User Manual

Tektronix

CDC250
175 MHz Universal Counter

070-7999-02

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Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

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Tektronix warrants that this product will be free from defects in materials and workmanship for a period of one (1) year from the date of shipment. If any such product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, with shipping charges prepaid. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; or c) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.

Injury Precautions

Use Proper Power Cord

To avoid fire hazard, use only the power cord specified for this product.

Avoid Electric Overload

To avoid electric shock or fire hazard, do not apply a voltage to a terminal that is outside the range specified for that terminal.

Ground the Product

This product is grounded through the grounding conductor of the power cord. To avoid electric shock, the grounding conductor must be connected to earth ground. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Do Not Operate Without Covers

To avoid electric shock or fire hazard, do not operate this product with covers or panels removed.

Use Proper Fuse

To avoid fire hazard, use only the fuse type and rating specified for this product.

Do Not Operate in Wet/Damp Conditions

To avoid electric shock, do not operate this product in wet or damp conditions.

Do Not Operate in Explosive Atmosphere

To avoid injury or fire hazard, do not operate this product in an explosive atmosphere.

Product Damage Precautions

Use Proper Power Source

Do not operate this product from a power source that applies more than the voltage specified.

Use Proper Voltage Setting

Before applying power, ensure that the line selector is in the proper position for the power source being used.

Provide Proper Ventilation

To prevent product overheating, provide proper ventilation.

Do Not Operate With Suspected Failures

If you suspect there is damage to this product, have it inspected by qualified service personnel.

Safety Terms and Symbols

Terms in This Manual

These terms may appear in this manual:

WARNING. *Warning statements identify conditions or practices that could result in injury or loss of life.*

CAUTION. *Caution statements identify conditions or practices that could result in damage to this product or other property.*

Terms on the Product

These terms may appear on the product:

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product

The following symbols may appear on the product:

DANGER
High Voltage

Protective Ground
(Earth) Terminal

ATTENTION
Refer to
Manual

Double
Insulated

Certifications and Compliances

CSA Certified Power Cords

CSA Certification includes the products and power cords appropriate for use in the North America power network. All other power cords supplied are approved for the country of use.

Getting Started

The Tektronix CDC250 175 MHz Universal Counter counts the signal frequency of sine, square, and triangle waves from 5 Hz to 175 MHz. An eight-digit display with automatic decimal point placement and an LED indicator shows the display measurement unit. In addition to frequency measurements, the frequency counter provides the following measurement functions:

- Period measurements in microseconds or milliseconds over a 5 Hz to 2 MHz range
- Frequency ratio measurements comparing two input signals
- Time interval measurements from a selected edge of one input signal to a selected edge of another
- Totalize measurements for counting individual events

The CDC250 has a locking, multiposition handle that folds under the instrument to allow stacking with other instruments of the same series. The CDC250 is delivered with a 115 V power cord, an installed fuse for 115 V operation, and this manual.

Preparing the CDC250 175 MHz Universal Counter for Use

Check the following items prior to operating the CDC250 175 MHz Universal Counter for the first time (see Figure 1 for item locations):

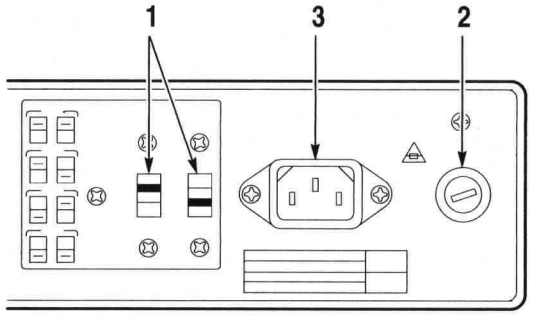

Figure 1: Line Voltage Selectors, Power Input, and Fuse Locations

CAUTION. *To prevent damage to the instrument, set the line voltage selectors to the proper voltage setting and install the correct line voltage fuse before operating the equipment.*

1. Set the line voltage selectors to the input line voltage. These selectors connect internal wiring for various line voltages. This product is intended to operate from a power source that does not supply more than 250 V_{RMS} between the supply conductors or between either supply conductor and ground. For line voltage ranges, refer to *Appendix A: Specifications* on page 27.

WARNING. *To prevent electrical shock, unplug the power cord and disconnect the signal input cable from any signal source before checking or replacing the fuse.*

2. Check that the correct line fuse is installed. The line fuse provides protection if the equipment malfunctions or an overload occurs. Refer to *Appendix C: Replaceable Parts* on page 37 for fuse part numbers.

WARNING. *To prevent electrical shock, connect the power cord to a properly grounded power source. The outside (ground) of this connector is connected through the equipment to the power source ground. Do not remove the ground lug from the power cord for any reason.*

3. Connect the input power cord. Use only the power cords specified for this equipment. Refer to *Appendix C: Replaceable Parts* on page 37 for power cord part numbers.

Front Panel

Figure 2 shows the front-panel controls, connectors, and indicators with brief descriptions of the items following the figure.

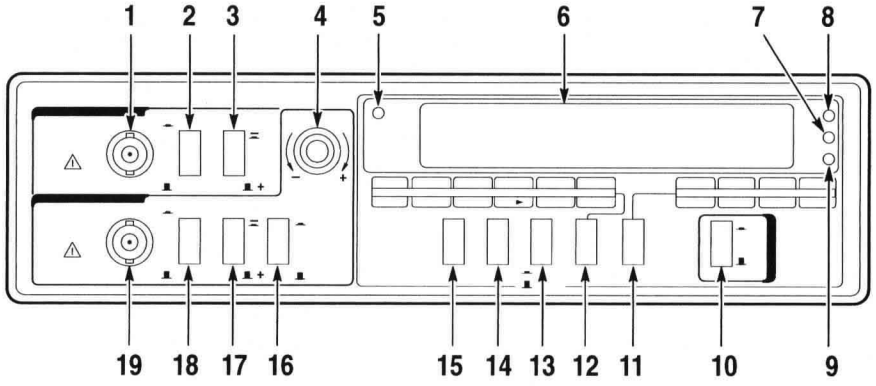

Figure 2: Front Panel

1. CHANNEL B INPUT Connector. BNC connector for 5 Hz to 2 MHz signal input.
2. CHANNEL B INPUT VOLTAGE Switch. When set to 3 V–42 V (HI) (button in) the CHANNEL B INPUT is attenuated by a factor of ten before application to the counter. When set to 50 mV–5 V (LO) (button out) the signal is not attenuated.

3. CHANNEL B SLOPE Switch. Selects positive-going or negative-going edge of the CHANNEL B signal for triggering. When – (button in), the negative-going edge is selected; when + (button out), the positive-going edge is selected.

4. TRIG LEVEL Control. Adjusts trigger threshold level on the CHANNEL A INPUT signal. Pushing the knob in (PUSH PRESET) sets this level at the midpoint of a symmetrical sinewave. Pulling the knob out and rotating it varies the level from negative (–) to positive (+) around the midpoint.

5. OVERRANGE Indicator. Lights whenever the range of the display is exceeded. One or more most significant digits are not displayed.

6. Display. Eight-digit, seven-segment, LED display with automatic decimal point placement.

7. kHz/µs Indicator. In FREQuency mode, indicates that the frequency displayed is in kilohertz. In PERIOD or TIME Interval mode, indicates that the period or time interval displayed is in microseconds. (Not used in RATIO or TOTALize modes.)

8. MHz/ms Indicator. In FREQuency mode, indicates that the frequency displayed is in megahertz. In PERIOD or TIME Interval mode, indicates that the period or time interval displayed is in milliseconds. (Not used in RATIO or TOTALize modes.)

9. GATE Indicator. Lights when a measurement is being taken.

10. POWER Switch. Turns the unit ON and OFF.

11. GATE Switch (0.01s, 0.1s, 1.0s, and 10s). This switch selects the degree of display resolution in all modes except TOTALize.

12. FUNC (Function) Switch. Use to select any one of the following as the operating mode:

    - FREQ. Frequency counter mode for CHANNEL A INPUT signal. readings are in kHz or MHz as selected by the MHz/ms–kHz/µs switch (item 13). Resolution is as selected by the GATE switch (item 11).

    - PERIOD. The period of one cycle of the CHANNEL A INPUT signal is displayed. Display reading is in milliseconds or microseconds as selected by the MHz/ms–kHz/µs switch (item 13). Resolution is as selected by the GATE switch (item 11).

    - RATIO. When this mode is selected, the unit measures the ratio of the CHANNEL A frequency to the CHANNEL B frequency. Resolution is selected by the GATE switch (item 11).

    - TIME. When this mode is selected, the unit measures the time interval from an edge of the CHANNEL A signal to an edge of the CHANNEL B signal. The positive-going or negative-going edge of each signal is selected by the SLOPE switches (items 17 and 3). The display is in microseconds or milliseconds, as selected by the MHz/ms–kHz/µs switch (item 13). Resolution is selected by the GATE switch (item 11).

    - TOTAL (Totalize). When this mode is selected, the unit counts the cycles of the CHANNEL A input signal and continuously displays that count. Totalization can be controlled by a gate signal at the rear panel TOTALIZE INPUT START/STOP connector (refer to *Rear Panel* on page 7).

    - CHECK. When this mode is selected, the unit displays the frequency of the internal time base, providing a functional check of performance.

13. MHz/ms–kHz/µs Switch. When pushed in, this switch selects megahertz display for frequency readings and millisecond display for period and time interval readings. When released (button out), it selects kilohertz display for frequency readings and microsecond for period and time interval readings. This switch is not used in RATIO and TOTALize modes.

14. HOLD Switch. Functions as follows:

- All modes except TOTALize:

  Setting switch to ON (button in) locks the display at the existing reading and resets the counter. Releasing the switch (button out) starts a new measurement, and the display is updated when this measurement is completed.

- TOTALize mode:

  Setting switch to ON (button in) locks the display at the existing reading and halts the totalizing process. When the switch is released, counting resumes, provided that the gating signal at the rear panel TOTALIZE INPUT START/STOP is high or open.

15. RESET Switch. In all modes, pushing this momentary switch resets the counter to zero. When it is released, the measurement starts again.

16. CHANNEL A LOW PASS FILTER Switch. When ON (button in), the CHANNEL A input signal is routed through a low-pass filter with a –3 dB point at about 10 kHz. Press in when checking signals below 10 kHz to prevent high-frequency noise interference.

17. CHANNEL A SLOPE Switch. Selects positive-going or negative-going edge of the CHANNEL A INPUT signal for triggering. When ON (button in), the negative-going edge is selected; when OFF (button out), the positive-going edge is selected.

18. CHANNEL A INPUT VOLTAGE Switch. When set to 3 V–42 V (HI) (button in) the CHANNEL A INPUT signal is attenuated by a factor of ten before application to the counter. When set to 50 mV–5 V (LO) (button out) the signal is not attenuated.

19. CHANNEL A INPUT Connector. BNC connector for 5 Hz to 175 MHz signal input.

Rear Panel

In addition to the line voltage selectors, power intput, and fuse discussed in *Preparing the CDC250 175 MHz Universal Counter for Use* on page 2, the rear panel contains the items shown in Figure 3.

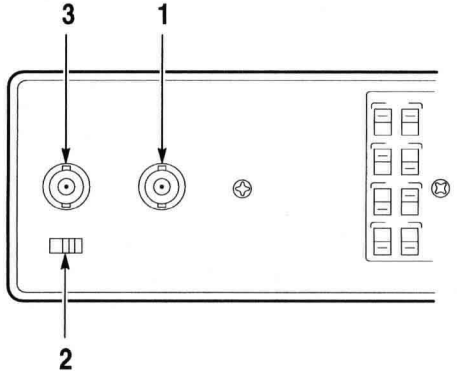

Figure 3: Rear Panel

1. TOTALIZE INPUT START/STOP Connector. BNC connector for Totalize input. TTL logic high to start; TTL logic low to stop.
2. EXT/INT Switch. Selects the function of the OSCILLATOR connector:
   - EXT—provides a nominal 50 Ω input impedance path for an external 10 MHz time base.
   - INT—monitors the internal time base oscillator.
3. EXT INPUT OSCILLATOR Connector. Serves as a monitoring point for the internal time base oscillator, or provides an input path for an external time base oscillator, depending on the EXT/INT switch setting.

Reference

General Considerations

Use the CDC250 175 MHz Universal Counter for adjustment, test, and repair of electronic equipment, such as audio instruments, AM/FM radios, TVs, CD radios, computer clocks, amateur radios, and musical instruments. Refer to test and calibration manuals for the specific equipment to locate the test points for required frequencies.

Any frequency counter is best used in conjunction with a good oscilloscope. The oscilloscope gives the operator a true picture of the waveform being counted, In many cases, a filter may be needed to remove unwanted transients, radio frequency interference (RFI), or other types of noise that may cause a counting error.

Duty Cycle Measurements

The TIME Interval mode can be used to determine the duty cycle of a digital waveform by applying the same signal to CHANNEL A and CHANNEL B and selecting the proper edges for triggering.

For an example, refer to Figure 4. The duty cycle, or ratio of on-time to total period, is found by selecting the positive SLOPE (button out) for CHANNEL A (so measurement starts at beginning of TI) and the negative SLOPE (button in) for CHANNEL B (measurement ends at end of TI). After this reading is taken, the period is measured by using PERIOD mode (refer to *PERIOD vs TIME Interval Mode* on page 10), and the duty cycle is obtained as follows:

$$\text{Duty cycle} = \frac{\text{TI}}{\text{PERIOD}} \times 100\%$$

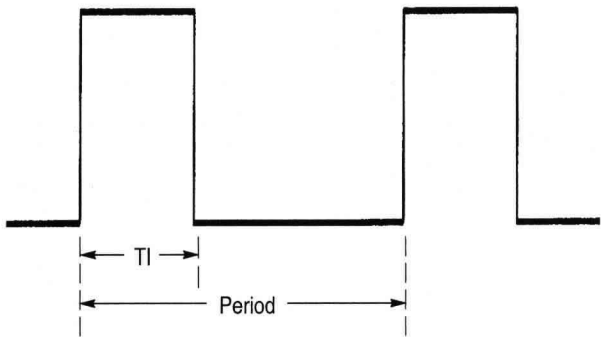

Figure 4: Duty Cycle Measurement

PERIOD vs. TIME Interval Mode

When measuring time interval between similar edges on the same waveform (for example, positive-going edge to next positive-going edge), it is advisable to use PERIOD rather than TIME, because of the following:

- In TIME mode, the unit may tend to both trigger and stop on the same edge, resulting in an incorrect reading. Waveforms with fast rise times (such as TTL signals) are not as likely to trigger and stop on the same edge as those with less steep slopes, such as sine and triangle waves.
- The PERIOD mode is more accurate than TIME mode, especially at finer resolutions. In TIME mode, the possibility of error increases with the number of intervals averaged (1, 10, 100, 1000) so that more digits tend to jitter as more are selected. No actual improvement in resolution is gained. In PERIOD mode the possibility of error is constant for all GATE times.

Using TRIG LEVEL Control

When pushed in (PRESET), the TRIG LEVEL control sets the trigger threshold to the approximate average of the CHANNEL A signal. While this is sufficient for many signals, it is not adequate for the waveform pictured in Figure 5. The lower dotted line represents the trigger level set by the PRESET position. This level, the average of the pulse train, is close to the level of noise present, and false triggering could occur.

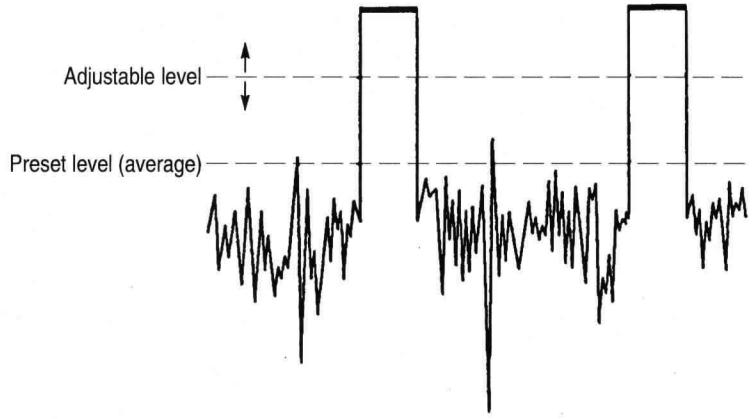

Figure 5: Example of Trigger Level Variation

By pulling the TRIG LEVEL control out and rotating it, the trigger threshold can be varied above (+) or below(–) the average. In Figure 5, an appropriate threshold setting would be somewhat above the noise level as shown by the upper dotted line.

Display Interpretation

The following factors may affect the display:

- Display instability
- Measurement delays
- Intermeasurement Interval

Display Instability

An uncertainty of ±1 least-significant digit is inherent in all digital measurements. However, the following factors can cause greater display uncertainties:

- Noise or ringing on the input signals can cause false triggering. The display may be unstable; or it may appear stable, but be an incorrect reading. The input-conditioning controls on this unit can help to achieve stable triggering on noisy input signals.
- An unstable input frequency can cause display uncertainty. This is common with LC (inductance-capacitance) and RC (resistance-capacitance) oscillators; crystal-controlled oscillators are much more stable.
- Trigger errors in period, time interval, and ratio measurements can cause uncertainty. In PERIOD and RATIO modes, the uncertainty can be reduced by taking the measurement over a greater number of cycles; that is, selecting a finer GATE time (greater resolution). In TIME interval measurements, however, multicycle measurements are subject to a possible error of one count per interval. Thus, the cumulative error is increased by measuring over a greater number of intervals, and the result is that all GATE settings have the same inherent resolution (displaying more digits results in more digits being subject to jitter).

  Period and frequency are reciprocals of each other. At low frequencies, more digits can be obtained (lessening the effects of instability) by using PERIOD mode. High-frequency accuracy is enhanced by using FREQuency mode. The crossover point between the two modes is 10 kHz.

Measurement Delays

In all measurements except TOTALize, the display is updated at the end of a finite measurement interval, which varies in length according to the operating mode and resolution selected. For some conditions, the delay can become significant. This should be considered when changing resolution or operating mode, or when using HOLD or RESET, because each of these actions initiates a new measurement. Measurement delays for each mode are discussed here.

FREQUENCY. In frequency measurements, each GATE setting establishes a set gate time during which the measurement is made (the GATE indicator lights during this interval). Table 1 shows GATE times for kHz and MHz modes.

Table 1: Gate Time and Measurement Resolution in Frequency Mode

Mode	Resolution	Gate Time
kHz	100 Hz	0.01 s
kHz	10 Hz	0.1 s
kHz	1 Hz	1 s
kHz	0.1 Hz	10 s
MHz	1 Hz	0.02 s
MHz	100 Hz	0.2 s
MHz	10 Hz	2 s
MHz	1 Hz	20 s

Lower gate times result in smaller gate times. Smaller gate times are useful when quicker updates are needed; for example, tuning an oscillator. Better resolutions require longer update intervals.

PERIOD AND TIME INTERVAL. PERIOD and TIME interval measurements are made by averaging over a set number of cycles or time intervals. That number is determined by the GATE switch settings as shown in Table 2.

Table 2: Gate time, Resolution and Cycles Averaged in Period and Time Modes

Mode	GATE Setting	Resolution	Cycles (intervals) Averaged
µs	0.01 s	0.1 µs	1
µs	0.1 s	0.01 µs	10
µs	1.0 s	.001 µs	100
µs	10 s	.0001 µs	1000
ms	0.01 s	.0001 ms	1
ms	0.1 s	.00001 ms	10
ms	1.0 s	.000001 ms	100

The time required for a PERIOD or TIME interval measurement to be completed can be found by multiplying the number of cycles averaged by the average cycle length.

For PERIOD measurements the time required for a measurement to be completed can also be found by dividing the number of cycles averaged by the input frequency (Hz).

FREQUENCY RATIO. To determine frequency RATIO, the unit applies the input signals to two separate counters. Each counts cycles of its input until the CHANNEL B counter reaches a specified number. Both counters then stop, and the number left in the CHANNEL A counter is applied to the display as the ratio. The GATE setting specifies a reference number for the CHANNEL B counter as shown in Table 3.

Measurement delays depend on the frequency of the CHANNEL B input and the GATE setting selected. The CHANNEL A frequency does not affect measurement time in RATIO measurments.

Table 3: GATE Setting and CHANNEL B Counts

GATE Setting	CH B counts to:
0.01 s	1
0.1 s	10
1 s	100
10 s	1000

Intermeasurement Interval

The time interval between measurements (GATE indicator off) is fixed at 200 ms in all modes except FREQuency MHz, where it is 400 ms, and in TOTALize mode, where counting is continuous. This fixed interval is independent of gate time, number of cycles, or input frequency.

Measurements

The CDC250 175 MHz Universal Counter can make five basic types of measurements: frequency, period, frequency ratio, time interval, and totalize. In addition, the CHECK mode provides a quick, partial check of instrument operation.

To prepare the frequency counter for use, refer to *Preparing the CDC250 175 MHz Universal Counter for Use* on page 2 . Also, check that the signal to be measured does not exceed the limits specified on the front panel of the frequency counter. The INPUT VOLTAGE switch does not change input voltage limits.

Set the POWER switch to ON (button in). If no other front panel buttons have been pressed, the display may be blank.

NOTE. *Because the outside (ground) of the BNC input connectors connects directly to the power source ground, polarity at the circuit end of the input cable may be important.*

Frequency Measurements

Use the following procedure to make a frequency measurement:

1. Apply the signal to be measured to the **CHANNEL A INPUT** connector.
2. Set the **FUNC** switch to **FREQ**.
3. Select the measurement unit with the **MHz/ms–kHz/µs** switch (button in for megahertz, button out for kilohertz).

   The indicator light (next to the digital display) for the selected measurement unit illuminates. If you are uncertain of the signal frequency, you may need to try both ranges.

NOTE. *Refer to* Appendix A: Specifications *on page 27 for limits on frequency ranges and sensitivities.*

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4. Set the **GATE** switch to the degree of resolution desired.

   The display shows the frequency. The GATE indicator lights while each measurement is in progress, and the display is updated at the end of each measurement interval.

   The OVERRANGE indicator lights whenever the range of the display is exceeded.

NOTE. *If measurement delay or display instability is encountered, see* Display Interpretation *on page 11.*

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5. Press the **HOLD** switch to lock the display. Release the **HOLD** switch to begin taking new measurements.

   When HOLD is released, a new measurement begins (GATE indicator lights), but the display continues to hold the old reading until the new measurement is completed.

   When RESET is released, a new measurement begins (GATE indicator lights), but the display remains at zero until the new measurement is completed.

6. Push in and release the **RESET** switch to reset the display to zero.

The following input controls can be used to condition the input as needed to prevent miscounting from input noise or ringing:

LOW PASS FILTER	Engaging the LOW PASS FILTER switch routes the CHANNEL A input through a low-pass filter before application to the counter. This helps eliminate counting errors in low-frequency measurements by reducing the effects of high-frequency noise.
INPUT VOLTAGE	Engaging the CHANNEL A INPUT VOLTAGE switch (button in) attenuates the CHANNEL A signal approximately 10:1 before application to the counter. This helps prevent miscounting caused by noisy or improperly terminated high-amplitude signals.
SLOPE	The CHANNEL A SLOPE switch selects the positive or negative edge of the CHANNEL A signal for triggering. Pushing the switch in triggers the unit on the negative-going edge; leaving it out causes triggering on the positive-going edge. The CHANNEL A SLOPE switch is bypassed whenever FREQ MHz/ms is selected, and the unit counts on the negative-going slope.
TRIG LEVEL	The CHANNEL A trigger threshold can be varied by the TRIG LEVEL control as follows: Pushing the control in (PRESET) fixes the trigger level at roughly the average value of the CHANNEL A input signal. Pulling the control out and rotating it varies the threshold level from negative (–) to positive (+) around the PRESET level.

For more information about the TRIG LEVEL control, refer to *Using TRIG LEVEL Control* on page 11.

Period Measurements

In PERIOD mode, the unit displays the period, or time required for one cycle of the input signal to occur. The measurement is made by averaging over 1, 10, 100, or 1000 cycles (depending on the GATE switch setting).

Use the following procedure to make a PERIOD measurement:

1. Apply the signal to be measured to the **CHANNEL A INPUT** connector.
2. Set the **FUNC** switch to **PERIOD**.
3. Select the measurement unit with the **MHz/ms–kHz/µs** switch (button in for milliseconds and button out for microseconds).

   Either the MHz/ms or kHz/µs indicator lights, showing the selected measurement unit.
4. Select the resolution with the **GATE** switch.

   GATE switch settings (0.01s, 0.1s, 1.0s, 10s) refer to the kHz/µs mode. For MHz/ms mode, multiply the GATE switch value by .001 to find the resolution in milliseconds. The upper line of the GATE switch degree of settings (1, 10, 100, and 1000) gives the number of cycles averaged in the measurement.

NOTE. *The 10 s GATE switch setting cannot be selected in the millisecond PERIOD mode (MHz/ms–kHz/µs button in). The switch will bypass 10 s and go from 1.0 s back to 0.01 s.*

   The period is given in the display. The GATE indicator lights while each measurement is in progress, and the display is updated at the end of each measurement interval. (At higher frequencies, the GATE indicator may flash too quickly to be seen.)

   The OVERRANGE indicator lights whenever the range of the display is exceeded.

NOTE. *If measurement delay and display instability are encountered, see* Display Interpretation *on page 11.*

5. Engage the **HOLD** switch (button in) to lock the display at the existing reading. Release the **HOLD** switch.

   When HOLD is released (button out), a new measurement begins (GATE indicator lights), but the display continues to hold the old reading until the new measurement is completed.
6. Push the **RESET** switch in to reset the display to zero. Release the **RESET** switch.

   When the RESET switch is released, a new measurement begins (GATE indicator lights), but the display remains at zero until the new measurement is completed.

The CHANNEL A input controls (LOW PASS FILTER, INPUT VOLTAGE, SLOPE, and TRIG LEVER) may be used to condition the input as described in *Frequency Measurements* on page 16.

Frequency Ratio Measurements

In this mode of operation, the counter displays the ratio of the frequency applied to CHANNEL A to the frequency applied to CHANNEL B. The CHANNEL A frequency should preferably be equal to or greater than that of CHANNEL B, and both frequencies must be within the limits listed on the front panel and in *Appendix A: Specifications* on page 27.

Frequency ratio is determined by counting the number of CHANNEL A cycles occurring during a specified number of CHANNEL B cycles (1, 10, 100, or 1000) and applying the result to the display.

Use the following procedure to make a RATIO measurement:

1. Connect the signals to be measured to the **CHANNEL A** and **CHANNEL B INPUT** connectors.

NOTE. *Connect both channels to the same signal for a ratio of 1.*

2. Set the **FUNC** switch to **RATIO**.

   Both the MHz/ms and kHz/µs indicators are off because the reading displayed is a ratio.

3. Set the **GATE** switch for the degree of resolution wanted.

   This setting will also determine the number of CHANNEL B cycles used for the ratio measurement.

NOTE. *The MHz/ms–kHz/µs switch setting is ignored in RATIO mode.*

The frequency ratio is given by the display. The GATE indicator lights while each measurement is in progress, and the display is updated at the end of each measurement interval. (At higher CHANNEL B frequencies, the GATE indicator may flash too quickly to be seen.)

The OVERRANGE indicator lights whenever the range of the display is exceeded.

NOTE. *If measurement delay or display instability is encountered, refer to* Display Interpretation *on page 11.*

4. Engage the **HOLD** switch (button in) to lock the display at the existing reading. Release the **HOLD** switch.

   When HOLD is released, a new measurement begins (GATE indicator lights), but the display continues to hold the old reading until the new measurement is completed.

5. Push the **RESET** switch in to reset the display to zero. Release the **RESET** switch.

   When RESET is released, a new measurement begins (GATE indicator lights), but the display remains at zero until the new measurement is completed.

The CHANNEL A INPUT controls (INPUT VOLTAGE, SLOPE, and TRIG LEVEL) can be used to condition the CHANNEL A input. The CHANNEL B INPUT controls (INPUT VOLTAGE and SLOPE) can be used to condition the CHANNEL B input. Refer to the description of input controls on page 17.

Time Interval Measurements

In TIME mode, the unit measures the elapsed time from a selected edge of the CHANNEL A waveform to a selected edge of the CHANNEL B waveform.

For a stable reading, the two input signals should be related to each other so that the time interval remains reasonably constant from one measurement to the next. For example, two digital waveforms derived from the same clock are suitable; two arbitrary frequencies from separate function generators are not suitable.

Both inputs may be connected to the same signal for duty cycle measurements (refer to *Duty Cycle Measurements* on page 9).

Use the following procedure to make a Time Interval measurement:

1. Connect the signals to be measured to the **CHANNEL A** and **CHANNEL B INPUT** connectors.

2. Set the **FUNC** switch to **TIME**.

   The switch-setting label serves as a reminder that the measurement starts at the CHANNEL A edge and stops at the CHANNEL B edge.

3. Select the desired edge of each waveform with the **CHANNEL A** and **CHANNEL B SLOPE** switches (button in (–) for negative-going edge and button out (+) for positive-going edge).

NOTE. *When measuring time interval between similar edges on the same waveform (for example, positive edge to next positive edge), use PERIOD rather than TIME mode. Refer to* General Considerations *on page 9.*

4. Set the **CHANNEL A TRIG LEVEL** control to **PRESET** (knob pushed in).

   This ensures that both CHANNEL A and CHANNEL B are triggering at the same level (approximately the average) on their respective waveforms.

5. Select measurement units with the **MHz/ms–kHz/µs** button — in for milliseconds, out for microseconds.

   Either the MHz/ms or kHz/µs indicator will light, according to your selection.

6. Set the **GATE** switch to the degree of resolution wanted.

   In TIME mode all resolution settings will have the same inherent resolution, because if more periods are averaged, there is greater accumulated error. Refer to *Display Instability* on page 11.

NOTE. *In TIME MHz/ms mode the GATE switch cannot be set to 10s. The switch will bypass 10s, going from 1.0s back to 0.01s.*

   The time interval is given by the display. The GATE indicator lights while each measurement is in progress, and the display is updated at the end of each measurement interval. (At higher frequencies, the GATE indicator may flash too quickly to be seen.)

   The OVERRANGE indicator lights whenever the range of the display is exceeded.

NOTE. *If measurement delay or display instability is encountered, see* Display Interpretation *on page 11.*

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7. Engage the **HOLD** switch to lock the display at the existing reading. Release the **HOLD** switch.

   When HOLD is released, a new measurement begins (GATE indicator lights), but the display continues to hold the old reading until the new measurement is completed.

8. Push the **RESET** switch in to reset the display to zero. Release the **RESET** switch.

   When RESET is released, a new measurement begins (GATE indicator lights), but the display remains at zero until the new measurement is completed.

9. Do the following steps to measure the time interval for once-only events:

   a. Select the **1/0.01s GATE** setting; this must be used for single events because the others are all multiple-event averaging.

   b. Set the **SLOPE** switches for the anticipated level transitions and push **RESET** to prime the unit.

      When the event has occurred (CHANNEL A transition followed by CHANNEL B transition), the time interval is displayed. For each single-event measurement, the counter must again be primed by pressing RESET.

The following input controls can be used to condition the input:

LOW PASS FILTER	Engaging the LOW PASS FILTER (button in) routes the CHANNEL A input through a low-pass filter before application to the counter. This helps eliminate the effects of high-frequency noise in the CHANNEL A input.
INPUT VOLTAGE	Engaging the CHANNEL A INPUT VOLTAGE switch (button in) attenuates the CHANNEL A signal approximately 10:1 before application to the counter. This helps prevent miscounting caused by noisy or improperly terminated high-amplitude signals.

Totalize Measurements

The TOTAL mode is used to count the total number of events occurring during a specific time period. This time period can be defined by front-panel switch action or by a gating signal applied to the rear panel TOTALIZE INPUT START/STOP connector. Events must occur at least five times per second for accurate counting.

Use the following procedure to make a Totalize measurement:

1. Set the **FUNC** switch to **TOTAL.** GATE and MHz/ms–kHz/µs switch settings are ignored.
2. If the counting is to be controlled electronically, connect the gating signal to the real panel **TOTALIZE INPUT START/ STOP** connector.

   A TTL high at this input enables the totalizing process; a TTL low disables it, holding the display at the accumulated value. If no signal is connected, the connector is pulled high internally so that counting occurs.
3. Press the **RESET** switch to zero the counter.

   If no gating signal is connected to the TOTALIZE INPUT START/STOP connector, the unit starts counting as soon as the RESET switch is released. If a gating signal is connected, counting starts when RESET is released and the gating signal goes high.

   As the unit totalizes, it displays the count continually. Maximum count is 99,999,999. If this is exceeded, the OVERRANGE indicator lights, and the count begins at zero again.
4. Stop counting by one of three methods:
   - Send a low gating signal to the **TOTALIZE INPUT START/STOP** connector.

     Counting stops and the display is held at the accumulated total. Counting resumes when the gating signal again goes high.

NOTE. *The gating signal at the TOTALIZE INPUT START/STOP connector halts totalization by inhibiting the CHANNEL A input signal. It also blocks this signal in all other operating modes except FREQ MHz. This should be considered if the input remains connected during other measurements.*

   - Engage the **HOLD** switch (button in).

     Counting stops and the display is held at the accumulated total. Counting resumes when the switch is released.
   - Press **RESET** at any time.

     Clears the counter and resets the display to zero.

The CHANNEL A input controls (INPUT VOLTAGE, SLOPE, and TRIG LEVEL) can be used to condition the input. Refer to the input controls description on page 17.

Checking Instrument Operation

The CHECK mode provides a quick, partial check of instrument operation.

Procedure. Use the following procedure to make a quick, general check of instrument operation:

1. Set the **FUNC** switch to **CHECK**.
2. Set the **MHz/ms–kHz/µs** switch to **kHz/µs** (button out).
3. Check that the CDC250 displays match those listed in Table 4. (Input controls have no effect in CHECK mode.)
4. For any setting in either kHz/µs or MHz/ms mode, press the **HOLD** button.

   This holds the display value and keeps the GATE indicator off for as long as HOLD is on (button in).

Table 4: CHECK Mode Displays

Mode	GATE Switch Setting	Display Reading
kHz	0.01 s	10000.0 kHz
kHz	0.1 s	10000.00 kHz
kHz	1.0 s	10000.000 kHz
kHz	10 s	0000.0000 kHz (OVERRANGE lit)
MHz	0.01 s	10.0000 MHz
MHz	0.1 s	10.00000 MHz
MHz	1.0 s	10.000000 MHz

5. Press **HOLD** again to turn HOLD off (button out).
6. Check that the GATE indicator resumes flashing. (If a new GATE setting has been selected, the display is updated to the new value after the first GATE interval.)
7. For any setting in either kHz/µs or MHz/ms Mode, press **RESET**.

   This clears all digits to the left of the decimal point (leaving only the decimal and the zeros that follow it). The GATE indicator stays off as long as the RESET button is held in.
8. Release the **RESET** button.
9. Check that the GATE indicator resumes flashing and the display updates at the end of the first GATE interval.

Appendix A: Specifications

Characteristics after one hour warmup time at 23° C ±5° C, 75% RH.

Table 5: Operational Characteristics

Frequency	
Range	
kHz Mode	5 Hz to 10 MHz
MHz Mode	5 MHz to 175 MHz
Accuracy	±1 count ± time base error
Resolution	0.1 Hz to 1 kHz, in decade steps
Display	kHz or MHz with decimal point
Period	
Range	0.5 µs to 0.2 s
Frequency Range	5 Hz to 2 MHz
Accuracy	±1 count ± time base error ± trigger error[1]
Resolution	100 ps to 100 ns in decade steps
Display	ms or µs with decimal point
Ratio	
Frequency Range	
Channel A	5 Hz to 10 MHz
Channel B	5 Hz to 2 MHz
Accuracy	± resolution ± ratio × trigger error[1]

1 **Trigger error is typically ±0.3% of reading divided by the number of cycles averaged for input signals greater than 100 mV with S/N ratio better than 40 dB.**

Table 5: Operational Characteristics (Cont.)

Ratio	
Resolution	$\frac{\text{CH B frequency}}{\text{CH A frequency} \times N^2}$
Display	Numerical ratio with decimal point
Time Interval	
Range	0.5 µs to 0.2 s
Frequency Range	5 Hz to 2 MHz, square wave
Accuracy	±1 count ± time base error ± trigger error[1] ± N^2
Resolution	100 ps to 100 ns in decade steps
Display	ms or µs with decimal point
Totalize	
Range	5 Hz to 10 MHz
Count Capability	0 to 99,999,999 before OVERRANGE
Control	Start, stop, and reset controlled by front panel pushbuttons or rear panel TOTALIZE INPUT START/STOP
CHANNEL A Input	
Bandwidth	5 Hz to 175 MHz, AC coupled
Sensitivity	
kHz Mode	
5 Hz to 10 MHz	20 m V_{RMS}

1 **Trigger error is typically ±0.3% of reading divided by the number of cycles averaged for input signals greater than 100 mV with S/N ratio better than 40 dB.**

2 **N = number of cycles averaged; 1, 10, 100, or 1000.**

Table 5: Operational Characteristics (Cont.)

CHANNEL A Input	
MHz Mode	
5 MHz to 125 MHz	50 m V_{RMS}
125 MHz to 150 MHz	100 m V_{RMS}
150 MHz to 175 MHz	150 m V_{RMS}
Impedance	1 MΩ paralleled by 40 pF
Maximum Input voltage	42 Vpk
Attenuation	Times 1 or times 10 (selectable)
Filter	Low pass < 10 kHz –3 dB (selectable)
Slope	Positive-going or negative-going (selectable)
Trigger Level	Preset or variable
CHANNEL B Input	
Bandwidth	5 Hz to 2 MHz, AC coupled
Sensitivity	30 mV V_{RMS}
Impedance	1 MΩ paralleled by 40 pF
Maximum Input voltage	42 Vpk
Attenuation	Times 1 or times 10 (selectable)
Slope	Positive-going or negative-going (selectable)
Time Base	
Crystal frequency	10 MHz
Line Voltage Stability	Less than ±0.4 ppm with ±10% line voltage variation
Temperature Stability	Less than ±0.001% (±1 ppm) from 0° C to 40° C ambient temperature
Aging Rate	Less than ±3 ppm per year

Table 5: Operational Characteristics (Cont.)

Display	
Display	Eight 0.43 inch, seven-segment digits with MHz/ms, kHz/µs, GATE, and OVERRANGE indicators
OVERRANGE Indication	LED indicator lights when count exceeds 99999999 during any selected gate time
Display Update Time	
kHz FREQ and CHECK Modes	User-selected gate time of 0.01, 0.1, 1.0, or 10 s plus fixed 200 ms interval
MHz FREQ Mode	User-selected gate time of 0.02, 0.2, 2.0, or 20 s plus fixed 400 ms interval
PERIOD< RATIO, and TIME Modes	User-selected cycles averaging of 1, 10, 100, or 1000 cycles plus fixed 200 ms interval
TOTALIZE Mode	Continuous

Table 6: Physical Characteristics

Physical	
Width	240 mm (9.5 in)
Height	64 mm (2.5 in)
Depth	230 mm (9.0 in)
Weight	2.0 kg (4.4 lb)

Table 7: Environmental Characteristics

Environmental	
Operating Temperature	0° C to 40° C, 75% RH
Storage Temperature	–20° C to 60° C, 80% RH

Table 8: Electrical Characteristics

Electrical	
Line Voltage Range	90 to 110, 108 to 132, 198 to 242, and 216 to 250 VAC at 50 to 60 Hz
Power Consumption	21 VA, 18 W maximum

Appendix B: Maintenance

This appendix provides information for the basic maintenance of the CDC250 175 MHz Universal Counter.

Cleaning

To clean the frequency counter, use a soft cloth dampened in a solution of mild detergent and water. Do not spray cleaner directly onto the instrument, since it may leak into the cabinet and cause damage.

Do not use chemicals containing benzine, benzene, toluene, xylene, acetone, or similar solvents.

Do not use abrasive cleaners on any portion of the frequency counter.

Preparing for Shipment

If the original packaging is unfit for use or not available, use the following packaging guidelines:

1. Use a corrugated cardboard shipping carton having inside dimensions at least three inches greater than the instrument dimensions.
2. Put the instrument into a plastic bag or wrap to protect it from dampness and loose packing material.
3. Place the instrument into the box and firmly stabilize it with packing material.
4. Seal the carton with shipping tape.

Troubleshooting

Electronic maintenance on the Tektronix CDC250 175 MHz Universal Counter must be performed by a trained technician. However, an operator can perform some basic and routine maintenance. The frequency counter will give some indications of problems to aid the operator.

WARNING. *To prevent electrical shock, unplug the power cord and disconnect the signal input cable from any signal source before checking or replacing the fuse.*

No Display with Power On

If the display is not lighted, but the POWER button is pushed in and the frequency counter power cord is plugged into an outlet, do the following steps:

1. Check the line fuse. If the fuse is open, replace it.
2. If the line fuse is good, check the power outlet for proper voltage. If the outlet voltage is incorrect, refer to the nearest Tektronix service center for repair.

WARNING. *To prevent electric shock, disconnect the power cord from the power source and the CDC250 175 MHz Universal Counter before checking continuity.*

3. If outlet voltage is correct, check power cord continuity. If the power cord fails the continuity check, replace the power cord.
4. If the power cord passes the continuity check, refer to the nearest Tektronix service center for repair.

Display On but Frequency Not Counted

If the display is on, but the frequency counter does not count, do the following steps:

1. Check INPUT VOLTAGE level button for HI/LO level signal input.

CAUTION. *Disconnect signal cable from the CDC250 175 MHz Universal Counter and the circuit being tested before checking continuity.*

2. If the INPUT VOLTAGE setting does not correct the problem, check the signal input cable for continuity.
3. If the signal input cable is good, check output of the circuit or equipment being tested with an AC voltmeter or oscilloscope.
4. If signal input cable is good, check LOW PASS FILTER button position to make sure that the button position agrees with the input signal frequency.
5. If the LOW PASS FILTER button is in the correct position, check the frequency setting.
6. If the frequency setting is correct, refer to the nearest Tektronix service center for repair.

Appendix C: Replaceable Parts

Replaceable parts may be ordered directly from your authorized Tektronix dealer.

Standard Accessories

The following items are shipped with the CDC250 175 MHz Universal Counter:

Table 9: Standard Accessories

Accessory	Tektronix Part Number
Fuse, 3AG, 0.250 A, 250 V, SB (90 – 132 V operation)	159–0187–00
CDC250 User Manual	070–7999–XX
115 V Power Cord	Refer to Table 11

Optional Accessories

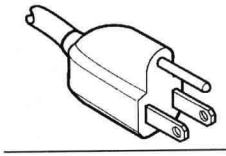
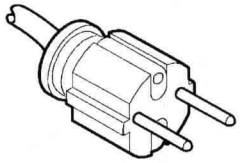
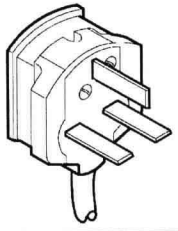
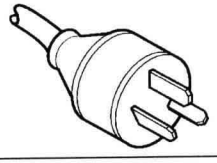
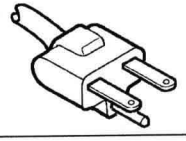
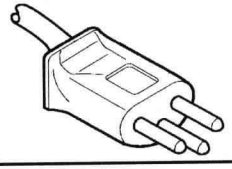
The following items are available as optional accessories:

Table 10: Optional Accessories

Accessory	Tektronix Part Number
Fuse, 3AG, 0.125 A, 250 V, SB (198 – 250 V operation)	159–0313–00
230 V Power Cords	Refer to Table 11

The following power cords are available.

Table 11: Accessory Power Cords

Plug Configuration	Normal Usage	Tektronix Part Number
	North America 115 V	161-0104-00
	Europe 230 V	161-0104-06
	United Kingdom 230 V	161-0104-07
	Australia 230 V	161-0104-05
	North America 230 V	161-0104-08
	Switzerland 230 V	161-0167-00