Practical Instrument Electronics

PIECAL Model 541
Frequency Calibrator with Totalizer
Operating Instructions

- **Easy to use**
  With the Model 541 you can check & calibrate all your frequency instruments and measure flow sensors.

- **Take it into the shop, plant or field**
  Carry it without worry - it comes with a carrying case and fits into your toolbox.
  Accurate to ±0.005% of range.

- **Calibrate in Hz, kHz , CPM and CPH**
  0.001 to 20.000 kHz
  0.1 to 2000.0 Hz
  0.01 Hz to 200.00 Hz
  0.1 to 2000.0 CPM (Counts-per-Minute)
  1 to 20000 CPH (Counts-per-Hour)

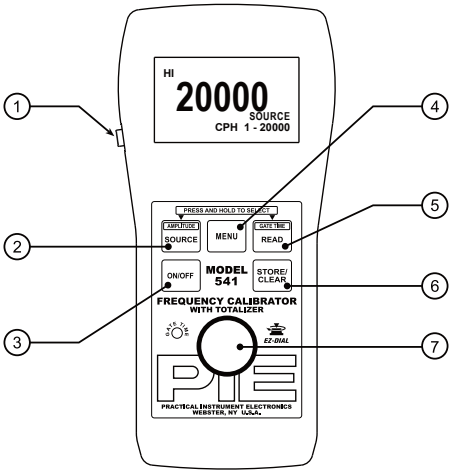
- **Quickly output the frequency you need**
  Simulate vibration pickups and variable speed drives with sine wave outputs and flow meters and magnetic pickups with square wave outputs. If you calibrate positive displacement flow meters, Watt-hour meters or slow rated integrators select frequencies as slow as 1 CPH (0.0002777 Hz). Easily set any value quickly to within 0.01 Hz with the two speed adjustable EZ-Dial™ plus store any three frequencies for instant recall with the EZ-Check™ switch. Verify optical pickups with the GATE TIME LED that is synchronized with the output pulses.

- **Match your instrument signal levels**
  Choose zero based or zero crossing square or sine waves output from 0.1 V to 12 V peak-to-peak. Measure from 0.1 V to 120 V peak with X1 or X10 attenuation. Turn the dial to adjust the output amplitude to the level required.

- **Read signals from flow meters**
  Measure flow meter, vibration, parts counter and other process frequency signals from 0.1 V to 120 V. GATE TIME LED flashes with received pulses indicating when the proper input adjustment level is achieved.

- **Calibrate totalizers without a stopwatch**
  Automatically output from 1 to 99999 pulses in 1 to 100 minutes. Easier and more accurate than waiting around with the stopwatch to stop generating pulses at the correct time. Count input pulses from 1 to 100 minutes to verify totalizer input signals.

Basic Operation



① EZ-Check™ Switch/EZ-Step™ Push-button

For Source - Slide the switch to select from three user stored values for the desired calibration points. The HI, DIAL and LO values can easily be changed to suit the calibration requirements. Press the push-button like a stopwatch to start or stop the totalizer output.

For Read - Slide the switch to the DIAL position. The Model 541 will begin making readings. Slide the switch to high and you will get the highest point read and then slide the switch to the low position and you will get the lowest range. Press the push-button like a stopwatch to start or stop the totalizer counting pulses.

② SOURCE/AMPLITUDE Key

Press and release the SOURCE/AMPLITUDE Key to step through the source ranges.

- Source CPH 1 - 20000
- Source CPM 0.1 – 2000.0
- Source HZ 0.01 – 200.00
- Source HZ 0.1 – 2000.0
- Source KHZ 0.001 – 20.000
- Totalizer

Press and hold SOURCE/AMPLITUDE key to enable amplitude adjustment. Turn the EZ-Dial knob ⑦ to adjust the amplitude voltage from 0.1-12.0 Vp.

Press and release the SOURCE/AMPLITUDE or STORE/CLEAR button to save your selection.

③ ON / OFF Key

Press the ON/OFF key to turn the Model 541 on or off.

④ MENU Key

Press and release the menu key to enable the configuration menu. This allows you to choose the settings for AUTO OFF, X1/X10, Zero Based/ Zero Crossing, EZ-Check HI/LO Readings, SINE/SQUARE Wave output and reset to BASIC CONFIGURATION.

⑤ READ/GATE TIME Key

Press and release READ/GATE TIME key to step through the read ranges.

- Read CPH 1 - 20000
- Read CPM 0.1 – 2000.0
- Read HZ 0.01 – 200.00
- Read HZ 0.1 – 2000.0
- Read KHZ 0.001 – 20.000
- Totalizer

Press and hold the READ/GATE TIME key to enable time adjustment for Source & Read Totalize mode.

Turn the EZ-Dial knob ⑦ to adjust the totalize time from 1 to 100 minutes.

Press and release the SOURCE/AMPLITUDE or STORE/CLEAR button to save your selection.

⑥ STORE/CLEAR Key

For Source - press the STORE/CLEAR key to save the calibration values. The display will flash “STORED” to confirm.

For Read - press STORE/CLEAR to clear the values saved in the EZ-Check™ HI and LO positions. The display will flash “CLEARED” to confirm.

⑦ EZ-Dial™ Knob

For Source - turn the EZ-Dial knob to change the output frequency in increments of one least significant digit. Push down and turn for faster dialing with increments of 100 digits.

For Read - turn the EZ-Dial knob to adjust the trigger level.

CHANGING BATTERY

Low battery is indicated by **“BAT”** on the display. Approximately one to four hours of typical operation remain before the 541 will automatically turn off. To change the battery remove the battery cover from the back of the unit. Replace with a single 9V battery.

Note: Alkaline battery is supplied and recommended for maximum battery life & performance.

Configuration

Configure the Calibrator

Press and release the ON/OFF Key ② to turn the calibrator on then press and release the MENU Key ④ to enable the configuration menu.

Turn the EZ-Dial™ Knob to scroll through the list of configuration options. Press the EZ-Dial™ Knob to change configuration items.
Press and release the MENU or STORE/CLEAR Key to save your selection.

>AUTO OFF	**ON**
X1/X10	**X10**
0 XING/BASED	**BASED**
EZ-CHECK	**ON**
SINE/SQ	**SQ**
BASIC CONFIGURATION	

Default Settings Shown

AUTO OFF - pressing the knob will toggle between ON and OFF. If AUTO OFF is ON, the unit will turn off after 30 minutes of inactivity to save battery life. If AUTO OFF is OFF the unit will stay on until the ON/OFF key is pressed. Set If you are using the Totalizer functions for over 30 minutes you should set AUTO OFF to OFF.
Press and release the MENU or STORE/CLEAR Key to save your selection.

X1/X10 - pressing the knob will toggle between X1 and X10 attenuation while reading frequency. Choose X1 when you are measuring signals with amplitudes between 0.1 and 12 V peak and X10 when measuring between signals with amplitudes between 12 and 120 V peak.
Press and release the MENU or STORE/CLEAR Key to save your selection.

0 XING/BASED - pressing the knob will toggle between zero crossing and zero based output waveforms. Select zero crossing when the instruments you are calibrating require a waveform that has both positive and negative peaks that are centered around zero. Select zero based when the instruments you are calibrating require only positive signals.
Note: To simulate negative only signals select zero based and connect the red lead to the ground and the black lead to the input connection of the instrument being calibrated.
Press and release the MENU or STORE/CLEAR Key to save your selection.

EZ-CHECK - pressing the knob will toggle between ON and OFF. Select ON to have the highest and lowest measured frequencies recalled by moving the EZ-Check switch on the side of the calibrator to HI or LO. Select OFF and the currently measured freqency will be displayed regardless of the position of the EZ-Check switch.
Press and release the MENU or STORE/CLEAR Key to save your selection.

SINE/SQ - pressing the knob will toggle between SINE and SQ. Select SINE when the instruments you are calibrating require a sine wave and SQ when the instruments you are calibrating require a square wave or pulse input.
Press and release the MENU or STORE/CLEAR Key to save your selection.

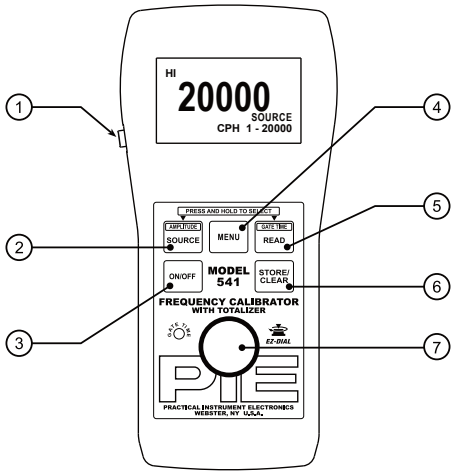
BASIC CONFIGURATION - pressing the knob will restore the 541 to the basic configuration with factory defaults as shown in the menu diagram. Output values stored in the EZ-Check HI and LO positions are not changed.
Press and release the MENU or STORE/CLEAR Key to save your selection.

Note: All settings are remembered even with the power off. Removing the batteries resets the configuration to factory defaults (Basic Configuration) and resets the EZ-Check HI and LO outputs to factory values.

Calibrating Frequency Instruments

SOURCE

Choose this function to provide a frequency signal into flow meters or any input devices that measure frequency signals.



1) Disconnect the input signal from the device to be calibrated.
2) Press and release the SOURCE/AMPLITUDE Key until the desired frequency range is displayed ②.
3) Press and hold SOURCE/AMPLITUDE key to enable amplitude adjustment. Turn the EZ-Dial knob ⑦ to adjust the amplitude voltage from 0.1-12.0 Vp.
   Press and release the SOURCE/AMPLITUDE or STORE/CLEAR button to save your selection.
4) Connect the 541 to the input of the device to be calibrated.

Turn the EZ-Dial knob ⑦ to change the output frequency in increments of one least significant digit. Push down and turn for faster dialing with increments of 100 digits.

Move the EZ-Check slide switch ① on the side of the calibrator up to recall the HI output value and down to select the LO output value.

Storing EZ-Check Outputs

STORING HI and LO EZ-Check Outputs

1) Store your high (SPAN) output frequency by moving the EZ-Check switch ① to the **HI** position and turn the EZ-Dial knob ⑦ until the desired frequency is on the display. Press the STORE/CLEAR Key and **STORED** appears on the display.
2) Store your low (ZERO) output frequency by moving the EZ-Check switch ① to the **LO** position and turn the EZ-Dial knob ⑦ until the desired frequency is on the display. Press the STORE/CLEAR Key and **STORED** appears on the display.
3) Instantly output your SPAN and ZERO frequency outputs by moving the EZ-Check switch ① between HI and LO. You may also select any third frequency output (such as mid-range) using the middle position on the EZ-Check switch.

Calibrating Optical Pickups

Position the optical pickup to be verified over the green GATE TIME LED. The LED is synchronized to the pulse output of the 541. Follow the Calibrating Frequency Instruments section to adjust the output frequency.

Calibrating Totalizers

Choose this function to provide a number of pulses for a set time into parts counters or totalizers.

1) Disconnect the input signal from the device to be calibrated.
2) Press and release the SOURCE/AMPLITUDE Key until TOTALIZER appears on the display.
3) Press and hold the READ/GATE TIME key to enable time adjustment. Turn the EZ-Dial knob ⑦ to adjust the totalize time from 1 to 100 minutes. Press and release the READ/GATE TIME or STORE/CLEAR button to save your selection.
4) Turn the EZ-Dial knob ⑦ to select the number of pulses you would like to output with increments of 1 count. Push down and turn for faster dialing with increments of 100 counts.
5) Connect the 541 to the input of the device to be calibrated.
5) Press the EZ-Step push-button ① like a stop watch to start outputting pulses.

The word RUN will appear on the display and the 541 display increments with each pulse while the totalizer is running. When the selected number of seconds has elapsed the word STOP appears on the display and the total number of pulses sourced during the time appears on the display.

Press the EZ-Step push-button ① like a stop watch to stop or re-start totalizing.

Note: If you are using the Totalizer functions for over 30 minutes you should set AUTO OFF to OFF (see Configure the Calibrator on page 3).

CPM/CPH CONVERSIONS

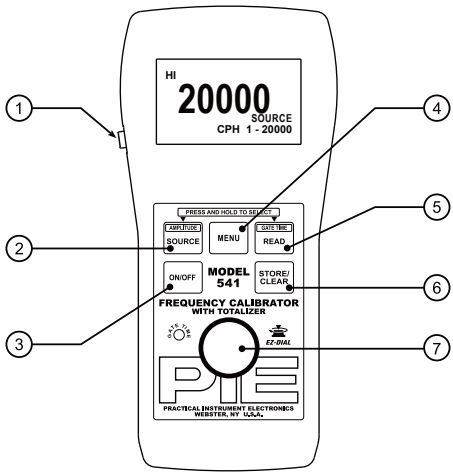
To Convert	From:	To:	Divide By:	To Convert	From:	To:	Multiply By:
	CPM	Hz	60		Hz	CPM	60
	CPH	Hz	3600		Hz	CPH	3600

Measuring Frequencies

READ

Choose this function to measure frequency from flow, vibration sensors or frequency outputs.

1) Disconnect the frequency sensor from any other device.
2) Press and release READ/GATE TIME Key ⑤ to step through the read ranges.
3) Connect the 541 to the output of the device to be calibrated.
4) Turn the EZ-Dial knob ⑦ to adjust the trigger level of the 541. The LED will light when the 541 locks onto the input signal indicating that it is properly detecting the signal.



Totalize (Count Pulses)

Choose this function to verify that parts counters or totalizers are working correctly.

1) Disconnect the frequency sensor from any other device.
2) Press and release READ/GATE TIME key ⑤ to step through the read ranges until TOTALIZER appears on the display.
3) Press and hold the READ/GATE TIME key to enable time adjustment. Turn the EZ-Dial knob ⑦ to adjust the totalize time from 1 to 100 minutes. Press and release the READ/GATE TIME or STORE/CLEAR button to save your selection.
3) Connect the 541 to the output of the device to be calibrated.
4) Turn the EZ-Dial knob ⑦ to adjust the trigger level of the 541. The LED will light when the 541 locks onto the input signal indicating that it is properly detecting the signal.
5) Press the EZ-Step push-button ① like a stop watch to start totalizing.

The word RUN will appear on the display and the 541 displays increments with each pulse while the totalizer is running. When the selected number of seconds has elapsed the word STOP appears on the display and the total number of pulses counted during the time appears on the display.

Press the EZ-Step push-button ① like a stop watch to stop or re-start totalizing.

Note: If you are using the Totalizer functions for over 30 minutes you should set AUTO OFF to OFF (see Configure the Calibrator on page 3).

Model 541 Specifications

(Unless otherwise indicated all specifications are rated from a nominal 23 °C, 70 % RH for 1 year from calibration)

General	
Accuracy	±0.005% of Range
Ranges	0.001 to 20.000 kHz 0.1 to 2000.0 Hz 0.01 to 200.00 Hz 0.1 to 2000 CPM (Counts-per-Minute) 1 to 20000 CPH (Counts-per-Hour
Operating Temperature Range	-25 to 60 °C (-10 to 140 °F)
Temperature Drift	± 0.01% of span outside of 23°C ±10 °C (73°C ±18 °F)
Relative Humidity Range	10 % ≤RH ≤90 % (0 to 35 °C), Non-condensing
	10 % ≤RH≤ 70 % (35 to 60 °C), Non-condensing
Size	7.00 X 3.30 X 2.21 inches (177.8 X 83.8 X 56.1 mm
Weight	12.0 oz (340 grams) (including battery)
Batteries & Battery Life	One "Alkaline 9V (6LR61), 45 Hours
Low Battery	Low battery indication with nominal 1 hour of life left
Protection against mis-connection	Over-voltage protection to 120 Vrms rated for 30 seconds or 240 Vrms for 15 seconds
Display	High contrast graphic liquid crystal display.
Normal Mode/Common Mode Rejection	50/60 Hz, 50 dB/ 50/60 Hz, 90 dB

Read Frequency	
Input Impedance	> 1 Megohms + 100pF
Signal Attenuation Adjustment Range	Adjustable trigger level with X1 (0.1 V peak to 12.0 V peak) and X10 (1 V Peak to 120 V peak)
Note on reading slow sine waves	High signal noise and low slew rate (Volts-per-second) will affect reading uncertainty

Source Frequency	
Output Impedance	< 25 Ohms
Source Current	> 6 mA at 12 V peak-to-peak, 20 kHz
Amplitude Adjustment Range & Accuracy	0.1 to 12.0 V peak ±10% of setting
Square Wave (Pulse) Rise/Fall Time Frequency Jitter Duty Cycle	Selectable Zero Based or Zero Crossing <0.0001% of output V peak per second <0.5 Least Significant Digit of full scale value 50% ±2%
Sine Wave Offset and Zero Crossing Symmetry	 <±10% of V peak output amplitude setting

Accessories

Included:

"9V" Alkaline battery, Certificate of Calibration

Large Carrying Case with PIE Logo Part No. 020-0204

Additional Information

This product is calibrated on equipment traceable to NIST and includes a Certificate of Calibration. Test Data is available for an additional charge.

Practical Instrument Electronics recommends a calibration interval of one year. Contact your local representative for recalibration and repair services.

Warranty

Our equipment is warranted against defective material and workmanship (excluding batteries) for a period of three years from the date of shipment. Claims under warranty can be made by returning the equipment prepaid to our factory. The equipment will be repaired, replaced or adjusted at our option. The liability of Practical Instrument Electronics (PIE) is restricted to that given under our warranty. No responsibility is accepted for damage, loss or other expense incurred through sale or use of our equipment. Under no condition shall Practical Instrument Electronics, Inc. be liable for any special, incidental or consequential damage.