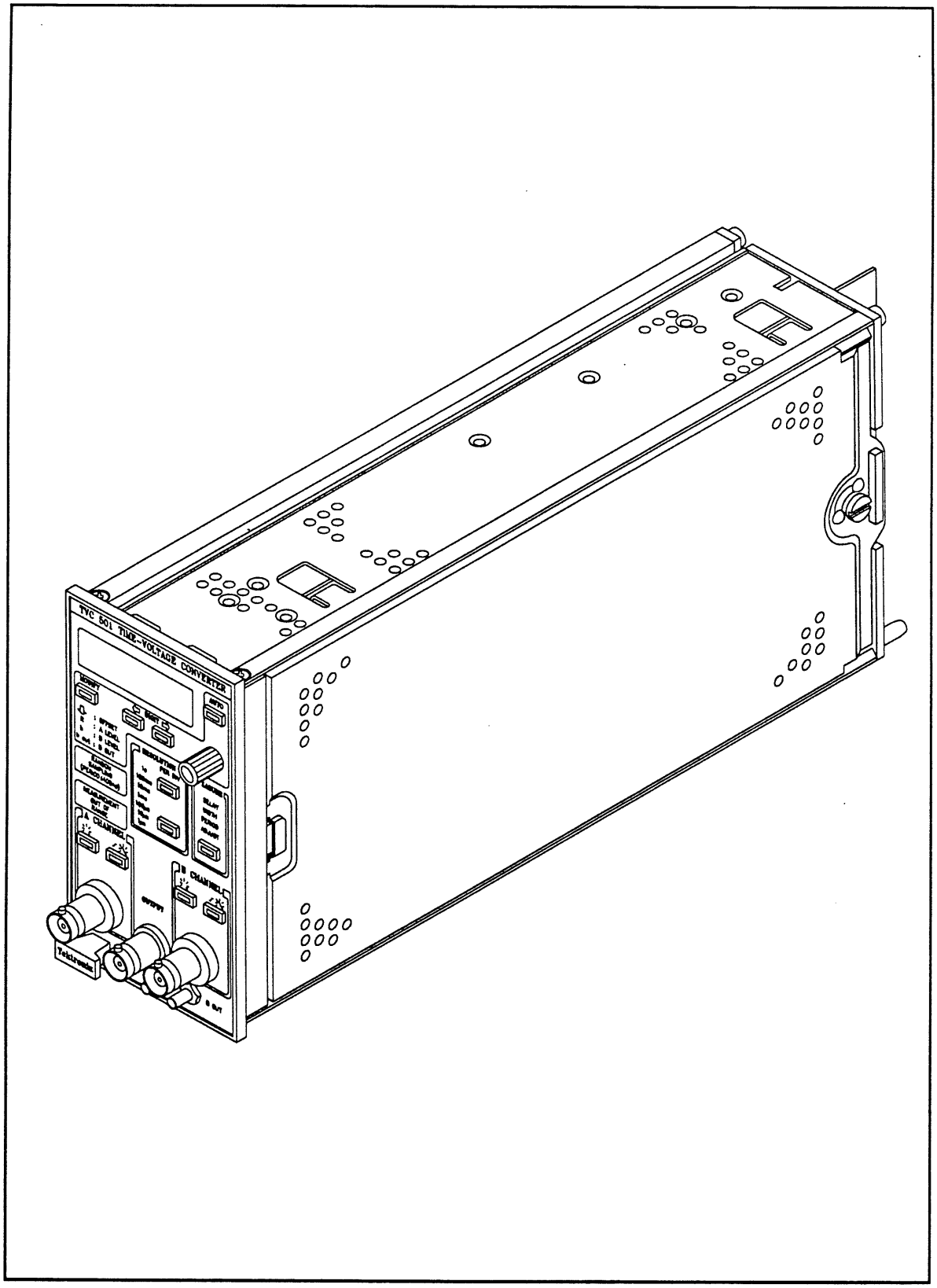
To avoid explosion, do not operate this instrument in an explosive atmosphere unless it has been specifically certified for such operation.

Operating Environment

For safe operation, operate this instrument in an environment compatible with the instrument and power module environmental specifications. To prevent instrument damage or fire, do not spill any liquids into the instrument.

Covers and Panels

To avoid personal injury or damage to the instrument, do not remove the instrument's covers or panels or operate the instrument without covers and panels in place.



The TVC 501 Time-to-Voltage Converter

Chapter 1: Theory of Operation

This chapter briefly describes the function of each of the three circuit boards in the TVC 501. Should an instrument failure ever occur, use this information with the troubleshooting guide in Chapter 4 to isolate any defective circuit boards.

The TVC 501 converts time-interval measurements to analog voltages. The instrument measures real-time delay, period, or pulse width measurements and converts the measurements into a proportional voltage that can be displayed on an oscilloscope screen.

The TVC 501 has three major functional blocks: the front panel, the processor board, and the counter board. Refer to Figure 1-1 when reading the following circuit descriptions.

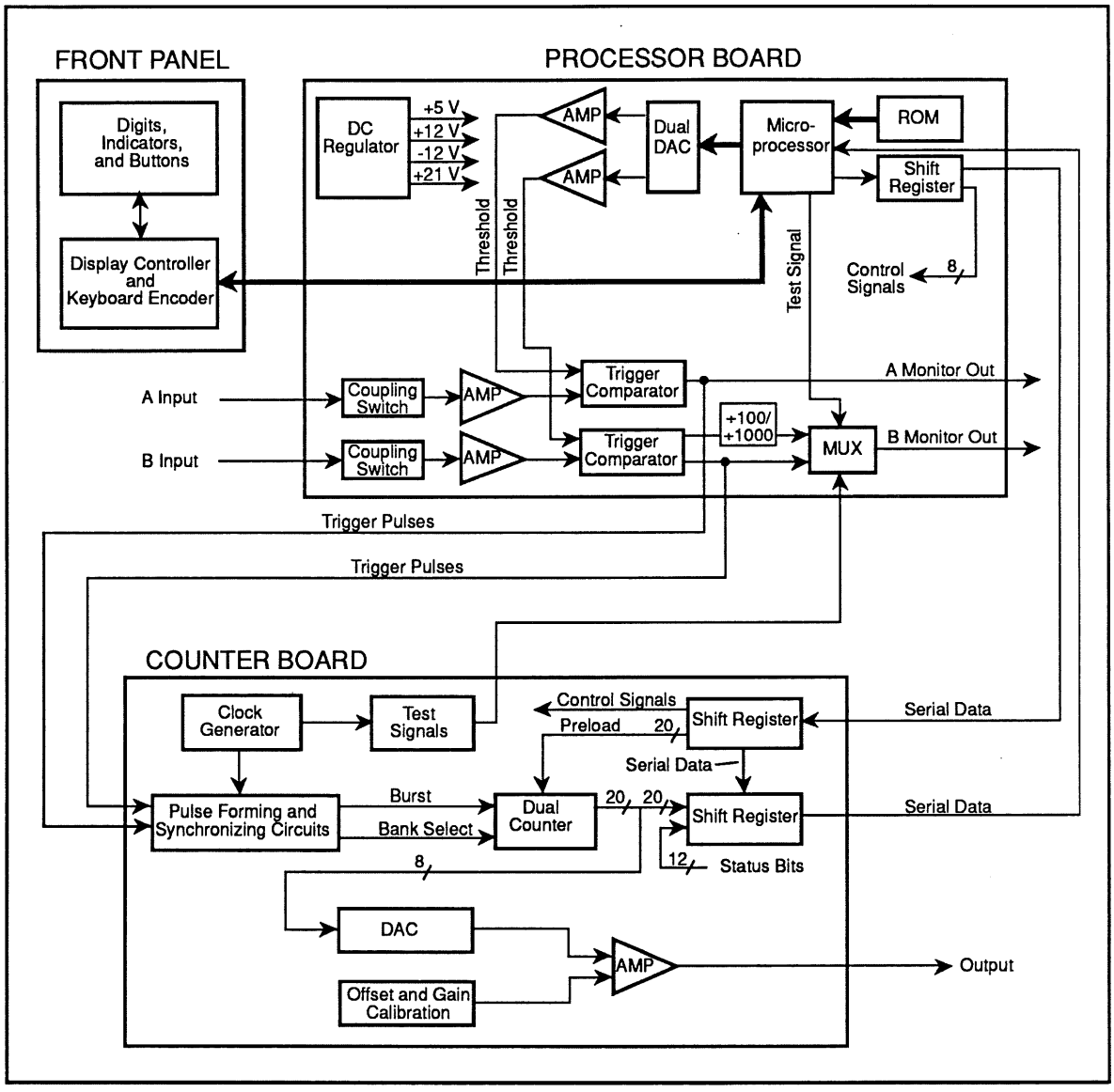


Figure 1-1. TVC 501 Block Diagram.

FRONT PANEL

The front panel provides the user interface for the TVC 501. Control buttons and a corresponding keyboard encoder reside on this board. Keyboard encoder data outputs to the processor board. Status and measurement data from the processor board inputs to the display controller and displayed by the front panel LEDs. For information about front panel operation, consult the *TVC 501 Operator's Guide*.

PROCESSOR BOARD

The processor board consists of the microprocessor, signal input circuits, and power regulators. The primary functions of this board include providing general instrument control and producing triggers from the input signal.

Microprocessor

The microprocessor processes keyboard data from the front panel and converts it to the corresponding control signals for the TVC 501 circuits. The microprocessor outputs measurement and status data to the front panel display controller.

The microprocessor also outputs data to a dual digital-to-analog converter (DAC). Each DAC output drives an operational amplifier that produces the threshold level for a trigger comparator. One comparator is for the channel A input and the other is for channel B.

The microprocessor shifts serial data, consisting of control bits and counter status bits, into a chain of shift registers. The shift register on the processor board outputs control bits for various processor board circuits. Shift registers on the counter board provide control bits, counter status bits, and counter preload data (see the counter board description).

Signal Input Circuits

Signal inputs from channel A and channel B are connected to coupling switches that are controlled by relays. These switches determine whether the input coupling is AC or DC. The switch outputs are sent to amplifier circuits and then to trigger comparators where the trigger slope and level are set. The trigger comparator outputs go to two places: the monitor outputs and the counter circuit board (see the counter board description).

The channel B trigger is available in divide-by-100 and divide-by-1000 prescaled (frequency divided) versions. In addition to the channel B trigger, several test and demonstration signals are available to the channel B monitor output. These signals originate from the microprocessor and counter circuit boards. The desired signal is selected by a signal multiplexer whose output is directed to the channel B monitor output.

Power Regulator

Using the source voltages of the TM 500 or TM 5000 Series Power Module, regulator circuits located on the processor board supply the following voltages:

- +5 V for analog circuits (+5VA)
- +5 V for digital circuits (+5VD)
- +12 V for analog circuits
- -12 V for analog circuits
- +21 V for relays

COUNTER BOARD

The counter board consists of the clock generator, pulse forming and synchronizing circuits, dual counter, DAC circuit, and shift registers. This board performs time-to-voltage conversions based on the duration of the input triggers. The counter board also generates three of the five test signals available at the channel B monitor output.

Clock Generator

The clock generator is the master clock that drives the pulse forming and synchronizing circuits. The clock generator also drives circuits that produce some of the channel B monitor test signals.

Pulse Forming and Synchronizing Circuits

The channel A and channel B outputs from the trigger comparators are input to the pulse forming and synchronizing circuits. The triggers are formed into a pulse representing the time interval to be measured. This time interval pulse is synchronized to the clock generator. When the time interval pulse is active (true), clock pulses are ANDed with it to form a burst. This burst is passed to the dual counter.

Dual Counter and DAC

The dual counter counts the number of pulses received in the clock burst from the pulse forming and synchronizing circuit. There are two banks of counters: one bank counts while data from the other bank is being processed. The bank select signal determines which bank is enabled for counting.

The pulse count is loaded into the DAC. The DAC converts the count value into a corresponding current. An amplifier following the DAC produces an output voltage from the DAC current. This voltage represents the time-to-voltage conversion. An adjustment circuit including gain and offset potentiometers provides offset and gain calibration for the output amplifier.

Shift Registers

Serial data from the processor board is shifted into a chain of shift registers and then back to the microprocessor. Data from the dual counter and status data is loaded into one set of registers. The microprocessor uses this data for the AUTO offset function. The processor can send a counter preload value to another set of registers. This preload value represents the offset value that is displayed on the front panel.

Chapter 2: Acceptance Tests

This chapter describes the tests used to verify the performance of the TVC 501. To achieve proper test results, operate the instrument within a temperature range of 0° C to +50° C (see the environmental specifications in Chapter 7: Specifications) and allow a 20-minute warm-up period.

If any tests fail, perform the calibration procedures in Chapter 3: Calibration and try the tests again. If the tests still fail, refer to the troubleshooting information in Chapter 4: Diagnostics and Troubleshooting. If you need additional help, contact your Tektronix service center.

REQUIRED TEST EQUIPMENT

Table 2-1 lists the equipment required to perform the acceptance tests in this chapter.

Table 2-1
Required Acceptance Test Equipment

Item	Description	Tektronix Equivalent
Oscilloscope	≥100 MHz bandwidth 1 MΩ input impedance	Tektronix 2465
Digital Counter	Bandwidth = ≥100 MHz Sensitivity = 50 mVp-p 2 ppm accuracy or better with features including ratio, frequency, and totalling	DC 509, DC 5009, DC 5010
Digital Voltmeter	4 1/2 digit resolution	DM 511, DM 5010
Pulse Generator	Minimum pulse width of ≤10 ns with 1 Vp-p of trigger output level	PG 502
Signal Generator	Frequency = ≤125 MHz at 1% Output = 250 mVp-p at 1%	SG 503
Power Module	Must accommodate 5 single-wide instruments	TM 500 or TM 5000
DC Voltage Source	Voltage Output: 100 mV at ≤0.5 mV resolution and 1.00 V at ≤5 mV resolution	PS 5004
Probe	10X passively coded	P6109, P6156
Cable	42" with SMB-to-BNC connectors	Part No. 012-0532-00
Cable (3 required)	42" with BNC-to-BNC connectors	Part No. 012-0057-01
50-Ω power divider	Female SMA connectors	Part No. 015-0565-00
BNC T Connector		Part No. 103-0030-00
Adapter (2 required)	BNC female-to-dual male banana	Part No. 103-0090-00
Adapter (3 required)	SMA male-to-BNC female	Part No. 015-1018-00
Termination (2 required)	50-Ω feed-through	Part No. 011-0049-01

PROCEDURES

Each procedure in this chapter describes how to connect the test equipment and how to perform the acceptance tests. Because the outcome of one procedure may affect a successive one, perform the procedures in the order listed.

>>Note *These procedures assume you are familiar with operation of the required test equipment listed in Table 2-1. If you need more information, consult the operator's manual for the appropriate piece of test equipment.*

Before beginning the tests, install the equipment in the Power Module and allow a 20-minute warmup period.

Test 1: Oscillator Stability

This procedure checks the stability of the TVC 501 internal oscillator. Refer to Figure 2-1 when doing this procedure.

1. Using the SMB-to-BNC cable, connect the TVC 501 **B OUT** to the channel A input of the Digital Counter.
2. Repeatedly press the TVC 501 **MODIFY** button until b.out appears in the display.
3. Turn the knob until b.out 4 appears in the display. The b.out 4 signal is a 60 Hz signal derived from the internal reference clock.
4. Set the Digital Counter to auto-average frequency A.
5. Set the trigger of the Digital Counter to positive slope, 1X attenuation, auto-level, and DC coupling.
6. Check the frequency reading on the Digital Counter. It should be **59.9985 Hz** to **60.0015 Hz**.

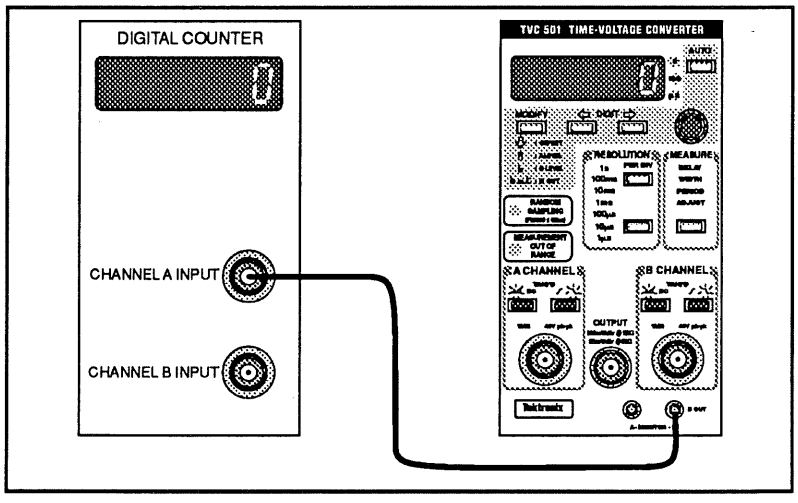


Figure 2-1. Oscillator Stability Test.

Test 2: Random Sampling Indicator

This procedure verifies that the **RANDOM SAMPLING** indicator doesn't light until the input signal exceeds the maximum rate. Refer to Figure 2-2 when performing this procedure.

1. Using a BNC-to-BNC cable, connect the Signal Generator output to the TVC 501 **A CHANNEL** input.
2. Repeatedly press the TVC 501 **MEASURE** button until **PERIOD** is selected.
3. Set the Signal Generator to produce a 500 mVp-p output with a frequency of 2.45 MHz.
4. Repeatedly press the TVC 501 **MODIFY** button until [A] appears in the display. This is the **A CHANNEL** trigger select mode.
5. Press the TVC 501 **AUTO** button.
6. Verify that the TVC 501 **RANDOM SAMPLING** indicator is off.
7. Change the Signal Generator frequency to 3.3 MHz.
8. Verify that the TVC 501 **RANDOM SAMPLING** indicator is continuously on.

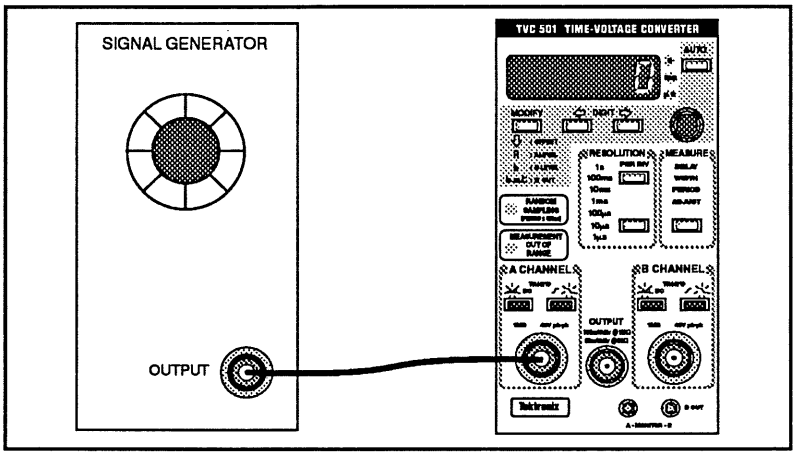


Figure 2-2. Random Sampling Test.

Test 3: Out of Range Indicator

This procedure verifies that the **MEASUREMENT OUT OF RANGE** indicator lights when the TVC 501 output exceeds ±4.3 divisions from center of the oscilloscope graticule.

1. Using the SMB-to-BNC cable, connect the TVC 501 **B OUT** to the TVC 501 **A CHANNEL** input.
2. Repeatedly press the TVC 501 **MODIFY** button until [b.out] appears in the display.
3. Rotate the knob until [b.out 4] is displayed.
4. Set the TVC 501 **A CHANNEL** trigger coupling to DC and the slope to rising edge (the coupling and slope LEDs should be off).
5. Set the **A CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until the [A] is displayed and then press **AUTO**. The **TRIG'D** indicator should be on.
6. Repeatedly press the TVC 501 **MEASURE** button until the **PERIOD** indicator lights.
7. Repeatedly press the **MODIFY** button until the offset value appears and then press **AUTO**. The offset should be **16666.7 µs**.
8. Using the TVC 501 **RESOLUTION PER DIVISION** buttons, select **1 µs** resolution.
9. Rotate the knob so that the offset value is **16670.7 µs**. Use the **DIGIT** buttons to make this adjustment more quickly.
10. Verify that the **MEASUREMENT OUT OF RANGE** indicator is off.
11. Rotate the knob to change the offset to **16671.0 µs**. Verify that the **MEASUREMENT OUT OF RANGE** indicator is on.
12. Change the offset value to **16662.5 µs**. Verify that the **MEASUREMENT OUT OF RANGE** indicator is off.
13. Change the offset value to **16662.3 µs**. Verify that the **MEASUREMENT OUT OF RANGE** indicator is on.

Test 4: Probe Scaling and ID Test

This procedure checks the ability of the TVC 501 to properly scale the trigger voltage using an attenuator probe; it also tests the identification function.

1. Select the **A CHANNEL** trigger by repeatedly pressing the TVC 501 **MODIFY** button until the [A] appears on the display.
2. Rotate the knob until the trigger level is at [A 1.00].
3. Connect a probe such as the Tektronix P6109 or P6156 to the **A CHANNEL** input of the TVC 501.
4. Verify that the display is 1 X the probe attenuation factor. For example, if you connect a 10X probe, the TVC 501 display should show a reading of [A 10.0].
5. Press the probe ID button and verify that the TVC 501 displays [ProbEA]. This display only lasts for about one second.
6. Repeat steps 1 through 5 for the **B CHANNEL** input. The TVC 501 should display the word [ProbEb] when you press the probe ID button.

Test 5: Minimum Pulse Width Test

This procedure verifies that the TVC 501 can trigger on the minimum pulse width and that the output measurement is accurate. Refer to Figures 2-3 and 2-4 when performing this procedure.

1. Using a BNC cable and 50-Ω termination, connect the Pulse Generator output to the Oscilloscope and adjust the Pulse Generator to produce a pulse duration of 10 ns and a period of 10 µs.
2. Set the output low level of the Pulse Generator to -125 mV and the output high level to +125 mV. When finished, disconnect the Pulse Generator from the Oscilloscope.
3. Using a BNC-to-BNC cable and 50-Ω termination, connect the Pulse Generator output to the TVC 501 **A CHANNEL** input as shown in Figure 2-3.
4. Using another BNC cable, connect the TVC 501 **OUTPUT** to the channel A input of the Digital Counter.
5. Set the TVC 501 **A CHANNEL** trigger coupling to DC and the slope to rising edge (the coupling and slope LEDs should be off).
6. Select the **A CHANNEL** trigger by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears in the display.
7. Press **AUTO**. The **TRIG'D** indicator should light.
8. Repeatedly press the TVC 501 **MEASURE** button until the **PERIOD** indicator lights.

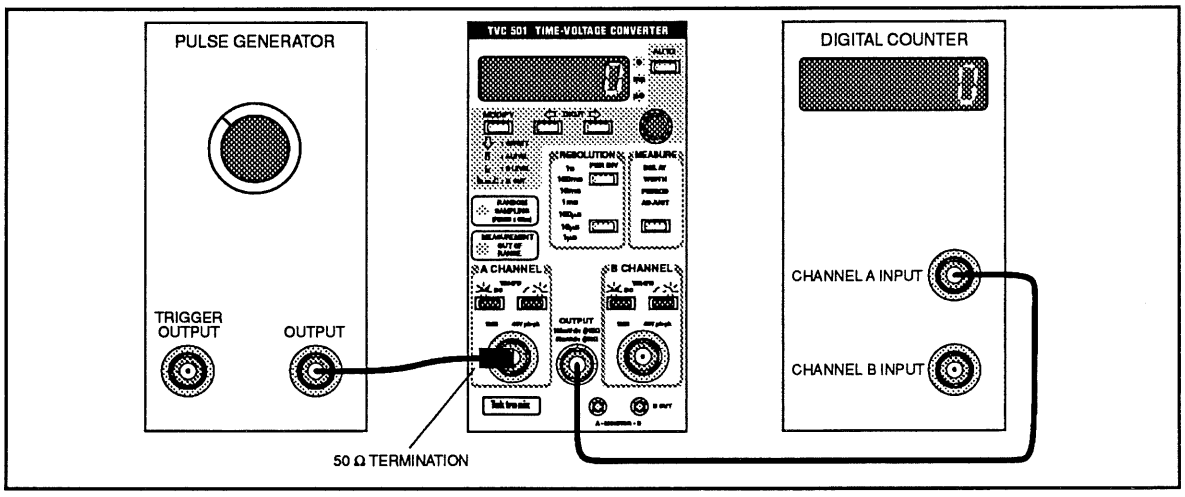


Figure 2-3. Channel A Minimum Pulse Width Test.

9. Press the TVC 501 **MODIFY** button until the offset is displayed and then press **AUTO**.
10. Verify that the TVC 501 displays an offset value between **9** µs and **11** µs. Also verify that the resolution is **1** µs.
11. Using the TVC 501 knob, set the offset to **15** µs.
12. Set the Digital Counter to total the channel A counts, set the trigger level to zero volts. Reset then enable the counter and verify that the totalling rate is less than one per 10-second period.
13. Move the Pulse Generator output connection from the TVC 501 **A CHANNEL** input to the **B CHANNEL** input as shown in Figure 2-4.
14. Using another BNC-to-BNC cable, connect the Pulse Generator trigger output to the TVC 501 **A CHANNEL** input.
15. Repeatedly press the TVC 501 **MEASURE** button until the **DELAY** indicator lights.
16. Select the **A CHANNEL** trigger by repeatedly pressing the **MODIFY** button until [A] is displayed and adjust it to **0.5** using the knob and **DIGIT** buttons. Select DC coupling and falling edge for the **A CHANNEL** trigger. The **TRIG'D** indicator for channel A should light.
17. Select the **B CHANNEL** trigger by pressing the **MODIFY** button until [B] is displayed. Select DC coupling and rising edge for the **B CHANNEL** trigger and then press **AUTO**. The **TRIG'D** indicator for channel B should light.

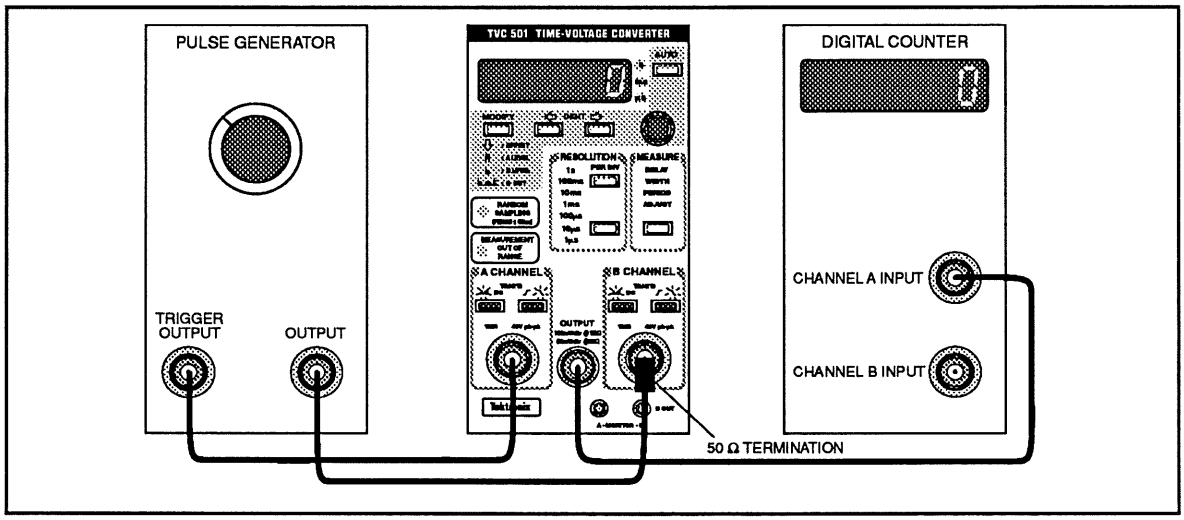


Figure 2-4. Channel B Minimum Pulse Width Test.

18. Repeatedly press **MODIFY** until the offset value is displayed and then press **AUTO**. Verify that the displayed value is between **4.5 µs** and **5.5 µs**.
19. Using the knob and **DIGIT** buttons, manually set the offset to **7.5 µs**.
20. Reset the Digital Counter and verify that the totalling rate is less than one error per 10-second period.

Test 6: Trigger Sensitivity

This procedure tests the AC and DC trigger sensitivity for both channel A and B inputs. Refer to Figure 2-5 when performing this procedure.

1. Connect the Pulse Generator output to the Oscilloscope and set the Pulse Generator to produce a pulse with a frequency 1 kHz ±100 Hz, a duty cycle of 40% to 60%, and an amplitude of 0.0 V to 100 mV ±3 mV. When finished, disconnect the Pulse Generator from the Oscilloscope.
2. Connect the Pulse Generator output to the **A CHANNEL** input of the TVC 501.
3. Select DC coupling and rising edge on the TVC 501 **A CHANNEL** trigger.
4. Select the **A CHANNEL** trigger by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears.
5. Press the **AUTO** button and note the value displayed.
6. Increment and decrement the **A CHANNEL** trigger level by rotating the knob. Note the upper and lower levels at which the **TRIG'D** status light goes out. The TVC 501 should remain triggered for at least two switch increments above and at least one switch increment below the **AUTO** level.
7. Move the BNC cable from the TVC 501 **A CHANNEL** input to the **B CHANNEL** input. Repeat steps 1 through 6 for the **B CHANNEL** input.

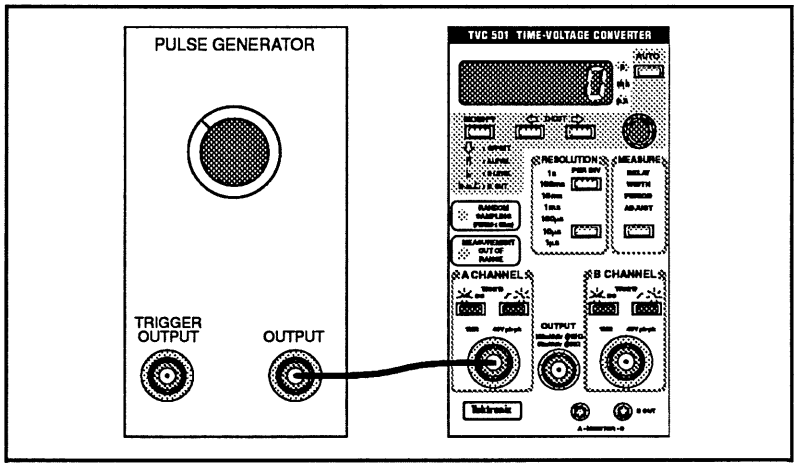


Figure 2-5. Trigger Sensitivity Test.

8. Reset the Pulse Generator amplitude to produce an output voltage with a low level of +2.0 V ±3 mV and a high level of +2.1 V ±3 mV. Verify this setting with an oscilloscope if necessary.
9. Switch the TVC 501 **B CHANNEL** trigger coupling to AC.
10. Select the **B CHANNEL** trigger by repeatedly pressing the TVC 501 **MODIFY** button until [B] appears.
11. Press the **AUTO** button and note the value displayed.
12. Increment and decrement the **B CHANNEL** trigger level by rotating the knob. Note the upper and lower levels at which the **TRIG'D** status light goes out. The TVC 501 should remain triggered for at least 2 switch increments above and at least 1 switch increment below the **AUTO** level.
13. Move the BNC cable from the TVC 501 **B CHANNEL** input to the **A CHANNEL** input. Repeat steps 9 through 12 for the TVC 501 **A CHANNEL** input.

Test 7: Trigger Level Accuracy

This procedure checks the trigger level accuracy of the channel A and channel B inputs. Refer to Figure 2-6 when performing this procedure.

1. Using the three BNC coaxial cables, BNC T adapter, and BNC-to-banana adapter, connect the DC Voltage Source to the Digital Voltmeter and TVC 501 **A CHANNEL** input.
2. Set the DC Voltage Source output to 1.00 V. Verify this voltage with the Digital Voltmeter.
3. Select DC coupling and rising edge for the TVC 501 **A CHANNEL** input.
4. Repeatedly press the **MODIFY** button until the channel A trigger level appears.
5. Press **AUTO**. The TVC 501 should display a reading of **0.93** to **1.07**.
6. Repeat steps 2 through 5 for the DC Voltage Source voltages listed in Table 2-2:

Table 2-2
Voltages for Trigger Accuracy Test

DC Voltage Source Output	TVC 501 Displayed Level
100 mV	+0.07 to +0.13
0.0 V	-0.02 to +0.02
-100 mV	-0.13 to -0.07
-1.00 V	-1.07 to -0.93

7. Move the BNC cable from the **A CHANNEL** to the **B CHANNEL** input and repeat steps 2 through 6 for the **B CHANNEL** input.

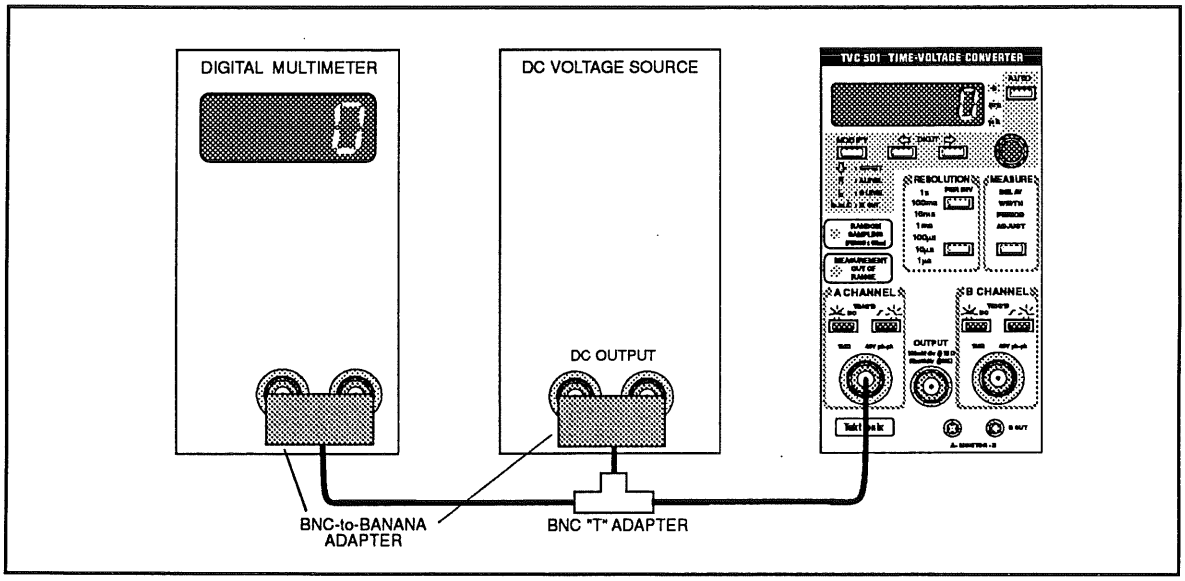


Figure 2-6. Trigger Level Accuracy Test.

Test 8: Trigger Slope

This procedure checks the functionality of the trigger slope controls for channels A and B. Refer to Figure 2-7 when performing this procedure.

1. Using the SMB-to-BNC cable, the two BNC coaxial cables, and the BNC T connector, connect the TVC 501 **B OUT** to the **A CHANNEL** and **B CHANNEL** inputs.
2. Repeatedly press the TVC 501 **MODIFY** button until the [b.out] appears and then rotate the knob until [b.out 5] appears.
3. Select DC coupling for both **A CHANNEL** and **B CHANNEL** inputs. Select rising edge for A and falling edge for B.
4. Repeatedly press the TVC 501 **MEASURE** button until the **DELAY** indicator lights.
5. Set the **A CHANNEL** trigger automatically by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears and then press **AUTO**. Repeat this process for the **B CHANNEL** trigger.
6. Repeatedly press the **MODIFY** button until the offset value is displayed and then press **AUTO**. The displayed offset value should be **49** µs ±1 µs.
7. Select falling edge for channel A and rising edge for channel B.
8. Repeat steps 5 and 6 but look for an offset value of **33.4** µs ±100 ns.

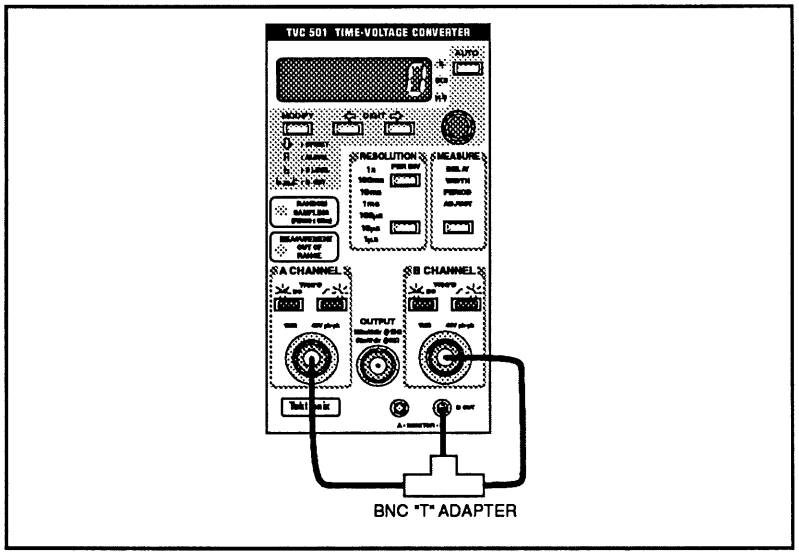


Figure 2-7. Trigger Slope Test.

Test 9: Monitor Output and TRIG'D Indicators

This procedure checks the toggle rate of the TVC 501 monitor outputs and the functionality of the **TRIG'D** indicators.

1. Using two BNC cables and two BNC T adapters, connect the Signal Generator output to the TVC 501 **A CHANNEL** input and the channel B input of the Digital Counter as shown in Figure 2-8.
2. Using the SMB-to-BNC cable, connect the TVC 501 **A MONITOR** output to the channel A input of the Digital Counter.
3. Adjust the Signal Generator to produce a 10 MHz sine wave with an amplitude of 250 mV ±50 mV at the **A CHANNEL** input. If necessary, verify this amplitude with an oscilloscope.
4. Set the **A CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears and then press **AUTO**.
5. Set the **B CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until [b] appears and then press **AUTO**.
6. Verify that both TVC 501 **TRIG'D** indicators are on.
7. Set the Digital Counter to measure the B-to-A ratio. Verify that the ratio is **1.0000**.
8. Using an oscilloscope with a 1 MΩ impedance, check the TVC 501 **A MONITOR** output voltage. The low level should be **0** to **100 mV** and the high level should be **450 mV** ±75 mV.

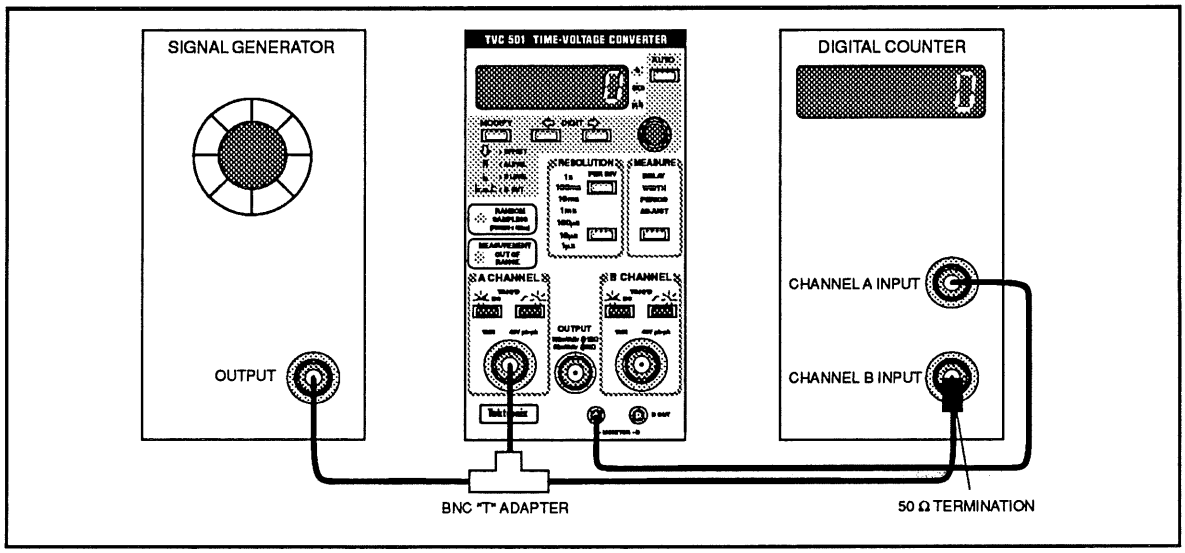


Figure 2-8. Channel A Monitor Output and TRIG'D Indicator Test.

9. Remove the connector from the TVC 501 **A CHANNEL** input and connect it to the **B CHANNEL** input. Remove the connector from the **A MONITOR** output and connect it to the **B MONITOR** output as shown in Figure 2-9.
10. Repeatedly press the MODIFY button until [b.out] appears in the TVC 501 display. Rotate the knob until [b.out 1] appears.
11. Repeat steps 1 through 7 for the TVC 501 **B CHANNEL** input and **B MONITOR** output.

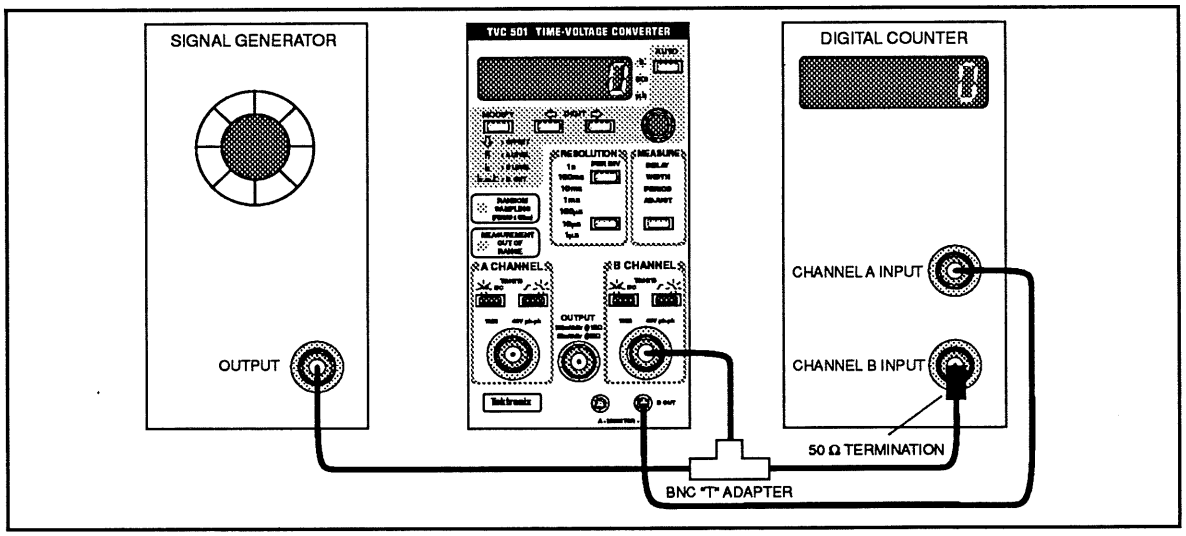


Figure 2-9. Channel B Monitor Output and TRIG'D Indicator Test.

Test 10: B÷100 and B÷1000 Monitor Outputs

This test verifies the operation of the prescaled (frequency-divided) channel B monitor outputs. Refer to Figure 2-10 when performing this procedure.

1. Using the three BNC cables, two 50-Ω terminations, BNC-to-SMA cable, and the Power Divider, connect the Signal Generator output to the TVC 501 **B CHANNEL** input and the Digital Counter channel B input.
2. Using the SMB-to-BNC cable, connect the TVC 501 **B OUT** to the Digital Counter channel A input.
3. Adjust the Signal Generator to produce a 125 MHz sinewave with an amplitude of 250 mV peak-to-peak.
4. Select DC coupling and rising edge for the TVC 501 **B CHANNEL** input.
5. Repeatedly press the TVC 501 **MODIFY** button until [b] appears in the display and then press **AUTO**. The **TRIG'D** indicator should light.
6. Repeatedly press the TVC 501 **MODIFY** button until the [b.out] display appears. Turn the knob until [b.out 2] is displayed.
7. Measure the B-to-A ratio with the Digital Counter. The result should be 100.
8. Turn the TVC 501 knob until [b.out 3] appears and measure the B-to-A ratio. It should be 1000.

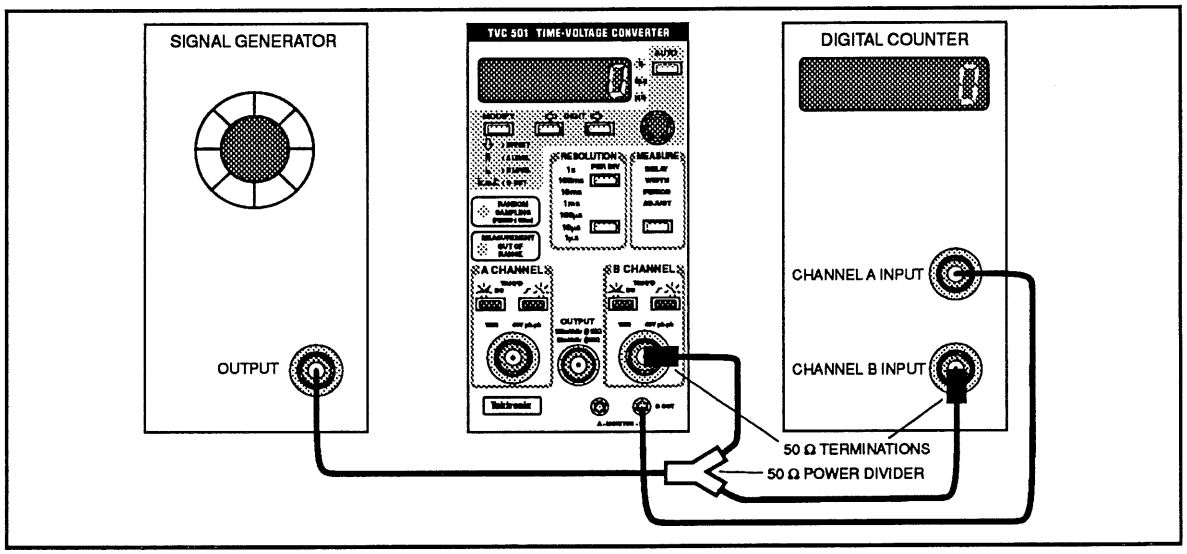


Figure 2-10. B÷100 and B÷1000 Monitor Output Test.

Test 11: B.out Signal Test

This procedure verifies that b.out test signals 4 through 8 are functioning properly. Refer to Figure 2-11 when performing this procedure.

1. Using the SMB-to-BNC cable, connect TVC 501 **B OUT** to the **A CHANNEL** input.
2. Select DC coupling and rising edge for the **A CHANNEL**.
3. Repeatedly press the **MEASURE** button until the **PERIOD** indicator lights.
4. Repeatedly press the TVC 501 **MODIFY** button until [b.out] appears in the display. Rotate the knob to select [b.out 4].
5. Set the **A CHANNEL** trigger level by repeatedly pressing the **MODIFY** button until [A] appears and then press **AUTO**.
6. Repeatedly press the **MODIFY** key until the offset value appears and then press **AUTO**. The displayed value should be **16666.7** µs with a resolution of **1** µs.
7. Repeatedly press the **MODIFY** button until the b.out appears and rotate the knob to select [b.out 5].
8. Perform steps 5 and 6 again. The displayed offset should be **83** µs with a resolution of **10** µs.
9. Repeatedly press the **MODIFY** button until the [b.out] appears and rotate the knob to select [b.out 6].

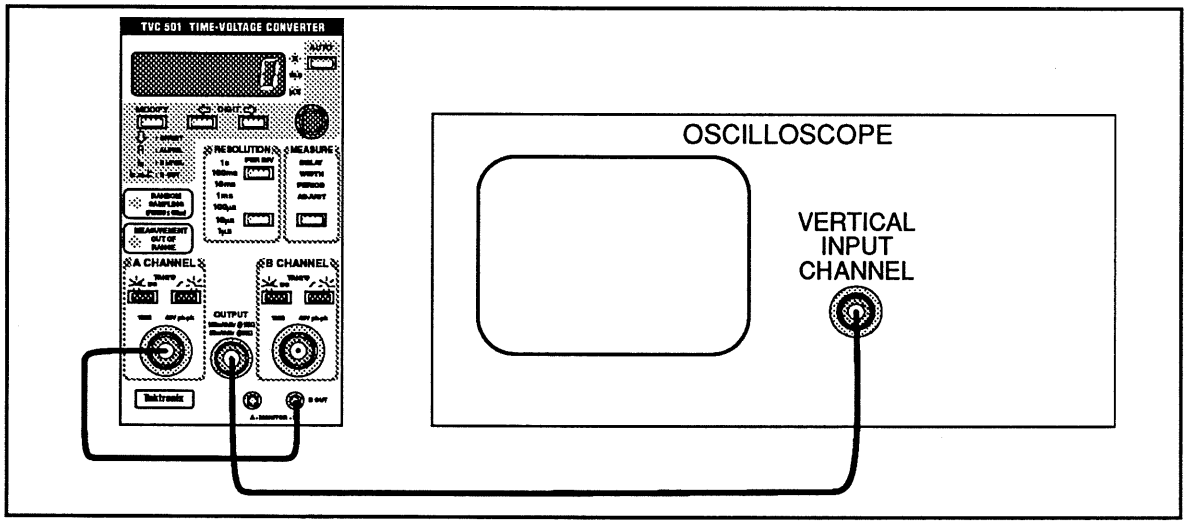


Figure 2-11. B OUT Test.

10. Set the **A CHANNEL** trigger level by repeatedly pressing the **MODIFY** button until [A] appears and then press **AUTO**.
11. Repeatedly press **MODIFY** until the offset value is displayed and then press **AUTO**. The displayed offset should be between **64** µs and **75** µs with a **10** µs resolution.
12. Repeatedly press the **MODIFY** button until the [b.out] appears and rotate the knob to select [b.out 7].
13. Set the **A CHANNEL** trigger level by repeatedly pressing the **MODIFY** button until [A] appears and then press **AUTO**.
14. Repeatedly press **MODIFY** until the offset value is displayed and then press **AUTO**. The displayed offset should be between **12** µs and **16** µs with a **1** µs resolution.
15. Using a BNC coaxial cable, connect the TVC 501 **OUTPUT** to an oscilloscope input as shown in Figure 2-11.
16. The waveform should look like the one in Figure 2-12 and have the specifications listed in Table 2-3.

Table 2-3
Specifications for b.out 7

Characteristic	Specification
Output:	
1 MΩ impedance	170 mVp-p to 220 mVp-p
50 Ω impedance	85 mVp-p to 110 mVp-p
Frequency:	70 Hz to 100 Hz

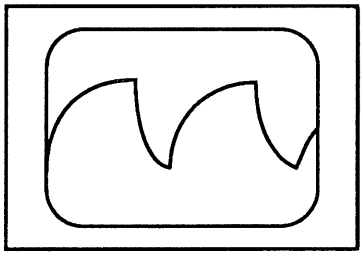


Figure 2-12. B OUT 7 Waveform.

17. Repeatedly press the TVC 501 **MODIFY** button until the [b.out] appears and rotate the knob until [b.out 8] appears.
18. Repeatedly press the **MODIFY** button to select the channel A trigger level and then press **AUTO**.
19. Repeatedly press the **MODIFY** button until the offset value appears in the display. Using the **RESOLUTION PER DIV** buttons, set the resolution to **1 ms**.
20. Using the knob and **DIGIT** buttons, manually set the offset to **6.7 ms**.
21. Connect the TVC 501 **OUTPUT** to the channel A input of the Digital Counter.
22. Set the Digital Counter to trigger on +100 mV ±50 mV. Set the counter to measure period. The counter should display a reading of **1.7** seconds ±100 ms.

Test 12: Auto Trigger

This procedure checks the minimum frequency limit of the auto trigger function.

1. Connect the Pulse Generator output to the TVC 501 **A CHANNEL** input. Figure 2-13 shows the cable connection.
2. Adjust the Pulse Generator to produce a 20 Hz ±2 Hz pulse with a duty cycle of 40% to 60%, a low amplitude of 0 V ±10 mV, and a high amplitude of 500 mV ±10 mV. Verify this signal with an oscilloscope.
3. Set the **A CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears and then press **AUTO**. The display should show a reading of **.25** ±0.1.
4. Repeat Step 3 five times to verify performance consistency.
5. Move the Pulse Generator connection from the TVC 501 **A CHANNEL** input to the **B CHANNEL** input. Repeat steps 1 through 4 for the **B CHANNEL** input.

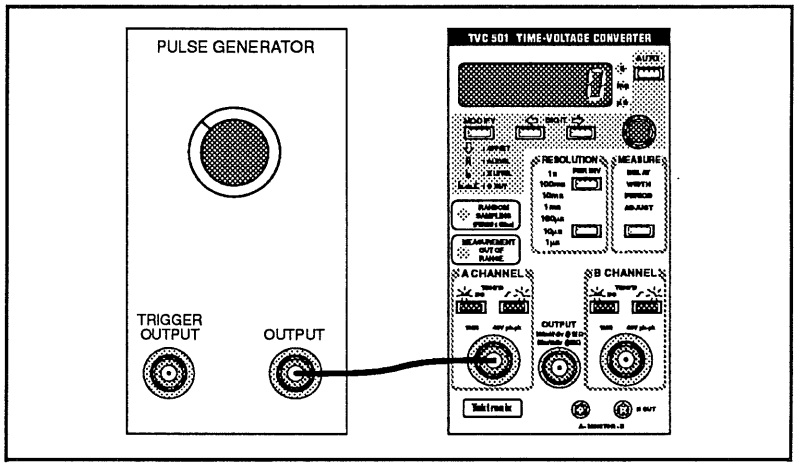


Figure 2-13. Auto Trigger Test.

Test 13: Auto Offset/Resolution

This procedure verifies the minimum frequency of the auto offset/resolution function.

1. Using a BNC coaxial cable, connect the Pulse Generator output to the TVC 501 **A CHANNEL** input. Figure 2-13 shows the cable connection.
2. Adjust the Pulse Generator to produce a 20 Hz ±2 Hz square wave with a low amplitude of 0 V ±10 mV and a high amplitude of 500 mV ±10 mV. Verify these amplitudes with an oscilloscope.
3. Set the **A CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears and then press **AUTO**.
4. Repeatedly press the **MEASURE** button until the **PERIOD** indicator lights.
5. Repeatedly press the **MODIFY** button until the offset value appears.
6. Press **AUTO** and note the display. The reading should be **50 ms** ±5 ms with a resolution of **10 ms** or less. If the resolution is not 10 ms, then manually set it to 10 ms using the resolution buttons. Verify that the **MEASUREMENT OUT OF RANGE** indicator is steadily off.

Test 14: Output Rise Time

This procedure tests the TVC 501 **OUTPUT** rise time using a 50 Ω load and a 1 MΩ load. Refer back to Figure 2-11 when performing this procedure.

1. Using the SMB-to-BNC cable, connect the TVC 501 **B OUT** to the **A CHANNEL** input.
2. Using a BNC cable, connect the TVC 501 **OUTPUT** to the oscilloscope input.
3. Repeatedly press the **MEASURE** button until the **PERIOD** indicator lights.
4. Repeatedly press the **MODIFY** button until the b.out signals are displayed and then rotate the knob until [b.out 5] appears.
5. Set the **A CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears and then press **AUTO**.
6. Repeatedly press the **MODIFY** button until the offset value appears and then press **AUTO**.
7. The TVC 501 **OUTPUT** voltage should be about ±170 mV into 1 MΩ or about ±85 mV into 50 Ω. Using the oscilloscope, measure the rise time from the 10% to 90% points. Repeat the measurement with a 50 Ω termination attached. Verify that the following values are obtained:
   - 150 ns to 350 ns rise time into 1 MΩ
   - 75 ns to 200 ns rise time into 50 Ω

Test 15: Time-to-Voltage Conversion

This procedure verifies the time-to-voltage conversion accuracy of the TVC 501. Refer to Figure 2-14 when performing this procedure.

1. Using the SMB-to-BNC cable, connect the TVC 501 **B OUT** to the **A CHANNEL** input.
2. Using the BNC cable, connect the TVC 501 **OUTPUT** to the Digital Voltmeter.
3. Repeatedly press the **MODIFY** button until the b.out signals appear in the display and then rotate the knob until [b.out 4] appears.
4. Select DC coupling and rising edge for the **A CHANNEL** trigger.
5. Set the **A CHANNEL** trigger level by repeatedly pressing the TVC 501 **MODIFY** button until [A] appears and then press **AUTO**.
6. Repeatedly press the **MEASURE** button until the **PERIOD** indicator lights.
7. Repeatedly press the **MODIFY** button again until the offset value appears and then press **AUTO**. The offset value displayed should be **16666.7** μs with a resolution per division of **1** μs.
8. Verify that the Digital Voltmeter displays a value of **0.0 V** ±7 mV.

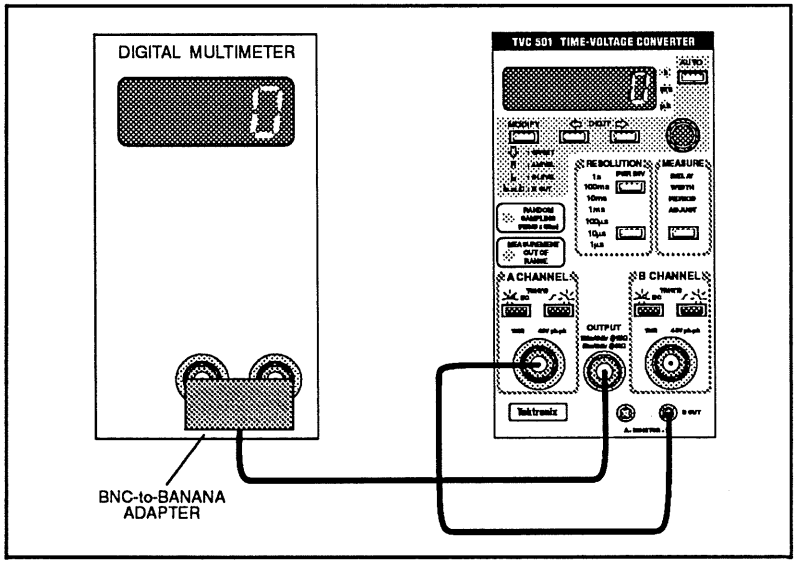


Figure 2-14. Time-to-Voltage Conversion Test.

9. Using the TVC 501 knob, manually set the offset to **16668.7** µs. The Digital Voltmeter should display **-200 mV** ±7 mV.
10. Adjust the TVC 501 offset to **16663.7** µs. Verify that the Digital Voltmeter displays a value of **+300 mV** ±7 mV.
11. Adjust the TVC 501 offset to **16672.0** µs. Verify that the Digital Voltmeter displays a value of **-423.3 mV** ±20 mV.
12. Adjust the TVC 501 offset to **16662.0** µs. Verify that the Digital Voltmeter displays a value of **+423.3 mV** ±20 mV.

Chapter 3: Calibration

This chapter describes four calibration procedures that you should perform annually or if the instrument fails to operate to specifications. Also, use these procedures after repairing or replacing instrument parts. Calibration must be performed at an ambient temperature between 20° C and 25° C. Allow a 20-minute warm-up period.

WARNING

Do not apply power to the instrument until you have read the instructions in this chapter and have properly connected the equipment.

Caution: Static discharge can damage components in this instrument. Observe the static precautions listed in Chapter 5: Disassembly/Assembly.

REQUIRED TEST EQUIPMENT

Table 3-1 lists the equipment required to perform the calibration procedures.

Table 3-1
Required Calibration Equipment

Item	Description	Tektronix Equivalent
Digital Voltmeter	4 1/2 digit resolution (capable of accurately measuring to 0.1 mV)	DM5110, DM504, DM5010
Flexible Extender Cable	For TM 500 or TM 5000 Power Modules	Part No. 067-0645-02
BNC Cable	42 inch, male-to-male connectors	Part No. 012-0057-01
Adapter	BNC female-to-dual male Banana	Part No. 103-0090-00
Power Module		TM 500 or TM 5000 Series

EQUIPMENT CONNECTIONS

To perform the calibration procedures, refer to Figures 3-1 and 3-2 and connect the equipment as follows:

1. Remove the TVC 501 side covers.
2. Attach one end of the flexible extender cable to an edge connector inside the TM 500 or TM 5000 Series Power Module and the other end to the TVC 501 edge connector. Figure 3-2 shows the connections.
3. Attach the BNC-to-banana plug adapter to the Digital Voltmeter terminals.
4. Connect one end of the BNC cable to the adapter used in step 3 and the other end to the TVC 501 **OUTPUT** connector.

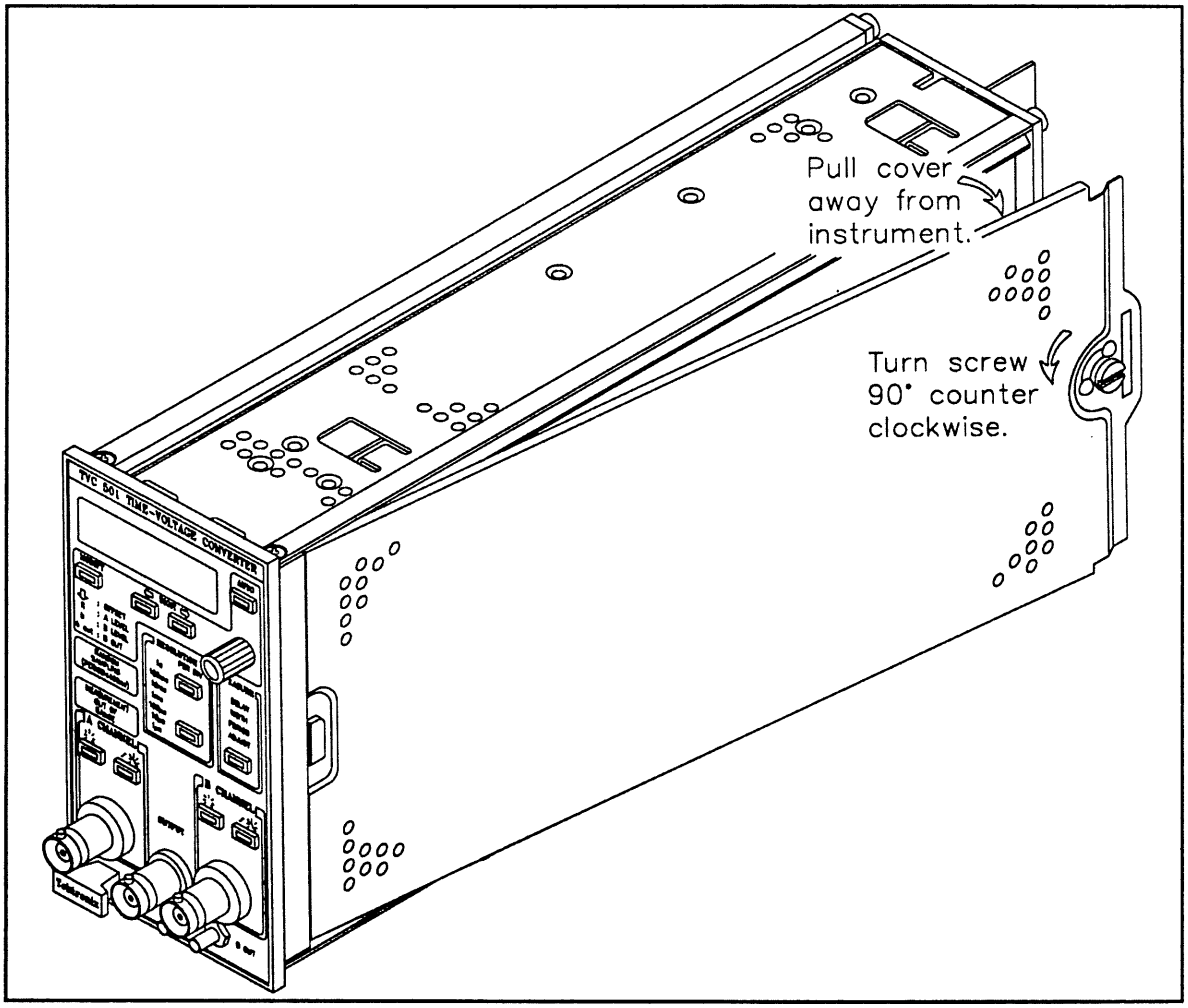


Figure 3-1. Removing the TVC 501 Side Covers.

5. Hold the TVC 501 **AUTO** button depressed and apply power to the Power Module. Release the **AUTO** button when the TVC 501 readout displays the word **CAL**. The TVC 501 is now in calibration mode.

>> Note *Do not press any other buttons while calibrating the TVC 501 or the instrument will exit the calibration mode. If this happens, turn the TVC 501 off and repeat step 5.*

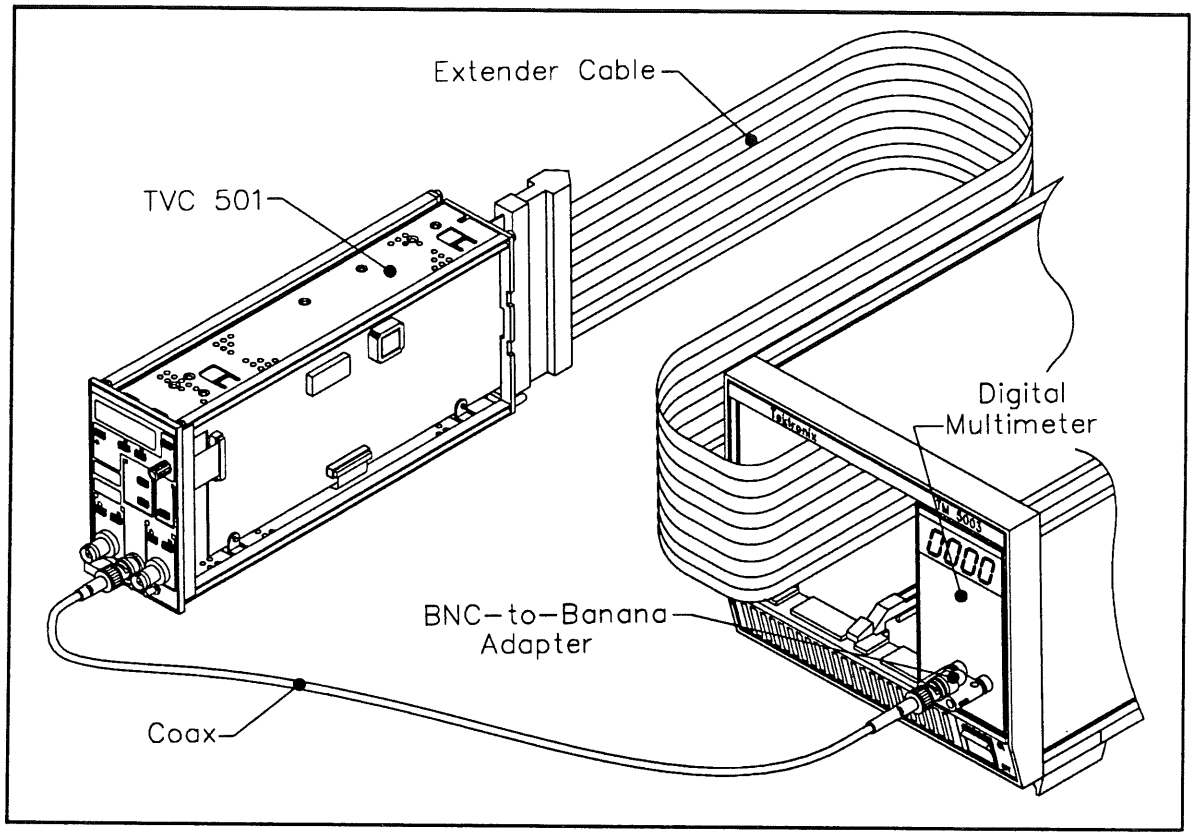


Figure 3-2. Preparing the TVC 501 for Calibration.

CALIBRATION PROCEDURES

The following four procedures are required to calibrate the TVC 501:

- output offset
- output gain
- channel A trigger offset
- channel B trigger offset

>> Note *A routine named dac.128 routine will also appear on the TVC 501 display. This routine is for factory use only. It allows different numerical values to be written to the output DAC by rotating the knob located below the AUTO button. The voltage at the TVC 501 output connector changes proportionally to the numerical value displayed.*

>> Note *Do not apply any signals to the TVC 501 A CHANNEL or B CHANNEL inputs while performing calibration. The calibration routines will not work if signals are present.*

Output Offset

1. To adjust the offset voltage of the TVC 501 **OUTPUT**, repeatedly press the **AUTO** button until the word OFFSEt appears in the display.
2. Adjust the **OFFSET** potentiometer, located on the counter circuit board, until the digital voltmeter displays a reading between -423.0 mV and -423.6 mV. Figure 3-3 shows the location of the counter board and Figure 3-4 shows the location of the **OFFSET** potentiometer.

Output Gain

1. To adjust the TVC 501 **OUTPUT** gain, repeatedly press the **AUTO** button until GAIN appears on the display.
2. Adjust the **GAIN** potentiometer, located on the counter circuit board, until the digital voltmeter displays a reading between +423.6 mV and +423.0 mV. Figure 3-4 shows the location of the **GAIN** potentiometer.

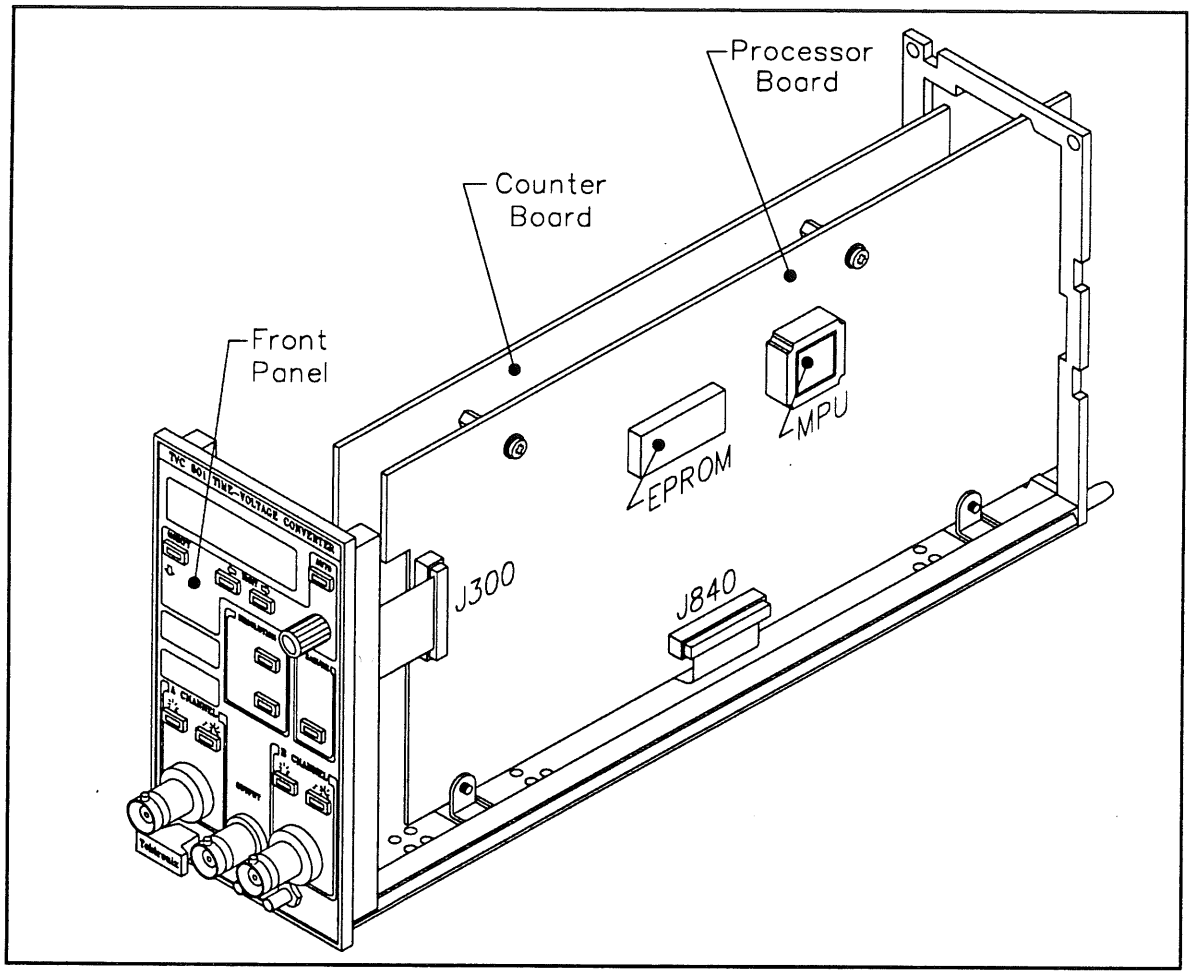


Figure 3-3. Location of TVC 501 Circuit Boards.

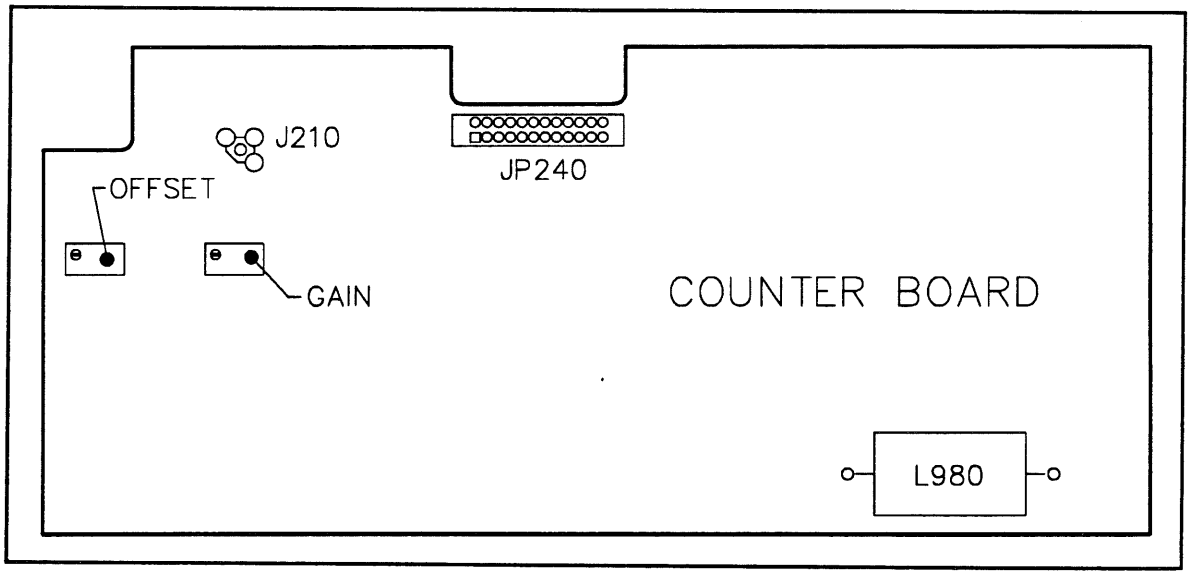


Figure 3-4. Offset and Gain Adjustment Locations.

Channel A Trigger Offset

1. To adjust the offset of the channel A trigger, repeatedly press the **AUTO** button until [ChA] appears on the display.
2. Adjust the **A TRIM** potentiometer (R820), which is located on the processor circuit board, until the TVC 501 readout displays [ChA .00]. Refer to Figure 3-3 for location of the processor circuit board. Figure 3-5 shows the location of R820.

Channel B Trigger Offset

1. To adjust the offset of the channel B trigger, repeatedly press the **AUTO** button until [Chb] appears on the display.
2. Adjust **B TRIM** potentiometer (R623), which is located on the processor circuit board, until the TVC 501 readout displays [Chb .00]. Figure 3-5 shows the location of R623.

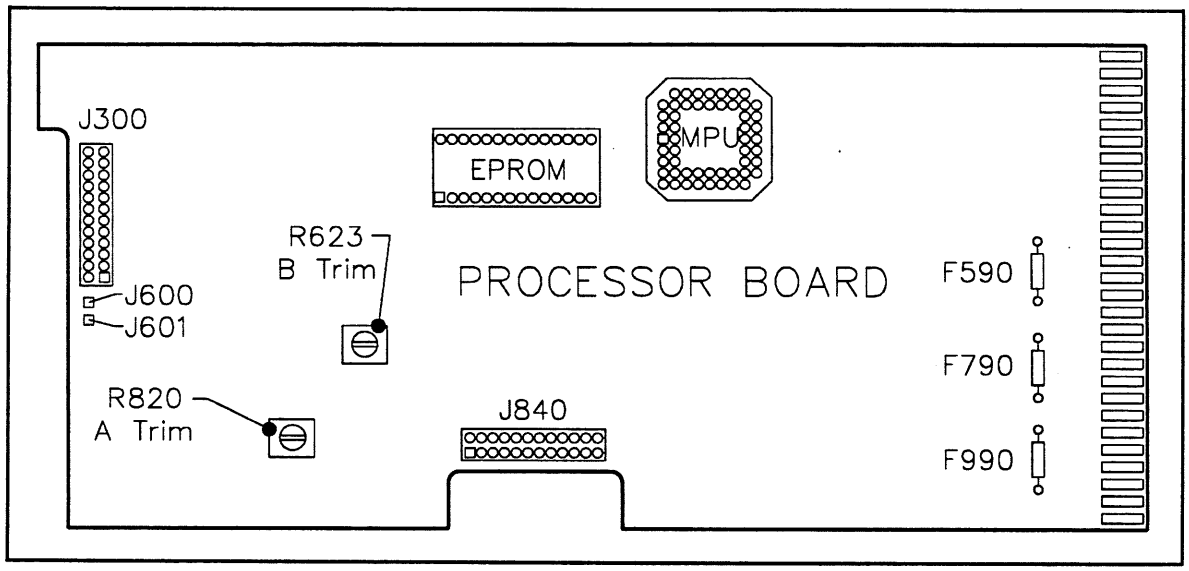


Figure 3-5. Trigger Offset Adjustment Locations.

After you have successfully completed these procedures, the TVC 501 is calibrated.

Chapter 4: Diagnostics and Troubleshooting

This chapter describes the diagnostics that the TVC 501 runs at power-up and defines the error codes that the instrument can display. This chapter also provides a troubleshooting guide to help you diagnose and repair instrument failures.

Tektronix provides service support for the TVC 501 to the circuit board level. The power-up diagnostics will detect the failure in most cases. When an instrument failure occurs, note the error code displayed and use Table 4-1 to determine what needs to be replaced or repaired. If the instrument has a problem that is not detected by the diagnostics, then use the troubleshooting guide to determine which board or boards are defective.

For additional information to help you with troubleshooting, read the circuit descriptions in Chapter 1: Theory of Operation.

Table 4-1
Diagnostic Code Summary

Display	Meaning	What to do
rELxx	The software release number	Continue; this is not a failure.
EPro-	Checksum failure in EPROM	Replace the EPROM or processor board.
HC11	Microprocessor hardware failure.	Replace the MPU or processor board.
P45678	All b.out signals passed	Continue; this is not a failure.
P-----	All b.out signals failed.	Replace the processor board.
P-5678	Signal b.out 4 failed. The unit will function, except for b.out 4.	Replace the counter board.
P4-678	Signal b.out 5 failed. The unit will function, except for b.out 5.	Replace the counter board.
P45-78	Signal b.out 6 failed. The unit will function, except for b.out 6.	Replace the counter board.
P456-8	Signal b.out 7 failed. The unit will function, except for b.out 7.	Replace the processor board.
P4567-	Signal b.out 8 failed. The unit will function, except for b.out 8.	Replace the processor board.
AdC	Microprocessor A/D converter failed. Probe encoding may not be read properly.	Replace the processor board.
SHF S1	Shift register bit stuck at 1. One or more shift registers failed.	See Shift Register Isolation Procedure in this chapter.
SHF S0	Shift register bit stuck at 0	See Shift Register Isolation Procedure in this chapter.
SHF xP	Shift register passed test, is x bytes long	See Shift Register Isolation Procedure in this chapter.
SHF xF	Shift register failed, is x bytes long	See Shift Register Isolation Procedure in this chapter.
Cntr x	Counter failure in bit group or groups represented by x	Replace counter board.
Erxxxx	Software error	Verify that the latest firmware version is installed.[1]
Efxxx	Software error	Verify that the latest firmware version is installed.[1]

[1]To check the firmware version number, power-up the TVC 501 and watch the display. The number should briefly appear. To determine if your version is the latest available, contact your Tektronix field representative.

POWER-UP DIAGNOSTICS

The TVC 501 performs a self-test diagnostic routine each time the unit is powered up. This routine tests various circuits of the TVC 501. As the tests progress, you will see different messages on the display. At each step, any errors that occur are noted by a message on the display. The particular message displayed indicates the test that has failed. Table 4-1 lists the possible error codes and their definition.

RAM/Microprocessor Tests

Upon powering up, the TVC 501 first checks the RAM and the microprocessor. If these tests pass, nothing is displayed and the self-test routine continues. If either test fails, the self-test routine stops and one of the following codes appears on the front panel readout:

- [EPro-] indicates that the EPROM has failed its checksum test.
- [HC11] indicates a hardware failure of the microprocessor RAM.

When either of these errors occurs, the TVC 501 displays the word [HALT], the diagnostics are aborted, and the unit will not operate. The processor board will have to be repaired or replaced. The microprocessor and ROM are individually replaceable parts. For ordering information, refer to Chapter 8: Replaceable Parts.

LED Test

Next the TVC 501 lights all the front panel LEDs. All the LEDs light at once, except the bank of LEDs in the **RESOLUTION PER DIV** area of the front panel. These light one at a time starting with the bottom one and ending with the top one. You can verify that all the LEDs are working.

Firmware Version

Next, the TVC 501 briefly displays the version number of the firmware installed. To find out if newer versions are available, contact your Tektronix field representative.

B.Out Signal Test

Next the TVC 501 tests the b.out signals numbered 4 through 8. The display shows [P] followed by the number of each b.out signal as it passes. If a signal does not pass, a dash (-) is displayed instead of the number of the b.out signal. When all the signals pass, [P45678] appears on the display. If the TVC 501 passes all other tests but fails any of the b.out signal tests, the unit is still functional except for the b.out signal that failed.

A/D Converter Test

Next the TVC 501 tests the A/D converter of the microprocessor. When this test passes, the routine continues with no message on the display. If this test fails, the letters [AdC] appear on the front panel readout. The unit will operate and the self-test routine will continue, but the probe coding may not be read correctly.

Counter Test

Next the TVC 501 tests the counter latch. When this test passes, the self-test routine continues with no message on the display. If this test fails, a message is displayed: [Cntr] followed by an encoded digit from 1 to 7 that indicates where the error is located. Table 4-2 defines the significance of each digit that can be displayed.

Table 4-2
Significance of Counter Test Digit

Digit	Defective Counter Bit Group
1	Lower-four bits
2	Middle-eight bits
3	Lower-four and middle-eight bits
4	Upper-eight bits
5	Lower-four and upper-eight bits
6	Middle-and upper-eight bits
7	All bits defective

If the counter latch fails completely, the instrument displays [HALT] and will not operate.

Shift Register Tests

Finally, the TVC 501 performs two tests on the shift registers. When these tests pass, the self-test routine continues with no message on the front panel readout. If either of these tests fails, a message is displayed. These messages are described next.

The first shift register test checks that the bits are not stuck. If this test fails, the front panel readout displays [SHF] followed by S1 or S0. S1 indicates that the shift register bit is stuck at 1; S0 indicates that the shift register bit is stuck at 0. To determine if the problem is in the processor board or the counter board, perform the Shift Register Isolation procedure (described after these diagnostic descriptions).

The second shift register test checks the length of the shift register. If the test passes, no message is displayed. If this test fails, the front panel readout displays [SHF] followed by a number, which is followed by P or F. The number indicates the length of the shift register. This number is followed by P to indicate that the shift register passed the test or F to indicate that the shift register failed the test.

To determine if a failure is in the processor board or the counter board, perform the Shift Register Isolation procedure (described after these diagnostic descriptions).

When the shift register tests fail, the TVC 501 displays [HALT] and stops the test sequence.

Test Completion

After the shift register tests are completed, the self-test routine is finished. If no errors that cause instrument failure occurred, the message [AdJUSt] appears and the TVC 501 is ready for operation.

In the unlikely event that the TVC 501 ever experiences a software error, an error code will be displayed. These codes appear as either [Er] or [E] followed by four digits.

Anytime a software error appears, the instrument will not operate. To restore operation, power the unit off and then on again. If the problem still persists, contact your Tektronix service center for help.

SHIFT REGISTER ISOLATION PROCEDURE

If the power-up shift register diagnostics fail, perform this procedure to isolate whether the problem is in the processor board, counter board, or interconnecting cables.

Caution: Static discharge can damage components in this instrument. Observe the static precautions listed in Chapter 5.

1. Pull the instrument out of the Power Module and remove the side covers of the instrument. Cover removal instructions and board location drawings are provided in Chapter 5: Disassembly/Assembly.
2. Using a soldering iron, lift wire jumper **W370** (on the counter board). Figure 4-1 shows the location of **W370**.
3. Connect a wire jumper across the test points labeled **SER_IN** and **SER_OUT**.
4. Plug the instrument back into the Power Module and apply power. Note the shift register diagnostic display. If the TVC 501 displayed [SH 1P], the shift register problem is in the counter board. If the display showed [SHF S0], the problem is in the processor board.
5. When finished, remove the **SER_IN** and **SER_OUT** jumper and re-solder jumper **W370**.

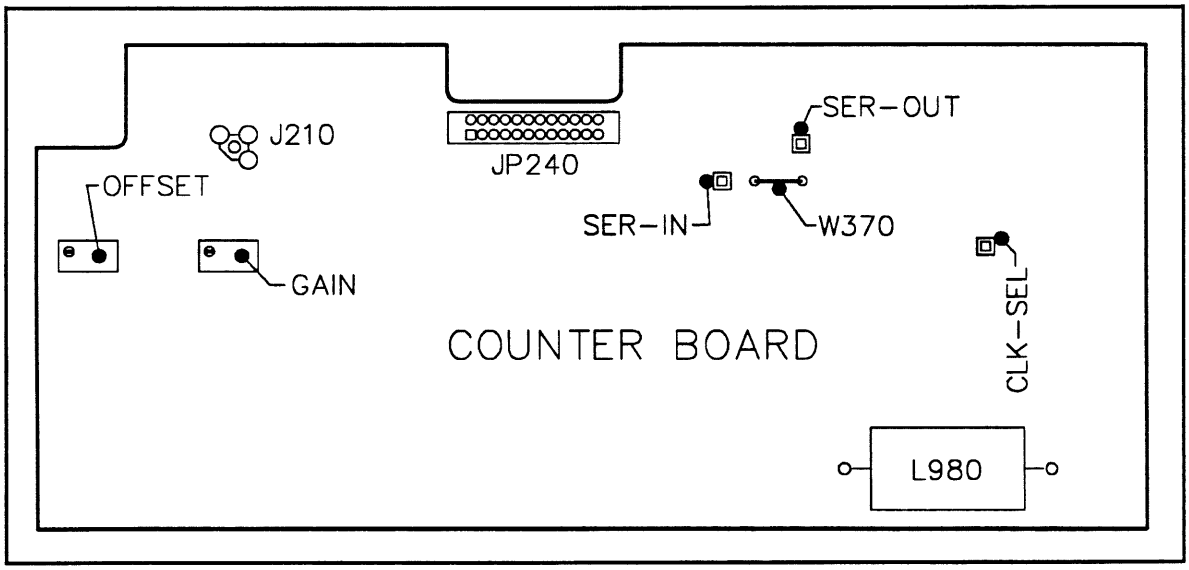


Figure 4-1. Location of Diagnostic Jumpers.

TROUBLESHOOTING GUIDE

Tektronix provides service support for the TVC 501 to the circuit board level. The power-up diagnostics will detect the failure in most cases. Use the information in Table 4-1 to determine what needs to be replaced or repaired. If the instrument has a problem that is not detected by the diagnostics, then use the following troubleshooting guide to determine which board or boards are defective. The guide is organized by the following functional categories:

- front panel indicators and controls
- input/output problems
- trigger problems
- measurement problems
- offset problems
- miscellaneous problems

Refer to Figure 4-1 for component locations on the counter board. Refer to Figure 4-2 for component locations on the processor board.

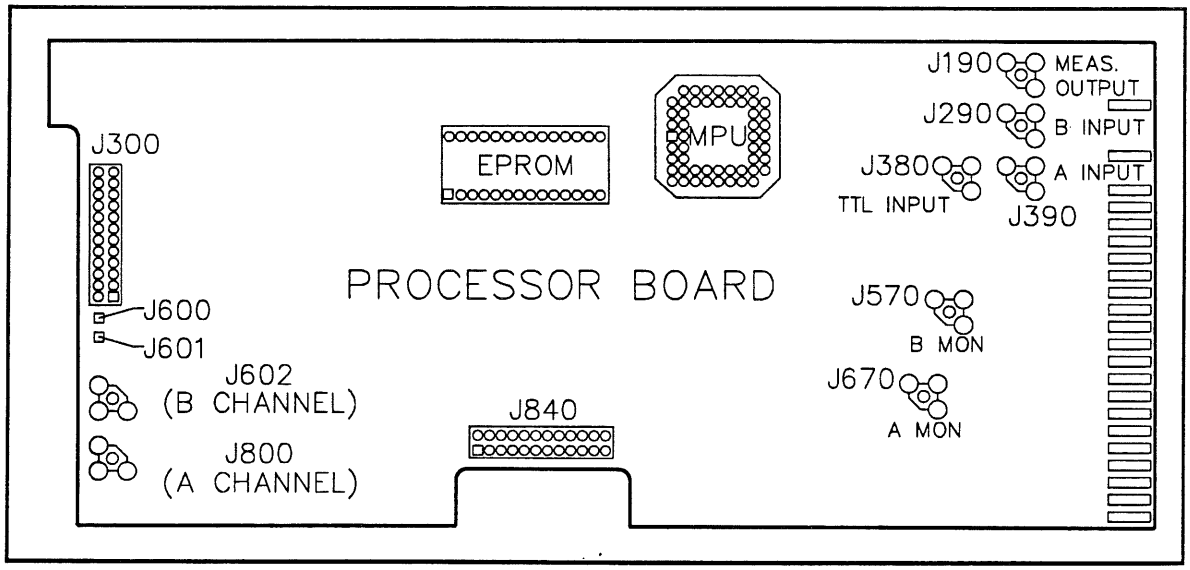


Figure 4-2. Processor Board Component Locations.

Front Panel Indicators and Controls

Before doing extensive troubleshooting, you should verify that the front panel is working properly. Many function failures could be caused by a defective front panel.

To verify front panel operation, first turn the TVC 501 on and observe the power-up diagnostics. If the TVC 501 passes power-up diagnostics and displays the adjust pattern, then the processor is functioning properly. To verify that the front panel is working, press each of the buttons and see if the instrument responds accordingly. If it does, then the front panel is working. If the instrument doesn't respond to the button press, then check the interconnect cabling for shorts or opens. If the cabling is good, then the front panel is probably defective.

Input/Output Problems

This category includes any problems acquiring signals from the system under test or obtaining a converted output signal from the TVC 501. It also includes problems with the Adjust pattern and b.out test signals.

Before running any of these tests, verify that the front panel is working properly by performing the tests described under "Front Panel Indicators and Controls" in this chapter.

Refer to Figure 4-2 for component and connector locations mentioned in the following information.

ADJUST Pattern

If the adjust pattern operates improperly, check fuse F790 located on the counter board. Also verify that the MEASUREMENT HOLD signal at the rear-panel interface is not at a TTL-high level (>2.0 V). (For more information about the rear-panel interface, see Chapter 6: Rear-Panel Interface.) If the fuse is good and the MEASUREMENT HOLD signal is not high, replace the counter board.

A CHANNEL Input

If the TVC 501 fails to respond to any signals input on channel A, then check the cable that connects to J800 on the processor board. Verify that there are no shorts or opens. If the cable is good, replace the processor board.

A MONITOR Output

If the instrument recognizes the input signal (the **TRIG'D** indicator is on) but the monitor output shows no activity, then check the cable that connects to J670 on the processor board. Verify that there are no shorts or opens. If the cable is good, then replace the processor board.

B CHANNEL Input

If the TVC 501 fails to respond to any signals input on **B CHANNEL**, then check the cable that connects to J602 on the processor board. Verify that there are no shorts or opens. If the cable is good, replace the processor board.

B MONITOR Output

If the instrument recognizes the input signal (the **TRIG'D** indicator is on) but the monitor output shows no activity, then check the cable that connects to J570 on the processor board. Verify that there are no shorts or opens. If the cable is good, then replace the processor board.

b.out 1 Signal.

See **B MONITOR** Output information previously described.

b.out 2 Signal (b.out 1 ÷ 100)

Verify that the channel B monitor signal (b.out 1) is working (if not, refer to **B MONITOR** Output information described earlier). If the channel B monitor is working, then replace the processor board.

b.out 3 Signal (b.out 1 ÷ 1000)

Verify that the channel B monitor signal (b.out 1) is working (if not, refer to **B MONITOR** Output information described earlier). If the channel B monitor is working, then replace the processor board.

b.out 4 through b.out 6 Signals

If any of these three test signals fail and all of the remaining test signals work properly, then the counter board is probably defective. If all of the b.out test signals fail, then the processor board is probably defective.

b.out 7 and b.out 8 Signals

If these test signals fail, replace the processor board.

OUTPUT

If the instrument is properly triggered by the input signal but is not producing an output signal, check the cable that connects to J210 on the counter board for shorts or opens. Also verify that the MEASUREMENT HOLD signal at the rear-panel interface is not at a TTL-high level (>2.0 V). (For more information about the rear-panel interface, see Chapter 6: Rear-Panel Interface.) If the cable is good and the MEASUREMENT HOLD signal is not high, replace the counter board.

Trigger Problems

This category covers problems affecting the ability to trigger on a signal or to adjust the trigger level.

Before running any of these tests, verify that the front panel is working properly by performing the tests described under "Front Panel Indicators and Controls" in this chapter.

AUTO Trigger

If Auto Trigger fails, then hold the **AUTO** button down and turn on the TVC 501. Release the button after CAL appears in the display. Next, press the **MEASURE** button and apply a signal to the defective trigger input. If the **TRIG'D** indicator lights, then the problem is with the counter board. If **TRIG'D** indicator doesn't light, then either the channel A input cable that connects to J800 is defective or the processor board is defective.

A CHANNEL AC/DC Coupling Switch

If the front panel is good and this function fails the acceptance tests listed in Chapter 2: Acceptance Tests, check the input cable that connects to J800. If the cable is good, then replace the processor board.

A CHANNEL Trigger Slope Switch

If the front panel is good and this function fails the acceptance tests listed in Chapter 2: Acceptance Tests, check the input cable that connects to J800. If the cable is good, then replace the processor board.

A Level Adjustment

If the front panel digits for the **A CHANNEL** trigger level change but the actual trigger level does not, check the input cable that connects to J800. If the cable is good, then replace the processor board.

B CHANNEL AC/DC Coupling Switch

If the front panel is good and this function fails the acceptance tests listed in Chapter 2: Acceptance Tests, check the input cable that connects to J602. If the cable is good, then replace the processor board.

B CHANNEL Trigger Slope Switch

If the front panel is good and this function fails the acceptance tests listed in Chapter 2: Acceptance Tests, check the input cable that connects to J602. If the cable is good, then replace the processor board.

B LEVEL Adjustment

If the front panel digits for the **B CHANNEL** trigger level change but the actual trigger level does not, check the input cable that connects to J602. If the cable is good, then replace the processor board.

Measurement Problems

The information in this category covers the primary measurement parameters: pulse width, pulse period, and delay between the channel A input pulses and the channel B input pulses.

Before running any of these tests, verify that the front panel is working properly by performing the tests described under "Front Panel Indicators and Controls" in this chapter.

MEASUREMENT button

See the tests listed under the heading "Front Panel Indicators and Controls" in this chapter.

DELAY Function

If delay measurements cannot be made, check the channel A and channel B input cables and verify that each channel can trigger on an input signal. If the delay function still fails, replace the counter board.

PERIOD Function

If period measurements cannot be made, check the channel A input cable and verify that channel A can trigger on an input signal. If the period function still fails, replace the counter board.

WIDTH Function

If width measurements cannot be made, check the channel A input cable and verify that channel A can trigger on an input signal. If the width function still fails, replace the counter board.

Offset Problems

This category discusses problems affecting the time offset of the TVC 501.

Before running any of these tests, verify that the front panel is working properly by performing the tests described under "Front Panel Indicators and Controls" in this chapter. Also, check the input cabling and verify the ability to trigger on the input signal (see the trigger tests listed in Chapter 2: Acceptance Tests).

Offset (auto adjustment)

If the Auto Offset function fails, then the counter board is probably defective. Power the instrument on and note the result of the shift register diagnostics (described earlier in this chapter). Perform the "Shift Register Isolation Procedure" also described earlier in this chapter. If the processor board is working properly, replace the counter board.

Offset (manual adjustment)

If the offset fails to change when adjusted at the front panel, power the instrument on and note the result of the shift register diagnostics (described earlier in this chapter). Perform the "Shift Register Isolation Procedure" also described earlier in this chapter. If the processor board is working properly, replace the counter board.

Miscellaneous Problems

This category includes various functions not covered in the preceding material.

Attenuator Probes are Not Recognized by the Instrument

If the TVC 501 does not properly recognize attenuator probes when they are connected to the input connectors, first make sure that the probe has attenuator code pins such as those on the P6109. If the probe has the proper pins, check the polarity of the cable that is connected to J600 and J601 located on the processor board by connecting a probe to the channel A input and check *both* the channel A and channel B trigger level displays for the proper values. Also verify that there are no shorts or opens in the cable. If the cable is good, replace the processor board.

Calibration Problems

Verify that no input signal is applied to the input connectors. If the **OFFSET** or **GAIN** adjustments will not calibrate, replace the counter board. If the **A TRIM** or the **B TRIM** adjustments will not calibrate, replace the processor board.

DIGIT or MODIFY button

See the tests listed under the heading "Front Panel Indicators and Controls" in this chapter.

Fuses

The fuses are located on the processor board. If either F590 or F990 are open, the TVC 501 will not operate at all. If fuse F790 is open, the instrument will power up but the adjust signal will output a DC voltage above +1 V instead of the staircase pattern.

RESOLUTION PER DIV Function

If the **RESOLUTION PER DIV** function fails to operate properly, then connect a frequency counter or an oscilloscope to the test point labeled **CLK_SEL** which is located on the counter board. Figure 4-3 shows the location of **CLK_SEL**. Verify that the **CLK_SEL** frequency measured for each resolution-per-division matches those listed in Table 4-3.

Table 4-3
CLK_SEL Frequencies

Res/Div	CLK_SEL frequency
1 s	30 Hz
100 ms	300 Hz
10 ms	3 kHz
1 ms	30 kHz
100 µs	300 kHz
10 µs	3 MHz
1 µs	30 MHz

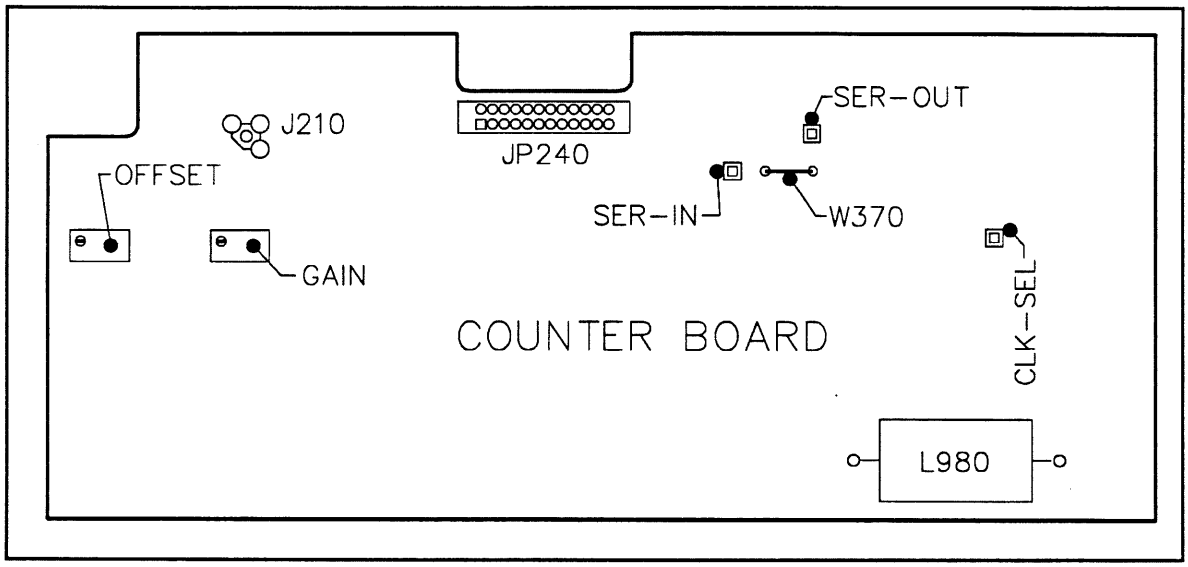


Figure 4-3. Location of CLK_SEL Test Point.

Chapter 5: Disassembly/Assembly

The information in this chapter supports the disassembly and assembly of the TVC 501 to the subassembly level. Not every component is replaceable. For example, the circuit boards and front panel are replaced as assemblies. These assemblies can be returned to Tektronix in exchange for new assemblies.

The part numbers for each replaceable part and subassembly are listed in Chapter 8: Replaceable Parts. Chapter 8 also provides an exploded view of the instrument. If necessary, use this drawing to aid in disassembly and reassembly.

Disassembly/assembly procedures and supporting illustrations are provided for the following subassemblies and components.

- side panel
- release lever
- counter circuit board
- processor circuit board
- EPROM and MPU integrated circuits
- fuses
- front panel
- interconnect wiring and coaxial cables

STATIC-SENSITIVE DEVICES

Caution: Static discharge can damage any semiconductor component in this instrument. Observe the following precautions.

This instrument contains electrical components that are susceptible to damage from static discharge. Static voltages of 1 kV to 30 kV are common in unprotected environments. Observe the following precautions to avoid circuit damage:

- Minimize handling and touching of static-sensitive components.
- Transport and store static-sensitive components or assemblies in the original container, on a metal rail, or on conductive foam.
- Allow nothing capable of generating or holding a static charge on the work station surface.
- Discharge the static voltage from your body by wearing a wrist strap while handling static-sensitive components or assemblies.
- Handle and service static-sensitive components and assemblies only at a static-free work station. Tektronix recommends use of the Static Control Mat (Tektronix Part 006-3414-00 and Wrist Strap (Tektronix Part 006-3415-00).
- Keep component leads shorted together whenever possible.
- Pick up components by the body–never by the leads.
- Do not slide the component or subassembly over any surface.
- Use a soldering iron that is connected to earth ground.
- Use only special anti-static suction-type desoldering tools.

REQUIRED TOOLS

The following tools are required to perform these procedures.

- large flat-blade screwdriver
- #1 POZIDRIV screwdriver
- #2 POZIDRIV screwdriver
- #1 Phillips screwdriver
- IC extractor tool (for 28-pin DIP)
- PCC Extractor tool (3M part number 400-6230-01 or equivalent)
- 1/4 inch nutdriver
- 1/2 inch nutdriver
- 9/16 inch nutdriver or boxed-end wrench
- 1/16 inch Allen wrench
- 15 Watt soldering iron
- anti-static suction desoldering device
- needle-nosed pliers

PROCEDURES

The following procedures explain how to disassemble and replace the various subassemblies of the TVC 501.

Side Covers

This procedure describes how to remove the side covers from the TVC501 plug-in unit. Refer to Figure 5-1 when performing the procedure.

1. Using a coin or a large flat-blade screwdriver, turn the two plastic securing screws located at the rear of the instrument 90° counterclockwise.
2. Lifting from the rear, swing the cover out and pull it away from the instrument.
3. To install a cover, perform steps 1 and 2 in reverse order, beginning with step 2.

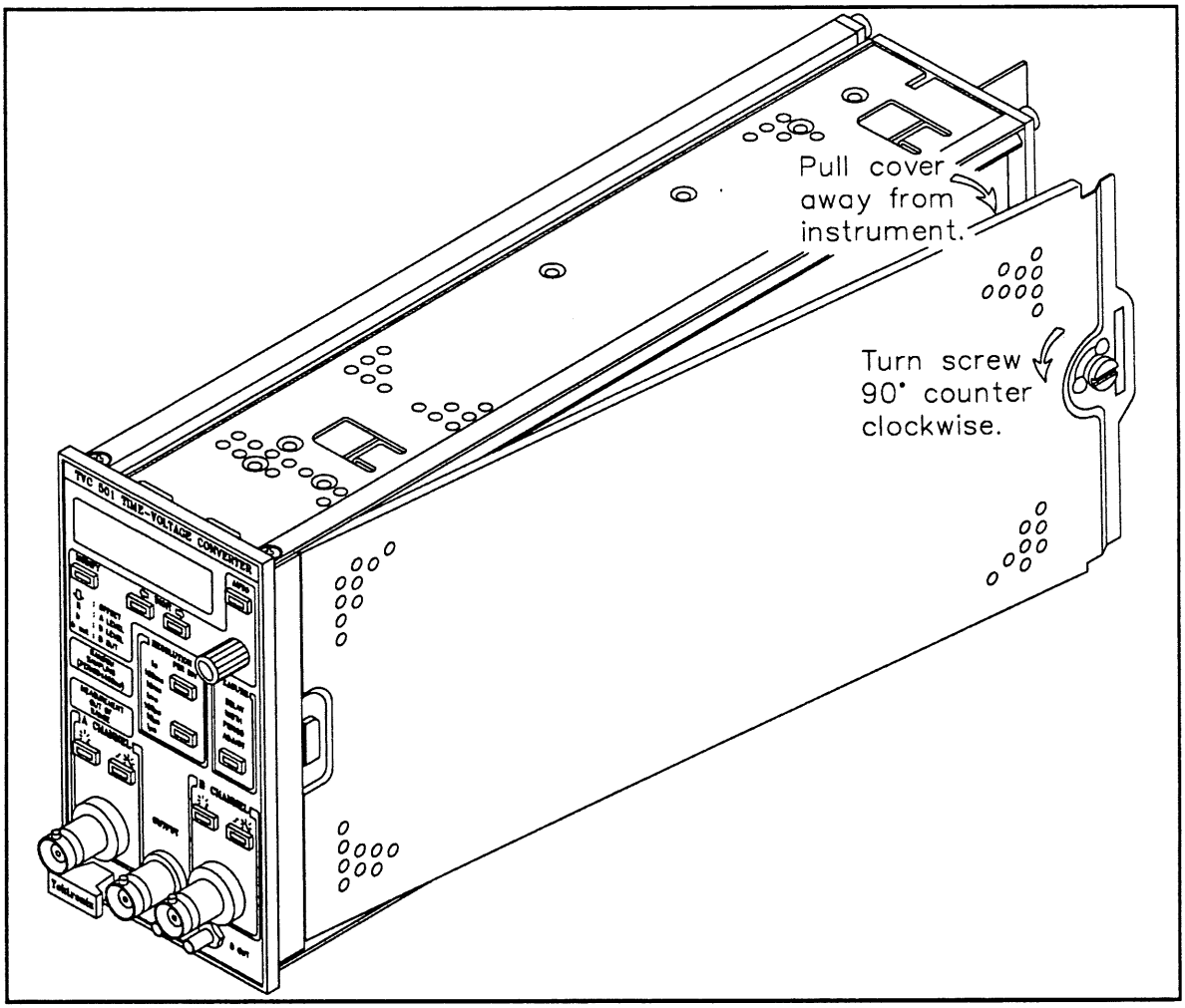


Figure 5-1. Removing the TVC 501 Side Covers.

Release Lever Assembly

The plastic release lever is located at the lower left-hand side of the front panel. There are four pieces to the assembly (see Chapter 8: Replaceable Parts, for part numbers and an illustration). The following procedure describes how to replace each piece of the assembly.

1. Remove the left side cover.
2. To remove the latch knob, push the latch bar forward slightly with your finger and lift the knob out of the latch bar as shown in Figure 5-2. Pull the latch knob out through the front panel.
3. Unhook each end of the spring with a pair of needle-nose pliers.
4. To access the latch bar, remove the top and bottom screws of the front panel as shown in Figure 5-2. Pull the front panel out just enough (about 1/2 inch) to access the latch bar.

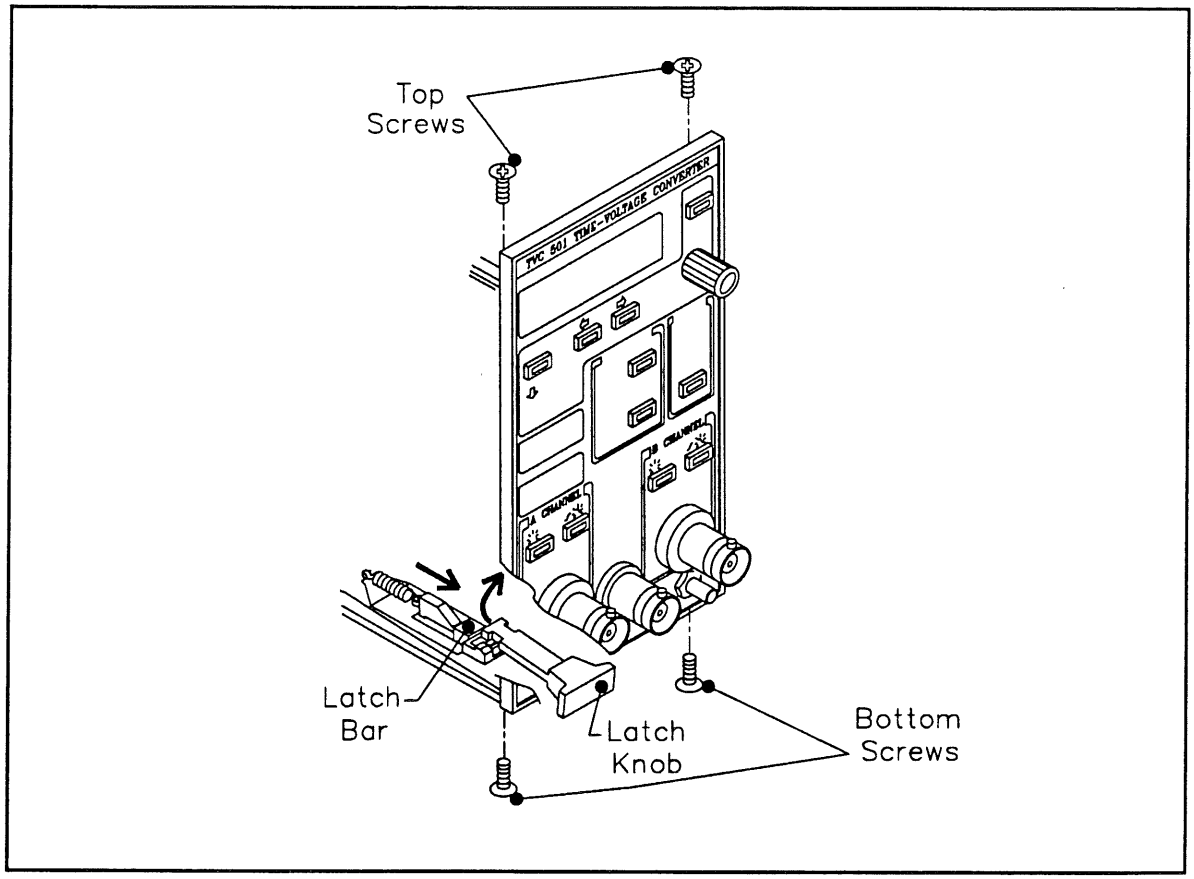


Figure 5-2. Removing the Latch Knob.

5. Slide the latch bar forward until it clears the retaining latch as shown in Figure 5-3.
6. Push the retaining latch up past the retaining clip, as shown in Figure 5-3, and remove the retaining latch.
7. To install the latch assembly, perform steps 1 through 6 in reverse order, beginning with Step 6.

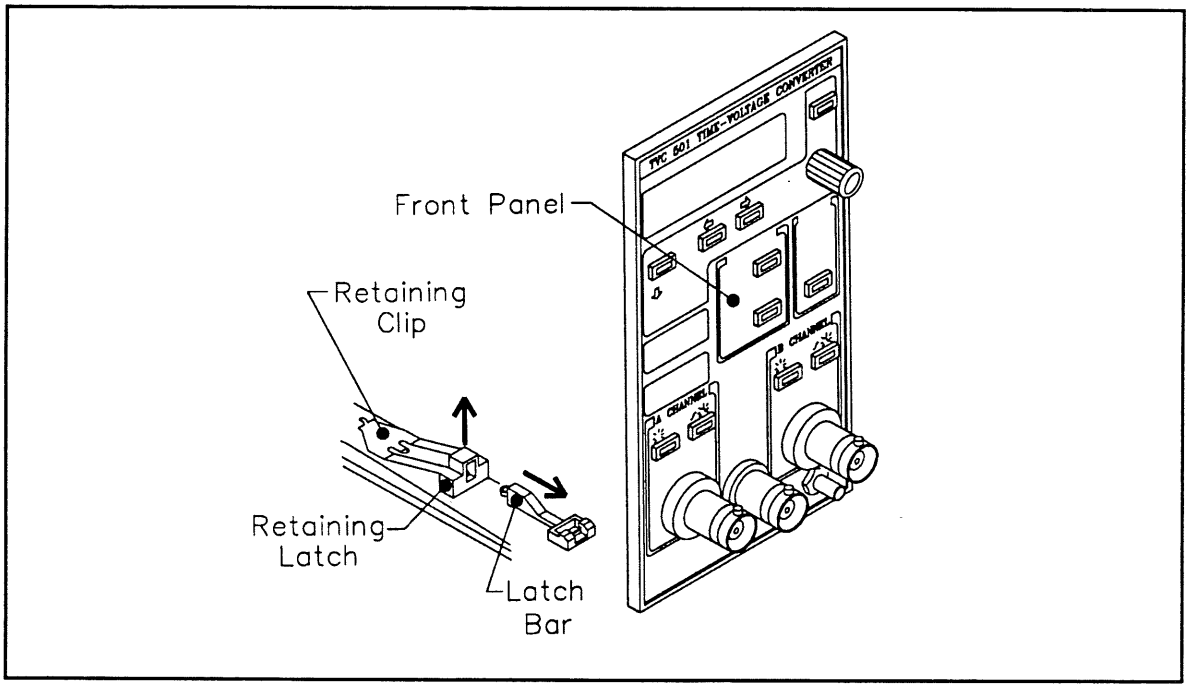


Figure 5-3. Removing the Latch Bar and Retaining Latch.

Counter Circuit Board

This procedure describes how to remove the counter circuit board. Refer to Figure 5-4 for screw and connector locations.

1. Remove the side covers.
2. Disconnect the coaxial cable connected to J210 and the ribbon cable connected to JP240.
3. Using a #1 Phillips screwdriver, remove the five counter board mounting screws.
4. Tilt the board outward at the top and remove it from the chassis.
5. To install the counter board, reinstall the items mentioned in steps 1 through 4 in reverse order, beginning with Step 4.
6. When replacing the counter board with a new one, perform the tests in Chapter 2: Acceptance Tests and calibration procedures in Chapter 3: Calibration after the new board is installed.

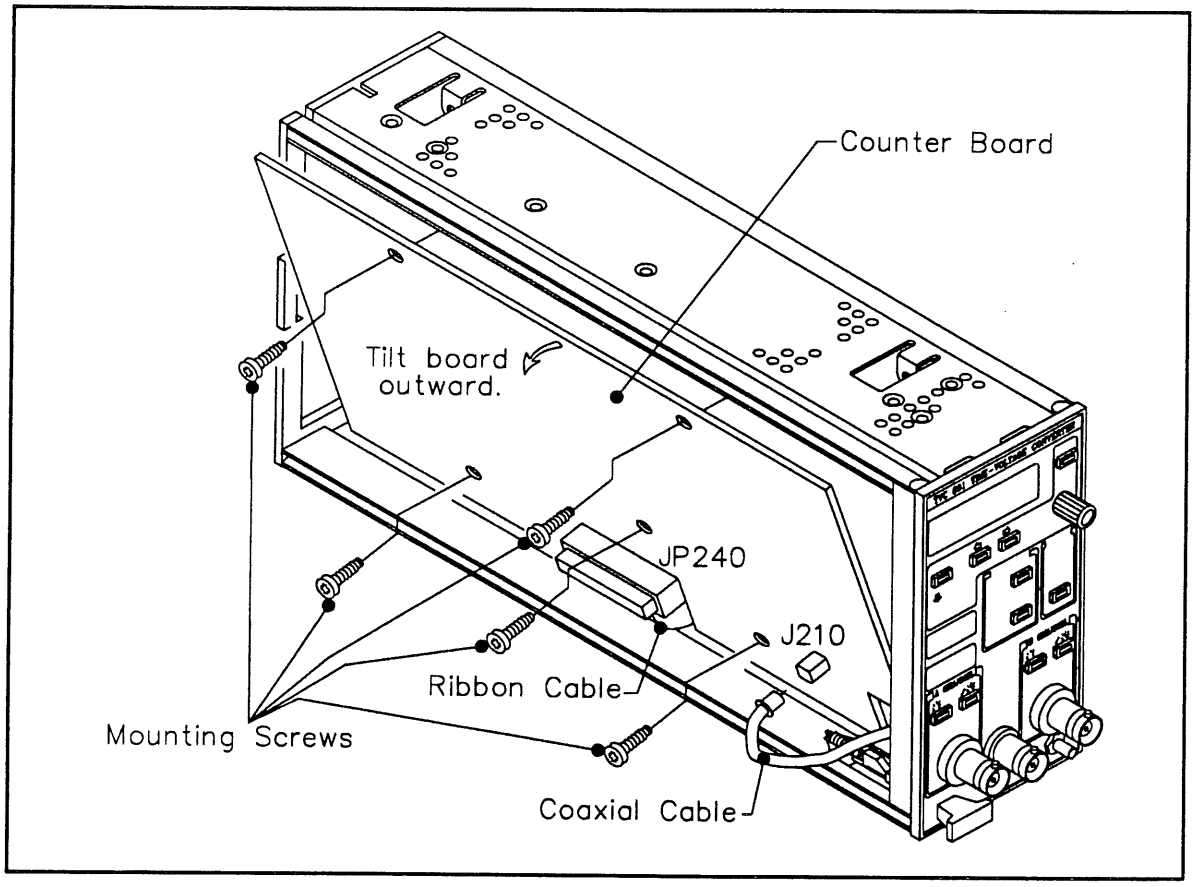


Figure 5-4. Removing the Counter Board.

Processor Circuit Board

To remove the processor circuit board, perform the following procedure.

1. Remove the side covers.
2. Remove the counter board as described under the counter board removal and replacement procedure.
3. On the processor board, disconnect the coaxial cables at J602, J800, J570 and J670 as shown in Figure 5-5.
4. On the processor board, disconnect the ribbon cables connected to J840, J600/J601, and J300.
5. Remove the top section of the chassis by removing two #1 POZIDRIV screws at the top front, the two #2 POZIDRIV screws at the top rear, and the two Phillips screws on the top of the processor board.

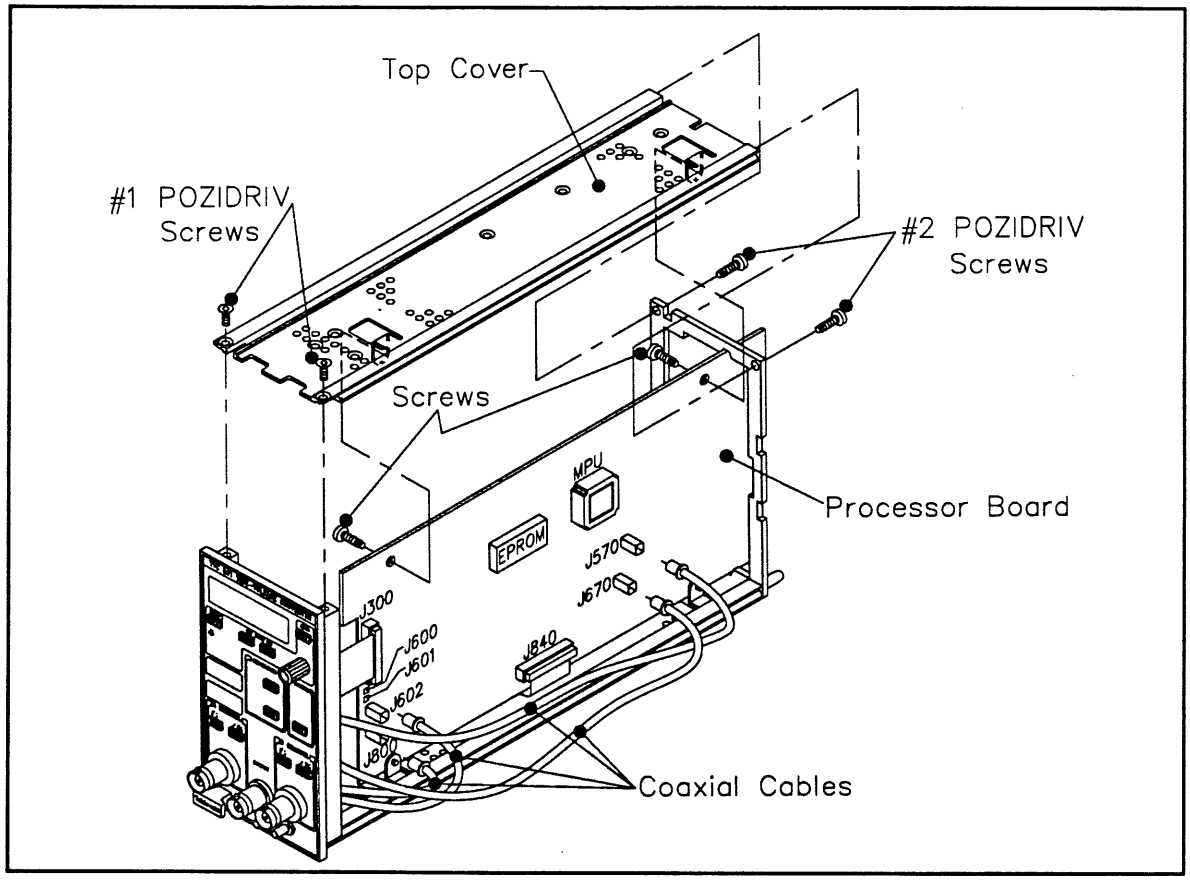


Figure 5-5. Removing the Processor Board.

6. Unscrew the two screws at the bottom of the processor board and lift the processor board away from the chassis. Figure 5-6 shows the screw locations.
7. If replacing the processor board, remove the spacers (shown in Figure 5-6) and any attached cables. Mount them onto the replacement board.
8. To replace the processor circuit board and to reassemble the TVC 501, perform steps 1 through 7 in reverse order, beginning with Step 7.

   Refer to Table 5-2 (located in this chapter under the heading "Front Panel and Associated Subassemblies") for information regarding cable connections.
9. When replacing the processor board with a new one, perform the tests in Chapter 2: Acceptance Tests and calibration procedures in Chapter 3: Calibration after the new board is installed.

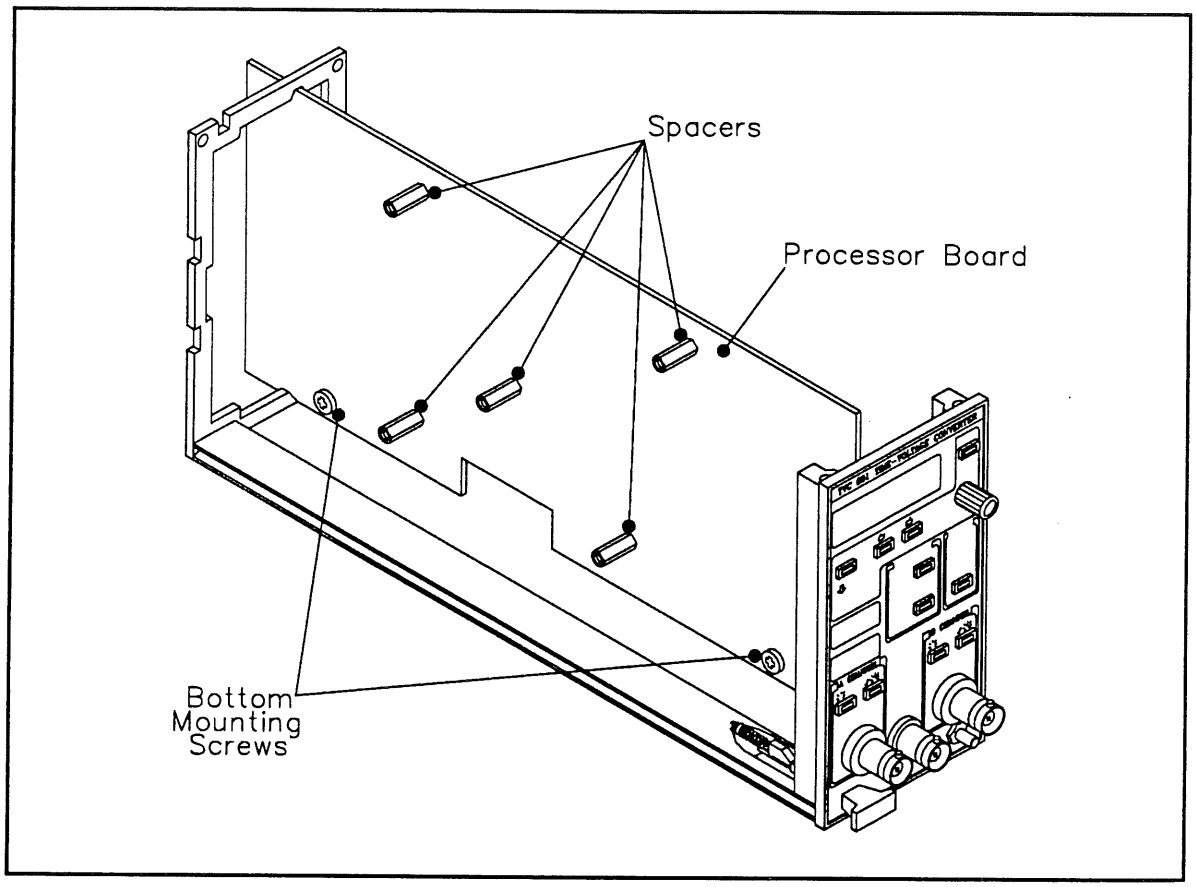


Figure 5-6. Processor Board Screw Locations.

EPROM Removal and Replacement

Perform the following procedure to replace the EPROM integrated circuit. Figure 5-7 shows the location of these components on the processor board.

Caution: Read the static caution statements at the beginning of this chapter. Observe static precautions to prevent inadvertent damage to integrated circuits.

1. Remove the right side cover.
2. Use an appropriate IC extracting tool to remove the EPROM IC from its socket. Take care not to bend any of the pins.
3. Before inserting the IC into its socket, check to ensure its pins are straight and properly aligned.
4. To replace the EPROM, insert the new EPROM into the socket.
5. Re-install the right-side instrument cover.

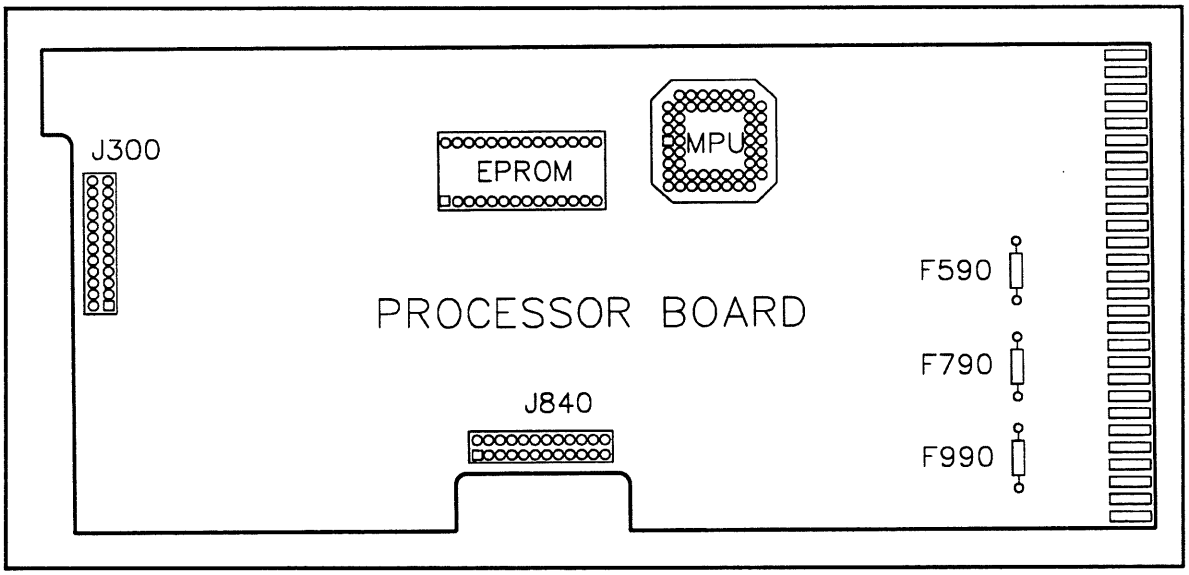


Figure 5-7. EPROM, MPU, and Fuse Locations on Processor Board.

Microprocessor Unit (MPU) Removal and Replacement

Perform the following procedure to replace the MPU integrated circuit. Figure 5-7 shows the location of these components on the processor board.

Caution: Read the static caution statements at the beginning of this chapter. Observe static precautions to prevent inadvertent damage to integrated circuits.

1. Remove the right side cover.
2. Using a PCC extractor tool, remove the MPU from its socket as illustrated in Figure 5-8a or Figure 5-8b.

   Note the keyed corner. This identifies the location of pin 1 and provides alignment to ensure that the MPU is installed correctly in its socket.

>> Note *The MPU is placed in either of two sockets as illustrated in Figure 5-8a or Figure 5-8b. The basic difference of these sockets is where you place the tip of the extractor tool to remove the MPU.*

3. To replace the MPU, align the keyed corner of the IC with the keyed corner of the socket and press the IC firmly into place.

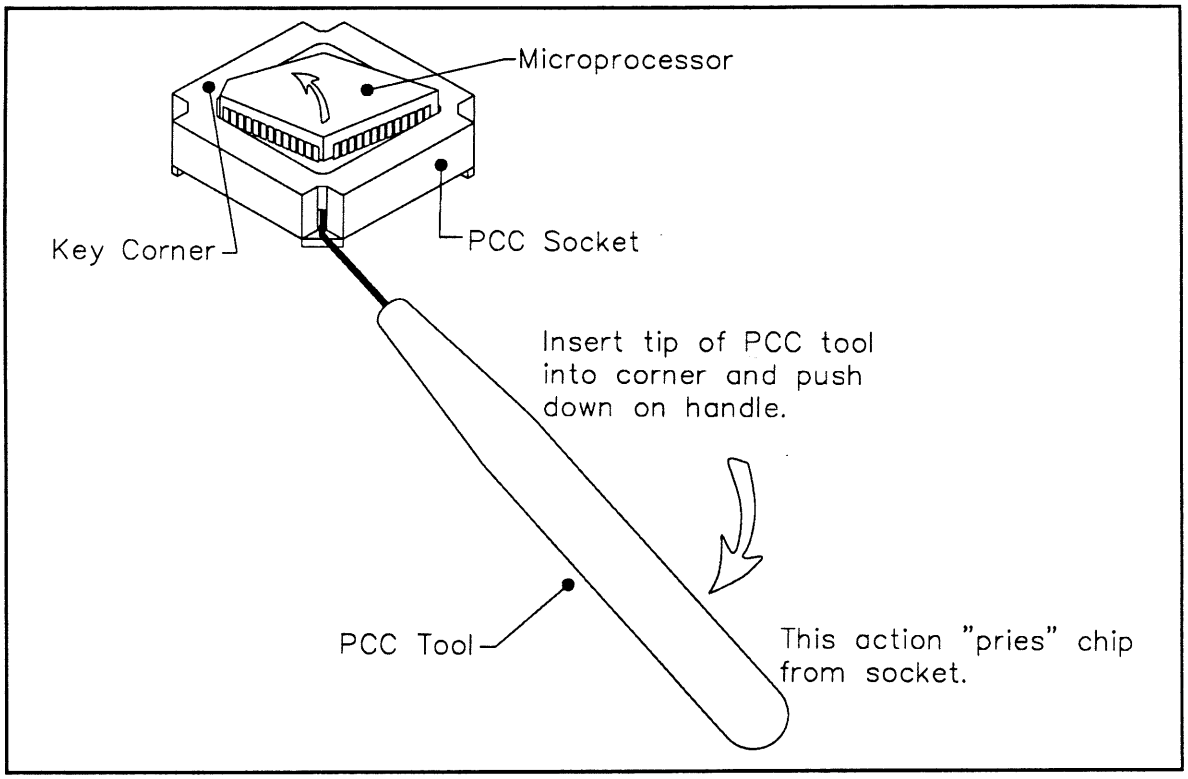


Figure 5-8a. Removing the MPU.

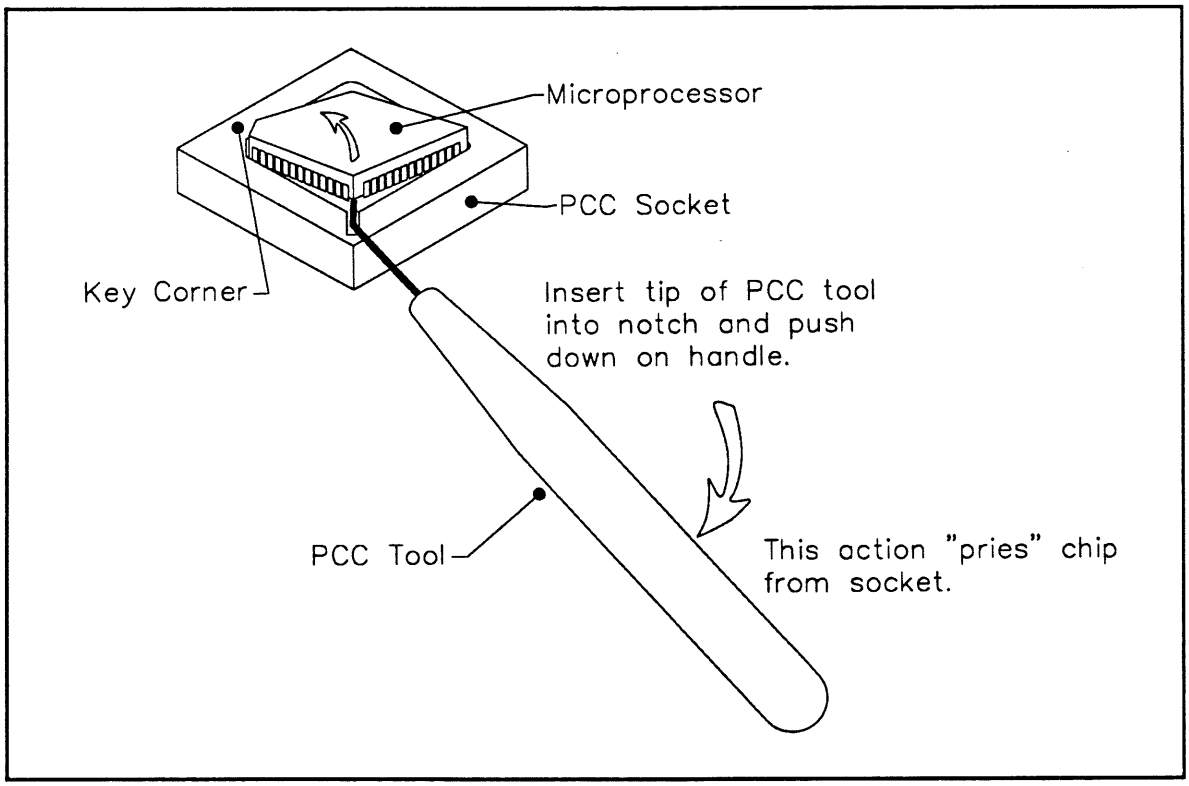


Figure 5-8b. Alternate Method for Removing the MPU.

Fuses

Caution: **Read the static caution statements at the beginning of the chapter. Observe static precautions to prevent inadvertent damage to integrated circuits.**

The processor circuit board provides fuse protection for the incoming Power Module supply voltages. Table 5-1 lists each fuse, the voltage source it is connected to, and the TVC 501 supply voltage it affects. Figure 5-7 shows the location on the processor circuit board for each fuse.

Table 5-1
Fuse Data

Fuse	TM 500 Voltage Source	TM 5000 Voltage Source	TVC 501 Supply Voltage
F990	+11.5 VDC	+8.0 V	+5 VD, +5 VA
F790	-33.5 VDC	-26.0 V	-12 V
F590	+33.5 VDC	+26.0 V	+12 V, +21 V

Perform the following procedure to replace any of the three fuses.

Caution: **Use a grounded 15-W soldering iron and an antistatic suction-type desoldering tool to remove and replace the fuses. Integrated circuits on the processor board can be damaged by static discharge.**

1. Remove the right-side cover.
2. Locate and replace the defective fuse(s).
3. Install the side cover and verify instrument operation.
4. If a fuse continues to blow, isolate and replace the defective circuit board or boards.

FRONT PANEL AND ASSOCIATED SUBASSEMBLIES

The following procedure describes how to remove the front panel and associated subassemblies; the front panel circuit board and the sub-panel electrical shield. In these procedures you will find instructions on removing and replacing individual cable/connector assemblies.

Front Panel Assembly

Perform the following procedure to remove and replace the front panel assembly.

1. Remove both side covers.
2. Using a #1 POSIDRIV screwdriver, remove the four screws that attach the front panel to the chassis. See Figure 5-9.
3. To free the front panel assembly, disconnect cabling at the counter and processor circuit boards.

>>Note *For reassembly purposes, note that the bottom-right screw is longer than the other three screws.*

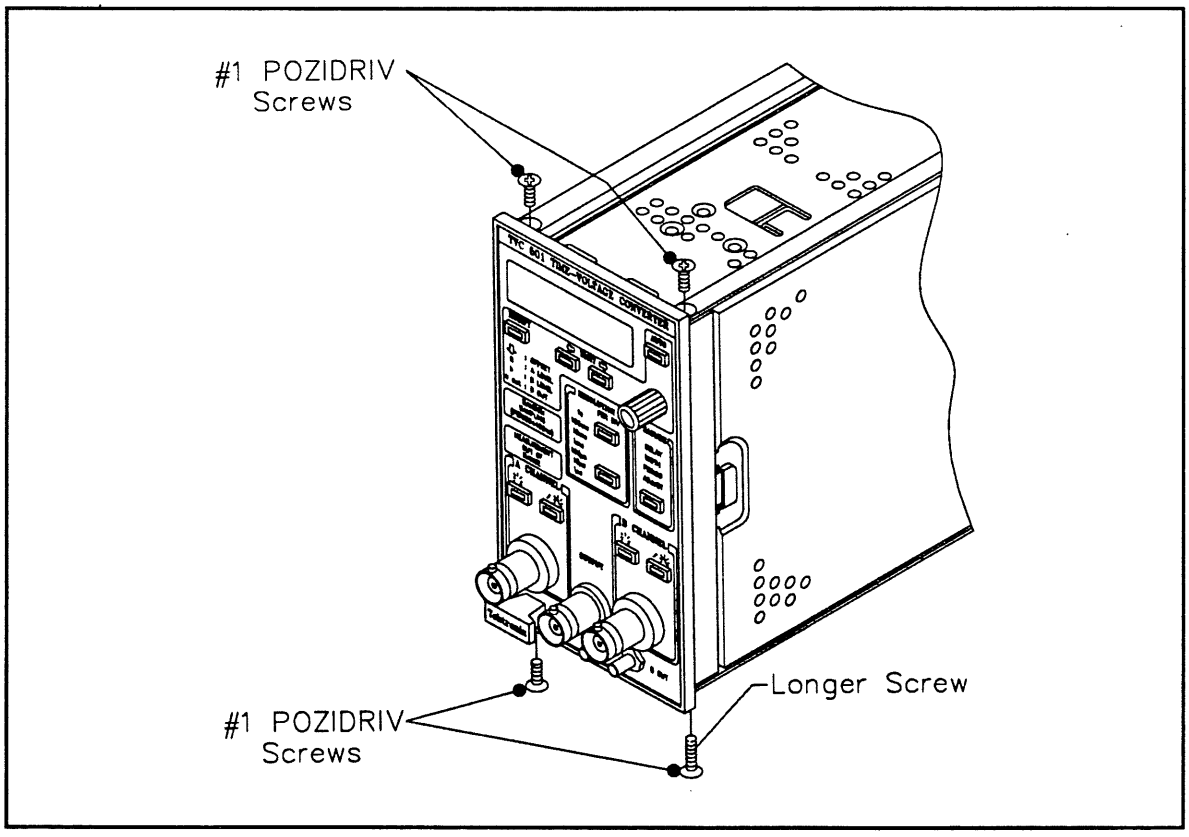


Figure 5-9. Removal of Front Panel Assembly.

4. To replace the front panel assembly, perform steps 1 and 3 in reverse order, beginning with Step 3.

   Refer to Table 5-2 to ensure proper cable connections during reassembly. Table 5-2 describes each coaxial cable, indicates the corresponding front panel-to-circuit board connection, and lists the Tektronix replacement part number. Refer to this table as necessary to ensure proper cable connection during reassembly.

Table 5-2
Front Panel Cable Connections

Front Panel	Connection Point	Cable Color	Length	Tektronix Part No.
A MONITOR	Processor Board: J670	Red-White	10.5 in	174-2341-00
B MONITOR	Processor Board: J570	Brown-White	11.5 in	174-2342-00
A CHANNEL	Processor Board: J800	Red-White	4.5 in	175-3073-00
B CHANNEL	Processor Board: J602	Brown-White	4.0 in	175-3986-00
OUTPUT	Counter Board: J210	Blue-White	4.5 in	175-9481-00
Channel A ID	Processor Board: J600	Red	5.25 in	175-5845-00
Channel B ID	Processor Board: J601	Brown	5.25 in	combined with Channel A ID cable
Interface Cable	Processor Board: J300	Gray	2.75 in	174-2330-00

Front Panel Circuit Board

Perform the following procedure to remove and replace the front panel circuit board. Figure 5-10 shows the disassembly components.

1. Remove the front panel assembly as previously described.
2. Using a 1/16 in Allen wrench, loosen the set screw and remove the circular knob from the front panel.
3. Using a #2 Phillips screwdriver, remove the three circuit board mounting screws and lift the circuit board away from the front panel.
4. To replace the front panel circuit board, perform steps 1 through 3 in reverse order, beginning with Step 3.

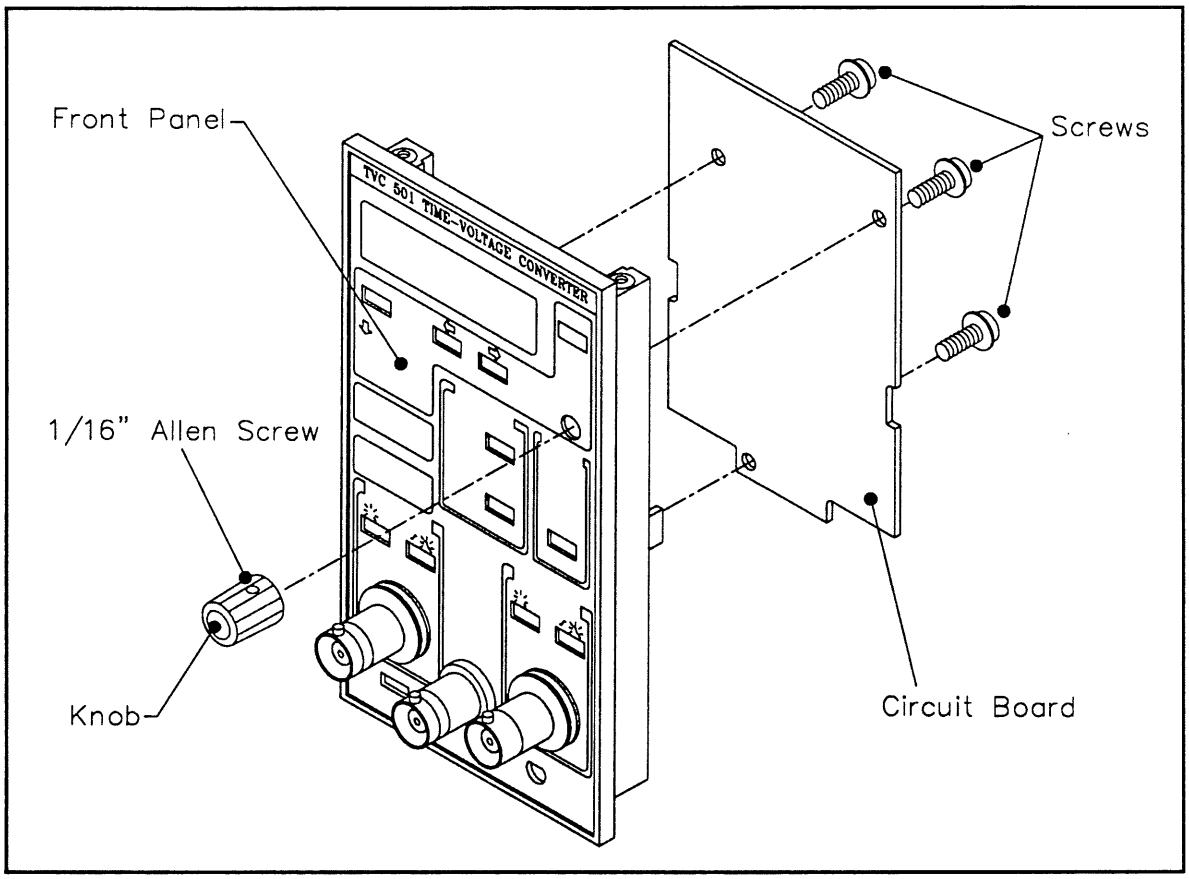


Figure 5-10. Front Panel Circuit Board Removal.

Sub-panel Electrical Shield and Coaxial Connectors

Perform the following procedure to remove and replace the sub-panel electrical shield and coaxial connectors with attached cables. Refer to Figure 5-11 for disassembly components.

1. Remove the front panel assembly as previously described.
2. Remove the front panel circuit board as previously described.
3. Using a 1/4 in nutdriver, remove the mounting nuts of the **A MONITOR** and **B MONITOR** connectors from the front panel.
4. Pull the connectors with attached cables from the rear of the front panel.

Caution: When reassembling the front panel, make sure that the beveled edge of the monitor output connectors face upward before inserting the connectors into the front panel. Failing to do so may result in damage to the front panel.

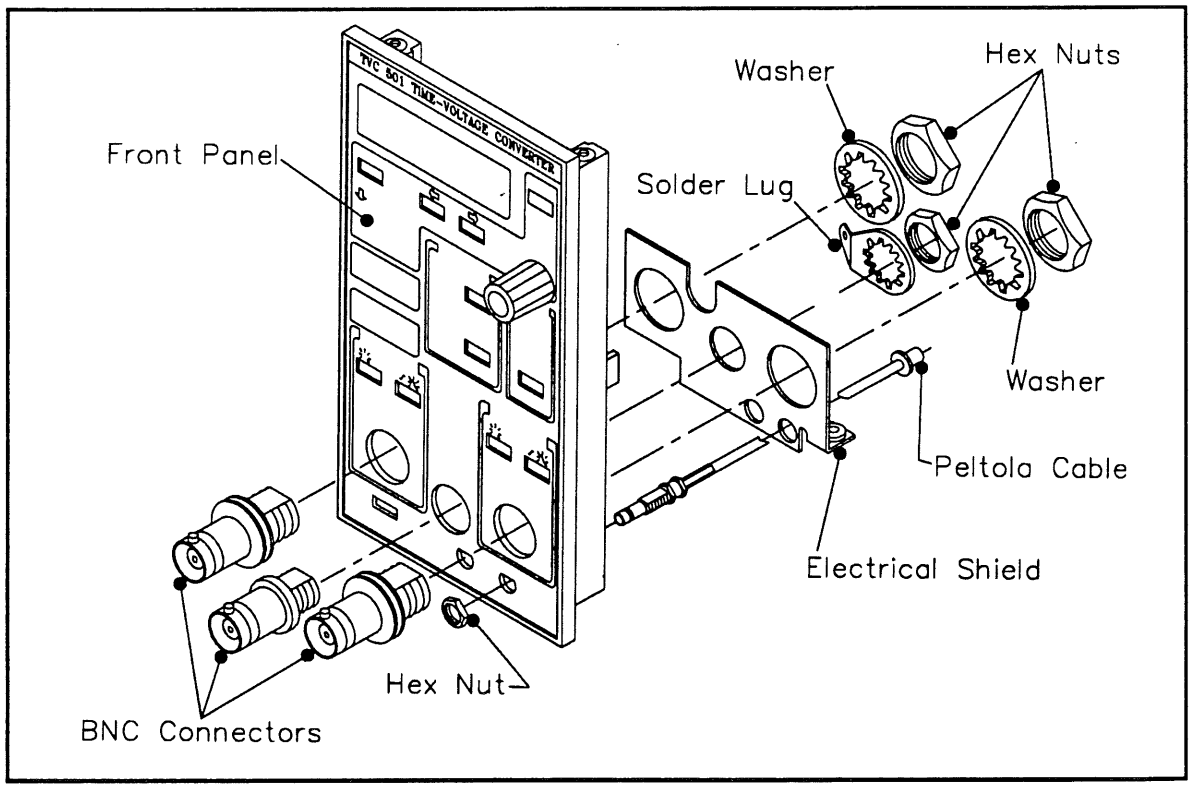


Figure 5-11. Removal of Front Panel Connectors and Shield.

5. Using a grounded 15-W soldering iron, unsolder the brown and red wires from the **A CHANNEL** and **B CHANNEL** BNC connectors, respectively. Also, unsolder the capacitors from these connectors.
6. Pull the coaxial cables out of the **A CHANNEL** and **B CHANNEL** BNC connectors.
7. Using a 9/16 in nutdriver, remove the **A CHANNEL** and **B CHANNEL** BNC mounting nuts. Pull the BNC connectors from the front panel.
8. Using a 1/2 in nutdriver, remove the **OUTPUT** connector mounting nut. Pull the BNC connector from the front panel.
9. Remove the ground lug with the attached capacitors.
10. The subassembly electrical shield can now be removed from the front panel.
11. To replace the subassembly electrical shield, install the items mentioned in steps 1 through 10 in reverse order, beginning with Step 10.

INTERCONNECT WIRING AND COAXIAL CABLES

Interconnect cables (flat, ribbon, and coaxial) can be individually replaced. For flat and ribbon cable part numbers, refer to Table 5-2 or see Chapter 8: Replaceable Parts.

Figure 5-12 shows connections for the two interface cables used in the TVC 501.

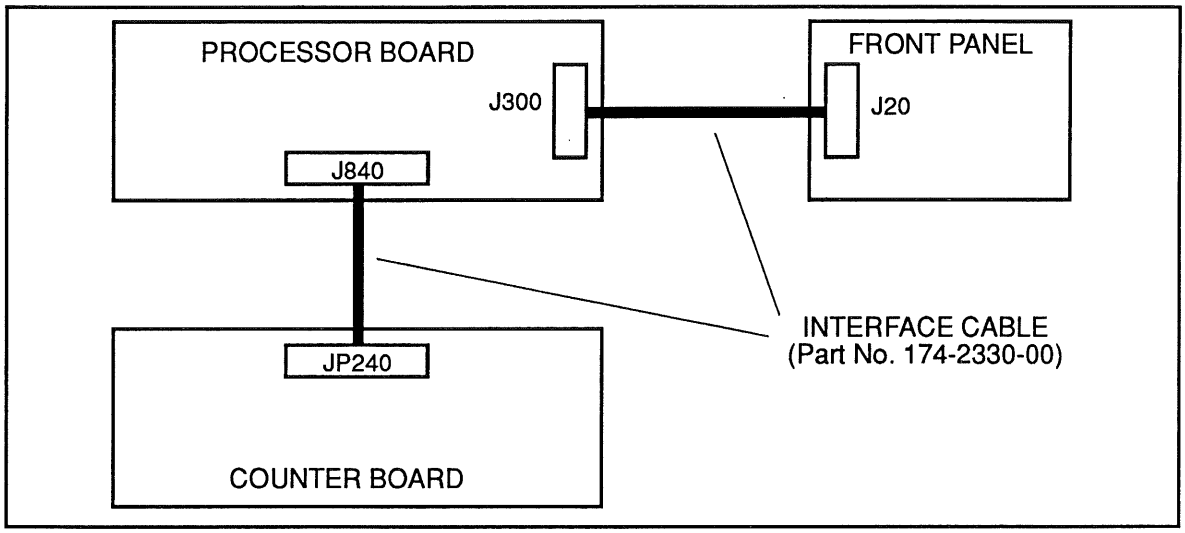


Figure 5-12. Interconnection Diagram for the TVC 501 Circuit Boards.

Chapter 6: Rear Panel Interface

This chapter describes the signals available at the TVC 501 edge connector and how the channel A input, channel B input, and the output signals can be custom-wired to the card edge connector. The rear-panel interface feature allows you to create permanent TM 500- or TM 5000-based test stations that don't require front panel patching between instruments. Unsightly and cumbersome patch cables can be eliminated.

SIGNAL DESCRIPTIONS

This section describes the signals available at the edge connector of the TVC 501. These signals are used for the rear interface of TM 5000 Series and TM 500 Series Power Modules. Figure 6-1 shows the pinout for the TVC 501 edge connector as viewed from the rear of the instrument.

TM 500/TM 5000 Interface Connector as viewed from the rear of the Power Module

	Pin No.			
Converted Output Ground	B	28	A	Hold Measurement Ground
Converted Output	B	27	A	Hold Measurement Input
Null Exceeded Output	B	26	A	Null Exceeded Ground
Not Used	B	25	A	Not Used
Ch B Monitor Output	B	24	A	Ch B Monitor Output Ground
Ch A Monitor Output Ground	B	23	A	Ch A Monitor Output
Not Used	B	22	A	RS-232C Data Out (RXD-2)
TM 5000 Barrier Slot		---		TM 5000 Barrier Slot
RS-232C Data In (TXD-2)	B	21	A	RS-232C Ready Out (DSR-6)
RS-232C Ground (Ret-7)	B	20	A	RS-232C Ground (Ret-1)
TTL Input	B	19	A	TTL Ground
Not Used	B	18	A	Not Used
Ch B Input	B	17	A	Ch A Ground
Ch B Ground	B	16	A	Ch A Input
Not Used	B	15	A	Not Used
Not Used	B	14	A	Not Used
Not Used	B	13	A	Not Used
+33.5 VDC	B	12	A	+33.5 VDC
PNP Series Pass-Collector	B	11	A	PNP Series Pass-Base
Not Used	B	10	A	PNP Series Pass-Emitter
±33.5 V Common	B	9	A	±33.5 V Common
-33.5 VDC	B	8	A	-33.5 VDC
NPN Series Pass-Collector	B	7	A	NPN Series Pass-Emitter
TM 500 Barrier Slot		---		TM 500 Barrier Slot
Not Used	B	6	A	NPN Series Pass-Base
Not Used	B	5	A	Not Used
+11.5 V Common	B	4	A	+11.5 V Common
+11.5 V Common	B	3	A	+11.5 V Common
+11.5 VDC	B	2	A	+11.5 VDC
Not Used	B	1	A	Not Used

Figure 6-1. Rear Connector Pinout.

Detailed Descriptions

The following text defines each TVC 501 rear-interface signal in detail. For Power Module signal descriptions, consult your Power Module Service Manual.

Pin 16A: Ch A Input

This is the input to channel A. A Peltola cable and socket are required.

Pin 17B: Ch B Input

This is the input to channel B. A Peltola cable and socket are required.

Pin 19B: Ch A TTL Input

This is an interface for the Channel A input signal that conforms to TTL level and hysteresis specifications. It is buffered, attenuated by a factor of 10, and can be patched to either Channel A or B. Refer to the Rear Panel Interfacing of Input and Output Signals later in this chapter. A Peltola cable and socket are required.

Pin 20A: RS-232C Ground (Ret-1)

This signal point is for factory use only.

Pin 20B: RS-232C Ground (Ret-7)

This signal point is for factory use only.

Pin 21A: RS-232C Ready Out (DSR-6)

This signal point is for factory use only.

Pin 21B: RS-232C Data In (TXD-2)

This signal point is for factory use only.

Pin 22A: RS-232C Data Out (RXD-3)

This signal point is for factory use only.

Pin 23B: Ch A Monitor Output

This is the output from the channel A trigger monitor. The signal output is at TTL levels. No Peltola cable is required.

Pin 24B: Ch B Monitor Output

This is the output from the channel B trigger monitor. The signal output is at TTL levels. No Peltola cable is required.

Pin 26B: Null Exceeded Output

When the measurement exceeds the current offset value, this signal goes high. When the measurement is lower than the current offset value, this signal goes low.

Pin 27A: Hold Measurement Input

When this input is driven TTL high, the TVC 501 holds the measurement output voltage at the last measured value. When this input is set TTL low or open circuit, the TVC 501 makes continuous measurements (normal operation). A Peltola cable and socket are required.

Pin 27B: DAC Output

This is the measurement output of the TVC 501. It corresponds to the signal at the **OUTPUT** connector. A Peltola cable and socket are required.

REAR PANEL INTERFACING OF INPUT AND OUTPUT SIGNALS

This section describes how to custom-connect the channel A and channel B input signals and the output signal to the TVC 501 edge connector. For detailed information about the rear-panel interface, consult the instruction manual for your Power Module and the *TM 500 and TM 5000 Series Rear Interface Data Book* (Tektronix part no. 070-2088-04).

Figure 6-2 shows the location on the processor circuit board where the channel A, channel B, and output signals can be connected to the card edge connector. There are four connector locations.

- **J380** The location where the channel A or channel B input signal, from the card edge connector, can be patched to an input that conforms to TTL level and hysteresis specifications. When connected at this location, the input signal is buffered and attenuated by a factor of 10.
- **J390** The location where the channel A input signal, from the card edge connector can be patched to the channel A input. Input specifications are identical to the front panel **A CHANNEL** connection.
- **J290** The location where the channel B input signal, from the card edge connector can be patched to the channel B input. Input specifications are identical to the front panel **B CHANNEL** connection.
- **J190** The location where the output signal can be patched to the edge connector.

Figure 6-3 shows the location on the counter board where the output signal originates.

- **J210** The location where the TVC 501 measurement output originates. Patch this connector to the front panel **OUTPUT** jack if you want the output to appear at the front panel or to J190 if you want the output to appear at the edge connector.

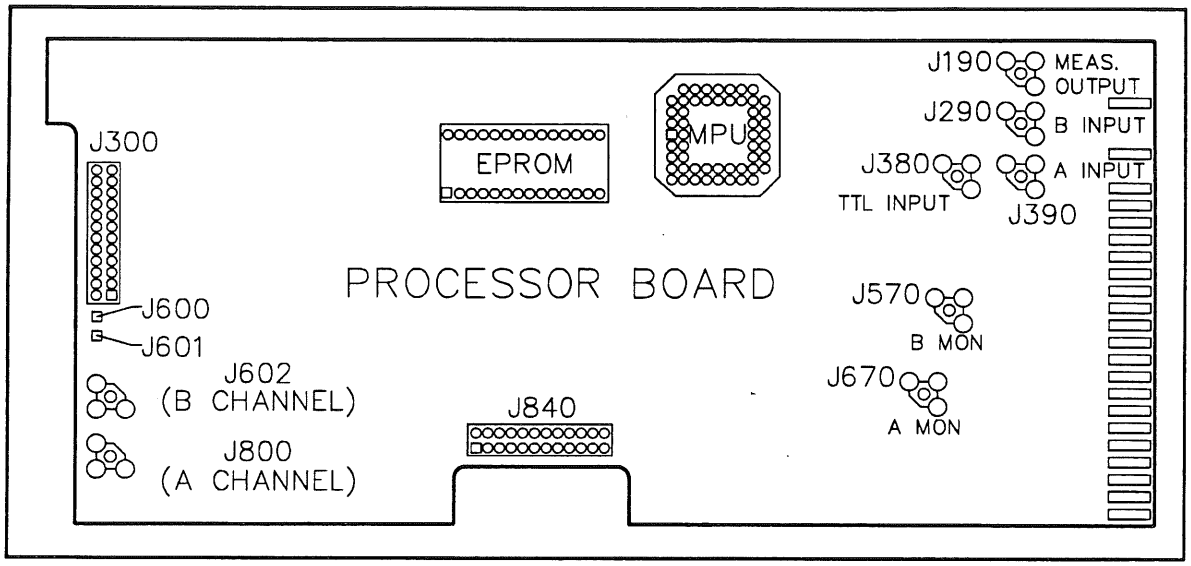


Figure 6-2. Patch Connector Locations on Processor Circuit Board.

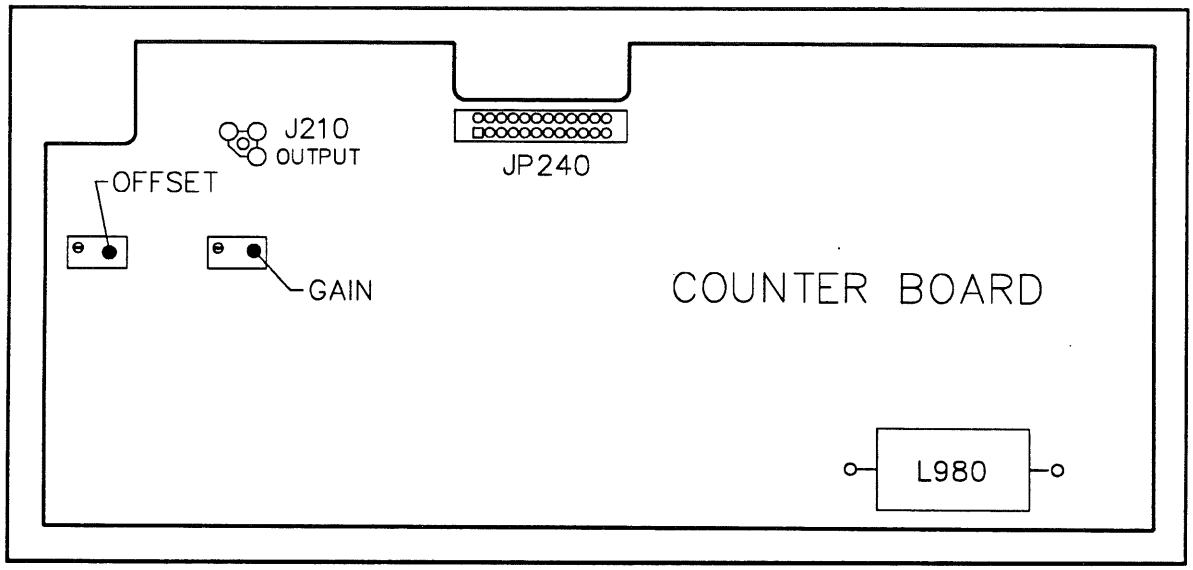


Figure 6-3. Patch Connector Locations on Counter Circuit Board.

Required Tools and Equipment

For information about required tools, refer to the tools listed in Chapter 5: Disassembly/Assembly. Miniature 50-Ω coaxial wiring with Peltola connectors and Peltola circuit board sockets are required for some rear-panel connections. You can obtain small quantities of the small diameter 50-Ω coaxial cable by ordering Tektronix part number 175-1020-00 by the foot. Or, you can order small 50-Ω coaxial cables with pre-installed special Peltola connectors on each end. We recommend the following sizes and quantities.

10-inch length (2 ea.)	Tektronix part no. 175-1827-00
14-inch length (1 ea.)	Tektronix part no. 175-1828-00
Peltola receptacle (4 ea.)	Tektronix part no. 131-1003-00
Peltola socket pin (4 ea.)	Tektronix part no. 136-0252-07

Channel A and Channel B Input Connections

Typically, the channel A input is patched to either J380 (TTL compatible) or to J390. The channel B input is typically patched to J290. Proceed as follows:

1. Remove the side covers and the counter board from the TVC 501 to allow access to the processor circuit board. For removal information, refer to the instructions in Chapter 5: Disassembly/Assembly.
2. For each channel to be patched to the card edge connector, obtain or build a 10-inch miniature 50-Ω coaxial cable with Peltola male connectors at each end.
3. Solder Peltola jacks onto the processor circuit board at the desired locations. Table 6-1 lists the input connection points.

Table 6-1
Rear-Panel Input Connection Points

Input Name	Connection Point
A INPUT	J390
B INPUT	J290
TTL INPUT	J380

4. Remove the miniature coaxial cables from J800 for channel A and J602 for channel B.
5. Patch J602 to either J380 or J390 (Channel A) using one of the 10-inch 50-Ω miniature coaxial cables.

6. Patch J800 to J290 (Channel B) using the remaining 10-inch 50-Ω miniature coaxial cable.
7. Reassemble the TVC 501 and verify instrument operation by performing the tests in Chapter 2: Acceptance Tests.

Output Signal Connection

The output signal can be patched to the card edge connector at J190. Proceed as follows:

1. Remove the side covers and the counter board from the TVC 501 to allow access to the processor circuit board. For removal information, refer to the instructions in Chapter 5: Disassembly/Assembly.
2. Obtain or build one 14-in miniature 50-Ω coaxial cable with Peltola connectors at each end.
3. Solder a Peltola jack at the J190 location on the processor circuit board (see Figure 6-1 for location).
4. Remove the miniature coaxial cable from J210 on the counter circuit board.
5. Patch J210 (located on the counter circuit board) to J190 (located on processor circuit board) using the 14-in 50-Ω miniature coaxial cable. Route the cable from the counter circuit board, behind the front panel, to the component side of the processor circuit board.
6. Reassemble the TVC 501 and verify instrument operation by performing the tests in Chapter 2: Acceptance Tests.

Chapter 7: Specifications

Chapter 7 contains two tables that list TVC 501 performance specifications. These specifications are only valid for an instrument calibrated at an ambient temperature between 20° C and 25° C. The instrument should have a minimum warm-up period of 20 minutes.

Table 7-1
Electrical Specifications

CHARACTERISTICS	PERFORMANCE REQUIREMENT	SUPPLEMENTAL INFORMATION
Output (front panel):		
Total Measurement % (500ns after the event into DMM. Time Measured ≥ Res. per Div ÷ 5)	Refer to Figure 7-1 and accompanying text for specification requirement	
Front Panel Output:		
Risetime (full scale)		
50-Ω load	75 ns to 200 ns	
1-MΩ load	150 ns to 350 ns	
Maximum Scale		
50-Ω load	211 mV ±10 mV	
1-MΩ load	423 mV ±20 mV	
Minimum Scale		
50-Ω load	-211 mV ±10 mV	
1-MΩ load	-423 mV ±20 mV	
Measurement Delay	Approximately 250 ns after event	
A and B Inputs:		
Impedance	1 MΩ shunted by ≤50 pF	
Level Range	±1.25 X Probe scale factor	
Dynamic Range	±2 V at the BNC connector	

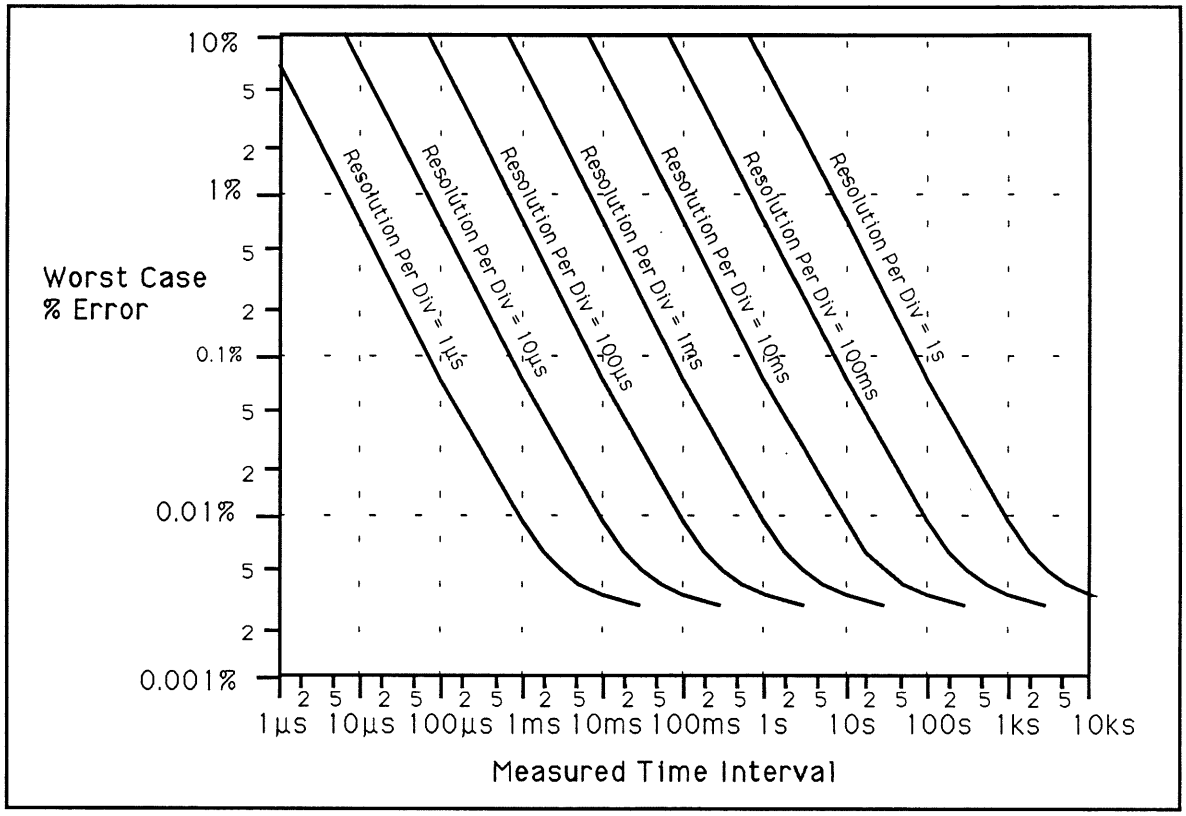


Figure 7-1. Worst Case Error. Total Measurement Error as it relates to the measured time interval and the Resolution Per Division.

Figure 7-1 assumes that there is no trigger jitter and that the time interval measured is greater than one-fifth of the resolution per division. It is a graphic representation for

$$\text{Total Measurement Error (in \%)} = \pm\left\{\left[\frac{7 \text{ X Resolution per Div}}{\text{Time Measured}}\right] + 0.0025\right\}$$

For example, if the measured period is 1 ms (frequency = 1 kHz) and the Resolution Per Division is 1 µs, then the error is ±0.0095%.

Table 7-1
Electrical Specifications (continued)

CHARACTERISTICS	PERFORMANCE REQUIREMENT	SUPPLEMENTAL INFORMATION
A and B Inputs (cont.):		
Level Error	±[5% of displayed value + (20 mV X Probe scale factor)]	Measured at ≤1 kHz
Probe Scaling	Recognizes 1X, 2X, 5X, 10X, 20X, 50X, 100X, 200X, 500X, and 1000X resistor-encoded probes	
Trigger Sensitivity	100 mV p-p at BNC connector	Measured at 1 kHz
AC Coupling	Blocks DC components and significantly attenuates below 2 Hz	
Measurable Pulse	≥10 ns	250 mV p-p at BNC connector
Indicator (TRIG'D LED)	≥10 ns	250 mV p-p at BNC connector
Auto Trigger:		
Minimum Reliable Frequency	20 Hz	
Minimum Reliable Pulse Width	50 ns	
Auto Offset/Resolution:		
Minimum Reliable Frequency	20 Hz	
A and B Monitor Outputs:		
High Level		
50-Ω load	250 mV ±75 mV	
1-MΩ load	450 mV ±100 mV	
Low Level		
50-Ω load	0V to 75 mV	
1-MΩ load	0V to 100 mV	
Maximum Frequency	10 MHz	
Minimum Pulse Width	Responds to 50 ns input signal	
Propagation Delay		Approximately 80 ns (+10 ns for channel B)
B Out = 2 Output	B Input ÷ 100	
Max B Input Frequency	100 MHz, 250 mV p-p	
B Out = 3 Output	B Input ÷ 1000	
Max B Input Frequency	100 MHz, 250 mV p-p	
B Out = 4 Output	60.0000 Hz ±0.0015 Hz	
B Out = 5 Output	Alternating periods of 100 µs and 66.7 µs	

Table 7-1
Electrical Specifications (continued)

CHARACTERISTICS	PERFORMANCE REQUIREMENT	SUPPLEMENTAL INFORMATION
A and B Monitor Outputs (cont.):		
B Out = 6 Output	Approximately 600 ns ±200 ns negative-going pulse at 60 Hz rate superimposed on B Out 5 signal	
B Out = 7 Output	12 µs to 16 µs modulated-width signal.	
B Out = 8 Output	Pseudo-random period variations with two "misplaced pulses." Maximum period = 10 ms ±2 ms Minimum period = 4.5 ms ±1 ms Maximum and minimum periods occur every 1.7 s ±100 ms	
Measurement Resolution:	≤0.1 X resolution per division	
Offset Resolution:	0.1 X resolution per division	
Range:		
Measurement	2^{20} X resolution per division ÷ 30	
Output	±4.2 X resolution per division	
Offset	0 to 30,000 X resolution per division	
Timing Stability:	±25 ppm (0.0025%)	
Maximum Measurement Rate:	2.5 million measurements per second	
Front Panel Indicators:		
Random Sampling OFF ON	 Period ≥405 ns ±10 ns Period ≤333 ns ±10 ns	Indicates that the input signal exceeds the maximum measurement rate of about 2.5 MHz. Minimum detectable period violation is about 100 ns.
Measurement Out of Range OFF ON	 ABS[1] (Measurement - Offset[2]) ≤4.1 X [resolution per division] ABS[1] (Measurement - Offset[2]) ≥4.3 X [resolution per division]	Indicates that the measurement exceeds the output range and that the output is clipped.

[1] ABS represents the "Absolute Value" of the expression within the parenthesis.

[2] Measurement is the time interval value (in seconds) as measured by the TVC 501. For example: A time interval of 130 µs with the resolution per div = 1 µs will not light the indicator as long as the Offset is between 125.9 µs and 134.1 µs. The indicator will light if the Offset is less than 125.7µs or greater than 134.3 µs.

Table 7-1
Electrical Specifications (continued)

CHARACTERISTICS	PERFORMANCE REQUIREMENT	SUPPLEMENTAL INFORMATION
Power Dissipation:	Approximately 10 Watts	
Rear Connector Signals:		
HOLD Not Held Held	 Open circuit or Vin <0.8 V. Enables the front panel output to track measurement results 5.0 V. >Vin >2.5 V. Holds the front panel output at the last measured value.	Vin applied at rear connector A-27. TTL compatible.
NULL EXCEEDED Not Exceeded Exceeded	 Vout <0.5 V. Indicates that the current measurement is less than the current Offset value. 5.0 V. >Vout >2.5 V. Indicates that the current measurement is greater than (or above) the current Offset value.	Vout is available at rear connector B-26. TTL compatible.
A and B Monitor	TTL compatible version of the front panel outputs	
Optional Rear Inputs		Requires additional Peltola cables and sockets.
TTL in		Direct TTL interface of level and hysteresis which is buffered and attenuated (÷10). It can be patched to channel A or B internally 10kHz maximum.
A Rear in		Patches the rear to Channel A
B Rear In		Patches the rear to Channel B
Measurement Out		Patches the rear to DAC output

Table 7-2
Environmental Specifications

CHARACTERISTICS	PERFORMANCE REQUIREMENT	SUPPLEMENTAL INFORMATION
Temperature		
Operating	0° C to +50° C	
Non-Operating	-55° C to +75° C	
Humidity	Meets MIL-T28800D Type III, Class 5	
Altitude	Meets MIL-T28800D Type III, Class 5	
Vibration	Meets MIL-T28800D Type III, Class 5	Tektronix Standard 062-2858-00, non-operating, swept 10 Hz to 55 Hz with 15 minutes dwell at 50 Hz on 3 axes
Shock	Meets MIL-T28800D Type III, Class 5	Tektronix Standard 062-2858-00. 30 g drop 3 times on each of 6 sides (18 drops total).
Bench Handling	Meets MIL-T28800D Type III, Class 5	Tektronix Standard 062-2858-00
Packaging	Passed National Safe Transit Association's pre-shipment test procedures	Tektronix Standard 062-2858-00. Dropped on 6 faces, all corners from 2-foot height.
Electrostatic Immunity	20 kV maximum	Tektronix Standard 062-2862-00
EMI Compatibility	Meets FCC regulations, Part 15, Subpart J, Class A Meets VDE 0871/6.78, Class B	
Safety	Conforms to UL 1244	Safety requirements for electrical and electronic test and measurement equipment

Table 7-3
Physical Specifications

CHARACTERISTICS	DESCRIPTION
Maximum Dimensions:	
Height	127 mm (5.0 in)
Width	66 mm (2.6 in)
Length	292 mm (11.5 in)
Weight	0.8 kg (1.8 lb)

REPLACEABLE MECHANICAL PARTS

PARTS ORDERING INFORMATION

Replacement parts are available from or through your local Tektronix, Inc. Field Office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available, and to give you the benefit of the latest circuit improvements developed in our engineering department. It is therefore important, when ordering parts, to include the following information in your order: Part number, instrument type or number, serial number, and modification number if applicable.

If a part you have ordered has been replaced with a new or improved part, your local Tektronix, Inc. Field Office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

ITEM NAME

In the Parts List, an item Name is separated from the description by a colon(:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, the U.S. Federal Cataloging Handbook H6-1 can be utilized where possible.

FIGURE AND INDEX NUMBERS

Items in this section are referenced by figure and index numbers to the illustrations.

INDENTATION SYSTEM

This mechanical parts list is indented to indicate item relationships. Following is an example of the indentation system used in the description column.

1 2 3 4 5 Name & Description

Assembly and/or Component
Attaching parts for Assembly and/or Component

END ATTACHING PARTS

Detail Part of Assembly and/or Component
Attaching parts for Detail Part

END ATTACHING PARTS

Parts of Detail Part
Attaching parts for Parts of Detail Part

END ATTACHING PARTS

Attaching Parts always appear in the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation.

Attaching parts must be purchased separately, unless otherwise specified.

ABBREVIATIONS

Abbreviations conform to American National Standards Institute Yl.l

CROSS INDEX - MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
04713	MOTOROLA INC SEMICONDUCTOR PRODUCTS SECTOR	5005 E MCDOWELL RD	PHOENIX AZ 85008-4229
0J260	COMTEK MANUFACTURING OF OREGON (METALS)	PO BOX 4200	BEAVERTON OR 97076-4200
12327	FREEWAY CORP	9301 ALLEN DR	CLEVELAND OH 44125-4632
24931	SPECIALTY CONNECTOR CO INC	2100 EARLYWOOD DR PO BOX 547	FRANKLIN IN 46131
75915	LITTELFUSE INC SUB TRACOR INC	800 E NORTHWEST HWY	DES PLAINES IL 60016-3049
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON OR 97077-0001
83385	MICRODOT MFG INC GREER-CENTRAL DIV	3221 W BIG BEAVER RD	TROY MI 48098
83486	ELCO INDUSTRIES INC	1101 SAMUELSON RD	ROCKFORD IL 61101
93907	TEXTRON INC CAMCAR DIV	600 18TH AVE	ROCKFORD IL 61108-5181
TK0435	LEWIS SCREW CO	4300 S RACINE AVE	CHICAGO IL 60609-3320
TK0858	STAUFFER SUPPLY CO (DIST)	810 SE SHERMAN	PORTLAND OR 97214
TK1326	NORTHWEST FOURSLIDE INC	18224 SW 100TH CT	TUALATIN OR 97062

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-1	366-0714-00			1	KNOB:DOVE GRAY,0.165 ID X 0.392 OD X 0.466 H	80009	366-0714-00
-2	366-1851-01			1	KNOB,LATCH:IVORY GY,0.625 X 0.25 X 1.09	80009	366-1851-01
-3	105-0865-00			1	BAR,LATCH RLSE:	80009	105-0865-00
-4	105-0866-00			1	LATCH,RETAINING:SAFETY	80009	105-0866-00
-5	214-3143-00			1	SPRING,HLEXT:0.125 OD X 0.545 L,XLOOP	80009	214-3143-00
-6	131-1315-01			1	CONN,RCPT,ELEC:BNC,FEMALE	80009	131-1315-01
-7	210-0255-00			1	TERMINAL,LUG:0.391 ID,LOCKING,BRS CD PL	12327	ORDER BY DESCR
-8	131-1171-00			2	CONN,RCPT,ELEC:BNC,FEMALE	24931	28JR231-1
-9	386-6188-01			1	PANEL,FRONT:W/LEXAN I.D. MARKER	80009	386-6188-01
-10	337-3731-00			1	SHIELD,ELEC:SUBPANEL	80009	337-3731-00
	175-9481-00			1	CABLE ASSY,RF:50 OHM COAX,4.5 L,9-6 (FRONT PANEL BNC TO COUNTER BOARD)	80009	175-9481-00
	175-3073-00			1	CABLE ASSY,RF:50 OHM COAX,4.5 L,9-2 (FRONT PANEL BNC TO PROCESSOR BOARD)	80009	175-3073-00
	175-3986-00			1	CABLE ASSY,RF:50 OHM COAX,4.0 L,9-1 (FRONT PANEL BNC TO PROCESSOR BOARD)	80009	175-3986-00
	174-2341-00			1	CABLE ASSY,RF:50 OHM COAX,10.5 L,9-2 (FRONT PANEL PELTOLA TO PROCESSOR BOARD)	80009	174-2341-00
	174-2342-00			1	CABLE ASSY,RF:50 OHM COAX,11.5 L,9-1 (FRONT PANEL PELTOLA TO PROCESSOR BOARD)	80009	174-2342-00
-11	671-1849-01			1	CIRCUIT BD ASSY:FRONT PANEL;;389-0959-XX WI RED (ATTACHING PARTS)	80009	671-1849-01
-12	211-0244-00			3	SCR,ASSEM WSHR:4-40 X 0.312,PNH STL (END ATTACHING PARTS)	TK0858	211-0244-00
-13	214-3406-00			1	SPRING,FLAT:1.48 L X 0.125 W,CU BE	TK1326	ORDER BY DESCR
-14	426-0725-24			1	FR SECT,PLUG-IN:TOP (ATTACHING PARTS)	0J260	ORDER BY DESCR
-15	211-0101-00			2	SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL (END ATTACHING PARTS)	93907	ORDER BY DESCR
-16	671-1851-01			1	CIRCUIT BD ASSY:COUNTER;;389-0961-XX WIRED (ATTACHING PARTS)	80009	671-1851-01
-17	211-0244-00			5	SCR,ASSEM WSHR:4-40 X 0.312,PNH STL (END ATTACHING PARTS)	TK0858	211-0244-00
-18	129-0759-00			5	SPACER,POST:0.53 L,4-40 THRU,AL,0.188 HEX	80009	129-0759-00
-19	671-1850-01			1	CIRCUIT BD ASSY:PROCESSOR;;389-0960-XX WIRED (ATTACHING PARTS)	80009	671-1850-01
-20	211-0244-00			5	SCR,ASSEM WSHR:4-40 X 0.312,PNH STL	TK0858	211-0244-00
-21	213-0146-00			4	SCREW,TPG,TF:6-20 X 0.312,TYPE B,PNH,STL (END ATTACHING PARTS)	83385	ORDER BY DESCR
					CKT BOARD ASSY INCLUDES:		
	156-3227-00			1	.MICROCKT,DGTL:HCMOS,SINGLE CHIP MICROCMPTR	04713	MC68HC11A1FN
	159-0208-01			1	.FUSE,WIRE LEAD:2A,125V,5 SEC,TAPE & REEL	80009	159-0208-01
	159-0221-00			2	.FUSE,WIRE LEAD:0.500A,125V,S20W	75915	255.500T1
	160-7650-00			1	.MICROCKT,DGTL:PRGM 156-3052-XX,TVC501 PROCE .SSOR	80009	160-7650-00
	174-2330-00			2	CA ASSY,SP,ELEC:24,28 AWG,2.75 L,FLAT GRAY (FRONT PANEL BOARD TO PROCESSOR BOARD, COUNTER BOARD TO PROCESSOR BOARD)	80009	174-2330-00
	175-5845-00			1	CA ASSY,SP,ELEC:2,26 AWG,5.25 L,RIBBON (FRONT PANEL BNC TO PROCESSOR BOARD)	80009	175-5845-00
-22	426-0724-30			1	FR SECT,PL-IN:BOTTOM (ATTACHING PARTS)	0J260	ORDER BY DESCR
-23	211-0101-00			1	SCREW,MACHINE:4-40 X 0.25,FLH,100 DEG,STL	93907	ORDER BY DESCR
-24	211-0025-00			1	SCREW,MACHINE:4-40 X 0.375,FLH,100 DEG,STL (END ATTACHING PARTS)	TK0435	ORDER BY DESCR
-25	386-4866-00			1	SUPPORT,FRAME:REAR,AL (ATTACHING PARTS)	80009	386-4866-00
-26	213-0793-00			2	SCREW,TPG,TF:6-32 X 0.4375,TAPTITE,FILH	83486	239-006-406043
-27	386-3657-01			2	SUPPORT,PLUG-IN:SAFETY CONTROLLED (END ATTACHING PARTS)	93907	ORDER BY DESCR
-28	337-3211-00			2	SHIELD,ELEC:	80009	337-3211-00
					STANDARD ACCESSORIES		
	012-0057-01			1	CABLE ASSY,RF:50 OHM COAX,43.0 L	80009	012-0057-01

Fig. & Index No.	Tektronix Part No.	Serial/Assembly No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
1-	012-0532-00			2	CABLE,INTCON:50 OHM COAX,42.0 L	80009	012-0532-00
	070-7991-00			1	MANUAL,TECH:OPERATORS,TVC501	80009	070-7991-00
	070-7992-00			1	MANUAL,TECH:SERVICE,TVC501	80009	070-7992-00
	----- -----			1	P6109 - PROBE,PASSIVE:150 MHZ,10X,2M		

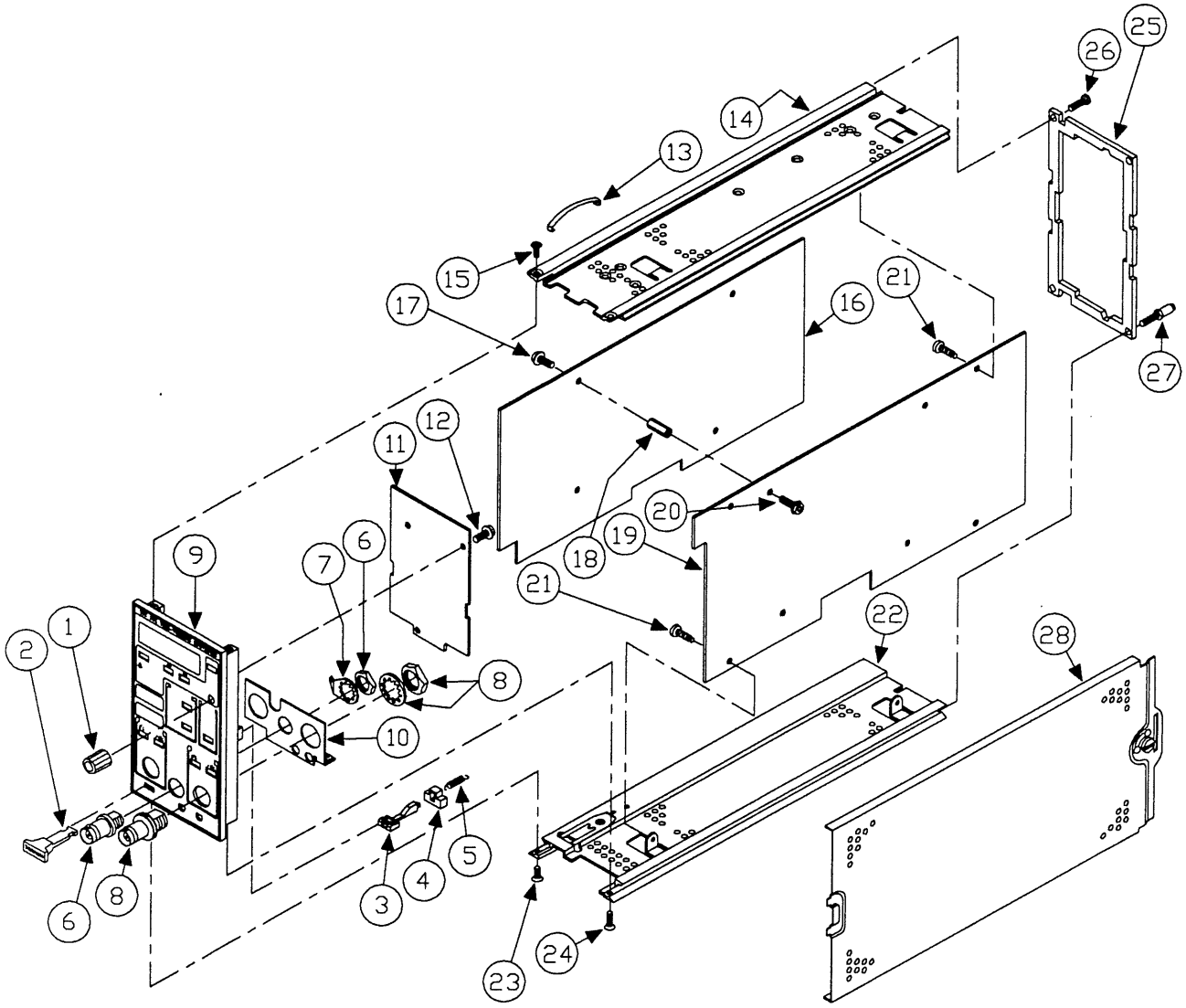


Figure 1. Exploded View